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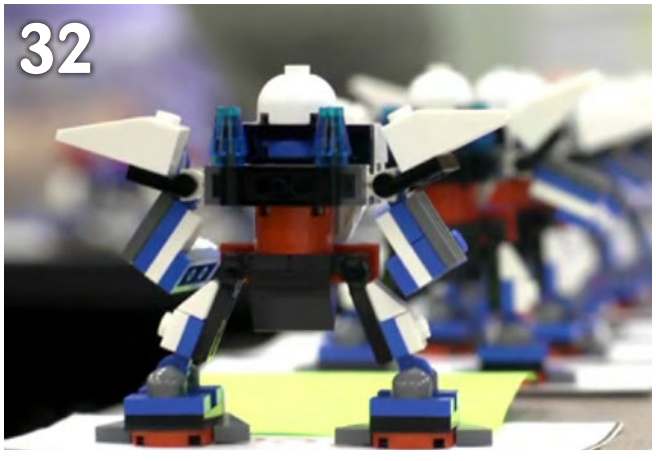

Assembly Training and Education

This month, *SMT Magazine* looks into the importance of workforce training and education on the continuous improvement of the PCB assembly process.

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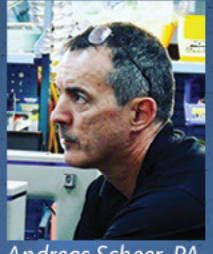
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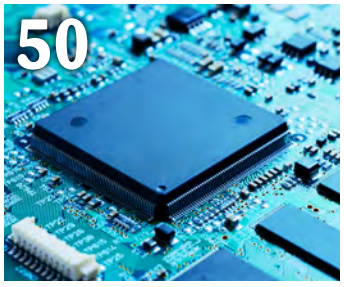

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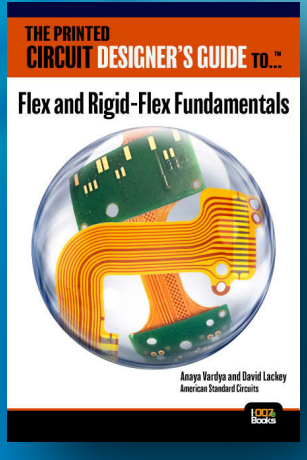

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Assembly Training and Education

by Stephen Las Marias
I-CONNECT007

When we set out to plan the topic and content for this month's issue of *SMT Magazine,* we initially focused on improving the electronics assembly industry. Because even if your PCB assembly process is optimized, there is always room for improvement; no matter how successful your company has been in the past, you can't rest on your laurels and be complacent, doing whatever you have done in the past because it has worked. It is always in your best interest to strive towards a better operations model.

But what we found during our conversations with industry experts is that, while investing in the latest technologies and having a systems-based approach in your assembly processes are important, the key factors that will make you successful in your continuous improvement goal are the skills, training, and education of your workforce. However you look at it, the human factor remains a critical issue when it comes to your overall efficiency. Your operators, engineers, supervisors, line managers, etc. will continue to oversee most, if not all, of your systems and processes.

So how do you make sure that they have the proper knowledge and skill sets to perform at their peak levels, day in and day out?

In our recent survey on assembly training and education, one of the questions we asked concerned the importance of training to electronics manufacturers.

Around 85% of our respondents consider training important to their workforce. In fact, the majority of respondents—47%—say it is very important. Such training could be on-the-job training, formal

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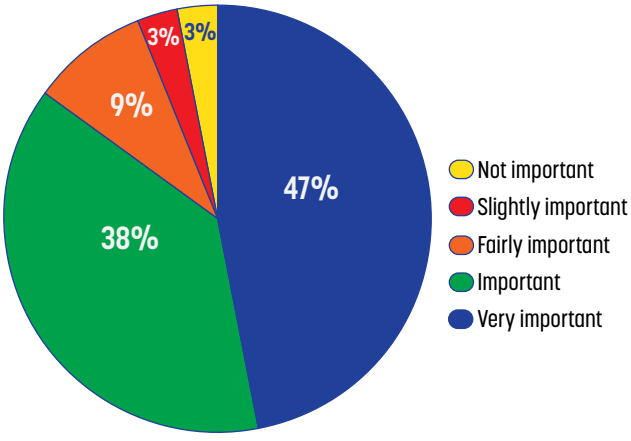
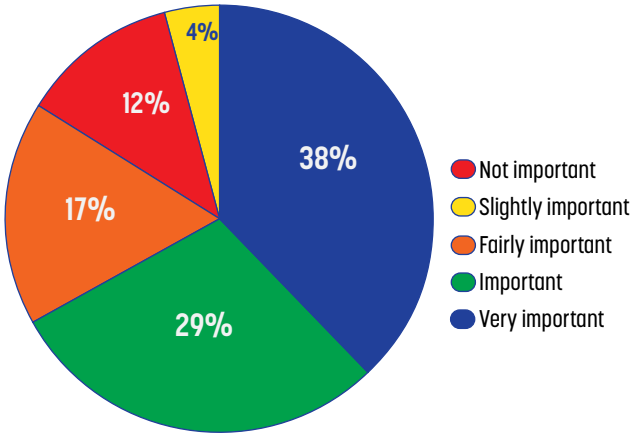
Q: How important is training to your organization?



Q: How important is it to have your suppliers provide training?



in-house training, training through third parties, and training by suppliers.

The majority, or 67% of the respondents, consider supplier trainings—be it in technology, equipment/machine, or chemicals, among others—to be important because suppliers are the process experts, thus their resources should be utilized as much as possible. One comment is that suppliers can introduce technology or knowledge that could help them address their issues in their respective areas.

Meanwhile, when it comes to determining what training their operators or engineers need, we found several factors: the technologies currently deployed and yet to be installed in the line, their mistakes, and productivity (yield data and rejections).

Industry Associations' Role in Training and Education

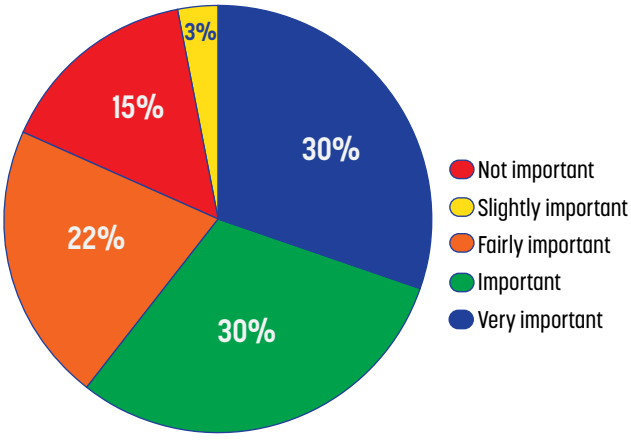
As we all know, industry associations, such as IPC and the Surface Mount Technology Association (SMTA), help advance the electronics manufacturing industry through standardization, training, education, advocacy, and interaction through trade events, exhibitions and symposiums. They help members to become aware of the latest technology developments happening in their industry verticals, and of the market trends shaping the direction of the industry. Moreover, they also provide platforms to connect all industry stakeholders to discuss strategies and solutions to the electronics manufacturing engineering challenges of the future.

In our survey on assembly training and education, we also asked our readers about the importance of industry associations, especially when it comes to training and education for their members. Majority, or 60.6% of the respondents, consider these associations important for their business—it's a split between "Very Important" (30.3%) and "Important" (30.3%).

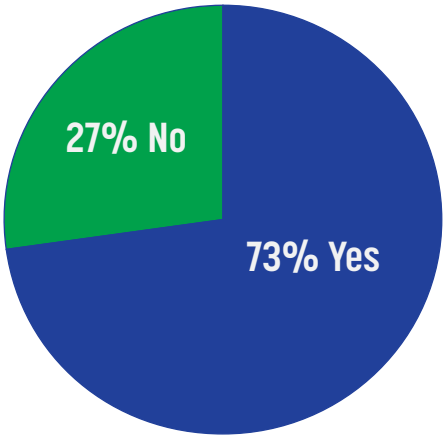
Key reasons mentioned include: they provide industry standard reference; they give non-partisan benchmarked industry consensus training; they provide a common ground for members to meet and share information; and they provide diverse support and idea sharing important to operations.

With their symposiums and numerous technical training and workshops on electronics manufacturing standards, industry associations give everyone a constant reminder for the need for increased knowledge for continuous improvement. And members embrace this opportunity to learn more by sending their operators, engineers, supervisors, among others, to receive training and education from these associations.

Q: How important are industry associations to your business?



Q: Do you send people to conferences to receive training ?



According to our survey, 73% of respondents send their people to conferences for training and further education. The frequency varies; some send their engineers for training once a year, while others attend such training every six months. Others say they send their people occasionally and per demand—and that these people vary from sales, to production, or the front-end guys—depending on the conferences and individual needs.

Continuous Education and Training to Improve the Assembly Process

As I mentioned earlier, we considered 'improving the assembly process' as our topic for this month's issue of *SMT Magazine*. But as we found out, education and training are key towards that assembly process improvement goal.

In this issue, you will find our discussions on this topic with MC Assembly's Luis Ramirez and Dan Prina, and Manncorp's Tom Beck and Chris Ellis. A separate article from MC Assembly, meanwhile, details their recent Incito Man training for its employees, and its impact on their quality, productivity, cost effectiveness, and continuous process improvement.

Industry veteran Steve Williams of The Right Approach Consulting, meanwhile, writes about the EMS skills gap epidemic.

We also have interesting articles from Alpha Assembly Solution's Westin Bent, Goepel Electronic's Jens Kokott, and from Stefan Meissner of ULT AG and Arne Neiser of SEHO Systems.

You will also find inside my interview with James Yeoh of Zestron Precision Cleaning in Malaysia. We talked about the latest developments in cleaning, and how their Zestron Academy is helping educate the industry in terms of cleaning systems and processes.

As always, *SMT Magazine* is not complete without our expert columnists. This month, we have Dr. Jennie Hwang writing a prelude on her upcoming series of articles on the role of bismuth in electronics.

We also have Tom Borkes' third installation of his article series on analyzing the cost of materials in today's global economy.

I hope you'll enjoy this month's issue of our magazine. Next month, we will focus is on repair and rework. Stay tuned! **SMT**

Stephen Las Marias is managing editor of *SMT Magazine*. He has been a technology editor for more than 12 years covering electronics, components, and industrial automation systems.

The Role of Bismuth (Bi) in Electronics: A Prelude

by Dr. Jennie S. Hwang
H-TECHNOLOGIES GROUP

Bismuth (Bi) is a unique element on multiple fronts. For your eyes, bismuth can be grown into beautiful iridescent rainbow crystals (Figure 1). When it comes to considering applications in electronics and microelectronics industry, over last three decades, the industry has shied away from using Bi, at least not in standard practices in mass production. However, an interest has surfaced recently.

After receiving various questions and comments, this series on *"The Role of Bismuth (Bi) in Electronics,"* is tailored to electronics and microelectronics industry, to provide an overview in its entirety in the areas of importance to industry applications going forward.

Backdrop

The Restriction of Hazardous Substances (RoHS) initiated by the European Commission indeed was impactful, similar to the Montreal Protocol—an international treaty agreed in 1987. Both RoHS and the Protocol have had profound impact on the electronics industry. The Protocol phased out the production of substances that are responsible for ozone depletion; and RoHS has driven the worldwide implementation of lead-free electronics.

On lead-free solder materials, our teams through the past two decades have conducted research far before the RoHS becoming effective. Our first patent (Patent Number: 5,520,752) in this area was filed in 1994 and issued in 1996. The patent, jointly owned by the U.S. Army of the Department of Defense and myself, disclosed Bi-containing lead-free alloys to replace SnPb solder including SnAgBi system, SnAgInBi system, and SnAgCuBi system and other non-Bi-containing lead-free systems. The patent embodies the concept and inventiveness of high-performance, lead-free alloys with the objective to serve military electronics.

The broad-based awareness of and the industry's effort in lead-free alloys started after the RoHS Directive was published by the European Com-

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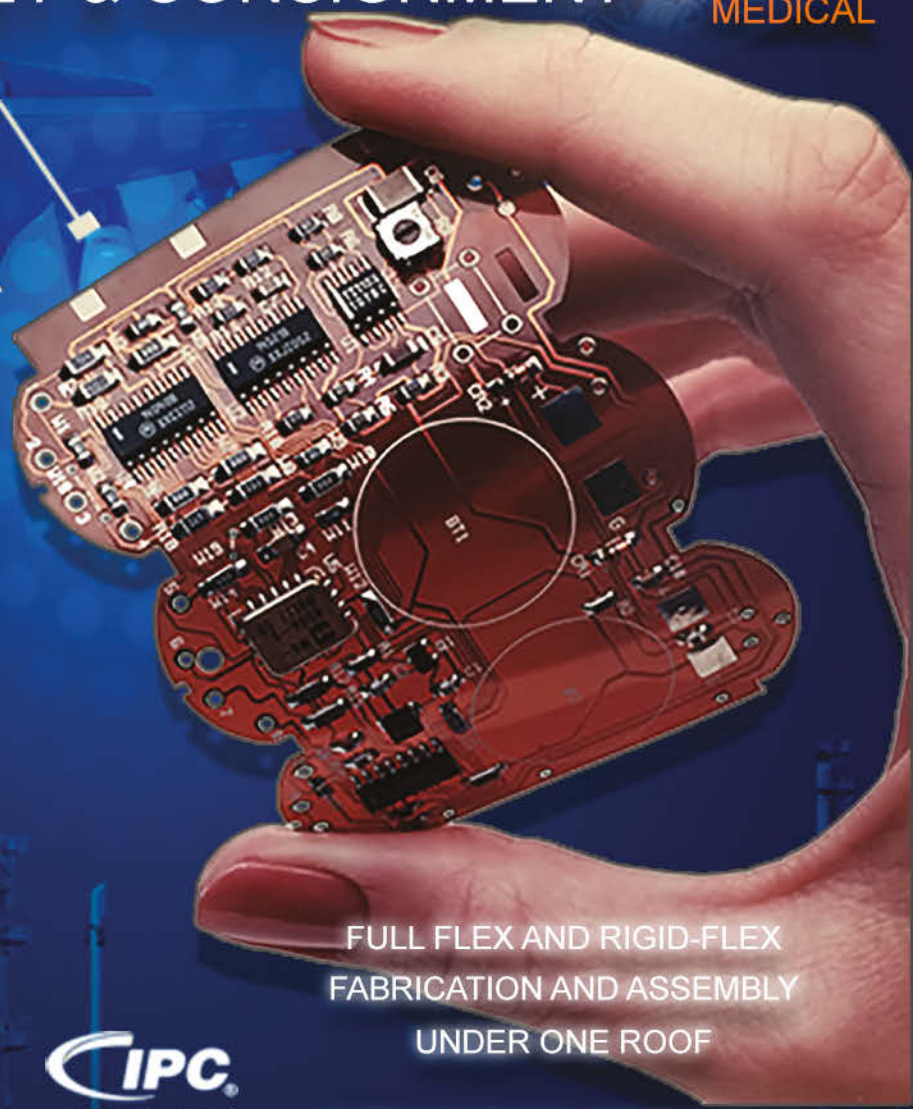

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mission and when the lead-free electronics appeared to become a reality (RoHS 1 in 2002/2004, RoHS2 in 2011/2013). Variations of EU RoHS adopted by other countries were later deployed globally in the mid-2000s and thereafter.

"It is cheerfully intriguing to observe that some esteemed engineers and scientists have always showed an interest in novel lead-free solder materials including Bi-bearing lead-free alloys."

It is cheerfully intriguing to observe that some esteemed engineers and scientists have always showed an interest in novel lead-free solder materials including Bi-bearing lead-free alloys. This is vividly demonstrated by the attendance at my lectures covering lead-free and the role of Bi, which were delivered in the Professional Development Courses offered by NEPCON West and NEPCON Japan in 1997–2003, IPC lead-free roadshows in 2003–2013, and at in-house programs at OEMs and NASA facilities over the last two decades, as well as recently (2017) by SMTA webtorial programs .

Fifteen years passed by; how is the lead-free electronics doing—its track record during this fifteen-year run and its outlook? And what is the role of Bi in the lead-free arena marching forward?

SAC system, specifically, SAC305 (Sn3.0Ag0.5Cu), has been widely known and used as a de facto "standard" alloy in the industry for the past 15 years. However, during this period, for a designed performance or other purposes, different alloys outside the SAC system have been successfully used by some OEMs at their discretion, albeit in special low-volume applications.

On the subject of Bi in the lead-free arena, one important point worth noting is to differentiate two separate Bi-containing lead-free alloy systems—Sn-based alloy system vs. Bi-based alloy system. The two systems bear separate metallurgical phenomena, thus physical properties and mechanical behavior, which in turn their respective intended applications and product service environments.

Bismuth can be introduced either through the supply chain (not by design) or by design. With the deliberation of all relevant parameters, theoretical and practical, Bi plays a potent role in electronic solder interconnections. The proper use of Bi can benefit the performance and reliability of electronic package and assembly including solder joint performance, tin whisker mitigation, among others.[1,2]

By the same token, its improper use could impart deleterious effects to solder joints, thus product reliability. An adequate understanding of the properties and performance parameters of Bi is critical to the product reliability. This series will discuss the relevant areas of Bi to help dispel misconceptions and to demonstrate performance criteria related to Bi. The goal is to help achieve the desired level of performance and product reliability.

Topics to be Covered

This series will highlight the following topics:

- Bi: Characteristics, resources, safety data
- Bi effects in 63Sn37Pb solder joint
  - Physical properties
  - Mechanical behavior
- Effects of Bi from component coating and PCB surface finish
  - Dissolving into solder joint
  - Estimation of concentration of Bi in solder joint
  - Effect of compositional change
- Bi effects in SAC solder joint (SnAgCuBi)
  - Compositional change
  - Stress vs. strain
  - Fatigue behavior
- Bi effects in other Pb-free alloys (SnCu, SnAg, SnAgIn)
  - Stress vs. strain
  - Fatigue performance
- Historically established Bi-containing electronic solder alloys

  – Pb-containing
  – Pb-free
- Bi-containing Pb-free solder alloys
  – Melting temperature range
  – Compositional control level
  – Physical, mechanical properties
  – BGA thermal fatigue performance
- PCB through-hole fillet-lifting vs. Bi
  – Causes
  – Solutions
- Low temperature BiPbSn phase
  – Presence or absence
  – Thermograms
  – Detectable or non-detectable effects
  – General guidelines
- Design limits in Pb-free solder joints vs. solder joint reliability
- Sn-based Bi-bearing solder vs. Bi-based solder
  – Differentiation
  – Physical properties
  – Mechanical properties
  – Service environments **SMT**

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1. Yves Palmieri, Bismuth Institute Information Center, Belgium.

2. Jennie S. Hwang, "Bismuth in Electronic Solders," Bulletin of Bismuth Institute Information Center, Belgium, #78, 2001.

Dr. Jennie Hwang, an international businesswoman, international speaker, and business and technology advisor, is a pioneer and long-standing contributor to SMT manufacturing since its inception as well as to the lead-free electronics implementation. Among her many awards and honors, she is inducted to the International Hall of Fame-Women in Technology, elected to the National Academy of Engineering, named an R&D-Stars-to-Watch and YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, IEM Corp., she is currently CEO of H-Technologies Group providing business, technology and manufacturing solutions. She serves as Chairman of Assessment Board of DoD Army Research Laboratory, Commerce Department's Export Council, National Materials and Manufacturing Board, various national panels/committees, international leadership positions, and the board of Fortune-500 NYSE companies and civic and university boards. She is the author of 475+ publications and several books, and a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. Further info: www.JennieHwang.com.

Soft and Stretchy Fabric-Based Sensors for Wearable Robots

A team of researchers at the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) and the Wyss Institute for Biologically Inspired Engineering at Harvard University has created a highly sensitive soft capacitive sensor made of silicone and fabric that moves and flexes with the human body to unobtrusively and accurately detect movement.

The team's technology consists of a thin sheet of silicone sandwiched between two layers of silver-plated, conductive fabric, forming a capacitive sensor. This type of sensor registers movement by measuring the change in capacitance of the electrical field between the two electrodes.

The hybrid sensor's performance stems from its novel manufacturing process, in which the fabric is attached to both sides of the silicone core with an additional layer of liquid silicone that is subsequently cured. This method allows the silicone to fill some of the air gaps in the fabric, mechanically locking it to the silicone and increasing the surface area available for distributing strain and storing electrical charge. This silicone-textile hybrid improves sensitivity to movement by capitalizing on the qualities of both materials. Finally, thin, flexible wires are permanently attached to the conductive fabric with thermal seam tape, allowing electrical information from the sensor to be transmitted to a circuit without a hard, bulky interface.

Training and Education:
Key to Improving Electronics Assembly

by Stephen Las Marias
I-CONNECT007

For this month's issue of *SMT Magazine,* we spoke with Luis Ramirez, COO, and Dan Prina, project manager of Lean enterprises and continuous improvement, at EMS firm MC Assembly to discuss the challenges of and strategies in improving the PCB assembly process from an EMS provider's perspective. We also spoke with Manncorp's Tom Beck, director of marketing, and Chris Ellis, Eastern sales manager, to get their viewpoints on the subject as an equipment provider.

"From my perspective, from a management standpoint, first and foremost, improvement is a philosophy, and whatever you're doing today there's always a better way to do it tomorrow. One of the biggest paradigms that we see across the industry is that one thing that may have worked in the past, we keep trying it and we keep trying it, and it may not work today because variables may have changed and the environment may have changed. That's one of the biggest paradigms that, from a management standpoint in manufacturing, we have to remove, because what worked in the past not necessarily is going to work in the future," explains Ramirez. "For us, first we want to have a standard. We want to make sure that we partner with our suppliers of equipment and create standards so that we know when there is a problem, when there is an event that is outside a standard, it is easier to troubleshoot and easier to determine the root cause. Having said that, once you have a standard established, then you have to measure. You have to create a metric to understand whether or not you're meeting your expected output out of that standard. With that measurement, then you are able to provide real-time feedback. That's what drives a lot of the continuous improvement activities when we see trends. For example, when we look at the work that has been done in the previous day and we see a problem that keeps repeating that triggers a review, and triggers a team meeting or a kaizen event for the team to get together and figure out the root cause. What could be causing the problem and then second, what actions we could implement to eliminate or minimize the problem."

Ramirez notes that in today's world of electronics, the PCBA real estate has become more and more critical. There are now a lot of low-

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profile BGAs. There are a lot of very small components that are all in very difficult areas inside a circuit board. "Even if you have great equipment, you still need to have that human intelligence that is able to figure out the right process to minimize any problem," Ramirez says.

He notes, though, that it does require having the equipment that is capable, but so is having the technical and the expertise and experience to be able to look at a problem and say, 'Yes, I know I can do A, B or C.'

Tom Beck

"If you cannot figure it out, you should be able to pick up the phone and call the manufacturer of the equipment, call the manufacturer of the part, and even invite all of them and tell them, 'Hey, I've got this problem. How do you guys think we can solve it?' Again, sometimes what we think is a simple problem actually may require a very complex solution. In our world, there is no such thing as a simple problem," adds Ramirez.

One of the key measurements they base their improvements on is the overall cycle time. "Initially, what we wanted to do was to just feed it into our machines, we've always had a big focus on the technology of it. We've invested pretty heavily in some really good equipment. What we've found lately though is there's a lot to be said for the simplicity," says Prina. "We definitely manage from a point where we look at running simulations and we know where our expected run times are on our equipment, but if you fail to manage the downtime, if you fail to manage the hand touch labor further on down the line, it can create a lot of problems. We have a phase-gate controlled process NPI release that goes step-by-step through the process. We try to identify what our problems are upfront but there's certainly still quite a bit being done out on the floor once it's released, and we go through that process. That's when we try to get our operators engaged and getting that feedback from them, where we can minimize times lost, where we can engage some efficiency, and just getting that feedback back up to the PDM group to rewrite those processes or to engineering for review is really critical."

Do they go back to their customers and suggest some modifications for future revisions? Ramirez says they do. "As Dan explained, in a perfect world during the pre-production type run, there are a lot of these sins that should have been identified and, in theory, should have been corrected. What we're finding is, in many cases, many of our customers' development phase take more time than projected in their tollgate process to bring a product to life. They consume all the work for one reason or the other in the design phase to the point that by the time you want to prove your design, it's way too late. In many instances, we are facing a situation in which the product has launched, even with a fault or deficiency we may have identified, because there is a pressure for that customer to launch a product," Ramirez explains. "We like to view ourselves as adding value to our customer. At MC, we're going to do our best to provide you, based on your design, a good product. However, we've got to work together. We've got to be partners so that, at the end of the day, if we can improve your design and it's going to make our assembly process better, that is going to be an economical benefit for both companies. For the most part, most customers tend to take that feedback and in the next revision they fix it."

But he says they have other customers who are facing difficulty in changing the design because of third-party approvals or very long testing.

"Again, we have a mix of some that early in the process as we are doing the prototypes. We're able to provide feedback, which then they use to refine their design versus the other ones that they get the feedback but they realize that, 'Hey, I don't have the time.' It's going to be changed in the next revision. Then we have to live with that situation. Therefore, that's where it's critical to have all the controls that we put in place, like Dan was mentioning, we've got to

figure out how to do it and how to do it well," says Ramirez.

Ellis agrees, saying that a lot of customers just don't know how to design for manufacturability. "We often have to guide them so that their designs are consistent with their capabilities and available resources. For example, a customer may have a BOM with 175 different part numbers, which would necessitate multiple pick-and-place machines, when they really don't have the budget for that. We can often assist them in designing their product in a way that meets the capability of equipment they can afford," he says.


Luis Ramirez

Beck adds that many of their customers, especially the larger companies, will invest in their own prototyping equipment to be able to work out a lot of these issues in advance, before turning a product over to an assembler, who would produce the boards on a much larger scale when necessary.

Training and Education is Key

Overall, one of the key factors that these experts point to when it comes to improving the PCB assembly process is training and better education, as most of the people in the line just don't have any formal training in electronics assembly methods.

"I think one very important area is better education, to be honest," says Beck. "If you're an OEM, you have a lot of different processes that you're trying to integrate to build a finished product. Electronic assembly is only one aspect of that. We find with a lot of our small- and medium-volume customers that they'll have people who are performing a wide variety of job functions. Many of them, for whatever reason, just don't have any formal training in electronic assembly methods and best practices.

"When we do installs, we very often find that there's quite a bit of hand-holding required because a lot of the operators simply lack experience and training. Many don't take advantage of the industry resources that are out there and really educate themselves. Not all of them; some certainly do. Some get semi-annual training and have experts come in and conduct reviews and training classes and the whole bit, but a lot of them don't. I think better overall education is extremely important."

MC Assembly, for their part, does a lot of internal training, according to Prina, especially when it comes to continuous improvement. "Things like the IPC's and the soldering classes; but I think to echo what we're talking about, as far as education, we do a ton of benchmarking. I think you need to get out of your own skin and live in a little bigger world. You go see some of these other plants. I've been here since 1994. If this is where I lived and I never got out of our plant, I would see things that would be considered to be common place, this is the way people do things, and you don't realize that there are better methods and better ideas out there," he explains. "It's not about stealing, because you have to go back and you have to adapt it to what works for you. I was at Toyota recently, again, just benchmarking to see their ideas on assembly. MC Assembly is never going to be Toyota. We're never going to buy billions of dollars' worth of tooling; but again, there are a lot of small things that we can take away from that and learn. We belong to AME (Association of Manufacturing Excellence) and 'share, learn, grow' is their mantra. Just getting out and seeing how other people are doing things and then adapting them to what works best for your process is fantastic."

Prina says that in addition to benchmarking, they also send large groups of people for things like Excel training. "People knew how to load an Excel worksheet and do some basic manipulations, but they didn't realize or even know what a macro was. We can save them hours on simple things like data entry just by doing that kind of training. We spend a lot of time and we encourage the supervisors to go out and search for things from which people would benefit and who should go."

Teaching people to think differently often results in new ideas and improved process—

leading to overall improvement in processes.

The education process also can come out of getting people from different sides of the spectrum to sit down and really talk about the manufacturing challenges.

"For example, we recently had a customer that we have had for years and their designs are very, very challenging," narrates Ramirez. "One day, we took a group of our manufacturing engineers and we went and had lunch with their engineers. Slowly, the ideas started flowing engineer to engineer. It was not rocket science. It was just getting the people that are designing talking to the people that are manufacturing it, and it was fantastic. We were able to solve chronic problems by having these guys talking. From my perspective, I think that OEMs need to treat their contract manufacturers (CMs) as partners. They're part of your organization, not just another vendor that is making you parts, but they've got to be a partnership, sharing ideas and having improvement activities and kaizen events together. Not just once in a quarter, let's see what your price is and let's see your quality, etc. The more involved the OEM is with their partner CM the better the results are going to be for both organizations."

Dan Prina

Ramirez adds that in their results, the customers that are involved have better yields, and they have better reliability. "For the ones that are not involved, there is a little bit of struggle. We do our best but you can see a difference between the customers that are completely involved versus the ones that are not involved with the manufacturer."

"I was just going to add on to what we were saying about education. I think what Luis was just saying is really important because it's not just about education in a single discipline like SMT technology, for example. You can't just operate in a vacuum. A manufacturer who is using an EMS should know about the day-to-day challenges that an EMS has to deal with from a practical standpoint. Beyond the technology itself. Communication, education, it all goes hand in hand," says Ellis.

When it comes to education in the assembly process, software, the continuous improvement, the level of education can be mainly comprehensive in a lot of fronts to continue to improve the process.

"I think a key thing that is very important is finding a supplier that can provide remote access and diagnostics for their equipment. Even if you only have a component with a 3% rejection rate, why is it being rejected that 3%? Sometimes it could be something as simple as your tolerances not being set exactly right on the pick and place machine. The amount that those components are supposedly out of tolerance may be totally insignificant from a process standpoint, yet it's reducing your efficiency. These are the kind of things that our technicians can easily pinpoint and rectify through a quick diagnostic assessment of the machine's performance. All we need is a quick phone call and an internet connection," says Ellis.

"For us, it's the same message. Reach out. Sometimes, I have to remind engineers that they're not God and they don't necessarily know everything. I know sometimes for the technical people, it's a little bit harder for them to admit they don't know everything. We try to encourage everyone to pick up the phone and call the manufacturer. I think that giving our suppliers a call and saying, 'Can you help us? I'm struggling. I don't understand.' It is very valuable," says Ramirez.

Understand Your Improvement Goals

You have to have a clear goal when you set out to improve a process. It may be a quality challenge, a cycle time challenge, or a set up challenge. It may be multiple things, according to Ramirez. "If you look at the fishbone, it could be multiple spines causing one problem. At the end of the day, what we want to do is have the product built, flow, and able to meet or exceed any quality requirements. That's what we want to accomplish," he explains. "It's interesting because we were talking earlier about the machine

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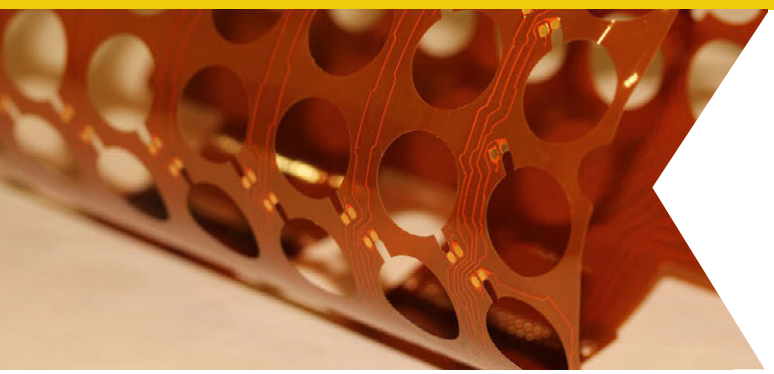

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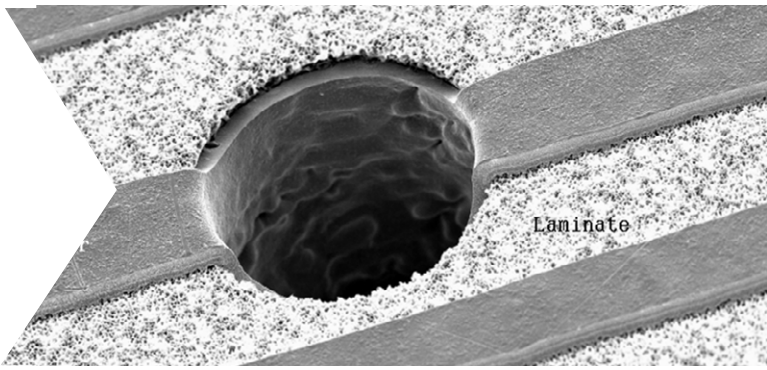

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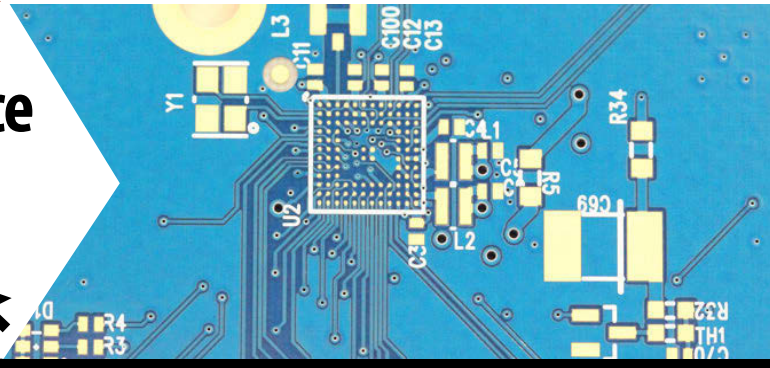

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cycle times. Some of our machines run 100,000 or a gazillion components, but interestingly enough, we have found that in some instances, slowing down the equipment significantly improves the output and the flow. It is a compromise. Back to your question about the goal, it could be many different aspects. It's just a matter of understanding what is it that you're trying to accomplish and what could be negatively impacting the goal."


Chris Ellis

"We're rabid about reducing waste and we sit down, we value-stream map, we do some measurements, and we see where we should focus first," says Prina. "The tough part is always how you make sure that whatever you've done sticks. We try to use multiple events and things like that. Get people involved and then go back and just get that standard work written down and then checked daily at a supervisor or lead level, and check monthly at an executive level. Did we stink? Are we still headed in the right direction? What's our next step? Okay, we reduced 50% of the waste, how do we get 50% out of there again?"

Best Practices

So, what are the best practices to consider when improving the electronic assembly process? Prina says its "measure what matters."

"For years, we've picked out a number of KPIs and we just took some numbers here, took some numbers there, and didn't really do much with them," he says. "We didn't get much effect for it. We built some KPI trees, decided what key processes we really want to monitor and what we're going to do with that information once we have it."

"Back to fundamentals," notes Ramirez. "The theory of constraints. There is one thing that is making your whole process slow. If you focus on that area, then you measure that area, you know that everything else flows. Listen to your employees. That guy or gal that is spending eight hours in front of that machine can probably tell you more about what is causing the problem. Maybe he or she doesn't know what exactly the problem is, but by getting their inputs, understanding under what circumstances these problems happened, they typically can tell you a lot of information and help you actually fix the problem. That is something that we have to keep repeating all the time to our management team. The more your people know, the more you involve them, the better your results are going to be." **SMT**

New 3-D Chip Combines Computing and Data Storage

Researchers at Stanford University and MIT have built a new chip to overcome the challenge of processing massive amount of data into useful information. The results are published in the journal Nature, by lead author Max Shulaker, an assistant professor of electrical engineering and computer science at MIT.

Shulaker began the work as a PhD student alongside H.-S. Philip Wong and his advisor Subhasish Mitra, professors of electrical engineering and computer science at Stanford. The team also included professors Roger Howe and Krishna Saraswat, also from Stanford.

Instead of relying on silicon-based devices, the new prototype chip uses carbon nanotubes and resistive random-access memory (RRAM) cells. The researchers integrated over 1 million RRAM cells and 2 million carbon nanotube field-effect transistors, making the most complex nanoelectronic system ever made with emerging nanotechnologies. The RRAM and carbon nanotubes are built vertically over one another, making a new, dense 3-D computer architecture with interleaving layers of logic and memory. By inserting ultradense wires between these layers, this 3-D architecture promises to address the communication bottleneck.

The team is working to improve the underlying nanotechnologies, while exploring the new 3-D computer architecture. For Shulaker, the next step is working with semiconductor company Analog Devices to develop new versions of the system that take advantage of its ability to carry out sensing and data processing on the same chip.

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Analyzing the Cost of Material in Today's Global Economy, Part 3

by Tom Borkes
THE JEFFERSON PROJECT

Last month, we continued our discussion on the disparities that exist in the cost of the material associated with electronic product assembly.

This is an important yet often overlooked factor in the ability of an EMS provider or contract manufacturer or original product developer (OPD) to compete in assembling electronic products.

It was recognized that any increase in material cost based solely on an assembly operation's geographic location could, in itself, cause a condition that would not allow a turnkey electronic product assembler to successfully compete on the global landscape—notwithstanding the difference that exists in direct labor rates.

Previous research has uncovered the fact that material price variation of this kind is present. The magnitude of the price differences cannot be explained by shipping costs or differences in the overhead costs of a particular component manufacturer or distributer's location.[1]

Considering that material is typically 70–90% of the total recurring production cost of a product, it is clear that even small disparities in material cost as a function of geographic location can bury the effect of labor rate differences. Regardless, it is differences in labor rates that always get the attention of the media and the public.

Why it Matters

In the first column of this series, we established the true variables that affect the ability of a product assembler in a high labor rate location to compete in the global marketplace.[2] These are:

1. High assembly-yield loss causing labor costs in high labor rate operations to balloon due to expensive rework. (Not an issue in low labor rate regions where rework labor costs can diminish the effect of poor process development and control.)


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2. High indirect and general and administrative labor costs that must be absorbed and greatly inflate the labor sell rate.

3. Material cost differences—a potentially big issue and the subject of this series of columns. This is especially true for tier 3, 4 and 5 operations that don't have facilities in low labor rate locations. Tier 1 and 2 companies usually have multiple assembly operations with at least one in a low labor rate area. Thus, they can use a central procurement center to leverage volume production for all their facilities and secure favorable low labor rate material pricing across all of their facilities.

4. Government policy such as corporate tax, tariffs and regulation that affects the cost of doing business.

Notice that the differences in direct or raw labor rate as a function of geographic location do not even make the list. Why?

> "Even though the difference can be substantial, the direct labor rate is a relatively small factor in product cost when examined in the context of reducing labor cost by reducing labor content through automation."

Even though the difference can be substantial, the direct labor rate is a relatively small factor in product cost when examined in the context of reducing labor cost by reducing labor content through automation. This content reduction is realized regardless of where the assembly is being done, but has a far greater impact on cost in high labor rate regions. When the other costs that are associated with variable numbers 1–4 are accumulated and piled on, the difference in direct labor rate has a minor impact on competition.

Of course, companies in high labor-rate regions who have trouble competing will use the pretext of having to go up against uncontrollable, low direct labor rate operations to avoid addressing the controllable root cause of the problem—numbers 1 and 2.

Even though both are controllable through a well-educated staff and workforce, low labor rate competition provides a convenient excuse for failure.

There is similarity here to requiring in-circuit test (ICT) on 100% of the assemblies built even through a 100% functional test will follow. The pretext is ICT is used as a process control tool. Actually, its purpose is to separate the good circuit boards we build from the bad circuit boards we build—those with assembly defects. The good boards go in one pile and the bad ones go into another pile—often the bone pile. As discussed in a previous column, increasing assembly yields can significantly reduce the labor cost associated with rework, as well as the frequency of performing ICT. In fact, if a functional test is being done, ICT can be eliminated altogether. Why? It doesn't pay back to do ICT on every board if it only identifies 1 in 200 boards tested as having an assembly defect. ICT can then return to its proactive function of helping to validate and control the assembly process.

However, there are valid uncontrollable reasons for competitive cost issues. These are numbers 3 and 4 (unjustified differences in material cost and government policy).

My kingdom for equitable material prices!

Richard the III has abandoned screaming for a horse and has taken up looking for material pricing that is not a function of geographic location. Typically, our assembly house doesn't because they don't know any better. Material is material, right?

The assembler generally calls the price paid for this material as raw "M." It is generally the price paid by the product assembler to the material distributor(s) to purchase the unique material for a particular product assembly. It usually does not include common expendable commodities such as solder and cleaning solutions. Distributors are the source of this material unless the assembler is ranked as a tier 1 or tier

2 with volume requirements that permit direct purchases from the material manufacturers.

Marking-up the Material

When generating a quote for a turnkey electronic product assembly, the raw "M" is typically marked-up by the assembler to:

1. Absorb the cost of money for the inventory they carry. This is an estimate of what the funds tied up in inventory could have earned if invested, or the interest that needs to be paid on the money borrowed to purchase the material.
2. Pay for the handling the material (inspecting, prepping, kitting).
3. Account for an estimation of material attrition and scrap. Both of these cause the assembler to have to purchase more material than they should have in order to build the required number of assemblies for the customer. Scrap and attrition are the result of material fallout during production. The material losses can be caused by poor product design and component solderability and packaging issues. Also, poor performance of the automated equipment used in the product's assembly, assembly processes that are incapable and/or uncontrollable, along with other non-conformances increase these losses.

Different companies account for these costs in different ways. Regardless, they must be accounted for.

The inability of assembly operations to properly manage material losses by accurately estimating these losses during the quoting process, and minimizing the losses during the production process, has resulted in many assembly companies effectively wrapping a $5 bill around each assembly they ship—then it's, "the more we ship to our customer, the more money we lose!"

However, in a business that has razor thin, "supermarket" level margins to begin with, the above issues concerning material performance will not last long (i.e., last person to leave please turn out the lights because the party's over).

But, this is not what I wanted to discuss in this column. Our immediate interest concerns the cost of the raw "M" to the assembler as a function of the geographic location of the assembly operation.

What contributes to the material cost of an electronic product?

Last month, we listed the cost elements affecting the price the assembler pays the material distributor.[3] These are:

1. The cost that the component manufacturers charge the distributors for the material they manufacture.
2. The distributor's overhead cost that must be loaded and absorbed in the component price.
3. The quantity of material the assembler orders from the distributor.
4. The currency that will be used to pay for the material (e.g., U.S. dollar (USD), yuan, etc.).
5. Any applicable import and export tariffs.
6. And, yes, the location where the material is shipped (although not publicized).

These costs are uncontrollable by the assembler and add up to the ultimate price that the product assembler pays for material. Of course, we are speaking of turnkey product assembly, or at least the turnkey portion of the assembly, as opposed to assembly with consigned material that is provided by the customer.

We went on to focus on uncontrollable material cost variable number 4: how monetary exchange rates affect the price paid for material.

We arrived at the surprising conclusion that a weak yuan, or what politically is the subject of derision in many circles because of alleged unjustified manipulation to keep the currency undervalued, actually should be an advantage to assembly companies paying in USD for electronic product material.

While a disadvantage for assembly labor in high U.S. dollar labor rate markets, a weak yuan should be an advantage in a strong currency environment because the material should be less expensive to purchase (i.e., a strong dollar buys more yuans, or buys material at a reduced price).

What is it then?

If it's not exchange rates (cost variable number 4), it's got to be the distributors running two

sets of books—one for customers in the high labor-rate world and one for those in low labor-rate regions.

Do the distributors have dual pricing structures because the component manufacturers charge them more if they are distributing to assemblers in high labor-rate areas?

Is it because of distributor overhead costs are much more in high labor-rate areas—material cost variable number 2? This was looked at in detail and the material price disparity could not be justified by this factor.[4]

"Then, what remains to explain the significant difference in material pricing for product assembly depending on where that assembly is done?"

That leaves material cost elements 5 and 6. Item 5, import and export tariffs, is generally applied to assembled products, not raw or manufactured (inseparable) material such as electronic components. However, this is a complex subject and is dependent on the specific material of interest. It will be addressed in more detail next month in the final column on the subject of analyzing the cost of material.

Then, what remains to explain the significant difference in material pricing for product assembly depending on where that assembly is done? Without the curiosity to first obtain the data and then challenge the data, we stop here and say, "It's just the way it is."

Data Explosion and Assimilation

I remember in the early 1970s, at the dawn of the digital revolution, some suggested that twice as much data and information existed in 1970 as in 1960. And, therein lies the rub. Data and information are pretty much useless until codified into knowledge. Applying critical thinking to the knowledge can allow it to be transformed into wisdom. This is what is commonly called the DIKW (data, information, knowledge, wisdom) hierarchy or pyramid. In my view, it is the responsibility of the educational system to provide the students with knowledge and teach them how to find the path to wisdom.

How does a public education system grapple with these geometric data and information explosions? The massive amount of information added to the public domain certainly hasn't stopped since 1970 and shows no sign of doing so in 2017 and beyond.

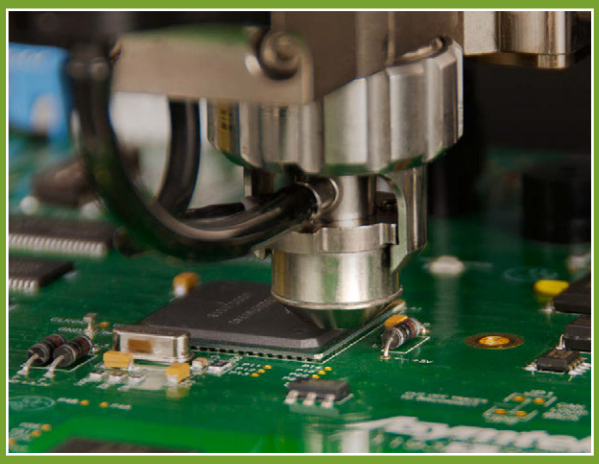
An educational system can capture the data and information in a digital format and store it on hard drives. It can teach the student how to access the information and require the student to glimpse into this cloud, memorizing certain information strings. However, unless the educational system can successfully help the student construct ladders to convert the information into knowledge, and then the knowledge into wisdom, their job is woefully incomplete.

This is the challenge facing our educational system. It will not be met by continuing a system that is failing or trying to improve by nibbling around the edges. The system must find a way to engender all students' curiosity and develop in them a love for learning that will last throughout the student's life.

It is tempting to say everything will change so why bother. Either just start by teaching the student the latest 'gee whiz' data, or continue to teach what is obsolete and is of little value to them in the real world. Since relativism is the soup du jour, you are what you think—there is no absolute.

An alternative is to suggest certain basic tenets and values will transcend the onslaught of new data and information—the wisdom will always remain true. There is not one ladder that leads to that wisdom, but many. On the journey, we jump from one ladder to another like Mario on a Pac-man™ screen.

In his 1995 book, Nicholas Negroponte discusses an economy based on atoms versus an economy based on bits.[5] We are taxed and the market assigns value to the magazine we buy at the newsstand, but not on the content on the hard drive in our laptop. What would you say the value of your laptop is to you? Is it the $3000



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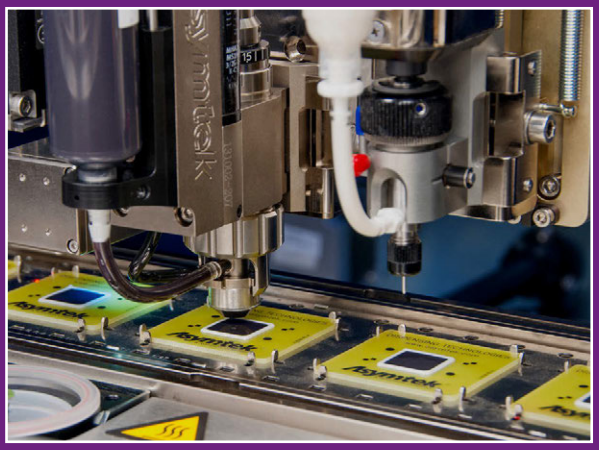

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you paid for it, or is it a lot more based on the 1s and 0s you have added to the hard drive or the cloud? What value do you declare for your computer when going through customs?

Will the issue of the price we pay for electronic components become moot and evaporate when we are able to create components or assembled products by simply printing them in our office? Will the human machine interface (HMI) for the pick-and-place machine become considerably less expensive when we will be able to directly program and control the machine with our brain? Will we even need a pick-and-place machine to assemble an electronic product?

Hey, what do YOU say? I'd like to hear your thoughts, reactions and opinions.

We'll wrap up our discussion on material pricing next month with input from people close to the uncontrollable material cost variables we have discussed in this column. SMT

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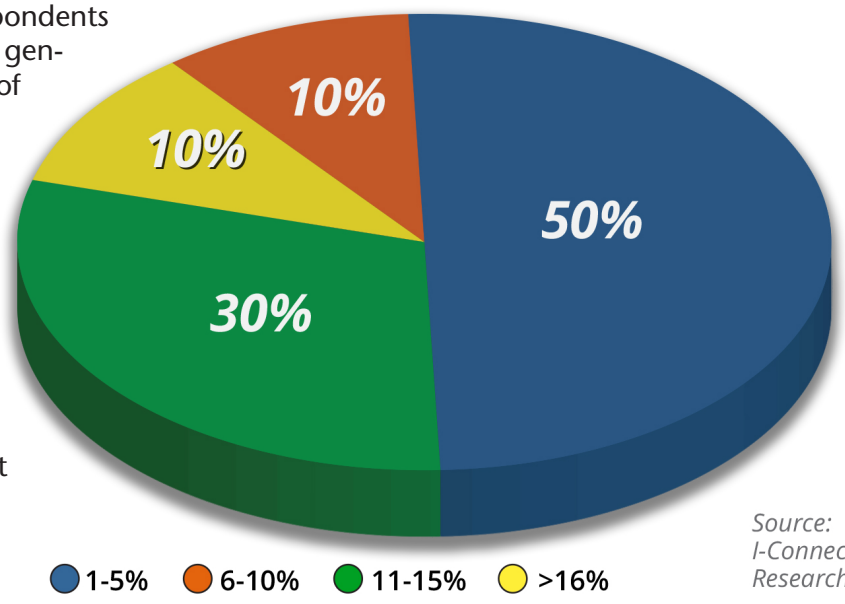
Tom Borkes is the founder of the Jefferson Project and the forthcoming Jefferson Institute of Technology. To read past columns or to contact Borkes, click here.

I-Connect007 Survey on Process Step Elimination: Percentage of Total Cycle Time Spent on Final Inspection

Around half of the respondents answered they only spend generally between 1% and 5% of their total cycle time doing final inspection of their products. On the other hand, about 30% of the respondents said almost up to 15% of their total cycle time is spent doing inspection, while 10% of the surveyed manufacturers even said they spend even longer time than that when it comes to final inspection.



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Empowering the Workforce Through Training: An Investment Return

by Daniel Prina
MC ASSEMBLY

Training is not shiny nor romantic. It doesn't make the front page of the magazine, it's not candy apple red, and, unless your executive team is enlightened, it can be a hard sell in the board room. However, lack of a robust and effective training program leads to underutilization and frustration.

Electronics manufacturers should take training seriously at all levels. To remain viable and competitive, it's vital that they keep up with the latest technologies and practices in the electronics field. Perhaps more importantly, investment in employees keeps them engaged and excited in the performance of their daily work. People need growth to avoid stagnation and burnout. Learning new methods and being exposed to new ideas is pivotal to personal growth. A company is, at its foundation, little more than the people that work there. They are responsible for its gains or its declines. The stronger the foundation, the better to build upon.

MC Assembly has always been quick to recognize the need for up-to-date equipment and tooling in the pursuit of quality, throughput, and flexibility. The investment for equipment is often substantial and often, too little thought is given toward maximizing the productivity of capital expense. We leverage the opportunities provided us by our suppliers. The Florida facility runs multimillion dollar Universal Instruments surface mount lines. When buying these lines, we set aside monies to be used in training. That means sending engineers or maintenance personnel for training at their facility in Binghamton, New York, or bringing their trainers to our facilities to work with groups of operators on the production floor. It greatly increases our chances of using our equipment to its full potential. Likewise, we are in the process of upgrading our Aegis MES software package (FactoryLogix) and have scheduled multiple tiers of training for engineers, process writers, and operators who will be using the application.

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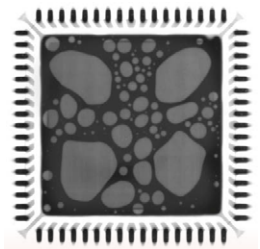

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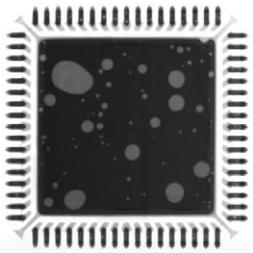

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our Florida and Massachusetts facilities, Incito Man training for all employees in addition to 150 employees that received this training in our Mexico facility. This program is an introduction to product flow, value stream mapping, and Lean manufacturing. Incito Man is a combination of classroom study and live, hands-on simulation. We train in groups of 25 employees selected from a variety of departments. They start in a classroom environment where they are given the basics of Lean. Then they're brought into the live simulation room where they are instructed that they have to build 30 robots out of Legos in 15 minutes. The process they are given is heavily constrained and flawed.

After 15 minutes, the employees have built somewhere between zero and three units. Often, there are defects in these units and employees are convinced that this is an impossible task. We review what went wrong and what went right with the round.

The responses vary, but typical themes are that the "stockroom personnel" are disorganized and that additional personnel are needed. The employees go back into the classroom and are shown how progressive build and better flow can yield higher quality product and more volume. Employees are shown the basics of creating a value stream map and will map out the Incito Man build. Meanwhile, the simulation has been reset and the employees are turned loose once again to attempt to build 30 robots in 15 minutes. They can move some of the processes, eliminating or reducing some constraints.

During this round, we typically get 10 to 12 units to our customer. As a group, we review cycle times and takt time requirements for the second round and discuss what went better during that round and what has yet to be improved. The third classroom session involves 5S organization and visual identification of product status. All constraints are removed for the third round and employees can reorganize the entire process.

It's common that, by this time, the employees have streamlined the process to the point where they are able to free up some resources and build using less personnel (remember in the earlier rounds, when they thought that adding personnel was the solution?). Those that have been freed up from their tasks are assigned a "development project" building Lego dragons. The simulation is restarted and we nearly always get all 30 robots to the customer as well as five to 10 Lego dragons. Aside from being a great team building exercise, we've given the employees basic tools to make their job easier and their workplace, more efficient. Most employees can't wait to get back to the shop and employ some of their new skills. It generates a ton of excitement for continuous improvement.

Several of our suppliers and customers have sent their own employees to participate in the Incito Man training alongside MC Assembly's employees. Through this training, we hope to promote understanding and help bring up the level of those who provide service to us.

Incito Man training is given to all employees, as Lean can be applied to all aspects of our business. However, much of our training is more specialized depending on the employee's job function. We provided Excel training for our production control, manufacturing supervisors, and process data management personnel. Although many of these employees had a firm grasp on the basics of Excel, they lacked some of the advanced training that allowed them to more fully use the software package and create short-

Figure 1: MC Assembly's Mexico facility team undergoing government certified electronics training course.

Figure 2: MC Assembly's Mexico facility team with their certificates of completion from the electronics course.

cuts to make their job more efficient. Based on need, several went on to even more advanced training where they learned how to create macros and graph data for analysis purposes.

We have multiple certified instructors of IPC and J-Standard on staff. They conduct classes to certify inspection and soldering personnel on site. Recertification is performed as required and the trainers are an available resource for clarification. They reinforce, daily, what trainees have been taught.

We are in close contact with the local colleges and universities. We help in training their engineering students through sponsorship of their senior design projects; sometimes, this includes as many as four teams at a time, providing them with projects and mentoring. In turn, we often receive assistance and the professors reach out to us with opportunities. There are many courses available that directly correlate to developing skill sets that are in high demand in our industry.

Repetition is key to proficiency in any training. Like any ISO or AS certified shop, we have an established QMS with procedures supporting specific functions. Around two or three years ago, we expected that we could hand an employee a written process, ask them to read it, and consider them trained, thinking they would follow what they had "learned." We have since realized that it is more likely they had forgotten most of what they read by the time they clocked in the next morning. Breaking this material up into smaller portions and reviewing it on a regular basis creates a habit in following the procedure rather than a regurgitation.

Our Mexico facility created a class in-house to provide a Six Sigma overview, which we termed "white belt". This was an introduction to Six Sigma, where the tools of the DMAIC (Define, Measure, Analyze, Improve Control) process are outlined. Even if employees are not developed in the use of these tools, they are now aware that they exist and can request additional training when needed. The Mexico team is now in the process of selecting teams for advanced green belt training for quality and product engineers.

Jose Santos, director of operations of our facility in Mexico, discovered a state-certified electronics course and had 20 employees train for and receive certifications. The payback on this was immediately evident as they lined up for a picture holding their newly signed certificates with beaming smiles. They feel worthy of investment and not just a name on an hourly time clock report.

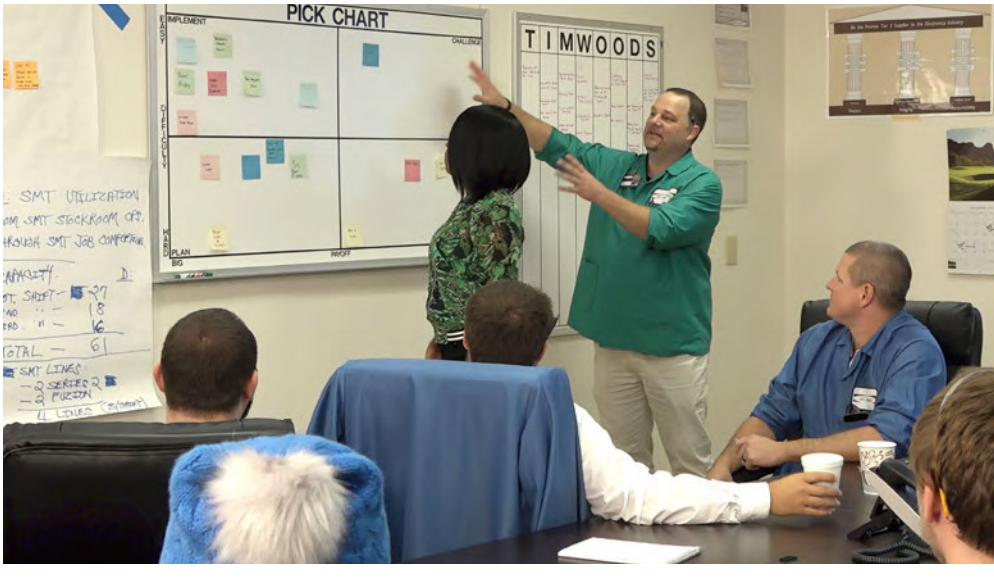

Figure 3: Dan Prina leading a Kaizen training exercise at MC Assembly headquarters in Melbourne, Florida.

Figures 4a and 4b: MC Assembly's Boston facility employees undergoing Inctio Man Lean Enterprise Simulation training.

Inspired by the initiatives shown in Mexico, the Florida team commenced on a journey to certify nearly a dozen employees in Six Sigma Black Belt study. This provides tools for statistical analysis of data and process improvement. It requires candidates to successfully lead a team through an actual project in Six Sigma process improvement. This is a train-the-trainer opportunity. Master Black Belts certify Black Belts, who can lead and mentor Green Belts, who can take their co-workers through basic waste analysis, elimination, and control.

Cross-training within our facilities is a mandate from our COO. Flexibility to perform multiple jobs gives employees opportunities to become more valuable to the organization. In this way, we can mitigate schedule risks caused by absenteeism or the departure of an employee. Cross training to eliminate a single point of failure is a benefit for the company and is rewarded during employee reviews. Tracking this training is performed by their area supervisor and training should be interdepartmental.

We spend a great deal of time outside of our facility, benchmarking training methods and ideas for best practice. Through this process, we have adopted the following beliefs and practices:

- Visually displaying training opportunities is important
- Employees made aware of what training is available often seek out training and thus training becomes pull instead of push

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- It's all too common to have a superstar in your employ and focus training and development on that person, but to be effective, training must be widespread
- We have created a tuition reimbursement program for personal professional development
- Supervisors must identify training needs and fill them. Someone, somewhere in your organization should be in training right now
- Let trainees become trainers. Nothing teaches like teaching
- Kata – train until a process becomes habit

Since the beginning of our Lean journey, over two years ago, we have initiated more than 50 kaizen events, carefully selected to make improvements that will contribute to our goal. Initially, these events were chaired and run and peopled by supervisors and leads, or engineers. And while these events were deemed successful, we have changed tack and instead now select participants who are users of the process under review. They are given the training needed to properly effect process change. This ensures the presence of a subject matter expert during the event and includes employees in the development of solutions to our everyday problems. In doing so, we are creating an army of problem solvers rather than a facility full of people waiting to receive direction from someone who may not be as familiar with the process as they are themselves.

The training becomes its own reword. We have a proverb posted in our Lean project-management office: "Tell me and I will forget, show me and I may remember, involve me and I'll understand." One, two or 10 people cannot drive cultural change. It requires empowerment, engagement, and consistency until it takes on a life of its own. Our early events involved convincing and coercion of employees to attend projects. But given even a modicum of success, employees were ready to join the next team and often requested to be involved. When their co-workers saw the change, and heard the success stories, they too became willing participants in the movement.

Training allows employees a higher sense of self-worth. It gives them confidence and the knowledge needed to transform the world around them. It can eliminate the need for close supervision. It eliminates employee frustration and eventual disengagement due to feelings of being powerless to effect change.

Although it may be more difficult to measure, a well-trained and empowered workforce will do more to drive quality, cost effectiveness, and continuous process improvement than the newest, sleekest, and fastest automation on the market. **SMT**

Editor's Note: For more information on Incito Man Lean Simulation training, click here.

Daniel Prina is the project manager of Lean enterprise and continuous improvement at MC Assembly.

MC Assembly Training Video

MC Assembly recently completed, in our Florida and Massachusetts facilities, Incito Man training for all employees in addition to 150 employees that received this training in its Mexico facility. This program is an introduction to product flow, value stream mapping, and Lean manufacturing. The training involved a live simulation room, wherein the employees were instructed to build 30 robots out of Legos in 15 minutes. To watch the video, click here.

IPC Global Marketplace

Delivers Intelligent Search Technology

IPC has launched IPC Global Marketplace, an innovative buyer's guide that enables electronics industry professionals to easily locate the products and services they need to effectively run their business.

With its intelligent search technology, mobile responsive design, and enhanced company profiles, IPC Global Marketplace take the user experience to the next level, all while putting your company in front of the "right" professionals in our industry. It's the place to see and be seen.

IPC Global Marketplace is available on IPC's website, www.ipc.org or directly through ipcglobalmarketplace.com.

MilAero007 Highlights

Ultra Electronics to Acquire Sparton

Sparton Corp. has entered into a merger agreement with Ultra Electronics Holdings plc, pursuant to which Ultra will acquire Sparton for $23.50 per share in cash.

Sanmina Expands Technology Center in Southern California

Sanmina Corp. has expanded its technology center in Costa Mesa, California. The company's technology center now offers an end to end solution, integrating microelectronics, PCB fabrication, PCBA, memory products, quick turn prototyping, NPI, and manufacturing services.

Inovar Breaks Ground for New Facility on USU Innovation Campus

Inovar Inc., a full-service EMS provider, has secured a spot on Utah State University's Innovation Campus. Company officials recently broke ground on a 100,000 sq. ft. facility at the university's research park.

NEO Tech Invests in New Facility to Support New England High-Tech Customer Base

NEO Tech plans to combine its two existing New England locations into a single site that will be more efficient and will offer customers improved service from a consolidated team. The Wilmington and Springfield, Massachusetts facilities will be relocated into one centrally-located facility in Westborough, Massachusetts.

Nortech Systems Secures New Credit Facility of Up to $21M

Nortech Systems Inc. has closed a new credit facility of up to $21 million with Bank of America Merrill Lynch, with an additional $20 million accordion feature.

Zentech First to Recertify for IPC Qualified Manufacturers Listing

Zentech Manufacturing Inc. has become the first company to be recertified to the IPC-J-STD-001 Space Addendum QML program.

Jabil Opens Mechanical Integration Facility in Silver Creek

Jabil Inc. has announced the grand opening of its Silver Creek mechanical integration facility, which enables Jabil to office customers specialized expertise and resources for complex metal fabrication, welding, assembly and integration services.

Cicor Strengthens Financial Flexibility with New Financing

Cicor signed a new syndicated loan facility on Friday 30 June 2017 with a financing framework to the amount of 75 million Swiss francs.

AWS Group Sustains Growth for Fifth Consecutive Year

AWS has announced continued revenue growth for a fifth year running. Since its consolidation strategy in the UK at the turn of the decade, AWS has invested significantly at both its Newcastle-under-Lyme site in the UK and its Námestovo facility in Slovakia, allowing for greater expansion in its offering.

OSI Systems Completes Acquisition of Explosive Trace Detection Business

OSI Systems Inc. has completed its previously announced acquisition of the former Morpho global explosive trace detection (ETD) business from Smiths Group plc for $75.5 million in cash, subject to a net working capital adjustment.

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The EMS Skills Gap Epidemic

by Steve Williams
THE RIGHT APPROACH CONSULTING LLC

Interviews with EMS industry executives across the country are united in their top concern for their businesses: finding new talent. Manufacturers can no longer afford to wait. It is time to educate and train the next generation of manufacturing.

The Results Are in

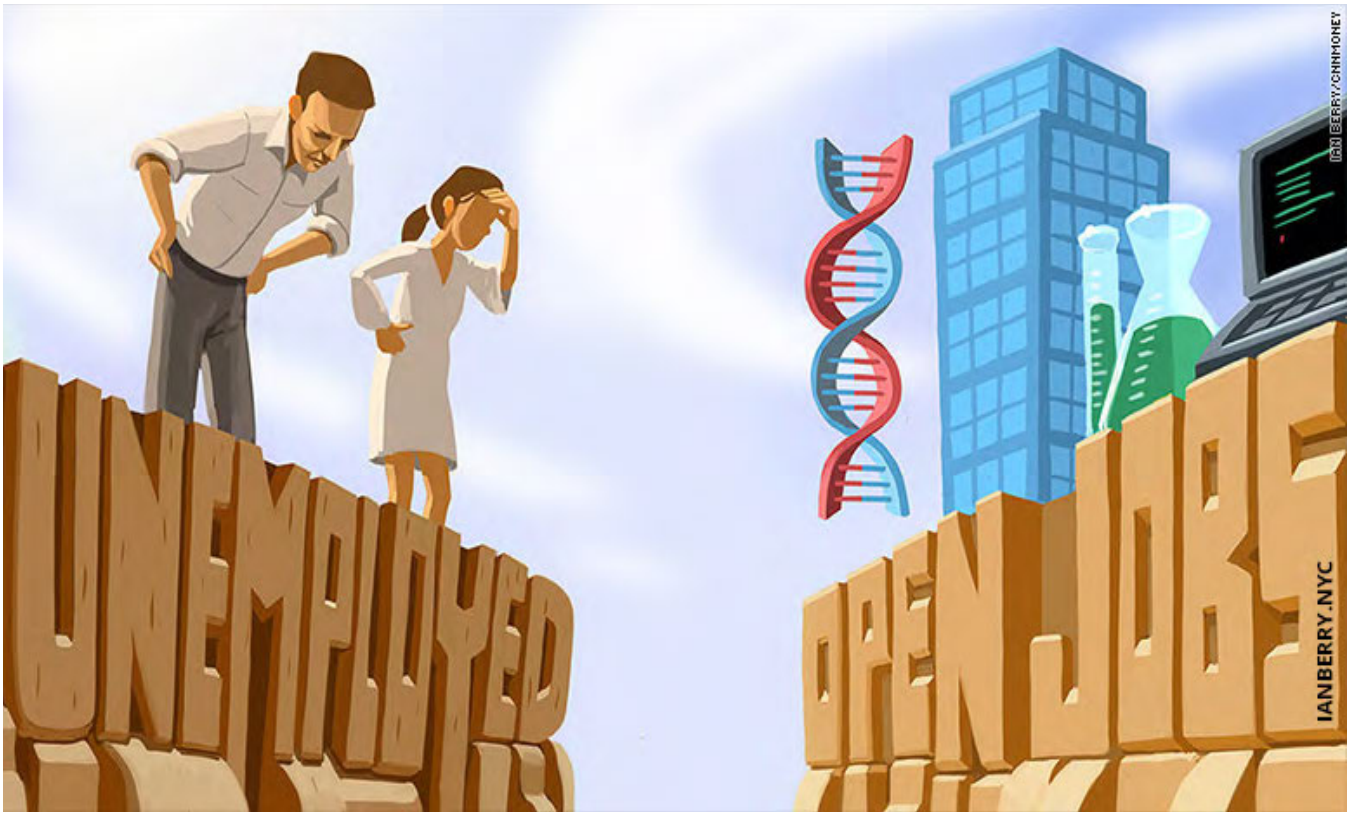
Is this really a problem? The short answer is yes; actually, it's hell yes! According to the U.S. Bureau of Labor Statistics, every dollar spent in manufacturing adds $1.37 to the U.S. economy, and every 100 jobs in a manufacturing facility creates an additional 250 jobs in other sectors. Yes, Virginia, manufacturing matters.

A recent survey by Career Builder, an online service that matches job seekers with open positions, highlights one of the most frustrating aspects of the current job market: Why can't employers fill their positions when approximately 7.5 million Americans are unemployed, and millions more are working part-time because they can't find full-time positions or have given up looking for work altogether? Looking at the following survey data, 68% of employers who said they were increasing their number of full-time, permanent employees in the first quarter (Jan.1–March 31, 2017), currently have open positions for which they cannot find qualified candidates. This is consistent across company sizes:

- 1-50 employees: 49% unfilled positions
- 51-250 employees: 74% unfilled positions
- 251-500 employees: 72% unfilled positions
- 501+ employees: 71% unfilled positions

The manufacturing skills gap is real.

Deloitte recently did an analysis of the skills gap from 2015–2025 that shows alarming results. The analysis showed that over the next decade nearly 3.5 million manufacturing jobs



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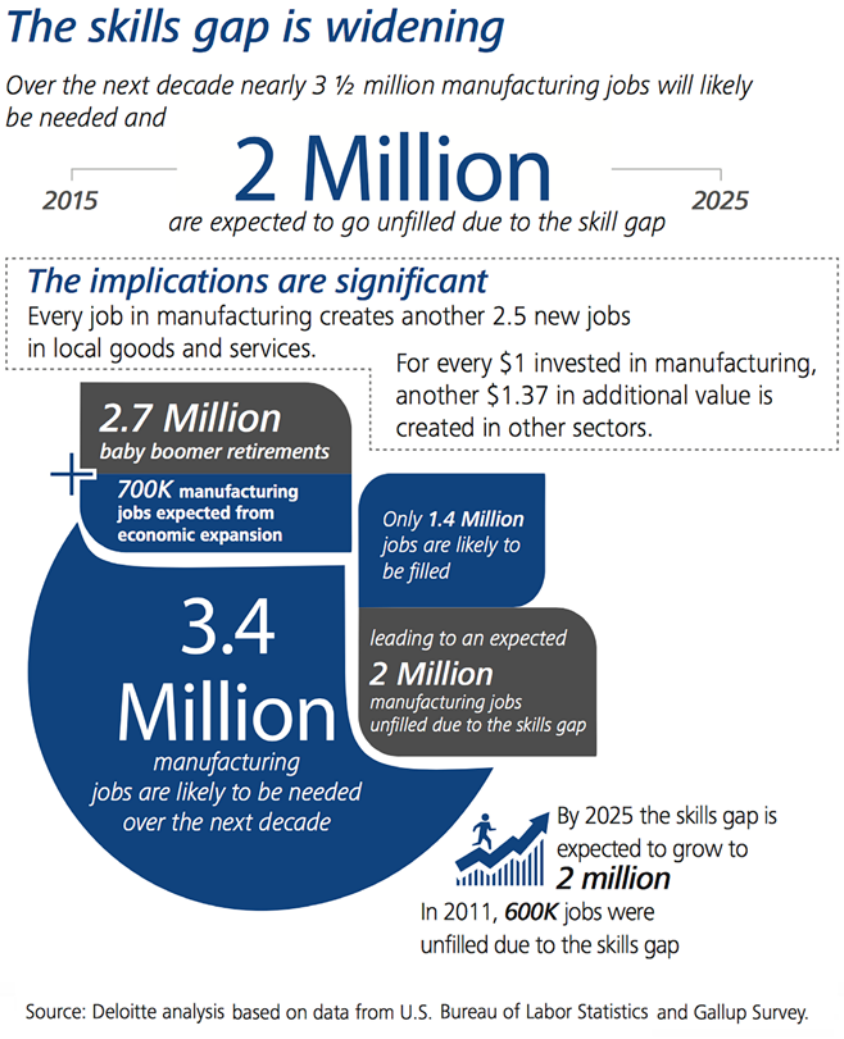
will need to be filled, with 2 million (60%) of those jobs going unfilled directly due to the skills gap. With industry executives around the globe identifying talent-driven innovation as the number one factor in establishing competitive advantage, it is very easy to draw a direct negative correlation from skills gap to growth and profitability. Deloitte reported that 82% of executives responding indicate they believe the skills gap will impact their ability to meet customer demand, and 78% believe it will impact their ability to implement new technologies and increase productivity.

In addition, executives indicate the skills gap also impacts the ability to provide effective customer service (69%), the ability to innovate and develop new products (62%), and the ability to expand internationally (48%). The sobering takeaway from the data is that the skills gap is real—and so are the consequences. An overwhelming number of American executives (92%) believe that American workers aren't as skilled as they need to be, and American workers agree, with 1 in 5 saying their professional skills are not up to date. What does this mean in bottom-line dollars? Almost $1 million in lost business for most companies.

This is a wake-up call for the industry.



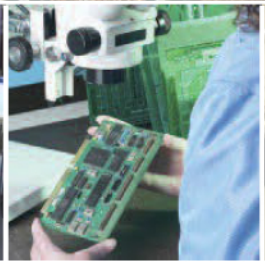
Source: Deloitte analysis based on data from U.S. Bureau of Labor Statistics and Gallup Survey.

College is a path, not a right!

A changing society is as much to blame as anyone for the lack of bench strength in our U.S. manufacturing companies. Ask any young person and they will probably tell you that college is not a privilege, it is a right! (If you really want to blow your mind, ask them who they think should pay for it.) Not to paint all young people with an overly broad brush as there are plenty of hard working kids with their heads on straight, but compared to past generations, they are a bit of an entitled bunch. Remember the aforementioned hard work, dues paying and understanding that you must earn what you want? Not so much with today's youth. Right out of college they expect a cushy desk job, with an office and a high-paying salary because they "paid their dues" simply by just going to college.

I don't blame the kids; first, I blame the educational system that teaches them from a very early age that college is the only choice, and that they are entitled to it. Remember when college was just one of three potential paths that high school graduates could pursue? The other choices were the trades or to enter the general workforce, both providing just as many opportunities, if not more, then the college path.



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Contrary to what our children are being taught, college is not for everyone, and certainly not for every job. What we have now is an awful lot of college educated 20–30 somethings asking, "do you want fries with that?" or choosing to live in mom and dad's basement because getting their hands dirty in a factory job is beneath them. I remember guidance counselors that actually helped students determine what to do with their *life,* not just what to do in *college.*

Second, I also place blame with the parents! We have been seeing the "participation trophy" generation entering the workforce for a while now, and the results are not pretty. Parents that push kids into college to earn a degree that there is little market for are part of the problem. Encouraging their kids to stay at home far longer than ever before is enabling the *entitlement syndrome* that has created the situation we are in relating to the next generation of manufacturing craftsmen and women.

Taking five, six, and seven years to graduate with a four-year degree is now the norm. I could write an entire book on how the participation trophy philosophy is leaving our kids ill-prepared for not only work, but life. Sorry kids, but life is not fair, never has been, never will be. Our children have lost the ability to handle failure and learn from their mistakes—invaluable life lessons. A recent Fox poll of current university students really highlights this point. When asked "What age do you consider yourself an 'adult'?" The overwhelming response was 30! Wow, when my generation was growing up the answer was 18, and we couldn't wait to get out on our own.

Brain Drain

There is no question that America has an aging workforce; and this is neither unique to contract manufacturing, nor a new phenomenon. However, in my humble opinion, the talent issue facing EMS leaders today is the most challenging I have seen over my 40-year career. In fact, I had this very discussion recently with John, an old friend that happens to be a senior executive with a midsize contract manufacturer on the east coast. As we spent some time catching up and talking about business, I asked John what kept him up at night. He said, "Steve, that's easy, people. We have a difficult time not only finding engineering talent, but also assembly, high-temp soldering and basic manufacturing people." We continued our discussion comparing notes on the lack of "minimum required skills" that the average job applicant walks through the door with. As I tend to routinely talk to a lot of industry leaders, unfortunately, this is not a one-off. This got me thinking, and again, comparing notes with the hiring managers in our industry, on what exactly are those "minimum required skills" that contract manufacturers are looking for.

Minimum Required Skills

Talking with many EMS executives and hiring managers over the past year, this is what they are looking for in an ideal new employee candidate:

Résumé
Skills for Entry-Level Assembly Position

Required Knowledge, Skills & Abilities

- Read and speak English
- Component identification skills for both PTH and SMT components, including polarity are required
- Be familiar with use of calibrated tools used for assembly, measurement and verification, such as pneumatic power tools, torque drivers or critical measurement tools such as calipers and pin or hole gauges is required
- Creative thinking and the ability to apply solutions
- Must be able to understand and follow complex work instructions, adapt quickly to changing priorities and job assignments and work well with others
- Advanced soldering skills to perform complex rework, modification or repair of PTH and SMT circuits in accordance with IPC Rework and Repair standards
- Working knowledge of IPC A-610 specifications is required and certification is desired
- Ability to perform simple computer related tasks such as data entry, look up information related to job tasks, and email
- Good manual dexterity, good vision and the ability to stay seated for long periods of time

- Must possess the ability to comprehend moderately complex written and verbal instructions (in English)
- Ability to write simple correspondence
- Ability to effectively present information in one-on-one and small group situations to customers, clients, and other employees of the organization
- Must have the ability to perform basic math functions including addition, subtraction, multiplication and division of whole numbers
- Have some understanding of basic metric measurements and tolerances as they apply to dimensional measurements of manufacturing processes and drawings
- Ability to apply common sense and good judgment to carry out detailed, moderately complex written or verbal instructions
- Competent at maintaining a neat and sanitized plant processing environment by religiously following cleanliness standards
- Documented success in effectively cleaning, repairing and maintaining factory machinery and equipment to ensure smooth operations
- Focused on ensuring that the quality of the end-product meets quality control standards by ensuring that each process is monitored closely.

This is not rocket science and certainly not too much to ask.

So, what do we do?

Fortunately, not all young people embrace this mindset, but we must change how, and where, we look for this talent (Figure 3, Skills Gap Variables). You can learn an awful lot about a person before you hire them through social media. If you really listen, the folks that may not be the right candidate for you from a work ethic standpoint will usually let you know that through their social media accounts. Shining examples do exist if you look hard enough. Speaking as a totally biased proud dad, I do have some personal experience in this arena. My daughter was a 4-year elite athlete and finished college in 4 years with honors, got a great job and bought a house at age 25. My son spent 4 years in the U.S. Coast Guard and is now about to become a police officer. Both would be considered millennials and both are not shy about calling out slackers, no matter what generation. Another shining example is Davina McDonnell, director of Marketing at Saline Lectronics Inc. Davina is author of a great series of articles at I-Connect007 titled, *Millennials in Manufacturing,* which is spotlighting the amazing work being done by millennials at her company. So…there is hope!

It's up to us to cultivate the next generation of manufacturers. Get involved with your local school districts and campaign for change. Let them know the jobs that are available in the real world, and the skill set needed from their students to do those jobs. Be vocal about the fact that college is not the only choice, that the trades and skilled general factory work is just as honorable as college. Offer internships for high school graduates and work with local technical colleges and universities to do the same. I had a great interview with IPC President Dr. John Mitchell a few months ago, and he discussed some exciting new programs they are launching to train people in the skill set needed to work in the EMS industry.

As usual, now more than ever, it's up to us to ensure the sustainability of our industry.

I will close as I opened, with the statement that manufacturers can no longer afford to wait. **SMT**

Editor's Note: Portions of this column appeared in Steve's column on a related topic in the May issue of The PCB Magazine.

Steve Williams is the president of The Right Approach Consulting LLC. To read past columns, or to contact Williams, click here.

Supply Lines Highlights

Flex Talk: Mina—Trouble-Free Soldering to Aluminum

Thinking about the RFID market and the significant growth projected in this market, I decided to do a little research on RFID tag manufacturing. During this research, I learned of a relatively new offering, Mina, an advanced surface treatment technology that addresses the common constraints of large scale manufacturing of aluminum on polyester (Al-PET) circuits.

The Importance of Conformal Coating, Now and in the Future

At the SMTA Michigan Expo and Tech Forum, held in Grand Rapids on May 11, Technical Editor Happy Holden spent a few minutes with AIM Solder's Technical Marketing Manager Tim O'Neill to discuss O'Neill's presentation on the topic of conformal coating over no-clean fluxes.

High-Volume Test Strategies

In an interview with I-Connect007 during the recent NEPCON China event in Shanghai, Siegmund Hornig, director of global sales for Europe and Asia, for production board test division at Teradyne discusses the new testing demands from customers, and strategies to help them address their high-volume test requirements.

Universal Adds SMTo Engineering to Channel Partner Network

Universal Instruments has strengthened its customer coverage in Mexico with the addition of a new channel partner, SMTo Engineering S.A. de C.V.

Chuck Ganzer Awarded Nordson's Fellowship of Distinguished Inventors Award

Chuck Ganzer, senior project engineer at Nordson Adhesives Division, was recently recognized and honored with the Nordson Corporation Fellowship of Distinguished Inventors Award. In his 27 years with Nordson, Ganzer—only the eighth recipient of the Fellowship Award—has been granted 24 U.S. patents, which were instrumental for product development across all Nordson's Adhesives Division served markets.

Alpha Celebrates 50 Years in the Italian Market

Alpha Assembly Solutions last month celebrated its 50th anniversary of the Alpha brand in Italy.

ViTrox Appoints MK Technology as New Strategic Channel Partner for South China

ViTrox Technologies has appointed MK Technology Co. Ltd as the new strategic channel partner for both AOI and AXI systems for South China.

Rehm Reorganizes Sales Team

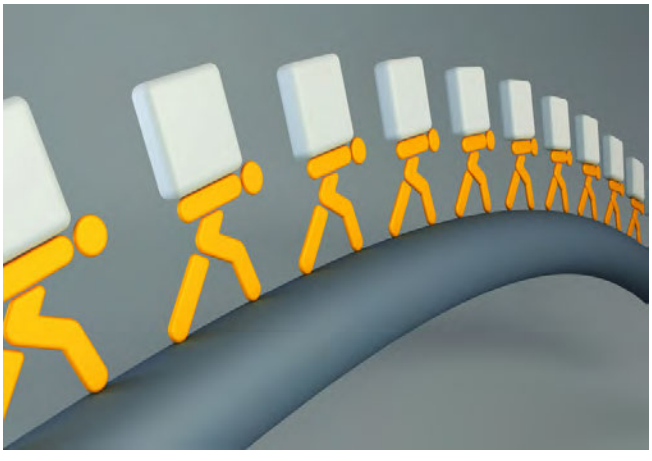
Rehm Thermal Systems has reorganized its sales team to better support its customers and partners better now.

Larry Fey Joins KIC as Principal Electrical Engineer

KIC has appointed Larry Fey to the position of principal electrical engineer. Fey is an exceptionally skilled and accomplished electrical engineer with more than 27 years of hands-on design experience.

Mycronic Doubles Net Sales in 1H 2017

Mycronic has posted net sales of SEK 1.586 billion for the first half of 2017, up by 97% compared with the same period last year.



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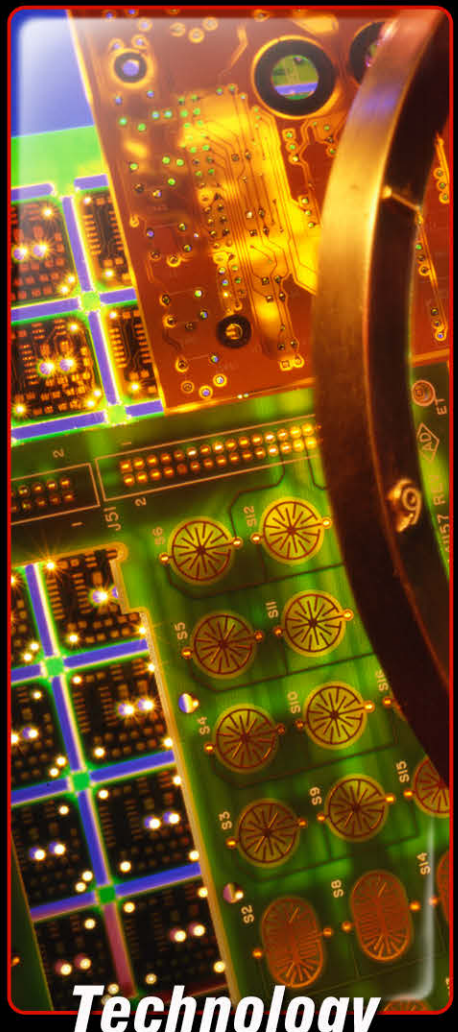

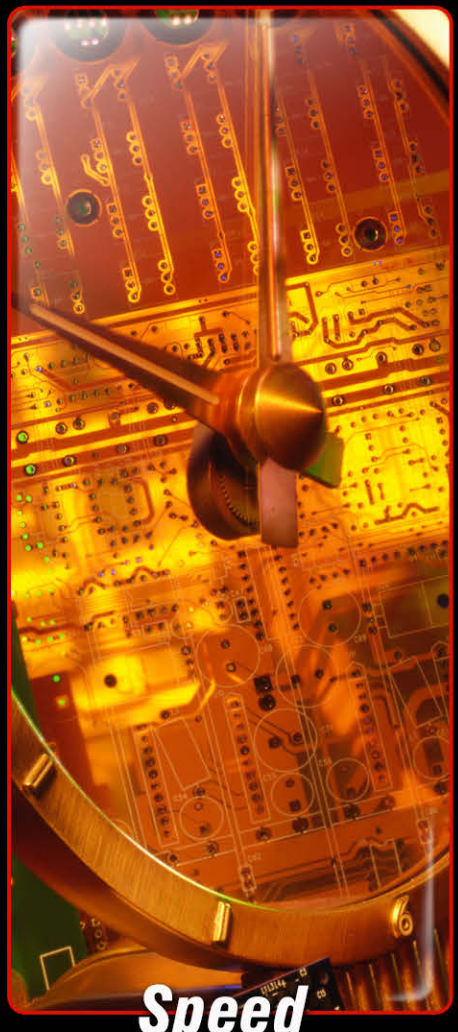

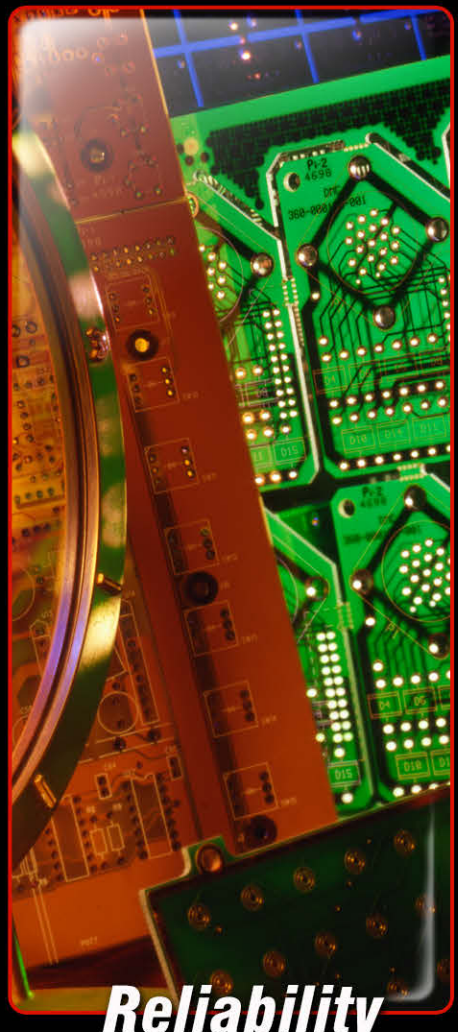

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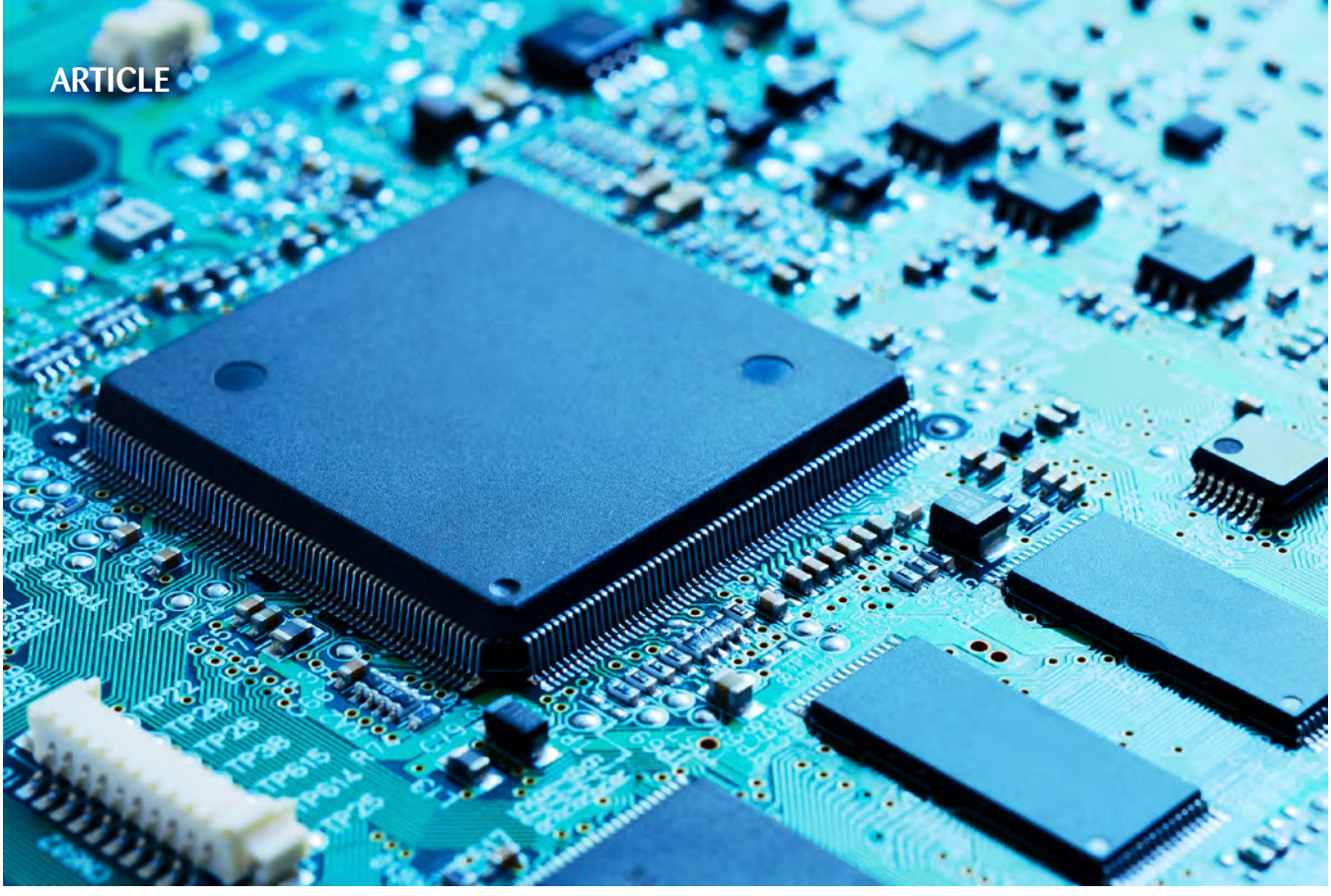

PROCESS STEP ELIMINATION:
Driven by Cost and Efficiency, Enabled by Process and Materials Innovation

by Westin Bent
ALPHA ASSEMBLY SOLUTIONS

Electronics manufacturing has evolved from the early days of hand soldering and wave soldering to the more modern surface mount technology (SMT) process. Most modern electronics are produced using the SMT process, but there are still some mixed technology applications, such as assemblies that are produced using both the SMT process and the wave soldering process. The number of mixed technology assemblies has decreased over time due to advances in the SMT process and the cost savings and increased efficiencies associated with eliminating the wave soldering process.

The recent electronics industry transition from SnPb-based alloys to lead-free alloys has provided electronics manufacturers with the incentive to try to eliminate the wave soldering process step due to the following:

1. Need for equipment upgrades in order to process new lead-free alloys
2. Higher energy costs due to the higher processing temperatures of the lead-free alloys
3. Higher material costs associated with lead-free alloys
4. Increased efficiency associated with eliminating an additional process step
5. Ability to avoid exposing the assembly to the additional thermal stresses introduced by the wave soldering process

Advances in the SMT process such as the development of the pin-in-paste (PiP) process, has enabled the soldering of through-hole components during SMT processing, eliminating the need for the wave process. In the pin-in-paste process the solder paste is first printed directly on top of the through-holes on the circuit board. The through-hole component pins are then inserted

MIRTEC

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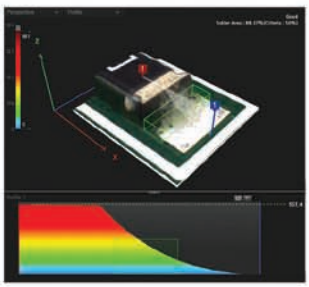
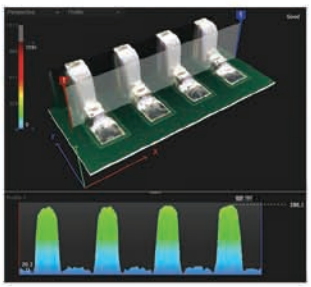
"SMT Hautes Technologies has earned a solid reputation for the assembly of high quality, complex printed circuit boards with short manufacturing lead times. As a High Volume PCBA supplier, SMT Hautes Technologies set out to purchase a robust, post reflow 3D AOI solution with the industry's lowest false call rate. After extensive research, we determined that no other AOI vendor could match the performance and speed of MIRTEC's MV-7 OMNI 3D AOI machine. The MV-7 OMNI has proven to be the perfect fit for our SMT inspection needs." - Stéphane Deschênes - PDG/CEO – SMT Hautes Technologies





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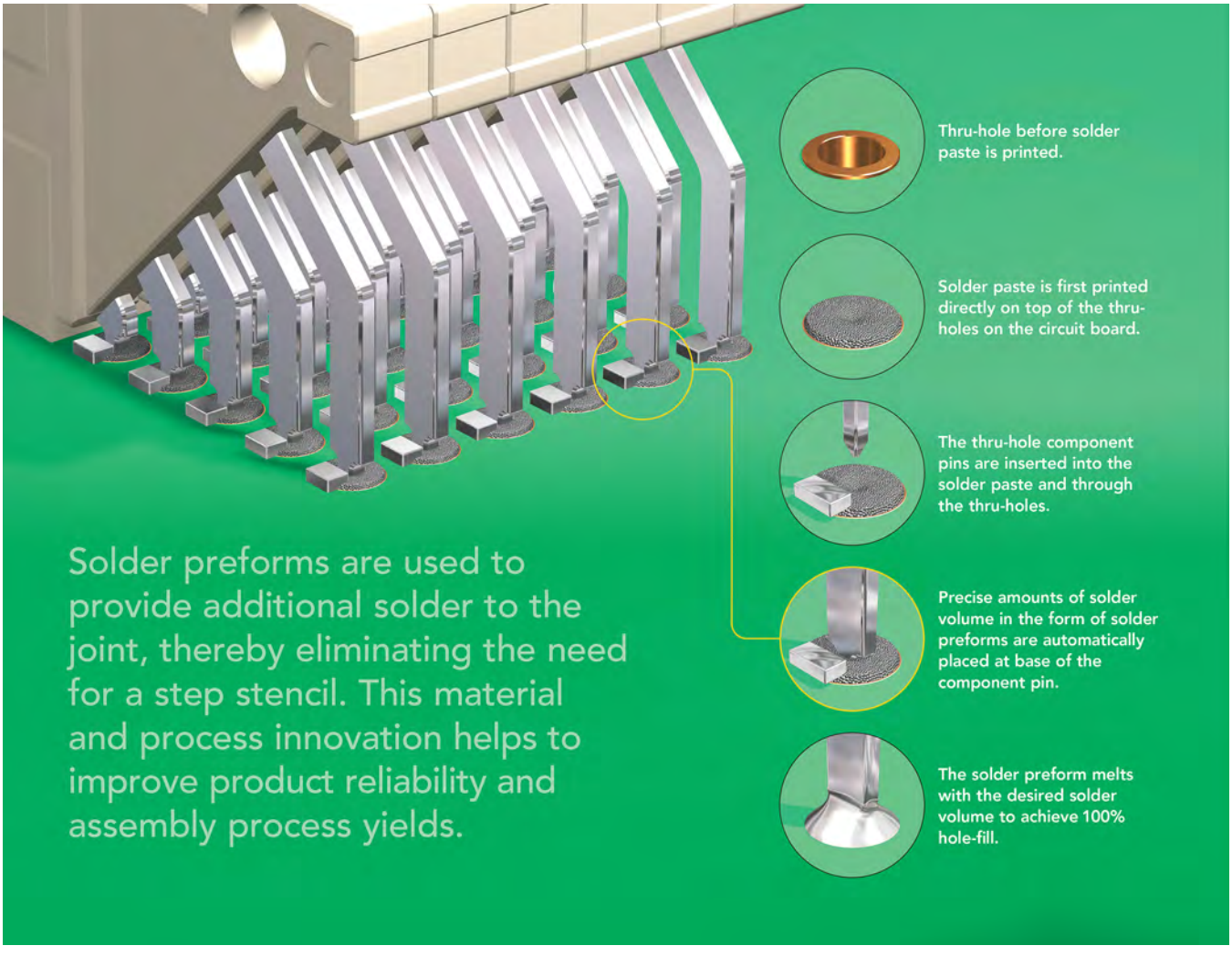
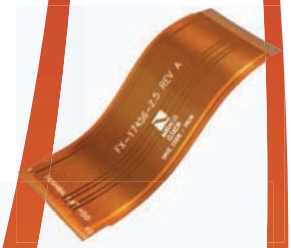


into the solder paste, and completely through the through-holes. Solder materials suppliers have been instrumental in making these process advances viable by developing solder pastes with rheological properties optimized for this type of processing, increasing process yields and reducing issues such as paste dripping from the pins as the assembly moves down the SMT line, particularly in the reflow oven.

Solder material suppliers have also been proactive in developing materials and process solutions to some of the challenges that are inherent to the PiP process. One such challenge is the need to provide enough solder volume to completely fill the through-hole providing the required mechanical and electrical reliability. In many cases, due to restricted real estate on the surface of the circuit board and the intricacies of component design, it is not possible to overprint with enough solder paste (which is only about 50% solder metal to begin with) to completely fill the through-hole, especially on the inner rows of a fine pitch connector.

As board thickness increases, it becomes even more challenging to provide enough solder to fill the through-hole. One solution that has been developed that eliminates the need for a step stencil, is the use of solder preforms to provide the additional solder to the joint. Solder preforms can be stamped in various shapes from solder ribbon and are pure metal alloy. The volume of solder required to fill a through-hole can be calculated and the appropriate sized preform can be stamped to provide enough solder to fill the through-hole. Preforms packaged in tape and reel can then be fed into pick and place equipment to be automatically placed in the appropriate locations.

Engineering And Providing Balanced Interconnect Solutions



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Flux-coated preforms are also increasingly being utilized as part of a voiding mitigation strategy for certain die attach and bottom termination component (BTC) soldering applications where thermal management is critical. Void reduction in these joints means increased thermal conduction away from the die resulting in better die performance and longer lifetimes. Recent studies have shown that flux coated preforms used in conjunction with solder paste can give voiding levels below 5% on BTC components[1]. In some die attach applications, flux coated preforms can be used in conjunction with dispensed paste flux, totally eliminating the need to print solder paste. Pick and place equipment is also now available on the market where dispensing of solder paste or flux material and component mounting can be alternately performed. This means that no separate dispensing equipment would be needed for such a process.

In the case of die attach and BTC soldering applications, the drivers leading to process elimination are improved product reliability and improved assembly process yields, but these are only made possible due to the materials and process development work done by solder materials suppliers. **SMT**

References

1. Lifton, Anna; Sidone, Jerry; Salerno, Paul; Khaselev, Oscar; Marzi, Mike;. s.l. Void Reduction Strategy for Bottom Termination Components (BTC) Using Flux Coated Preforms. SMTAi 2017.

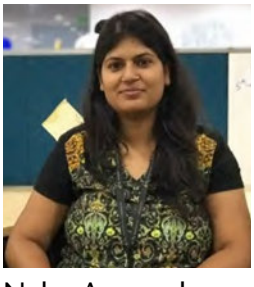
Westin Bent is a senior process engineer, R&D, at Alpha Assembly Solutions.

Acousto-Optic Devices: Finding New Horizons

by Neha Agarwal, MARKETSANDMARKETS

The acousto-optic (AO) methods of optical beams work on the principle of light diffraction of ultrasonic waves in crystals. These methods of modulation of optical beams have several uses in optics, spectroscopy, and laser technology.

AO devices are suitable for various laser applications in scientific research and the medical field for scientific purposes. They are used in barcode scanners, three-dimensional holography, microscopy, spectroscopy, and laser-based medical diagnostics and surgery. For spectroscopy, lasers can be used to make extremely sensitive detectors for various molecules, which can measure molecular concentrations up to parts per trillion (ppt) level.



Neha Agarwal

AO devices are also used in laser microscopy applications. AO tunable filters (AOTF), on the other hand, are used in fluorescence spectroscopy and medical applications, which can access wavelengths from 0.4 µm to 5 µm (up to 25 mm).

The demand for AO devices has increased due to the research conducted in various fields such as imaging cytometry, photoacoustic imaging, optical coherence tomography, and multiphoton microscopy for biomedical imaging and scanning applications. Also, using AO devices for controlling laser beams for cutting materials enables the manufacturing of miniature components such as stents and surgical tools at micron tolerances.

Furthermore, scientists are also using acousto-optic devices with laser technology for research in areas such as femtosecond micromachining, two-photon polymerization, and semiconductor metrology. In the life science and scientific research segments, various acousto-optic devices such as modulators, deflectors, and tunable filters are widely used to modulate the frequency and intensity of laser beams for laser scanning applications.

Despite strong demand for AO devices, however, a significant challenge for the market is the high initial cost and the increasing R&D expenses on this technology.

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Verification of Inspection Results: Local, Central, Global?

Figure 1: Part of a production line with AXI system and inline verification station.

by Jens Kokott
GOEPEL ELECTRONIC GMBH

Inspection systems—such as automated optical inspection (AOI), automated X-ray inspection (AXI) and solder paste inspection (SPI) systems—are now a firm part of every electronics production. Depending on the production size and throughput, these are implemented directly in the line (in-line) or as an isolated solution with automated or manual loading (offline).

However, it is not only the implementation of the actual test tasks that is crucial for an efficient use, but also the meaningful inclusion of the internal company process and data structure. Peripheral modules, such as verification and repair stations, play an important role in this.

Fault Verification Classic: Directly after the AOI System

Even if inspection systems should no longer be foregone, a necessary evil is attached to them: because of the unavoidable pseudo faults and due to the detailed fault classification, verification stations are necessary for classification after AOI or AXI systems.

Within production lines, verification of detected faults is typically undertaken by inline workstations, equipped with a PC, monitor, software and corresponding licences. Their main task is often the dismissing of pseudo faults by the operator. Depending on the cycle time of the line and occurring pseudo faults, the employee is only utilized at this verification station for a part of their working time.

Efficiency through Centralization: Mutual Verification for Numerous Inspection Systems

If numerous inspection systems are available in electronic production, then the logical next step is also to have this employee undertake the verification of results from other inspection systems. Depending on the spatial arrangement of the systems (into one or more lines), this does mean that a part of the working time has to be allocated for the distances to the individual verification stations.

To assess the faults recognised by the AOI system, there is often additional, helpful information available (e.g., comparison pictures of a good PCB or angled-views of the respective part). This ensures that a skilful operator is able to undertake an assessment in most cases without having to view the objective PCB.

Verification with Greater Security: Use of All Test Results

This is now possible with verification software tools. One example is the PILOT Verify verification software, which is a part of the in-

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Figure 2: Verification station software PILOT Verify with AOI and AXI fault images.

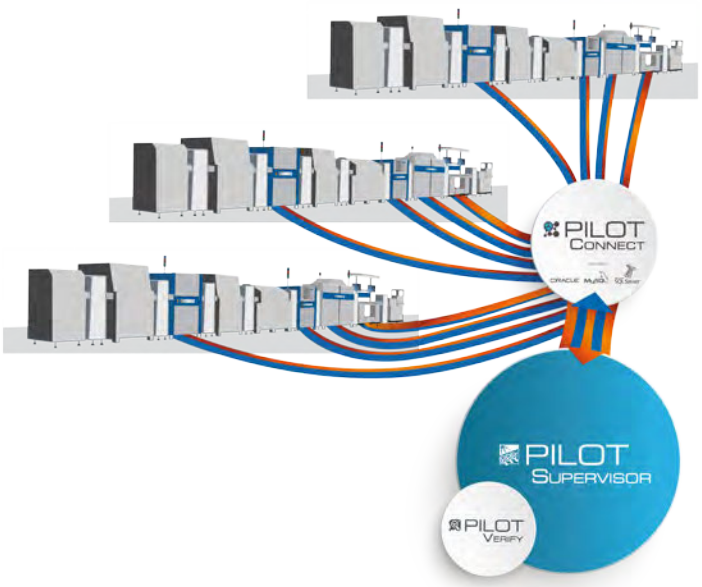

Figure 3: Central verification for numerous production lines with PILOT Supervisor.

spection systems by Goepel electronic. Using this software, for example, not only is the actual AOI fault image displayed, but also the respective angled-view images from a horizontal angle of 45° or 90°, comparison images of a good PCB, or the 3D view of the PCB or solder joint.

If further inspection systems (SPI or AXI) are integrated into the production process, these results, measurements and images are also available for assessment.

Moreover, SPI, AXI and AOI systems from other manufacturers that are already integrated into the production line can also be integrated via the PILOT Connect software module, enabling their results to be presented at the verification station.

Central Verification for Numerous Production Lines

These opportunities shown make it possible to competently assess the detected errors remotely. But how does the technical implementation for central verification take place in a production with numerous inspection systems or numerous lines? A simple solution would be the remote control of existing inline verification stations (e.g., via a remote desktop connection). However, the entire equipment of such a workstation at the respective position in the production line would be required for this, made up of a PC, interface card to the belt module as well as software licences. Both costs and required space for the inline workstation are impacted here.

With a system such as Goepel's PILOT Supervisor, the transfer of the classification result (PASS or FAIL) to the line (e.g., for sorting the PCB into the corresponding hopper), takes place via ethernet communication—either directly with the belt module or via a conversion into potential-free outputs. This ensures the verification of inspected PCBs (by AOI, AXI or SPI) is possible both for numerous lines and for various systems from a central station. In the age of globalization and worldwide networking, this can even be done from a remote company location.

Apart from the central verification of inspection results, the system also enables operators to see these inspection systems in a schematic diagram in their respective production lines, as well as the currently tested PCB. A display of the pending data sets is also available for ver-

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Figure 4: Cross-line diagram of PCBs to be verified.

ification just with a click of a mouse. Furthermore, information about the current throughput as well as the throughput development is permanently available to the respective inspection systems.

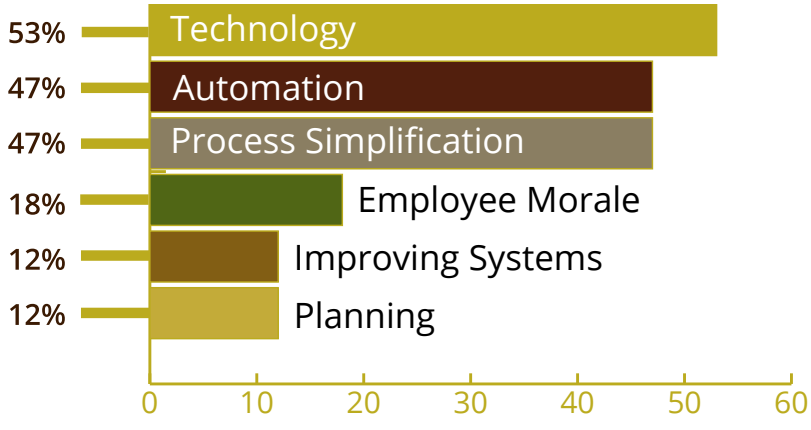
In order to be able to react to possible changes in the production process (e.g., increased number of PCBs to be verified), a flexible assignment of employees to the respective inspection systems by the administrator is possible from a central workstation.

Gone are the days when inspection systems are viewed as something that don't add value in production lines. As reliability became critical in markets such as aerospace and automotive electronics, there is an increasing need for inspection systems to ensure the reliability and quality of electronic assemblies. But with the need for flexibility in production processes amid increasing globalized manufacturing strategies, manufacturers should consider powerful inspection tools that not only provide central verification of numerous lines in local and overseas production sites, but also with a comprehensive presentation of inspection results. **SMT**

Jens Kokott is the AOI product manager at Goepel electronic GmbH.

I-Connect007 Survey on Process Step Elimination: Factors to Improve Productivity

Majority of the respondents in our recent survey on process step elimination consider technology as among the key factors that would impact productivity. Find out more in the upcoming issue of *The PCB Magazine.*



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Electronics Industry News
Market Highlights

Server Shipments for 2H17 to Grow by 10%
Global server shipments fell in the first quarter of 2017 due to the seasonal effect on demand, according to the latest server market analysis by DRAMeXchange, a division of TrendForce. However, shipments rebounded in the second quarter and rose by about 10% compared with the first quarter.

Global Wearable Medical Devices Market Report
The global wearable medical devices market was valued at $2.7 billion in 2014 and the opportunities in the market is expected to reach about $10 billion by 2023, according to Transparency Market Research. The market is projected to rise at a robust CAGR of 18% from 2015 to 2023.

Artificial Intelligence and Blockchain Among Top 10 Technologies Disrupting the ICT Industry
The breakneck speed of innovations in information and communication technology (ICT) over the past few decades has radically transformed the way businesses, individuals and even things such as physical devices operate and interact with each other.

The Lithium Boom is About to go Into Overdrive
Demand for lithium is soaring, thanks to battery demand. And interest in the industrial metal has never been higher.

3D Printing Market Worth $32.78B by 2023
The 3D printing market is expected to be worth $32.78 billion by 2023, at a CAGR of 25.76% between 2017 and 2023, according to a new report by MarketsandMarkets. The growth is attributed to the factors such as the ease of development of customized products, ability to reduce overall manufacturing costs, and government investments in the 3D printing projects for the development and deployment of the technology.

South Korean and Chinese TV Makers' Panel Demand Expected to Pick Up in Q3 2017
Panel demand from South Korean and Chinese TV makers is expected to pick up in the third quarter of 2017, after recording lower-than-planned panel purchases in the second quarter, according to IHS Markit.

Global Printed Antenna Market: Growth Underpinned by Rising Adoption in Defense and Aerospace Industry
A report by Transparency Market Research predicts the global printed antenna market to rise at a CAGR of 7.7% between 2017 and 2025. Progressing at this rate, the market is poised to display an opportunity of $12.87 billion by 2025, up from $6.66 billion in 2016.

Agile IoT Market Upsurges Swiftly to Worth $199.9B by 2023
Every day, every hour, every minute, devices are becoming connected. The Internet of Things (IoT) has gone from a buzzword floating through the echoes of Silicon Valley to a tangible and quickly advancing movement in the world of hardware.

Pulsed RF Power Semiconductor Device Markets to Top $200M by 2022
ABI Research forecasts markets for pulsed RF power devices up to 4GHz will show continued moderate growth over the next five years and exceed $200 million by 2022.

Semiconductor Production Equipment Market Report
Rising demand for tablets, smartphones, wireless communication infrastructure, network hardware, digital televisions, computers and medical devices is encouraging the global demand for semiconductors, thereby boosting the demand for semiconductor production equipment.

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Soldering Fumes in Electronics Manufacturing: Damaging Effects and Solutions for Removal

by Stefan Meissner, ULT AG,
and Arne Neiser, SEHO SYSTEMS GMBH

Modern electronics manufacturing is made up by a multiplicity of different separation and joining processes, with the later surely taking the vast majority of production technology. Alongside gluing, welding and laser processes, soldering still holds a primary position in electronic assemblies. However, soldering methods are not always equivalent, because there are quite a lot of different soldering technologies. Accordingly, you have to distinguish between automated and manual soldering procedures.

No matter which soldering process you analyse, all of them have one aspect in common: They produce airborne pollutants, which may have a negative impact on employees, plants and products as well.

Soldering Procedures in Electronics Manufacturing

There are a variety of soldering procedures, but not all of them are used in electronics manufacturing. Common soldering techniques in assembly production are:

- Wave soldering or flow soldering
- Reflow soldering
- Dip soldering
- Hot air soldering
- Selective soldering
- Laser soldering
- Vacuum soldering
- Vapor phase soldering

In the production of electronic assemblies, almost only soft soldering is used. The melting temperature of the solder is lower than the melting temperature of the elements to be joined (e.g. component leads to PCB pads [approx. 180 to 260°C]). The molten solder flows

Figure 1: Selective soldering plant (Courtesy of SEHO Systems).

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between the metal parts. The objective is to create a firm, airtight, corrosion-resistant, electrically and thermally conductive interconnection. The solder is mostly designed from alloys in the form of solder wire, solder bar or solder paste. Depending on the scope of application of the final product, these alloys are composed of tin, lead, antimony, silver and/or copper. In the solder, fluxing agents can be contained, which are compiled from different chemical compositions such as rosin. Normally, halogen-free flux agents are used to support the build of proper solder joints.

Automated Soldering Procedures and Hand Soldering

Some decades ago, numerous workers, equipped with soldering irons, soldered electrical assemblies by hand, whereas today automated soldering systems of different size are used. These plants are highly specialized systems and perform a unique soldering technique (e.g. reflow soldering or selective soldering). The use of these systems depends on type and lot size of the assemblies. Many production lines feature different systems, which are used according to their distinct technology.

Hand soldering at manual workplaces is still found in the vast majority of assembly production plants. The main application area is for pre-production runs, prototyping and repair.

Released Airborne Pollutants

Depending on areas of application of the finished assembly and requirements of the components, various soldering alloys and flux agents

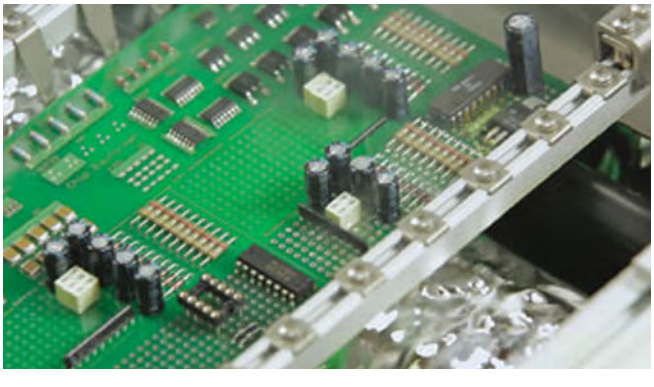

Figure 2: PCB during wave soldering process with soldering fumes (Courtesy of SEHO Systems).

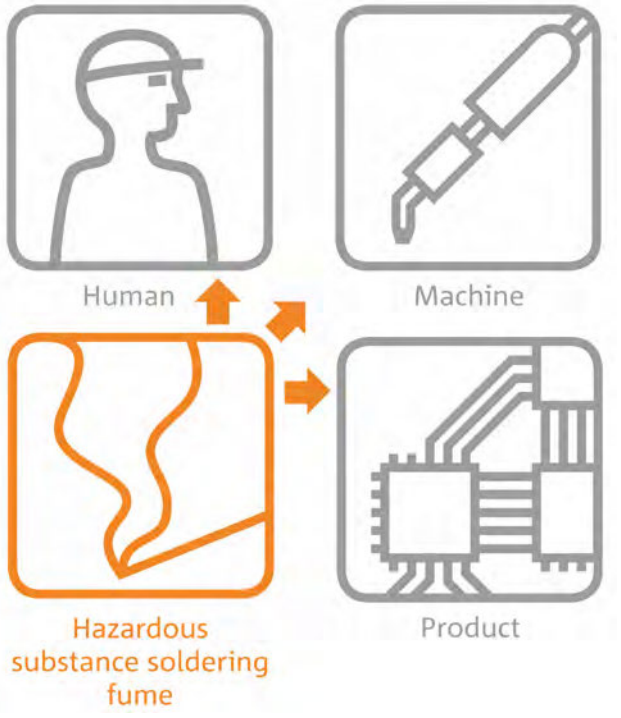

Figure 3: The threefold damaging effect of solder fumes.

are considered. During the soldering process, large parts of the flux agent and a small portion of the solder will evaporate. The emerging aerosols and particles could be released into ambient air. This will not only spread unpleasant odours, but these airborne pollutants can lead to serious medical conditions. Particularly dangerous substances are aldehydes, which emerge from materials containing colophony; some of them may be carcinogenic. In addition, gases are released from coatings, adhesives or substrates during heating of the assembly.

These gases also transport sticky aerosols, which build up in the soldering machines or—even worse—on the products and contaminate them. This leads to increased cleaning and maintenance costs, and the operability of the plant can be impaired. In addition, the manufactured products may even be corroded by the contaminations, which could affect functionality and quality.

In conventional wave soldering processes, the entire printed circuit board is fluxed. The emerging spray mists from alcohol-based flux and other evaporations may lead to explosive, highly flammable vapor/air mixtures.

Differentiation and Legal Regulations

Airborne pollutants are classified according to particle size. This classification is set primarily by the influence of the emissions on the human organism. Thus, airborne pollutants are not only differentiated, whether they are brain, nerve or airway damaging. A distinction is made, whether they are inhalable (I-fraction) or alveolar (A-fraction). Pollutants of the A-fraction overcome the so-called lung-blood barrier, which separates air-filled cavities of the pulmonary alveolus from blood in the capillaries.

Figure 4: Mobile extraction and filtration unit for solder fumes for use at manual work places, JUMBO Filtertrolley 2.0 LRA.

Therefore, the DIN EN 481 defines statutory limit values. According to technical rules for hazardous substances in various countries, there are limit values and legal regulations that determine the utilization of extraction and filtration technology to meet these regularities.

Air Pollutants and Sustainable Filtration

In order to eliminate developing air pollutants, it is not sufficient to provide for only good ventilation in the manufacturing environment. The use of efficient extraction and filtration technology is mandatory and required by the Employer's Liability Insurance Association.

The variety of the available extraction and filtration systems is high. The selection of the appropriate system depends on type and volume of pollution, the use in automated, semi-automated or manual production environments and on mobility as well as flexibility.

State of the art extraction and filtration units achieve such a high cleaning rate for the processing air that the cleaned air can even be re-circulated into the work area.

Collecting the airborne pollutants is a significant aspect, when running extraction systems for air purification. Close proximity to the source of emission is crucial—the closer, the better. Not only in terms of capturing all particles before they reach ambient air and build up on plants and products, but also to minimise economic expenses. The larger the distance between source of emission and collection element, the higher the necessary suction capacity of the extraction and filtration system—with, in turn, a huge impact on energy consumption.

Collection elements help to increase the effectiveness of the extraction process. They are end fittings of extraction arms, which ensure an optimal absorption of the emissions. Depending on the amount and type of the pollution, as well as the airflow principles, users can select from a great variety of designs. Even complete enclosures are available.

Choosing the proper collecting element is decisive for the quality of the entire extraction and filtration system. The level of pollutant coverage is the basis for a subsequent high-

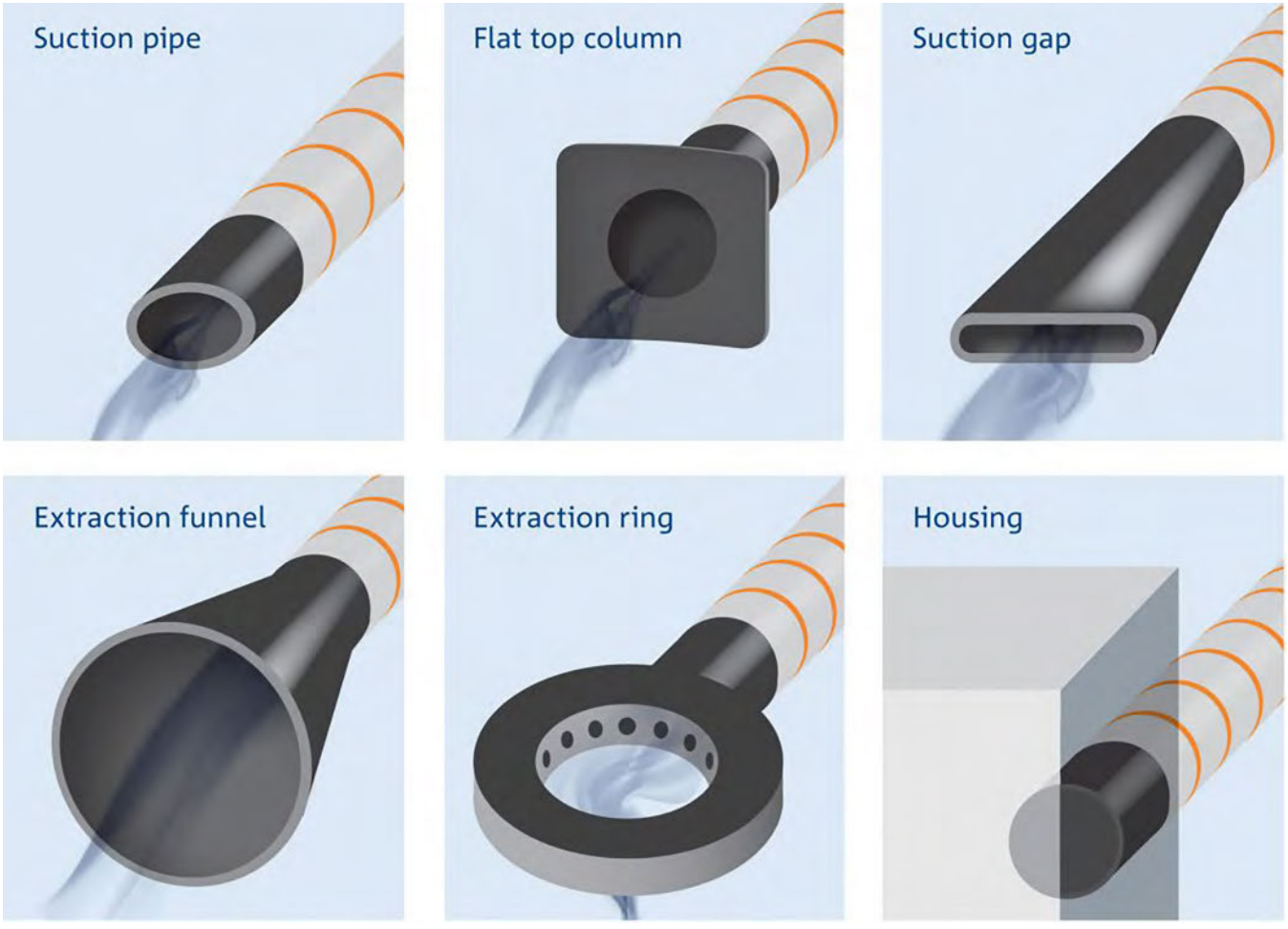

Figure 5: Various collecting elements (selection).

grade filtration, which finally defines the overall efficiency and therefore the residual amount of pollution in the re-circulated air.

Summary

The competitive pressure in electronics manufacturing is tremendous. Only those who provide high-quality products, minimize maintenance costs and rely on healthy employees, will successfully survive in highly competitive markets. Thereby air purification plays a major role.

In the field of electronic assembly manufacture, this means more than ventilation and vacuum cleaning. Besides removing dirt and unpleasant odors, it is mainly about removing airborne hazardous substances, which may have a drastic impact on humans, machinery and products. Effectively running extraction and filtration units help entire enterprises to maintain competitiveness. SMT

Stefan Meissner is the head of corporate communications at ULT AG.

Arne Neiser is product manager for wave and reflow soldering systems at SEHO Systems GmbH.

Cleaning that Matters

by Stephen Las Marias
I-CONNECT007

As the executive director of Zestron Precision Cleaning Sdn Bhd, James Yeoh is responsible for South Asia—predominantly Taiwan and the Southeast Asian region. In an interview with *SMT Magazine,* Yeoh discusses the challenges in the cleaning industry, and strategies that can help manufacturers address those issues. He also covers the need for continuous education when it comes to cleaning, and how automation can ensure the stability of cleaning systems.

Stephen Las Marias: What is your company's sweet spot?

James Yeoh: We are one of the cleaning companies with seven technical centers to support our customers: one in the United States, one in Germany, two in China—in Shanghai and Shenzhen—one in Malaysia, one in Tokyo, and one in South Korea. Very soon we will have an eighth—in Taiwan—which we hope to start running this this year or early next year.

None of our competitors has as many technical centers as we have. And in all our technical centers, we have more than 70 different cleaning machines, most of which are owned by cleaning equipment manufacturers for us to run evaluation and trials for customers. One thing that is unique here is that we can replicate whatever customer parameters are at different sites if there is a need to.

This is one of our strongest selling points. We can do as many trials as the customer wants before they qualify our chemistry. Also, we have a very strong application technology team, and these people are so mobile. Take my region for example: Every week, there is a Zestron application engineer somewhere travelling in our region to talk to customers. And we are continuously employing people to cater to the increase in our business as well as customer base.

Another strength we have is that we continue the education process for the industry. We call it Zestron Academy. We have highly qualified trainers to teach and train the industry.

For us here in Asia, we continue to provide free seminars. In my region alone, we organize 30 training sessions every year. Some of them are for the whole industry, while others we do for particular customers. For instance, one customer has 20 engineers interested in cleaning. We will come in and do the training for them.

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James Yeoh

In fact, we have plans in South Asia to expand the Zestron Academy. Not only do we want to train the engineers of our customers, but we want to extend it to technical colleges because cleaning is not part of their syllabus of studies. When these graduates eventually get hired, they will already be able to handle cleaning.

We will extend Zestron Academy, but it is not something that will happen tomorrow. It is in the pipeline, maybe two or three years down the road. We also want a dedicated academy team. Right now, we use the application engineers to do the training. But what we want to do at the end of the day is to have a separate Zestron Academy team, so that it can stand alone by itself.

Las Marias: In which end-markets are you seeing strong growth?

Yeoh: We have seen very good growth in the automotive and semiconductor industries. The latter is very wide, we have power module and automotive electronics, we can cover IoT, we can cover mobile phones. Even aerospace industry is a growing market. If you talk about the automotive and the aerospace industries, there's no compromise. Cleaning is a priority.

Las Marias: From a cleaning standpoint, what challenges are your customers facing?

Yeoh: Basically, most of the challenges are very closely related. Our customers don't have a lot of equipment, because these are all investments. Some customers have one or two cleaning machines. In some cases, these customers, especially the EMS providers, may have 20 different products to run. It's a big challenge because the pastes are different, a lot of their fluxes are different, there are variations in products, and they need to run. They need to clean with just one machine, and they need to clean with just one chemical. That is a challenge for them. And it is a part of our duty to make sure we go in and optimize and help them, with one chemical solution, to clean all their boards.

The market now is driven predominantly by two trends: one is IoT, the other is hybrid vehicles. These two will be very significant going forward. When we talk about hybrid or electric vehicles, these are very European and American driven. This industry is growing and will continue to drive the market. When you have more and more electronics in the vehicles, there is a need for more cleaning.

Meanwhile, things have become narrower and smaller. At one point, you can no longer put a lot of components into the board. So probably, the ICs or packages will be 2D or 3D. In the future, the ICs will be so small that there will be an even lower standoff height. Now, it's

0.05 mm. It may continue to become lower than that. This is a challenge because water will no longer be able to penetrate such low standoff heights. You need chemicals to wash. But you also must consider material compatibility issues.

We are the first in the market to offer what we call pH-neutral cleaning solutions. Now, we have our third-generation pH-neutral cleaners. With pH-neutral solutions, we are able to address material compatibility issues, especially with copper lead frames.

Las Marias: Do people still have some sort of misconception when it comes to no-clean solder pastes?

Yeoh: If you talk about the aerospace and the automotive industries, cleaning ensures it's 100% clean. Even though you use no-clean flux or paste, you still clean because there is a reliability issue and safety issue. When it comes to reliability and safety, I think nobody wants to take a chance. A few years ago, people started talking about no-clean solders and fluxes, and that the cleaning business will go away. It did not. In fact, the business just kept on increasing, first, because of the safety and reliability issues; and second, as you go to lower and lower standoff heights, you basically just cannot clean with water anymore. So, cleaning is essential; it will be a priority as we move forward. Of course, there are still some who use DI (deionized) water for cleaning. But moving forward, as standoff heights become significantly lower, there is no choice. Chemical cleaning is the trend.

Las Marias: There are still companies who are manually dosing their bath to maintain the stability of the cleaning solution. What's the challenge here?

Yeoh: Manual replenishment is not wrong; it's okay. The only thing is that what I think companies look for in terms of their production is stability. If I am a manager in a manufacturing company, I will always look at consistency. If Zestron tells me my cleaning system must run at, let's say, 20%, I want to make sure that at any point in time when I go to the line or when my customer comes for audit, it's 20%. If I manually do it, it may fluctuate. With Zestron EYE and Zestron EYE CM, all these are coordinated, which means if the concentration level drops from 20%, there will have a trigger that will inform you that it's time to replenish the chemical. In terms of ISO, it is also good. Because you will have a record to show your auditors that it's always at 20%.

This is one of the areas that the Zestron EYE or Zestron EYE CM can help customers in terms of stability and consistency, which are very important now from a manufacturing perspective to ensure yield.

Las Marias: To make your line more efficient, it makes sense to automate some processes and remove the human element, to improve the yield and minimize errors. I think from a cleaning perspective, that's what Zestron EYE is offering.

Yeoh: Exactly. Of course, we will keep educating the market, as it will take the industry some time to fully automate that process. But we believe that two or three years down the road, it will become standard practice, especially if you have a high throughput, because customers want stability and reliability.

Las Marias: What are the developments right now in your Zestron EYE and CM technology?

Yeoh: We just had the CM, which we launched last year. It's the continuation of Zestron EYE. We are not machine makers, so we will not spend too much time in coming up with different kinds of machines. The EYE and the CM are basically our two primary machines to ensure process capability. As to how we want to improve the technology in terms of the CM or the EYE, our R&D engineers are looking at it and we hope to come up with a new generation maybe a year or two down the road.

Las Marias: Do you also work with cleaning equipment manufacturers?

Yeoh: We work very closely with machine manufacturers, because when they want to come up with new designs of machines, but they do take our input on how to ensure that the chemical process may be improved. They do talk to us so we give our inputs. If the machine is customized, for example there are certain machines right now that are customized for certain customers, then we play a bigger role because right from day one, we are in there. But if they will come out with a new model, then they will take some input from us, such as how do we want certain nozzle designs and flows.

Las Marias: If I were a potential customer. If I were a potential customer, what are the key factors to consider when selecting a cleaning system?

Yeoh: From a commercial perspective, you need superior technical support. When we talk about the education part, with Zestron, it doesn't matter whether you want us to go to your factory to do the training for you once, twice, three times, or even four times a year. We will be there if you request it. There's always a need for education. Because some engineers may have just joined the company, or some have left, or even some are new graduates. You must always train them.

And then what you want is a product that can have a longer bath life. Every time you change a bath, it is a cost, so you want to have a longer bath life. At the end of the day, what you should also look for is the lowest cost per part cleaned. This requires some cooperation, as it depends on the flux loading and types of parts to be cleaned. What we can do is help our customers to optimize their cleaning system. Most of the time, it's not just a chemical problem; but is also a machine problem. The chemical may be able to do it, but the machine may not be able to do it. So, from a customer's perspective, it is very important to have a three-party, or four-party—including solder paste and flux manufacturers—collaboration. We really have to sit down and look at the process. If you talk about the machine, for instance an in-line system, you must consider the way you place your nozzle, the power of the spray, etc. All these work together, not just us. Essentially, the chemical can remove the residues. But the equipment also needs to work well together.

It is not our problem alone. It is an industry problem, where I think all parties need to sit down and talk about optimizing the nozzle, spray pressure, angle, agitation, etc.

Las Marias: Is there anything that we haven't talked about that you think we should be talking about?

Yeoh: A lot of people don't know the importance of cleaning, which we hope to address through the academy. Every day, you may hold a product or you may come across a product that's been cleaned by Zestron chemistry, yet you are not aware of it.

Regarding automation, automated concentration monitoring is a very important factor right now when it comes to the cleaning process. The industry is trying to optimize the processes amid increasing costs of labor and raw materials; as much as possible, every process has to be optimized and efficient.

Las Marias: Thank you very much for your time, James.

Yeoh: Thank you. **SMT**

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- Work directly with PCB sourcing teams to generate interest in our company
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- Manage quality/engineering/logistics issues pertaining to key accounts

Qualifications:

- 3 years' professional experience in PCB sales or similar electrical component experience
- Excellent communication and relationship building skills
- Organizational skills, with a strong attention to detail
- Knowledge of Japanese or Mandarin languages a plus

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The ideal candidate will have some initial prospective customers located nearby in the Midwest region and the ability to travel as needed to our Asia-based manufacturing locations.

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American Standard Circuits is seeking a candidate to join its team in the position of CAM operator. Applicants will need experience in using Valor/Genesis (GenFlex) CAD/CAM software with printed circuit board process knowledge to edit electronic data in support of customer and production needs. Other requirements include:

- 5+ years of experience in PCB manufacturing
- Process DRC/DFMs and distinguish valid design and manufacturing concerns
- Modify customer supplied data files and interface with customers and engineers
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- Prepare NC tooling for machine drilling, routing, imaging, soldermask, silkscreen
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- Create various types of topic based content, such as online help, online user guides, video tutorials, knowledge base articles, quick start guides and more
- Distill complex technical information into actionable knowledge that users can understand and apply
- Continually develop and maintain product knowledge

Requirements:

- Understanding of EDA electronic design software, schematic capture and PCB layout software
- Bachelor's degree in electronics engineering or equivalent experience
- Sales engineering and/or support engineering experience
- Circuit simulation and/or signal integrity experience
- Understanding of ECAD/ MCAD market segments
- Understanding of micro controllers, SoC architecture and embedded systems market
- Database experience preferred (i.e., MySQL, PostgreSQL, Microsoft Access, SQL, Server, FileMaker, Oracle, Sybase, dBASE, Clipper, FoxPro) etc.
- Experience with PLM/PDM/MRP/ERP software (Program Lifecycle Management) preferred
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Associates degree or better is required. Must have a minimum of 3 years of experience working for a printed circuit board manufacturer. Must have Valor Genesis software experience. Scripting knowledge is beneficial but not required. This is a full time salaried position on 1st shift. Pay commensurate with experience.

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Positions available in the Eastern, Midwest and Western United States. Positions will focus on supporting sales and applications development for Miva Technologies' DLP direct imaging system within the PCB and micro-electronics markets. Experience with photoresist and imaging preferred, but not required.

Service Technicians

Positions available for Eastern and Western United States. Service technicians will support our rapidly expanding installed base of Miva Technologie's DLP imaging systems and other systems sold by the company.

Send resume and contact information for both jobs to Brendan Hogan.

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- Engage suppliers in quality improvements and process control issues as required
- Generate process control plan for manufacturing processes and identify opportunities for capability or process improvement
- Participate in FMEA activities as required
- Create detailed plans for IQ, OQ, PQ and maintain validated states as required
- Participate in existing change control mechanisms such as ECOs and PCRs
- Perform defect reduction analysis and activities
- Participate in technology roadmap planning
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Southern California Territory Sales Engineer

Technica, USA, a Western regional manufacturer's representative/distributor, has an open sales position for our Southern California territory. The position will be responsible for selling and servicing our entire product line within the specified territory to the PCB manufacturing industry.

This position requires a highly self-motivated, hands on, confident individual of the highest integrity.

Required Skills:

- BA/BS degree-desired, in a technical area is preferred
- Two years of outside/inside sales or manufacturing experience in the PCB manufacturing environment is desired
- Self-motivated self-starter with the ability to initiate and drive business with little supervision
- Independent worker with a strong commitment to customer satisfaction
- Understanding of consumable sales process
- Ability to organize activities and handle multiple projects simultaneously with effective and timely follow-up
- Ability to solve problems and make decisions for which there are no precedents or guidelines and be resourceful in nature
- Positive attitude while operating under pressure and be an independent problem-solver
- Computer skills in Windows, Outlook, Excel, Word and PowerPoint
- Must have a valid driver's license with good driving record

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Western Regional Equipment Service Technician

Technica, USA, a Western regional manufacturer's representative/distributor has an opening for an equipment service technician covering the Western USA, including but not limited to, California, Oregon, Washington, Utah, Colorado, and Arizona. The position will be responsible for servicing our PCB fabrication equipment product line, including installation, troubleshooting, repair service, rebuild service, etc. This position requires a highly self-motivated, hands on, confident individual of the highest integrity.

Key responsibilities are to install and service equipment, conduct equipment audit, and provide technical service when appropriate to solve problems.

Required Skills:

- 2+ years of experience in a PCB manufacturing environment or similar
- Willing to travel
- Positive "whatever it takes" attitude while operating under pressure
- Self-motivated self-starter with the ability to initiate action plans
- Ability to work independently with a strong commitment to customer satisfaction
- Excellent communication and interpersonal skills
- Strong ability to use all resources available to find solutions
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Duties include:

- Marketing research to identify target customers
- Initial customer contact (cold calling)
- Identifying the person(s) responsible for purchasing flexible circuits
- Exploring the customer's needs that fit our capabilities in terms of:
  - Market and product
  - Circuit types used
  - Quantity and delivery requirements
  - Competitive influences
  - Philosophies and finance
  - Quoting and closing orders
  - Bonding
- Submitting quotes and sales orders
- Providing ongoing service to the customer
- Problem solving
- Developing customer information profiles
- Developing long-term customer strategies to increase business
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- Assist in customer quality surveys
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With more than 30 years of experience, Prototron Circuits is an industry leader in the fabrication of high-technology, quick-turn printed circuits boards. Prototron of Redmond, Washington, and Tucson, Arizona are looking for an experienced sales professional to handle their upper Midwest Region. This is a direct position replacing the current salesperson who is retiring after spending ten years with the company establishing this territory.

The right person will be responsible for all sales efforts in this territory including prospecting, lead generation, acquiring new customers, retention, and growth of current customers.

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For more information, please contact Russ Adams at 425-823-7000, or email your resume .

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Process Engineer (Redmond, Washington)

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Arlon EMD, located in Rancho Cucamonga, California is currently interviewing candidates for **manufacturing** and **management positions.** All interested candidates should contact Arlon's HR department at 909-987-9533 or fax resumes to 866-812-5847.

Arlon is a major manufacturer of specialty high performance laminate and prepreg materials for use in a wide variety of PCB (printed circuit board) applications. Arlon specializes in thermoset resin technology including polyimide, high Tg multifunctional epoxy, and low loss thermoset laminate and prepreg systems. These resin systems are available on a variety of substrates, including woven glass and non-woven aramid. Typical applications for these materials include advanced commercial and military electronics such as avionics, semiconductor testing, heat sink bonding, high density interconnect (HDI) and microvia PCBs (i.e., in mobile communication products).

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2008 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customer's requirements.

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Responsibilities will include:

- Planning job travelers based on job release, customer purchasing order, drawings and data files and file upon completion
- Contacting customer for any discrepancies found in data during planning and CAM stage
- Consulting with director of engineering regarding technical difficulties raised by particular jobs
- Informing production manager of special material requirements and quick-turn scheduling
- Generating job material requirement slip and verify with shear clerk materials availability
- Maintaining and updating customer revisions of specifications, drawings, etc.
- Acting as point of contact for customer technical inquiries

Candidate should have knowledge of PCB specifications and fabrication techniques. They should also possess good communication and interpersonal skills for interfacing with customers. Math and technical skills are a must as well as the ability to use office equipment including computers, printers, scanners, etc.

This position requires 3 years of experience in PCB planning and a high school level or higher education.

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Recent Highlights from SMT007

1 Technology Enabler Highlights Benefits of Having Design Services for an EMS Firm

At the 14th Philippine Semiconductor and Electronics Convention and Exhibition (PSECE) held last week in Manila, Robin Ramiso, design and development manager at Technology Enabler, discusses their activities and the benefits of having a design services team for an EMS company.

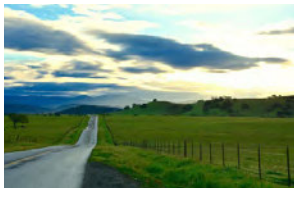
2 The Significance of the PCB in the Value Chain of the European EMS Industry

At SMT Nuremberg, Pete Starkey meets with Dieter Weiss, who comments upon the significance of the PCB in the value chain of the European EMS industry, and looks to a future where we embrace an open-minded attitude and a willingness to work together.

3 A New Player in the Philippine EMS Industry

There's a new EMS player in town. Come August 2017, Artem Global, a startup EMS firm in the Philippines, will start manufacturing operations, with services ranging from PCB assembly to box build, and even turnkey services. I-Connect007 Managing Editor Stephen Las Marias caught up with Artem Managing Director Art Ledonio at last week's PSECE event in Manila.

4 Does Your EMS Provider Have an Industry 4.0 Roadmap?



At its simplest level, the Fourth Industrial Revolution or Industry 4.0, is about automation and connectivity. This should lead to faster, more efficient manufacturing—and therefore advantageous pricing. Additionally, it might also mean that products can be made in a different way.

5 EMS Firm Tsukiden Electronics Seeing More Business in Prototypes

At the recent Philippine Semiconductor and Electronics Convention and Exhibition (PSECE) held in Manila, Karen Flordiles, marketing supervisor at EMS firm Tsukiden Electronics Philippines Inc., talks about their customers' changing requirements and their manufacturing challenges. She also discussed new opportunities they are seeing in the EMS sector.

6 How Important DFM is for Your Electronics Assembly Partner

EMS firm Valuetronics Holdings Ltd has announced net profit of HK$154.1 million ($19.77 million) for the fiscal year 2017, up by 27.9% year-on-year.

7 NOTE to Manufacture myFC's JAQ Hybrid

NOTE will start volume production of myFC's JAQ Hybrid, a powerbank for smartphones containing a fuel cell and battery, in China.

8 SMTA Launches New Partnership with Thayer School of Engineering at Dartmouth College

The Surface Mount Technology Association (SMTA) and Thayer School of Engineering at Dartmouth College have launched a new collaboration to provide professional development training workshops through the SMTA organization.

9 DAQRI Partners with Flex for Production of AR Headsets

Flex and DAQRI have entered into an agreement to manufacture DAQRI Augmented Reality headsets at the Flex facility in Cork, Ireland, beginning this summer.

10 Kitron Inks New Contract with Husqvarna Group

Kitron has received a contract with a potential value of NOK600 million over a five-year period from Husqvarna Group.

SMT007 has the latest news and information. Subscribe to our SMT Week newsletter when you register at: my I-Connect007.

Events

For 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.

NEPCON South China 2017
August 29–31, 2017
Shenzhen, China

24th FED Conference
September 15–16, 2017
Bonn, Germany

SMTA International 2017 Conference and Exhibition
September 17–21, 2017
Rosemont, Illinois, USA

electronicAsia
October 13–16, 2017
Hong Kong

TPCA Show 2017
October 25–27, 2017
Taipei, Taiwan

productronica 2017
November 14–17, 2017
Munich, Germany

HKPCA/IPC International Printed Circuit & South China Fair
December 6–8, 2017
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47th NEPCON JAPAN
January 17–19, 2018
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DesignCon 2017
January 30–February 1, 2018
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