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Recently published on smtonline.com:

Managing Dross in Soldering Processes

Wave soldering involves large volumes of molten solder that are exposed to the atmosphere. Turbulence, oxygen exposure, temperature, and other factors affect dross formation in wave soldering processes. *Keith Sweatman and Keith Howell, Nihon Superior*, advise operators on how to reduce dross.

Limitations of Hansen-Hildebrand with Aqueous Cleaning

While *Harald Wack, Ph.D., ZESTRON*, is encouraged by the numerous pathways of innovation that have developed to meet new cleaning challenges, he is discouraged by one in particular. Recently, Wack witnessed the promotion of Hansen solubility parameters as a means to determine the performance of cleaning agents and processes.

PCB Designers Notebook: Planning for Very-fine-pitch and High I/O Flip Chip

In Part I, *Vern Solberg* covers how flip chips are created and how to work with these devices, small and large. In Part II, he examines PCB design geometries for flip chips and preventing defects. Part III covers preparation for flip chip on PCB assembly.

Detection of Counterfeit Semiconductors: Nondestructive and Destructive Examples

We need to go beyond visual inspection to track down counterfeit components. *Hemant C. Warad, Sakda Sangthamma, Anusorn Sawetwong, and Martin Huehne, Celestica*, describe two examples of counterfeit ICs received from a broker. The counterfeits were intercepted by a counterfeit detection procedure routinely applied to every purchase of electronic parts from a broker. The successful detection of the counterfeiting was based on optical inspection of the package, X-ray imaging, C-SAM, and optical inspection of the die after decapsulation.

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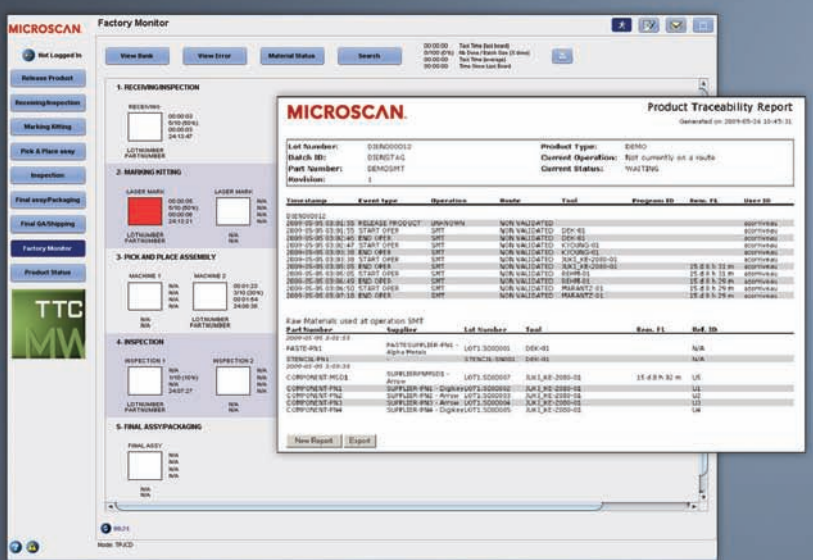

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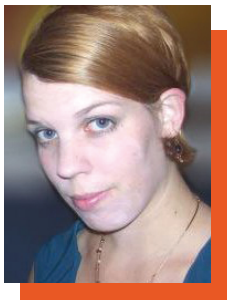
How Do You Clean PCB Assemblies?

As part of this issue's cover story, p.6, we queried readers about your PCB cleaning habits. Cleaning equipment is a significant investment for an SMT line, and the cleaning materials, water treatment, and other recurring costs can also impact a facility's bottom line. We wondered if assembly houses are getting the most return for their investment in cleaning systems, and how cleaning was adopted. What assemblies do you clean? How often do you clean PCB assemblies? We discovered that, while most participants in the survey do, not surprisingly, have cleaning as part of their SMT line, this is where the trends stop.



Nearly half of the readers that participated in the survey (48.9%) perform prototype and few jobs, less than a quarter of their total production, or nearly all of their jobs. Of the responses we received, 35.2% of manufacturers clean very few jobs. At the other end of the spectrum, 30.2% are cleaning 75% or more of their production boards. In the middle group, 34.5% of respondents clean around half of their jobs. We expect that this division depends on the reliability ranking of the respondents: high-reliability manufacturers might clean 100% of their assemblies, whereas a high-mix EMS provider might only clean circuit boards to meet the specs of two small customers. It may also represent a shift in the perception of cleaning as relegated to the military/medical sectors. Companies cleaning less than 50% of their jobs may have just begun using cleaning steps for some products, where before they wouldn't have cleaned any assemblies. In this case, cleaning system utilization could be improved by collaborating on process optimization with cleaning product suppliers.

"Reader survey respondents make everything from medical to cell phone assemblies. And not every electronics manufacturer cleans all assemblies equally."

We didn't expect the answers we received for the last question on the survey, "Do you clean no-clean assemblies?" Surprisingly, the majority of respondents (55.3%) do put no-clean PCB assemblies through the cleaning step. Why is this? Is no-clean solder/flux not successfully providing reliability by encapsulating contaminants? Are process specs set up without considering the effect of cleaning on no-clean, assuming that cleaning will always improve finished assembly quality?

We'd like to hear your thoughts on the subject. Email *SMT* at mcourtemanche@pennwell.com, and fill us in. SMT

Meredith Courtemanche,
Executive Editor

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SN100C (040) Solder Wire

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Mr. Tetsuro Nishimuro, Pres., Nihon Superior
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SN100C (040) Halogen-free flux-cored wire is an effective solution in preventing Sn whiskers that result from solder surface corrosion. In testing, no Sn whiskers were observed when exposed for 1,000 hours under the condition of 85C°/85% temperature and humidity, while other so-called halogen-free cored-fluxes generated Sn whiskers. Completely halogen-free: No intentional halogens of F, Cl, Br or even I hidden or locked in chemistry. Delivers silver-free stable microstructure; accommodates long-term and impact solder joint strain.

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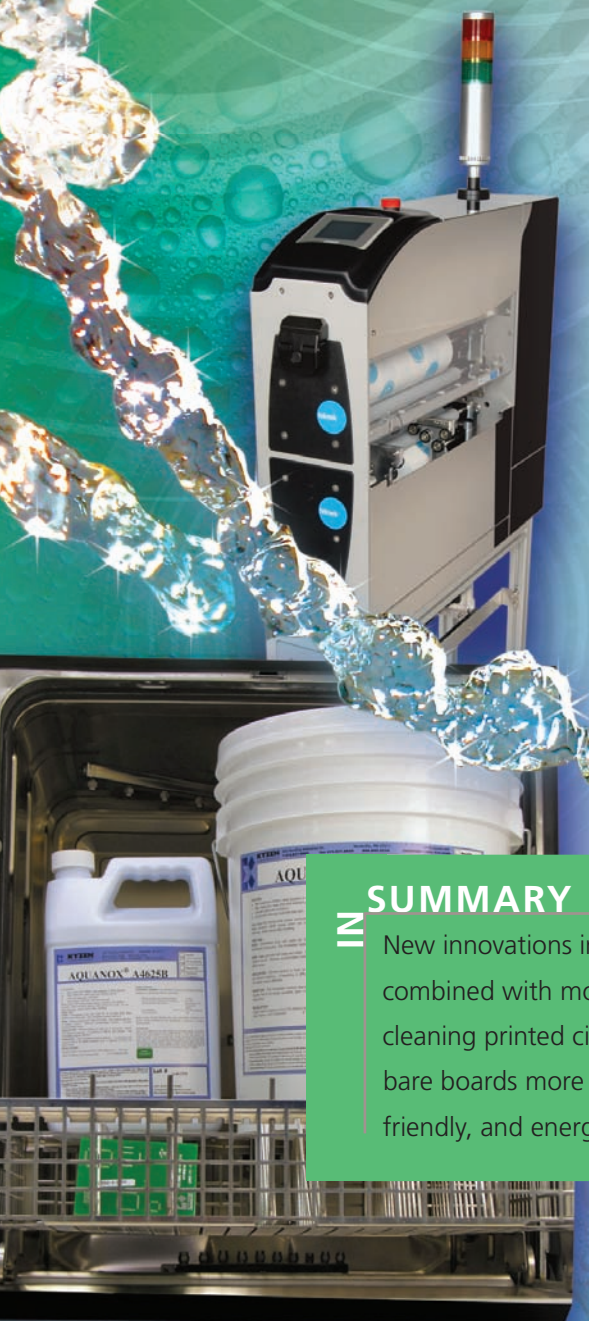
Making PCB Cleaning More Energy Efficient

BY **Pete Singer**, SMT



Most of the challenges in cleaning printed circuit boards (PCBs) are well known. Solder flux residue and contaminants must be completely removed from densely populated circuit boards, including beneath components that are close to the board (i.e., low standoff). Cleaning equipment, chemicals, and processes have evolved over the years to accomplish this quite satisfactorily. There are even no-clean solders and fluxes that are designed to eliminate the need for cleaning (although many people still clean them anyway, according to our reader survey, the results of which are presented throughout this article).

What's new is the push to ever greener, more energy-efficient methods to PCB cleaning/defluxing. Equipment is smaller and less power-hungry; cleaning chemistries are more environmentally friendly; recycling of water and chemicals has become the norm. Of course, the best energy savings is found when the clean is completed in one step. The perfect clean? "No white residue, no residues in tight gaps or blind holes, with lead-free and organic acid (OA) residues removed along with good material compatibility," according to Tom Forsythe, VP, Kyzen.

IN SUMMARY

New innovations in batch and in-line systems, combined with more effective chemistries, have made cleaning printed circuit boards (PCBs), stencils, and bare boards more cost-effective, environmentally friendly, and energy efficient.

Batch vs In-line

When it comes to cleaning/defluxing equipment design, there are two fundamental machine formats: batch and in-line. Suppliers of each type claim that their approach is best when it comes to energy efficiency, and there has clearly been progress on both sides. Michael Konrad, president of Aqueous Technologies, said that there have been significant changes in the design of batch machines, to the point where it a "complete evolution." He said that in the past, batch cleaning systems were "little more than dishwashers," lacking in both cleaning power and throughput. "While there are still examples of that, many batch-format cleaners have been transformed into high-power, high-throughput defluxing machines. Modern batch-format cleaning systems provide an environmental advantage to in-line counterparts," he said.

Konrad said that best-in-class batch cleaning systems feature built-in, real-time cleanliness testing capabilities. "This feature provides two distinct advantages: consistent predictable cleanliness, and a reduction of water usage because the system automatically stops the cleaning process when the assemblies are measured to be clean." Without such a feature, most users "over-clean" the assemblies to compensate for process variables.

Like in-line cleaning systems, batch-format cleaning systems may also feature wash-solution recirculation systems, which capture and reuse the wash solution. "Unlike in-line systems, batch cleaners have extremely low drag-out volumes and

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Trident QUAD

Aqueous Technologies

Michael Konrad, President, Aqueous

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Aqueous Technologies

Rancho Cucamonga, CA USA
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almost no evaporative losses. The reduction of both drag-out and evaporation allow the wash solution, and the defluxing chemical it contains, to remain in the machine, almost eliminating the chemically-charged wash solution from being directed to the drain. Because of their low chemical and water usage, batch-format defluxing systems are easily configured into zero-discharge models via evaporative or ion-exchange technologies," Konrad said.

An equal amount of progress has been made on in-line systems. "Long gone is the day of the 40 foot behemoth in-line cleaner that dims the lights every time you run boards," said Austin American Technology Corp.'s representative. "Today's in-line cleaners utilize energy much more efficiently because of new developments like progressive energy fluid delivery for faster washing and rinsing." He adds that new drying technology uses un-heated jet manifolds to replace multiple air knifes and heated sections. "These changes have allowed in-line cleaners to shrink to less than half their original length, while improving performance. The end result is less than one half the cycle time and a quarter of the energy to clean a board than ma-

Read More about Cleaning on SMTonline.com

- Harald Wack, Ph.D., ZESTRON, *The Future of Cleaning OA Fluxes*, SMT, September 2009. Cleaning temperature and cleaning chemistry concentration can be manipulated to meet cost and cleanliness requirements for the majority of solder pastes. Experimental results are presented here.

- Mike Bixenman, D.B.A., Kyzen, *Eliminate Trial and Error When Cleaning Advanced Packages on PCBs*, SMT, May 2010. Cleaning materials developers must study the soils found on common PCB assemblies and produce cleaners that will attack residues effectively without damaging component bodies, PCBs, labels, or solder joints.

- Harald Wack and Joachim Becht, Ph.D., ZESTRON, *Cleaning No-clean Solder and Flux*, SMT, March/April 2010. Are no-clean soldering processes really more cost-effective or reliable enough for a given application?

- *IPC Standard Helps Define How Clean Is Clean*, SMT, February 2010. A new cleaning standard, IPC-5704, Cleanliness Requirements for Unpopulated Printed Boards, defines the recommended requirements for the cleanliness of unpopulated single, double-sided and multilayer PCBs.

Visit the Cleaning Center on SMTonline.com for these and more articles about cleaning equipment, materials, and cleanliness testing technologies.

chines built just 10 years ago," he said. "Batch cleaners have not made the same leap forward in power reduction as achieved in the last 10 years with in-line cleaners. In general, batch cleaners have grown larger and more complex to meet modern cleaning challenges. On the positive side, some new batch cleaners do offer lower power by using three levels of coherent jet manifolds for more efficient fluid energy delivery."

Konrad adds that due to smaller footprints, smaller sump sizes and the ability to heat only on demand, today's batch cleaning systems require only 20-30% of the required energy over in-line models.

Cleaning Chemistries

Beyond the cleaning system, the "chemistry" of the cleaning process (i.e., the type and concentration of the chemicals used) can also dramatically impact energy efficiency. Selecting an energetic chemistry has several advantages, according to Harald Wack, Ph.D., president of ZESTRON. "First, chemistry-assisted cleaning allows for a reduction in energy through lower operating temperatures, i.e., 120°-140°F versus 150°-160°F. Second, studies have shown that with the introduction of chemistry, energy can be conserved by operating at higher belt speeds, which lead to less machine operation. Third, close looping the cleaning process (versus cascading DI-water) saves energy by preserving heat in the cleaning bath. Fourth, filter technologies can extend the bath life and vapor recovery devices significantly reduce the amount of chemistry consumed," Wack said. "If implemented properly, energy savings made possible by using chemistry will be maximized."

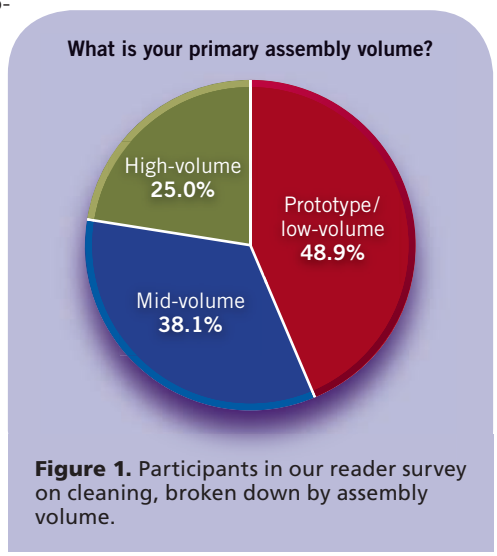
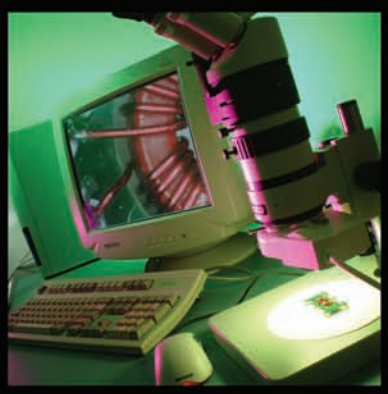


Figure 1. Participants in our reader survey on cleaning, broken down by assembly volume.

Austin American Technology's rep adds that cleaning chemistries have continued to improve allowing lower temperatures for traditional flux removal. "This is largely offset by the recent change to higher temp lead-free fluxes, which require longer/hotter cycles because they are more difficult to clean," he said.

Vapor Degreasing

While most PCB cleans are done on batch or in-line water-based systems, recent improvements to vapor degreasing systems make it an attractive alternative, at least when it comes to energy efficiency. Mike Jones of MicroCare Corp. said that, for decades, the vapor degreasing process has proven to be "a consistent and headache-free" cleaning process.



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Kyzen Corporation

Tom Forsythe, VP & Director, Kyzen Corporation
Karen Watkins, Publisher, SMT
Meredith Courtemanche, Executive Editor, SMT

AQUANOX® A4703 is the first cleaning chemistry to achieve three out of three key challenges: Cleans, Economical & Eco-Friendly! The key cleaning industry challenge has remained how to clean a large number of very difficult lead-free and no-clean soils in our industry with an economical and eco-responsible material. Two of three goals had been reached, but AQUANOX® A4703 is the first to achieve all three. AQUANOX® A4703 was developed by Kyzen chemists in response to customer needs for a neutral product that works. The solution has effectively removed 300 soldering materials from the world's leading suppliers.

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"But now engineers are choosing vapor degreasing because it is more economical and environmentally acceptable than other cleaning processes. In particular, the low energy consumptions of even large vapor degreasers are generating an increased interest," he said.

Jones said that, in general, vapor degreasers out-perform aqueous cleaning systems due to three main factors. First, vapor cleaners tend to be smaller than aqueous systems, because their brisk cleaning cycles enable a smaller machine that can still deliver the required throughput of clean parts. Solvent systems also avoid the need for the secondary water-treatment systems that most aqueous cleaning systems require, thereby avoiding many energy-hungry subsystems.

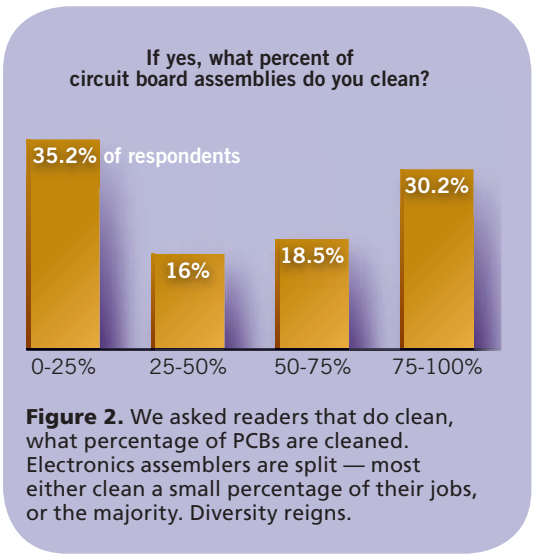

Figure 2. We asked readers that do clean, what percentage of PCBs are cleaned. Electronics assemblers are split — most either clean a small percentage of their jobs, or the majority. Diversity reigns.

Secondly, the cleaning process uses little energy. The solvent is heated to lower temperatures than aqueous systems — and heating water is very energy-intensive. Lastly, the low-boiling solvents evaporate from the parts being cleaned while aqueous systems require air knives, extra heaters, or drying ovens to ensure the parts are completely dry. "If a current aqueous cleaning system is reaching the end of its life cycle, now is the time to explore vapor degreasing as an alternative in your manufacturing plant," Jones declared.

Other Cleaning Processes in SMT Assembly

Populated PCBs are not the only products in an assembly line that need cleaning, of course. Stencils used to apply solder paste also need an effective clean, and the opportunity to optimize energy efficiency and environmental impact exists here as well. In fact, Bill Schreiber, president of Smart Sonic, said that stencil cleaning has been identified as "the most hazardous process with the greatest potential environmental impact associated with SMT assembly." Why? Wastewater evaporators are often used to manage the liquid hazardous waste, boiling away the wastewater with high-powered (12 kW) electric heaters. That's not a problem with Smart Sonic's EnviroGuard Closed-loop Stencil Cleaners, which eliminate the heating process completely with an energy-efficient closed-loop filtration system. Schreiber said the EnviroGuard matches the unique properties of 440-R SMT detergent to a specifically designed filtration/UV system that facilitates 100% closed-looping; zero VOC emissions; and cleaning all types of solder paste and flux residues from stencils, pallets, oven radiators and misprinted PCBs. "The liquid hazardous waste never exits the system since 99% of the waste solder paste is captured for easy recycling. The remaining 1% is removed by the filtration system," he noted. Like a wastewater evaporator, the filtration system is "zero discharge" but operates on a fraction of the energy, requires no venting, and reduces maintenance. All water (wash and rinse) is reused rather than boiled to atmosphere. "EnviroGuard reduces electrical consumption by thousands of kilowatt hours daily," Schreiber asserted.

Another way to increase a stencil cleaner's overall energy efficiency is to boost the clean's mechanical energy through the use of ultrasonic energy, which helps to dislodge solder spheres from fine-pitch apertures. Michelle Ogihara, sales & marketing manager at Seika Machinery, says her company's portable Sawa Ultrasonic Stencil Cleaners reduce cleaning time to two minutes, including drying. Also, DI water, non-VOC solvents or regular IPA, etc. may be used, depending on the type of solder paste or adhesive. "Because very little solvent is required, there is little liquid waste disposal or solder catcher concerns," she said.

Another target for cleaning: bare boards. "Effective removal of surface particle contamination prior to the solder paste print process will improve first time pass, increase yields, and reduce rework/wash offs, making the line more process efficient and reducing batch production times while also reducing overall energy consumption," said David Westwood, general manager, Teknek. He said the company's low-energy, high-performance SMT bare board cleaning machine does not use chemicals, high-velocity air or vacuum, which by comparison are high energy and low performance in removing the small particles that can lead to print defects, loose solder balls, dry solder joints, and tombstoning. "Customers report AOI failure rates improving from 9.5% to 5% following the installation of a Teknek machine. Others report saving up to 300 boards per month per assembly line. Extrapolate this over the last 10 years and over 1500 Teknek machines installed globally has potentially saved the assembly industry over 1 billion boards. The associated cost to produce this number of boards therefore represents a massive saving in energy and materials," Westwood said.

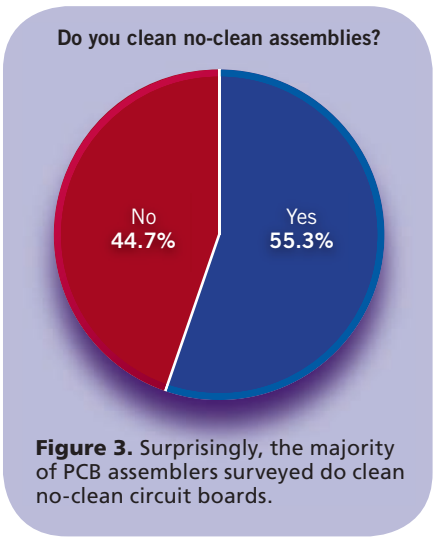

Figure 3. Surprisingly, the majority of PCB assemblers surveyed do clean no-clean circuit boards.

Conclusion

Whether using batch, in-line, or vapor degreaser PCB assembly cleaning equipment, electronics assemblers have more options to save energy via smart water and electricity management.

Cleaning materials have undergone radical changes due to environmental restrictions and changes in solder alloy formulations. Cleaning chemistries that work at lower temperatures and in lower concentrations can improve the energy draw at PCB cleaning.

Elsewhere on the line, stencil cleaners and circuit board cleaners are being designed to cut out hazardous materials and inefficient processes. SMT

Pete Singer, editorial director, *SMT*, may be contacted at (603) 891-9217; psinger@pennwell.com.

Leaders in SMT
Kyzen Corporation

Q: How are new cleaning chemistries different from the earlier formulations?

The short answer is that today's materials mostly work much better than earlier formulations. Keep in mind that while the latest no-cleaning innovations can be challenging for older, legacy technology, those same older materials work well on rosin flux just like they did 20 years ago. There are many frozen designs out there, still using rosin, that are still economically and effectively cleaned with older technology. When I say the new materials work better, I mean better, cheaper (to operate) and faster, along with ever improving eco-friendliness. Kyzen has been offering eco-friendly materials for 20 years. We continue to lead in this area with our latest triple award winning neutral AQUANOX® A4703, paired with our award winning low alkalinity AQUANOX® A4625 and AQUANOX® A4241. Neutral and low-alkaline materials are safe for your staff, parts, and the environment, unlike older technology that is frequently corrosive and hazardous.

Tom Forsythe's professional focus has been on cleaning technology since the late 1980s. A well published and recognized expert, Tom is a frequent contributor to technical programs and industry publications. He is currently a member of the SMTA Global Board of Directors, as well as VP of Communications. Tom also has been an advisor to the SMTA China Board of Directors for several years. He is vice president and director of Kyzen Corporation and resides in Nashville, TN.

Q: Are today's cleaning chemistries harmful to the environment?

The most modern products tend to be low alkalinity or neutral materials. Both categories include very biodegradable technologies that are very compatible with the environment. The challenges facing the new technologies are vastly different than those of even 10 years ago. The soils are new and challenging, the economic environment is tough, and manufacturers globally are far more open and enthusiastic about eco-friendly technologies. Kyzen continues using renewable resource materials whenever possible, as has been our practice for all our 20 years.

Of course, the real key is the notion of kaizen, which means continuous improvement. We at Kyzen consider this essential to the success of our customers, and if they succeed, we succeed. We invented modern aqueous materials that were not high alkalines, corrosive materials with short tank life, and poor compatibility with components and packages. For the past 10 years in particular, as new no-clean solders, leaded or lead-free, with or without halides or halogens, emerge, Kyzen has led the way with a steady stream of innovative new products. In fact, the day a new product is introduced, work begins on the next generations. After all, the name Kyzen is derived from that Japanese word, kaizen. At Kyzen, it is more than just an idea or concept, it is who we try to be every day for our customers.

Q: What can an assembler do to optimize cleaning?

Any manufacturing process requires good design and implementation to be successful. While cleaning expertise is in short supply, our customers are safe. Kyzen's Technology Team won its first award years ago. It is simply what we do; optimize our customer's processes and deliver value. Of course, the customers' manufacturing operation is an expensive place to shake out and enhance process design of any kind. Kyzen has been a leader with our Applications Laboratories around the world, supported by the best Analytical Laboratory to help complete this work rapidly and effectively.

Q: What are the dangers of a poorly cleaned PCB?

The end users' expectations of reliability and longevity are the key to deciding what should be cleaned. As consumer electronics continue their ever increasing technical sophistication and capabilities, consumers are also demanding greater value. That is why the demand for cleaning is increasing; the end user is demanding superb design and robust useable life. There have always been market segments that clean: medical, military, and other high-reliability devices. That list is expanding because field failures are expensive and bad for business. Moisture, contamination and current are all that you need to cause a field failure. Cleaning removes that contaminant and its risk of causing an expensive field failure.

Anti-Counterfeiting Protective Measures

IN SUMMARY

This article provides information on the various types of counterfeit semiconductors on the market, and methods to prevent counterfeits from ending up on finished assemblies.

George Karalias, ROCHESTER ELECTRONICS

As the semiconductor industry has grown, so too has the sophistication of counterfeit semiconductors. The fraudulent manufacturing, distributing, and selling of fake and substandard semiconductors reflects negatively on reputable component manufacturers and distributors. The counterfeit industry also causes purchasing dilemmas for component buyers, problems for equipment manufacturers, and trouble for equipment operators. In worst-case scenarios, counterfeit incidents can drive manufacturers out of business, or result in catastrophic equipment failure disasters.

The Semiconductor Industries Association (SIA) anti-counterfeiting task force has defined counterfeiting as a substitution or unauthorized copy of a product; a product produced by someone other than the original manufacturer in which the materials or the performance has been changed without notice, and/or a substandard component misrepresented by the supplier.

The Supply Chain

Any product that is not supplied directly from the original manufacturer or their approved distribution channel is subject to quality questionability. This applies specifically to components that are purchased through unauthorized sources. Because they are unauthorized, these sources provide no product traceability, no approved quality control, and no manufacturer's guarantee. OEMs in need of critical semiconductors, especially end-of-life components, can be tempted to procure parts that show an initial cost savings or shorter lead times. However, these components are prone to have a high failure rate.

Even incorrect handling of potentially "good" semiconductors can introduce weaknesses and early failure due to contamination or electrostatic discharge (ESD), as well as assembly problems due to incorrect dry packaging. The original manufacturers and their authorized distribution partners understand these problems and take steps to prevent them. The original manufacturers choose their distribution outlets carefully and, from time to time, audit them to ensure their storage and handling protocols are up to date.

Dollars and Sense

The cost of active products supplied from an unauthorized source is sometimes less than it would be from the original manufacturer, except, perhaps, during an original product shortage or in the case of end-of-life products. When purchasing critical semiconductor devices, consider "total cost" instead of pricing. If the purchase price is a bargain, it is probably too good to be true. In the end, the use of faulty counterfeit devices can cost significant manufacturing downtime and/or end product failure. In a safety-critical operation, consequences may be disastrous. These potential end-cost scenarios significantly outweigh any front-end savings.

In addition to monetary losses from production downtime or recalled equipment failures, counterfeit component problems also damage the reputations and credibility of genuine semiconductor manufacturers as well as the OEM.

Figure 1. Component inspection and test will help determine validity.

Future business partners seek alternative opportunities when troubles arise.

Types of Counterfeiting

The semiconductor industry is a global industry with worldwide manufacturers, subcontractors, distributors, and customers. There are many ways counterfeit devices are produced.

Total counterfeiting. Semiconductors are manufactured by a counterfeit operation to look like and function in the same manner as the genuine devices. Quality

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and proper handling are not priorities.

Manufacture at subcontractors (product "skimming"). Semiconductor companies that are fabless rely on subcontractors for device fabrication, and/or assembly and testing of devices. Subcontractors may over-produce or claim a lower production yield than their actual output. The extra devices are then introduced through unauthorized brokers and distributors across the gray market.

Inadequate control during disposal of scrap and rejects. Rejected devices are identified at various stages throughout the manufacturing operation. The rejected devices are sent to recycling or reclamation companies for precious-metals salvage. These operations provide certification to the original manufacturer that scrapping was accomplished. However, salvagers sometimes provide the certification without scrapping the devices, which they then sell into the counterfeiting chain.

Reclamation of used components. Vast quantities of electronic equipment are scrapped each year — dumped in landfill sites or processed through salvage operations for their precious metals. This equipment, however, still contains working semiconductors, some of which are removed for sale on the gray market prior to the final recycling operations.

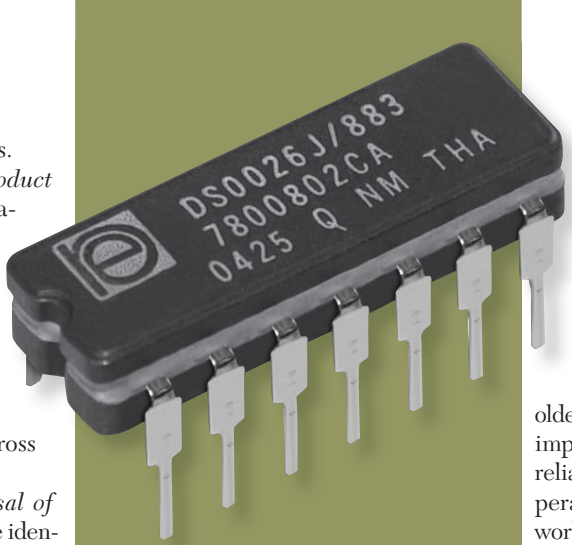

Figure 2. The package encapsulant is not an ideal surface for complex marking, but processes are improving.

Re-branding to sell at higher cost. Certain counterfeiters target components that are highly priced because of performance requirements and/or the need for stringent testing operations in the manufacturing flow. Examples are devices that must operate at extended temperature ranges, such as in industrial or military applications; or the higher speed versions of memories and processors. Counterfeiters obtain the lower-cost, lower-specification versions, re-mark them, and sell them at the higher price.

Falsely claiming conformance for legislative standards (e.g., RoHS). Legislation such as RoHS in Europe and China bans the use of certain hazardous materials. Counterfeiters provide paperwork stating that devices are compliant with the legislation when, in reality, the devices are non-compliant.

Anti-counterfeiting Measures

Counterfeit products enter the market supply chain through the sales brokering networks that exist to source and supply difficult-to-find products. It is extremely rare for counterfeit devices to be supplied by an authorized manufacturer or distributor.

Size and complexity make identifying and detecting counterfeit semiconductors increasingly difficult. The encapsulation of many devices is too small a surface to allow sophisticated marking techniques, and counterfeiters find it relatively easy to replicate the original manufacturer's markings on older, larger-packaged devices. It is virtually impossible to screen every device for high-reliability, high-performance, and high-temperature qualifications. In addition, paperwork intended to guarantee compliance can be easily forged.

Three types of testing are required to check for counterfeit product. In visual checking, people inspect the device paperwork/documentation, device packaging, and device marking and appearance. Initially, this can be carried out by the buyer, but, if there is any inconsistency or uncertainty, the original manufacturer must be involved. Some disassembly of product may be necessary to check the last two items. Electrical testing typically requires help from the original manufacturer. While there are independent test houses that can check electrical performance, they are unlikely to be able to test a device exactly the same way it was tested by the original producer. Finally, reliability testing is a complex exercise and one that takes considerable expertise, equipment, and time.

Development of identification technology is an emerging process. Original semiconductor manufacturers are working on various sophisticated techniques for semiconductor device marking. One example is hidden encrypted, on-chip performance designation and more sophisticated coded marking.

Figure 3. Counterfeiting can occur when the supply chain is not secure and assemblers look to the gray market to match their demand. Non-authorized distribution can be discouraged by a strong procurement process.

Another example is radio frequency (RF) tagging of devices and packaging.

There are ways that manufacturers and customers can address the problems of counterfeiting and legally protect themselves from the counterfeit operations. Original component manufacturer's (OCM's) can legally register their trade and product branding marks. Technologies can be patented, and chip designs can be registered. Counterfeiters will ignore all of these legal entities unless they see registrations being enforced, prosecutions being successful, and sufficiently punitive penalties being imposed. In addition to only purchasing directly from the original manufacturer or their authorized and franchised sources, OEMs must create and manage an effective procurement process. Historically, there has been reluctance from both OCMs and OEMs to report instances of counterfeit activity. Until the industry openly admits the problem is occurring, makes the enforcement authorities aware of the problem, and works together to address the problem, counterfeiting will continue to grow. More recently, both original and contract manufacturers have revealed specific instances of counterfeit part usage in an effort to work together to identify counterfeiting instances and prosecute offending sources and manufacturers.

In the U.S., the SIA now recognizes counterfeiting as a major threat to the sustainability of their industry. In 2006, they established an anti-counterfeiting task force to address the problem, raise awareness, and develop countering methods and procedures. Recognizing that they cannot achieve success through their efforts alone, they proposed working with other trade bodies such as the National Electronic Distributors Association (NEDA), and legal authorities such as the Department of Defense (DoD). Since the counterfeiting epidemic is a global phenomenon, it is vital for trade associations and legal authorities worldwide to communicate and support the fight against counterfeiters.

Conclusion

Semiconductor counterfeiting damages the industry by destroying the credibility of the legitimate manufacturers and distributors, as well as the OEMs that unintentionally use counterfeit devices and experience equipment failures. To date, there have been few cases of successful counterfeit prosecutions.

Only with global cooperation between industry members and governments will anti-counterfeiting efforts be successful. If devices are procured from a questionable source, the risk of receiving damaged or counterfeit devices is high. Without continuous traceability, a device must be subjected to the fullest extent of comprehensive, supplier-approved testing, especially if the devices are to be used in mission-critical situations. Ultimately, there are only two fail-safe ways to ensure that the components being purchased are legitimate: buy directly from the original manufacturer or enlist the help of authorized distributors and manufacturers. SMT

George Karalias, the director of marketing and communications at Rochester Electronics, may be contacted via sales@rocelec.com.

Designing In Thermal Management

IN SUMMARY

In the case of mixed-signal, analog, and mostly analog boards, special attention must go to careful thermal analysis. The PCB designer performing the thermal analysis must best to deploy certain design steps and techniques to maximize heat dissipation through component and board levels.

BY **Zulki Khan**, NEXLOGIC TECHNOLOGIES INC.

Thermal management determines and implements methods to transfer the heat PCB components generate away those devices to other sides of the board or eventually into the ambient. Historically, the well-proven heat sink has been the stalwart for board heat dissipation. Today, thanks to new technologies, it continues to dissipate even greater heat more efficiently.

However, with the complexity of today's boards, the PCB layout engineer must think well beyond implementing state-of-the-art heat sinks. For example, take a board with considerable analog circuitry. The PCB designer must first focus on special board requirements, conduct a thermal analysis, then design the board considerating factors that will increase heat dissipation.

Thermal Analysis

Let's take a board design with analog circuitry intended for a DC-to-DC conversion application. Included are a power amplifier, high-performance LEDs, and analog ICs that demand considerably more power. Analog signals carry heavy loads of current, as well as high voltages. When this current passes through physical conductors, it creates considerable heat. Increasing integration of analog functions on a system-on-a-chip (SoC), for example, continues to escalate the need for thermal dissipation.

LEDs pose yet another heat dissipation challenge. LEDs in automobile, industrial, commercial, medical, and other applications continue to grow dramatically. LEDs by their very nature create considerable heat. Special thermal management must be applied to properly dissipate this heat. Here, the experienced PCB designer places special emphasis on a "thermally challenged board." This means the board has a number of areas where heat is being generated and needs to be dissipated.

The PCB designer focuses on the component and board levels to dissipate heat. For the past several years, component manufacturers have significantly contributed in this regard by producing thermally friendly packages. They're taking a page from PCB fabrication structures to build up packaging laminates to increase thermal performance superiority.

For example, a BGA may have 2, 4, or 6 laminate layers. These multi-layer laminates contain internal ground planes connected to thermal vias under the silicon die. In effect, component manufacturers are helping to dissipate the heat before it goes further into a board.

A TO72 package is another good example of how packaging can increase heat dissipation. An alloy used as a heat sink dissipates the heat directly off the component body. However, in most cases, even with these packaging advances, thermal management continues to be challenging to the contract manufacturer (CM) or EMS provider, especially when it comes to analog components.

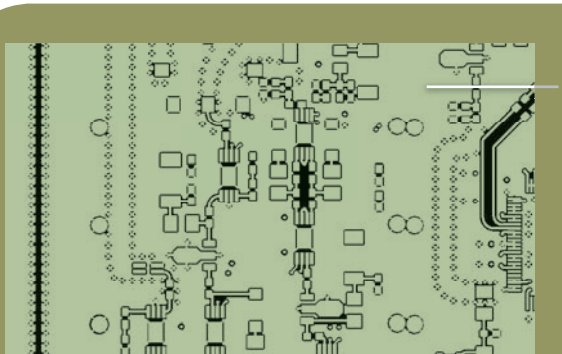

Figure 1. PCB ground pour is a means of spreading heat to the atmosphere.

Beyond component heat dissipation techniques, the traditional heat sink attached to a thermal-intensive component is the best-known method for dissipating heat. Heat sinks are continually improv-

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DEVICE PROGRAMMING

FlashCORE III

DATA I/O Corporation

Phil Christenson, Dir. of Mktg, Data I/O
Karen Watkins, Publisher, SMT
Meredith Courtemanche, Exec. Ed. SMT

FlashCORE III programming architecture allows you to keep your production processes running at maximum velocity for devices and files of any size. Maximized production rates: Read and write speeds near theoretical device limits, and extremely fast downloads over Ethernet. Smart investment supporting production processes now and in the future: Supports latest device types and sizes, including MoviNAND, OneNAND, iNAND, e-MMC and more. Support for files > 4 GBytes (32 Gbits). Save time and money: Works with all algorithms, adapters, and software solutions created for previous FlashCORE programming engines.

Data I/O

Redmond, Washington USA
www.data-io.com

ing with different materials and alloys.

When the PCB designer plans component placement during the layout phase, he needs to review the amount of power that is being generated by these components and then perform the critical thermal analysis and develop a strategy for implementing it.

Thermal analysis involves defining areas of the board where extreme heat is being created. A straightforward rule is not to physically localize heat-generating components in one PCB location, but to spread them out evenly on the board, if possible. An experienced CM or OEM PCB layout engineer ensures that digital and analog components are properly separated.

The designer takes one further step to ensure all analog components are not placed right next to each other. Otherwise, the amount of heat those clustered analog circuits generate will create individual problems, and have a ripple effect throughout a system, especially when used in rugged environments. Therefore, heat being generated in an analog segment must be dissipated to minimize or at least effectively spread it out.

Evaluating and selecting the right heat sinks is a major part of this analysis. In some cases, special heat dissipation considerations are factored into thermal analysis. For example, the PCB designer may not have the luxury of using tall heat sinks if it's a small board going into a handheld product. In those cases, designers must deviate slightly from this heat dissipation method and search for other techniques to cool the PCB.

Another important factor to consider is what application the PCB targets. Is it purely analog? Is it only digital? Or is it mixed signal? If it's purely digital, there aren't too many components generating inordinate heat, so thermal analysis can be fairly straightforward. The challenge comes when it's a mixed signal, completely analog, or mostly analog PCB. At this point, the PCB designer performing the thermal analysis considers how best to deploy certain design steps and techniques to maximize heat dissipation through component and board levels.

Thermal Management and Miniaturization: Collision Imminent

Dr. John Parry, Mentor Graphics

There is a strong case to be made for considering thermal management from the outset of almost every electronic product design project. Why? Because most everything electronic is getting smaller, and thermal management and miniaturization are on a collision course.

Historically thermal management has been the realm of the mechanical engineer, deploying thermal management solutions after the electronic design has been completed. At the enclosure level, cooling fans can be included in the chassis. At the PCB level, small clip-on heat sinks can be attached selected packages. The afterthought approach has been generally satisfactory until recently.

Power density is increasing as miniaturization reduces the size of silicon chips and their packages, and PCBs and their enclosures. The traditional thermal solutions hamper potential miniaturization. Heat sinks take up space (especially when keep-out regions are considered), fans too use space and consume power from the power supply, and both add weight and cost to the product.

Considering thermal design from the outset can save a lot of time and cost later on, and ultimately lead to quieter, cheaper, and more reliable products. If fan cooling can be avoided, then operation will be silent and the product more reliable, as fans are prone to failure. Clip-on heatsinks may offer a convenient afterthought solution for components that are just a bit too hot, but become an Achilles' heel for reliability as their size increases; they can actually unclip under shock and vibration and increase solder joint fatigue.

Leading electronics companies consider thermal design from a project's outset, typically using computational fluid dynamics (CFD) software dedicated to electronics cooling. CFD analysis can involve 'what-if' simulations to evaluate different cooling strategies for the enclosure before the architectural design is complete, and PCB-level simulations prior to layout closure. Instead of performing multiple PCB re-spins to achieve thermal verification, most companies do just one re-spin and complete their thermal verification in about 1/3 of the time taken by other companies. Thermal modeling and simulation tools can attenuate the verification process, arguably the number one cause of late deliveries for new products. Timely thermal design in the overall product creation process is the best way to avoid costly collisions between shrinking devices and their cooling solutions.

Dr. John Parry, CEng, business development manager, Mechanical Analysis Division, Mentor Graphics Corporation.

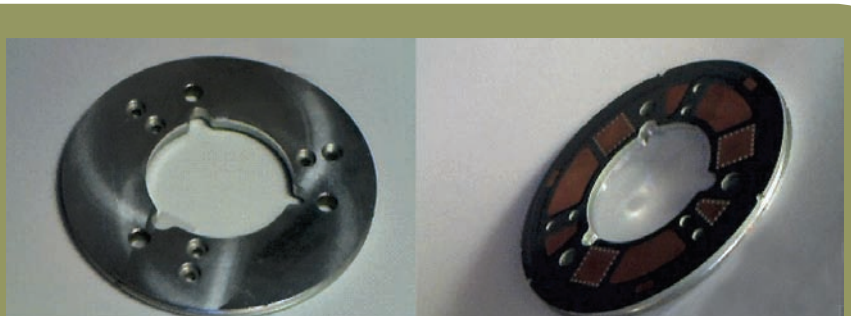

Figure 2. Metalcore PCB with an aluminum base.

Designing In Thermal Management

While there is a number of considerations an experienced PCB designer applies for thermal management, the essential design steps for effectively dissipating heat are:

- Properly distributing analog circuitry throughout the board.
- Effectively using ground pour on the circuit board.
- Strategically deploying thieving, when it is possible.
- Considering a metal core (MC) board, if applicable to the situation.
- Creating more solid planes for transfer of heat.
- Selecting the proper heat sinks and attachment process.
- Using thermally conductive grease, when applicable.

Here, the experienced PCB layout engi-

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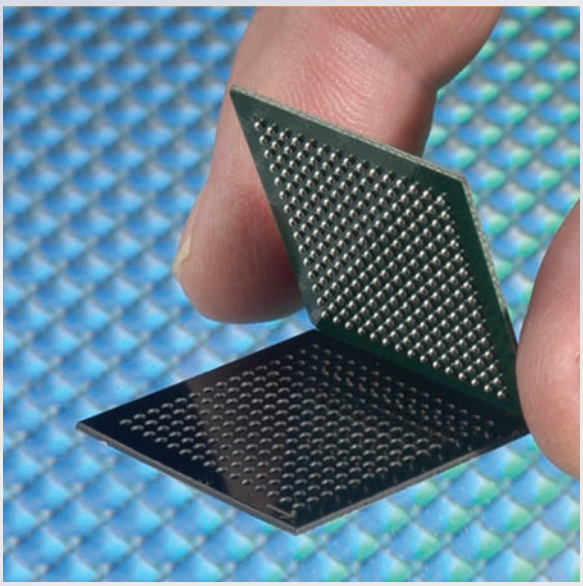
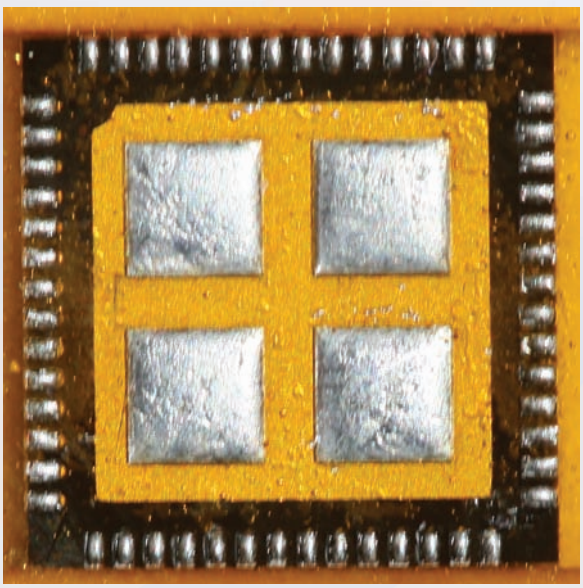
REWORK AND REPAIR

StencilMate™

BEST, Inc.



EZReball



StencilMate

BEST, Inc. is a group of soldering "geeks" who teach soldering skills, rework and repair and test PCB's and continue to develop innovative PCB rework and repair tools which make the job simpler and faster. This year's SMT VISION Award WINNER is the StencilMate™ rework stenciling process. It follows on the heels of the EZReball™ reballing preform, allowing solder balls to be quickly placed onto area array devices. With a breadth of PCB repair, rework, troubleshooting, and consulting services, combined with expertise in rework and repair process development, BEST is the source for getting large rework/repair jobs done quickly, or when a high degree of expertise is required.

BEST

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neer is extremely valuable for designing circuitry in such a way that it can effectively dissipate generated heat. This is especially true for PCBs loaded with analog. First off, the designer distributes analog circuits on the board so there is no thermal concentration in a particular area.

If the circuitry allows it, the next step is to perform so-called ground pour. This involves pouring copper on the PCBs unused surface area. Basically, the PCB designer is spreading copper over the surface area; copper will conduct the heat to dissipate. So, instead of using one small surface mount (SM) pad for heat dissipation, the PCB designer is now increasing the surface of the board, for example, to a half-inch by half-inch pour surface area. This ground pour area would then be able to dissipate the heat a lot more quickly compared to the SM pad alone (Figure 1).

An astute PCB layout engineer will also carefully consider thieving and metal-core (MC) boards as other ways to design in thermal management. Thieving is a process used to distribute copper on a board to improve the etching process. It also increases thermal dissipation because now there is more copper area. So, now the expanded copper area can dissipate the heat from the main section or sources into the air using those extra, non-functional copper pads.

As for the MC PCB, a base metal material is used as a heat distributor and is an integral part of the circuit board (Figure 2). A single-layer MC PCB provides a highly thermally conductive base material for spreading heat.

The PCB layout engineer also creates solid planes, when possible, as a way to reduce thermal challenges and increase heat dissipation. A board with a number of planes allows greater heat dissipation through those planes, although they are sometimes internal planes and not in direct contact with the ambient temperature. Nonetheless, solid planes offer increased surface area to dissipate heat.

Figure 3. Heat sink with short fins dissipates heat to the ambient.

Last, but not least, is the important task of selecting the right heatsink and attachment process in designing for thermal management. A heat sink's purpose is to conduct heat away from the thermal-generating devices to other parts of the silicon tree to the ambient.

The more efficient heatsinks provide greater capacity to spread the heat out, and higher thermal conductivity means higher rate transfer. Therefore, if a heat sink with lower thermal conductivity is selected, it won't dissipate as much heat compared to one with a conductor demonstrating a higher thermal conductivity.

Heat sinks are made of extremely high thermally conductive materials like aluminum and copper. When a PCB designer opts for a heat sink with fins, it helps to increase heat dissipation into the ambient atmosphere (Figure 3). Also, an important aspect to factor in a design is to over-specify a heat sink by at least 15 to 20 %. This buffer prevents problems that can occur due to exposure to extremely hot conditions, mil/aero applications, rugged environments, or because of thermal mismanagement at the design stage.

As part of the design process, the PCB designer places special emphasis on the interface between heat sink and associated component or to the board itself because it is critical for effective thermal transfer. Normally, thermally conductive aluminum filled epoxy is used for bonding the fins of the heat sink to the component or to the board. It's important that the right kind of alloy or substrate is used for attaching those heat sinks.

That requires considerable calculations and the right amount of aluminum or copper content within the epoxy and alloy substrate. The substrate material connects the heat sink to its associated component. For instance, as shown in Figure 4, a thermally-conductive grease is used to attach an IC with its heat sink. SMT

Figure 4. Thermal grease is used as a way to dissipate heat, mostly in LED applications.

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PACKAGING

ECAT Reflow System

VJ Technologies, Inc.

Don Naugler, President, VJ Technologies
Al Cabral, Dir Sales & Mktg, VJ Technologies
Karen Watkins, Publisher, SMT
Meredith Courtemanche, Executive Editor, SMT

VJ Technologies' ECAT automatic straddle mount reflow system is designed specifically to deliver precise, controlled heat to connector leads while protecting the connector body and PCB. Proprietary SierraMate™ Windows®-based software provides an easy-to-use "1-2-3-Go" graphical user interface, featuring intuitive programming, automatic profiling, and data collection for product traceability. The ECAT is "production ready" for high-volume assembly of straddle mount connectors. The ECAT has been developed for volume assembly of straddle mount connectors and high-efficiency convection heaters to deliver energy to the leads. The unique, high response model enables precise profiles at very high throughput, while avoiding the risk of surface damage to the PCB.

VJ TECHNOLOGIES

Littleton, MA USA
www.vjelectronix.com

Adhesives/Coatings/ Encapsulants/Underfill
Company: Alltemated Inc.
Product: PLACE-N-BOND

Assembly Tools
Company: Production Solutions
Product: Ultra HD

Cleaning Equipment
Company: Aqueous Technologies
Product: Trident QUAD

Cleaning Materials
Company: Kyzen
Product: AQUANOX A4703

Design Software
Company: GreenSoft
Product: GreenData Manager-REACH

Device Programming
Company: Data I/O
Product: Flashcore III

Dispensing Equipment
Company: Nordson EFD
Product: Ultimus V

Electronics Manufacturing and Design Services
Company: Victron
Product: VMVO

Environmentally Friendly Product/Services
Company: Aqueous Technologies
Product: Trident QUAD

Inspection
Company: Speedline
Product: RapidView Inspection

Packaging
Company: VJ Technologies
Product: ECAT (Edge Connector Assembly Tool) Reflow System

Pick-and-Place
Company: Assembléon
Product: MC-24X

Printing
Company: Speedline
Product: MPM Momentum

Process Control
Company: Valor Computerized Systems
Product: Valor MSS

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Rework and Repair (tie)
Company: Finetech
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Soldering Equipment
Company: SMT Wertheim
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Solder Materials
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Testing
Company: Acculogic
Product: FLS980Dxi Flying Scorpion

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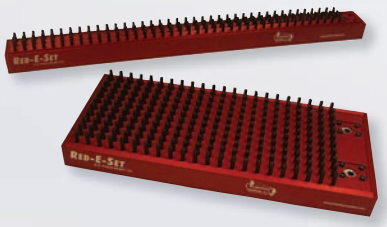
These winning products and services demonstrate user friendliness, innovation, cost effective operation and maintenance, and an improvement to SMT manufacturing processes.

Adhesives/Underfill

PLACE-N-BOND Pick and Place Underfilm from Alltemated is a solid thermoplastic film cut to size to make preforms. It is packaged in standard tape and reel, enabling pre-forms to be placed onto the PCB at part placement on any standard pick-and-place machine from a standard feeder. It eliminates all additional equipment and secondary processes associated with traditional corner bonds, edge bonds, and underfills, which reduces man hours and maintenance costs and provides energy savings. It also eliminates PCB preheat requirements. PLACE-N-BOND has been used in over 1 billion placements. Alltemated, ***www.alltemated.com/***

Assembly Tools

The Ultra HD is a large-format, high-density, flexible board support line. As circuit boards continue to become more densely populated and thinner, it has been a challenge to provide enough support during the printing and placement process.



Inadequate support will lead to defects, including solder bridging, shorts, insufficiencies, misaligned placement, tombstoning, and missing components. By eliminating the need for machined custom tooling plates that have faster end-of-life, the Ultra HD cuts down on disposal, metal usage, energy use, and waste. Implementation of the Ultra HD will also reduce required floor space. Production Solutions, ***www. productionsolutions.com***

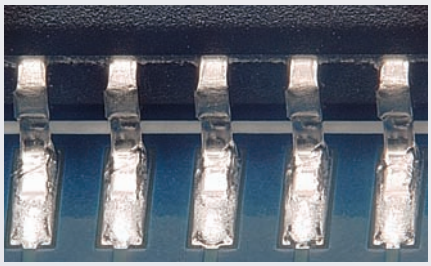
Cleaning Equipment

The Trident Quad from Aqueous Technologies is capable of removing all flux types including rosin, water soluble, and all no-cleans from both eutectic and lead-free applications. Trident high-

yield defluxing systems are equipped with multiple (2-4) autonomous defluxing chambers. Each chamber is controlled by a dedicated computer controller and may be operated with different defluxing chemistries for maximum flexibility. Trident Quad's operational costs average 80% less than comparable in-line cleaners. Aqueous Technologies, ***www.aqueoustech.com***

Cleaning Materials

How do we clean a large number of very difficult lead-free and no-clean soils with an economical and eco-responsible material? Kyzen's AQUANOX



A4703 neutral pH aqueous cleaning chemistry is neutral and effective at concentrations as low as 3%, while being environmentally friendly at a low cost of ownership. The Kyzen Applications Laboratory has evaluated AQUANOX A4703 for effective removal of nearly 300 soldering materials. Kyzen, ***www.kyzen.com***

Design Software

Complying with environmental regulations and

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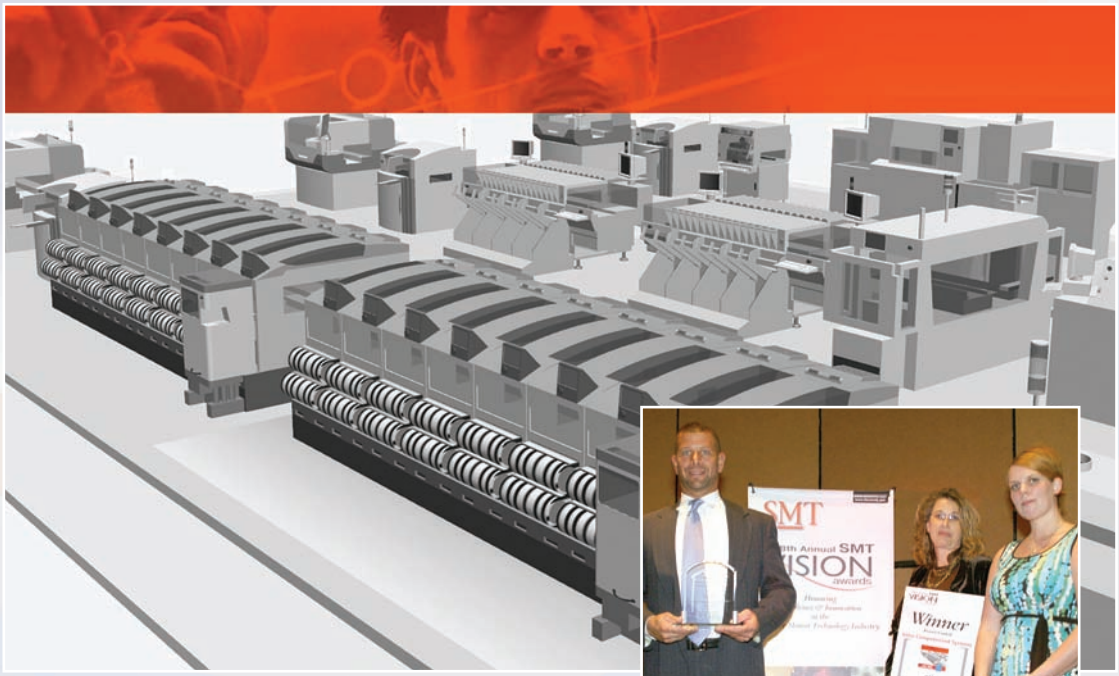
PROCESS CONTROL

Valor MSS Suite for PCB Assembly

Valor Division of Mentor Graphics



Dan Weitzman, Amer. Bus Mgr, Valor Div Mentor
Karen Watkins, Publisher, SMT
Meredith Courtemanche, Executive Editor, SMT

The central challenge to the industry is to provide complete and accurate information in real-time to drive manufacturing planning and execution in the most profitable way possible. Manufacturers face huge challenges in this area for two major reasons: dependency on multiple software solutions, each with their own data types, formats and software platforms, making it extremely difficult to share and leverage information; and reliance on manual systems to collect critical shop floor data relating machine performance, lot tracking, material consumption, process yields, compliance, asset utilization or traceability. Valor's MSS Suite solves both crucial problems by driving all systems from a centralized open database architected specifically for PCB assembly.

Mentor Graphics®

Valor Division of Mentor Graphics

www.valor.com

directives has become a challenging task for electronics OEMs. There are frequent changes to RoHS regulations and exemptions; REACH regulates more than 30,000 substances and the SVHC Candidate list may be revised up to twice a year; and large OEMs are developing their own unique requirements. For these reasons, GreenSoft believes that the best way to manage declarations is to collect, whenever possible, full disclosure material information for all components. GreenData Manager-REACH from GreenSoft also collects REACH SVHC statements, RoHS Certificates of Compliance, lifecycle data, manufacturing process data, and much more. GreenData Manager-REACH helps to manage and analyze all of this information. GreenSoft, ***http://www.greensofttech.com/***

Device Programming

The FlashCORE III programming engine from DATA I/O solves the problem of not being able to program large data files in a timely fashion. The FlashCORE III is the first programming engine

to support device and image data sizes greater than 4 Gigabytes, while maintaining programming speeds near the theoretical limit of the device. In addition to fast programming speed, the FlashCORE III supports fast data downloads over the Ethernet network to facilitate quick job setup and short changeover times, enabling efficient production. Data I/O Corporation, ***http://www.data-io.com/index.asp***

Dispensing Equipment

The Ultimus V high-precision dispenser takes Nordson EFD's proven air-powered dispensing technology to a new level of accuracy and performance, and has been designed for use in both benchtop and automated dispensing applications. All dispensing parameters, including time, pressure, and vacuum, are electronically regulated for exceptional accuracy and repeatability. Using the Ultimus V dispenser's Interactive PC Software and onboard memory cells, a particular fluid's viscosity curve can be mapped and the dispensing parameters calculated to accommodate changes in fluid viscosity. The Ultimus V will then automatically adjust dispensing parameters after a predetermined number of seconds or dispense cycles to keep deposit size consistent. Nordson EFD, ***www.nordson.com/en-us/divisions/efd/pages/default.aspx***

Electronics Manufacturing & Design Services

Victron Managed/Vendor Owned Inventory Program (VMVO Program) is unique in that EMS provider Victron manages the inventory with the use of its own employees and its proprietary inventory control system. Victron's employees help eliminate the need for supplier's personnel in-house and the need to manage

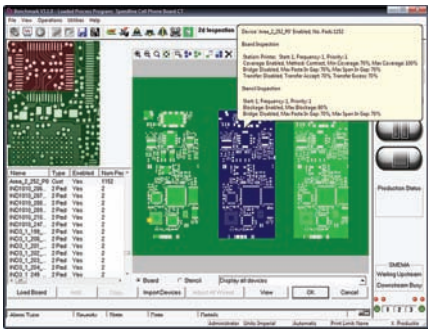
systems across multiple platforms of suppliers. Victron's quality and cost effective printed circuit board assembly (PCBA) operations are designed to meet a high mix of product lines with varied volume and complexity. Victron, ***http://www.victron.com/***

Environmentally Friendly

The Trident Quad from Aqueous Technologies is capable of removing all flux types including rosin, water soluble, and all no-cleans from both eutectic and lead-free applications. Trident high-yield defluxing systems are equipped with multiple (2-4) autonomous defluxing chambers. Each chamber is controlled by a dedicated computer controller and may be operated with different defluxing chemistries for maximum flexibility. Trident Quad's operational costs average 80% less than comparable in-line cleaners. Aqueous Technologies, ***www.aqueoustech.com***

Inspection

RapidView Inspection from Speedline allows customers using Speedline screen printers to perform post-print solder paste inspection, at a rate of up to three and half times faster than the standard Speed Vision Inspection system. Inspection times to inspect 100% of a typical cell phone PCB went from 70.6 seconds with Speed Vision to 20.7 seconds with RapidView Inspection. In the past, especially for larger boards, it may not have been practical to inspect 100% of the board after printing while the board is still in the screen printer. RapidView Inspection makes 100% on-printer



inspection a viable option for a number of board types and sizes. Speedline Technologies, ***http://www.speedlinetech.com/index.aspx***

Packaging

Shrinking lead pitch and increased signal integrity demands have made lead-free connector assembly for telecommunication and high-end computing more challenging. Yield with traditional IR assembly methods have failed to keep pace. The ECAT (Edge Connector Assembly Tool) Reflow System from VJ Technologies provides a cost-effective method with high yield and throughput. The ECAT system uses an innovative variation of a design implemented decades ago for QFP devices. The proprietary linear heaters provide unmatched thermal response, allowing profiles to be tuned to the specific requirements of each assembly. When paired with VJT's SierraMat software, process development is quick and easy. The ECAT system is an energy-efficient solution for lead-free soldering. In addition, built-in fume containment and extraction protects users and the environment from potentially harmful smoke and particulates from soldering. VJ Technologies, ***http://www.vjt.com/***

Pick and Place

Assembléon's MC-24X is a new pick-and-place machine with a footprint of 27 square feet, almost half the footprint of competitive models in its class. The output of the MC-24X has been designed for 54,000 components per hour

SMT

18th Annual SMT VISION awards

ASSEMBLY TOOLS

RED-E-SET Ultra HD

Production Solutions, Inc.

Doug Farlow, President, Production Solutions

RED-E-SET Ultra HD replaces costly, dedicated PCB support tooling. Ultra HD eliminates: expensive custom tooling plates; the need for new custom tooling plates for each board revision; defects due to inadequate board support; time-consuming change-overs; and machine downtime. Manufacturers that have been using Dedicated Tooling Plates due to the lack of adequate support from Universal Tooling but are tired of the expense, turn-around time, maintenance and inventory management of these plates will benefit from RED-E-SET Ultra HD.

Production Solutions, Inc.
Where ideas come together

Poway, California USA

www.production-solutions.com

(CPH), using 96 intelligent feeder positions. Saving the end user 1 machine if you need an output of >60,000 components per hour in high-component-mix applications. Assembléon, ***http://www.assembleon.com/***

Printing Equipment

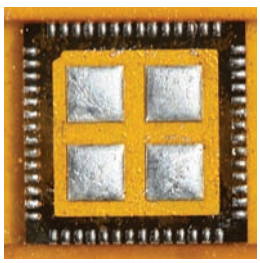
Transitioning from a single-lane manufacturing mentality to the dual-lane approach is difficult due to the fact that there is added expense for the shuttles and limitations for the redeploy ability of the dedicated dual-lane equipment. The Speedline MPM Momentum Dual Lane solution allows for near infinite flexibility, eliminating extraneous shuttles. The Dual Lane machines can be deployable in any environment initially or subsequently. While other Dual Lane printer products contain rails with 2 fixed mount positions, Speedline can move all rails under software control and accommodate the full variety of board sizes as well as automated conversion from a single lane printer to a dual lane printer. Speedline Technologies, ***http://www.speedlinetech.com/mpm/index.aspx***

Process Control

MSS Suite for PCB Assembly from Valor drives all systems from a centralized open database architected specifically for the electronics industry. Every application takes advantage of real-time information gathered from automated systems; information that has been cross-linked to leverage value across the entire value chain from the supply of materials to kitting, process planning, assembly, inspection, test, box build, final quality control (QC), and shipping. The result is real-time control and instant visibility of actionable intelligence. Valor, ***http://www.valor.com/en.aspx***

Rework and Repair (Tie)

The Martin Expert 10.6XL from Finetech is an under-heating system that combines IR radiation with convection. The Expert 10.6XL is more powerful than its predecessor 09.6XL, due to its revolutionary hybrid design, and it is housed in an elegantly stylish enclosure. It is a package that combines a powerful 5000W hybrid under-heater in a compact control unit. The unit is especially suitable for the repair of large PCBs, such as high value server boards up to 490 × 600 mm. Martin, a Finetech company, ***http://www.martin-smt.de/***



Rework and Repair (Tie)

Unlike metal stencils, which can be used to "bump" the component, the StencilMate from BEST Inc. remains in intimate contact with the component during the printing process. In addition, the stay-in-place feature of the board stencil keeps the apertures of the stencil aligned allowing the user multiple printing passes. Both features of the stay in place StencilMate allow for a very consistent past volume to deposited onto the lands of the reworked device thereby increasing the yield of the rework process. BEST Inc., ***http://www.solder.net/***

Soldering Equipment

The SMT Vacuum Plus N2 module from SMT Wertheim is an independent unit that can be integrated in an SMT reflow soldering system. The Vacuum Plus unit is positioned immediately after the peak zone, and can be utilized when required (the vacuum process is centrally controlled and can be switched on or off). The continuous reflow pass is then automatically switched to vacuum operation. The product is exposed to a vacuum for a short period of time during the soldering process (cycle time between 60–90 seconds). Voids in the solder joint are reduced to a minimum, which improves quality. SMT-Wertheim, ***http://www.smt-wertheim.de/en/smt.html***

Solder Materials

SN100C (040) halogen- and lead-free flux-cored wire from Nihon Superior is an effective solution in preventing tin whiskers, which are due to corrosion of the solder surface. In testing, no Sn whiskers were observed when exposed for 1,000 hours under the condition of 85°C/85% temperature and humidity. SN100C (040) is completely halogen-free, which means there is no F, Cl, Br or I hidden or locked up in the chemistry intentionally. The SN100C alloy delivers a silver-free stable microstructure that can accommodate the long-term and impact strains to which a solder joint can be subjected. Nihon Superior Co. Ltd., ***http://www.nihonsuperior.co.jp/english/***

Testing

Acculogic's FLS980Dxi Flying Scorpion flying probe system is designed for maximum test coverage and access. Shrinking component sizes and denser packaging technologies are posing new challenges to test. FLS980Dxi uses highly repeatable closed loop linear motor drives and joystick-like variable angle probe modules (0° to 6°) to maximize physical access and guarantee repeatable probing of fine-pitch devices and small components like 0201 and 01005s. FLS 980Dxi is a double-sided, multi-probe (16) Flying Probe system with 3D probing, analog, digital and boundary scan test capability on all probes (top and bottom side). Acculogic, ***http://www.acculogic.com/*** SMT

INTERVIEW Q&A: BRIAN D'AMICO

Leaders in SMT
MIRTEC Corp.

Q: What impact does MIRTEC's 15 MP ISIS Vision System have on the electronics inspection industry?
MIRTEC's ISIS Vision System brings unprecedented speed and performance to the electronics inspection industry. Preliminary throughput comparisons between 5 and 15 MP technology show an increased throughput of nearly 400%. This is a tremendous improvement in production efficiency that will be leveraged by global, volume-driven customers.

The electronics manufacturing industry, however, is a very demanding market with a diverse range of production requirements. At one end of the spectrum are the high-speed, high-volume production requirements associated with mobile device and LED BLU manufacturing. On the other end are the high-accuracy inspection requirements associated with micro-electronic component manufacturing. MIRTEC's ISIS Vision System is fully capable of addressing this diverse range of inspection requirements with a single state-of-the-art camera system. ISIS is an acronym for Infinitely Scalable Imaging Sensor. The ISIS Vision System may be scaled or modified to address the specific inspection requirements of virtually any production environment without sacrificing speed or performance. By changing the magnification of the Precision Telecentric Lens, the resolution of the ISIS system may be scaled from 18.2 µm/pixel with an FOV of 70.6 x 76mm, which is suitable for extremely high-speed manufacturing; down to 5 µm/pixel with an FOV of 19.4 x 19.4mm, which is suitable for high-end micro-electronics manufacturing. Even with a resolution of 5 µm/pixel, the FOV is still very generous allowing for high-speed, high-precision inspection.

Brian D'Amico has more than 27 years of experience in the electronics manufacturing and test equipment industry. He began working in field service and applications engineering with Eaton Corporation's Memory Test Systems Division. This is where he developed strong technical skills, as well as an enthusiasm for effectively managing customer expectations. Brian then took a national sales manager position with Contact Systems, where he managed a global network of manufacturers' representatives and distributors in the sale of automated SMT and through-hole assembly equipment. He also worked with both MYDATA and Quad Systems Corporation in a similar capacity, selling automated SMT assembly equipment. In 2004, D'Amico and partner Chanwha Pak established MIRTEC Corp., MIRTEC Co. Ltd.'s North American Sales and Service Division.

Q: How does MIRTEC continually stay one step ahead of the competition?
Quite frankly, it is a matter of survival. As the electronics manufacturing industry becomes more volatile, manufacturers have become more selective in purchasing equipment that will add value to their business and provide them with a competitive edge. Equipment suppliers must either develop new products that address specific customer requirements or risk extinction. At MIRTEC, we are extremely focused on advancements within the electronics manufacturing industry, as well as the ever-changing requirements of our valued customers. We invest heavily in R&D, persistently focused on using state-of-the-art optics, lighting, and laser technology to develop the industry's most technologically advanced inspection solutions. As a testament of our commitment to continuous improvement, over the last 18 months we have increased R&D engineering from 21 individuals to 45. Our goal is simple: to be the number one supplier of inspection solutions to the electronics manufacturing industry. The only way to get there is to stay not one, but three steps ahead of the competition.

Q: How do you encourage investment in a down market?
Current market conditions are such that electronics manufacturers are competing to capture as much business as possible in an environment that yields ever decreasing profit margins. The reality is that electronics manufacturers must invest in automated SPI and AOI to maximize efficiency and acquire quantitative information that may be used to streamline the manufacturing process and reduce defects. By increasing first pass production yields, manufacturers are able to decrease costs, save time and reduce the need for non-value added rework and repair.

SMT VISIONARY Leader
The Morey Corporation

Q: How did you address a major challenge in 2009?

Ahmad arrived at MOREY in November 2008 with a mandate to fundamentally shift operations and manufacturing, rendering MOREY a more attractive manufacturing partner. Ahmad implemented a lean manufacturing model and six sigma practices, driving those practices across overall corporate operations to establish a world-class, continuous improvement culture.

At the time, MOREY was a 75-year-old U.S.-only EMS provider suffering growing pains from roughly 1,100% growth in the past five years. Manufacturing processes and methods of accountability developed for smaller-scale operations were creating inefficiencies, making global competition difficult.

Simultaneously, MOREY was planning expansion to offering its own products to the market, launching a major new division. MOREY planned to keep manufacturing operations in the U.S. only, dedicated to maintaining a reputation for ultra-high-quality electronics.

Taymur Ahmad is VP of operations for The Morey Corporation. Prior to joining MOREY, Taymur served as director of global operations for Philips Lighting Electronics. His tenure in manufacturing also includes significant roles at major corporations including Aloca and Textron.

Ahmad initiated MOREY's lean transformation with a communications infrastructure and kick off with management. He conducted one-on-one meetings with all department heads to develop a cross-organizational situation analysis. Communication included book reviews and Q&A sessions to educate MOREY's 550 employees on lean and six sigma. Ahmad developed an organizational structure with standardized levels for cultural and operational transformation. Morey developed a strong lean-minded binary help chain, where team leaders serve their members, who solve problems. Ahmad defined objectives and the meaning of success for all levels.

As part of the help chain, Ahmad installed an andon system, part of the jidoka (built-in-quality) mentality he implemented company-wide. An andon signals for help when a problem is identified by someone on the line. All manufacturing stops until the problem is permanently fixed, giving workers hands-on problem-solving experience. Ahmad's ultimate objective is a system that is self-adjusting and self-improving.

After a successful pilot line program, the company-wide improvement plan began, which included a 5S effort and Kaizen events weekly to ensure that departments were moving toward established key metrics. Ahmad organized all manufacturing operations into value streams, making operations exponentially more customer-focused, efficient, and accountable.

Q: How did you save customers money and improve services in 2009?

MOREY helped suppliers and customers establish communication channels and lean ideas, favorably impacting their operations (better lead times and product quality, on-time delivery, greater responsiveness.

Lean at Morey enhances product quality, sharpens focus on customers' business through value streams, and saves costs through the efficiencies created in operations. With lean ops, MOREY can serve customers cost effectively, while decreasing products' cycle times, meeting demand fluctuations. MOREY's lean production also supports new customers seeking nearshore partner-based manufacturing.

Prior to lean implementation, production workers were being asked for "more, faster, now." MOREY realized that this led to in-process, half-built, or "trouble" units getting put aside and never finished — sacrificed in the name of efficiency to meet specific numbers or required shipments. This scenario was not allowing MOREY to solve process-based quality issues that were causing the defective units. With the current system and andons, MOREY fixes problems fast at the root cause with permanent solutions that ensure optimum long-term product quality. MOREY removed a lot of pressure from the production workers, reallocating it to management, engineering, and quality.

Q: What best characterizes innovation at your company?

Innovation is ever-present. A culture of continuous improvement and innovation permeates the organization from senior executives to the shop floor. The lean implementation has opened the door to business expansion and empowered workers. SMT

What's Hot in Electronics for 2010?

IN SUMMARY

Consumer electronics are undergoing changes spurred by consumer behavior. Data usage, connectivity, miniaturization, and aesthetics/ergonomics are driving new product introductions (NPI).

Following a very tough first half, 2009 demand and production of consumer electronics showed signs of recovery. However, demand for some of the most recognizable products has slowed and 2010 will likely see the emergence of some strong consumer electronics newcomers. New components will support the increased data needs, portability and cost concerns, and LED consumption of modern electronics users.

Data Consumption

Behavior also is changing. In January 2010, ComScore said 173 million U.S. Internet users watched online video compared to 147 million in January 2009. But this is only half of the story, as each viewer watched an average of 93 videos a May/June, up 50% from the previous year. All of this means that video views increased by +133% whereas viewers only increased 18%. While the numbers are significant, this is only one small part of the massive increase in data transmission and innovations that we are going to see this year.

Read Craig Hunter's recent columns on SMTonline.com:

- SMDs in Medical Electronics: Just What the Doctor Ordered
- With Electronics, You Can Never Be Too Thin
- SMT Components Toughen Up for Rugged Applications
- Embracing Brand Value and New Web Technologies
- Power MOSFET Evolution

Supporting this increased data throughput are two main industry segments: infrastructure and end-equipment. Both of these will see significant change during 2010. 4G technology, which increases performance by 10× over the previous generation, will require new high-performance components and will enable many new end-customer services like more interactive game systems and other enhanced graphics capabilities, which will proliferate globally in the coming years.

Wireless Mobile Technologies

Prime View International estimates there will be 10 million e-Books sold in 2010 from up to 50 new vendors. This application, in concert with hardware like Apple's new iPad and other all-in-one PCs, will require a complete wireless solution as well as display graphics and other circuit functions. New miniature power surface-mount inductors in 1212 and 1616 size packages; and high-capacitance (1500 µF, 6.3 V), low-profile conformally coated tantalum capacitors meet this high pulse requirement and will also help to reduce weight and size. Mobile TV will be another entertainment enhancement that will gain traction in 2010. New chip antennas with reception in the 470 MHz to 1.1 GHz frequency range are transforming mobile television into a more viable application.

The PC market will see over 360 million units shipped in 2010, according to Gartner, but increasingly netbooks and emerging applications like the iPad will cannibalize this product segment. The pressure points these technologies are looking to exploit are size, weight, and cost. Notebook makers are addressing these concerns wherever possible. Higher levels of integration are the order of the day, particularly when it comes to power management. For buck converter applications where it makes sense to use a separate controller IC, the high- and low-side MOSFETs can now be combined in a single package that reduces board area and allows better current handling. New ICs take integration a step further, combining the MOSFETs, a driver IC, and a bootstrap diode in a tiny MLP 6×6 package. Where integration of all active components is desirable, new devices can incorporate the PWM controller IC as well as the MOSFETs, which provides 95% efficiency in a 4 × 4 mm MLPQ.

Light Emitting Diodes (LEDs)

iSuppli recently reported that there were 63 billion LEDS sold in 2009. Astonishingly, that's almost 10 LEDs for every person on the face of the earth. Here's another area where surface-mount innovation is proceeding apace. Much effort has been spent to make LED illumination brighter and more natural, but making them more thermally efficient is of critical importance as well.

Typically LEDs offer about 10% efficiency, while the other 90% is dissipated as heat within the die. LEDs are extremely sensitive to heat; therefore the rate at which the heat can be transferred away from the die determines the steady-state operating temperature of the device and part efficiency. Recently, new and improved thin-film thermally conductive substrate solutions have been introduced. This and other modifications, including solid-filled copper vias to provide the shortest path through the substrate and spread heat away from the die and solder, are helping minimize thermal resistance and enable LEDs that are brighter and suitable for a wider range of applications.

Conclusion

Not just LEDs, but the electronics market in general is starting to look brighter. These are just few of the enabling technology products which will be lighting — and lightening — up our houses, offices, and briefcases during 2010. SMT

Craig Hunter is an *SMT* Editorial Advisory Board member and director, global Internet marketing at Vishay Intertechnology Inc. Contact him at craig.hunter@vishay.com.

IPC Insights

BY **Terry Costlow,** IPC

IPC-A-610E Broadens Scope

Streamlined IPC-A-610E is supplemented with flex circuits, board in board and package on package (PoP).

Rapid advances in semiconductors are increasing the complexity of assembled boards, escalating the difficulty for inspectors who determine whether assemblies meet desired quality levels. This complexity comes as business changes put more pressure on inspectors to provide higher quality without adding time to the examination process.

IPC performed a major revision of IPC-A-610, *Acceptability of Electronic Assemblies*, in response to the industry's needs. The E revision of IPC's most widely used standard, which provides visual acceptance criteria for post-assembly mechanical and soldering assembly requirements, now addresses additional technologies, including flexible circuits, board in board, package on package, depanelization, and additional SMT terminations.

In addition, the standard has been revamped for ease of use and clarity. Sections have been reorganized so that data and images are easier to find and information easier to use.

The photos and drawings that show good and bad connections — deemed one of the most important features of IPC-A-610 since it was released in 1983 — have also been upgraded. There are 165 new or updated illustrations, bringing the total to more than 800. These images will help inspectors quickly determine whether the assembly they're examining should pass or fail.

"The improved organization and categorization of IPC-A-610E has made the document more concise and user friendly, current with industry advancements and technology," said Zenaida Valianu, training and development specialist at Celestica. "The document is more intuitive and manageable than before, allowing users to navigate more easily and locate information promptly, which will also reduce the amount of time spent on interpretation.

For example, inspectors who have boards with potentially damaged parts can now turn directly to the section on damaged components. In the past, all data, including damage associated with a component termination style, was located in a section on those part types, forcing users to flip between sections.

Minor yet powerful wording changes have been made in the E revision to eliminate some of the uncertainties that have plagued inspectors in the past. "The use of the emphasis implied by 'shall' informs the reader that the requirement is mandatory," said Vicky Freeman, engineering technician at Flextronics. "The upgraded standard's format will allow our employees to easily comprehend the requirements of the job they are performing."

The many changes that have occurred in array packaging since the standard's last revision are also addressed. As array usage expands, BGAs, flip chips, and similar technologies are evolving quickly.

"We're providing criteria for non-collapsible balls on area arrays. Previously, we only looked at tin/lead balls that collapsed during reflow," said Jack Crawford, IPC director of certification and assembly technology. "Lead-free solder balls don't collapse and have different wetting characteristics. That means there can be more process-related problems during manufacturing."

Changes related to through-hole lead-free processes, such as hot tear and fillet lifting, are also updated in the latest iteration of IPC-A-610. Hot tear most commonly occurs when the copper in solder alloys doesn't disperse evenly, prompting the copper-rich areas to separate. However, this doesn't mean it is a defect. Similarly, the document details the appearance of fillet lifting. This anomaly appears when the solder fillet is lifted from the land, but it is not a defect.

One of the new areas covered by the upgraded document is depanelization, which Crawford calls a "high interest area." He adds, "We're covering it now, looking at edge routing, edge delamination, and other issues. There are pictures that show various defects, things like cutting too close to the edge and damaged conductors."

The growing number of companies using flexible circuits will also find sections that detail common issues, such as flex-to-flex interconnections.

For designers and manufacturers trying to jam more components into smaller spaces, criteria for PoP technologies, often used to boost memory capacity in large data processing and telecommunication systems, are now included.

For board-in-board connections, daughter boards can be mounted perpendicular to the assembly using a through-the-board method. IPC-A-610E now provides solder acceptance criteria. The enhanced text and additional photos should benefit trainers and new personnel almost as much as it helps inspectors on production lines.

Some trainers note that the most important change in the standard is that it is better synchronized with existing training approaches. "Restructuring the IPC standard sections to follow a proven IPC training flow will help communicate information more readily," said Valianu, who also serves as a Master IPC Trainer at Celestica. Another Master IPC Trainer, Freeman, agrees, "The new format allows enhanced reference to related areas that improves training and minimizes discrepancies in associated areas of fabrication."

Upgrades to a companion document, J-STD-001E, *Requirements for Soldered Electrical and Electronic Assemblies*, have also been made. IPC J-STD-001E provides material and process requirements for producing soldered electrical and electronic assemblies, aiding those who set up manufacturing processes. Additional pages and 14 new photos help these specialists move into production quickly. SMT

Terry Costlow, IPC online editor. IPC-A-610E, *Acceptability of Electronic Assemblies*, is available at www.ipc.org/610E. Translations of the revised standard in multiple languages will be released in the coming months.

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