

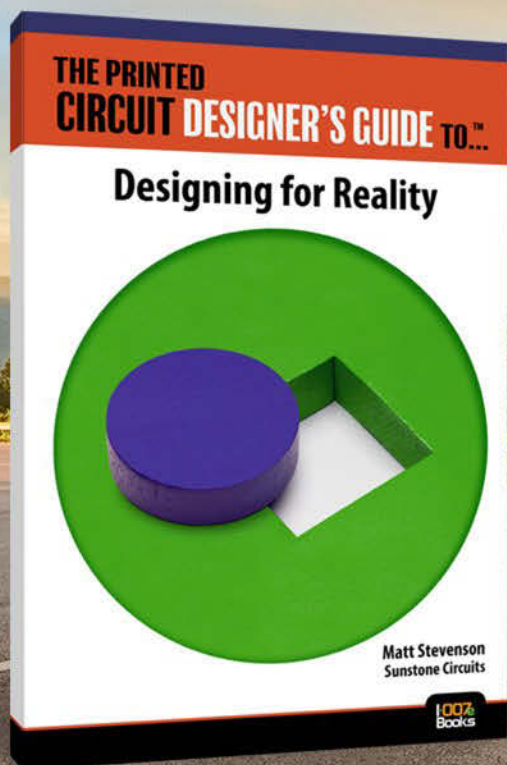
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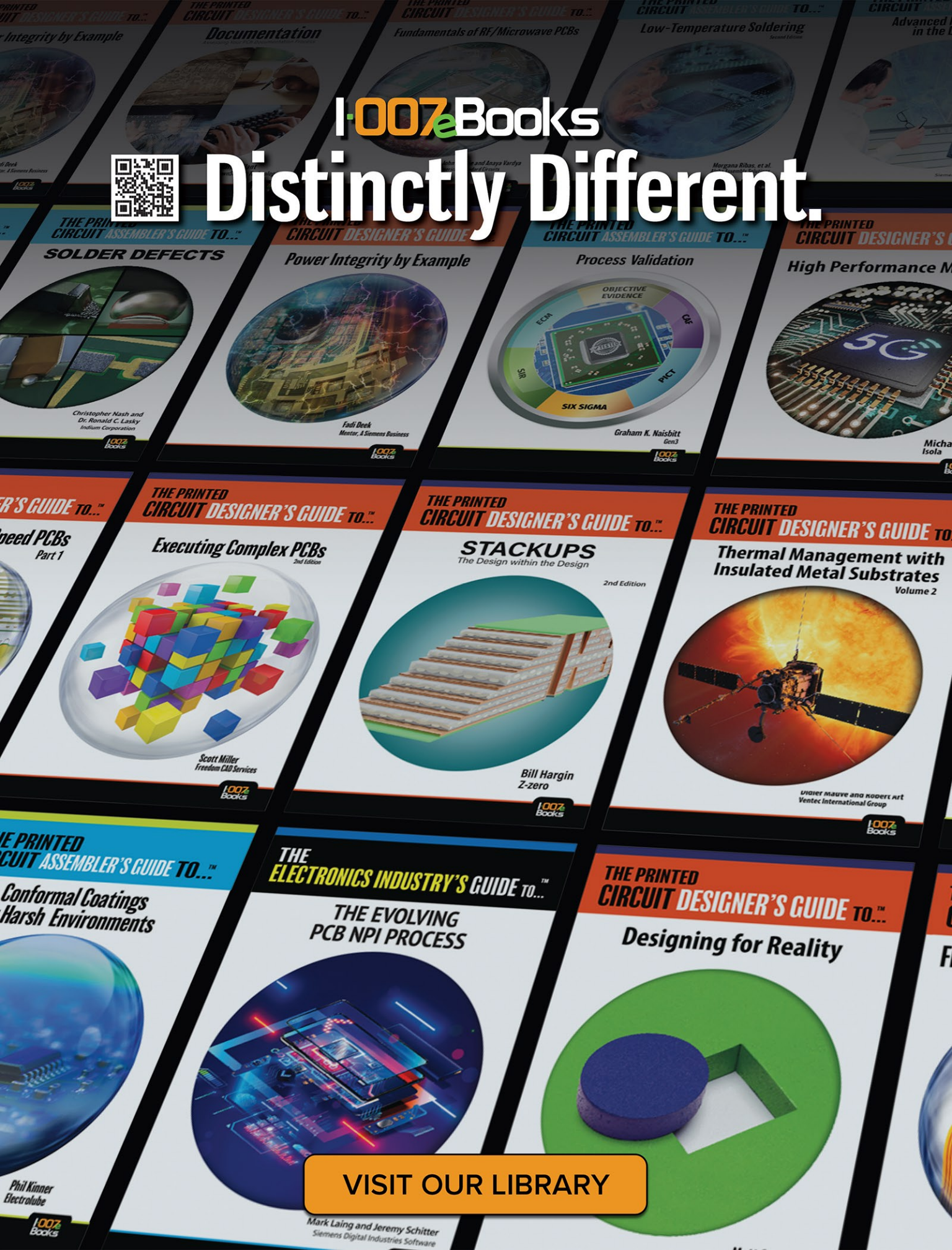
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The EMS Mindset

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The Manufacturer's Mindset

Nolan's Notes

by Nolan Johnson, I-CONNECT007

It's the ongoing balance of the four forces of flight—thrust, drag, weight, and lift—that will keep any flying object aloft. To gain altitude, the pilot adds lift, which usually requires more thrust. To descend safely, there must be less thrust, allowing weight to exert more force on the trajectory. Applying this concept to the business world: thrust is revenue, lift is manufacturing capacity, weight represents various business obstacles, and drag stands in for the operating costs and other financial burdens on your business. Just as the bird or pilot must balance their four forces, you must balance yours to climb and stay upward.

Consider the external forces that contribute to the balance of the forces. Just as a plane may fly faster thanks to a tailwind, the economy, government, or investors can influence the thrust/drag balance in either direction. Investment can also increase the lift or capacity. The warning, of course, is that too much of one force can upset the balance enough to cause something unmanageable, like a stall. The key is to fine tune these forces to follow the flight path you've chosen. We can all think of examples of companies that tried to climb (expand) faster than their thrust and lift (revenue and investment) could sustain, causing the drag of their operating costs to pull them into a crash.

In this month's issue, we address those forces working for and against our businesses. As we've made our way through some turbulent times, and on the heels of a quite successful trade show, this is the perfect time to find out what's on your mind. If you were in San Diego, you likely felt the buzz; you know what I'm talking about. This is the ideal time to suggest read-



ing our annual edition of *Real Time with... IPC APEX EXPO 2023 Show & Tell Magazine*. It's a comprehensive look and feel to what happened at the show. While there, we most certainly picked up on the EMS mindset, and you'll see us discussing it here and in future issues.

For example, there was ample upbeat talk. Shawn DuBravac, IPC chief economist, repeatedly used the term "tailwind" in his keynote to describe external economic forces. There was also discussion of challenges and ongoing shortages with components and skilled staff. Overall, the opinion was that a lack of capacity is throttling industry growth, and that staffing is a prime contributor, followed by supply chain issues and investment. These are the challenges of an industry in ascent. They stand in stark contrast to the challenges of a shrinking industry, where companies are scratching tooth-and-nail to keep or steal orders, scrambling for as much "lift" as they can possibly find.

But did the conference attitude match the rest of the industry? Our March issue seeks to deliver a wide-angle view of the industry, a perspective from a somewhat higher altitude: Where are the common areas of thought? Is there a "hive mind" of thought to uncover?

This issue features an article by Mark Wolfe, a long time EMS industry insider now consulting with IPC. Mark's job is to be the voice of the EMS industry, so he's in constant contact with industry leaders. He provides an assessment of the industry and the top five challenges for EMS leadership. He was instrumental in making the IPC APEX EXPO EMS Leadership Summit a successful event in San Diego, something we'll take a deeper dive into for our April issue.

We also conducted a series of interviews with EMS providers, looking for a sense of how business is progressing and what they think about it. We conducted these interviews during their daily routines, away from the show and the group discussions. This allowed for frank and insightful commentary. We've

also referenced some recent coverage in other magazines that coincidentally share the EMS mindset as a theme; you'll want to follow those links for even more manufacturing mindset.

To round out the issue, we have an interview with Schweitzer Electronics, as well as another with Sheldon Fernandez from Darwin AI. I've included a written perspective from Mark Laing at Siemens, and another by Norihiro Koike from Saki. Our columnists, Michael Ford and Ron Lasky, also share their current thoughts.

One of the unexpected outcomes of our conversations has been how AI has crept into everyday thinking. Quality control and final inspection seem like natural points to insert AI in the production process. In fact, one can argue that automated testing and inspection have been striving to deliver artificial intelligence all along; it's just becoming more sophisticated thanks to the mainstream work done by entities such as ChatGPT. As I read and digest the information about this specific AI, I realize that it can be a most helpful assistant, automating the drudgery tasks and even helping us with research. But we are well advised to use generative AI output only as a starting point, not as the finished product. The facts in AI-generated information still need to be fact-checked, point-by-point.

I share this example because it touches on how AI is on the minds of more than just EMS managers. Will AI give us lift or will it be a weight? My interview with Sheldon at Darwin AI really helped clarify the issue.

Remember, you are at the controls, and I know this issue will help raise your perspective. So, what's on your mind? It's time to let me know. **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](#).



Five Issues **Troubling** EMS Companies

Feature Article by Mark Wolfe

IPC

The role of electronics manufacturing services (EMS) companies is very often misunderstood. Some perspectives, however, are helpful in framing the question of what's on their minds, especially in the current global environment.

EMS companies build products but they are not really “product” companies. While they may provide design services, the designs are still owned by their customers. As a result, they do not have the right to select or change components. In most cases, the EMS company will still be responsible for purchasing these components which are typically 70–90% of their cost to produce the end products. They also do not determine what volumes should be built.

At the same time, they are in an extremely competitive market, with over 1,000 EMS com-

panies in North America alone. Large, publicly-traded EMS companies report gross margins in the high single digits. Smaller and niche EMS companies typically have slightly higher margins but are generally more constrained by working capital availability. In either case, to make this work in a sustainable, profitable manner, they must be able to manage materials and add value to create products as efficiently as possible. They need to convert component inventory to cash; to achieve this, it's essential to have dependable supply chains and a trained labor force.

Consequences of the Past Two Years

Anyone who has been in the electronics industry for any length of time knows that the past two years have seen an unprecedented



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combination of labor shortages, supply constraints, demand surges, and global disruptions. In the past, EMS companies and their customers could typically escalate within their established supply chains and reasonably mitigate significant constraints to a manageable level. This has not been the case over the past couple of years. Trusting that the original part from the established supply chain would ultimately be available with enough effort and leverage has just not worked.

As a result, EMS companies have been forced to push component issues back to their customers more often than ever before. When the parts are available in secondary markets or from brokers, they are viewed as having higher counterfeit risks and are often at extremely high relative costs. If the secondary market is not an option, the burden typically falls on the customer to explore alternate designs. These are usually last resorts and can create high-risk product transitions. Ultimately, all these issues are pushed back to customers for risk signoff and financial support, or an EMS company may not be able to survive the financial consequences.

When the parts are available in secondary markets or from brokers, they are viewed as having higher counterfeit risks and are often at extremely high relative costs.

The availability of a trained workforce, especially on the production floor, has also been challenging, especially as demand has grown. When parts are available, many EMS companies have not had enough wage workforce available to recover quickly.

The result? Even the most historically efficient EMS operations are being continuously disrupted and too many materials are occupying space, if not cash. Customer relationships, cash flow, and EMS profits have all been under duress.

Five Issues Plaguing EMS Companies?

Here are five issues I hear most often among leaders of U.S. EMS companies. I'll explain the issues and what I see can be done about it.

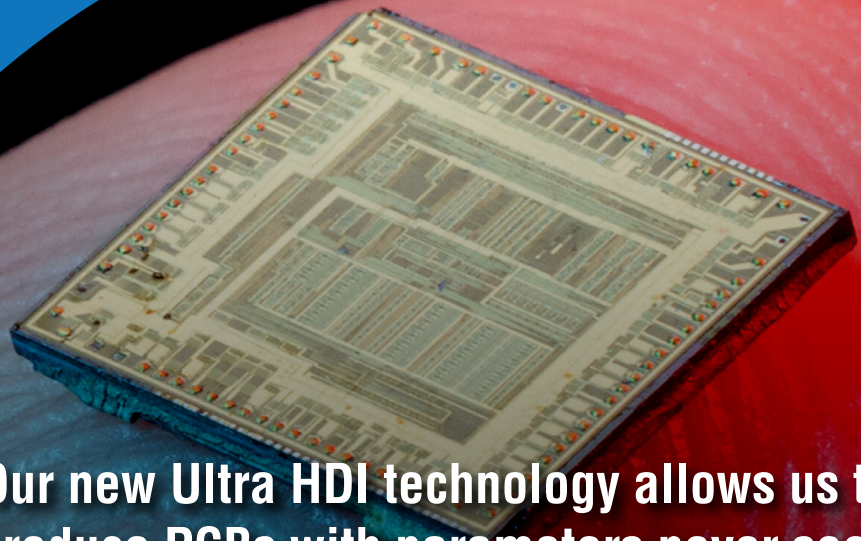
1 How do I address my ongoing talent shortages?

Most EMS companies are finding it very challenging to attract, develop, and retain the workforce they need today, yet alone for future growth. This applies to the production floor as well as administrative and technical professions.

In IPC's January Global Sentiment Report¹, survey results indicate that only 13% of global companies in the electronics supply chain believe that their ability to recruit skilled talent is improving, while 39% report it's getting worse. The outlook over the next six months is similar. Not surprisingly, labor costs and skilled talent shortages have joined material costs as the most significant headwinds in the industry.

Unfortunately, there is no single solution to the talent shortage in electronics manufacturing. Most jobs are certainly not virtual, especially as EMS companies are being challenged to build more complex products. The solution requires efforts to create greater visibility for young students, so they are excited about at least exploring electronics as a potential career path. EMS companies then need to demonstrate that they can provide a challenging and rewarding career and that they are not just a temporary stop for a specific job. In support of these needs, the industry needs much stronger onboarding, pathway-related (growing in the job) and upskilling-related (preparing for the next job) education and training.

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2 When can I start trusting my supply chain again?

There has clearly been improvement in the supply chain over the past six months. Overall lead times and material availability are gradually improving. At the same time, both are still substantially worse than pre-pandemic levels and there are still significant constraints with a much shorter but still critical list of manufacturers. Confidence in “commitments” from most manufacturers remains relatively low. As a result, confidence also remains low that all components required to build a product will arrive in the same relative timeframe.

A state-of-the-art semiconductor fab today represents a minimum \$10 billion investment with three to four years to achieve full production. At the same time, semiconductor demand is projected to grow from around \$600 billion today to over \$1 trillion by 2030, meaning that these investments will be largely to support incremental demand. The recent CHIPS Act is a very important step in the right direction but will still leave North American wafer capacity at less than 20% of global supply, meaning we will still be largely dependent on a global component supply chain well into the future.

A state-of-the-art semiconductor fab today represents a minimum \$10 billion investment with three to four years to achieve full production.

There will very likely be more areas of constrained supply than in the past, even as the current constraints continue to subside. With the extended processing time of newer, complex components, and the extraordinarily

high cost of unused semiconductor capacity, the electronics supply chain is unlikely to see capacity fully catch up with demand in quite the same way it has in past cycles.

Supply chain strategies have emphasized “just in time” in the pre-pandemic world but this approach is obviously fragile when supply chain disruptions compound as they have over the past two years. Given the growing complexity of global supply chains, the likelihood of continued constraints and the seemingly higher frequency of global disruptions, it is likely not the best strategy for the future. Instead, more adaptive supply chain strategies with emphasis on resiliency and agility should be required in the future to rebuild trust with supply chains.

3 How do I manage my inventory, so I have cash available to invest and grow?

Another potential issue is that the current situation may make inventory at EMS companies worse in the short term. They likely have a higher percentage of their bill of materials (BOMs) available to them as supply improves. In fact, many orders have required non-cancelable non-returnable (NCNR) contracts over the past few years so inventory will continue to arrive at the EMS company whether they want them or not. Given an ongoing list of constrained manufacturers combined with ongoing volatility in “commitments,” the risk of building up excess inventory remains high.

Put another way, when perhaps 50% of the BOM cost was not available 12 months ago, they would have the other 50% in inventory. Now it may be “only” 5 or 10% of the BOM that is not available, but this means the EMS company is likely forced to have the other 90-95% in inventory. In either case, the EMS company cannot ship products, but in the latter case, even more cash is consumed.

Fortunately, there has been a growing number of customers, especially those who truly understand the market issues and have strong partnerships with their EMS supply chain,

that have been willing to provide cash deposits to offset the excess inventory. While this is a short-term fix, it is not clear whether it's a long-term solution and it may diminish the perceived value of EMS companies.

4 How do I continue to maintain and grow my customer relationships in a sustainable manner?

Many customer relationships have been under strain as they experience a level of ongoing “participation” which they thought they were largely removing with the decision to find an EMS partner in the first place. As already discussed, over the past few years customers have been regularly asked to approve the purchase of components due to NCNR contracts, approve both costs and risks on very short notice where broker parts are necessary, pay for inventory at their EMS partners well ahead of receiving finished products, and to redesign at least portions of existing products on an unplanned basis.

Fortunately, many OEMs understand the electronics industry dynamics, view their EMS partners as long-term partners, and successfully work with them to find “what’s fair.” At the same time, all these items create a “surprise” at the OEM, leaving both EMS companies and OEMs wondering whether traditional business models are still appropriate. Views regarding long range forecasting, associated commitments to the extended supply chain, and overall inventory management and financial ownership will likely need to evolve in a similar fashion to supply chain strategies.

5 What impact will the economy have on me and how do I mitigate the risks?

It may not be obvious, but the EMS industry is just as vulnerable to swings in demand that are upward as they are to downward, maybe even more so. Clearly, when demand drops, EMS companies need to adjust their component orders quickly to prevent inventory buildup. Unfortunately, inventory will still



Mark Wolfe

grow even with a fast reaction as it is extremely difficult to hard stop orders even in the absence of the NCNR situation that has already been discussed.

Similarly, when demand increases, one delayed component in the supply chain will have the same impact. In some ways, it is worse. Upward orders mean increasing component commitments. In many cases, EMS companies may also be adding staff or equipment to support increases. All these can tie up operating cash when there is no ability to complete and ship the product to the customer without the final components.

EMS companies do their best to understand where the economy is headed and try to take pre-emptive actions when possible. As to customer demand, they really do need to plan and execute specific to what they receive orders for. While they may suspect that orders are too high or too low, it is very risky to try to out-plan their customers. At the same time, they may certainly choose to delay or ramp up peo-

ple, plant, and equipment decisions depending on perceived economic direction and their confidence in what customers are telling them. It is a delicate balance under any circumstances.

Why Would You Want To Do This?

There are clearly significant challenges for any EMS company today. At the same time, the penetration and breadth of electronics in our lives visibly grows every day. As the demand for electronics grows, the demand for EMS capabilities must grow with it. EMS companies do this because demand is and will continue to be high.

They also do it because well-managed EMS companies can absolutely build and sustain profitable businesses. An EMS company that

manages its material liabilities appropriately, builds strong customer relationships, and invests in the right people and equipment can do it successfully from any part of the world. They also have the opportunity to be a part of many new and innovative products and processes. It can be both challenging and rewarding for all involved.

Perhaps the question should be: Why not?

SMT007

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1. The Current Sentiment of the Global Electronics Manufacturing Supply Chain: Executive Summary, January 2023, ipc.org.

Mark Wolfe is principal at Wolfe Consulting, an EMS advisor for IPC, and former IPC EMS Executive Council chairman and IPC board member.

AI and Cautious Optimism

Article by Bill Cardoso

As we wrap up another successful IPC APEX EXPO in San Diego, for me the two major themes of the conversations in the aisles were: what's ahead for the industry in 2023 and how artificial intelligence is slowly becoming ubiquitous in electronic manufacturing. After a slow start to tradeshow in 2022, it was great to ramp up participation to levels close to normal, or perhaps a "new" normal.



We kicked off 2023 with our industry carrying over big backlogs from 2022, where we added 35,000 jobs and saw incredible growth. We're unlikely to add another 35,000 jobs in 2023, as we're expected to see negative growth in the U.S. economy in the beginning of the year, though there may be some growth in the second semester. Hopefully, we will creep into positive territory by early 2024.

Some of the major challenges of 2022 have been ameliorated: material and shipping prices have come down, matching improvements in component availability. However, these improvements came at the price of higher inflation, which inevitably applies downward pressure on demand for consumer products. As we start 2023 with a healthy backlog, the question in everyone's mind is whether the stack of orders in the books will materialize. When lead times are long like they were in 2021 and 2022, customers tend to push purchase orders in the expectation that a solid demand will materialize. As inflation increases, demand softens, increasing the risk of orders being cancelled or pushed forward.

To read the rest of this article, which appeared in the *Real Time with... IPC APEX EXPO 2023 Show & Tell Magazine*, [click here](#).



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Special Session: e-Mobility/EV

Article by Tracy Riggan

IPC

In the first-of-its-kind event, IPC brought together stakeholders from e-mobility, OEMs, their supply chain, regulators, and policy and technology experts at IPC APEX EXPO 2023 for the e-Mobility/EV Automotive Special Session. These experts discussed the many challenges as well as collaborative-based solutions to those challenges. Panelist Udo Welzel of Robert Bosch framed the challenge with a compelling statement: “The modern car has 10X more lines of code than an airplane, thus making it the most complex technical system we are building in volume.” Even if a failure rate stays the same, Welzel advised, when opportunities for failure rise, failures rise as well.

In the first part of the special session, Tom Derry, CEO at Institute for Supply Management, framed the supply chain circumstances challenging EV makers. Loren McDonald, CEO of AVAdoption, added the context of gov-

ernment regulations and incentives, as well as consumer trends driving EV maker design and implementation choices. This confirmed the supply chain trend of de-emphasis on China, consumer focus on technology features, and policies that will drive charging unit reliability requirements higher.

While this session was dynamic, it was unable to take a deep dive into the technology challenges facing EV designers. Michael Schleicher of Semikron Danfoss said these challenges are behind the push for more features with higher reliability, and that the complexity is causing more issues for consideration, like added heat and system capacity.

The key takeaway was that industry is focused heavily on software vs. hardware and yet, over-the-air (OTA) updates cannot fix a resistor or a dendrite. Hardware must be a focus to support the power, heat, and safety demands of feature-rich, OTA upgradeable systems.



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The key message of the day was that collaboration and communication across industries are necessary to address the technical challenges, the limits of which are increasingly pushed by competition, consumer demand, and government safety regulations. The aim of defining the scope of e-mobility and challenges was met, but many in the audience were hoping for a deeper dive into the technical challenges. Thursday's panel discussion certainly set the stage for these conversations to happen in 2023 and beyond.

We look forward to more legacy automakers, startups, charging companies, e-mobility suppliers, and others to join or bring challenges to IPC's e-Mobility Quality and Reliability Advisory Council, bring e-mobility concerns to standards development

The second part of the special session featured a panel discussion:

- Alex Preciado, product launch engineering manager at Rivian, spoke about the many design and manufacturing implications of new applications for electronics in e-mobility, such as thermal dissipation, heavy copper designs, and narrow pad-to-pad pitches.
- Both Welzel and April Butterfield, vice president of engineering, regulated industries, automotive and transportation at Jabil, challenged the automotive industry to take a holistic view and build understanding across industry to reach the acceleration we need in technology development, addressing power level challenges, and discouraging the creation of individualized standards.
- Jason Schwartz, business development manager at KYZEN, touched on the lack of skilled labor in both automotive and electronics, as well as lack of time for process development, automation, and continuous improvement.

task group discussions, and bring solutions to the IPC Technical Program Committee as part of the IPC APEX EXPO call for papers.

The e-mobility session is supported by IPC's e-Mobility Quality and Reliability Advisory Council and closely aligns with the council's mission to help deliver e-mobility quality, reliability, and safety while protecting the drive for innovation.

IPC appreciates the efforts of the co-chairs for the Technical Program Committee special sessions, Brian O'Leary, global head of e-mobility and infrastructure at Indium, and Jason Schwartz, business development manager at KYZEN, as well as TPC members Dr. Stanton Rak and Udo Welzel for their support and guidance on bringing e-mobility issues to the forefront. **SMT007**



Tracy Riggan is senior director of business, Solutions, at IPC.

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Schweitzer: Building Inner Strength

Feature Interview by Nolan Johnson

I-CONNECT007

Schweitzer Engineering Laboratories (SEL) has been building out a Greenfield captive facility for board fabrication and assembly. As we conducted this interview, SEL was nearing production; just before this magazine went to print, [SEL announced](#) that the facility had moved into production.

In this conversation—part of a larger, wide-ranging discussion published in the February 2023 issue of *PCB007 Magazine*—we spoke with John Hendrickson, engineering director; Frank Harrill, vice president of security; and Jessi Hall, senior director of vertical engineering. They discussed what goes into the mindset of a captive EMS facility.

Schweitzer is currently building a captive facility. There isn't much of that happening in North America right now, so I think your perspective on this is unique and likely very insightful. How do you view the current marketplace when you have just one dedicated customer?

John Hendrickson: It's both exciting and challenging. It's challenging because a typical shop in the United States has many customers. Those customers have their needs and are always pushing those facilities into looking and researching capabilities or new areas. For us, since we have just one customer, the challenge is in being proactive in how we address that.



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John Hendrickson

We must be in tune with what the next level downstream suppliers are providing to our design engineers and how that impacts our product development.

What's exciting about that is we get to partner a lot closer with our R&D folks. We become integrated into the project teams early, so we understand the challenges that they're trying to solve and the components they're using to solve those challenges.

We also get to do a lot of proactive research and help drive the designs in the manufacturing space as well; we're driving things like consistency and simplified designs. There are a lot of buzzwords in industry: HDI, blind buried via, sequential lamination, etc. That's when we take a step back and really look at the reliability of our products. Do we really need to go to those levels? If we do, we have to consider how that impacts our reliability, because we have a 20-plus-year lifecycle in our products.

Most of the EMS providers in the industry right now have to be reasonably good at a lot of things. In contrast, you have a thick set of constraints you can rely on.

Hendrickson: We do have a diverse product mix. We might decide not to invest in something because it's a low volume piece and the justification for that investment isn't there. Balancing that vs. keeping things captive is part of the challenge.

So, you don't always build everything for your product in your own facility? Do you need to outsource on occasion?

Hendrickson: Yes, for instance, we've decided not to invest in hard gold right now. We have a

small amount of product and very low volume overall that requires that technology.

Are there other considerations?

Frank Harrill: Cybersecurity has always been central to SEL; it's been a part of what we've done since 1982, before "cybersecurity" was even a term. Vertical integration allows us to extend what is today a mature and established cybersecurity umbrella, which covers the entire enterprise, all the way down to third-party certifications. This approach pays dividends all the way down the supply chain.

Frank, how is SEL addressing the upcoming CMMC requirements?

Harrill: CMMC has gone through several iterations. We're now in version 2.0; we're doing the self-attestation first and a third-party assessment in the future. We're already undergoing those processes. For instance, our entire information security management system (ISMS) is already independently certified to ISO 27000. Our entire company-wide secure development lifecycle is certified to the IC 62443 as well. CMMC and 801-71 maps directly to our ISO 27001 ISMS process already. We're already well positioned to comply with CMMC. We've successfully completed the preparation for that process.

CMMC has a trickle-down impact across the manufacturing chain for your products, which is unique. I presume it's important to Schweitzer because your end-product, as well as your suppliers, will end up being subject to CMMC scrutiny as well.

Harrill: Correct. In this vertical integration approach, it's not just simply a flow down, it's something that we are controlling by ensuring that we meet those requirements in every aspect of our manufacturing. I'll also note that we have long enjoyed a close partnership with each of our suppliers.



Frank Harrill

For instance, every year in Pullman, Washington, we host hundreds of our suppliers for a multi-day supplier conference, where we make clear not just our expectations but the why and how of achieving those goals—which may align

with the already high standards in CMMC—within the context of our partnership. Where appropriate, the CMMC standards will be part of those expectations.

Which CMMC certification are you planning to attain?

Harrill: It really depends. Implementation will differ because we have different environments, different specifications. We'll have certain requirements that require us, in certain environments, to certify to level three controls.

John, I'm curious, how does a captive shop best leverage your one-customer relationship to optimize your processes?

Hendrickson: It goes back down to getting really integrated and driving our design capability back to our customer. In some cases, that looks like predicting their needs, simplifying our designs. We started this journey a long time ago in terms of how to best design our products to meet current fabrication. We did a really good job of incorporating that into our design practices in research and development. It's continuing to evolve our capabilities. We didn't just look at what our needs were at the time, we considered what our needs might be in the next five or 10 years, and we've picked equipment sets and processes that we believe will scale to meet those needs.

Jessi Hall: We're in a unique position. Not only do we have R&D under the same roof, but we also have the assembly folks who are using the boards. From design to assembly into the final product, we're able to really understand what our challenges have been in the past and what they currently are today.



Jessi Hall

Are you simplifying the processes on the assembly side also?

Hall: Yes, we're designing and manufacturing boards that complement our assembly practices and processes.

Automation

How much of a role has automation played in setting up your facility? Has that been a consideration when it comes to finding talent to operate the equipment?

Hendrickson: We don't focus on automation for the sake of automation. I've been in a lot of board shops around the world where I've looked at their Pareto list of defects. Handling damage is typically at the top of that list.

At SEL, we focus on quality and the dignity of our employees' work. Those are some of the ideals that have driven our automation focus. Yes, the factory is heavily automated. Most of our lines have loaders and unloaders but we've purposely left certain areas not automated, like drill or AOI. Final inspection areas are still very manual because we want to make sure that we're not automating just to automate. We want to learn that process and make sure that if we do automate it, it's done in the correct way.

Hall: Our focus is always the safety of our employees first. If there's something that could be safer, whether it's ergonomic or potential hazards, we want to automate that. Quality comes next, of course. That is how we have always operated in our manufacturing, and we've brought that philosophy into this factory as well.

Our focus is always the safety of our employees first.

How will you respond if there is a major technology shift? Let's imagine that you suddenly realize you'll need to go in a new direction on the floor. For example, John, what if you need to go to additive?

Hendrickson: Great question. We've designed certain entry points into our planning process, so we'd be able to do that without much interruption in our current process flow. Our process flow is nice and linear. If we were to transition to something like an additive process, our process or our product flow would just be a little bit different. We inject things in different places, which is part of how we designed the factory—we thought ahead. Also, we haven't filled this factory with everything we'll need 10 years from now. We plan on growing this building out over time, and with our growth curve, we will continuously look at current technology and make decisions on the appropriate equipment sets when we get to those stages in our development.

Assembly Details

You have equipment there for what you need now, but you have a road map for how new equipment should be added, swapped out,

or evolved over that five- to 10-year period. You're anticipating where you think the technology changes will be. Is the planning on the assembly side similar?

Hall: It would be very similar.

What do you see as the upcoming technology challenges on the assembly side? What are you planning for? Does advanced packaging play a role here?

Hall: That's an area we are constantly looking at in our manufacturing environments.

Harrill: Something else that we enjoy with this vertical integration is that short feedback loop, meaning constant feedback and a continuous scanning of the horizon for both risks and threats—but also for opportunity. That tight coupling with R&D, with our business intelligence units, with security teams, and our supplier quality and development teams—all that feeds into controlling these aspects of production.

Are you doing this through a dedicated team task force style? This method sounds quite methodical and formalized.

Harrill: It is formalized, and these are dedicated teams that work closely together, and we strive to communicate left, right, up, and down, in the same way that every organization does, but we take special care when doing that so we don't create information silos or surprises. We're always striving to have the right level of cross-team collaboration, and that's how we've been and will continue to be successful.

It sounds like you've dedicated quite a bit of your attention to making sure that you are future proof.

Harrill: We have to. This is something you don't necessarily see in other industries, but we have to keep it in mind because of the long lifespan of our products and the resilience

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they're required to have, as well as the care we've taken in the choice of components and technologies. Many of these systems are in service in places where updates and upgrades can be difficult and costly for the customer. We design our products to work for many years in austere, hard-to-reach locations, and that must be factored into every aspect of product design and the security controls in place.

CAM in a Captive Facility

Most sites in PCB fabrication or assembly are job shops, right? Whether they're optimized for high-volume production for a few products, or they're low-volume, high-mix and really optimized for getting through a lot of small jobs quickly, they have a lot of customers to manage. You don't. What's the challenge there? Likewise, if there's an ebb and flow in product demand within your own internal supply chain, how do you keep things running smoothly and consistently through fabrication and assembly?

Hendrickson: I'll touch on the ebb and flow question first. That's one thing that SEL does extremely well in all our manufacturing facilities today—we staff to a certain level. We have what we expect for our product output

throughout the year, and we staff to that. If that ebbs or flows, we have a lot of training opportunities and things of that nature. We focus on cross training, specifically. We've talked about our assembly and R&D folks. Our goal is to cross-train with those teams, to have them work in our factory and vice versa. In the times of those ebbs and flows, we can do training. Or we can pull from those resources that we've trained because they now have a good understanding of what we do. When we need help, we can go to them, and then we can go help them when they have challenges as well.

It's our philosophy to respond or plan, rather than just react. We'll be doing quick turns along with production, but because of that tight relationship with R&D, we'll know at least two to four weeks out, maybe longer, that those things are coming, so we can plan for it. We can have that longer visibility other PCB facilities don't. They get an order that shows up and they're expected to build it; we can plan and manage that so we'll have material here and we'll be able to execute. Having that one customer also allows us to integrate a lot of our engineering data through CAM. Our goal is to CAM a design within an hour and have it out to the production floor. That's something that you can't do when you're trying to service 100

different customers that give you information in 100 different ways, and all those customers have varying levels of understanding of how to design. Those are some of the tight-knit relationships that will help us succeed there.

Let's talk about that a bit more. Getting a job through CAM in an hour? That sounds like you need a close working relationship between the design team and manufacturing. Everyone must know exactly what the design rules are.

Hendrickson: Yes, and again, our CAM team is involved in the design. They're able to review it and give feedback well



before the raw data is ready to be sent to them to execute. We're able to dial in a lot of those fabrication design rules up front. That's something our engineering teams do really well; they're great at implementing that up front into their tools so that it's not something that constantly needs to be corrected.

I'm imagining the design team as a classic cross functional team, where you've got the engineers, a design lead, the CAM department, and fab and assembly production representatives. They meet to talk about key design decisions as those designs are being made. Folks can raise their hand and say, "That will be a manufacturing issue for us if we continue with that particular approach." Is that what goes on?

Hendrickson: Yes, in our printed circuit board design process, we start with a kickoff meeting. We call it "initial point release," and that's where we gather all the input for the design: the schematics, mechanical requirements, and all our people—the electrical engineers, the PCB designer, mechanical designers, test engineers in assembly, process engineers, and manufacturing engineers—are involved in these meetings so they can understand the data and get feedback up front. Then we go through a development cycle, followed by a placement review where everyone gets back together and looks at how the progress is going, making sure everything's looking good. Then when everything's wrapped up, there's a final point release as well, where they do that final review to make sure that all those items have been addressed and that everybody's confident that the product will go through the factory with no issues.

Obviously, SEL sees having a captive facility as good business, especially given the current geopolitical situation and supply chain issues. Do you believe that captive



facilities are a wiser choice in Europe and North America today than in the past?

Harrill: Yes, absolutely, and here's why. The more we can reshore, the more we can bring back home—at least to North America with any type of critical manufacturing—it means more resiliency and security. We'll reap benefits throughout our entire system, for critical infrastructure in the United States, and in partner countries.

Hendrickson: SEL has been focused on this for the 20-plus years that I've been here, and we've been buying our circuit boards in North America that entire time. We have not gone to other places. We've stayed domestic because we've had this philosophy all along. Our president and CTO, Dr. Schweitzer, and our CEO Dave Whitehead, believe that circuit boards are not a commodity; they are a critical component to our products and very important to the success of SEL.

Harrill: That's a great point, John. Unless it's infeasible, we always source products from the United States and then North America. I think it's incumbent upon companies to commit to making that choice, now and in the future.

Thank you all for sharing your thoughts. SMT007

All photos courtesy Schweitzer Electronic Laboratories.

Differentiation, Community, and Composability

Smart Factory Insights

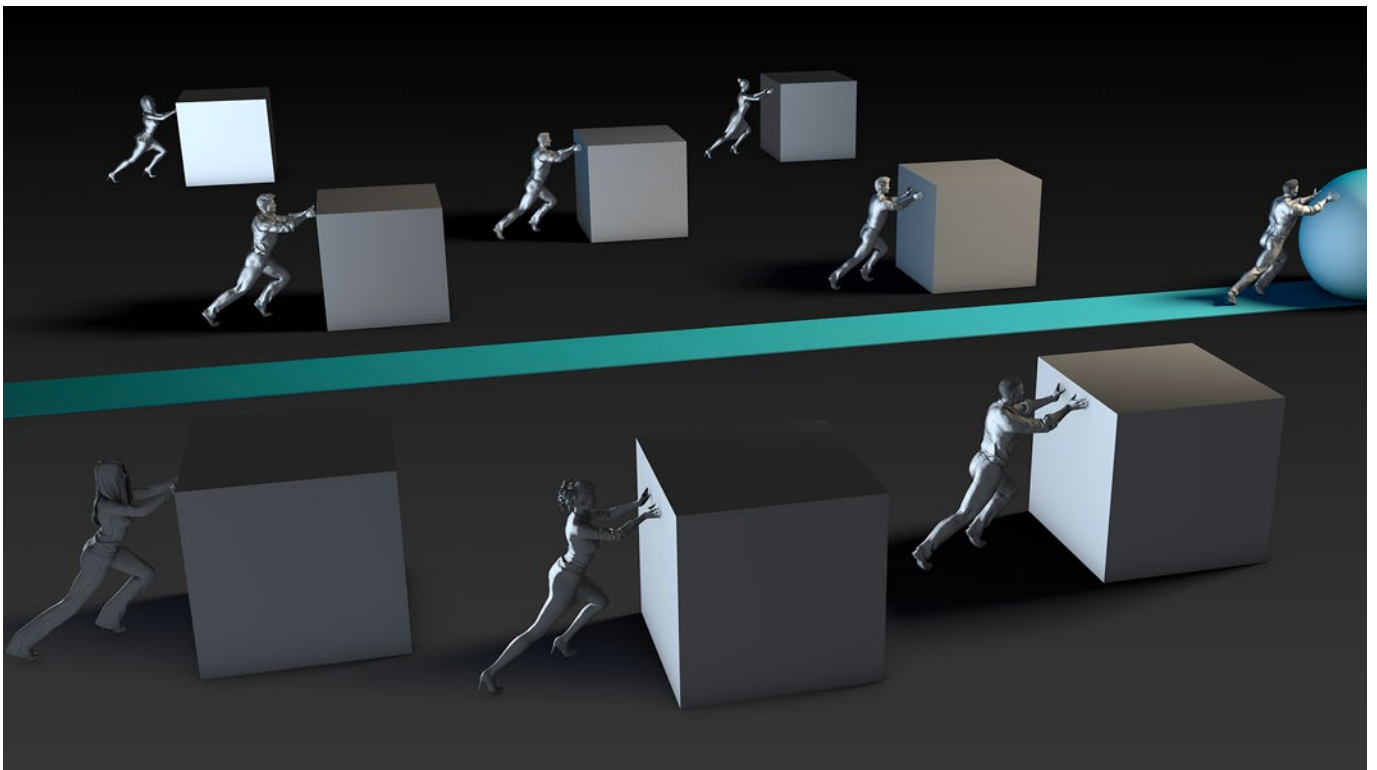
Feature Column by Michael Ford, AEGIS SOFTWARE

Are progress and evolution in the industry driven by collective hive minds, business opportunity, and thought leadership, or is it just through random events? I believe it's all the above. The real question about progress is better related to the strategy of how we balance differentiation with our contribution to common industry goals that bring about business opportunity, and then how we apply that same strategy to the tools and services that we use. Let's look both internally and externally into how we control and actively reduce risks and threats to our business.

Differentiation

The potential of a manufacturing operation is the sum of its assets and capabilities, including skills, location, size, expertise, and focus, as well as both the positive and negative effects of cumulative experience. Every operation is therefore unique and uses that to differentiate itself as it competes on conditions of quality, price, delivery, reliability, and trustworthiness.

As a business seeks to differentiate, external factors can influence and restrict the business. Success, therefore, rests on the ability to influence these external conditions, which are





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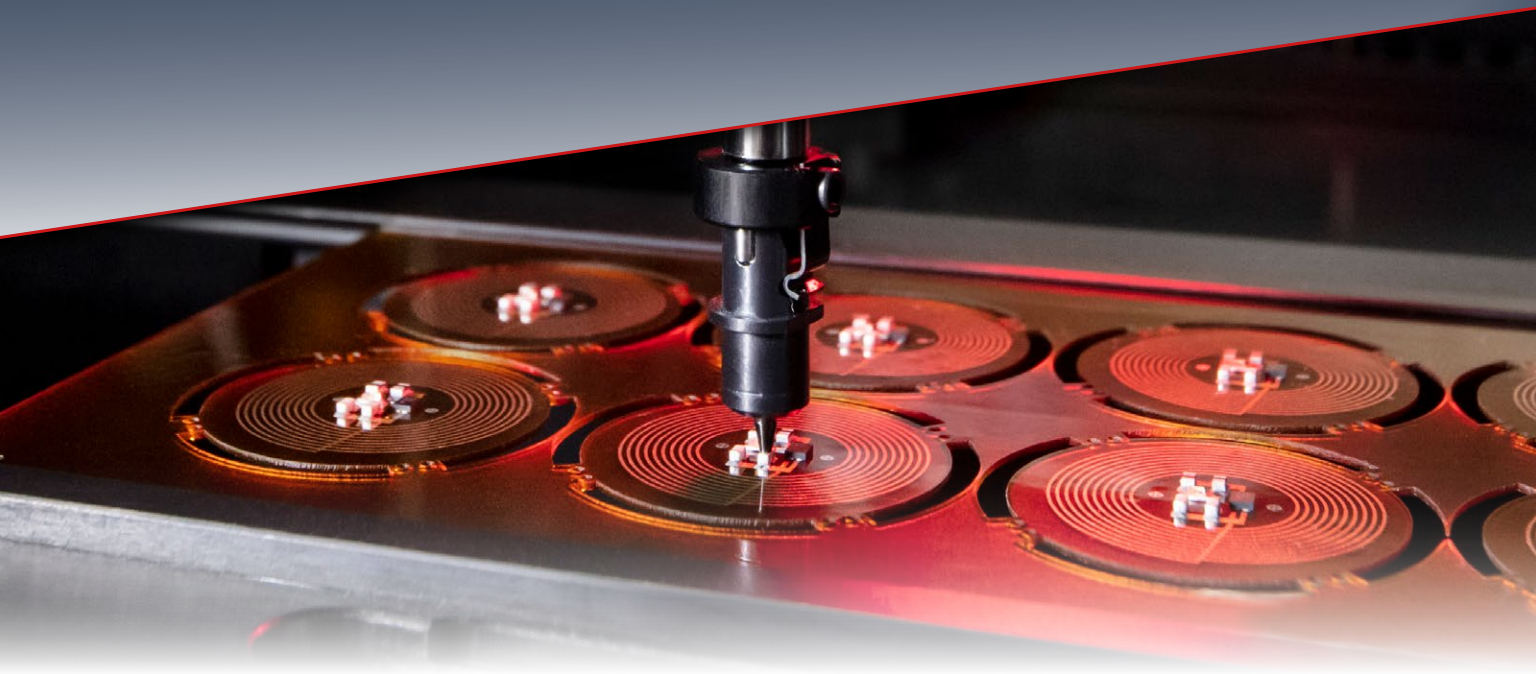
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usually common across peers in the industry. Simply reacting to trends and changes is too passive for companies seeking to succeed and expand, though most of these external issues cannot be directly influenced by a single, average company.

Let's look at the material supply network. A manufacturer in the U.S. or Europe—encouraged by government support for onshore manufacturing—is inspired by new automation technologies. For them, this is a sustainable business growth opportunity. But reality hits: The needed materials cannot be locally sourced. To access them, the materials must travel halfway around the world and likely from relatively unmanageable partners. Such risk often kills the best of local manufacturing business plans. Giving up is not an option, so how can the manufacturing supply network be motivated to locate onshore?

Giving up is not an option, so how can the manufacturing supply network be motivated to locate onshore?

Historically, to reduce logistics costs and by utilizing “just in time” (JIT), the supply network will follow the customer. Their investment will only be viable once a critical mass of material consumption business is available that spreads their risk to an acceptable level. Local manufacturing, however, must bear the additional costs and risk of remote material sourcing, so it's challenging for this to happen organically. To expedite this process, trade associations that represent both manufacturing and supply networks must work together. They should encourage local manufacturers to share their broad business plans and intents. Such representation works best with aggregation to

the regional and national levels, as trade associations can combine information in a way that protects the privacy and IP of individual companies; potential competitors will effectively be working together.

Community

This need not negatively impact the EMS business model, which competes based on business owners' material buying power. Localized manufacturing communities collectively drive the volume that reduces supply network relocation risk, whilst still allowing larger companies to negotiate individual, volume-driven pricing. The key point is that these two elements are not mutually exclusive.

Balancing differentiation vs. common goals is relevant to more than the upstream supply network and other external conditions; a similar strategy should be followed internally and downstream. Let's take an example of a machine vendor looking at their potential customer base. To be successful, the vendor must create machines that meet common requirements, while also supporting any significant residual needs required for different groups of customers, rather than customizing case by case. This allows the development and provision of technologies that support the evolution of the industry.

This is, by far, the most efficient and preferred method of the automation market, other than where specialized, bespoke functional test or mechanical assembly stations are required. It is important that such flexibility is easy for the customer to select, implement, and support, such as the case of an SMT placement machine, where the selection of different conveyor widths, number of stages and lanes, types of heads, feeders, cameras, nozzles etc., are available. The hardware automation market has evolved—and has proved itself in this respect—over hundreds of years. Though differentiated, most manufacturing operational needs, especially in electronics, have a very high degree of com-

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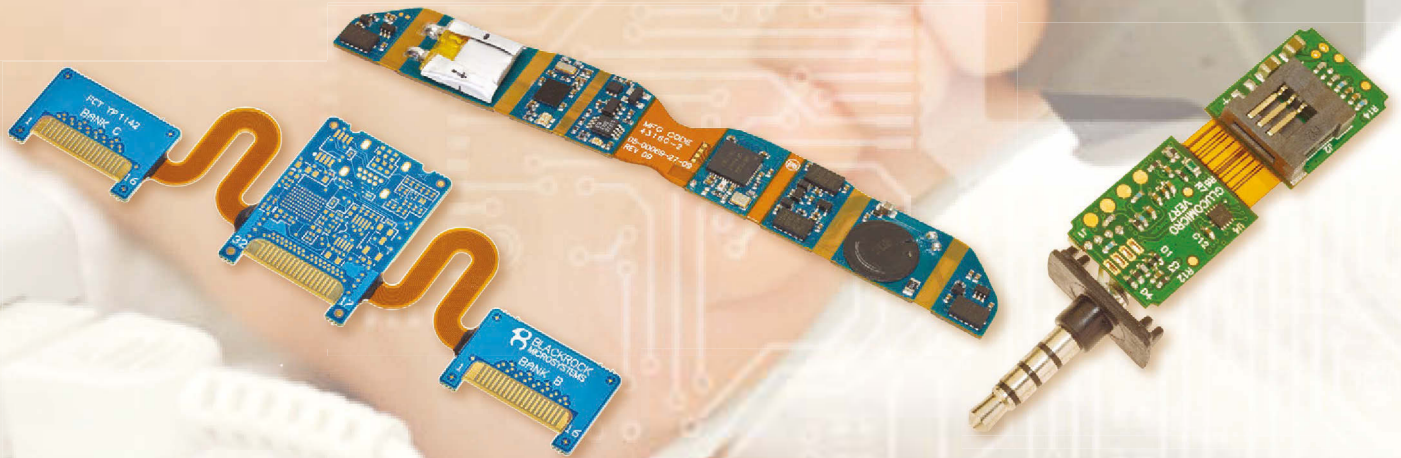
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monality, and are satisfied by common automation products.

The same principle should be true for software automation solutions (such as MES), but compared to hardware, the software industry is relatively new and still evolving. We see the same patterns emerging from many software automation providers—including those newly emerging in the industry. They follow immature product architectures that behave like those early, primitive, hardware solutions, and are based on continuously customized and bespoke development.

It is disappointing to see software automation solutions today where the customer is expected to develop bespoke code—including database queries that drive dashboards and reports—as well as some common functionality. It is worse still to see the perceived need in many manufacturers that drive them to develop solutions themselves.

Even the latest, simplistic “app-based platforms” perpetuate this at the low end of the market, which may represent a low initial investment and code development overhead, only to reveal the need for extensive coding, customization, and DIY data modelling after installation. This reveals the lack of value creation built into the solution’s data-model and architecture. Successful manufacturing cannot afford perpetual bespoke customizations from neither hardware nor software vendors, nor by having to do it themselves.

Composability

From a mature software automation solution perspective, differentiation is satisfied through composability—the easy way to tailor operational visibility, control, and data exchange—by simply selecting appropriate options and configuring built-in templates within the solution that meet the required needs. It is crucial that these can be altered at any time to suit multiple, simultaneously changing conditions and use-cases. Composability represents the lowest cost of flexibil-

ity, such that businesses can adapt and thrive, and differentiate themselves with the greatest of agility—without the cost and risks associated with customization. The fact that many companies use the same automated machine or software solution does not diminish their differentiation.

We must become smarter about how we approach change in the industry; we must be willing and able to influence conditions around us, as well as differentiate our business. Significant challenges continue to emerge due to evolving world conditions. We cannot afford to waste resources on planet-wide logistics and risk being locked into restrictive practices associated with product volumes expectations, nor to be endlessly customizing our solutions every time some change takes place.

As we look ahead, we see that in some areas we differentiate, while in others we benefit from a collective evolution. In the supply network, we enjoy volume-driven, pricing-based competitive differentiation, while working together to attract local low-risk suppliers. For hardware and software automation solutions, we use off-the-shelf industry hardware with supported options, and composable software automation solutions, eliminating the need for customization and self-coding. It is the best of both worlds.

Let’s all make a change to compete based on differentiation whilst also being respectful and responsible members of our manufacturing industry infrastructure. This will bring confidence to those who would invest in manufacturing reshoring initiatives. **SMT007**



Michael Ford is the senior director of emerging industry strategy for Aegis Software. To read past columns, [click here](#).



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Automation and Flexibility: Essential Components for Future-thinking EMS Companies

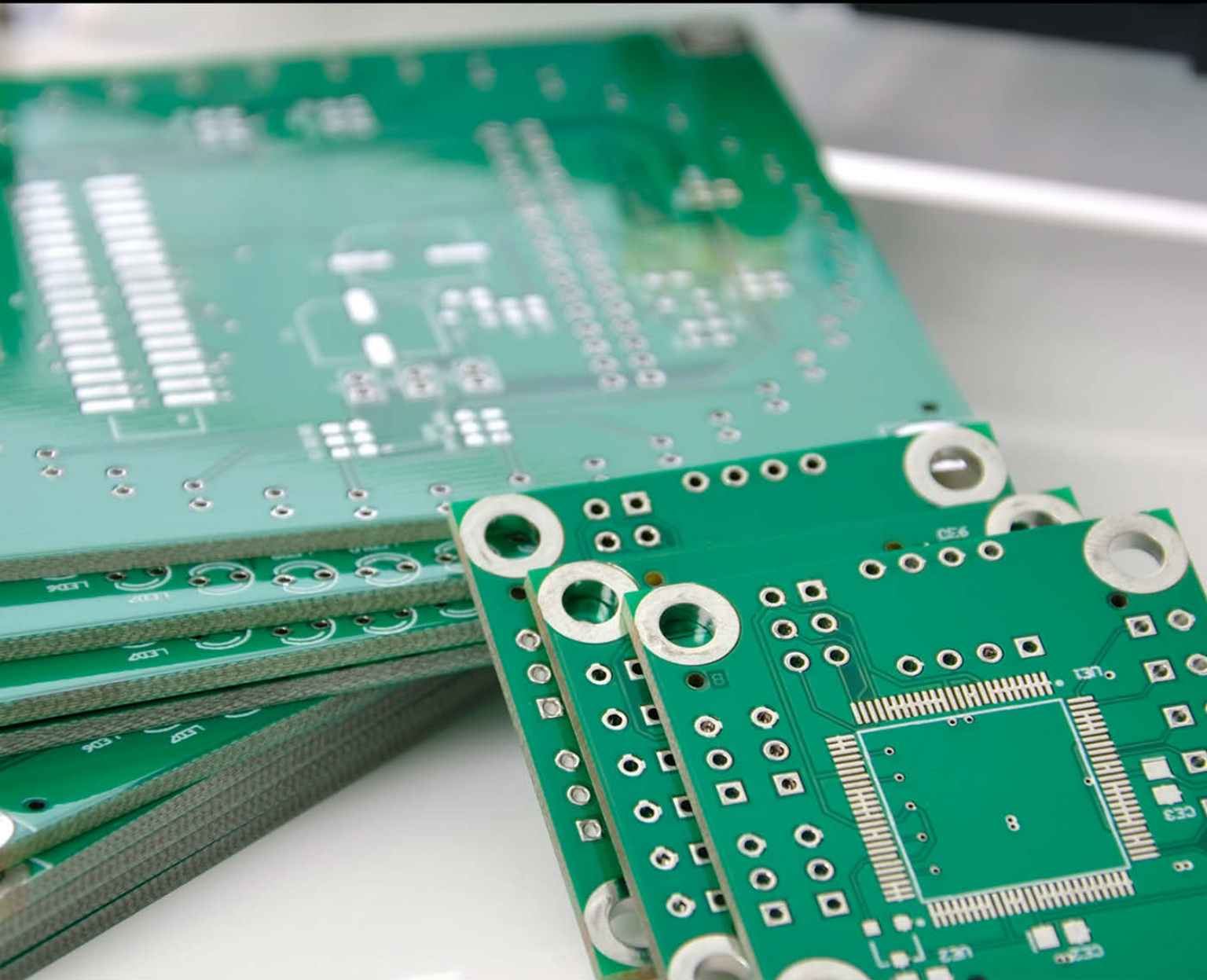
Feature Article by Norihiro Koike
SAKI CORPORATION

The near future for electronics manufacturing services is all about automation and flexibility. Three key factors affect EMS companies today: the high cost of labor, maintaining a reliable supply chain, and an increasingly high variety of products being manufactured. Quality trained personnel are essential and the supply of both product components and machine parts must remain stable despite a difficult geopolitical situation.

EMS providers in Europe and the U.S. continue to lead technologically, with manufacturers in China rushing to follow. The situation in China is changing. Once predominantly a major location for high-volume mass production, there has been a shift to high-end products primarily for domestic consumption,

and neighboring countries such as India are moving into the mass-production market. Now, for many traditional high-volume geographies, there is a greater need for customization in EMS manufacturing, with high-mix, low-volume production on the increase.

Saki is upbeat. The challenges for manufacturers are improved when automation and flexibility are given priority. Automation reduces labor-hours, improves both production efficiency and quality, and inspection solution providers are continually working toward offering an entirely automated inspection solution. To this end, solutions are being developed which unify hardware and software, an essential aspect for automation. With standardized hardware, parts management is significantly



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Norihiro Koike

easier, and costs are lowered in terms of both labor and consumables.

Software consistency means programs and operations are improved; training time and costs are reduced, day-to-day operations are smoother, equipment becomes simpler to use, and productivity increases. Collaborations with major solder print and pick-and-place machine manufacturers have ensured integrated operations and improved efficiency of not just the inspection machine alone, but the entire line.

For EMS companies, the variety of products produced is increasing, and with it comes a demand for greater flexibility in production planning as well as mass-producing the same product. We have entered an era where custom requests are driving the need for flexibility in the production itself. The conventional wisdom of setting specifications for AOI, AXI, and SPI at the time of purchase and simply allowing operations to continue for 10 years unadjusted is being overturned. Flexibility in production forces inspection machines to be flexible, too. It is driving the development for next-generation inspection machines, with models entering the market that allow customers to switch camera heads with ease, without hav-

ing to change the machine configuration of the line.

As a result, when the manufacturer's product changes, it is possible to change the resolution of the optical head of the inspection machine to match the inspection object requirements. This interchangeable camera ensures that the product life of the inspection machines is significantly extended beyond the previously typical 10 years. For example, it is currently possible to exchange two models of a camera—an 8 μm model ideal for use with 0201 mm components, and a 15 μm high-speed model—both with an extended height-measurement range; but of course, the latest

camera heads will be immediately installable as they are released. This adaptability allows the high-speed 3D inspection of a variety of component types and ensures Saki's inspection machines are never a bottleneck.

The realization of a highly accurate product platform improves the integrity of inspection. By applying this platform to the entire line, it is possible to reduce user labor-hours while maintaining the high-quality, high-performance results. Further, cost reductions can be achieved after the initial equipment introduction with the flexibility to upgrade, according to the customer's production situation and quality requirements.

All these sensibilities form the impetus for the development of total line inspection solutions. Available product ranges are increasingly being designed with hardware and software cohesion to provide a full product line quality assurance solution that is low maintenance, future-proof, easy to operate, and integrated with the third-party machines in the process.

The final piece of the puzzle? Artificial intelligence.

AI has become such a focus for many industries, including EMS companies, but under-



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standing how to properly develop AI processes, and where they might be of use, is a significant learning curve for all. A unified product platform design approach can take advantage of AI functionality, improving inspection quality and automation through the addition of advanced intelligent programming.

Already a successful AI inspection platform has been delivered to a Tier 1 automotive customer. The practical application of the same platform to EMS customers still has some obstacles to overcome thanks to the variation of the products and components. This has led Saki to reevaluate and redevelop these functions. Instead of passing the inspection itself over to the AI, Saki has been working to make the AI platform function more as an operator assistant, easing much of the workload while still involving a human element for improved accuracy through experience. Tests at customer sites have proven positive so far, and further work is currently underway in the field. Though we are in the early stages of integrated AI technologies, the benefits throughout Saki's systems are already showing. The

need for maintenance has dropped significantly, with the software able to assess prospective issues before they arise and advise the operator accordingly. Operator time is also reduced thanks to AI-assisted assessment of results, with initial set-up and programming also swifter.

Listening to the feedback from customers is the key to success. Already, our approach is resulting in significant improvements to manufacturing around the world. The required number of costly machine operators and maintenance staff has lessened, the cost involved in the supply of parts has diminished despite geopolitical difficulties, and inspection time across the range is significantly lower. This has made EMS production cheaper and more efficient in every way.

Through automation and flexibility, the inspection process for both present and future EMS customer needs is being modernized.

SMT007

Norihiro Koike is president and CEO of Saki Corporation.

New Quantum Computing Architecture for Large-scale Devices

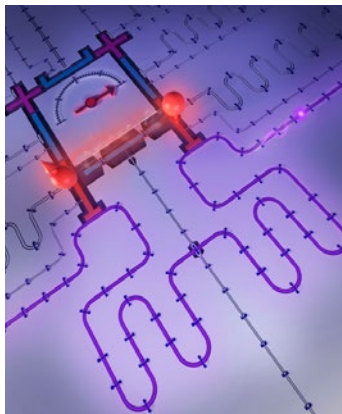
Quantum computers hold the promise of performing certain tasks that are intractable even on the world's most powerful supercomputers. In the future, scientists anticipate using quantum computing to emulate materials systems, simulate quantum chemistry, and optimize hard tasks, with impacts potentially spanning finance to pharmaceuticals.

However, realizing this promise requires resilient and extensible hardware. One challenge in building a large-scale quantum computer is that researchers must find an effective way to interconnect quantum information nodes—smaller-scale processing nodes separated across a computer chip. Because quantum computers are fundamentally different from classical computers, conventional techniques used to communicate elec-

tronic information do not directly translate to quantum devices. However, one requirement is certain: Whether via a classical or a quantum interconnect, the carried information must be transmitted and received.

To this end, MIT researchers have developed a quantum computing architecture that will enable extensible, high-fidelity communication between superconducting quantum processors. In work published today in *Nature Physics*, MIT researchers demonstrate step one, the deterministic emission of single photons—information carriers—in a user-specified direction. Their method ensures quantum information flows in the correct direction more than 96 percent of the time.

(Source: MIT News)



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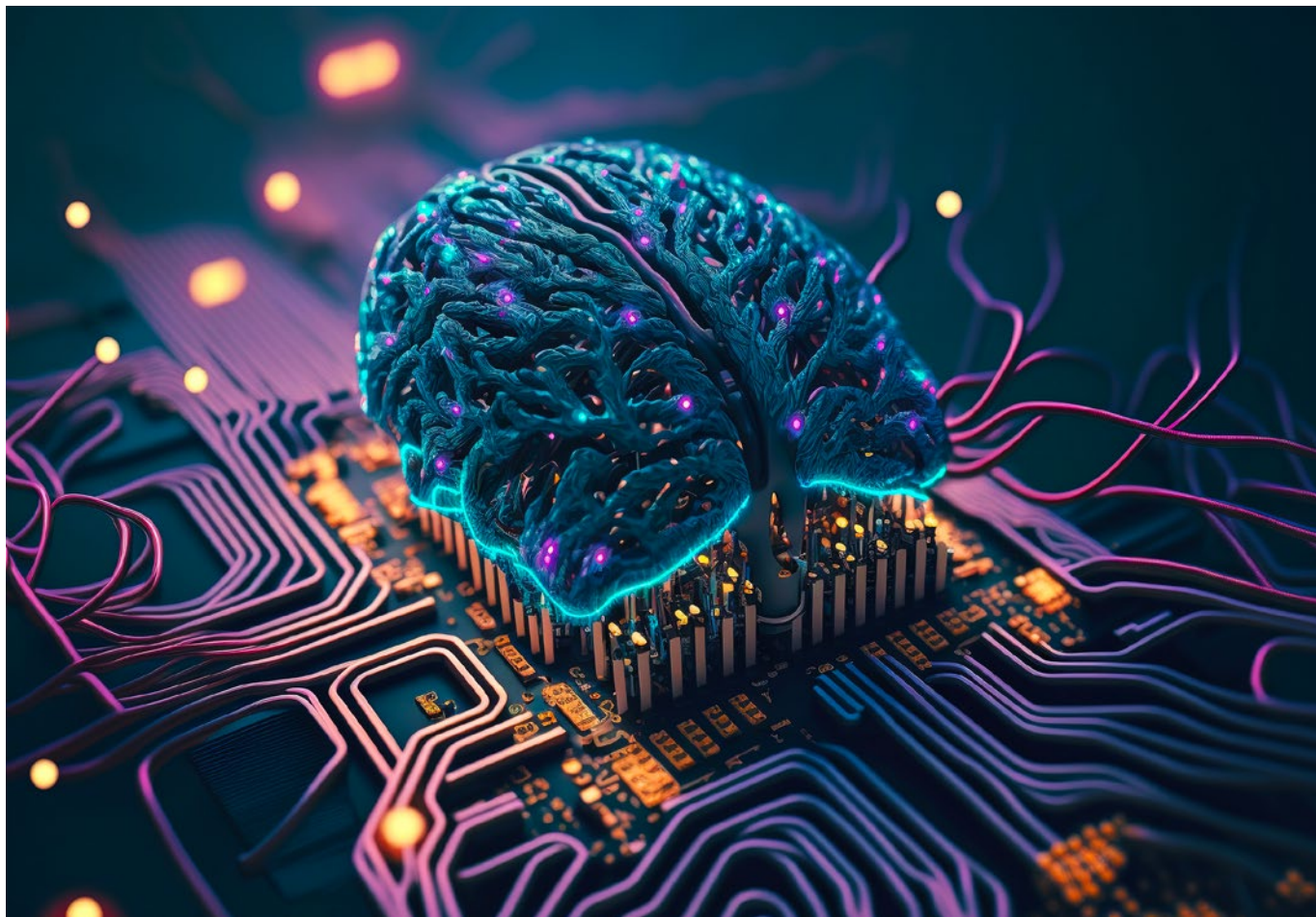
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Darwin AI: Evolving the Islands of Automation

Feature Interview by Nolan Johnson

I-CONNECT007

When Canadian artificial intelligence company Darwin AI was founded in 2017, machine learning and deep learning were still relatively new terms. In the past five years, CEO Sheldon Fernandez and his team have been working with this technology to develop some foundational IP to simplify implementation. About a year ago, Sheldon took a “part happenstance, part deliberate” opportunity to develop a vertical offering for EMS manufacturing. Here’s what happened.

Sheldon, it’s nice to meet you. Would you briefly introduce your company?

Sheldon Fernandez: We’re based out of Waterloo, Ontario, Canada, and we’re organically connected to the University of Waterloo, which is kind of like Canada’s MIT. Two of our co-founders are professors at the institution, including Professor Alexander Wong, Canada’s Research Chair in AI and Medical Imaging.

We’ve been working on foundational machine learning and deep learning technology for the past five years. A couple of years ago, our large industrial and aerospace clients were telling us about their supply chain challenges during the pandemic and reshoring sensitive electronics manufacturing work back to North America, specifically printed circuit

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Sheldon Fernandez

boards (PCB). We thought that created an opportunity for us.

When we looked at PCB manufacturing, it became apparent that while the SMT placement workflow was highly automated, there was a need in automating back-end production and final assembly. This laborious part of the process was where EMS companies and OEMs were still employing manual inspection. These inspection tasks are tough to crack from a traditional machine vision perspective, and we wondered, “Can AI bring anything to bear on this problem?” We spent about a year developing a hardware and software solution which fits into the typical assembly line for PCB manufacturing. It also does post-assembly analysis, and what’s really fascinating is how quickly an operator can program our product.

We often hear that AOIs are good at what they do but are laborious to program and maintain. With our system, there’s not a lot of manual work. You give the system a good (i.e., golden) board—or a couple of good boards if there’s a union of different components—and our AI system creates a map of where components should be in less than a minute; away you

go. You can tweak it after that, and it’s striking how quickly you can configure the product.

We brought our mini system to IPC APEX EXPO, and the response was fascinating. So many companies were intrigued by finally automating back-end production, and we’re really excited about becoming a part of the community.

There’s a lot of hype about ChatGPT, and what it can and can’t do. How does AI work in an industrial environment compared to AIs like ChatGPT?

When ChatGPT came to the forefront, I had been invited to appear on “The National,” which is the Canadian equivalent of “60 Minutes.” I commented that ChatGPT is remarkable in what it has achieved in terms of natural language understanding. I saw it as an important inflection point in AI that we—or our children—will look back and say, “That was the moment when something noteworthy happened.” ChatGPT is very good at generating language that human beings find convincing, but it doesn’t always contain useful or correct information. It uses a technology that is broadly termed “generative” AI; which is essentially, when AI generates artifacts for us. In this case, the artifact is language. (There’s also DALL-E, a technology that creates images from text.) For example, if you ask ChatGPT for information on an esoteric topic it will provide what sounds like a completely plausible answer. If you didn’t know the correct answer, you might be convinced that it’s the truth. This shortcoming is an extremely important caveat with the technology. That said, it is quite an accomplishment from the natural language perspective, and that will infiltrate many elements of work.

So, how does generative AI apply to an industrial context? Remember that AI requires data to learn. In our industry, it needs examples of defects that are valuable to detect in a manufacturing context (missing components, bad orientations, tombstones, etc.). Given

that many EMS companies run efficient processes, such anomalies—what we term “negative data”—can be difficult to obtain.

It turns out you can use the principles of generative AI to generate different types of defects, which in turn allows us to create an intelligent system. It is the kind of foundational technology that has enabled ChatGPT and will enable better AI for many industries, including our industry.

Finally, whereas a user cannot necessarily trust the output of ChatGPT, an operator can trust the results of our system by asking it to “explain” how it reached a particular conclusion.

How easily does Darwin AI integrate into an existing line? Do I need to be fully CFX-capable along my entire line? What’s the minimum threshold for bringing you in?

We fit right into existing manufacturing lines with inline, standalone, and benchtop solutions. The standalone and benchtop versions can be set up at an existing inspection station; the operator can put in the board and check it. With our inline version, boards can travel on a conveyor or sliding rail, so it integrates with existing PCBA machinery. The inline systems are SMEMA compatible. We’ll be adding CFX compatibility in the future. Although the boards vary, the machinery and workflow are consistent across different suppliers. It was important for us to create a modular solution that could scale across different customers.

In the past, golden boards could mess you up because if what you thought was your golden board inadvertently contained flaws, your acceptance criteria would now contain those flaws. Like our discussion of ChatGPT, you could end up building artificial intelligence on inaccurate input information. How do you mitigate that risk? What are the checks and balances?

There are a couple of things. First, we’ve noticed that some of our clients use two dif-

ferent but equally viable components that are acceptable in the context of the production line. They’ll give us multiple golden boards and want the union of that data set to be the source of truth. Second, our system can use a golden board that’s passed an ICT/functional test, reducing the risk of a flawed board. Our software allows the user to remove any components (e.g., through-hole components, connectors) that are not needed at a particular inspection point.

The system determines the ground truth extremely quickly and will detect all the components on the board, but there is still an operator verifying that everything was properly configured. He or she might then run some known flawless boards through the system to ensure functional correctness. We’ll never get away from a robust process—setting things up in a way that is significant and trustworthy. With an AI system, the difference is you can do this in less than an afternoon.

We’ll never get away from a robust process—setting things up in a way that is significant and trustworthy.

You have some recognizable customers on your list. How much can you quantify the efficiencies or ROI at the customer site?

Our clients are calculating the first-order benefits of the system: Is it doing a good job? Is it better or more precise? In terms of rework or eliminating rework cost, what is the benefit? Every time a board runs through our system, we take multiple pictures of it, and we find that, at the technological level, that’s exciting to thought leaders and executives. They say things like, “You’re making my line more



Darwin AI, VQI Mockup.

efficient, but what about the data I'm collecting? Can I now compare, say, line or plant efficiency?" The holistic analysis—the digitization—of this aspect of the workflow is quite exciting.

Right now, we're just deploying the system and quantifying the first-order benefits. But we hear from customers, asking if we can trace back to the root cause and address it in real-time. There's a lot of potential with this digitization element.

Let's look forward to when all these effects start to stabilize. What's your vision on the floor? How will this change staffing for an SMT line?

Artificial intelligence is wonderful at the things that humans are traditionally not good at: rote, laborious, repetitive work which, if we were asked to do it for 12 hours, would eventually

result in significant inefficiencies. So, why not supplant that work with artificial intelligence and automation, and redirect people to places where they will bring the creativity and the intuition of industry professionals to augment the automation you've introduced?

We envision multiple inspection points throughout the workflow. A quality engineer needs to make sense of the inspection trend data and to draw conclusions on how to avoid defects in the first place; the AI's job is to be exceptional at detecting defects.

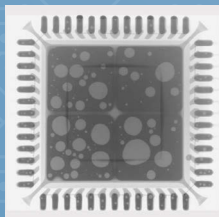
ChatGPT is an interesting analogy; I read an article that said ChatGPT illustrates the difference between writing and thinking. It can produce words that sound nice, but it doesn't understand what you're asking. Now transfer that analogy to our industry, where AI will give you all this data, but you need a learned professional to decide what it means. That

Pyramax Technology to Eliminate Solder Voids

Pyramax Vacuum

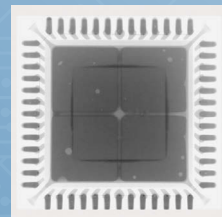


Vacuum reflow is a proven solution for PCB assemblies or products that require low solder voiding for critical performance applications. Pyramax Vacuum has been designed with the requirements of large EMS, OEMs and high-volume automotive segments in mind. The system features controlled heating within the vacuum chamber enabling industry leading thermal uniformity and the tightest control of liquidus time. Processing temperatures of up to 350°C can be achieved with vacuum levels lower than 20 Torr. Integrated controls and fully automatic vacuum operation are achieved via BTU's proprietary WINCON™ control system.



Traditional Reflow

Voiding occurs when flux or solder paste oxidation is entrapped in the solder joint. Shown here is an MFL processed with and without vacuum reflow. BTU's vacuum reflow solution is designed to reduce voiding to <5% (process dependent).



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said, just imagine all the data and insight that you will get from automation and what you can do with that in terms of design, traceability, efficiency, etc.

So, when AI gets it wrong, it can gaslight quite convincingly (laughs). My other take-away is that the staffing on an SMT line will probably be smaller, but better educated. We're moving toward more engineers than operators.

A quality engineer needs to make sense of the inspection trend data and to draw conclusions on how to avoid defects in the first place...

I used to say that, statistically, AI could perform better than human beings. But when it's wrong, it's egregiously wrong. You still need human beings to be a part of the process.

I would argue that a system like ours can be used by operators with less AI expertise than one might think. We're working with those operators now and asking them what they need to see and so forth. You don't need to be a coder or know a programming language, but you do need knowledge of PCBA defects: this is a tombstone; this is a bad solder joint, etc. That's probably where we're heading, to upskill an operator who's applying their domain expertise with an AI workflow.

That, and a well-thought-out user interface?

Yes, exactly. That's something we're proud of. We came from the enterprise world where we were used to very polished graphical UIs (user interfaces). At IPC APEX EXPO, some-

one called our system the iPhone of interfaces because it was just so simple; that's something we like to hear.

What are your customers hoping to achieve with this application of AI?

Some are looking to address concerns around labor; they have an aging workforce that is doing this work and they're concerned that they can't replenish it with younger workers. They're introducing automation to offset those concerns. Part of it is reduction in costs. We're also seeing the effects of the U.S. CHIPS Act, which is encouraging the movement of sensitive electronics manufacturing work to North America. If you want to compete with prices in the Far East, you need to bring more automation to your plant. The last one is increased throughput. If I have part of the workflow done by automation, I can get product out the door quicker. Of course, that speaks to anybody in our industry who needs to fulfill so many orders in a given amount of time.

Finally, there is a bit of cachet; some EMS houses like to say to their customers, "We're on the cutting edge. We're using the latest AI in this part of the workflow," to distinguish themselves from their competitors. That said, we're starting to see the substance behind the hype with the concrete results our clients are realizing.

Obviously, there is some consultation involved in the setup. Once the company decides to work with you, there's some system analysis to figure out what's already in place and what needs to be added to create a system. What is a typical setup for a customer from start to finish?

Our implementation team will come onsite with the system and help set it up. Our system will then undergo a site acceptance test to ensure it is ready for production, increases productivity, and is safe. They sort of believe it, but they need to see it working on their line.

After it is accepted, working it is quite simple, but we do offer ongoing support.

What are the purchase costs?

Roughly, it's a five-figure cost upfront with an annual license for the software, which gets you full support and software upgrades. Based on our experience, that's an order of magnitude less than AOI, which is typically six figures. We can offer this because we use low-cost, off-the-shelf hardware components. In addition to the AI, we have custom computational imaging algorithms that have been tailored to PCB image analysis. In addition to his AI work, Professor Wong, whom I mentioned earlier, has quite a deep background in computational vision and computational imaging algorithms. Under his guidance, our team developed significant proprietary IP for our solution.

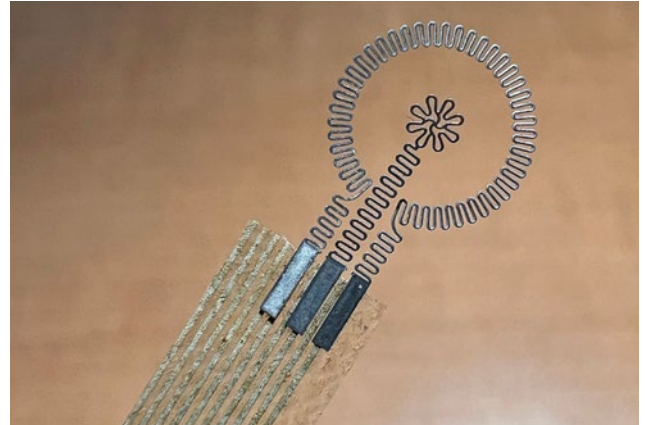
With AI technology such as this, why did you choose to specialize in the EMS market?

Every time we go to an EMS company and I meet a senior leader, I ask how they got into this. I'm so curious because not many people say, "Yeah, I'm going to manufacture printed circuit boards; that's what I want to do." For us, it was half happenstance; our clients were doing it and they identified a real need. We just saw it as a challenge. Nobody was doing it, so could we develop AI for it? That was fascinating to us. My wife is a psychiatrist, and she was trying to wrap her head around exactly what we've been doing. I explained to her how a PCB goes into almost everything, from the kettle that we just bought, to the toaster to our car. Imagine being able to generate these more efficiently; we're creating the manufacturing engine for the next wave of industries. That really appealed to us.

Thanks for the conversation, Sheldon.

My pleasure. Thank you. **SMT007**

First Transient Electronic Bandage Speeds Healing by 30%



Northwestern University researchers have developed a first-of-its-kind small, flexible, stretchable bandage that accelerates healing by delivering electrotherapy directly to the wound site.

In an animal study, the new bandage healed diabetic ulcers 30% faster than in mice without the bandage.

The bandage also actively monitors the healing process and then harmlessly dissolves—electrodes and all—into the body after it is no longer needed. The new device could provide a powerful tool for patients with diabetes, whose ulcers can lead to various complications, including amputated limbs or even death.

Nearly 30 million people in the U.S. have diabetes, and about 15 to 25% of that population develops a diabetic foot ulcer at some point in their lives. Because diabetes can cause nerve damage that leads to numbness, people with diabetes might experience a simple blister or small scratch that goes unnoticed and untreated. As high glucose levels also thicken capillary walls, blood circulation slows, making it more difficult for these wounds to heal. It's a perfect storm for a small injury to evolve into a dangerous wound.

The researchers were curious to see if electrical stimulation therapy could help close these stubborn wounds. By applying electrical stimulation, it restores the body's normal signals, attracting new cells to migrate to the wound bed.

(Source: Northwestern University)



MilAero007 Highlights



Printed Circuit Boards Have Champions on Capitol Hill ▶

House Resolution 7677 from the 2021/22 Congressional session may have run out of time before the election cycle, but that hasn't ended the effort to help fund the printed circuit board industry alongside the semiconductor industry. IPC vice president of global government relations, Chris Mitchell, shared a letter, sent to DOD by Reps. Anna Eshoo (D-CA) and Blake Moore (R-UT), which insists DOD must leverage all available resources to increase domestic production of PCBs and IC substrates.

Testing Todd: Turning Into the Wind ▶

The last three years have been a challenge, from the pandemic to the circus of shenanigans in Washington, neither of which have been pleasant. So, it's not hard to figure out why we are all in this current situation. We're not quite in a recession but rather a stagnation.

TTM Adopts Special Board Resolution with DCSA Replacing SSA ▶

The replacement of the SSA with the SBR is a result of the significantly reduced foreign ownership of TTM. The effective date of the SBR was February 2, 2023.

Nano Dimension Receives a Purchase Order from Another U.S. Government Defense Supplier ▶

Nano Dimension Ltd., a leading supplier of Additively Manufactured Electronics (AME) and multi-dimensional polymer, metal, and ceramic 3D printers, announced that it has received a purchase order from a supplier to

the U.S. government defense industry for a DragonFly IV, the leading Additive Manufacturing Electronics (AME) 3D-printer.

Amphenol Reports Fourth Quarter, Full Year 2022 Results ▶

Amphenol Corporation reported fourth quarter and full year 2022 results. Sales of \$3.239 billion, up 7% in U.S. dollars and 8% organically compared to the fourth quarter of 2021.

DARPA Collaborates with Commercial Partners to Accelerate Quantum Computing ▶

DARPA has selected three industry corporations for the Underexplored Systems for Utility-Scale Quantum Computing (US2QC) program. US2QC seeks to determine whether an underexplored approach to quantum computing is capable of achieving utility-scale operation—meaning its computational value exceeds its cost—much faster than conventional predictions.

Curtiss-Wright to Provide Actuation Technology Supporting Dynetics' Launcher System for U.S. Army ▶

Curtiss-Wright Corporation announced that it has been awarded a contract to support the new Enduring Shield platform from Dynetics, a Leidos company, to meet the U.S. Army's cruise missile defense needs.

Brigitflex Achieves AS9100D: 2016 ▶

Brigitflex has upgraded its QMS from ISO 9001: 2015 and received certification to AS9100D: 2016 from certifying body TÜV Rheinland.

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The EMS ‘State of The Union’

Feature Article by Mark Laing

SIEMENS DIGITAL INDUSTRIES SOFTWARE

We recently heard President Biden’s State of the Union address, and it got me thinking that perhaps now is a good time to look at our own post-pandemic “state of the union” in the electronics manufacturing services industry. I will describe several key issues that our customers around the world are facing as we move forward into a new normal.

Accelerated High-mix Trend and Part Availability Constraints

One trend that appeared prior to COVID (but has accelerated since) is the increase in the number of unique products being built—the move to higher product mix and variety. Instead of a single product being built in a day, higher mix facilities are building several unique products with smaller production

volumes. The line beat rate (Tact time of the line) becomes less important as the number of batches increases, and the changeover time becomes more significant.

The high-mix trend, together with supply chain issues, is driving a need for more agility in production schedules based on part availability. As product mix increases, part availability becomes a constraint to having unlimited agility to move from product to product.

Since companies are no longer able to acquire parts on demand as they did before the pandemic, they are forced to increase inventories and store components for future use. In addition, they are often driven to find alternative component sources, making the approved vendor lists (AVLs) more critical than ever. AVL management will also put additional



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pressure on communication channels between OEMs and EMS suppliers, as the initial AVL created by the OEM will need to be adjusted in real time based on actual component availability.

I also see further automation around component availability and purchasing as key to overcoming this challenge. There will be a movement toward component portals that deliver real-time data on stock levels and lead times for components rather than relying on manual methods that rely on human intervention. However, this is particularly challenging when it comes to semiconductors where AVLS focus mostly on passive and discrete components. Although simple logic devices can also form part of an AVL, it is the more complex components that are more specific, so less likely to have functional and fit replacements. Even if it is physically the same package, with the same number of pins, different pin outs can be common. It only takes one part to be unavailable to create the situation where the build can't be completed. This has led some OEMs to redesign products to remove dependencies on parts that are proving to be much harder to source. We have talked about design for manufacturing (DFM) for many years, but we may soon see specific designs being constantly adjusted for part availability. This will also contribute to the increase in higher-mix manufacturing.

Reshoring to the U.S.

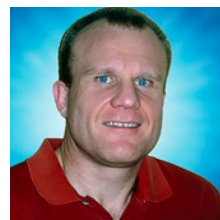
Another trend is the reshoring of electronics manufacturing to the United States or Mexico and away from China and the Asia Pacific region. Obviously, the labor costs are higher in the U.S. compared to Asia-Pacific, so being able to build products efficiently in the U.S. requires more digitalization and automation. Being able to efficiently create a digital twin of the product once and then using that twin to create the requirements for each machine in the line to reduce duplicate effort will be key to increasing U.S.-based production. With the increases in product mix, being able to effi-

ciently manage the changeovers will also be another critical element of U.S. manufacturing. Deeper partnerships between companies will be necessary to further integrate the different solutions needed to effectively manage higher mixes and their impact on changeovers. In practice this will mean earlier involvement for the EMS company with the OEM and getting more advanced notice of what will be needed. Maybe a footprint has been designed to only accept a single part but adjusting that a little allows another part to be substituted in its place. Now the EMS has a choice of two parts and either one will fit the board.

Further consequences of this reshoring will be the human resource requirements. Finding sufficient people to run a successful electronics assembly business, or any business for that matter, in the current economic climate is highly challenging. However, there are many incentives for companies to consider these paths. The recent U.S. Inflation Reduction Act affected how rebates for electric cars were calculated based on the amount of U.S.-sourced content. Although details are still being defined, expect to see other federal rebates being applied in similar ways to help drive more U.S. manufacturing.

Conclusion

Next year, IPC APEX EXPO moves back to Anaheim after several years in San Diego. My first one of these trade shows was in the mid-'90s in Anaheim, so I see it as coming full circle after over 25 years attending the event (missing only that one COVID year). We still have many challenges ahead as we navigate the "new normal" but given our collective capability, I'm sure we will overcome them together. **SMT007**



Mark Laing is a business development manager for Siemens Digital Industries Software.

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Source: I-Connect007



Finding Stability in the Supply Chain

Feature Interview by Nolan Johnson

I-CONNECT007

MacroFab is clearly on the grow. CEO Misha Govshteyn, speaking from the company's Guadalajara, Mexico, facility, shares that the company recently closed a second round of funding, bringing the total investment pool to just north of \$80 million. Second round investors include Foundry and BMW i Ventures as well as existing investors Edison Partners and ATX Venture Partners. They also just opened a 48,000 square foot plant in Houston, Texas.

Misha, we are focusing this issue on the “mind of the manufacturer.” What is your mindset? What worries you, but what opportunities do you see as well?

Misha Govshteyn: Many customers seem nervous about 2023. They look at the stock market; there's obviously been a decline there. Many are forecasting a recession and that has been reflected in their customer orders or lack of demand. However, our pipeline has never

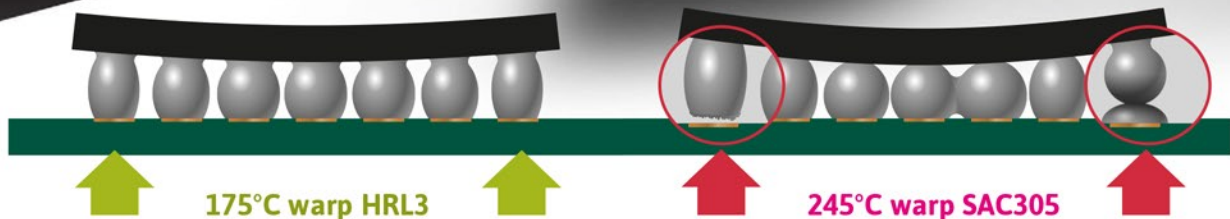
been higher and even if there were a recession, 50% of what we're doing now is reshoring/nearshoring. In fact, 25% of our pipeline is coming from Europe, which we've never seen before.

The European business is a new development, and our footprint is all over North America. We have over 100 factories in our network, which means we can move customers out of Asia to North American manufacturing when necessary. In some cases, it's purely based on where their product catalog will be a best fit. About 50% of the work ends up in the U.S., with the other 50% in Mexico. We are seeing more business gravitate toward North America for manufacturing. Even if there was a worldwide slowdown in demand, what's happening geopolitically has everybody rattled enough to where supply chain managers are looking for resiliency in their supply chain. While they're not moving out of China, they're looking for other options. They want to find a foothold in

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Misha Govshteyn

the North American market, including projects I've never seen before.

If something happens geopolitically in Taiwan, for example, the factory space in North America will be at a huge premium. From a cold start to a legal agreement to manufacturing ODM product in North America, it won't happen that quickly.

The bigger deal is worrying about whether the world will be stable or whether it's best to move manufacturing to a region unaffected by global instability. We hear that in almost all our conversations.

Is it fair to say that the geopolitical effect is a primary driver for your customers?

Yes. There was a switch six months ago; many are just resigned to a difficult sourcing situation for the next year or two.

Now, they're worried about the next shoe that will drop. Frankly, it all started when Russia invaded Ukraine. It seems unrelated, but that's what customers were sharing. These days, anything can happen. If you told me two weeks ago we would be talking about Chinese balloons, I would have said that's crazy, but that's where we are now.

Supply chain managers are probably no longer thinking that we'll go back to normal—that ship has sailed.

The overall view of the supply chain was starting to shift toward becoming resilient and multi-channel after COVID and that has only amplified, in my opinion.

But the real action is the quoting activity in the supply chain. The CEOs can say whatever they want on their earnings calls, but if they're not incentivizing their teams to diversify their supply chain, nothing will happen. We see that happening.

Is the reshoring activity coming from new projects, or are your customers bringing existing product back as well?

It's both. What we see is that if the contract is up for renewal, they'll run a competitive bid with a multitude of companies, including companies in North America. Off to the side, they'll whisper, "Just between us, we want you guys to win this."

It's a competitive process, but if it's in the range of 7–10% more than my Chinese counter-parts, they'll award that deal to North American companies. This may not last forever, but we are in a sellers' market right now. North America is in demand. That doesn't mean that we can do whatever we



want, but it does mean that we won't lose deals based on a 2-3% difference. The fully landed costs are more important.

For new launches, they will quote them worldwide with a preference for North America if they can make it work. If it's an existing project that's up for renewal, they start to look for North American options; again, nobody's pulling up stakes and moving out of China in an emergency. They're just working in a normal course of business.

What do you think the price elasticity is with respect to moving back? There seems to be a value worth paying for in supply chain resilience. Can we monetize that?

It's more expensive. Look, I ignored ESG (environmental, social, and corporate governance) as a topic until the last 12 months, but now it's showing up in bidding packages. They're asking not to just have a statement, but to certify that you're not using abnormally low-cost labor or abusive labor situations.

A lot of the ESG topics can now be measured with metrics. This is a new thing that I haven't seen until the last 12 months. It paints a picture for what's on the minds of our customers, that's for sure.

Are you tracking your impact of the broker market on this space?

I'm aware of one that was maybe \$1.2 billion before the pandemic; now, they're about \$5.5 billion.

On CNBC recently, Ford CEO Jim Farley described being under a lot of margin pressure. Who did he blame? The component brokers. I do believe the big winners in the supply chain crunch have not necessarily been EMS companies, but rather the secondary distribution and brokers taking the opportunity to improve their margins just a little bit. We certainly work with authorized distribution as a preference because we get the best price and the best support that way.



We get a guarantee of conformity in the product, and we don't have to worry about counterfeit parts, but I can't think of a single customer of significant size that we've built in the last two years for whom we didn't need at least some of their BOMs sourced from either unauthorized distribution or a parts broker.

We've had to build up our practice internally; we have a supply chain team that is now very good at sourcing broadly and in multiple theaters—both in the U.S. and Mexico. We shop through distribution in both places; we're thinking about setting up a distribution office for entering that market.

It sounds like your world view is that this sort of multiple channel sourcing isn't going away.

This is our new best practice. I'm getting it from the hyperscale server companies. Who does Foxconn build for? Apple, Google, anybody who's got a cloud. Where are they getting some of their parts? They have to get them from some of the brokers. The Ford CEO monitors his brokers because he knows they impact his margin.

The broker markets serve an important role. We buy from most of the reputable ones. It just changes the way you think about it. There are professionals who have been doing this for 20 years and it was a difficult mental switch for them because their whole career has been, "Don't buy from anyone other than authorized distribution."



But when you stick to authorized distribution in this market, BOM completion may take 12 months—sometimes 24 months. That’s just a non-starter for those companies. Many EMS companies made the adjustment to work with whomever found a part. The customers understand the risks; just give them a strategy to mitigate them.

How are you protecting your customers from counterfeits?

We may be a “new kid on the block” with venture funding, but we hire supply chain people who have been doing this for 20 to 25 years. In Houston, a lot of our staff comes from HP, Compaq, Foxconn, or Smith & Associates. Flex is big in Houston as well, so you need people who can find those materials that obviously look wrong, maybe where somebody in receiving can tell that the labels don’t look exactly like they expected.

We’re doing a lot more lab testing now that we are buying from secondary distribution, and in some cases, this stock may have been in a large factory somewhere for a couple of years. Maybe it was unused, and the parts are fine, but you still have to validate them. Depending on the parts, we might run everything from verifying that the parts are still usable, to wheel runs, solderability tests, and making sure that they will behave as expected. Obviously, customers must carry that cost; usually they’re

more than happy to pay because that’s the only way to move forward. But as you know, it causes major price increases for customers.

We’ve seen BOMs go up by 40%, and a few by 80%. I think many OEMs are just absorbing that cost. Secondary distribution of parts is where you run out of price elasticity.

This must have changed your data collection and tracking practices. We collect a lot more traceability data. We want that data to be in the cloud—to always be accessible. I think there’s a chance to innovate for a lot of EMS companies over the next five years.

The last 20 years have been nothing but a race to the bottom—the lowest possible price. Yes, there will be a space for innovation in the next 10 years.

Do you see that additional traceability as being a value to your customers? Do you have to sell that idea to them, or are they seeing the value of that all on their own?

We often associate traceability with downstream production requirements. Let’s say I work for BMW; it has a requirement for my supply chain to be traceable, and I must prove it.

We look at that as a mandated requirement. But if you ask the question a different way, we can make this information about which parts were used and in which production cycle available to you. Would that be useful? Yes. You do that through the traceability. It depends on how you describe that information.

I think the government can do a better job of mandating those things because it adds to the degree to which our manufacturing industry can innovate. Many will buy into that notion, but others will wait until they receive that requirement from their customers.

Misha, thank you for sharing your insights.

You’re welcome. I’m glad to talk about it. SMT007

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Vayo Technology on the Cutting Edge of SMT Manufacturing

Sponsored Interview by Edy Yu and Tulip Gu

Edy Yu and Tulip Gu recently spoke with Howard Liu, senior director of Vayo (Shanghai) Technology Co. Ltd, to discuss the development history of the company and its unique development strategies. The company, founded in 2005, is located in Kangqiao Advanced Manufacturing Technology Innovation Park, Pudong New Area, Shanghai.

Q As a leading PCBA process design simulation and manufacturing integrated industrial software supplier, what is Vayo's growth and development experience? Why does Vayo focus on this field?

A The company focuses on NPI (new product introduction) intelligent industrial software for the electronics industry to accelerate the process from electronic design to manufacturing. We advocate using digital electronic process design simulation software to help companies solve quality defects, starting with the design to improve the overall manufacturing capacity of the electronics industry. Vayo believes in "value for you" and the vision of "making design and manufacturing good products become the norm." We are committed to becoming a high-quality partner for companies to implement digital intelligent manufacturing.

Production in the SMT industry is highly automated, but pre-production process preparation is dependent on engineering and technical personnel. If there is no efficient software to assist with the daily complex and repetitive work, it is tiring for engineers. So, several of our like-minded partners targeted these industrial challenges by coming together to find tools that allow for greater efficiency for engineering and technical personnel in the SMT industry. Our goal is to develop intelligent, automatic, and poka-yoke tools to simplify the daily complex tasks of customers that will make their work easier and more efficient.

Vayo Technology now has a professional team of more than 90 people, and through more than 10 years of continuous research and development, it has overcome a series of technical challenges. Today, Vayo has a series of software products with more than 20 solutions, including DFM and SMT experts, a test expert, a stencil designer, and experts in document, view, and SPI. We have more than 40 invention patents at home and abroad, and our software has been used by more than 500 enterprises in more than 20 countries and regions around the world. Our application fields include communication networks, computer technology, consumer electronics, automobiles and their parts, rail transit, energy, security, medical treatment, industrial interconnection equipment, and education. Our user types include multinational companies, foreign companies, joint ventures, private companies, and various scientific research institutions.



Howard Liu

Q After 18 years of development, you have customers in many countries and are involved in many industries. What is the key strategy and exclusive approach of Vayo's development?

A For 18 years, we have been committed to studying various difficulties in the process of new product design and manufacturing, and developing various intelligent software tools to

help customers reduce errors, risks, and costs, as well as improve efficiency and quality. Our products have been recognized by many top OEM and EMS customers from various industries, and EMS customers are mostly the top enterprises in the world. In addition, we also have small- and medium-sized enterprises that focus on proofing as our customers.

Like every enterprise that strives for excellence, we have implemented two major development strategies: listening to customer needs and continuous innovation. On one hand, we often interact with customers, listening to how they use the software and where they would like to see improvement. We also analyze the challenges faced by the industrial development; we constantly explore new technologies, research new methods, and create better products. For example, the DFM product



adds about 50 new algorithms for rules every year, and the software architecture will be updated every two or three years to improve the operation speed and meet the increasing advanced process review requirements of products.

Q Vayo intelligent NPI software solutions include DFM manufacturability analysis, SMT intelligent placement programming, TEST expert test coverage analysis and quick programming, and stencil digital design software. Can you talk about the features and advantages of these main products? One of those is the DFM manufacturability analysis software, which won the 2019 IPC Global Science and Technology Innovation Award. Why did you receive the award and what are customers saying?

A So far, Vayo has developed more than 20 software products to meet the challenges of new product introduction. Each software has its own advantages.

First, our DFM manufacturability analysis software is a 3D solution. The DFM software won the IPC Global Science and Technology Innovation Award in 2019 because it was upgraded from 2D to 3D, there was a design process simulation analysis, and it filled a gap in the industry. Dr. John W. Mitchell, IPC president and CEO, personally presented this top award to us in San Diego, California. At that time, only five enterprises in the world won the award, and Vayo Technology was the only software company.

Second, Vayo SMT intelligent placement programming software uses a patented technology to create the interaction with the SMT



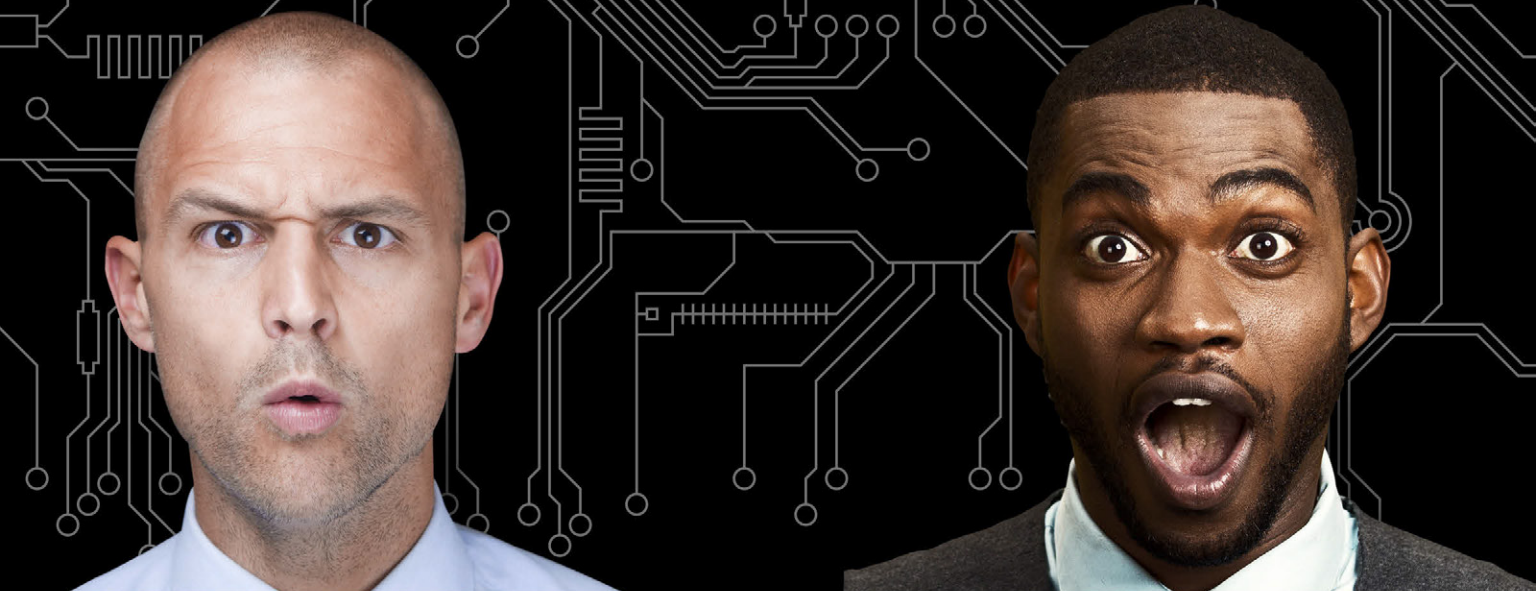
Figure 1: Dr. John W. Mitchell, IPC president and CEO, presented the 2019 IPC Global Science and Technology Innovation Award to Vayo Technology.

core device—SMT placement machine database, data mining and intelligent matching—which is completely different from the traditional approach, and innovatively solves the two major problems of placement programming. The first is the creation and preparation of component package, and the second is the confirmation of a mounting angle. This transformation of traditional manual programming into intelligent automation greatly shortens the programming time, improves the accuracy of the program to “get it right the first time,” and minimizes the production risk.

Third is the Vayo Test Expert, a test engineering analysis software that can optimize the test nail selection, conduct comprehensive test strategy analysis, efficient fixture reuse analysis, and quickly generate test programs so as to reduce the programming/debug cycle. In terms of flexibility, we have made unprecedented improvements. Test engineers can easily reply to various scenarios using our software. Currently, our solution is one of the sim-

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plest and most efficient test engineering analysis software solutions in the industry.

Finally, the Vayo Stencil Designer software digitalizes the core SMT process (solder paste printing/stencil) and helps the SMT factory transform into a digitalized knowledge base which then transfers experience among the entire team. The software automates the required preparation of solder paste stencil, ensures the quality of stencil, improves the soldering quality, automatically reviews the stencil design, and traces the usage of aperture for new products. It brings unprecedented management changes to SMT factories.

Q Over the years, your company continuously brings forth new upgrades. In the past two years, you have released new products such as CAM365 and the DFX Execution System. Do you have any other product plans?

A According to the industry trend of electronics manufacturing, we launch new product solutions every one to two years. For example, we were keenly aware that AOI transforming from 2D to 3D had become a trend, and AOI equipment programming was facing new challenges. Through dedicated research and development, we launched new intelligent programming software for 3D AOI equipment. Another example was for inkjet printing equipment, where there are programming difficulties in inkjet printing location and path.

Our R&D team overcame a series of technical problems and finally launched intelligent programming software.

CAM365 and DFX Design Execution System are new products we've launched in the past two years. The popular CAM software products used in the SMT industry are mainly for PCB fabrication, rather than for SMT factories. After field research on the habits of a large number of engineers, we launched the CAM365, a software made especially for SMT factories. It has many innovative functions, including an intelligent review of SMT process difficulties, automatic comparison of version differences, provision of stencil aperture templates, and optimization of traditional operation methods.

Another new product is the DFX Execution System, a web-based DFX/DFM/DFA tasks execution platform applicable to large R&D teams. It supports single- and multi-point deployment, and directly uploads DFX/DFM/DFA tasks without the need to install it. The system automatically accomplishes an analysis and can download result reports at any time. Moreover, it enables highly effective management functions for R&D managers, achieves easy access, an accurate analysis, and team efficiency management.

We have a couple of products still in the planning and development stage. For example, FAI Meta for first article inspection, Panel Meta for advanced panel design, and Fixture Meta for advanced fixture design. In addition to those application software products, we plan to launch the PCA digital process platform for large enterprise clients, integrating all our products into this platform, and allowing easier access for the entire team of large clients, and making the team management easier.

Q All industries are talking about intelligent manufacturing and digital transformation. How do you view these development trends and chal-





Vayo workstations.

lenges in the electronics manufacturing industry? How do we change and innovate?

A The managers of electronics manufacturing companies are constantly exploring intelligent manufacturing, trying to change and innovate. In the past, companies focused on industrial automation, such as introducing intelligent robots to replace production line workers. As they further explored intelligent manufacturing, some managers realized that “software is the key, and digitalization is the core” in intelligent manufacturing. Over the years, we have visited many SMT factories around the world and seen that various companies are making different attempts to achieve change and innovation. Our advice to these managers is to digitize the manufacturing process with the help of excellent software efficiency tools, so that the engineering team can work easily and efficiently.

Now the trend of the entire electronics manufacturing industry is to miniaturize the components and accelerate the iteration of new products. With this idea in mind, how do

we ensure the quality and stability of PCBA? This is a major challenge for SMT manufacturers. Also, how do we manage high staff turnover? This is a difficult problem faced by many.

Somehow, you want to digitalize SMT process knowledge with personnel experience. Engineers are using digital tool software to efficiently complete process preparation. This innovation will help SMT manufacturing enterprises to simplify management to the greatest extent and improve the work efficiency of the entire engineering team.

Based on the current digital transformation and intelligent manufacturing, we continue to explore and innovate, and is launching solutions that exceed customer expectations and industry needs. With comprehensive upgrades to global intelligent manufacturing, Vayo Technology upholds the spirit of craftsmanship, continues to focus on the field of NPI industrial software, and keeps moving forward. **SMT007**

Sponsored link: vayoinfo.com/en/

The Finishing Touch

Maggie Benson's Journey

by Dr. Ronald C. Lasky, INDIUM CORPORATION

Editor's note: Indium Corporation's Ron Lasky continues this series of columns about Maggie Benson, a fictional character, to demonstrate continuous improvement and education in SMT assembly.

Let's check in on Andy Connors and Sue March at Castellanos Electronics after Maggie and John's decision to buy the company. In our last episode, Sue was working on solutions to minimize solder defects that have been categorized in a Pareto Chart¹, whereas Andy was working on creating a training program to develop some process engineers and implementing an improvement plan developed by Chuck Tower and José Castellanos.

After working so hard to bring Castellanos Electronics up to speed, Sue and Andy decided

to go out to dinner by themselves for a change. They had often gone with José or some of the workers but thought they needed some time just for the two of them.

"Let's go see the new Tom Hanks movie, *A Man Called Otto*, after dinner," Sue enthusiastically suggested. "It's a cute romantic comedy."

"Since it's a *romantic* comedy, will you let me hold your hand?" Andy teased.

"Yes to the hand holding, but no necking," Sue teased back, and they both laughed.

"You know the movie probably has that subtitle thing going on again," Andy grumbled.

"We'll survive," Sue joked and punched his arm playfully.

Current movies from the U.S. were often played in English with Spanish subtitles at the theatre near the factory. Whenever they went



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to see a film, Andy and Sue would both get distracted reading the Spanish and then, if the translations were off, would let out a sigh.

At dinner, they discussed how the work was going at Castellanos Electronics, as they had only a little over a week to wrap things up.

“With José and some of his team, we have implemented the process improvement opportunities that Chuck and José identified. The new solder paste that has excellent response-to-pause has really helped improve productivity,” Andy began.

Sue asked, before taking a bite of her meal, “You were also working on line balancing, right?”

“Yes, surprisingly, their uptime wasn’t too bad, but the lines were almost never time balanced for the component placement machines,” Andy replied. “By time balancing the placement machines, production improved 8%. There was one case where the chip shooter was taking 55 seconds and the flexible placer only 26 seconds, meaning cycle time was 55 seconds. By mov-

ing some components off the chip shooter to the flexible placer, each machine needed only 47 seconds—a time savings of about 15%.” He then shifted the conversation to ask Sue about her progress. “How’s it going on the Pareto chart?” (Figure 1)

“We’ve made significant progress on graping, head-in-pillow (HIP), voiding, and insufficients, and we have only tombstoning left to work on. In all cases so far, we have reduced defects by 90% or more,” Sue said excitedly.

“So, what is your plan for tombstoning? I’m interested, since I don’t know much about it,” Andy said.

“Tombstoning occurs in the reflow oven when one side of a passive solder paste deposit melts before the other side and the surface tension of the melted solder pulls the passive upright like a tombstone,” she said. (Figure 2)

“So, we either have to prevent the one side from melting too rapidly or reduce the surface tension forces?” Andy asked.

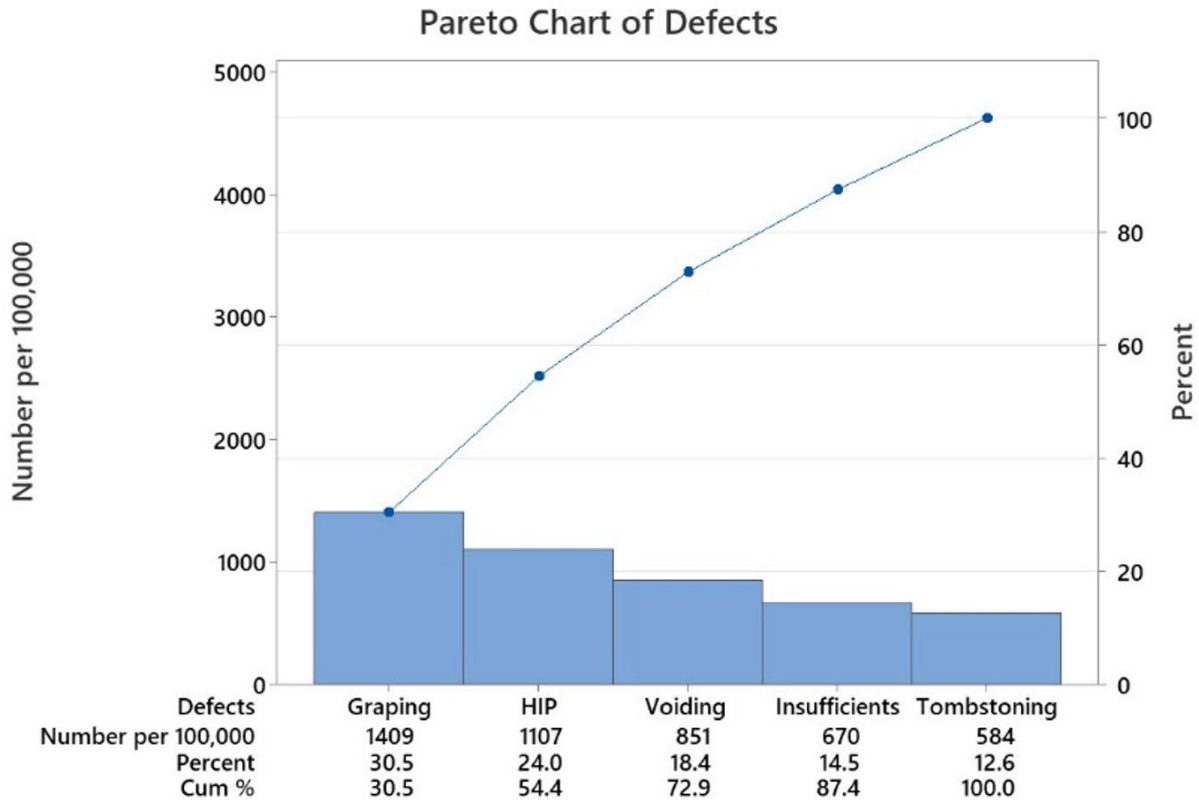
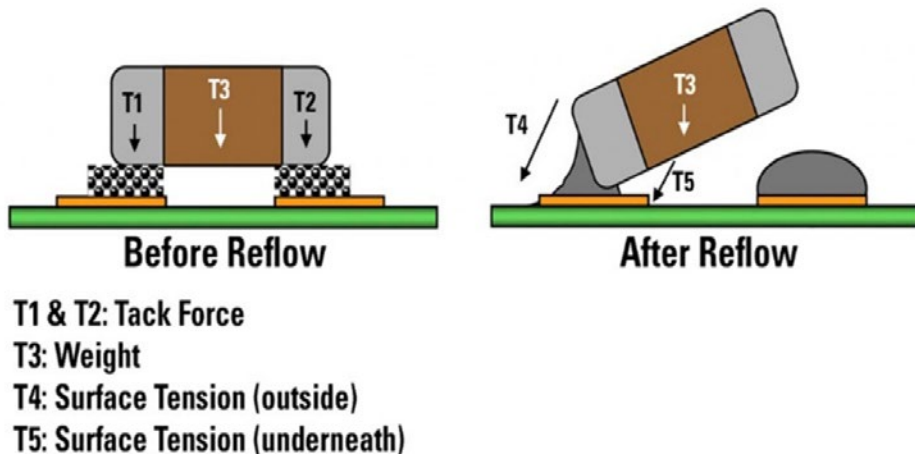


Figure 1: A Pareto chart of defects at Castellanos Electronics.



T4 is significantly higher using SnPb solder paste

Figure 2: The mechanism of tombstoning of a passive component.

“Good start, Einstein!” Sue said, laughing. “It helps to have a solder alloy that has a ‘pasty range,’ meaning that it doesn’t completely melt at one temperature. Since we use SAC305, which has a reasonable pasty range, we can’t improve too much in that regard.”

She continued, “Beyond the pasty range, we can try ensuring that the solder paste deposits are the same amount on each side of the passive and that the components are placed squarely with no skewing. I’m going to ask Miguel to check those things out first.”

“So, if addressing those things doesn’t solve tombstoning, we’ll have to reduce the surface tension forces some other way?” Andy asked.

“Yes, we could modify the reflow profile so that the melting is slower, but that might negatively affect graping,” Sue said.

“However, we should look into it.”

After thinking a while, she continued, “Modifying the stencil would help a lot, but that would be an added expense and we should only do that if all else fails.” She then showed him an image of a proposed stencil. (Figure 3)

“It’s quite easy to see how the stencil would work,” Andy said, excitement building in his voice. “There is almost no paste on the edges of the passive, so there is almost no paste to cause

the tombstoning effect.”

They chatted for a few more minutes about Sue’s efforts, then she questioned, “How is the training going on your end?”

“We’re just about finished,” he replied with confidence. “I’ve covered all the material in the *Handbook of Electronic Assembly*². I think they

0402 Stencil Aperture Openings

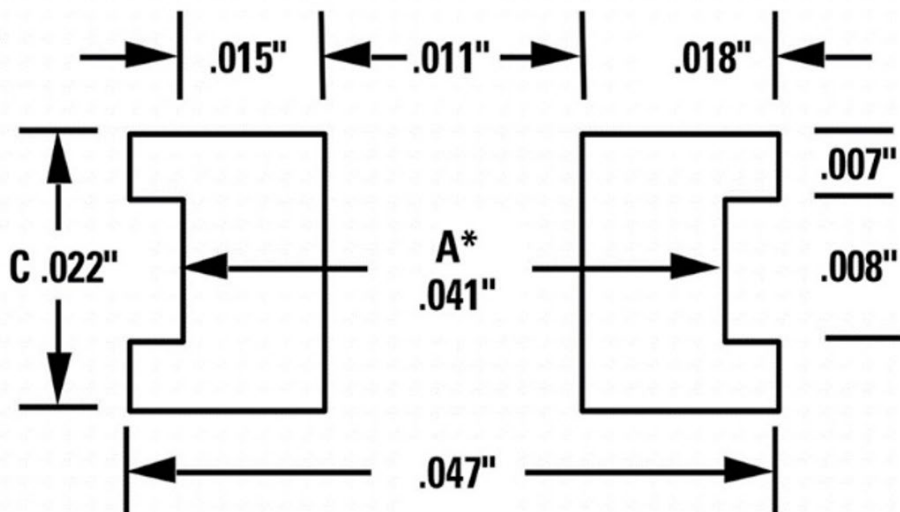


Figure 3: A stencil designed to reduce tombstoning of passive components.

are well-prepared for the SMTA Certified Process Engineer's exam³. As a matter of fact, I just gave them three practice quiz questions and they teased me that they were too easy."

"What were the questions?" Sue asked.

He then shared these three questions:

1. What is the area ratio of a 15 mil-round aperture in a 5-mil-thick stencil?
2. A PWB is presented to the reflow oven every 40 seconds. The PWB is 20 cm long and a 5-cm spacing is desired between the PWBs. What must the belt speed on the reflow oven be to support this 40-second cycle time?
3. The PWB in question 2 must be in the heated tunnel of the oven for four minutes. How long must the heated tunnel be?

"If they think those questions are easy, that's really promising," Sue said of the staff members in training. "I think many people would find them challenging."

Epilogue

Sue and Andy finished all their assignments at Castellanos Electronics. All the workers who took the SMTA Process Engineer Certification exam passed with flying colors. Defects

were reduced by 90% overall. The best news was that the team of workers now had the skills to run the factory when José wasn't there and could also handle new yield, productivity, and quality issues on their own. Since he could now take an occasional vacation, José agreed to stay on as the factory manager, reporting to Maggie and John.

Tune in to the next episode to find out the solutions to Andy's three problems. **SMT007**

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1. "Pareto chart," Wikipedia.org, Sept. 17, 2022.
2. *Handbook of Electronic Assembly and A Guide to SMTA Certification*, by Ron Lasky et. al, SMTA Publishing.
3. "SMTA: Certification," SMTA.org.



Ronald C. Lasky is an instructional professor of engineering for the Thayer School of Engineering at Dartmouth College, and senior technologist at Indium Corporation. To read past columns, [click here](#).

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Can you solve the three questions above? The first person to send me an email with all three answered correctly will win a Dartmouth sweatshirt. Send your answers to Dr. Ron at rlasky@indium.com.



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The Government Circuit: Building Industry Resilience in 2023

As the 118th U.S. Congress begins, we at IPC look forward to working with members of both parties to ensure the electronics manufacturing industry's long-term success by advancing policies that increase innovation, investment, and growth. We're looking forward to improving on our successes and, with your help, we hope to achieve even more victories for the entire electronics manufacturing industry.

Bright Lights, Big City: STEM Event Kicks Off

The San Diego sun was warm and bright on Wednesday afternoon, but it didn't stop the crowds from filling the aisles at IPC APEX EXPO 2023 for the trade show's second official day. Technical conferences, professional development courses, and a keynote from IPC President and CEO John W. Mitchell kept attendees busy. But the real highlight of the day was upstairs where approximately 300 high school students from the local San Diego area arrived for



a day full of activities meant especially for them.

Real Time with... IPC APEX EXPO 2023: Positioning in the Market

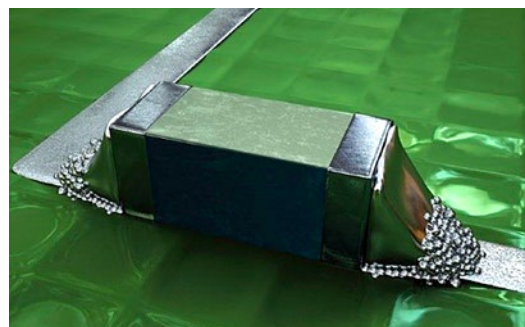
Mycronic's Kevin Clue shares with guest editor Jesse Vaughan new innovations in Mycronic AOI and their position in the dispensing/coating equipment market.



As a leading global partner for flexible PCB assembly solutions, Mycronic continues to respond to growing customer demand for standardized software integration and state-of-the-art inspection technologies. The company has introduced major advances in 3D inspection technologies and factory connectivity.

Maggie Benson's Journey: Fair and Square

This month in the ongoing saga of Maggie Benson's Journey, Sue March and Andy Connors choose to remain in Mexico after the purchase of Castellanos Electronics to help Chuck Tower coordinate the company's transition.



Winners of IPC Hand Soldering Competition at Southern Manufacturing & Electronics 2023 Announced



In conjunction with Southern Manufacturing & Electronics 2023, IPC hosted the UK regional Hand Soldering Competition in Farnborough, UK, February 7-9, welcoming 27 competitors from 20 European electronics companies.

Coreen Blaylock, Lockheed Martin Missiles and Fire Control, Earns IPC Excellence in Education Award

In recognition of her significant contributions and leadership in workforce development while building a culture of continuous learning within her organization and the electronics industry, Coreen (Cory) Blaylock, Lockheed Martin Missiles and Fire Control, earned an IPC Excellence in Education Award at IPC APEX EXPO 2023.

Real Time with... IPC APEX EXPO 2023: Connecting the Digital Thread

Jason Spera of Aegis Software has an interesting conversation with Nolan Johnson focused on Lean material management and composable architecture. Key topics included their new PLC gateway, material management systems, and the emerging concept of composability.

KYZEN Recognized Its Top Sales Representatives During IPC APEX EXPO



KYZEN, the global leader in innovative environmentally friendly cleaning chemistries, announced its '2022 Representatives of the Year' during the recent IPC APEX EXPO at the San Diego Convention Center in California.

North American EMS Industry Down 2.7% in December

IPC announced the December 2022 findings from its North American Electronics Manufacturing Services (EMS) Statistical Program. The book-to-bill ratio stands at 1.36.

BTU Announces 'Rep of the Year' Awards Before the Start of IPC APEX 2023

BTU International, Inc., a leading supplier of advanced thermal processing equipment for the electronics manufacturing market, announced its 'Rep of the Year' Awards during a sales meeting and dinner on Monday, January 23, 2023, before the start of IPC APEX EXPO.



Ivan Romo, SMarTech Technologies and Chris Heesch, BTU

Jason Wahba, The JW Corporation and Isaiah Smith, BTU

James Lyndon, EAP Inc., and Chris Heesch, BTU

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DETAILS OF FUNCTION:

- Develops and maintains strategic partner relationships
- Manages and develops sales reps:
 - Reviews progress of sales performance
 - Provides quarterly results assessments of sales reps' performance
 - Works with sales reps to identify and contact decision-makers
 - Setting growth targets for sales reps
 - Educates sales reps by conducting programs/seminars in the needed areas of knowledge
- Collects customer feedback and market research (products and competitors)
- Coordinates with other company departments to provide superior customer service

QUALIFICATIONS:

- 5-7+ years of related experience in the manufacturing sector or equivalent combination of formal education and experience
- Excellent oral and written communication skills
- Business-to-business sales experience a plus
- Good working knowledge of Microsoft Office Suite and common smart phone apps
- Valid driver's license
- 75-80% regional travel required

To apply, please submit a COVER LETTER and RESUME to: Fernando Rueda, Americas Manager

fernando_rueda@kyzen.com

[apply now](#)

Career Opportunities



Application Engineer

Flexible Circuit Technologies (FCT) is a global supplier providing design, prototyping and production of flexible circuits, rigid flex circuits, flexible heaters and full assembly services.

Responsibilities

- Gain understanding for customer/specific project requirements
- Review customer files, analyze - application, design, stack up, materials, mechanical requirements; develop cost-effective design to meet requirements
- Quote and follow up to secure business
- Work with CAD: finalize files, attain customer approval prior to build
- Track timeline/provide customers with updates
- Follow up on prototype, assist with design changes (if needed), and push forward to production
- Work as the lead technician/program manager or as part of FCT team working with an assigned application engineer
- Help customer understand FCT's assembly, testing, and box build services
- Understand manufacturing and build process for flexible and rigid-flex circuits

Qualifications

- Demonstrated experience: flex circuit/rigid-flex design including design rules, IPC; flex heater design +
- Ability to work in fast-paced environment, broad range of projects, maintain sense of urgency
- Ability to work as a team player
- Excellent written and verbal communication skills
- Willing to travel for sales support and customer support activities if needed

Competitive salary, bonus program, and benefits package. Preferred location Minneapolis, MN area.

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Technical Marketing Engineer

EMA Design Automation, a leader in product development solutions, is in search of a detail-oriented individual who can apply their knowledge of electrical design and CAD software to assist marketing in the creation of videos, training materials, blog posts, and more. This Technical Marketing Engineer role is ideal for analytical problem-solvers who enjoy educating and teaching others.

Requirements:

- Bachelor's degree in electrical engineering or related field with a basic understanding of engineering theories and terminology required
- Basic knowledge of schematic design, PCB design, and simulation with experience in OrCAD or Allegro preferred
- Candidates must possess excellent writing skills with an understanding of sentence structure and grammar
- Basic knowledge of video editing and experience using Camtasia or Adobe Premiere Pro is preferred but not required
- Must be able to collaborate well with others and have excellent written and verbal communication skills for this remote position

EMA Design Automation is a small, family-owned company that fosters a flexible, collaborative environment and promotes professional growth.

Send Resumes to: resumes@ema-eda.com

[apply now](#)

Career Opportunities



MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

Pluritec North America, Ltd., an innovative leader in drilling, routing, and automated inspection in the printed circuit board industry, is seeking a full-time field service engineer.

This individual will support service for North America in printed circuit board drill/routing and X-ray inspection equipment.

Duties included: Installation, training, maintenance, and repair. Must be able to troubleshoot electrical and mechanical issues in the field as well as calibrate products, perform modifications and retrofits. Diagnose effectively with customer via telephone support. Assist in optimization of machine operations.

A technical degree is preferred, along with strong verbal and written communication skills. Read and interpret schematics, collect data, write technical reports.

Valid driver's license is required, as well as a passport, and major credit card for travel.

Must be able to travel extensively.

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ventec

INTERNATIONAL GROUP

騰輝電子

European Product Manager Taiyo Inks, Germany

We are looking for a European product manager to serve as the primary point of contact for product technical sales activities specifically for Taiyo Inks in Europe.

Duties include:

- Business development & sales growth in Europe
- Subject matter expert for Taiyo ink solutions
- Frequent travel to targeted strategic customers/ OEMs in Europe
- Technical support to customers to solve application issues
- Liaising with operational and supply chain teams to support customer service

Skills and abilities required:

- Extensive sales, product management, product application experience
- European citizenship (or authorization to work in Europe/Germany)
- Fluency in English language (spoken & written)
- Good written & verbal communications skills
- Printed circuit board industry experience an advantage
- Ability to work well both independently and as part of a team
- Good user knowledge of common Microsoft Office programs
- Full driving license essential

What's on offer:

- Salary & sales commission--competitive and commensurate with experience
- Pension and health insurance following satisfactory probation
- Company car or car allowance

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits. Please forward your resume to jobs@ventec-europe.com.

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Career Opportunities



Technical Service & Applications Engineer Full-Time — Midwest (WI, IL, MI)

Koh Young Technology, founded in 2002 in Seoul, South Korea, is the world leader in 3D measurement-based inspection technology for electronics manufacturing. Located in Duluth, GA, Koh Young America has been serving its partners since 2010 and is expanding the team with an Applications Engineer to provide helpdesk support by delivering guidance on operation, maintenance, and programming remotely or on-site.

Responsibilities

- Provide support, preventive and corrective maintenance, process audits, and related services
- Train users on proper operation, maintenance, programming, and best practices
- Recommend and oversee operational, process, or other performance improvements
- Effectively troubleshoot and resolve machine, system, and process issues

Skills and Qualifications

- Bachelor's in a technical discipline, relevant Associate's, or equivalent vocational or military training
- Knowledge of electronics manufacturing, robotics, PCB assembly, and/or AI; 2-4 years of experience
- SPI/AOI programming, operation, and maintenance experience preferred
- 75% domestic and international travel (valid U.S. or Canadian passport, required)
- Able to work effectively and independently with minimal supervision
- Able to readily understand and interpret detailed documents, drawings, and specifications

Benefits

- Health/Dental/Vision/Life Insurance with no employee premium (including dependent coverage)
- 401K retirement plan
- Generous PTO and paid holidays

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Arlon EMD, located in Rancho Cucamonga, California, is currently interviewing candidates for open positions in:

- Engineering
- Quality
- Various Manufacturing

All interested candidates should contact Arlon's HR department at 909-987-9533 or email resumes to careers.ranch@arlonemd.com.

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

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2015 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customers' requirements.

For additional information, please visit our website at www.arlonemd.com

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Career Opportunities

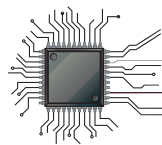


Are You Our Next Superstar?!

Insulectro, the largest national distributor of printed circuit board materials, is looking to add superstars to our dynamic technical and sales teams. We are always looking for good talent to enhance our service level to our customers and drive our purpose to enable our customers to build better boards faster. Our nationwide network provides many opportunities for a rewarding career within our company.

We are looking for talent with solid background in the PCB or PE industry and proven sales experience with a drive and attitude that match our company culture. This is a great opportunity to join an industry leader in the PCB and PE world and work with a terrific team driven to be vital in the design and manufacture of future circuits.

[apply now](#)



MivaTek

Global

Field Service Technician

MivaTek Global is focused on providing a quality customer service experience to our current and future customers in the printed circuit board and microelectronic industries. We are looking for bright and talented people who share that mindset and are energized by hard work who are looking to be part of our continued growth.

Do you enjoy diagnosing machines and processes to determine how to solve our customers' challenges? Your 5 years working with direct imaging machinery, capital equipment, or PCBs will be leveraged as you support our customers in the field and from your home office. Each day is different, you may be:

- Installing a direct imaging machine
- Diagnosing customer issues from both your home office and customer site
- Upgrading a used machine
- Performing preventive maintenance
- Providing virtual and on-site training
- Updating documentation

Do you have 3 years' experience working with direct imaging or capital equipment? Enjoy travel? Want to make a difference to our customers? Send your resume to N.Hogan@MivaTek.Global for consideration.

More About Us

MivaTek Global is a distributor of Miva Technologies' imaging systems. We currently have 55 installations in the Americas and have machine installations in China, Singapore, Korea, and India.

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Career Opportunities



eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

Opportunities are available in Canada, New England, California, and Chicago. If you love teaching people, choosing the classes and times you want to work, and basically being your own boss, this may be the career for you. EPTAC Corporation is the leading provider of electronics training and IPC certification and we are looking for instructors that have a passion for working with people to develop their skills and knowledge. If you have a background in electronics manufacturing and enthusiasm for education, drop us a line or send us your resume. We would love to chat with you. Ability to travel required. IPC-7711/7721 or IPC-A-620 CIT certification a big plus.

Qualifications and skills

- A love of teaching and enthusiasm to help others learn
- Background in electronics manufacturing
- Soldering and/or electronics/cable assembly experience
- IPC certification a plus, but will certify the right candidate

Benefits

- Ability to operate from home. No required in-office schedule
- Flexible schedule. Control your own schedule
- IRA retirement matching contributions after one year of service
- Training and certifications provided and maintained by EPTAC

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American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

The CAD/CAM engineer is responsible for reviewing customer supplied data and drawings, performing design rule checks and creating manufacturing data, programs, and tools required for the manufacture of PCB.

Essential Duties and Responsibilities

- Import customer data into various CAM systems.
- Perform design rule checks and edit data to comply with manufacturing guidelines.
- Create array configurations, route, and test programs, penalization and output data for production use.
- Work with process engineers to evaluate and provide strategy for advanced processing as needed.
- Itemize and correspond to design issues with customers.
- Other duties as assigned.

Organizational Relationship

Reports to the engineering manager. Coordinates activities with all departments, especially manufacturing.

Qualifications

- A college degree or 5 years' experience is required. Good communication skills and the ability to work well with people is essential.
- Printed circuit board manufacturing knowledge.
- Experience using CAM tooling software, Orbotech GenFlex®.

Physical Demands

Ability to communicate verbally with management and coworkers is crucial. Regular use of the telephone and e-mail for communication is essential. Sitting for extended periods is common. Hearing and vision within normal ranges is helpful for normal conversations, to receive ordinary information and to prepare documents.

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Career Opportunities



U.S. CIRCUIT

Plating Supervisor

Escondido, California-based PCB fabricator U.S. Circuit is now hiring for the position of plating supervisor. Candidate must have a minimum of five years' experience working in a wet process environment. Must have good communication skills, bilingual is a plus. Must have working knowledge of a plating lab and hands-on experience running an electrolytic plating line. Responsibilities include, but are not limited to, scheduling work, enforcing safety rules, scheduling/maintaining equipment and maintenance of records.

Competitive benefits package.

Pay will be commensurate with experience.

Mail to:
mfariba@uscircuit.com

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APCT
Passion | Commitment | Trust

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.

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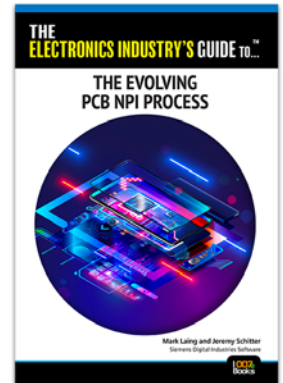
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The Electronics Industry's Guide to... The Evolving PCB NPI Process

by Mark Laing and Jeremy Schitter, Siemens Digital Industries Software

In this book, the authors look at how market changes in the past 15 years, plus the slowdown of production and delivery of materials and components in recent years, have affected the process for new product introduction (NPI) in the global marketplace. As a result, we feel that PCB production companies need to adapt and take a new direction to navigate and thrive in an uncertain and rapidly evolving future.



I-007e
Books

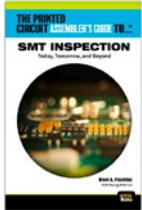
The Printed Circuit Assembler's Guide to...



Solder Defects

by Christopher Nash and Dr. Ronald C. Lasky, Indium Corporation

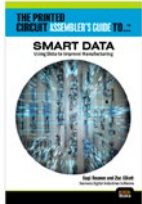
This book is specifically dedicated to educating the printed circuit board assembly sector and serves as a valuable resource for people seeking the most relevant information available.



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

An in-depth insight into new and exciting true 3D inspection technology is provided in this book, along with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



Smart Data: Using Data to Improve Manufacturing

by Sagi Reuven and Zac Elliott, Siemens Digital Industries Software

Manufacturers need to ensure their factory operations work properly, but analyzing data is simply not enough. Companies must take efficiency and waste-reduction efforts to the next phase using big data and advanced analytics to diagnose and correct process flaws.



Process Validation

by Graham K. Naisbitt, Gen3

This book explores how establishing acceptable electrochemical reliability can be achieved by using both CAF and SIR testing. This is a must-read for those in the industry who are concerned about ECM and want to adopt a better and more rigorous approach to ensuring electrochemical reliability.



Advanced Manufacturing in the Digital Age

by Oren Manor, Siemens Digital Industries Software

A must-read for anyone looking for a holistic, systematic approach to leverage new and emerging technologies. The benefits are clear: fewer machine failures, reduced scrap and downtime issues, and improved throughput and productivity.

Our library is open 24/7/365. Visit us at: I-007eBooks.com

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