

IConnect007

MAY 2019

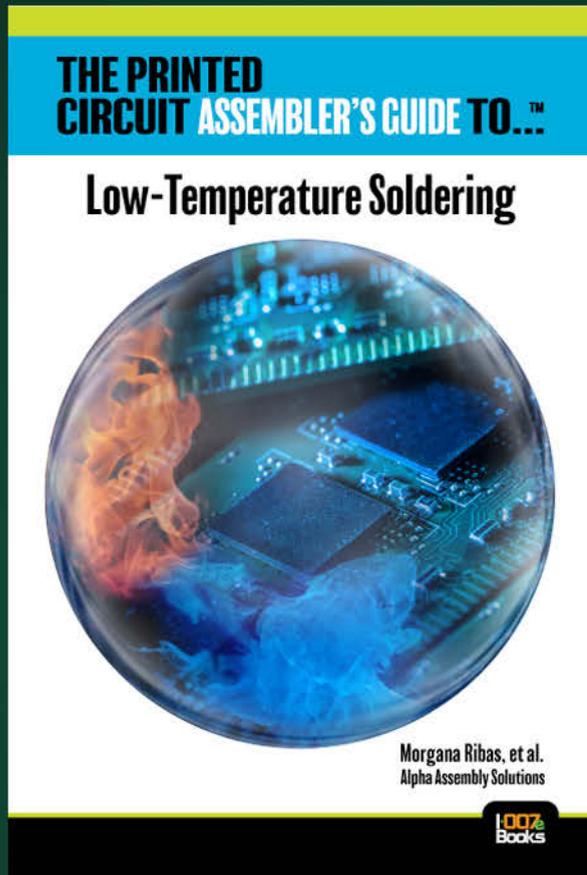
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This issue features extensive in-depth discussions with six different contract manufacturers and assembly houses representing a wide range of specialties, from prototype/startup specialists to medium-scale production and high-complexity mil/aero. Learn how these companies help their clients succeed and grow into #happySMTcustomers.



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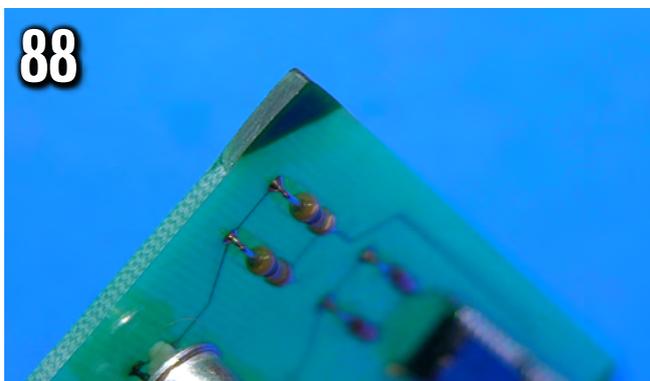


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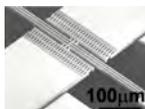
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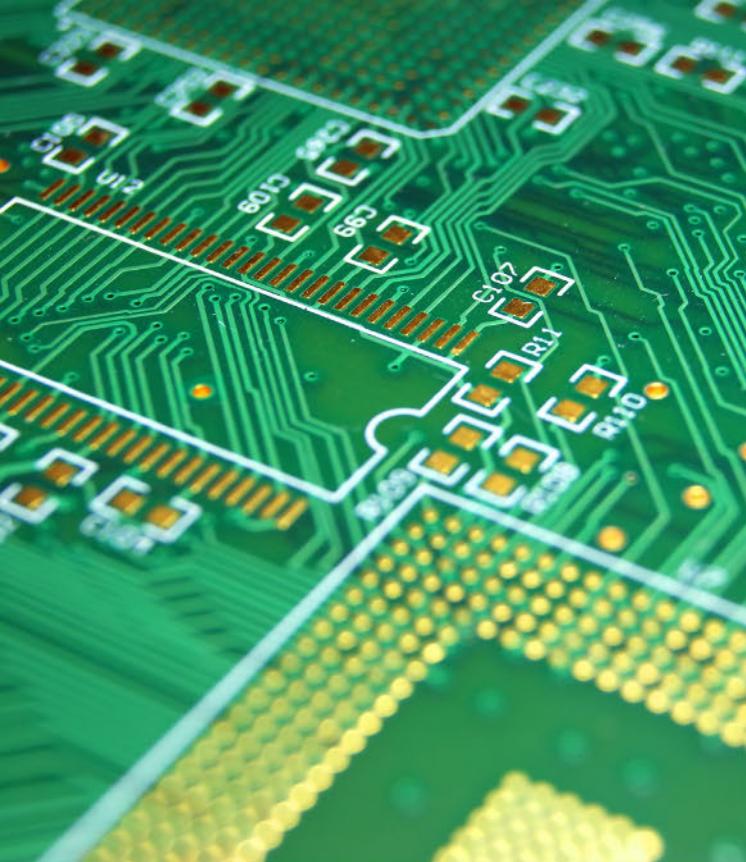
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Customer Success— Plans and Projects

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Leo Tolstoy stocked his novel *Anna Karenina* full of many wonderful passages. One of my favorites is his description of spring time on Levin's farm as the Russian winter gives way to warmer weather. "Spring is the time of plans and projects," he stated barely 50 words into the chapter. I cannot help but think of this powerful quote every spring.

Tolstoy's phrase is fitting for this issue of *SMT007 Magazine* as well. Manufacturing is thriving and transforming into a new kind of ecosystem, and opportunities for skilled workers abound. As an industry, we are becoming greener, leaner, faster, and better. Like Tolstoy's spring, our industry is full of plans and projects, all intended to create happy customers.

But first, our cadre of columnists continues to grow. Last month, we introduced you to Mike Fiorilla with his column "The Mannifest." Fiorilla is a writer at Manncorp and addresses common problems and solutions encountered by Manncorp customers.

And that's not all. In this issue, you'll also be treated to a brand new contributing columnist and enjoy the return of a former.

Alfred Macha, president of AMT Partners, debuts his column "In Search of Operational Excellence" with a discussion on how process validation can take you to a higher level of performance. Macha will concentrate on supply chain management, government contracts and regulations, process control, and operational excellence, among others.

Ray Prasad stages his comeback with his column "SMT Solver" by addressing how assemblers can help their customers reduce cost and improve reliability. Prasad is president of Ray Prasad Consultancy Group and will cover various SMT interests, including DFM, manufacturing processes, yield improvement, quality control, and IPC standards. His exceedingly deep knowledge of the industry will be enlightening.

And since we're highlighting columnists, we must take a moment to re-introduce our ongoing columnists for readers who are new to our magazine. Our wise and informative regular columnists also include Dr. Jennie Hwang, CEO of H-Technologies Group, and Bob Wettermann, president at BEST Inc. Hwang, an authority on SMT, offers her perspective on a range of technical and process issues. Wettermann looks at the challenges in rework and repair, providing strategies for addressing them.

Lest you thought I forgot, this issue features extensive discussions with five different contract manufacturers and assembly houses representing a wide range of specialties, from prototype/startup specialists to medium-scale production and high-complexity mil/aero. The I-Connect007 editorial team asked these companies to give their best practical advice on how they help make their customers successful.

We start with Dr. Jennie Hwang's column (part six in the series) on the role of bismuth in electronics.



Next, we kick off our coverage of how to make customers successful with “That One Thing,” the first of our overview features. Our showcase contract manufacturers all had a lot to say about the question, “What is the one thing your customers can do to be successful.” Read their insights here.

Then, we give the podium to our returning columnist, Ray Prasad. Following Prasad is our second overview feature, “The Perfect Job,” where our showcase companies share their insight on how to make the handoff to manufacturing as worry-free as possible.

What follows are shortened interviews with each showcase company: mil/aero specialist Zentech (John Vaughan); Milwaukee Electronics/Screaming Circuits (Duane Benson); Green Circuits (Joe Garcia); Whizz Systems (Muhammad Irfan); and the whole team at Data Electronic Devices (DataED). Overall, these conversations were so detailed that we’re publishing edited versions here. At the end of each article, you will find a link to the complete conversation.

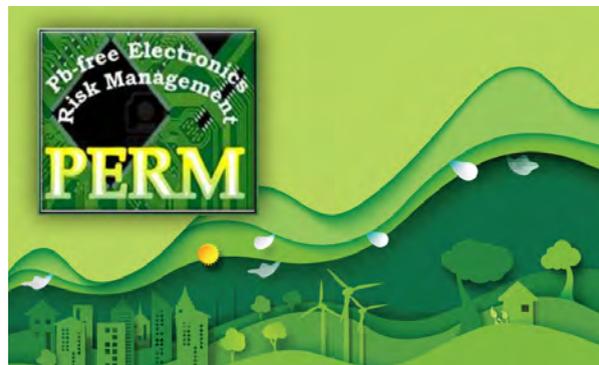
Intermixed with the interviews, you’ll also find Mike Fiorilla’s column, The Manifest. Mike shares practical insight on how to manage your double-sided assemblies. You’ll also meet Alfred Macha with his column on performance improvements through process validation.

In the anchor slot on this issue is columnist Bob Wettermann with his discussion on damaged corner repair techniques.

Yes, behind all of this discussion are the themes of spring: growth, revitalization, creativity, excitement, energy, and ambition with a practical application in creating successful and happy customers for you.. This issue, just like spring itself, is full of projects and plans. Here’s hoping they help you with yours. **SMT007**



Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, [click here](#).



IPC Working to Revive Lead-free R&D in High-reliability Sectors

Over the last 15 years, the commercial electronics industry has largely phased out its use of lead (Pb) in the manufacture of electronic components and circuit assemblies. The transition to Pb-free electronics was driven by the European Union’s Restriction of Hazardous Substances Directive (RoHS), which placed new restrictions on the use of lead in commercial products.

RoHS has had a global impact on the electronics industry. Other countries have followed suit and manufacturers are now obligated to eliminate the use of lead in their goods for markets around the world.

The migration to Pb-free electronics has been successful in the commercial markets, but the aerospace, defense and high performance (ADHP) electronics sectors have been slower to abandon the traditional tin-lead solder used in the production of components and circuit assemblies because they have more demanding performance requirements than consumer electronics; they need to perform flawlessly in harsh environments and in safety-related applications; and there is not enough data on the performance of Pb-free products to support the move.

Enter the Pb-Free Electronics Risk Management (PERM) Council, comprised of subject matter experts from government, industry, academia, and other stakeholders. Founded in 2008 and housed by IPC since 2012, the PERM Council provides leadership and coordination of Pb-free electronics risk management activities in both government and industry.

To read the full article, [click here](#). (Source: Chris Mitchell, IPC)

The Role of Bismuth (Bi) in Electronics, Part 6

SMT Prospects & Perspectives

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

In this installment of my column series on the role of bismuth (Bi) in electronic products, I'll look at the effects of Bi on the properties and performance of solder interconnections in electronic products when Bi is not contained in the solder alloy for the SMT assembly process (Bi-absent solder alloy composition of solder paste). The effects of Bi in solder joints are created by an unintentional path through the supply chain, which introduces Bi into the resulting solder alloy of solder joints. The performance and reliability of the resulting solder joint impacted by the presence of Bi can vary; it can be beneficial or detrimental or no-detectable-effect.

From the supply chain in electronics assembly, Bi can come from component lead coating, passive component termination coating, and PCB surface finishing that are Bi-con-

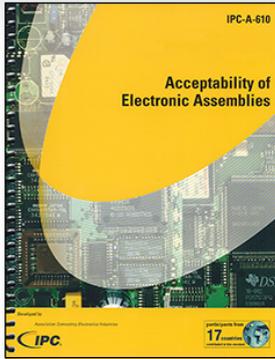
taining material (albeit, this has not been a common PCB surface finish in recent years). Accordingly, even in a Bi-absent assembly process (e.g., using SAC solder paste or SnPb solder paste), the changes in the properties and performance of solder joints due to the introduction of Bi into the solder joint could occur. Similarly, for BGA components, the Bi-containing solder ball will make Bi-containing solder joint.

In SMT assembly after reflow, the composition of solder joints is expected to deviate from the composition of the solder alloy used in solder paste. The compositional change in solder joints as a result of Bi contributions from one or both of component and PCB surface finish should not be dismissed. Bi contribution from component leads (component surface coating) to the composition of the solder joint, while

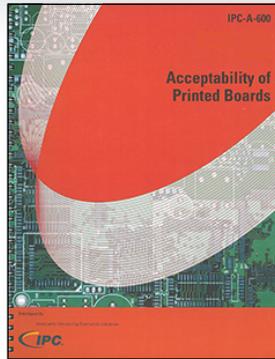




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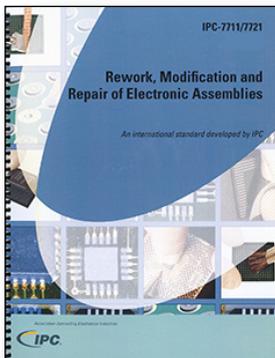
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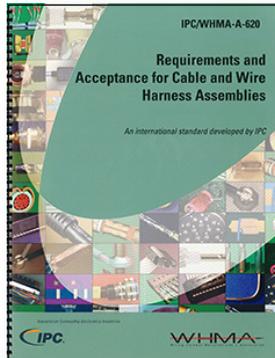
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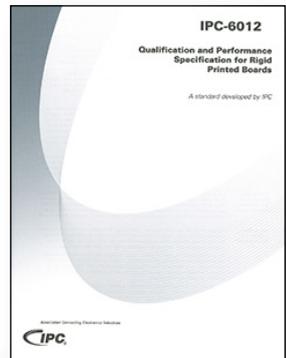
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using Bi-absent solder paste for SMT assembly, depends on the:

- Type of component
- Configuration and dimensions of the component lead
- Surface area of component leads embedded in the solder joint
- Thickness of the coating
- Resulting solder joint volume (including the solder paste volume)
- Substrate surface metal (e.g., Cu vs. Ni)

As an illustration, one study focused on 20-mil (0.5-mm) pitch QFP208 with Cu-lead or Alloy 42 lead-coated with SnPb or SnBi, using SAC305 or SnPb solder pastes reflowed at 245°C (for SAC305) or 220°C (for SnPb). Test results indicated that SnBi coating/SAC solder paste performed better than SnBi coating/SnPb solder paste, which was better than SnPb coating/SnPb solder paste under accelerated temperature cycling (-40–125°C, 10 minutes dwell). However, with the same system except for the component lead material (replacing Cu leads by Alloy 42 leads), both SnBi coating/SAC solder paste and SnPb coating/SnPb solder paste performed better than SnBi coating/SnPb solder paste [1-3].

For BGA components, a Bi-containing solder ball is expected to contribute to the resulting solder composition in a much significant proportion compared to leaded-components. Nonetheless, the resulting solder joint composition will contain less Bi than in a BGA solder ball composition when a Bi-absent solder paste is used during SMT assembly. Bi contribution from BGA component to the composition of the solder joint depends on the:

- Diameter of BGA solder ball
- Resulting solder joint volume (including the solder paste volume)
- Substrate surface metal (e.g., Cu vs. Ni)

Regarding surface finish, one study examined the effect of Bi-coated PCB pads on the solder joint integrity using SnPb eutectic solder paste [4]. The PCBs were deposited with 4–6 micro-

inches of pure Bi and assembled using LCC and QFP components under surface mount processes. In comparing the Bi finish with the SnPb HASL finish, the fatigue data exhibited that two surface finishes essentially imparted similar thermal fatigue results in terms of the failure percentage at given temperature cycles. Visual inspection also revealed that the solder joints have the same general appearance after temperature cycling.

Thus, Bi contribution from the PCB surface finish to the composition of the solder joint depends on the:

- Thickness of the surface coating
- Dimensions of pad
- Resulting solder joint volume

Bi is a unique metal that can offer multiple positive effects on solder joint performance (outlined in Part 2, Part 3, and Part 4 of this column series). In Sn-based binary solder alloy, its two-phase phase diagram possesses multiple strengthening mechanisms (Figure 1). There are opportunities to maneuver the microstructure through compositional tailoring and process condition variations.

However, Bi is a brittle metal and has a finite solid solubility in an Sn matrix. The Bi precipitation process is expected to be additive to other strengthening phenomena. There is a natural breakdown in the relationship between

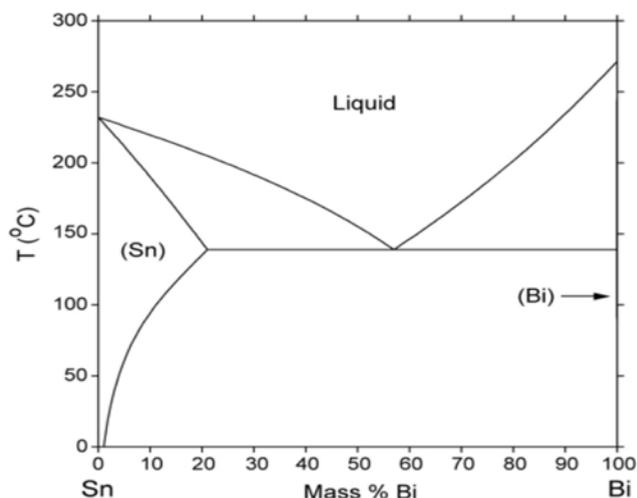


Figure 1: Schematic of Sn-Cu phase diagram.

yield strength and Bi volume fraction as a result of the transition of the strengthening mechanism. Bi must be used properly to eschew any likely adverse effects in the reliability of solder joint, which may lead to likely product failure.

To utilize the benefits that Bi can offer in forming electronic solder interconnections, a specified dosage in a specific alloy composition system is required; the knowledge of its intricate interplay with other constituents in an alloy composition is indispensable. An understanding of the design-for-performance demands as well as application constraints is also a prerequisite.

Overall, the concentration of Bi in solder joint has to be carefully designed. Unfortunately, many studies and testing programs with an intent to compare Bi-containing alloys with a Bi-absent solder alloy have often selected a Bi dosage apart from what is required or desired. This lack of proper composition (a proper Bi dosage in a specific system) has contributed to highly publicized negative test results. Thus, this has impeded the application of Bi in Sn-based solder alloy systems during the first decade of deployment of lead-free solder interconnecting materials for producing electronic products. **SMT007**

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Dr. Jennie S. Hwang—an international businesswoman and speaker, and business and technology advisor—is a pioneer and long-standing contributor to electronics hardware manufacturing as well as to the envi-

ronment-friendly lead-free electronics implementation. Among her many awards and honors, she was inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, an R&D-Stars-to-Watch, and YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and CEO of International Electronic Materials Corp., she is currently CEO of H-Technologies Group providing business, technology and manufacturing solutions. She is the Chairman of Assessment Board of DoD Army Research Laboratory, serving on Commerce Department's Export Council, National Materials and Manufacturing Board, Army Science and Technology 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 500+ 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 the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, please visit www.JennieHwang.com. To read past columns or contact Hwang, [click here](#).

Eileen Hibbler and Jason Emes on Improving the West Penn SMTA Chapter



While attending the recent West Penn SMTA Expo, I-Connect's Patty Goldman spoke with Eileen Hibbler, a chapter support specialist at SMTA, and Jason Emes, the current president of the West Penn SMTA Chapter. Despite having an active membership, the local chapter has seen some officer turnover due to job changes and Eileen and Jason were anxious to discuss ways to improve meeting attendance and develop a new slate of chapter officers.

To read the interview, [click here](#). (Source: I-Connect007)

The One Thing

Feature by Nolan Johnson
I-CONNECT007

A tip of the hat to best-selling authors Gary Keller and Jay Papasan and their book who came up in the real estate business; their book *The ONE Thing: The Surprisingly Simple Truth Behind Extraordinary Results* is based on a simple, general truth. Often, in major projects, success is greatest and risk is least by just focusing on one key part. As we talked to contract manufacturers, one thing did move to the top of the list of secrets to success in the assembly space: communication.

“The vast majority of the problems that we run into—whether they be in our forecasted manufacturing with Milwaukee Electronics or our on-demand manufacturing with Screaming Circuits—fall to communication and information,” said Duane Benson, an I-Connect007 columnist and a representative from Milwaukee Electronics. “As with the old ‘telephone game,’ each time information goes from one party to another, the risk of misinterpretation increases.” Benson pointed out, “If we are given unclear information from a customer, we may not be able to give the right information to Sunstone [Circuits, their partner fabricator].”

Joe Garcia, VP of sales and marketing at Green Circuits, echoed that sentiment, “We want to be as thorough as possible with each customer’s particular job. But, at the same time, we want to match our speed and flexibility to the needs and expectations of the customer—truly being a customer solution provider in the EMS space.”

“Well, I’m old-school, so planning and communication still matter more than anything to me,” stated John Vaughan, VP of sales and marketing at Zentech Manufacturing, “What does the customer think the product architecture looks like? What part challenges do they see? What’s different and unique? Who are our technical liaisons going to be? Because the demand side is really high right now, particularly in mil/aero, and the lead times to deliver both quotes and products are very compressed right now, the more we know about the objectives on the front end, the better we can perform.”

“We like to think of ourselves as a family atmosphere and build relationships with the customers we have,” said Jeff Hamlett, director of sales and marketing at Data Electronic Services (DataED). “Anybody can build a product, but it’s important to have established relationships and treat the customers well, which has led to our success today. We have all of the bells and whistles that other CMs do, but that’s the one factor that makes us stand apart.”

Muhammad Irfan, president at Whizz Systems, put it this way, “Internally, we have the capability to offer from concept all the way to a launched product.” He continued, “Our strength is knowing our strengths and whether we are a good fit for the customer.”

Duane Benson stated, “That information is critical, and if you don’t have it right in the first place, you’re going to have a cascading



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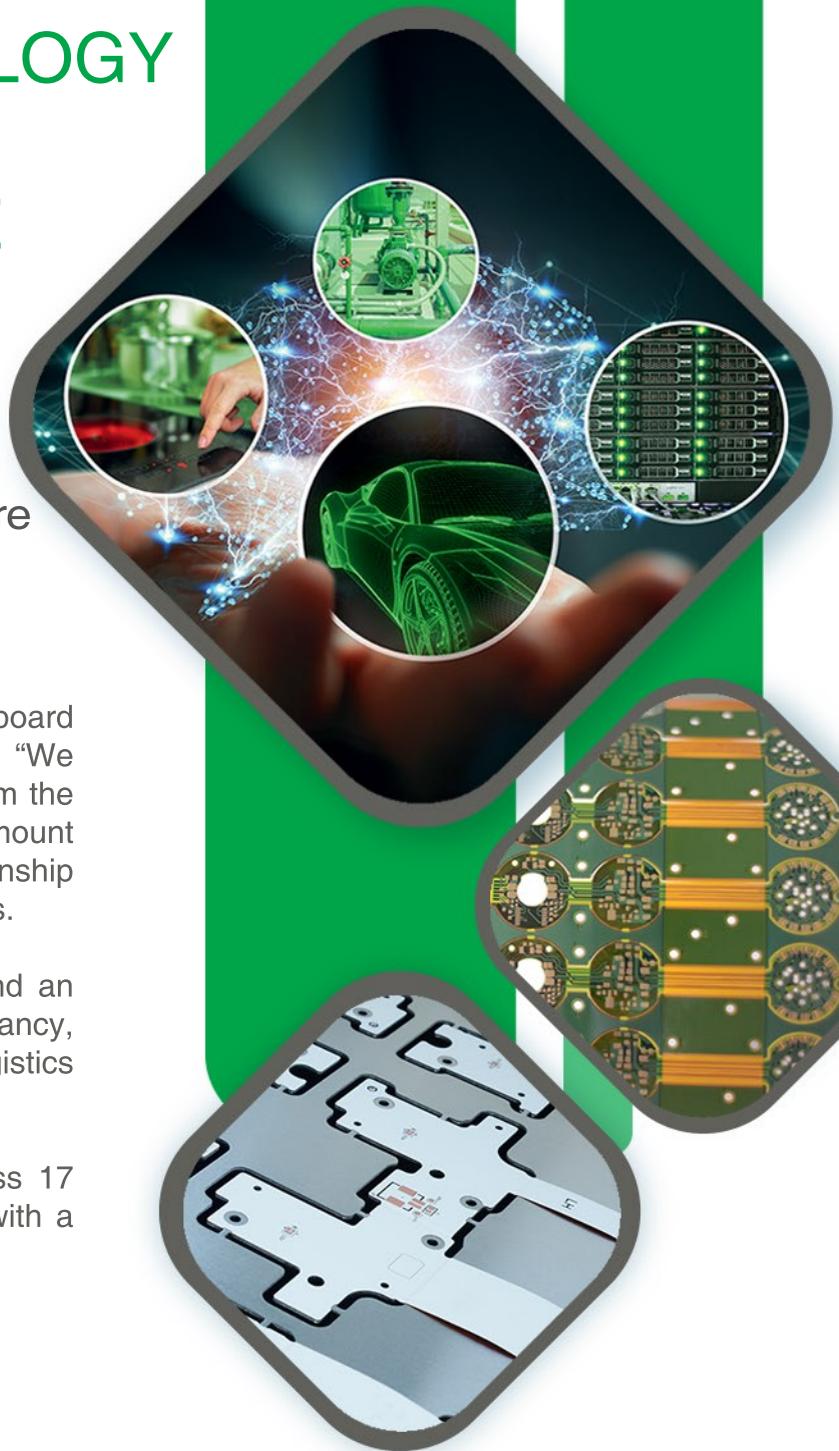
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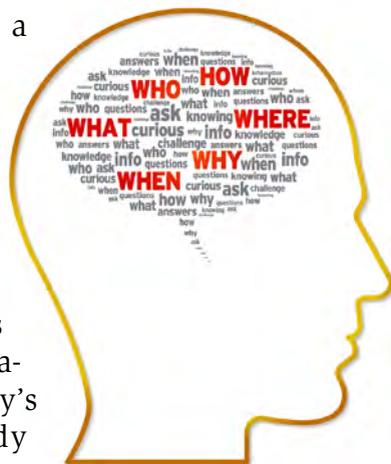
pcbs from just around the corner

set of problems. We will do our best to solve those problems. We'll call you to try and figure it out, but we need good communication and information, and we need people to respond quickly, especially in a prototype or on-demand type environment."

Benson further detailed, "Most people think of the design files as being the CAD files—the schematic and layout. And of course, you can't build it without an accurate layout. But the BOM is the single most important file in this entire setup that has all of the information about the components; it matches the components to the boards, which is where the brainpower is needed." He drove the point home, "The process of creating the circuit board is about translating a file to board material with precise process control. Adding the parts to it is where there is a higher risk for ambiguity; thus, it requires a transfer of information from somebody's head to somebody else's head."

When asked for specifics, Duane Benson shared, "We may get a bill of materials (BOM) that has three line items that aren't completely filled out. That means we now have three parts, and we don't know what they are. We're not in the engineer's head, so we can't guess." Benson continued, "Or we'll get three components that aren't available in stock. We don't know what to do as a substitute because the customer hasn't given us one. Later, in the BOM, there are three components that don't have reference designators, and in the design files, it's a different version, and they're missing some of the polarity markings."

It's no wonder assemblers stop the process to work out the details. While the board design itself may be high in intellectual property, the components simply must be attached correctly, or nothing will work as intended. It seems so



obvious, yet build packages arrive at the CMs in an incomplete format every day.

Janet Tomor, senior business development manager at Suntronic, said, "It doesn't matter if [the job] is consigned or total turnkey, if the building material doesn't have a reference designator on it, if it doesn't have (hopefully) two or three substitutions, or if it doesn't have the right description with the part number; all those issues take time to get sorted out." She continued, "Unfortunately, we find a lot of them once the parts get here and we ordered off the bill of materials (BOM) that it's not what the description says or the part number is a 0805, and we receive a 01206 from their manufacturer. Then, you have to stop for two or three days minimum."

Muhammad Irfan said Whizz Systems sees this too, "Sometimes, we have customers who want to run very fast, but they have not defined the product well enough so that counter-productive speed hurts the project more than it helps. Going too fast leads to defining things as we go, and the cost of correction becomes huge."

So, what does Whizz Systems do to help resolve this? "We educate the customer upfront and hold their hands as well where we see it is a necessity to prepare them better. We know how to engage them and be efficient with this whole process." Irfan continued, "That is a huge value-add, especially startups, because they can go to a friendly place that understands startup culture and knows how to help, and can keep them disciplined if they lack that."

Lori Giglio, general manager at the NPI Engineering Center for DataED, added, "We have new designs walking through the door and things we've never even thought to do...a customer will ask, 'Can you do it?' And we will. As we collaborate with them and try it, we learn

something from it...through good collaboration.”

Janet Tomor’s Suntronic team will engage directly. “Whether it’s a production or prototype run, we have a new product introduction (an NPI) meeting,” explained Tomor. She continued, “I love when the customer attends. Sometimes they do, and sometimes they don’t, but we sit down with all the powers that be: the production manager, quality personnel, my engineer on the floor, and my buyers. Everybody sits down and goes through the packet that they give us, and we try to catch as much as we can at that point. Unfortunately, things get through occasionally, and then you have to do some backtracking, but we make a concerted effort to make sure that they have everything right before we even send it to the machine.”

The investment in an NPI meeting can pay off later when customers, “can see what needs to be done; then, [the packet] might come in a little cleaner next time,” according to Tomor.

John Vaughan also mentioned supply chain, noting that “The [component] lead time is primarily a byproduct of the component supply chain. After we have a complete kit of all of the components, our actual build schedule is only anywhere from 2–4 weeks, which is fast when you think about the complexity of the product. The challenge is that the component supply chain lead times have crept up dramatically across all device types, and it’s not unusual for us to run across components that have a year lead-time in today’s environment.”

Vaughan further explained, “If the customer is proactively communicating from the beginning, and the design cycle might take them six months, we can get in front of a lot of issues by working together. If we’re in lockstep with them from the beginning, then we can negate some of those supply issues by pre-buying



components, etc.” Additionally, “We [Zentech] can’t control the lead time on the components, which is the primary challenge that everybody needs to think about.”

Muhammad Irfan’s perspective was, “Sometimes, customers shy away because they don’t know where to go for a complete package... But we truly are an extension of their team. We give them the flexibility to pick and choose by tag-teaming with their internal team or handing off certain defined areas to us.” The takeaway, however, is simple. Make sure the documentation package you deliver to your contract manufacturer is complete, clear, and thorough.

Irfan wrapped up his perspective, “We want our customers to know that they can engage with us and hand off the project at any stage and have one company responsible to deliver the end result all under one roof.” While that may be the case at Whizz Systems—and most contract manufacturers for that matter—the more work you put onto the CM to do, the more it’s going to cost. And that cost will come in the form of labor, expedited pricing, and potentially field failures or yield issues; all of which ultimately comes out of the OEM’s profit margins. **SMT007**

How Assemblers Can Help Their Customers **Reduce Cost** and **Improve Reliability**

SMT Solver

Feature Column by Ray Prasad, RAY PRASAD CONSULTANCY GROUP

If you are not a millennial or Generation X, Y, or Z, you probably know that there was a print version of this magazine for decades. I was one of the columnists for the print version for over two decades, starting in the mid-1980s. However, this is my first column in the globally popular technical *SMT007 Magazine*. In my future monthly columns, in addition to covering various aspects of SMT design and manufacturing processes and issues and IPC standards, I will also answer your questions. So, to keep it interactive and interesting for both you and me, please let me know your questions or comments not just about my columns but any questions related to the aforementioned topics that you may have.

The theme of this month's issue of this magazine is how assemblers can help their customers. While others are focusing on addressing various aspects of this question in this issue, I thought I would address how assemblers can help their customers reduce cost by reducing defects and improving yield.

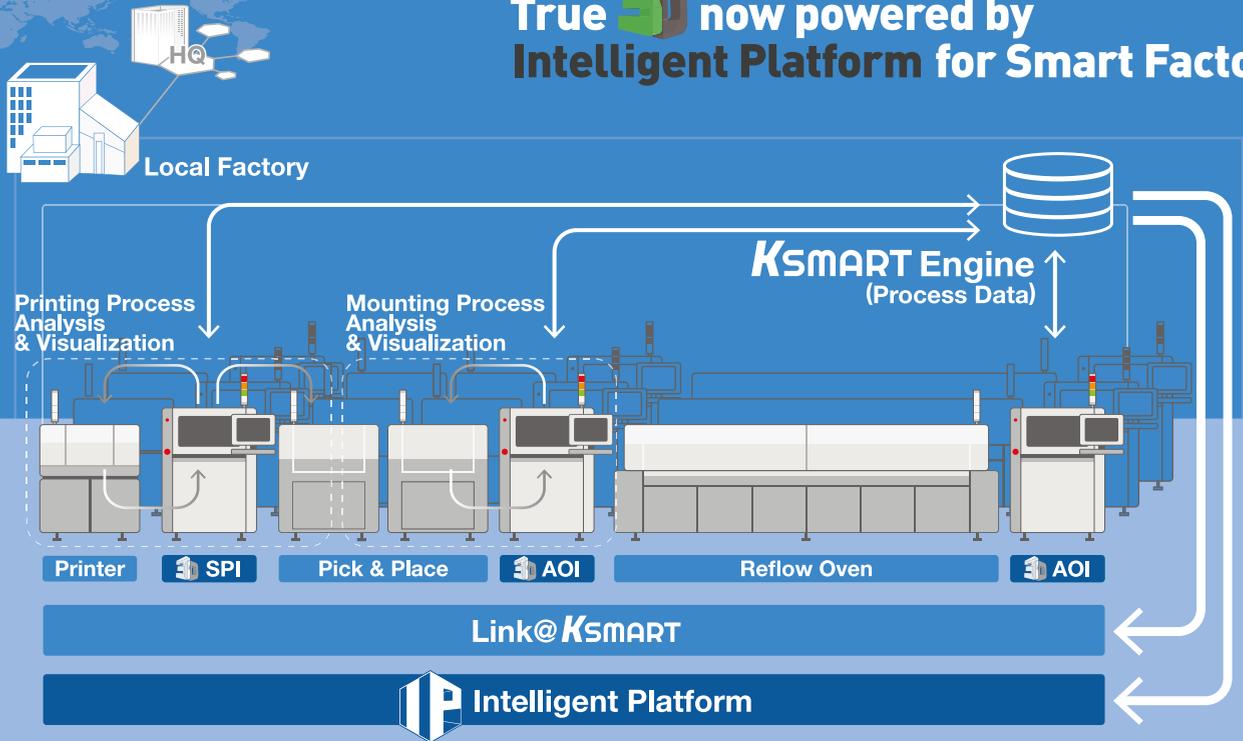
It is commonly assumed that the level of defects is primarily dependent on how the assemblers control their manufacturing processes. This sort of mistaken belief will cause you to never find the root cause of the problem. Hence, the problem will persist forever. Let me explain.

Just because defects are discovered in manufacturing does not mean that they were created in manufacturing. If you take a 50,000-foot view of the major causes of defects in an electronics assembly, you can put them in three buckets: (1) design for manufacturing (DFM), (2) quality of incoming materials, and (3) the manufacturing processes.

As we all know, the design of the board is done by the customer (OEM). The customer also makes all of the decisions about major incoming materials, such as PCBs and components; thus, they have control over two of the major sources of defects in electronics assemblies. Meanwhile, the assembler controls only their manufacturing processes and equipment



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unless they are a turn-key assembler responsible for purchasing PCBs and components as well.

In this column, I will focus on how the assembler can help the customer in making DFM decisions. Some of the examples of DFM issues that can cause defects, including land-pattern design, inter-package spacing, component orientation, types of laminates, surface finishes, solder mask design, via size, and line width and spacing.

Who Knows Better Than the Assembler?

Most boards are designed by OEMs and not by the assembler, but very few designers have any understanding of manufacturing processes. We are not talking about circuit design here; we are talking about the design of the board for manufacturing. Who knows better than the assembler about poor designs causing defects in manufacturing? This is where the

Who knows better than the assembler about poor designs causing defects in manufacturing?

assembler can help the customers—especially customers who do not have in-house manufacturing capabilities and have very little idea about the complexity and interdependence of design and manufacturing.

Why Should the Customer Listen to the Assembler?

With the help of assembler, if the customer can eliminate or at least minimize some of the root causes of defects under their control, defects will go down substantially as well as the cost. An added bonus is that reliability will improve because of reductions in defects and rework; hence, there is less potential for rework-related damage. This also improves on-time delivery since the products are not held

up for rework. There are many good reasons for the customer to work with the assembler for the mutual benefit of cost, reliability, and on-time delivery.

How Should the Assembler Proceed in Helping the Customer?

Start with helping the customer understand the basics of SMT processes, such as paste printing, placement, and all of the soldering process, repair, cleaning, test, and inspection with a focus on how the design impacts defects. For example, if you are having lots of tombstoning, the land-pattern design is most likely not good (too much space between the lands). I am not talking about making the designer a process engineer but helping them to fully understand how the design impacts process yield.

The next step for the assembler is to have the customer follow the assembler's DFM or develop their own in-house, company-specific DFM. In my global audit, I find that less than 10% of companies have their own in-house, company-specific DFM even though every company needs one. A DFM document requires the cooperation of both the assembler and OEM. I have taught classes at major OEMs where they invited all of their major EMS suppliers to make sure both parties were on the same page as far as DFM was concerned.

Using an industry standard, such as IPC-7531 (formerly IPC-782 when I chaired it) is a good place to start. However, you should keep in mind that industry standards are trying to solve world hunger and not company-specific issues. There are many common issues that can apply to every company, but there are many company-specific issues since every company builds different products for various applications, such as Class 1, 2, or 3.

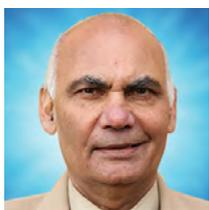
Here are some specific areas where the assembler can help the customer. Each area is also a major section of DFM (and some of them are potential topics for columns):

- Establish design rules and guidelines while emphasizing the importance of differences between them

- Component selection criteria, including consolidation of parts lists to reduce redundancy and eliminate obsolete parts
- Surface finish and solderability considerations
- Paneling considerations
- Fiducial requirements
- Land-pattern design
- Solder-mask considerations
- Via-hole location
- Design for test (DFT)
- Anything unique to your design

With the widespread use of high-pin-count BGAs and BTCs that cannot be inspected visually, sufficient test coverage for in-circuit test (ICT) should be seriously considered. Keep in mind that no inspection method is perfect. The only way to prevent defects from escaping to the field is to rely on overlapping test and inspection methods. Once a DFM document developed by a well-trained team is finalized and released, the possibility of DFM violation generally does not arise.

Creating a DFM document is not easy; however, it will correct problems at the source and prevent their recurrence. This is critical in an environment where essentially all manufacturing is being outsourced or sent offshore. **SMT007**



Ray Prasad is the president of Ray Prasad Consultancy Group and author of the textbook *Surface Mount Technology: Principles and Practice* debuting his first column in *SMT007*

Magazine. Look forward to more insights from Mr. Prasad in future issues. Mr. Prasad is also an inductee to the IPC Hall of Fame—the highest honor in the electronics industry—and has decades of experience in all areas of SMT, including his leadership roles implementing SMT at Boeing and Intel; helping OEM and EMS clients across the globe set up strong, internal, self-sustaining SMT infrastructure; and teaching on-site, in-depth SMT classes. He can be reached at smtsolver@rayprasasd.com.

Precision Control of Complex Electrochemical Interfaces for Separations

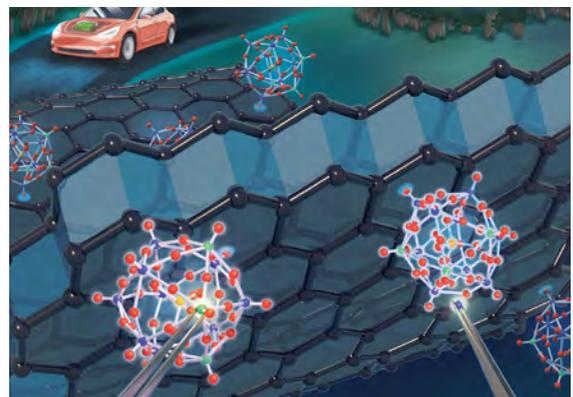
Researchers working within Pacific Northwest National Laboratory's (PNNL) Separations Science program succeeded in coupling a highly controlled way of modifying surfaces, called ion soft landing, with an electrochemical cell designed and built by PNNL to achieve precise control over the chemical composition of complex interfaces.

This allowed them to make atom-by-atom changes to electrodes to study the effect on performance and stability. They revealed that substitution of only one to three tungsten atoms by molybdenum atoms in complex metal-atom clusters resulted in a pronounced improvement in their electronic behavior, which controls how efficiently these species accept electrons for separation applications. The experiments, combined with theoretical calculations by collaborators in Spain, were published in *ACS Nano*.

In electrochemical devices used for separations, a lot is going on at once as electroactive ions, solvent molecules, and supporting electrolytes interact, exchanging electrons and mass during charge transfer processes. To understand these processes, it is necessary to decouple the different charge transfer and ionic interactions occurring on electrodes. In this study, the researchers did just that, and further exerted control over the process by tuning electrodes at the atomic level.

The researchers are now studying how to modulate the efficiency of separating different ions in solution using well-defined electrodes with precisely controlled anions and membrane layers. The fundamental insights gained in understanding molecular-level electrochemical interfaces may serve as a foundation for designing superior electrodes for separations, or even energy storage, at the device scale.

(Source: Pacific Northwest National Laboratory)



The Perfect Job

Feature by Nolan Johnson
I-CONNECT007

It can almost feel like it's illegal, can't it? Designers, we're talking to you. That moment when the documentation for the job is, well, perfect. Because let's face it; you weren't trying for perfect. You just wanted it off your desk and "over the wall into manufacturing."

After all the days and weeks invested into developing the schematic, the PCB design, poring over the data sheets and online libraries for component parts, and running the calculations for mechanical clearances inside the enclosure, you're ready to be done. You've spent so much time sweating every little detail.

Why can't someone else just wrap up the documentation? You cooked, right? It's someone else's job to clean up. You're ready for the next design challenge—not for a week or so perfecting the bill of materials and the design notes.

Kicking a mostly correct documentation set over to manufacturing is a tempting thing—a bit of subterfuge. You got away with something. Except you didn't.

This issue showcases common themes and thoughtful insights contract manufacturers have uncovered on packaging the data for delivery to the assembler or CM. So, listen up. Your downstream manufacturing partner wants you to know what to do differently to be more successful (faster, cheaper, more reliable) in the transfer.

Let's start with what the perfect job looks like. Some of the CMs in this issue laughed and said that they had never seen one. Lori Giglio, general manager at the NPI Engineering Center for Data Electronic Services (DataED), put

it this way: "It's hard for me to answer because here we're dealing with new designs and every job is exciting." As Giglio pursued that thought in our conversation, it became clear that "exciting" was code for "incomplete upon arrival and needs clarification."

Sure, there's good-natured joking about this fact of life for CMs, but there is an underlying seriousness as well. "Everything that we do is custom and/or customer-specific," stated Joe Garcia, VP of sales and marketing for Green Circuits. He continued, "We really take pride in

engaging with customers on jobs that are critical for them and require a quick turnaround."

Lori Giglio also said, "I don't often see perfection. What I usually see is somebody's idea of something. We collaborate and get to a point where the job is repeatable and producible in the

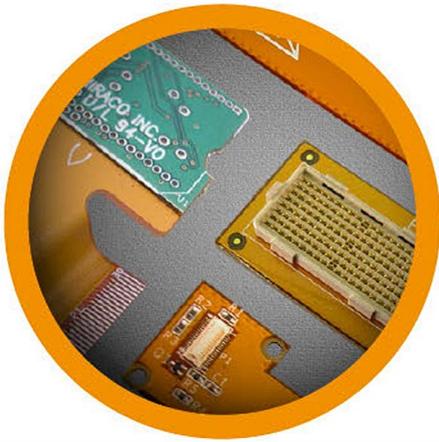
manufacturing environment. By the time it gets into the manufacturing facility, it might be perfect."

"I've been at this almost 40 years, and I've yet to see the perfect package where we could release it to our supply chain and the Gerbers and BOM was straightforward and perfect. It just doesn't happen that way," explained John Vaughan, VP of sales and marketing at Zentech Manufacturing. "If you're looking for success, the customer has to participate."

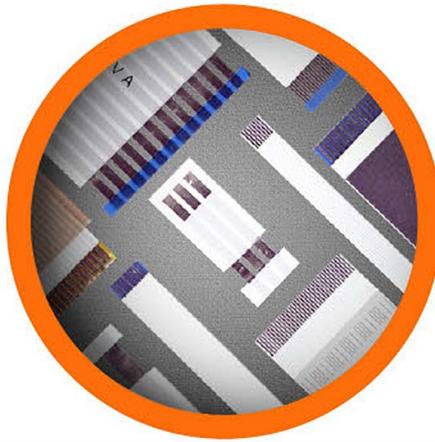
"We're equally efficient in dealing with start-ups to very large companies," said Muhammad Irfan, president at Whizz Systems Inc. "For example, we consider the level of documentation required for each type of customer. We can run with them as fast as they want, but



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we also document and protect them and us to have a good end delivery.”

Back at DataED’s NPI Center, Lori Giglio was optimistic. “For every job an engineer walks in with, we can help them to improve it.” Giglio also expressed some realism, “Nobody is going to walk through the door with the perfect design at an NPI center. They walk in with something in their hands, saying, ‘Is this even going to work? Can you make this into an actual product so that we can test it and see where we can improve?’”

Duane Benson, an I-Connect007 [columnist](#) and a representative from Milwaukee Electronics, discussed prototype versus production, “For a forecasted production build, like we would put together in our Milwaukee Electronics EMS factory, we go through a new product introduction (NPI) process. It’s a multi-week process to prepare a design to go to the manufacturing line. We create a perfect job in that process.” He continued, “At Screaming Circuits [a division of Milwaukee Electronics], we do that six- to eight-week job in six to eight hours.”

That short amount of time to perfect the job means that either the customer gets very involved or the build start gets delayed. Benson added, “We have a lot less time to go back and forth, so to put together one of these on-demand manufacturing jobs perfectly, we need that BOM to be accurate. We need to know that all of those parts are available. We need to have the latest set of the CAD files, and we like to see intelligent CAD data, such as an ODB++ file; it has more information in it. And we need to make sure that those are all the same version. Even though Gerber is an old format—and that still helps—make sure it’s the same version. It’s pretty common for us to receive ODB++, Gerber, and then a BOM; one will be a 2.1, one will be a 2.1A, and one will be a 1.9B. But they all have to be the same version. Double check them and make sure the part numbers are complete and accurate.”

Lori Giglio shared some similar words of advice, “Issues could include a pad mismatch,

a part that they thought was going to fit the right way but doesn’t, or they put things on the edge that shouldn’t be there. Sometimes it’s the board layout, or they violated some IPC standards and need to keep that in check too. Our board houses will often share that back as well, and we can help them with that.”

John Vaughan mentioned the supply chain, “Well-organized programs that allow sufficient lead time to procure the components work well for us. So, it may be during their design activity that the designer picks out the part and has a conversation with field application personnel from Altera or Xilinx or some of the higher end parts, they’re going to lock in that architecture early and build everything else around those parts. They have a plan and the lead time on those devices can be 20–26 weeks. Since they know they need 25 of them, that’s a time to buy those because the lead time isn’t going to shrink when you create your BOM. Why not address the obstacles upfront when you already know they exist?”

Janet Tomor, senior business development manager at Suntronic, used board fabrication as an example, “The PCB manufacturers that we typically use...will invariably have questions about the board once they get the order and they delve into it, such as design issues. The board shop won’t start the board manufacturing until they have all their questions answered, which seems to be a problem for customers. They respond, ‘I thought I’d have this in two weeks,’ but that’s what can happen when they take a week to answer the supplier’s questions. Some customers don’t seem to understand how crucial communication is; it’s the biggest part of their delivery schedule.”

In some cases, though, that incomplete status can be an opportunity for a value-add. Joe Garcia shared, “We had a customer who needed a project completed for a trade show, and we were able to assist them with doing the final design—in this case, board layout—ordering the parts and delivering a product to



them in just over two weeks. So, we felt like we added value to them. They came to us in a pinch, and we were able to move quickly like that, solve a problem, and, ultimately, help the customer be successful. That's as close to a perfect type of job as we can get."

Benson mirrored Tomor with some practical advice, "If you're sending in a parts kit, make sure that all of the parts have the complete part number on them and the reference designator. The reference designator goes between the BOM and board; we need that to program the machine." Benson added, "The BOM includes all of the components. It's the primary file that we build from, but it doesn't tell us where that part goes on the board...The reference designator is the key between the physical PCB and file set."

"The other thing that's important about this is to make sure that polarities are very clear," said Benson. He continued, "We have so many people who mark diodes with a plus. Conventionally, the plus goes to the anode, but not necessarily. What if it's a barrier or Zener diode? What if it's a bridge when you have an anode and a cathode going to the same spot? You have to clearly mark with a diode symbol or anode—A for an anode or K for a cathode—and we use K so that it won't be confused with the capacitor. Anything that might be ambiguous needs to be removed; that's what creates a perfectly clear file set and kit."

Muhammad Irfan had a different perspective based on his company's positioning in the market. To him, a perfect, well-prepared job is one where the designers, "Know what they want at the concept level architecturally, and they understand the major blocks of their design: which processor, the two or three major pillar components of their design, etc. They should know what they need and engage with us at that point to let us do what we are good at." He continued, "They should also define the end result properly. What constitutes the

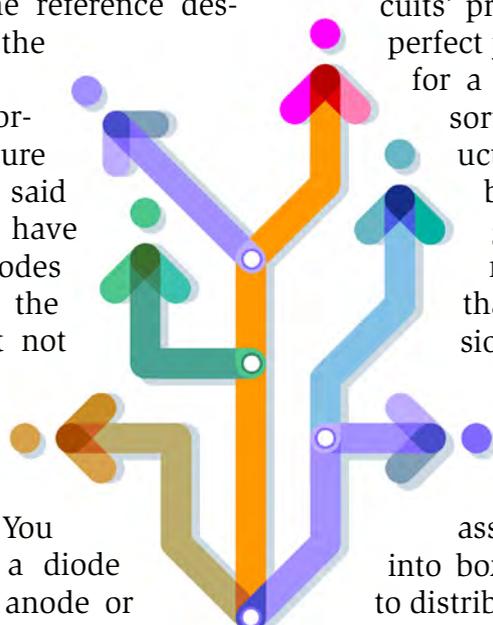
acceptance of our work to them? Where [in the process] do they want that hand-off back to them?" Irfan also said it works best, "If the start point and end point are well understood, and they let us do everything in between with properly defined milestones..."

Jeff Hamlett, director of sales and marketing at DataED, commenting on the move to production, said, "It's critical to have all of the documentation in line... Once it comes from the NPI Center, everything is pretty much in line; they've run it through a couple of iterations already, so we can hit the ground running."

Joe Garcia expanded on one of Green Circuits' production specialties as well, "A perfect job would be customers looking for a full turnkey solution for some sort of complex electronic product ideally going to go into box build with some test...We're getting more and more inquiries about that capability...And that quickly turns into a discussion about moving to functional test capability or gear to our facility...being a multiple turnkey solution provider, and putting finished system assembly products that are tested into boxes and shipping them directly to distribution centers or directly to their customers."

John Vaughan concluded, "Having a technical point of contact readily available for dialogue is important because there will be questions."

No, it seems that you can't get away with short-circuiting the documentation process—at least not for very long. Your manufacturing partners will compel you to remove every ambiguous detail because otherwise, they'll deliver an inferior product that reflects badly on them and you. It's your choice to be thorough in your documentation upfront or answer a list of clarifying questions inversely proportional to the completeness of your documentation set. To borrow another movie trope, "You can do this the easy way, or the hard way." **SMT007**



Zentech's Mission-critical Tips for Program Success

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson and John Vaughan, I-Connect007 [columnist](#) and VP of sales and marketing at Zentech Manufacturing, discuss how to make customer programs successful through early communication, complete design packages, and more from a company servicing mission- and life-critical industries, including military, aerospace, and medical.

Nolan Johnson: John, can you start by giving us a brief introduction of Zentech Manufacturing?

John Vaughan: Zentech Manufacturing is an electronics manufacturing services (EMS) provider located in the Pentagon Region of the U.S. with operations in Baltimore, Maryland, and Fredericksburg, Virginia. Our business is primarily focused on the Department of Defense (DoD) and the military prime defense contractor space. We have approximately 200 employees, and this is our 21st year in business.

Johnson: That's a pretty significant size and a vibrant market.

Vaughan: We're about 80% mil/aero now, and the balance would be approximately 20% medical. We also touch a handful of commercial



products each year that tend to be in the high-end computing space. So, we do high-complexity manufacturing for highly regulated markets. One thing you've likely noticed is that we were early adopters of the IPC validation services programs, and I believe we were one of the first to become IPC-610 Class 3 mission-critical certified and were the first to become IPC J-STD-001 certified with the space addendum. We are also one of only three certified under the new IPC-1791 trusted assembler certification. In short, we support these highly regulated markets with advanced certifications and high-complexity level manufacturing and test. The result is a pretty narrow pool of competitors.

Johnson: What's the one thing you would want every customer to understand about delivering a data package to your quote team?

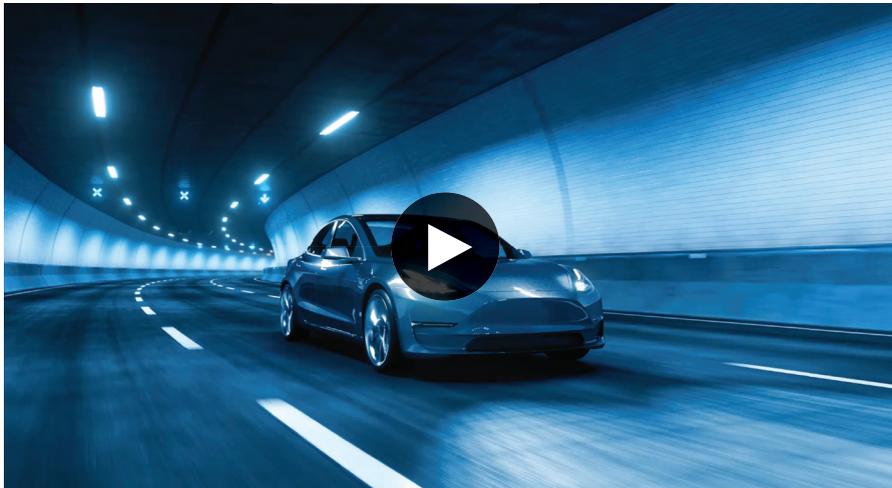
Vaughan: Well, I'm old-school, so planning and communication still matter more than anything to me.

Often, if customers are running late against their deadlines, they will feel pressure inter-

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nally to simply toss a data package over the fence, thinking that it's complete enough and sufficient to both quote and build. If it's a highly complex product, there's a lot of dialogue that's required. And the earlier the customer can engage us and communicate with us, outline their intentions, and be available for dialogue, the better results the program will have.

They also need to understand that the lead time is primarily a byproduct of the component supply chain. After we have a complete kit of all of the components, our actual build schedule is only anywhere from 2–4 weeks, which is fast when you think about the complexity of the product. The challenge is that the component supply chain lead times have crept up dramatically across all device types, and it's not unusual for us to run across components that have a year lead-time in today's environment.

After we have a complete kit of all of the components, our actual build schedule is only anywhere from 2–4 weeks, which is fast when you think about the complexity of the product.

So, if the customer is proactively communicating from the beginning, and the design cycle might take them six months, we can get in front of a lot of issues by working together. If we're in lockstep with them from the beginning, then we can negate some of those supply issues by pre-buying components, etc. If communication and data packages are incomplete, untimely and sporadic, then we cannot turn back the clock or accelerate the component supply chain appreciably. We can't control the lead time on the components; that's a primary challenge that everyone needs to con-

sider. Zentech is one of the few EMS companies that will work with customers to mitigate risks, which is a significant, long-term benefit for everyone involved.

Johnson: With a lot of military, aerospace, and medical work, what are some of the services or assistance Zentech can provide that your customers tend to overlook?

Vaughan: Going back to the schedule compression, a lot of times, shockingly, when customers are developing high-tech products, they don't give the proper amount of mindshare and planning to the test side of the product design and verification equation. Given the environments we operate in, typically mission or life critical, we prefer to test everything we build. The further along a customer has considered their testing approach and what that methodology looks like, the better.

Also, it's shocking how many designers of printed circuit boards and assemblies have never been in an assembly operation or a PCB manufacturing environment. A design might look great on the computer, but design for manufacturing (DFM) matters a lot more. Much of our work for our core customers is spent on design for assembly (DFA) analysis or DFM analysis. As a customer, you have this great product, and we're behind you 100%. We want to help you bring it to market, but the problem arises when it can't be built the way it's currently constructed.

Johnson: How often are you involved with the prototype process, or does Zentech become involved as the product moves into production?

Vaughan: It's a hybrid. We're a little bit different than a lot of EMS providers and not transactional in nature. We have a customer set that has been developed primarily with military clients. A typical scenario for us is to engage early with the program office as the active requirements have been developed, and then map out an approach and strategy to support the prototype. We also review all of the various mate-

rial and manufacturing readiness requirements within the DoD. We want to be involved early on a program to ensure that there's financing allocated in the DoD budget; we don't want to necessarily engage in one-off R&D or science experiments. We will, on occasion, for the right customer or long-term opportunities. But typically, we prefer involvement in the whole life cycle.

Johnson: What does a perfect program look like for Zentech, and what makes for a well-prepared customer?

Vaughan: Well-organized programs that allow sufficient lead time to procure the components work well for us. Again, having a technical point of contact readily available for dialogue is important because there will be questions. I've been at this almost 40 years, and I've yet to see the perfect package where we could release it to our supply chain and the Gerbers and BOM were straightforward and perfect. It just doesn't happen that way. If you're looking for success, the customer has to participate.

Another key would be to share your pricing with us. A lot of our clients are large, and on an annual basis, they're negotiating specific pricing tiers with their distribution partners and even direct with some of the manufacturers. It wastes time for everybody if you don't share that information because even though we're a large spend in our market in the Pentagon Region—probably the largest component spend—but we're not in the magnitude of some of the larger military clients' combined spends. The more they can share that registered pricing with us in the beginning, the better our overall materials cost is going to be as well as their ultimate cost.

Johnson: Do you have a success story about a relationship with a customer that you can share?



Vaughan: Yes, lots of them. We work on challenging stuff, and somehow through all the twists and turns that are inevitable with high-complexity military electronics manufacturing, we manage to produce great outcomes through our teamwork and finely developed processes. We also have a lot of depth. There are certainly larger electronics contract manufacturers than Zentech, but we pride ourselves on having an OEM mindset and a very deep bench across all key disciplines. We're heavily staffed on the front end with engineering capability.

Our CEO was previously VP of product development and operations for an OEM corporation with a couple of billion dollars in revenue each year. When he came to Zentech over a decade ago, he was able to draw some talent from his former company over to our side. We have a lot of engineers on the front end that most organizations of our size don't have. And on the back end—for test development, methodologies, testing for fixture construction, and engineering talent that can troubleshoot to the component level—we are also very deep in those areas. We bring engineering solutions to everything that we do.

We had a customer in the heads-up display (HUD) environment supporting a military plat-

form where they have a fantastic solution that worked most of the time, but in a mission-critical environment, most of the time is not good enough. We acquired that product build and did a lot of engineering on the front end with heat dissipation techniques in their operating environment. After several hours in the battlefield, the devices and boards ran pretty hot, and the system began to shut down, and there were all kinds of anomalies. Even though we're not a bare board PCB manufacturer, our VP of technology has extensive bare PCB background, as do I, as does our VP of operations.

Within six months, we had the program back up and running successfully. And good news travels fast so that particular HUD was on a larger platform for a larger military OEM, and they caught wind of the solutions that we provided, and that led to more problems to solve (laughs). No good deed goes unpunished, so it led to additional opportunities throughout the supply chain on that particular platform.

Johnson: In this industry, we're in the business of solving problems.

Vaughan: Right, and that's a big part of our strategy, swimming in the blue part of the ocean and not in the red, bloody part where everybody's racing to the bottom and competing on price. There's a low bar of entry if

you're only ISO certified. A lot of companies can play over there, and the pricing and margins are going to reflect that. We tend to focus on the blue ocean where we swim around and pick out where we want to engage and then apply our expert resources to solve problems for programs of significance.

Johnson: Zentech has a number of dynamics in play regarding customer requirements and potential business areas. There is a lot of activity with new and specialized materials, and you already mentioned the bare board as arguably the most important part of your BOM. From your perspective, are customer needs and requirements changing?

Vaughan: We see demand accelerating across every customer that we've cultivated over the past 10 years. We went on a mission, as I alluded to earlier, to become highly certified for highly regulated markets, and there were certainly some budget challenges, such as sequestration, associated with the customer set that we developed over the years. And believe me, I heard a lot about that at board meetings. But the budget turned our direction a couple of years ago.

By the same token, the delivery timelines for our customers are also compressed right now. Everybody wants to get their gear to whatever threat environment their product functions in as quickly as possible, and the DoD wants that as well. There's a lot of unrest in the world, as I'm sure everybody knows, and peace doesn't look like it's going to break out anytime soon anywhere. So, there's lots of accelerated demand, and at the same time, the build windows are compressed.

Even worse, the quote cycles are very shortened. Customers used to be fairly understanding if you get a quality quote put together for a complex electronics product, that it takes at least



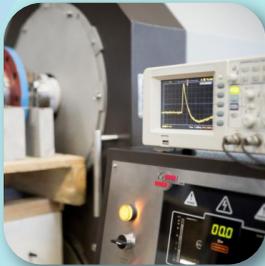


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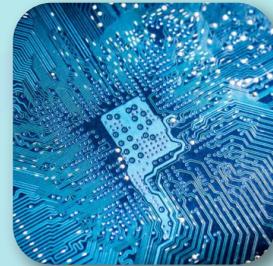
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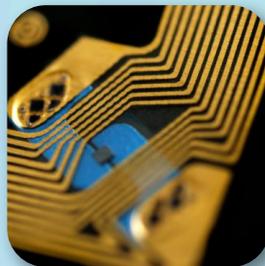
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3–4 weeks. And then you throw in the biggest challenge—many large organizations thinned out over the past 5–6 years due to a combination of a lot of people retiring in procurement and program management across the military client sector. With employees retiring and company restructuring, some roles were also being eliminated. Now, we’re faced with all of the challenges that I’ve just outlined at once, and there’s a more junior set of people occupying those chairs.

Johnson: Just when communication and relationships are more important than ever before—and there are challenges to get things done faster and in shorter windows of time—now, it takes more time to finish the complex parts. You also need to help build a base for a less-experienced group of people with whom you’re communicating.

Vaughan: Absolutely. And you can take the approach of the glass being half full, which is what we take, which spells opportunity for us. We’re uniquely set up to have the resources that are gaps within our customers right now, so we’re bringing a high level of value to all the program activity. So, it’s great, but very challenging. And that takes you back to the same equation we’re solving that everybody else is too—we need more engineers and we need them now.

You can take the approach of the glass being half full, which is what we take, which spells opportunity for us.

And we build high-complexity products, so it takes a seasoned person. We’re hiring and training straight out of college and have been very active in those type of STEM-related initiatives and have been aligning with technical and community colleges for many years.

You need a blend of experienced engineers and emerging engineers to become more educated for optimal results.

Johnson: Are you looking for new areas of business right now?

Vaughan: We are. As I mentioned earlier, we’re about 80% concentrated in mil/aero and the DoD right now. And that’s great, but when you sit back and look at it, you have to say, “We need to proportion out our business a little bit better.” So, we’re looking at a couple of things. One is the expansion of our medical business because there’s a lot of striking similarities between military and medical—the most obvious being a Class 3 build, which is typically a requirement for medical. There’s also the intellectual property (IP) piece and the avoidance of going offshore. Both mil/aero and medical industries prefer to be built in the U.S., so we have the engineering and test set as well as the manufacturing capabilities to support a Class 3 environment, so more medical is a natural extension.

Along the way, because we are doing high-complexity builds, we’ve dialed in pretty tight processes for some of the more sophisticated parts out there; for example, some of the processors, bottom-terminated components, and more challenging devices. If you look at high-end computing, they’re always putting a lot of processing power into a small form factor, so that is a fit for us. With acquisitions, we’re actively looking at several companies to acquire right now. The shortest pathway to new markets and customers is to acquire an organization that’s already doing a great job, so that’s another avenue that we’re looking at closely right now.

Johnson: Do you see more of the newer and more specialized materials being specified by the teams you’re working with regarding bare boards in particular?

Vaughan: Most of what we do tends to be a lot of RF and microwave work for electronic warfare and signals intelligence. We see a lot of



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Alun Morgan, EIPC President

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Rogers Corporation and MEGATRON 6 materials, primarily. And we're manufacturing very high layer count boards. The platforms we're building on are anywhere from 18–40 layer PCB requirements with two-mil space and trace and lots of blind and buried vias and special processing techniques.

Most of what we build is for the military, and our bare board fabricator supply base is all in the U.S., which has significantly diminished over the past several decades. There are fewer than 200 domestic PCB players in total and around 30–32 of them are 31032 MIL-certified right now, and probably half of those are owned by a single entity.

Johnson: When high-speed, low-loss materials come into play, your clients are likely to want

a material that is tried-and-true, not necessarily the latest product.

Vaughan: That's absolutely right. Everything we do is not a new program. It doesn't really matter what the latest and greatest material is. In many instances, it's dialed in the way it needs to be on the drawing or the platform flying in the air. If it works, we're not going to change anything—that's the attitude—so new materials are much more applicable on new product development.

Johnson: Thank you, John. This has been very helpful.

Vaughan: Yes, sir. It's my pleasure, and I look forward to seeing you soon. **SMT007**

Argonne Researchers Create a Unique, Tiny Resonator

A team of scientists at the Center for Nanoscale Materials (CNM), a U.S. Department of Energy (DOE) user facility at Argonne National Laboratory, have pioneered a micromechanical device that responds to external signals in an entirely new way compared to conventional ones. Their work was recently published in *Physical Review Letters*.

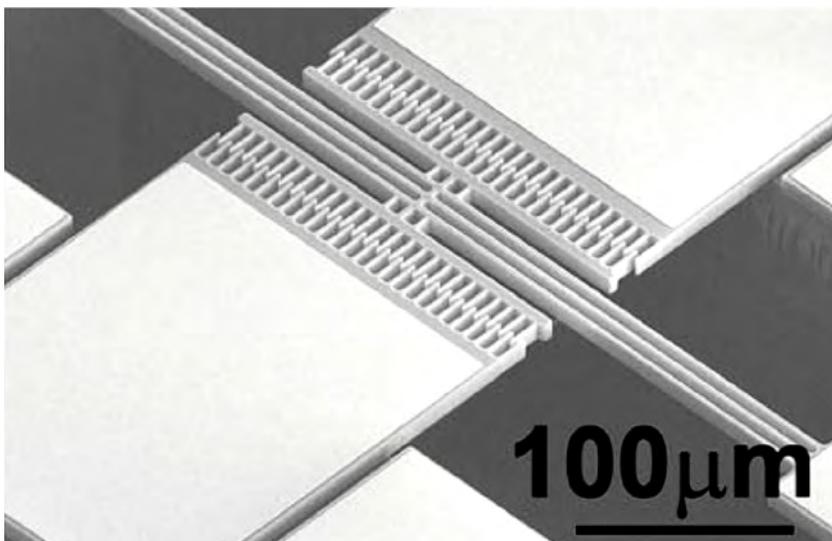
"For every device running at a specific frequency, you need a timing source," said CNM nanoscientist Dave Czapski, the paper's lead author. "Having multiple devices running at multiple frequencies makes the sys-

tem much more complex." While a common approach to this problem involves multiple resonators, multiple signals, or both, the researchers created a single, microsize resonator that can generate multiple frequencies from one signal.

The research was conducted partly at the CNM, where researchers designed the resonator and used electrical characterization techniques to measure its responses. The silicon device anchors three beams that move together in two vibrations: a side-to-side swaying motion and a twisting motion. The researchers used this duality to generate a frequency comb that can be used to study a specific type of dynamic known as saddle-node on an invariant circle (SNIC) bifurcation in mechanical, optical, and biological systems. In a biological setting, for example, understanding this behavior could aid in the design of micro-mechanical elements that emulate the way neurons respond to stimuli.

The next step in the research will be to reproduce the frequency comb phenomenon in higher-frequency resonators and extend the number of frequencies that can be generated.

(Source: Argonne National Laboratory)



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From smartphones to implantable medical devices, electronic designers and fabricators are continuously challenged to miniaturize the size of their products. The SMTA Additive Electronics Conference brings together practitioners looking at the SMT-SEMI convergence. Targeted at substrates with line space/width down to 5um, this conference will showcase substrate design and manufacturing technologies that will enable the next generation of electronic products.

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Supplier Highlights



Nano Dimension Offers Update on DragonFly 3D Printer a Year After Launch ▶

The Nano Dimension DragonFly 3D printer arrived in much fanfare a little over a year ago. The company has been selling them to customers around the world, many of whom are using them to print antennas, sensors, and PCBs. At AltiumLive in Munich, Product Manager Robert Even discusses what they've learned in the year since the DragonFly debuted, and some potential uses for 3D printing technology.

MacDermid Alpha Opens Tech and Applications Center in Taiwan ▶

MacDermid Alpha Electronics Solutions officially opened a Global Development Application Center on March 19, 2019. The advanced technology and application center will house sales, technical service, customer service, and office personnel alongside the laboratory staff.

Rehm Focuses on International Hiring ▶

Rehm Thermal Systems has been successfully recruiting skilled workers from abroad for some time now.

Tips & Tricks: Humidity Level for Electronics Assembly ▶

Low relative humidity (RH) can allow for higher static charges to build on objects. It can also affect solder pastes, especially OR-class pastes, and this can reduce print performance and stencil life. Read on to find out what level of RH you need for your assembly facility.

IPC Issues Call for Participation for Electronics Materials Forum ▶

IPC—Association Connecting Electronics Industries invites engineers, researchers, aca-

demics, technical experts, and industry leaders to submit presentation topics and descriptions for the IPC Electronics Materials Forum, a new technical conference focusing on developments in materials and processes associated with electronics assembly and manufacturing.

Electrolube Launches Next-gen UV Cure Coatings at SMTConnect ▶

Electrolube developed the exciting new UVCL range to meet the various requirements of electronics, LED, and automotive manufacturers with the additional benefit of rapidly increasing production time and offering even higher levels of performance.

Emil Otto Launches New Flux Remover onto the Market ▶

Emil Otto expands the range of assembly cleaning agents with a manually applied medium for the removal of flux residues.

Datest and VJ Technologies Celebrate First Year of Success ▶

Datest is celebrating its first year of partnership with VJ Technologies (VJT) on a West Coast inspection services center, showroom, and demonstration facility. VJT is a global leader in providing digital X-ray inspection system and services solutions.

Valtronic Adds Two New Juki Machines to Meet Growth Demands ▶

Valtronic, an EMS manufacturer focusing on medical devices, recently invested in two new Juki 3020 SMT pick-and-place machines, expanding its SMT lines to meet growth demands. These additions will provide flexibility, depth, and breadth to the company's manufacturing lines.



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Duane Benson

Communication and Information: Two Keys to Success

Feature Interview by Nolan Johnson I-CONNECT007

Nolan Johnson and Duane Benson, an I-Connect007 [columnist](#) and a representative from Milwaukee Electronics, discuss how assemblers can help their customers through submitting and maintaining accurate information, and engaging in open communication early and often about the highly important bill of materials (BOM).

Nolan Johnson: Duane, can you kick this off with a quick description about Milwaukee Electronics, what they do, and what your role is?

Duane Benson: Milwaukee Electronics is a full-service contract manufacturer celebrating our 65th anniversary in business this year. And by “full service,” I mean that while we are primarily a contract manufacturer and EMS service, we also have custom design engineering in the corporate office. We also do layout with our San Diego PCB division, and we have prototype and on-demand small and limited quantity manufacturing in our Screaming Circuits division.

Screaming Circuits started to turn manufacturing on its head in 2003. We started with prototypes but are now building on-demand manufacturing, end-product prototypes, and mid-volume. We build items that go into outer space, deep underwater, and pretty much anything in between.

Johnson: So, there’s no real specialty for the ideal type of customer; you talk to everybody.

Benson: Right. Especially with Screaming Circuits, we specialize in a phase of the design and manufacturing cycle—not in a specific industry. Once the engineer hits save in that CAD software for the last time, we specialize in what happens next.

Johnson: Just to clarify, is that statement just for Screaming Circuits or Screaming Circuits and Milwaukee Electronics?

Benson: Screaming Circuits has a broader focus in that we do everything. Milwaukee Electronics has a narrower focus, but not by an awful lot. We work on medical devices in our Portland EMS facility, which is ISO-13485 certified.

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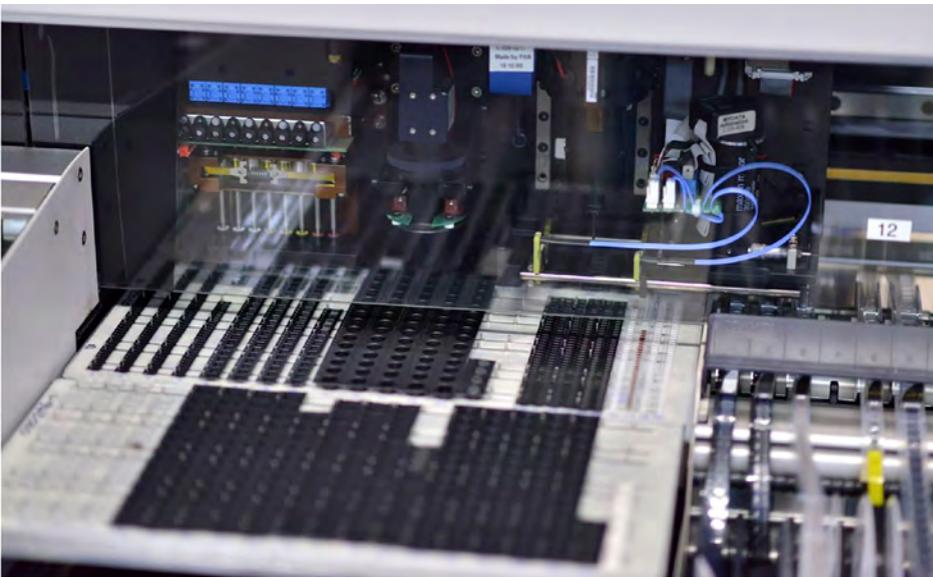
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Components plate on the MyDATA machine.

One of our factories works on military equipment, and all of our factories work on power equipment and communications. We have a very wide set of devices and consumer electronics. We don't specialize as much as most other manufacturers do.

Johnson: This makes for a very interesting perspective for our conversation today, which will focus on how assemblers can help their customers.

Benson: Obviously, it's about making the customer's job easier, which depends on who in the company we are working with. With the scheduled and forecasted volume manufacturing at Milwaukee Electronics, we're working with purchasing agents. With our Screaming Circuits division, we're working directly with an engineer, so it's important to understand what each of those different customers need. For example, purchasing agents need predictability while engineers need flexibility. Overall, the most important thing that we can do to help our customers is good communication.

Johnson: Based on how your company is structured, you may have two different answers to my question—one for the production side and one for the engineering side—so, what's the

one thing that customers can do to connect better with you?

Benson: Well, it's the same answer for both: good communication, as I mentioned, and accurate information. The vast majority of the problems that we run into—whether they be in our forecasted manufacturing with Milwaukee Electronics or our on-demand manufacturing with Screaming Circuits—fall to communication and information.

At Screaming Circuits, for example, we may get a bill of materials (BOM) that has three line items that aren't completely filled out. Now, we have three

parts, and we don't know what they are. We're not in the engineer's head, so we can't guess as to what they are. Or we'll get three components that aren't available in stock. We don't know what to do as a substitute because they haven't given us one. Later, in the BOM, there are three components that don't have reference designators, and in the design files, it's a different version, and they're missing some of the polarity markings.

We work with a partner for the blank PCB—the foundation of every electronic device—which makes the accuracy of information even more critical. Most of our PCBs are fabricated by Sunstone Circuits. If we are given unclear information from a customer, we may not be able to give the right information to Sunstone. As with the old "telephone game," each time information goes from one party to another, the risk of misinterpretation increases.

That information is critical, and if you don't have it right in the first place, you're going to have a cascading set of problems. We will do our best to solve those problems. We'll call you to try and figure it out, but we need good communication and information, and we need people to respond quickly, especially in a prototype or on-demand type environment.

All companies face this risk, but we built our business around mitigating that risk. We've

been working with Sunstone since we started Screaming Circuits, and that level of understanding allows both of us to focus on what each of us is good at. We are so well integrated that the risk of miscommunication is significantly reduced.

Johnson: You've used the word "on-demand," but you've also described production as a forecasted model. Communication is the one theme across it all. Does it look different in a forecasted model?

Benson: Inside of the company that we're building the boards for, they have meetings about reducing the forecast, increasing the forecast, and component availability. That's all going on in conversations at the company; they're not necessarily communicating that to us. We have a schedule that they gave us two months ago, so we build to that schedule. All of a sudden, they may call us and say, "We can't take any more product this month. You've already sent us too much."

If we had known that two weeks ago when they made the decision, we could have planned for it. Or we may end up asking, "What do you want us to do? We can't find this component anywhere." They've already decided some time ago that there was a good substitute. But if they don't communicate that to us, we don't know what to do. We don't know what's in their heads, but we're building based on the assumption that we do.

Johnson: Let's drill down on that. You talked about communication, and between the two—on-demand versus forecast models—does it come down to BOM management?

Benson: Most people think of the design files as being the CAD files—the schematic and layout. And of course, you can't build it without an accurate layout. But the BOM is the single most impor-

tant file in this entire setup that has all of the information about the components; it matches the components to the boards, which is where the brainpower is needed. The process of creating the circuit board is about translating a file to board material with precise process control. Adding the parts to it is where there is a higher risk for ambiguity and things not matching up; thus, it requires a transfer of information from somebody's head to somebody else's head.

Johnson: Designers think of the PCB as being the central part. But by the time you get to assembly, the board is simply a line item in the BOM, even though it happens to be application-specific compared to some of the others.

Benson: You could look at it that way. If you want to make an analogy about something in the real world, we can use the highway system and transportation, for example. The construction of the highway is critical. It has to be safe and go to the right place, but what happens on it—all of the traffic and variables, such as different vehicles and people driving too fast or slow—that's the BOM.

Johnson: With Milwaukee Electronics and Screaming Circuits, what assistance or services you can provide that your customers seem to overlook? What ends up being underutilized?



3D X-ray.

Benson: One of the things that's unique about Milwaukee Electronics is our Screaming Circuits division. Some companies were designed around building prototypes and nothing else. Milwaukee Electronics and other companies were designed around high volume. Screaming Circuits was started by Milwaukee Electronics to bridge that gap.

Johnson: One of the unique configurations for Milwaukee Electronics is that once the design has come through prototype and assembly with Screaming Circuits, you've pretty much shaken out a lot of the issues with moving into production.

Benson: We have, and not all of our customers go from Screaming Circuits to Milwaukee Electronics, but a number of them do. And even if you aren't one of those that goes to our forecasted EMS service, you can still use that information; we give it out for free. We don't require that you be a customer to learn from what we know.

Johnson: Bringing suppliers in early to consult is a common theme, whether we're talking about design rules, DFM, etc. By connecting a designer with someone in manufacturing who can say, "That's not going to work. The CAD tool may let you do that, but it won't work in the real world," you're saying you will help by consulting even if they don't become a customer?

Benson: Yes, and for those that do, we have our engineering design team, San Diego PCB layout specialists, and Screaming Circuits. We can help people from the cradle to the grave. But again, part of our mission is to pass this information and knowledge base that we have into

the entire industry. If every engineer designs better circuit boards, we're all better off for it even if we don't build them.

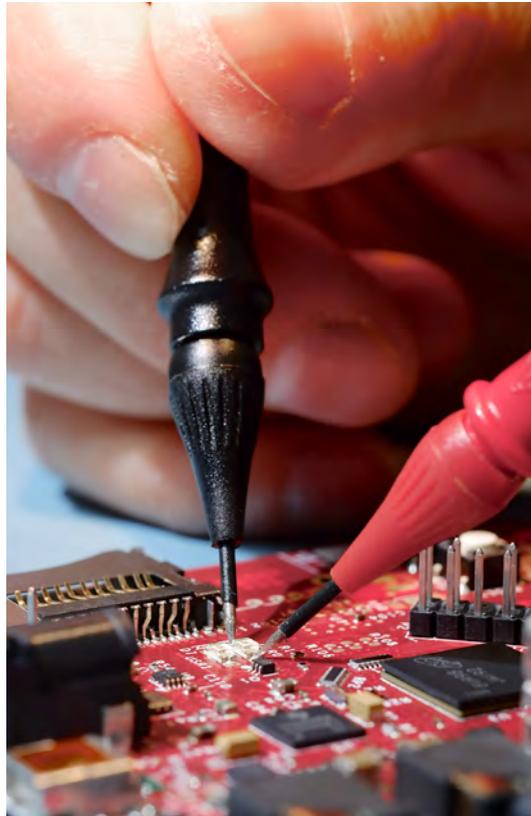
Johnson: What does a perfect job look like for you and your shop?

Benson: For a forecasted production build, like we would put together in our Milwaukee Electronics EMS factory, there's a process that we go through called new product introduction (NPI). We have a lot less time to go back and forth, so to put together one of these on-demand manufacturing jobs perfectly, we need that BOM to be accurate. We need to know that all of those parts are available. We need to have the latest set of the CAD files, and we need to make sure that those are all the same version.

Johnson: At a practical level, they may be the right versions for those particular documents, but because the version numbers don't match to you, you're going to ask.

Benson: Yes, and we also have cases like that where they're all version 2.1 but

different. And if you're sending in a parts kit, make sure that all of the parts have the complete part number on them and the reference designator. The reference designator goes between the BOM and board; we need that to program the machine. The BOM includes all of the components. It's the primary file that we build from, but it doesn't tell us where that part goes on the board. The board has a lot of spots for parts, and the BOM doesn't tell us what part goes in those spots. The reference designator is the key between the physical PCB and file set.



Board with LED being verified.



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Johnson: What makes for a well-prepared customer? Is there something qualitative that helps you out?

Benson: There is. To a lot of engineers, manufacturing is kind of like a black box—it's a mystery—and many feel like once they hit save for the last time, then it just goes off into some magic land and comes back.

Johnson: Kind of like the printer on your desk; it just works.

Benson: Exactly. A well-prepared customer knows that this is very difficult for them and us. We signed up for it, but it's a very difficult job. A well-prepared customer is also curious; they want to know what we're up to and are willing to communicate quickly and think through and help us solve problems creatively. Having an interest in what we're doing and what's happening in manufacturing is critical.

Having an interest in what we're doing and what's happening in manufacturing is critical.

Johnson: Can you tell me one of the success stories?

Benson: Not long ago, we built a badge for a trade show. The trade show organization came to us and asked if we wanted to build it for them, and they would give us some publicity. We gave them a pretty good discount, but we also treated them as a regular customer. So, they sent us their design, and somewhere in the process, they realized they weren't finished with the software yet. So, it was an end product—not a prototype anymore—because we build 300 to go to the open hardware conference.

We had a hard deadline and could not miss that. They didn't have a test or programming fixture for us. We found a problem in the first

two or three that ran through the line, so we stopped because we don't want to build 300 of them with issues.

I was directly involved in this because we were doing some sponsorships with them, and I thought we were going to miss the deadline. We had blown transistors and had other problems on the first two boards I powered up, but they kept in touch. They finally sent me a programming fixture that I was able to use, and through a process of elimination, we found out that there was not a problem with the physical design. The programming fixture wasn't ready yet, and without the fixture, the way we powered up the board essentially caused a problem. We were just guessing at how to power up the board, so I blew up three transistors on three boards. Then, when they sent us the programming fixture, we were able to verify that the design was good and successfully build the rest of the badges.

Johnson: Designers talk about concurrent engineering. Once you move over to manufacturing, it's pretty sequential. We engineering concurrently but manufacture sequentially. However, in your story, there was some concurrency between engineering and software and the hardware to make this project work, and it did.

Benson: Right. In theory, if all of the data is accurate and the design is good, it's essentially a hands-off process, and everything happens automatically. But there are issues in about 70% of our jobs.

Johnson: What's the most common thing that goes wrong?

Benson: Open vias in surface-mount pads where the solder gets sucked down into the via, and you don't have a good connection.

Johnson: So it's design issues on the board.

Benson: Correct. We have clearances where components are too close together or too close to the edge of the board. Footprints are another

huge issue. People use a footprint that's close, but with footprints, close enough is, quite often, not close enough.

Johnson: Do you have a cautionary tale from a bad customer experience you could share?

Benson: Once, we had a job where there was a wireless module on it, and we bought all of the components except for the wireless module. The wireless module was from a cheap offshore supplier, and it was a batch, so I'm guessing it was overstock or something like that. They sent us the documentation, and the data sheet for the module was very ambiguous. It was very difficult to tell what the orientation was supposed to be, and the documentation led us to believe that the component was supposed to go on 180 degrees from what it really was.

We built 5,000 of these, and after building it, one of our technicians thought that something didn't seem right. So, before we shipped them to the customer, this technician looked at them and determined something was wrong. We contacted the customer, and they were not very happy. So, we said, "We may ruin these when we pull them off. It's going to take a lot of time to pull off 5,000." In response, the customer said, "That was overstock or an out-of-production order. There are no more of those."

As a result, we had to bring extra people in from the EMS division to help Screaming Circuits pull 5,000 of these things off, reverse them, clean up the board afterward, and put them back on. It was incredibly painful. We made it work, but an ambiguous data sheet caused that entire problem. Our customer received working boards on time and at the original price, but accurate data would have made it a lot easier for us.

Johnson: That particular design process took the ambiguity and kicked it down the road.



High-speed SMT line.

Benson: Exactly. The sooner in the process you can clear up any ambiguity, the better we will all be. Diodes and LEDs are horrendous in terms of marking. I design and build some of my own electronics devices from time to time; I call myself a method actor in that regard.

Johnson: That takes us all the way back to the beginning: communication is important. Because you're high mix/low volume, you see a lot of jobs and have a lot of highly varied experience.

Benson: Right, and that goes right back to BOM accuracy. Every single character in that part number is critical.

Johnson: Do you see customer needs and requirements changing, and how are you adapting to that?

Benson: I do. Over the last decade, the electronics design and manufacturing world has changed radically. Even more in the last few years. The rate of change is staggering. With half of the companies we deal with today, the design engineer does everything, and design engineers in the past typically designed a schematic; they didn't lay out a board, figure out what a BOM needs, or plan and forecast. The



Milwaukee Electronics Tecate, B.C., Mexico.

competition is just merciless these days. There are so many people out there trying to do the exact same thing.

Another concern is IP theft. When you design something, you get it built. Six months later, somebody has an identical product for half the price. We can no longer assume anything in manufacturing. When I say Screaming Circuits takes a six- to eight-week quote order and NPI process and does it in six to eight hours, that's the reality for half of our customers. And half of those aren't prototypes; half of those are going directly to an end product that's going to be sold, sent up to work on the Hubble space telescope, or put on the Mars 2020 Rover.

There are weeks of double checks that our customers simply don't have anymore, and we were either lucky or had a lot of foresight when we originally designed our systems to be so flexible. We didn't design our systems around what it takes to build something; we designed them around what an engineer would face. So, every single job is re-engineered from the start. We re-engineer our entire process for every single job, and while that seems oppressive, it works in today's world, and it's probably going to be the only thing that works going into the future. A good portion of our customers are very intelligent, well-educated design

engineers who were never taught how to lay out a board.

Johnson: With customer requirements and needs changing, are you also seeing opportunity in some new business sectors?

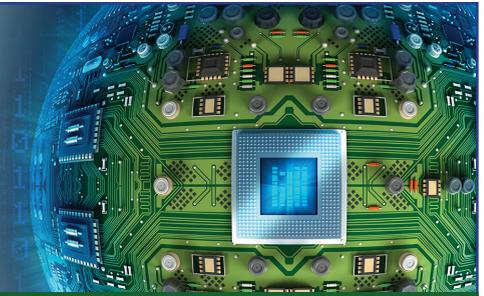
Benson: It's really more in the new world than new business. Milwaukee Electronics started Screaming Circuits in 2003 because they saw that changes starting to happen in the manufacturing world and they needed to be there. We purchased our San Diego PCB layout division a few years ago because we felt like our customers needed that particular service. So, we have done some acquisition and internal startups, and Screaming Circuits is the leading edge.

Johnson: And that helps the business.

Benson: Absolutely. We have grown every year that I've been there, except for the bad recession year from 2008–2009 despite how difficult the environment has been for manufacturing over the last few decades.

Johnson: Great. Thank you very much, Duane.

Benson: You're very welcome. Thank you. SMT007



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Green Circuits' Three Tips to Be a Well-prepared Customer



Joe Garcia, Green Circuits

Nolan Johnson speaks with Joe Garcia, VP of sales and marketing at Green Circuits, about how they can help on both the front and back end of the process, their hidden gem—design services—as well as three tips to be a well-prepared customer.

Nolan Johnson: We're here to talk about how to make your customer successful. For our readers, can you start with a quick overview of Green Circuits?

Joe Garcia: Green Circuits focuses on servicing customers in the prototype development phase of their product life cycle as well as ongoing and sustaining production—mostly low to medium volume and medium- to high-mix products. The more complex, the better, which is where we see our niche. We're able to work quickly and nimbly, which creates the added benefit of being flexible to meet our customer's needs. We can also scale quickly for customers that come out of the NPI prototype phase and need to ramp up to production. We ramp them using the same team and systems to help the transition and enable them to get to market faster.

Johnson: That's a great summary. What's the one thing you would want every customer to understand about delivering a job to your shop?

Garcia: We want to be as thorough as possible with each customer's particular job. But, at the same time, we want to match our speed and flexibility to the needs and expectations of the customer—truly being a customer solution provider in the EMS space.

Johnson: What sort of services and assistance do you provide to customers that they seem to overlook, or don't realize you have?

Garcia: Most customers know that a majority of what we do is complex, turnkey, PCBA work. But they often don't think about using us for the things on the front and back end of that core solution. For example, we often have a good dialogue with our customers about supporting them with more layout work; that seems to be where the low-hanging fruit is from a design standpoint. In addition, we provide DFM input on the front end and open their eyes to our



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Green Circuits' San Jose facility is a balanced mix of automation and human expertise.

ability to support their system assembly and test requirements on the back end.

Many customers take advantage of some or all of the services on the menu. What may happen is some of these service offerings will be introduced to a prospective or an existing customer as they're going through a particular job, but our customers may not have time to take advantage of them because a lot of what we do is quick turn. So, we may see a request on subsequent orders for this additional service. Again, the places they tend to overlook are on the front and the back end of the value stream.

Johnson: Let's talk just a little about the very front end, such as design services. I'll confess that I didn't realize Green Circuits offered that service.

Garcia: We can do full product design. Currently, 80% of our design work comes from customers requesting some sort of board layout activity. We often hear from our customers that their internal engineering teams tend to want to focus on new product development. So, there's an opportunity—especially in today's climate with material obsolescence affecting new and existing designs—to redesign or update the design of an existing product to incorporate better material availabil-

ity or implement DFM suggestions. We can take over the type of work that the OEM's internal engineering or design development team doesn't necessarily want to do.

Of our existing business, less than 15% of our customers are utilizing our design service offering. So, that's an area where we are trying to create more awareness. The customers that use it are happy with the service and returning for follow-on work in the design space and manufacturing.

Johnson: That is a hidden gem. If you find a customer who needs a design service, you provide a great deal of value.

Garcia: Absolutely. And we do a good job of implementing what we learned in the design phase when we run the first prototype job with the new design. So, we're very collaborative on the manufacturing side when working with our design team.

Johnson: What does a perfect job look like for your shop? That might be how it's packaged or where it fits with respect to volume or type.

Garcia: That's a tough question because everything we do is custom and/or customer-specific. We really take pride in engaging with customers on jobs that are critical for them and require a quick turnaround. For instance, we had a customer who needed a project completed for a trade show, and we were able to assist them with doing the final design—in this case, board layout—ordering the parts and delivering a product to them in just over two weeks. So, we felt like we added value to them. They came to us in a pinch, and we were able to move quickly, solve a problem, and, ultimately, help the customer be successful. Outside of that, a perfect job would be customers looking for a full turnkey solution for a complex electronic product ideally going to go into box build with some test.

Johnson: So, box build is a customer need that's a pretty good fit for you?

Garcia: Yes. We're getting more and more inquiries about that capability. Customers don't want to do that in their own facilities. And that quickly turns into a discussion about moving to functional test capability and relocating customer functional test gear to our facility. Ultimately, we want to be a full turnkey solution provider, putting finished system assembled products that are tested into boxes and shipping them directly to distribution centers or directly to their customers.

Johnson: Can you share any trends as to why your customers are trying not to do box build themselves?

Garcia: I think it's a couple of things. First, we're a company that continues to talk to and embrace the startup community, and more and more of those players are not so old-school; they're not as enamored with having torque wrenches and stuff in their facility. They'd rather have engineering talent, hardware and software development people, and marketing personnel, and outsource everything else. For those companies, as they start to mature and are ready for their system assembly to be complete, they're very much at ease with companies like ours taking over that part of the business. Second, I'm seeing that customers in some of the more established industries, such as the medical device industry, that have been slow to outsource some of their system assembly builds just due to the critical nature of the end-job function show interest in our services.

Johnson: Right, especially if they're life-critical products.

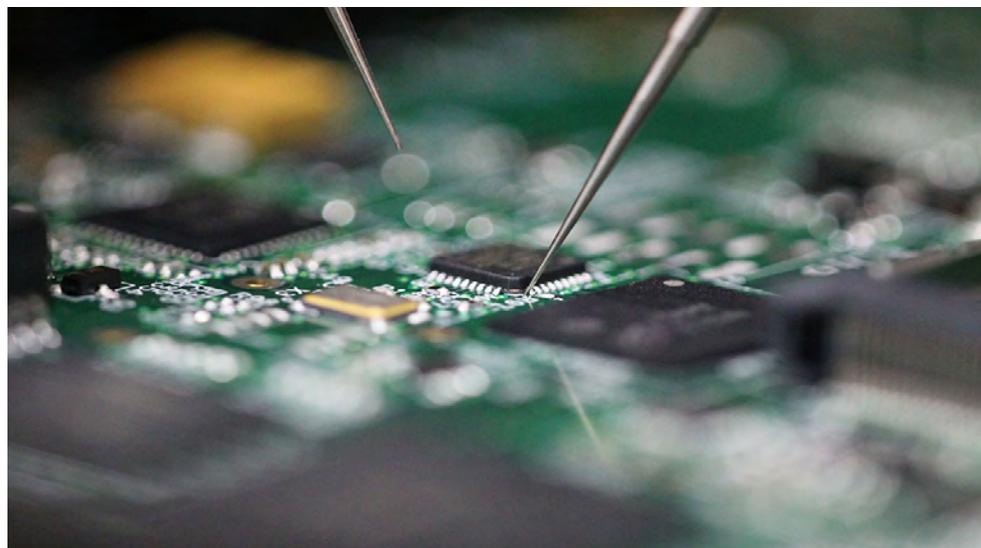
Garcia: Correct. And just for clarity, we're not currently doing anything that's life-critical.

We are supporting the production and prototype development of non-life critical medical devices and have observed that those types of medical device customers are more open to outsourcing subassemblies that go into their final product. It makes it easier for them to focus on just putting the final unit together.

Johnson: What makes for a well-prepared customer? I have to assume that in your work with startups, they do want to outsource the build, but they might not necessarily know what information to deliver. So, I'm sure there's some tutoring going on for you.

Garcia: That's a timely question. We recently asked a similar question to our program management team. We have 11 program managers at the forefront of receiving quote requests and documentation packages from our customers. So, we asked, "What are the things that are most important in allowing us to react quickly to a quote request or a build request?" And their top three answers were clear communication, a clean dataset, and timely responses.

First, clear communication of the request starts at the quote or request for quotation (RFQ) stage. It saves us a lot of time if the customer communicates clearly what their expectations are around the build quantity or quote quantity requested, how quickly they want something done, and the turn time both on the



The flying probe tester in action at Green Circuits' facility.

manufacturing side and the PCB fabrication side if applicable. Be specific about what kind of test requirements you have and any other special considerations you might have for the quote or build.

The second answer was a clean dataset. You would think that with all the advancements in software and development tools, that all of the datasets that we receive would be very clean, but it's amazing how many times we're missing part numbers on a bill of materials (BOM) or even reference designators. Some customers won't have CAD drawings or assembly drawings. A clear and concise dataset takes away the hassle of going back and forth to figure out what's in the package.

Third, we need timely responses. Questions will come up during the process, whether it's the quote process or if we're starting to get into the build. So, being available and responding quickly to questions that arise helps to make a smoother transition and customer experience.

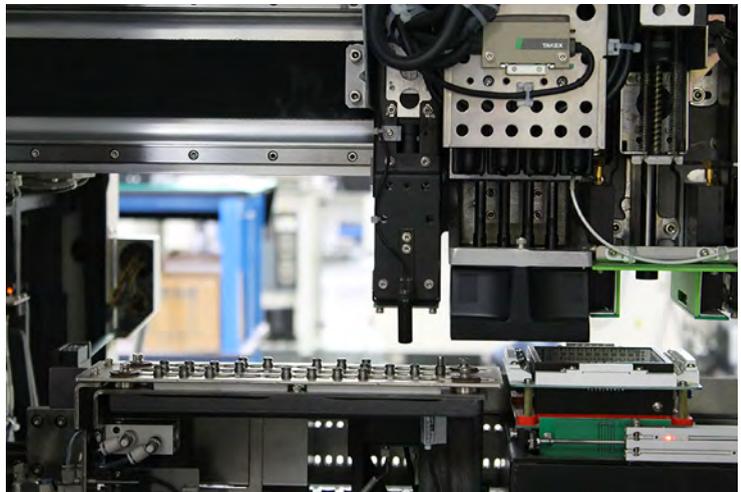
Johnson: Can you quantify how much smoother it can be when a customer is well-prepared?

Garcia: The difference can be night and day. The example that I gave earlier of us being able to turn something around from starting a board layout to delivering product took two weeks. Sometimes, with a front-end delay, if the data package is not clean or communication is unclear, that can eat up 2-4 days of that cycle, which is a waste of time. So, it's significantly better and faster when we get clear communication, a clean dataset, and the customer is responsive to questions and clarifications.

Johnson: The customer's going to have to make those decisions anyway; you're either going to coax it out of them, or they're going to offer it willingly.

Garcia: True.

Johnson: Do you see customer needs or requirements changing?



Pick-and-place machine in action at Green Circuits.

Garcia: Not really. Technology constantly changes, but the voice of the customer, in my experience at Green Circuits, is that they're still looking for flexibility, quick turnaround, and someone that's very responsive as an EMS partner. The customers that have been through this before, either at their existing company or somewhere else, realize that there are going to be challenges. And, for the most part, they are willing to work through them as long as we are transparent and run our operation as a true extension of their manufacturing solution. Transparency, communicating often, and demonstrating a consistent ability to be flexible, fast, and responsive while delivering quality product are the common needs that, in my 20 years in this industry, have been what customers have always wanted.

Johnson: Is Green Circuits looking for some new business areas?

Garcia: We're always looking for areas to grow our capabilities and stay at the forefront of technology development in our industry. Because we are located in Silicon Valley, we're fortunate to work with a customer base that typically puts themselves at the bleeding edge of technology. So, we are involved early on in developing processes to support their latest design or their latest program. In some cases, we're at the forefront of designing something

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Green Circuits' Silicon Valley Research Center.

that's going to be in the market several years out. In that sense, we're always looking for ways to improve or develop ourselves.

Aside from technology, the areas in which we're looking to grow or provide more support to include design services, back-end system assembly tests, and direct order fulfillment. We want to focus on those areas of the value chain where customers don't commonly see us as a core solution provider. We want to market better and make the customers more aware of the fact that we're very capable and able to take that headache off their hands and manage it for them.

Johnson: What are the factors that might be inhibiting you in your growth right now?

Garcia: Good question. Well, there's some uncertainty regarding our global climate. What are the tariffs doing in China, for instance, and what's going on in Europe? It's not necessarily stunting our growth, but there's some insecurity from the general customer base whether they continue to push for low-cost regions like China, for example. Or do they try to find a way to keep business in the United States? What's the impact for them either way? A lot of customers who were manufacturing in China started to move to Mexico; we saw that influx, and then capacity in Mexico started to get tight, and pricing started to rise. I'm also hearing that in some cases, customers are finding workarounds to the tariffs, which we all

anticipated would happen. There's just a lot of uncertainty, whereas if it was hard and fast one way or another, customers could make decisions on whether or not to keep stuff local, in the United States, or aggressively look at other low-cost solutions.

Johnson: How about human resources? Are you finding the hires you need?

Garcia: In one sense, for our direct labor workforce, there's a very dense population of EMS companies in and around the Bay Area. The talent pool here is strong, so I don't think we will have challenges growing as our business grows and we have a need to add direct labor team members. I am seeing a little bit of a challenge with some of the indirect hires. On the procurement side, what we do is very dynamic. In some cases, we're almost buying as we're quoting. It takes a special kind of person to respond very quickly to customer demands, put some thought into it based on their experience, and make the right decision so that we receive the right parts at the right time and don't suffer through unwanted excess material. For other indirect positions, we are competing with the "who's who" in Silicon Valley, so it can be challenging to recruit the right talent, but we have built a strong team. And we do a good job of utilizing our people networks to bring in the best people.

Johnson: I would guess that you're looking for the right kind of front-end engineering staff as well to continue your growth.

Garcia: Yes, we have a solid engineering team and are looking for a senior engineer to add to the team right now. We're probably going to need somebody on the system assembly side as that business starts to grow. We have people that are system engineers, but we'll need other team members added to that group as business warrants.

Johnson: Well, thank you for your time.

Garcia: Very good. Thanks. SMT007

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Managing Your Double-sided Assemblies

The Manifest
by Mike Fiorilla, MANNCORP INC.

As technology improves and products become smaller and smaller, the argument for double-sided board applications grows. Using a double-sided board in your finished application allows you to produce more complex circuits while saving space, offering an array of benefits for high-tech applications and electronics. Challenges to double-sided board implementation include placement questions, solder processing challenges, and heat dissipation. Planning out a double-sided assembly can seem overwhelming at first, but taking it one step at a time can help show that while the process may be more involved and complex, it's not substantially different from handling a single-sided board assembly. One of the most important aspects to consider is how you'll address the reflow process.

Take process control into account first. Make sure you have the information that you need through tests and inspections that can monitor both sides of the board simultaneously. This lets you know possible failure points of your assembly process and which areas deserve the most focus. Allow for enough space at the

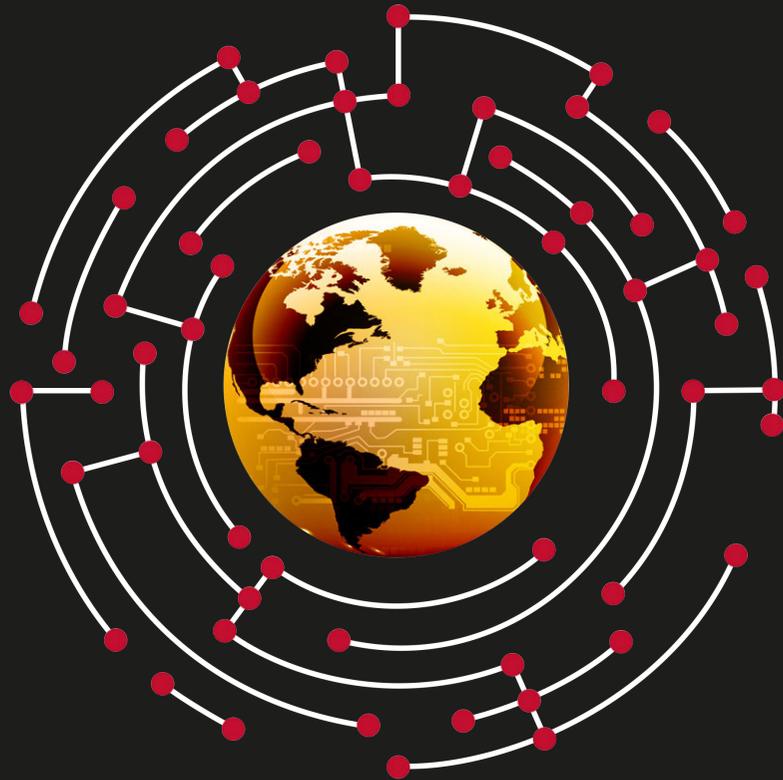
edges of the board to be transported on the conveyor system or use panels with frames. Flexible bottom supports that can be adjusted to accommodate components on the bottom of the board may be a good choice as well. Ensure that your boards won't warp or twist as they're being reflowed, which could negatively impact solder joint reliability. Also, this may go without saying, but designing your board so that the heaviest components are all located on one side of the board—where they can be placed after the first reflow and won't need to hang at the mercy of the solder's surface tension—is a key part of the layout process.

Further, clearance can be a concern. Screen printers often use individual board supports that can damage your board, and the pressure





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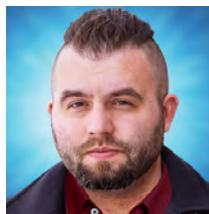
of a board being clamped down with a solder screen pressed onto it will transmit directly through existing parts and can result in a hair-line crack that may be overlooked.

When thinking of your reflow process for a double-sided assembly, you need to settle on how you're going to fix your components to the underside of your board. For a number of assemblies, there's no need for an additional step to the process. If you're careful about the layout of your components and their respective weights, the surface tension of the solder may be enough to hold your components in place. The question is how you're going to keep your components fixed in place throughout the secondary reflow process. You may need to take extra steps to ensure that your components stay held in place throughout the second reflow stage. There are a variety of options available to you, each with their own associated benefits and drawbacks.

For example, consider gluing the components to hold them in place or utilizing a Loctite paste to temporarily give components support as they undergo the reflow process. This is a workable solution but can lead to increased costs, additional process steps, and specialized equipment. You may also consider using a hierarchical alloy system with two different alloys with different melting points used to affix the components to the board. This can lead to complications, including damage to the components due to the higher reflow temperature of the high melting point alloy or a shift of components in operation due to the low-temperature threshold of the low melting point alloy.

Finally, you could consider a system to blow cool gas across the bottom side of the assembly throughout a secondary reflow process, ensuring the solder joints on the bottom of the assembly remain below a liquidus temperature. However, this could introduce potential stresses on the board due to the temperature differential between sides. If you're looking to prevent component fall-off beyond ensuring that the weight of the components doesn't exceed the surface tension of your solder, you'll need to consider these questions.

The density of components makes double-sided assemblies an attractive choice for a number of high-tech applications. For some electronics, the size of a given circuit makes double-sided assemblies a necessity. If you're worried about tackling your first double-sided assembly for a product, it's important to be prepared and know what issues you might face. While double-sided assembly does add complications to the PCBA process, in many cases, the benefits outweigh any issues you might face. As with any SMT issue, having the information that you need is the key. Make sure you're aware of the pros and cons of double-sided assembly before jumping into a new project as well as potential snags you may encounter when building out your production steps. **SMT007**



Mike Fiorilla is a writer at Manncorp Inc.

Tips & Tricks: Water Contamination and Flux Expiry



First, can water contamination cause failure? Absolutely! Rainwater contains much higher electrochemically active content than the deionized water used for cleaning PCB assemblies and can lead to corrosion and dendritic growth. If discovered before introduction

to the service environment, cleaning may be possible, and the assemblies may be able to be salvaged. Exposure to rainwater in the service environment is a sure path to failure unless the assembly has been ruggedized against such exposures as part of the design.

To find out more what Jason Fullerton, customer technical support engineer at the Assembly Division of MacDermid Alpha Electronics Solutions, has to say, [click here](#).

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IPC: Trump's FY2020 Budget Plan Kicks Off U.S. Policy Debates ▶

Within the last week, U.S. President Trump released his \$4.7 trillion fiscal 2020 budget plan, kicking off the annual federal budget process. IPC is watching several budget debates that could impact the electronics industry and its supply chain.

Sypris Reports Double-digit Revenue and Margin Growth Forecast for 2019 ▶

Sypris Solutions, Inc. reported financial results for its fourth quarter and full year ended December 31, 2018. Net revenue for the full year 2018 increased 6.9% over 2017 and gross margin improved 460 basis points.

Tempo Automation Inks Manufacturing Contract with Lockheed Martin ▶

Tempo Automation, the world's fastest electronics manufacturer for prototyping and low-volume production of printed circuit board assemblies (PCBAs), has signed a manufacturing contract with global security and aerospace company Lockheed Martin.

Which IPC-A-610 Class Is Best for Your PCBA? ▶

For many EMS providers, IPC-A-610 is the agreed standard to define what's acceptable and what's not in the world of PCBA production. As an OEM, it's important that you're clear on the basic principles that separate those classes so that you have a clear and realistic expectation of what the results are going to be.

IPC Validation Services: New Programs and Updates ▶

Randy Cherry, director of IPC Validation Services, gives Judy Warner an overview of a new

IPC-1791 QML program focused on prime contractors and OEMs and provides updates on existing programs.

Naprotek Renews AS9100D Certification ▶

Naprotek Inc., a provider of electronic manufacturing services, has successfully renewed its AS9100D certification. With this milestone, together with the ISO 9001:2015 certification, Naprotek maintains the appropriate, consensus-driven quality benchmarks to serve the aviation, space, and defense industries.

Harris Signs Definitive Agreement to Sell Night Vision Business to Elbit Systems ▶

Harris Corporation and Elbit Systems Ltd. have announced the signing of a definitive agreement under which Elbit Systems of America LLC (ESA) will acquire Harris' Night Vision business for \$350 million in cash.

OSI Systems Wins \$4M Contract to Provide Explosives and Narcotics Trace Detection Systems ▶

OSI Systems Inc. announced that its security division was awarded a contract valued at approximately \$4 million by an international airport to provide multiple units of its Itemiser 4DX explosives and narcotics detection system and follow-on service and spare parts support.

IPC Working to Revive Lead-free R&D in High-reliability Sectors ▶

Ask yourself the following question: Why is it that the aerospace, defense, and high-performance (ADHP) electronics sectors remain reliant on lead solders and components even as the commercial sector has largely phased out their use? Read on to find the answer.

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Process Validation Can Lead to Higher Performance Levels

In Search of Operational Excellence
by Alfred Macha, AMT PARTNERS

Alfred Macha is the president of AMT Partners debuting his first column in this month's issue.

Look forward to more insights from Alfred in future magazines. He can be reached at Alfred@amt-partners.com.

One of the fundamental current good manufacturing practices (CGMPs) that medical device manufacturers implement are robust process validation procedures. Medical OEM manufacturers typically have deployed effective process validation systems in their operations; however, contract manufacturers may struggle to deploy effective process validation systems in their operations. The column provides a practical guideline on how to effectively implement a sustainable process validation program for contract manufacturers. A robust but practical process validation program can make a contract manufacturer achieve consistent, high-quality performance.

The quest for each manufacturer is to grow its business by establishing robust processes that yield consistent and reliable parts meeting customer drawing specifications and purchase order requirements. This statement sounds straightforward conceptually but can be a daunting task in practice. Having audited, managed, or consulted with over 100 factories in the last 20 years, I have found a common theme that defines top performing manufacturing plants. Top-performing manufacturers have *practical* and *consistent* methods in implementing, validating, and monitoring processes. Con-

tract manufacturers can significantly improve the quality and consistency of their parts by having a robust and effective process validation program.

Before we evaluate an effective approach to process validation, it is important to understand the quality system requirements of validation. In the ISO 9001:2015 standard—Clause 8.5.1—on control of production and service provision, there is a requirement for you to have controlled conditions for “validation and periodic revalidation of the ability to achieve planned results of the processes for production and service provision where the resulting output cannot be verified by subsequent monitoring or measurement.” In regulated industries, such as aerospace and medical devices, specific process validation requirements are called out in AS9100D—aerospace standard—Clause 8.5.1.2 “Validation and Control of Special Processes,” and ISO 13485:2016—medical devices, quality management systems—Clause 7.5.6 “Validation of Processes for Production and Service Provision.”

The FDA made process validation a regulatory requirement in CFR 820.75(a), process validation with supplemental guidance for industry—“Process Validation: General Prin-



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ciples and Practices, Current Good Manufacturing Practices (CGMPs).” These standards and regulations provide general guidance on the requirements but do not specify how process validation should be implemented. Each manufacturer is required to develop its own methodology best suited to its manufacturing environment. This is where manufacturers have the opportunity to implement a sustainable and effective process validation program that not only meets compliance to the standards but provides value to the manufacturer in ensuring that a process yields consistent and reliable product quality.

How do you implement an effective process validation program? Let’s first understand the difference between process validation and process verification. One approach is to understand how the FDA defines these requirements. Per the Code of Federal Regulations, Title 21—Food and Drugs, Part 820, quality system regulations:

- Validation means confirmation by examination and provision of objective evidence that the particular requirements for a specific *intended use* can be consistently fulfilled [CFR 21 Part 820.3(z)]
- Verification means confirmation by examination and provision of objective evidence that specified *requirements* have been fulfilled [CFR 21 Part 820.3(aa)]

When these definitions are applied to a manufacturing operation, we conclude that not all processes can be verified. In theory, you could conceivably validate all processes, but that’s not cost effective nor practical for the organization. Process validation should only be applied to those processes where process ver-

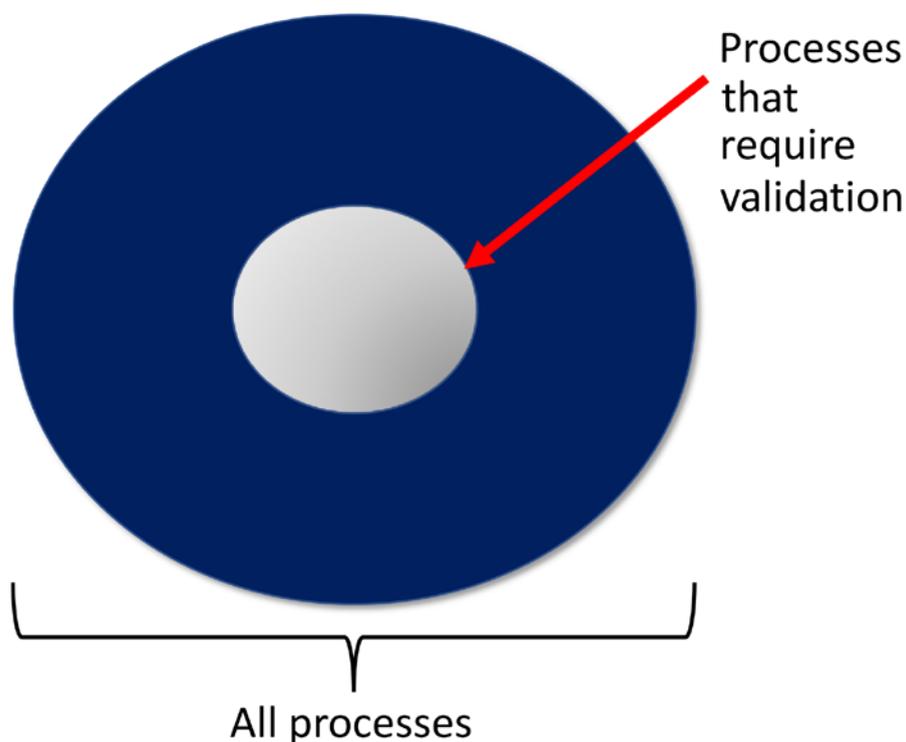


Figure 1: Few processes require validation.

ification cannot be accomplished (Figure 1).

Typical processes that require validation are heat treating, cleanroom ambient conditions, plating, plastic injection molding, sterilization, and packaging sealing processes. The manufacturer should prepare a table that lists all processes with defined measures for each process as illustrated in Figure 2.

Processes that require process validation should undergo a robust validation program, using validation protocols for each phase. The validation phases include:

- **Installation qualification (IQ):** This validation phase verifies that the instrument or equipment being qualified—as well as its subsystems and any ancillary systems—have been delivered, installed, and configured in accordance with the manufacturer’s specifications
- **Operational qualification (OQ):** This validation phase is performed to check that the equipment’s performance is consistent with the user requirement specification within the manufacturer-

Process description	Output verification	Method to record measurement	Process validation (Y/N)	Validation protocol

Figure 2: Recommended approach to categorize each process between verification and validation.

Installation Qualification (IQ)	<ul style="list-style-type: none"> • Facility layout and location of installation • Power, gas supply, and other energy sources • Environmental and operating conditions • Cross-checking contents against the packing list • Documentation of computer-controlled instrumentation • Recording calibration intervals • Gathering all manuals and certificates of conformance
Operational Qualification (OQ)	<ul style="list-style-type: none"> • Review of operating procedures that define instructions and controls of affected equipment • Temperature and humidity controls and fluctuations • Temperature and humidity distribution profile • Air pressure control mechanism • Review of control systems for automated chemical dispensing • Other functional controllers that affect operational equipment qualification
Performance Qualification (PQ)	<ul style="list-style-type: none"> • Manufacturing conditions, such as equipment limits, operating parameters, and component inputs to be reviewed • Traceability records for each unique production batch to be manufactured during this phase • A list of the data that should be recorded or analyzed during tests, calibration, and validation • Tests that need to be performed to ensure consistent quality at key production steps • A sampling plan, outlining the sampling methods used between production batches • Proven methodology to review data using scientific and risk-oriented decisions based on a statistical analysis • Defining process control limits and appropriate contingency plans for handling non-conformances

Table 1: Items to consider when creating validation protocols for each phase.

specified operating ranges. All items in the test plan are tested individually and their performance documented

- **Performance qualification (PQ):** The final validation phase involves verifying and documenting that the equipment is working *reproducibly* within a specified working range

Table 1 provides a practical checklist of items that should be considered as requirements for each of the phases where applicable. The manufacturer should define the extent of documentation for each item, and it is recommended to maintain simplicity to allow for ease of implementation and sustainability.

The process validation program's effectiveness is measured by product yield consistency and reduced process variation in a validated process where IQ, OQ, and PQ protocols are completed before the process was released to production. Process validation reviews should be carried out regularly and incorporated into the manufacturer's standard management review procedure. Organizations that adopt this approach to process validations will achieve higher product quality consistency and customer satisfaction. Customers place significant value to process validation programs when assessing the risk of a manufacturer. **SMT007**

Whizz Systems on Knowing Your Strengths and Building Customer Relationships

Nolan Johnson speaks with Whizz Systems Inc. President Muhammed Irfan about knowing your strengths, engaging startups, and building strong customer relationships through education and preparation.

Nolan Johnson: Muhammad, can you start by introducing yourself, your role, and Whizz Systems?

Muhammed Irfan: My education is in electrical engineering and computer science. Right after graduation, I met Manny Karim in '89 and we both joined a startup. We developed an engineering services and product development business model, taking ideas into the market and navigating the initial stages of manufacturing. Early on, we understood the pain points and offered to turn that into a business to help customers launch products. Our business continued to grow, and through acquisition, we ended up being part of Celestica.

Manny, my business partner, and I left Celestica and funded and founded Whizz Systems Inc. in 2000. We complement each other well. Manny handles all of the operations, materials, and manufacturing as the CEO. Meanwhile, I handle engineering and some aspects of business development, such as customer relationships, strategy, and where to lead our business for the future.



Johnson: What is one thing you would want every customer to understand about delivering a job to your shop?

Irfan: Generally, customers have to deal with a lot of different suppliers to take a concept to production and product launch. One thing we like our customers to know is under our one-stop shop model, Whizz has all of the capability in-house from concept to hardware and mechanical design, thermal, CAD simulations, and world-class manufacturing. All of these facets interact with each other through the critical phases of the project. We want our customers to know that they can engage with us and hand off the project at any stage and have one company responsible to deliver the end result all under one roof.

Sometimes, customers shy away because they don't know where to go for a complete package, or they think, "I have half of this in-house. How do I deal with another company only taking full turn-key projects?" But we truly want them to know we're an extension of their team. We give them the flexibility to pick

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The Whizz Systems staff, taking care of their customers.

and choose by tag-teaming with their internal team or handing off certain defined areas to us. Internally, we have the capability to offer them from concept all the way to a launched product. All the services we offer are not afterthoughts; these are well-integrated internal teams. We've put together world-class services and talent at Whizz.

Johnson: That makes a lot of sense. Some shops would start at a defined spot in the manufacturing chain, but you're in a place where you can become involved wherever the customer is in their overall flow.

Irfan: Exactly. Typically, customers have always reached to Taiwan for the original design manufacturer (ODM) model, but ODMs evaluate how much volume they will generate from a customer; they don't take ODM business from everyone. There's also an intellectual property (IP) risk with that model and no specialization in the hardware; it's the same hardware. Every ODM in Taiwan is sharing with each other, so it's the same design. They will just put a different logo, bezel, or front plate on it, but the engine is the same underneath.

Thus, there is almost no hardware distinction in the product. The only distinction you are left with is software. In our model, we say, "We are your U.S. ODM," and there aren't too many of us in the U.S. In Silicon Valley, we are pretty much the only ones who can offer

this type of model. We have the engineering team and world-class manufacturing in Silicon Valley, and we have a path to cost reduction with our own factory in Malaysia, which has played very well for us because there is no tariff issue in the current environment there. We know where we excel, and we know what to not get into. We are up-front with the customer. We will take you from the early concept through new product introduction (NPI) and certification. We'll get the product done, and that includes hardware, embedded firmware, and software—the complete package.

You can still choose to keep whatever you want to until a certain volume, but if we have too much high volume, that's not who we are. We help you with where you would need to go, so our strength is knowing our strengths and whether we are a good fit for the customer. Overall, that is a huge value-add to the customer, especially startups, because they can go to a friendly place that understands startup culture and knows how to help and can keep them disciplined if they lack that.

Sometimes, we have customers who want to run very fast, but they have not defined the product well enough so that counter-productive speed hurts the project more than it helps. Going too fast leads to defining things as we go, and the cost of correction becomes huge. We educate the customer upfront and hold their hands as well where we see it is a necessity to prepare them better. We know how to engage them and be efficient with this whole process.

Johnson: Based on this role, it sounds like you're providing a lot of services that work well for startups or smaller volumes with an understanding that a successful product is going to graduate into a different channel outside of what Whizz does.

Irfan: Many products don't go to those large volumes, so we are a great fit for launch, NPI, and early production runs through our Malaysia facility. If they start to build tens of thousands of units a month, we can either manage other CMs better suited for that type of

volume or help them transition. Depending on the complexity, if customers are building 5,000–10,000 units a month and it's still a great fit, we'll take care of it. For example, we're a great fit for high complexity and low- to mid-volume products. They don't have to move to other channels, but once it gets to very large volumes—due to materials, logistics, and the aggregation cost-benefit from large Tier 1 suppliers—that may outweigh the cost.

We are cognizant of that fact and we want what is right for the customer and will help the most in those channels. The value with Whizz is the ease of doing business with us. We understand IP protection, will work to understand what you want, and provide topnotch service and world-class quality. Those are huge benefits that we offer, which are very difficult for Tier 1 suppliers to offer for everyone.

Johnson: For some of your customers who want to move really fast, you're offering some discipline to the manufacturing side that helps them overall?

Irfan: Yes, and on the engineering side as well. I'll give you an example. We had a customer engagement where they just received funding. We geared up to start with specifications with the schedule six months down the road to have first prototypes in the lab to bring. In between, they had not thought enough early on, and they started looking at what-if scenarios, saying, "What if we used this chipset?" As soon as we saw that, we gathered all of the teams together and said, "There's no point burning implementation resources and keeping the cost tab running." We continued, "Let's first define the architecture of the product properly so that it meets all of your requirements. What is it that your software team really needs? We'll help you define and validate the architecture based on that and the cost objectives."

Once we had that logged on, we then turned the implementation resource part on and quickly implemented what we'd decided. They appreciated that because sometimes, at the VP level, they don't understand why there is an additional schedule or cost requirement from



ISM2000 automatic store for SMTs and THTs in use at Whizz Systems.

the budget that they started with. It's important to have visibility and to protect everybody in the chain. We spent an extra month locking down the architecture but didn't burn a lot of extra resources that the customer would have ended up paying for, which saved them that disappointment. Also, you have much better implementation because you have a more thoughtful plan based on the original architecture lockdown.

Johnson: That's a great example. Thank you. What services or assistance can Whizz Systems provide that your customers often overlook?

Irfan: Often, they don't think we offer mechanical design, thermal simulation, or airflow analysis because they think, "This is an electrical shop, and they have world-class manufacturing. Maybe I have to find another partner for mechanical." We understood the value of a complete package, so we've addressed all of the pain points, and everything that is impor-

tant in that entire flow of design concept to product launch, so mechanical and thermal capabilities are crucial. We have an in-house engineering team that works with the electrical team, and the beauty is not just these two teams, but the buyers, materials, planning, and manufacturing are all part of that effort.

We consider real-time feedback on issues with supply chain, availability of parts, and end of life. We design based on real-time market feedback from our buyer and manufacturing teams, and that interaction is very important. Sometimes, that benefit is overlooked by the customer until they've been burnt going down that road with a rocky handoff from one team to another, and all of the issues have to be cleared by the customer.

In our case, from DFM input to sole-source parts issues, for example, we're incorporating all of that as the design progresses before it matures. We have a good lockdown on which fabricator we're going to work with as well as technology, material availability, and impedances. Are we going to have the complete kit clear to build status internally before the fabricator arrives? All of these are critical considerations. And as a design progresses, there are changes constantly being made to the bill of materials (BOM). We have to the flow of those changes efficiently to the manufacturing team and the buyer's teams so that they are well

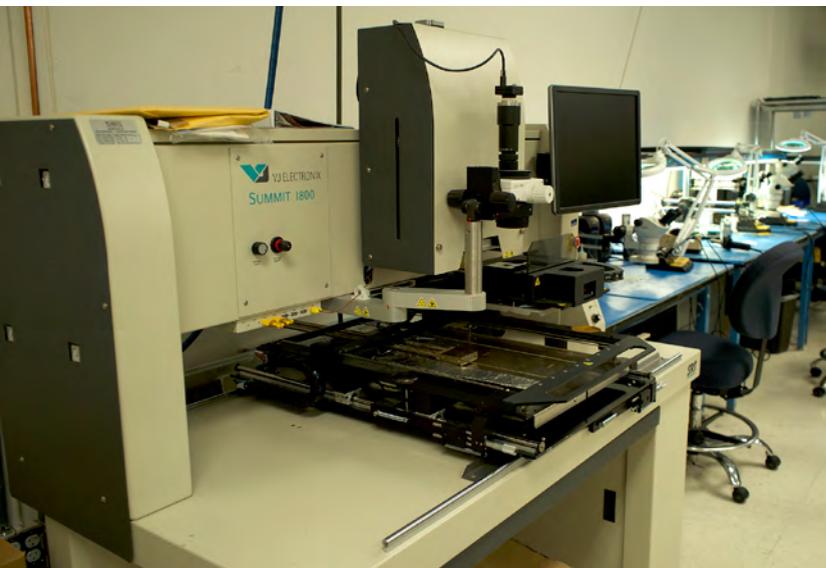
prepared and buy the right parts, which is a huge task.

Again, if customers are dealing with multiple vendors, they underestimate that effort, or they have the burden to make sure those transitions are happening. We take care of that, so the customers really have to focus on interacting with us, making sure what they want is clearly defined, and we implement that. They don't have to handle the interaction between multiple disciplines. Traditionally, multiple vendors have to handle the bridge between the translational information of those vendors. We have a strong combination of world-class manufacturing talent; and mechanical, thermal, material supply chain, and design expertise.

Johnson: With all those disciplines inside your own shop, what does a perfect job look like to you when a customer delivers their data package for the design?

Irfan: A perfect job is they know what they want at the concept level architecturally, and they understand the major blocks of their design: which processor, the two or three major pillar components of their design, etc. They should know what they need and engage with us at that point to let us do what we are good at. They should also define the end result properly. What constitutes the acceptance of our work to them? Where do they want that hand-off back to them? If the start point and end point are well understood and they let us do everything in between with properly defined milestones, that's a perfect customer for us.

But we have customers where we help to educate them on the value of milestones, etc. That's what they need to really prepare ahead of time for the strategic negotiation of some of the key components early and up front before they lock those down. And we're equally efficient in dealing with startups to very large companies. For the last 20 years, we have had very loyal customer relationships with most Tier 1s, so we understand what it takes to engage with that



Some of the rework equipment in use at Whizz Systems.

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Component management onsite at Whizz Systems.

type of customer versus a startup and how to keep both. For example, we consider the level of documentation required for each type of customer. We can run with them as fast as they want, but we also document and protect them and us to have a good end delivery.

Johnson: So, a well-prepared customer is very clear on their intended start point with you and what they want the end point to be. Then, they let you drive.

Irfan: They should also understand all of the in-between steps and the importance of the process, such as simulations, airflow, thermal analysis, etc. They are very appreciative that we will drive it and finish it versus someone who underestimates understanding the process.

Johnson: If we all learn from mistakes and wise people learn from the mistakes of others, do you have a story that turned out well as to why it is important to be prepared and organized when bringing your design to a contract manufacturer or an ODM?

Irfan: Before I answer, because we talked a lot about engineering, we want to make sure customers understand our manufacturing is world-class in both of our facilities in Santa Clara and Malaysia. We have all of the bells and whistles needed to handle complex projects. A lot of customers come to us with everything done in-house and say, “Here’s a set of Gerber data. We need you to produce this NPI or prototype run as well as a couple of runs after that.” We offer the flexibility for them to engage with us at any level. It doesn’t have to be a full-blown engineering project, but we want to know everything that exists internally, and it’s not meant to replace our internal resources; it’s meant to complement them. So, they could deal with us for manufacturing only or DFM—whatever makes them successful. Our model is to provide the customer with the combination of skills needed for the project to be successful.

Now, coming back to a couple of examples. Last year before CES, we had a customer come to us. They were burned by their previous vendors multiple times and had a wearable device. They were struggling to form the concept and had limited time before CES, so they came to us and laid out the problem. We deployed all of our teams very quickly, including even doing the look and feel for the product, the industrial and mechanical design aspects, and electrical simulation because it was a wearable device with a very tight form factor.

In six weeks, we had something for them as a first prototype. Three weeks later, after the first prototypes had been made, we had another version that they successfully took to CES, which found success at CES and gained large exposure on all Tier 1 news channels. We were proud to bring that value to the customer in about 10 weeks before CES. We developed a plan for something that had gone bad and made it into something that they were able to raise money for in the next round.

Johnson: That’s great. Was there a time where things didn’t go so well?

Irfan: About three years ago, we had another project that was much more complex in terms

of a large system with multiple field-programmable gate arrays (FPGAs). The project was shelved and another department was trying to revive it. Their original designers had left the company, and the company was going through turmoil. The marketing team wanted to revive that product and engineering was not willing to support it, so the marketing team came to us, asking, “Can you revive the project? We only have a few weeks before we take the system to our customer for a demonstration.”

We were reluctant, but the customer really pushed that they needed help, and asked, “Can you please put a lot of resources to try to revive it?” We took the project and tried to put a lot of resources toward it, but their internal engineering team had not bought into that effort, so there was no support to revive what had been done in the past. We had set the expectation with the marketing team that we would do what we can.” So, they assumed it was going to be a great working product, but we were struggling between the two internal teams in a limited timeframe.

In the end, the marketing team was disappointed because they didn’t get what they were looking for. We got somewhere, but it wasn’t something we felt proud about, and we kept explaining to them throughout that we’re limited by what we can get from other departments. So, there was a case of a lack of internal buy-in from all the teams, and we were in the middle. We should have been firm on not taking it. We learned our lesson from that—understand the dynamics of the engagement. It didn’t have anything to do with the ability to get the work done; it was the dynamics of the engagement and all of the stakeholders.

Johnson: That’s an interesting point. When we talk about what to do for customers, it’s not common that we discuss our client’s interdepartmental dynamics, and yet, it’s crucial. We’re not talking about components, packages, processes, and pick-and-place programming; we’re concerned with how much unified belief our customers have, which is different.

Irfan: That’s very important, and I want to drive this point that for customers out there to know that we have been in trenches for 20 years with almost all aspects of what it takes to launch a product. We’ve faced all types of difficulties and hurdles, and we have overcome a lot of them. There is tremendous value in a supplier who has gone through all of that and has your best interest in mind. You cannot find other companies like us out in the market. People are more focused on one individual domain, but again, the bridge it takes from one to another to another is a burden customers have to take on. In our case, we say, “Let us take care of all of that for you, so you have one party responsible.”

And in manufacturing, we have now Tier 1 customers who have extensive relationships and contacts in place with other Tier 1 CMs where these products eventually end up, but they bring in their early launch and ramp-up volumes to us sometimes. We leveraged the volume pricing that they already have in place to prepare the first few hundred to 10,000 while their large CMs are coming up to speed. We’ve also had some Tier 1s verbalize to us several times that it takes two weeks even for them to get in the system of our Tier 1s to get rework done. But with us, they show up in the lobby and say, “We have two large FPGAs with two connectors. We need them replaced now. Can you take care of it?”



The human touch at Whizz Systems.

We take care of it, and they're back on with their engineering team doing what they're supposed to do. They don't have to go through a CM and a large Tier 1 supplier; have a number issued; pack everything; and ship it to some facility in Silicon Valley, Texas, Mexico, or offshore. It's a long process for them to get simple stuff done. So, once they recognize that value, they're able to convince their supply chain and say, "We have two processes. Let's get Whizz to do this early NPI launch for us, and then while we're in parallel, preparing a large CM, we can move over to them." Other times, they say, "Whizz is a good back-up because we may need a few hundred to 5,000 systems right away within a few weeks," and it takes more time for large CMs to ramp everything up, so it's good to have both paths in place.

Even if people are set up with large CMs, if their engineers are more productive, they'll get things done much quicker. Imagine the cost of a large engineering and software team waiting for two weeks just for work to come in from a large CM. Those two weeks are very crucial in this world, especially when the time-to-market window and product life cycles are shrinking, so every day is important. We move here by the hours. Once they see the value, then they clearly can see the distinction, and they don't have that barrier, "We are only set up with this Tier 1 supplier." They bring us in for the right stage, and we support that move onto whatever CM they want to go to for the larger volume production. We don't tie them down to anything, which is what it takes for us to make them successful.

Johnson: From that perspective, and you've been doing this for 20 years, do you see customer needs and requirements changing?

Irfan: Yes, we're seeing the customers are more concerned about IP, taking development projects off-shore in the last couple of years because there have been a lot of incidents in our industry. Thus, customers are more focused on protecting the IP. And they also understand that the productivity from offshore teams is a lot lower than what they initially think it will be. Some customers do not understand absolute dollar savings versus relative cost; some do, but more are starting to see the value in getting stuff done quicker locally and protecting their IP. When you add all of the productivity factors into calculating these costs, the time-to-market advantage is huge.

The other thing customers sometimes overlook when they engage with offshore suppliers. Customers in the U.S. spend time at night with their family to deal with the offshore suppliers because the offshore supplier will only deal with you during their time, which is night time in the U.S. That is a tough situation for many engineers; they don't like it because they have to pick up conference calls after dinner with worldwide engineering teams in India, China, etc. We relieve all of that from them, so it's easier

to engage and much more productive. We have tremendous experience taking these products, including certification, into volume production. A lot of design groups don't understand manufacturing very well, what it takes to get certification done, or cost optimization.

We provide those services, and since we manufacture internally, we understand that world very well. Our approach is, "What's the simplest way to design this product that is manufacturable wherever customers choose to go?" Then, we start to rule out what cannot be done and consider where we can get more exotic materials. Because any exotic material or parameter on the board will trans-



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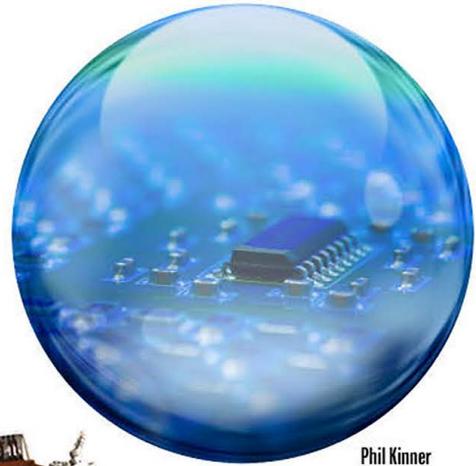
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late to higher costs—certification through FCC, environmental certification, shock and vibration test, drop test, thermal cycling, etc. We've done so many products that we know our reliability test mean time between failures.

We incorporate all of those reliability tests into our process as an ODM, which is a challenge. You cannot find a smaller company of our size in Silicon Valley that has all of this to offer. We are very unique in that aspect and have years of a very successful track record of delivering full turn-key projects.

Johnson: And are you looking for new business areas? Where do you want to grow?

Irfan: So far, we have grown from word of mouth, and we've had very stable customer relationships that have grown slowly over time. We are at a size now where we believe that to do justice to our business and for our team to grow, we want to slowly grow into a couple of other areas. We want to make investments into the defense industries because there is more of a focus on doing things locally as well as the medical space. We service customers both of these domains. We have vendors with most of the Tier 1 defense suppliers, but we have never focused on selling into any of this space.

We have a very strong foundation and are looking to grow our sales and marketing team. We have the best employee retention in our industry. We have the engineering team that started with us in 2000, and over 95% of them are still with the company. Members of our administrative, materials, supply chain, and manufacturing supervisory staff teams have all been with the company 15+ years, which goes back to our principles of treating our employees with respect.

In 2001, when the market fell off the cliff, we lost money as a startup business. We had the option to lay off 30% of the workforce, but we didn't want to do it. We had a meeting with all of our team members, and said, "These are the two choices. Either we retain everybody, and we all take 30% pay cut, or we lay off 30% of the workforce." Everybody opted, "Let's keep everyone and take the 30% pay cut." They respected the fact that it was a collective decision, and as the two founders, we went on zero salaries for the first four years. First, we raised everybody back to their normal salary, and then we started on a nominal salary in the fifth year before slowly building.

That sense of loyalty has resonated with our team, and we're very proud of that. We take care of our team, and on the technical side, we

empower them. Whatever training they need or want, we highly encourage them. We invest in tools and training our people so that they can do a world-class job. We think through every aspect.

Johnson: I noticed you have quite a bit of design and engineering with FPGA design all the way up to mechanical and thermal. Were you saying you'd offer that to someone regardless of whether they're having stuff manufactured?

Irfan: If it's a strategic decision, we'll support them on any aspect of the design, even if they don't use manufacturing initially. But we don't take that openly for everyone because there's a risk of when they go to another manufacturing shop, different issues could come in that could reflect as an issue on the design, which it is not. We are more comfortable taking it on where if you're doing the design, at least build the first set of prototypes, debug, and bring it up so that it's contained. But if some customers come to us and they have been in a situation where they were already locked in, their kit was there, and they needed our help, we may take it on as long as we see a path to something that will open the door for us to be a more valuable supplier.

If they come for manufacturing only, we have no problem with that; we take that sort of thing all the time. But when it is some small portion of design only, we do take it on, but there has to be a strategic reason for us to do that if we see a path of growing the customer. Because those are very valuable resources, and we don't want to allocate them. For example, one company came to us with an RF issue where the signals and a lot of packets were dropping. They asked if we could help debug the issue. Everything is based in Taiwan, they were going to build in Taiwan, and those were precious resources. The most we could do was 40–80 hours of billing for us to debug their most crucial issue, but there's no ROI for Whizz in that.

Like any company, we would like jobs to turn into business for us. And that is why local

companies may be more eager to take care of offshore companies. We take them on, and we have companies coming to us from India and China for their own IP concerns. We take it on when we can contain who's responsible for what.

Johnson: And your original ODM services are pretty interesting.

Irfan: On the manufacturing side, we're very sophisticated. We do boards that have 20,000 components on them with 6–8 large FPGAs. Those types of boards turn on a three-day turn. To assemble 20–25 high-quality boards for customers is a huge undertaking. We shine in that area. We have customers who call us on a Thursday afternoon, saying, "We need these on Sunday. Our engineers are going to China. They have to take these boards with them and we need them on the flight by this time." We're able to turn those types of boards. Sometimes, due to our relationships with customers, the paperwork and purchase order happen on Monday when the boards were done on Friday or over the weekend. We provide the boards that they need.

We're not cheap, but when they understand the value, they're glad to pay for that premium because it's our ability to have that bandwidth and skillset available for customers when they need it. This stuff is not planned before, but all of a sudden, they need it. And if you have that open for them, by design, that's a business model we are in, which is why we are not a very low-cost business. We don't go after everybody, and we're not a good fit for everyone. We're a great fit for people who are looking for value, need that sophistication, and want to get the job done right; that is who we are. By design, we take the right type of customers and don't chase everything.

Johnson: This is all very impressive. It's refreshing to hear. Thank you for your time and your candor. We appreciate it.

Irfan: You're very welcome. SMT007

ein Electronics Industry News and Market Highlights



As the Economy Slows and Wages Surge, Corporate Profits Likely to Decline ▶

In 2019, surging labor costs and slower revenue growth will likely lead to a decline in corporate profits in both the U.S. and other advanced economies, finds a new study on labor market trends.

Taiwan's Solar PV Market Aims 1.5GW in New Installations by 2019 ▶

The year 2018 proved to be the most disastrous year for Taiwan's solar PV manufacturers, yet the best year in terms of solar PV system installations downstream, bringing new installations up to 1GW for the first time in history.

Double-digit Growth Expected in the Smart Home Market ▶

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5G Fixed Wireless Access Market to See CAGR of 97.47% From 2019-2026 ▶

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N.A. Semiconductor Equipment Industry Posts February 2019 Billings ▶

North America-based manufacturers of semiconductor equipment posted \$1.86 billion in billings worldwide in February 2019 (three-month average basis), according to the "February Equipment Market Data Subscription (EMDS) Billings Report" published by SEMI.

Intelligent Electronic Devices Market 2019-2023 Forecast ▶

The global intelligent electronic devices market was valued at \$10.55 billion in 2017 and is expected to reach \$17.09 billion by 2023, registering a CAGR of 9%.

Worldwide Spending on Security Solutions Forecast to Reach \$103.1 Billion in 2019 ▶

Global spending on security-related hardware, software, and services is forecast to reach \$103.1 billion in 2019, an increase of 9.4% over 2017.

Smart Manufacturing Market to Reach \$548.14 Billion by 2024 ▶

The opportunity in the global smart manufacturing market is likely to touch \$548.14 billion by 2024, expanding at a CAGR of 13.02% between 2016 and 2024, according to Transparency Market Research (TMR).

Semiconductors Surpass Cars as a Top U.S. Export in 2018 ▶

According to recently released U.S. government data, U.S. semiconductor exports in 2018 totaled \$44 billion, ranking fourth among all U.S. exports, following aircraft and oil (crude and refined), and surpassing automobiles for the first time since 2010.

Consumer Augmented Reality Market Continues to Grow ▶

By 2023, the revenues from consumer software and content will reach more than \$8.5 billion while consumer AR smart glasses will reach four million-unit shipments by 2023.

PCB ASSEMBLY *for* SMARTIES



Part 4 of 4

That's a Wrap!

Our **For Smarties** series concludes with the fun part – PCB assembly. It is time to stuff the bare board with components and put it to work. You've successfully navigated the process from board design through manufacturing, but even experienced makers can hit a snag at assembly.

This paper will offer strategies for ensuring a smooth assembly process that produces a quality product.

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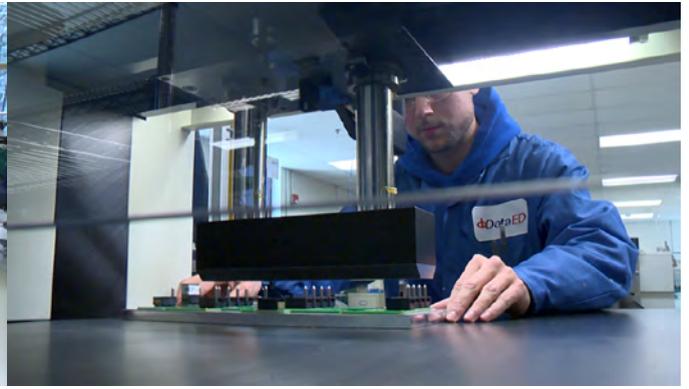
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From DataED's NPI Center to the Manufacturing Floor

Feature Interview by the I-Connect007 Editorial team

The I-Connect007 team recently spoke with a team of technologists and managers at Data Electronic Devices (DataED). We had a wide-ranging discussion with Jeff Hamlett, director of sales and marketing; Lori Giglio, general manager at the NPI Engineering Center; Vic Giglio, president and CEO; and Ron Sprizza, VP of quality for DataED. They provided an overview of the importance of company culture and making your customers the first priority. They also discuss how they collaboratively help customers move from NPI to making products on the manufacturing floor.

Nolan Johnson: Jeff, can you tell us about DataED, where you are located, and what your role is with the company?

Jeff Hamlett: We're headquartered in Salem, New Hampshire. We have two facilities in Salem, one being the worldwide headquarters plus domestic production. We also have our new product introduction (NPI) prototype facility, which stands alone and is located about four miles from our headquarters where we do a lot of NPIs and prototypes for quick turns. We also have two facilities in Shenzhen, China, that

we opened up in 2002, and we've been running successfully over there for 15–17 years.

DataED started in 1980, so we've been in existence in the contract manufacturing arena for 39 years now. We've grown tremendously over the last few years. I joined DataED in 2010 as the director of sales and marketing. Before DataED, I was with another contract manufacturer in Vermont as well as Massachusetts—Nexus, a small Tier 3 CM. I've been in the contract manufacturing world for close to 30 years.

Johnson: What's the one thing you want every customer to understand about delivering a job to your shop?

Hamlett: It's mostly about understanding the culture of our company. We're in Tier 2 manufacturing and we're in the \$100 million category now. We like to think of ourselves as a family atmosphere and build relationships with the customers we have. Anybody can build a product, but it's important to have established relationships and treat the customers well, which has led to our success today. We have all of the bells and whistles that other CMs do, but that's the one factor that makes us stand apart.

Johnson: Lori, can you tell us a little bit about your background and your role at DataED?

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Lori Giglio: I'm the general manager at the NPI Engineering Center for Data Electronic Devices and have been with DataED for 18 years now. I started as an account manager, and when they opened up the NPI Center about four years ago, I came over with a small team to head up the project, which has been very successful. We came over with approximately 4-5 dedicated employees, and now we're up to 13. The business has been successful since day one. We were profitable in the first year, which was a surprise to everybody. But it speaks to the service we offer, and the commitment that we have to our customers and their success.



Lori Giglio

Johnson: What's the one thing that you want every customer to understand about delivering a job to your shop?

Lori Giglio: Our customers are our first priority. Every customer that walks through our door, in my philosophy of business, should feel like they're the only customer and that their project is of the utmost importance to us. It should be completed in a timely manner within the timeframe we commit to, and they should be treated with the respect that they deserve.

Hamlett: Recently, we've been talking about what differentiates us from other companies. Some of our customers had complaints about the way we were doing business, and we listened and came up with a solution for everyone. And with that, the word spread. We don't have people trying to sell the business; it has been spread by word of mouth.

Lori Giglio: We have a high referral rate from our customers. We receive a lot from customers once they've engaged with us, done business with us, and are happy with the service they received. Customers often send me referrals to other companies in different industries that they are aware of that need the services

we offer at the NPI Center. Again, our customer-focused philosophy is working.

Johnson: What services or assistance can you provide at DataED that your customers seem to overlook?

Hamlett: From a production standpoint, one of the things that people don't know that we have is conformal coatings for the assemblies. We offer tests and test design and do a lot of repair work, including ball grid arrays (BGAs), as well as design for manufacturing (DFM) and design for testing (DFT). We have some environmental stuff too. A lot of people don't know that because they think of us as a board house that builds boards and stuffs parts on them, but we offer more than that. And in terms of materials, we can look at the bill of materials (BOM) and give customers an idea of if there are obsolete parts listed. If parts are going to go end of life, we can make them aware of that so that they can do last-time buys.

Lori Giglio: I agree, Jeff. Even though I don't have conformal coatings at the NIP Center, I have the extension of the production facility. I can offer services that a small, standalone NPI center could not offer because I can offer them through the other facility. I can offer to do conformal coatings, for example. And we can offer the test aspect if customers need it because we have a big production facility on the other side of town.

We also offer that same engineering and manufacturing expertise. We're approaching it from an engineering perspective to look at the design, build it, critique it, and help the customers. Often, the customers are on site and present. If not, they're definitely involved. We engage throughout the whole process, so they're learning as well.

Johnson: So, you help customers get from what they think is a finished design to something that is more ready for production and manufacturing.

Lori Giglio: Yes. We help address things that an engineer designing may not be aware of when

you get onto a manufacturing floor. Something that looks great on paper or CAD doesn't necessarily translate to the manufacturing floor. The NPI Center can take that, get through the first build, and help critique it so that things run smoother, corrections are made, and it's less costly the next time. Essentially, we assist in DFM.

Johnson: Lori, let's follow the flow through your shop. What does a perfect job look like to you? Let's start with the NPI, and then talk about what it looks like going into production.

Lori Giglio: That's an interesting question. It's hard for me to answer because here we're dealing with new designs and every job is exciting. For every job an engineer walks in with, we can help them to improve it. But nobody is going to walk through the door with the perfect design at an NPI center. They walk in with something in their hands, saying, "Is this even going to work? Can you make this into an actual product so that we can test it and see where we can improve upon some things?" I don't often see perfection. What I usually see is somebody's idea of something, and we partner with them and collaborate and get to a point where it can be repeatable and produced in the manufacturing environment. By the time it gets into the manufacturing facility, it might be perfect.

Johnson: At the NPI Center, I'm sure the 80/20 rule comes into play where 80% of the things you're fixing can be found in the 20% of the things that could possibly go wrong. What are the most common issues that you clean up for your customers?

Lori Giglio: Issues could include a pad mismatch, a part that they thought was going to fit the right way but doesn't, or they put things on the edge that shouldn't be there. Sometimes it's the board layout, or they violated some IPC standards and need to keep that in check too. Our board houses will often share that back as well, and we can help them with that.

Johnson: Jeff, let's turn that question a little bit on its edge for you. Obviously, from the NPI Center, you get exactly what you need for production. What about the customer that comes to you from outside of that flow?

Hamlett: It's critical to have all of the documentation in line. Our processes align with those at the NPI Center, so it flows pretty easily. In terms of the types of boards we're looking for, keep in mind we don't always take everything from the NPI Center over to production. We don't even sell it that way; we sell it as a standalone facility. If they want to bring in production, we'll take it, obviously, and it could even go to worldwide manufacturing in our China facilities. But we're looking for high-tech boards, low to medium volume, and very high mix boards with lots of density complexity. We stay away from smaller, consumer boards. We are looking at more box build type stuff too. Once it comes from the NPI Center, everything is pretty much in line; they've run it through a couple of iterations already, so we can hit the ground running.



Jeff Hamlett

Vic Giglio: Lori's expertise is to make sure that as she's designing the process well, taking a concept, and making it a robust documentation package as well as ensuring that the hardware is ready to go to the next level of manufacturing. Whether Lori works with another CM, a mom-and-pop shop, or a Tier 1, she has already done the homework for them. Now, they have a real documentation package that can move forward to streamline production, whether it's here or elsewhere. Lori works with all of the other CMs. There's not a caveat that they have to work with after the NPI and construction work is done.

Feinberg: Right now, what do you see as your biggest challenge? For example, is it finding the most qualified employees?

Vic Giglio: Our biggest challenge is human resources and finding qualified employees who are in the advanced manufacturing world and have technical expertise. Our high schools and colleges are not focused on manufacturing anymore. Typically, in our China facilities, we don't have this issue. Even with engineering, when you talk about the graduation classes of engineers; they're not into electronics; they're into software, gaming, and chemistry.



Vic Giglio

Feinberg: I totally agree with you. In fact, that's something that IPC is very involved in training and preparing young people involved in this industry.

Vic Giglio: We're becoming albatrosses, us old people. We're involved with the incubators in the area, especially in the Boston area, and Lori has exposure to it as well as Jeff with upfront sales. Greentown Labs, MassChallenge, and others are coming out of MIT that are leading edge. But as large as those incubators are, very few design electronic hardware. It's puzzling to me that they're receiving funding from private equity companies and venture capital companies that are investing millions upon millions of dollars into the futuristic view of these products. Most of those young people don't have any concept of how to design hardware.

Happy Holden: When you get a new product or customer, on average, are you having to invest more of your own engineering talents and experience to make this manufacturable or less?

Vic Giglio: Often, we need the technical expertise to assist these design engineers in creating the hardware for them. Lori's typical focal point is throwing the engineering resources at that to do that piece of the design.

Johnson: So, how do you see your customers' needs and requirements changing?

Lori Giglio: From the NPI Center side of the business, I see things becoming quicker and quicker. People need products in 2–3 days versus 5–15 days to procure and build. Everybody seems to be so “under the gun” on designing the newest, greatest thing that by the time they get here, everything is just so fast.

Johnson: Are you also facing problems from the supply chain for components, etc., and the timing you need on components to fulfill orders?

Lori Giglio: We've been very fortunate and haven't run into a lot of issues except for Victor's scenario where there's a lot of custom parts somebody has designed in and they weren't aware would take weeks to obtain. But for the most part, our quantities and lot sizes are small enough that we're not running into a lot of issues with being able to source; customers just need things so fast.

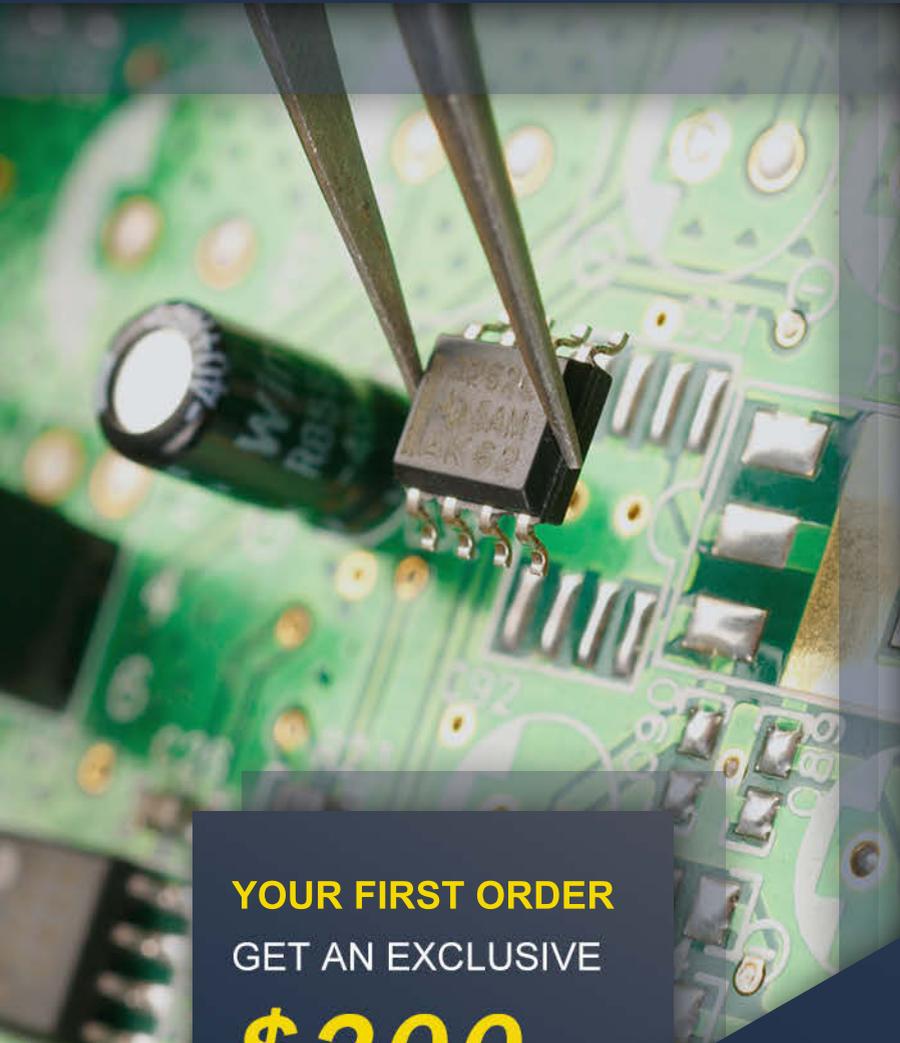
Johnson: Lori, when younger, creative designers show up at your doorstep with their design, I'm sure it's common for them to say, “The CAD tool said this will work; therefore, it will be straightforward to make.” Is that a chance for you to educate them on what actually happens?

Lori Giglio: Yes. I've done some projects with Dartmouth College, and often, especially with young engineers, they're still in school. Many have never seen the actual equipment that produces what they design, such as pick-and-place equipment. They've never seen the process that a PCB has to go through to become a product. When they're at the NPI Center, it's an extension of their education because they're learning that there are some restraints to what they're doing..

Johnson: Do you have a success story you could share. Lori, you probably have a number to choose from where the customer was well prepared, or you helped them get there, and it made a big difference in their design.

Lori Giglio: We do that almost every day, but I like to share success stories where a cus-

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tomers came in for NPI, not somebody who was already doing business with us in the production facility. Once, a group out of Marlborough, Massachusetts, came to the NPI Center in a critical state because they had a supplier—a CM—that wasn't delivering. They couldn't get commitments on the product, and I had a VP of engineering show up on my doorstep saying, "I need this high-tech board built within a few days. Can you help me out?" After procuring materials and building product built within a few days, they became a customer and still are today. Their VP of engineering is one of our biggest fans as far as referrals go.

Johnson: Am I correct in assuming that your team quickly became part of their consulting process going from design to manufacturing?

Lori Giglio: Oh, absolutely—on a regular basis. I either go down to visit them, or they come up to visit us. They confer with our engineers directly, so it's an ongoing relationship. We're part of their group now. It's almost like we all work for one company because they will send a design concept to us and ask for our input.

Johnson: You need to have that sort of collaborative environment with your customer; that is a lot of what seems to be missing. How about an experience that didn't go so well and had some lessons learned?

Lori Giglio: Again, that's an interesting question for me because I know we've had opportunities to improve on things, such as communication. But I can't tell you of a customer experience that was that bad that stuck in my mind. If we have any concerns or issues, we're so involved with the customer—talking and corresponding every day—so I can't think of something that went completely wrong.

We learn things every day because we have new designs walking through the door and things we've never even thought to do where a customer will ask, "Can we do it?" And we will. As we collaborate with them and try it, we learn something from it, but that's not a bad experience—it's just through good collab-

oration. It's through that excitement of somebody's new idea and idea, wondering if something can work, and we try to make it work and get the customer to where they want to be.

Hamlett: I have to agree with that. I can't really come up with an individual bad experience we've had. We retain most of our customers over long periods of time. Our longest customers have been with us here since 1980. And they're continuing to grow with us, which has been a great experience. We just improve on what we see as some of the small pitfalls that we come across with some of the customers. When situations don't go as planned, it's because of a lack of communication, as Lori mentioned. But we ask lots of questions.

Ron Sprizza: I also want to emphasize that we take the relationship with our customers very seriously; it's extremely important to us. So, when a customer brings up any issues, we take it to another level. No matter how bad the situation might be, we can take those lemons



Ron Sprizza

and turn them into lemonade. And we've had a few of those in both production and probably one or two over on the NPI side. As Lori mentioned, we view those as learning experiences.

It's all about the relationship and how you treat the customer when something goes bad. In terms of making a mistake that could have been a total disaster, Lori went to the customer and told them that we were going to build the board for free. We aren't going to charge them for fixing the problem or building new boards; we would take the hit on that. But the customer didn't want to do that because it was partially their fault, so Lori responded, "We can share it." But they didn't even want us to do that. So, that situation could have been a total disaster.

Johnson: Fumbles are going to happen. Sometimes, it's in your control to have prevented

it, but other times, it's completely out of your control. Of course, the big question is how do you respond when mistakes occur?

Sprizza: Exactly.

Hamlett: One of the bigger success stories at this production facility was a customer years ago that had government jobs, had financial trouble, and CMs were throwing them out left and right and couldn't deal with them anymore. We stuck with them. We were nervous at some points. They ended up eventually having to claim bankruptcy, but a company bought them out, and we recovered the money. Last year, they were our second-biggest customer.

Happy Holden: Earlier, you mentioned that you have two facilities in Shenzhen, China. That's fairly unusual.

Hamlett: Yes, and they're not partnerships; we own them.

Holden: Since you have more flexibility, is it possible to teach customers the NPI process you have and grow NPI engineers in your facilities in China?

Hamlett: That's the whole idea behind it. In terms of the NPI facility, we want to open that up. We already had the China facility, so now you're going from design inception all the way to a worldwide order fulfillment as needed. There are very few CMs in our category size that can do that. It's a great selling feature for us, and it works.

Johnson: Are you looking for new business areas? It sounds like this is a potential area of growth for you.

Hamlett: Well, part of the growth for me, and not necessarily in China, is we don't do a lot of medical and military. The military industry is starting to pick up again. We held back from it over the last few years, and it is coming back, so we are going to try to concentrate more on that along with the medical. But we need some



certifications to do that. We're going to get our AS9100 certification. We are 13485 certified in China for medical, but not at this location.

Holden: Is there anything new coming out that we can expect to see at SMTA International in September? Or things that you're looking for that you hope to see there?

Sprizza: As Lori works with customers on new products and designs, we get to see some of what the future is going to hold. That gives us an opportunity to start thinking about what equipment we might need to service the customers. We don't buy capital equipment because we hear that there's some new technology coming out; we may never hear that from any of our customers. So, we wait for somebody to say that they need something, and we get the capital for it.

Feinberg: We talked about the fact that you're looking at maybe getting involved in military and medical. Right now, what is your largest demographic?

Hamlett: Industrial controls is currently our largest, and security is starting to increase because of everything going on in the world today.

Johnson: Great. Thank you for your time today.

Hamlett: Sounds good.

Lori Giglio: Thank you. SMT007

Straightening Out Those Corners

Knocking Down the Bone Pile by Bob Wettermann, BEST INC.

Physical damage to a printed circuit assembly is typically done to the board through improper handling. A board can be dropped, dinged, or mishandled as it is placed into a board carrier in the PCB assembly operations area (Figure 1). When the laminated material is damaged in this manner, can it be repaired? The answer, like most engineering answers, is that it depends.

The industry standard IPC-A-610 “Acceptability of Electronics Assemblies” describes the various conditions for what is acceptable and what is defective based on the class of the electronics. This inspection specification calls out broken corners or laminate damage as a defect when the minimum electrical clearance is violated, and the assembly does not fit the “form, fit, or function” as it is designed to be part of the assembly or it does not meet the specification on the customer’s print.

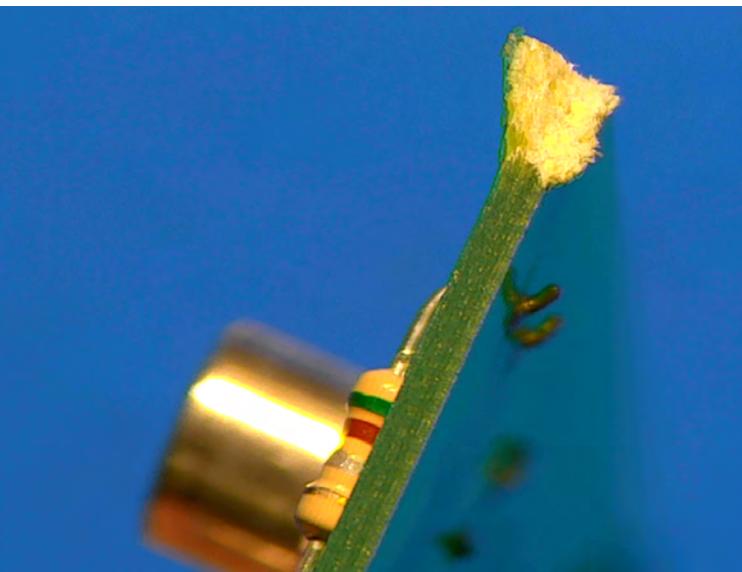


Figure 1: A PCB with a damaged corner.

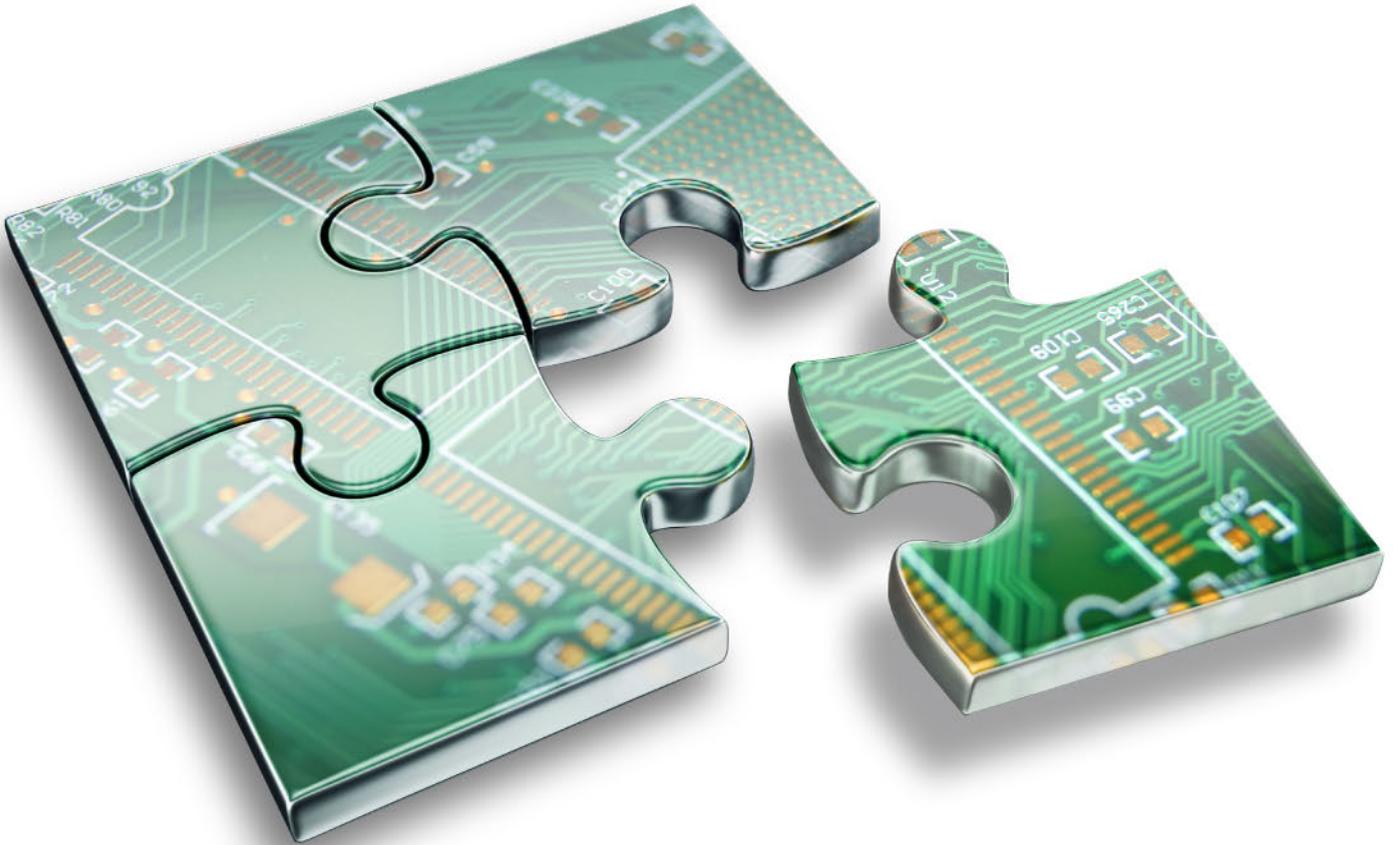
All of the above are defects per the acceptability standards for all classes of products. In addition, for any of the classes, if the base metal is exposed because of the edge or corner damage, it too would be determined to be a defect. Per section 10.2.5 of the IPC-A-610 standard, if the “nick” or corner damage exceeds 50% of the distance from the PCB edge to the nearest conductor of 2.5 mm (0.1 inches) or less, that would also be deemed a defect.

While customers will ultimately decide what is a defect by choosing the previously cited industry standards, there are various types of disposition once it has been determined that the damaged corner represents a defect condition. The options are to use the board as is (with customer approval), repair it (physical damage to the PCB), or scrap it. When the second option is chosen, the corner of the PCB requires repair.

When a board is physically damaged either by mishandling, or by the assembly being dropped, and the corner is damaged or missing, there are several other items to inspect on the assembly. In some cases—especially for brittle solders, such as various lead-free alloys—the solder joints may be fractured due to the physical event. In addition, parts near the corner may have pads or traces ripped off. If the PCB has a coating, then it may have become fractured after the assembly was dropped. Finally, there needs to be an inspection of the solder mask as well as the component bodies that may have been destroyed during the impact.

There are a variety of methods outlined in the PCB repair guidelines for PCBs—IPC-7721 “Rework, Modification, and Repair of Electronic Assemblies.” The first method is a repair

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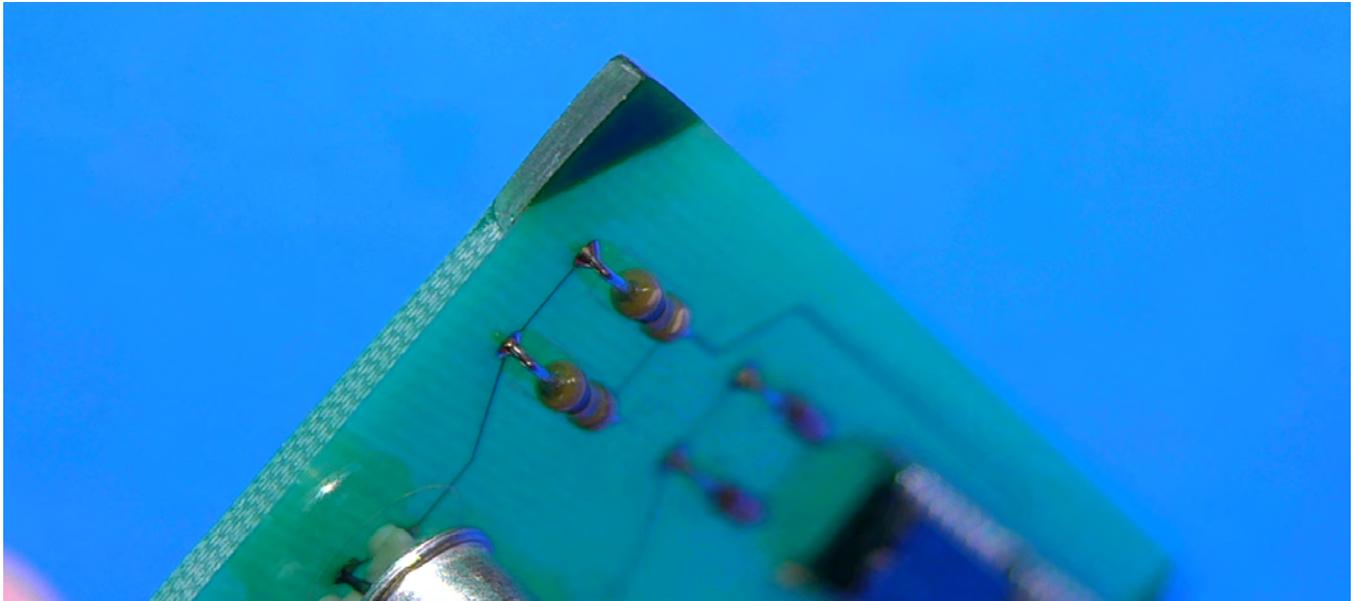


Figure 2: Repaired corner of a PCB (not color-matched for illustration purposes).

using epoxy to repair the laminate. Generally, this method is used to repair minor damage to the laminate. Second, you can use an area or corner transplant method. This is used when there is extensive damage to the PCB laminate or when the material is no longer existing, such as in the case when a corner is broken off. As the name of the method implies, a replacement laminate is used and glued using a tongue and groove joint to make the repair.

The focus of this column will be on the epoxy method, which has been adopted for the repair of broken or damaged corners on rigid, assembled PCBs. The first step is discerning to what extent the PCB has been damaged. First, clean the area to make sure that the area can be thoroughly inspected. Either through evaluation of the Gerber file set or X-ray analysis, determine if any inner layer circuit traces may have been damaged. If there are no circuits in the inner layers or missing parts due to the damage, then the repair method described will be the only one required.

Use a ball mill to grind off rough edges or fibers of the laminate. If it is a large corner, perform an undercut into the laminate edge to increase the bonding area. If interior circuitry has been damaged, then you will need to have the approval and/or skill to make those repairs.

Then, find a small plastic box that you would find for holding small tools or nuts and bolts. This will be a single use of the box, so make sure that if you “borrow” it from somewhere else that you can easily get a replacement.

Next, mix the two-part resin and hardener over the manufacturer’s instructions. Now, using the small container that has been modified to leave only a single corner, place the remaining corner so that it aligns with the damaged corner. Pour the epoxy mixture into the box and smooth the surface. Cure the epoxy per the manufacturer’s instructions as well. Using emery cloth and some water, wet sand to make fit the corner. You may have to add some epoxy and/or colorant to match the form, fit, and function of the corner (Figure 2). Clean and re-inspect the repaired area per the acceptance criteria based on the class of the electronics assembly.

Using this epoxy method, you can successfully straighten out the corner of the board and not have to discard it in the scrap heap. **SMT007**



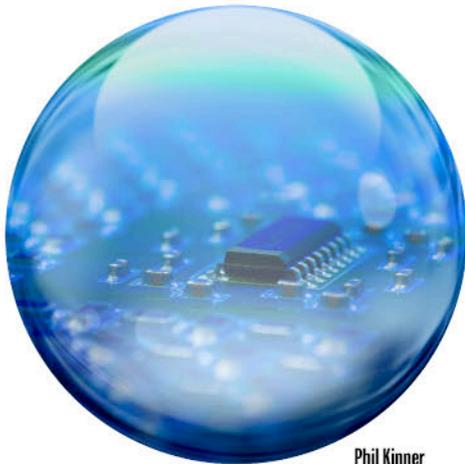
Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. To read past columns or contact Wettermann, [click here](#).

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Editor's Picks from SMT007.com

1 SMT Perspectives & Prospects: Get Ready for Disruptive Technologies ▶

Nolan Johnson and Dr. Jennie S. Hwang—an I-Connect007 columnist, author, and all-around expert in PCB assembly—discusses some of the changes she has seen since joining the industry, and disruptive technologies that technologists we are going to have to face in the near future. Are you ready for the future?



Dr. Jennie S. Hwang

3 Automation and the Smart Factory: Introduction to Industry 4.0 ▶

The characteristics of successful automation application in manufacturing depend on how well business and technical management understand and promote the strategies, tactics, and philosophies used in modern manufacturing. This article briefly outlines the background of computer-integrated manufacturing (CIM) and its evolution to Industry 4.0 and smart factories.



Happy Holden

2 Powerful Prototypes: Proper PCB Storage—Top Three Hazards ▶

Overall, our modern world could not exist without PCBs; they are everywhere, but they aren't items to be taken for granted. Like most technology, PCBs need proper handling and storage. PCBs don't last forever and are even more vulnerable before the parts are soldered on. The solderable metal surface is very thin and subject to a number of potential problems, especially if not stored properly.

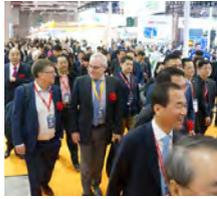
4 IPC's Annual High-reliability Forum Adds Microvia Summit ▶

IPC's High-Reliability Forum and Microvia Summit—a three-day technical conference to be held in Hanover, Maryland, May 14–16—will focus on electronics for milaero, automotive, and long-life applications.



5 CPCA Show and productronica China 2019 Review ▶

It was a busy week in China for the electronics industry. With multiple trade shows and conferences going on simultaneously in Shanghai—including the CPCA Show 2019, productronica China, SEMICON China, electronica China, and FPD China—it appears from the crowds that the market is strong in the region.



6 Punching Out!: Getting to a Signed Letter of Intent ▶

The letter of intent (LOI) serves as a roadmap for the buyer's attorney to begin drafting the purchase agreement, so it is important that there are enough details in the agreement. Any major terms that are important to the parties should be included. Here's a list of the very important items in the LOI.



7 Industry Outlook from IPC's Sharon Starr ▶

Sharon Starr, IPC's director of market research, updates Patty Goldman on the EMS and PCB industry outlook, benefits of IPC membership and participation, plans to expand the EMS statistical program, and new studies being published.



8 Flex Joins Open Invention Network Community ▶

Flex announced that the company has joined the open invention network (OIN). As a global company offering a full range of manufacturing capabilities, Flex is demonstrating its commitment to open source software as an enabler of smart, connected devices.



9 Altus' Axis: What Makes the Smart Line So Smart? ▶

The drive for increased automation and significantly escalating the productivity of an SMT line requires several critical factors coming together to create a truly smart line. There must be innovative individual machines should maximize the potential performance for the respective processes, interconnectivity between the machines, and the ability to automatically adjust to products coming down the line with minimized downtime.



10 Contract Manufacturing and Design Services to Hit \$658B by 2025 ▶

The global electronic contract manufacturing and design services market size is expected to reach \$658.0 billion by 2025, according to a new study by Grand View Research, registering a CAGR of 7.9% over the forecast period.



For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at [my I-Connect007](http://myI-Connect007.com).

Career Opportunities

Pssst!
Are You Looking
for Someone?



Place your notice in our Help Wanted section.

For just \$500, your 200 word, full-column—or, for \$250, your 100 word, half-column—ad will appear in the Help Wanted section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs and suppliers.

Potential candidates can click on your ad and submit a résumé directly to the email address you've provided. If you wish to continue beyond the first month, the price is the same per month. No contract required. We even include your logo in the ad, which is great branding!

To get your ad into the next issue, contact:

Barb Hockaday at barb@iconnect007.com or +1.916.608.0660 (-7 GMT)

I-Connect007
GOOD FOR THE INDUSTRY



Career Opportunities



Analyst Programmer, Hong Kong

We believe in caring about our people because they are our greatest asset. CML works with multi-cultural stakeholders daily to achieve more and bring them the best solutions. That's why we continuously invest in optimizing our culture and focus on providing our team with opportunities to develop their skills (e.g., through professional coaching to achieve their highest potential).

The analyst programmer will assist the IT and ERP manager in Hong Kong to support the company's BI systems, ERP systems, and other related IT-landscape applications.

In addition, this post will participate in system development projects and provide support including, but not limited to, user requirement collection and analysis, user training, system documentation, system support and maintenance, enhancement, and programming.

- Develop and enhance related IT systems and applications
- Prepare functional specifications
- Transfer the relevant business and interface processes into IT systems and other applications to get a maximum automation degree and prepare all required business reports
- Conduct function testing and prepare documentation
- Manage help desk/hotline service

CML is a leading provider of printed circuit boards. We develop tailor-made sourcing and manufacturing solutions for our customers worldwide with strong partnerships and reliable connections.

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APCT, Printed Circuit Board Solutions: Opportunities Await

APCT, a leading manufacturer of printed circuit boards, has experienced rapid growth over the past year and has multiple opportunities for highly skilled individuals looking to join a progressive and growing company. APCT is always eager to speak with professionals who understand the value of hard work, quality craftsmanship, and being part of a culture that not only serves the customer but one another.

APCT currently has opportunities in Santa Clara, CA; Orange County, CA; Anaheim, CA; Wallingford, CT; and Austin, TX. Positions available range from manufacturing to quality control, sales, and finance.

We invite you to read about APCT at APCT.com and encourage you to understand our core values of passion, commitment, and trust. If you can embrace these principles and what they entail, then you may be a great match to join our team! Peruse the opportunities by clicking the link below.

Thank you, and we look forward to hearing from you soon.

[apply now](#)

Career Opportunities



Technical Service Engineer (PCB Process Engineer)

Plano, Texas

PRIMARY FUNCTION:

To provide expert technical advice on production and engineering issues in the application of solder mask and other Taiyo products.

ESSENTIAL DUTIES:

- Troubleshoot customer problems
- Conduct technical audits
- Advise and consult on product evaluations
- Conduct technical presentations
- Frequent travel to customer facilities (travel required, up to 50% of the time)
- Write trip/audit reports
- Coordinate travel arrangements to realize significant transportation savings
- Respond to and write email messages
- Write monthly reports
- Prepare agendas for customers, detailing goals and objectives
- Must comply with all OSHA and company workplace safety requirements at all times

OTHER DUTIES:

- Other duties as assigned from time to time

REQUIRED EDUCATION/EXPERIENCE:

- College degree preferred with solid knowledge of chemistry
- 10 years of technical work experience in the printed circuit board (PCB) industry
- Computer knowledge
- Good interpersonal relationship skills

WORKING CONDITIONS:

- Occasional weekend or overtime work

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Multiple Positions Available

The Indium Corporation believes that materials science changes the world. As leaders in the electronics assembly industry we are seeking thought leaders that are well-qualified to join our dynamic global team.

Indium Corporation offers a diverse range of career opportunities, including:

- Maintenance and skilled trades
- Engineering
- Marketing and sales
- Finance and accounting
- Machine operators and production
- Research and development
- Operations

For full job description and other immediate openings in a number of departments:

www.indium.com/jobs

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Career Opportunities



Field Service Engineer: Multiple U.S. Locations

Reporting to a regional service manager, these customer-focused engineers will uphold the Koh Young culture while delivering professional technical services for our award-winning portfolio of inspection solutions. The role will enthusiastically visit our growing list of customers for installations, training, and evaluations, as well as technical support and maintenance.

We are looking for candidates with a technical degree or equivalent plus three or more years in a production environment with relevant experience. Given our growing customer base, the position will require extensive travel, including some internationally, as well as a collaborative attitude that drives success.

Koh Young is the leading 3D measurement-based inspection equipment and solutions provider. We perform quality control and process optimization across a growing set of industries including PCBA, machining, final assembly, process manufacturing, and semiconductors. In addition to our corporate office in Seoul, our international sales and support offices help us maintain a close relationship with our customers and provide access to a vast network of inspection experts.

Join the industry's leading provider of true 3D inspection solutions. Forward your resume to Michelle.Hayes@KohYoung.com.

[apply now](#)



Vision and Machine Learning R&D Engineer Atlanta, GA or San Diego, CA

At Koh Young, we are focused on developing the future and continue to bolster our newly established R&D center near San Diego, California, with top talent focused on vision engineering and machine learning for electronics and medical applications. Currently, we are collaborating with top medical universities and hospitals across the U.S., Korea, and Japan to develop innovative neurosurgical robotic systems. With core technologies developed in-house, we expect to deliver neurosurgical breakthroughs.

The role will develop practical, scalable 3D machine learning solutions to solve complex challenges that detect, recognize, classify, and track medical imagery. Additional focus on the design, implementation, and deployment of full-stack computer vision and machine learning solutions.

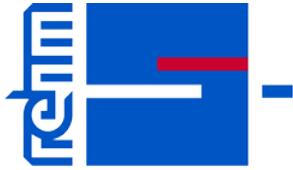
The ideal candidates will hold a master's (doctorate preferred) in computer science or electrical engineering with at least three years of relevant experience. We desire a strong understanding of machine learning and computer vision algorithm application within embedded systems, plus significant vision expertise in multi-view geometry, 3D vision, SFM/SAM, and activity recognition.

Koh Young is the leading 3D measurement-based inspection solutions provider. We perform quality control and process optimization across a growing set of industries including electronics, final assembly, semiconductors, and most recently, medical imagery.

Join the 3D inspection leader as we expand. Forward your resume to Michelle.Hayes@KohYoung.com.

[apply now](#)

Career Opportunities



THERMAL SYSTEMS

Service Engineer Reflow Soldering Systems (m/f)

To strengthen our service team at Rehm Thermal Systems LLC. in Roswell, Georgia, we are seeking candidates to fill the position of Service Engineer—Reflow Soldering Systems.

Your area of responsibility:

- Installation of Rehm reflow soldering systems at the customers' site
- Maintenance and repair work as well as technical service for our customers in the USA and Mexico
- Execution of machine training

Your profile:

- Completed education studies as an engineer in the field of electrical engineering/mechatronics or comparable education (m/f)
- Basic and specialist knowledge in the field of electronics and electrical engineering/mechatronics
- High willingness to travel and have flexible employment
- Service-oriented and like to work independently

We offer:

- Performance-oriented, attractive compensation
- Comprehensive training
- A safe workplace in one successful group of companies
- Self-responsibility and leeway

Please send application documents online to Natalie Werner at n.werner@rehm-group.com.

[apply now](#)



SMT Operator Huntingdon Valley, PA

Manncorp, a leader in the electronics assembly industry, is looking for a technician to operate our new in-house SMT LED assembly lines.

Duties and Responsibilities:

- Set up and operate automated SMT assembly equipment
- Prepare component kits for manufacturing
- Perform visual inspection of SMT assembly
- Participate in directing the expansion and further development of our SMT capabilities

Requirements and Qualifications:

- Prior experience with SMT equipment, or equivalent technical degree preferred
- Basic computer knowledge
- Proven strong mechanical and electrical troubleshooting skills
- Experience programming machinery or demonstrated willingness to learn
- Positive self-starter attitude with a good work ethic
- Ability to work with minimal supervision

We Offer:

- Paid training period
- Health and dental insurance
- Retirement fund matching
- Continuing training

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Career Opportunities



SMT Field Technician Huntingdon Valley, PA

Manncorp, a leader in the electronics assembly industry, is looking for an additional SMT Field Technician to join our existing East Coast team and install and support our wide array of SMT equipment.

Duties and Responsibilities:

- Manage on-site equipment installation and customer training
- Provide post-installation service and support, including troubleshooting and diagnosing technical problems by phone, email, or on-site visit
- Assist with demonstrations of equipment to potential customers
- Build and maintain positive relationships with customers
- Participate in the ongoing development and improvement of both our machines and the customer experience we offer

Requirements and Qualifications:

- Prior experience with SMT equipment, or equivalent technical degree
- Proven strong mechanical and electrical troubleshooting skills
- Proficiency in reading and verifying electrical, pneumatic, and mechanical schematics/drawings
- Travel and overnight stays
- Ability to arrange and schedule service trips

We Offer:

- Health and dental insurance
- Retirement fund matching
- Continuing training as the industry develops

apply now



Sales Personnel, Japan

The Gardien Group is looking to expand the sales team in Tokyo, Japan, and seeking highly motivated team players with a positive attitude. Prior experience in the PCB industry is an advantage but not necessary for the right candidate.

The role involves working closely with the customer to identify their needs and deliver the right solution. The candidate should be able to offer a high level of customer satisfaction to ensure ongoing sales.

Training will be provided along with a competitive benefits package, excellent growth opportunities, and periodic bonuses.

Interested candidates, please contact us at careers.jp@gardien.com with your resume.

Kindly note only shortlisted candidates will be notified.

apply now

Career Opportunities



U.S. CIRCUIT

Sales Representatives (Specific Territories)

Escondido-based printed circuit fabricator U.S. Circuit is looking to hire sales representatives in the following territories:

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

apply now

ELECTROLUBE
THE SOLUTIONS PEOPLE

We Are Recruiting!

A fantastic opportunity has arisen within Electrolube, a progressive global electro-chemicals manufacturer. This prestigious new role is for a sales development manager with a strong technical sales background (electro-chemicals industry desirable) and great commercial awareness. The key focus of this role is to increase profitable sales of the Electrolube brand within the Midwest area of the United States; this is to be achieved via a strategic program of major account development and progression of new accounts/projects. Monitoring of competitor activity and recognition of new opportunities are also integral to this challenging role. Full product training to be provided.

The successful candidate will benefit from a generous package and report directly to the U.S. general manager.

Applicants should apply with their CV to
melanie.latham@hkw.co.uk
(agencies welcome)

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Career Opportunities



ZENTECH

Zentech Manufacturing: Hiring Multiple Positions

Are you looking to excel in your career and grow professionally in a thriving business? Zentech, established in Baltimore, Maryland, in 1998, has proven to be one of the premier electronics contract manufacturers in the U.S.

Zentech is rapidly growing and seeking to add Manufacturing Engineers, Program Managers, and Sr. Test Technicians. Offering an excellent benefit package including health/dental insurance and an employer-matched 401k program, Zentech holds the ultimate set of certifications relating to the manufacture of mission-critical printed circuit card assemblies, including: ISO:9001, AS9100, DD2345, and ISO 13485.

Zentech is an IPC Trusted Source QML and ITAR registered. U.S. citizens only need apply.

Please email resume below.

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BLACKFOX
Premier Training & Certification

IPC Master Instructor

This position is responsible for IPC and skill-based instruction and certification at the training center as well as training events as assigned by company's sales/operations VP. This position may be part-time, full-time, and/or an independent contractor, depending upon the demand and the individual's situation. Must have the ability to work with little or no supervision and make appropriate and professional decisions. Candidate must have the ability to collaborate with the client managers to continually enhance the training program. Position is responsible for validating the program value and its overall success. Candidate will be trained/certified and recognized by IPC as a Master Instructor. Position requires the input and management of the training records. Will require some travel to client's facilities and other training centers.

For more information, click below.

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Events Calendar

SMTconnect ▶

May 7–9, 2019
Nuremberg, Germany

Electronics Manufacturing Korea ▶

May 15–17, 2019
Seoul, South Korea

Medical Electronics Symposium 2019 ▶

May 21–22, 2019
Elyria, Ohio, USA

EIPC Summer Conference 2019 ▶

June 13–14, 2019
Leoben, Austria

IPC SummerCom ▶

June 15–20, 2019
Raleigh, North Carolina, USA

NEPCON Thailand 2019 ▶

June 19–22, 2019
Bangkok, Thailand

NEPCON South China 2019 ▶

August 28–30, 2019
Shenzhen, China

SMTA International 2019 ▶

September 22–26, 2019
Rosemont, Illinois, USA

productronica India 2019 ▶

September 25–27, 2019
Delhi NCR, India

electronica India 2019 ▶

September 25–27, 2019
Delhi NCR, India

Additional Event Calendars



Coming Soon to *SMT007 Magazine*:

JUNE: Everything Starts With Design

A look at the powerful impact that the design phase has on the rest of the manufacturing processes downstream.

JULY: Failures and Reliability

Original equipment manufacturers are seeking improved reliability from electronics manufacturing. We explore current trends and developments in failure prevention, analysis, and reducing field failures.

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