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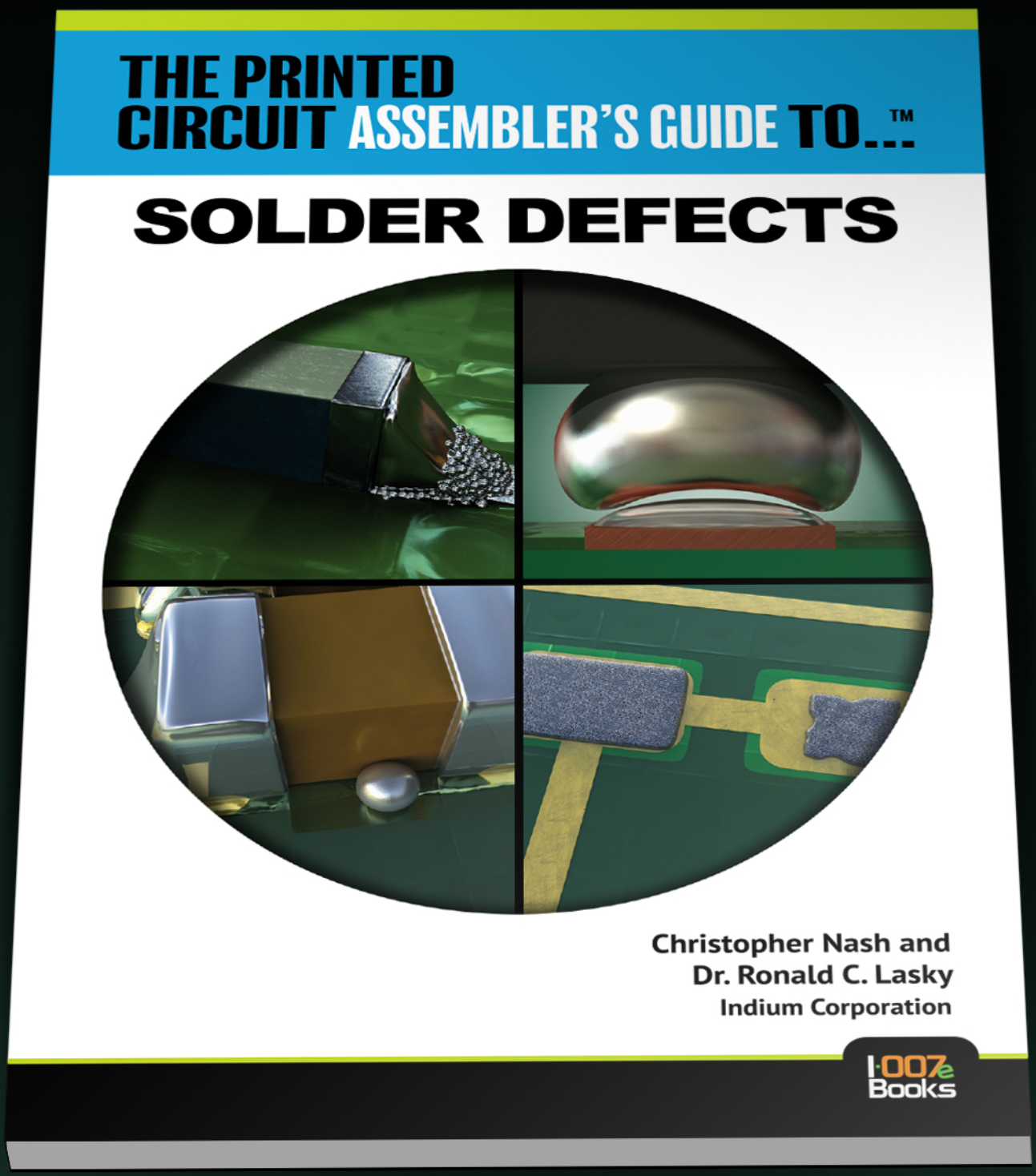

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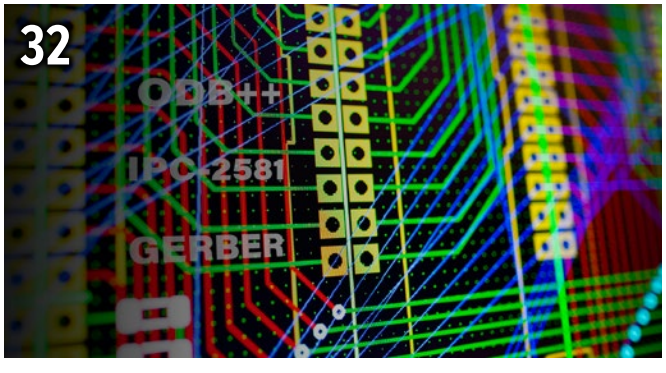
Managing High-Mix Work on the Shop Floor

The requirements for assembly continue to move toward smaller components and higher densities. But what are the challenges that accompany this steady shift? In a series of interviews, articles and columns, we learn what assemblers are really facing.



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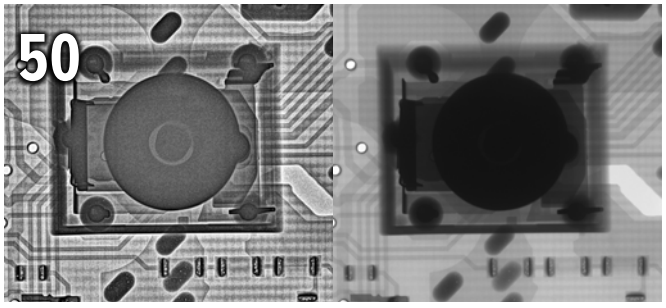

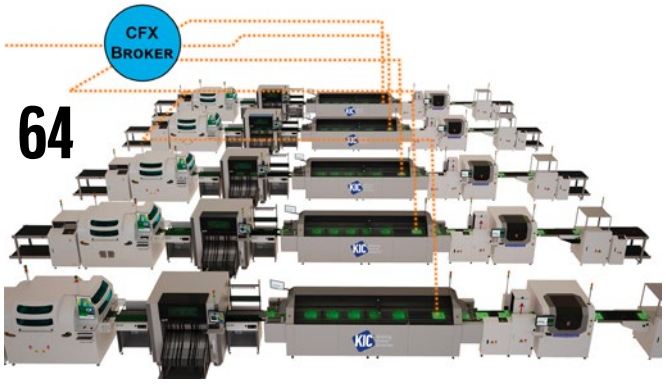


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Changing Expectations

Nolan's Notes

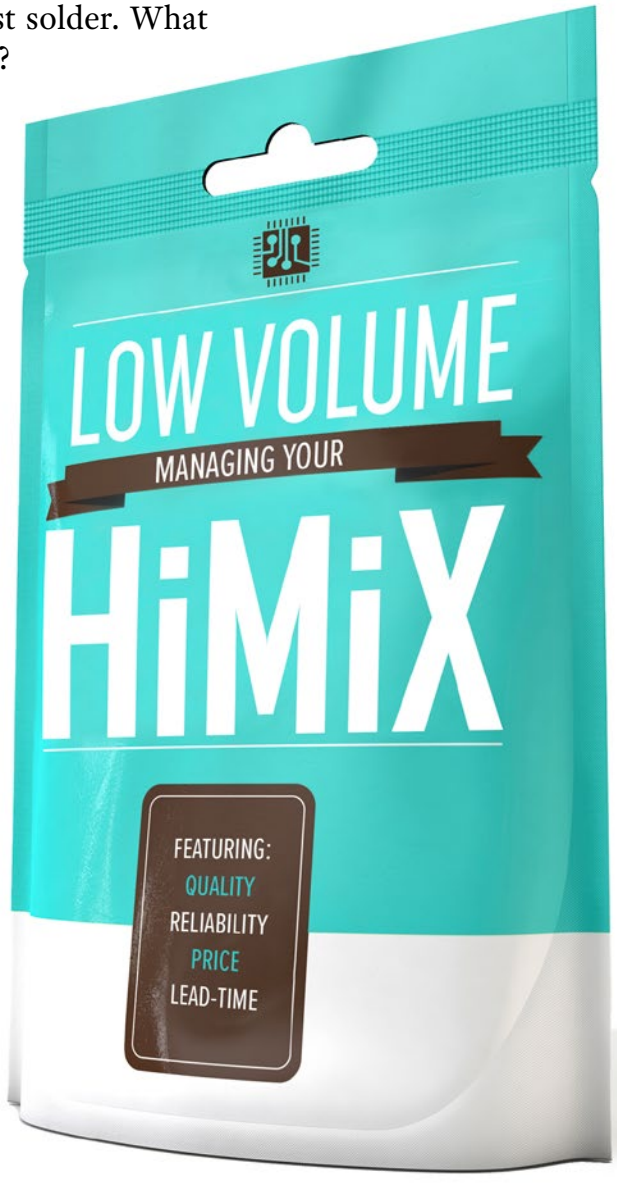
by Nolan Johnson, I-CONNECT007

What are the common challenges to high-density board assembly?

For example, while it seems that non-electrical components are moving closer to the board assembly process, this skill set requires more expertise than just solder. What about fluid cooling? Both applications have strong ties to high-end data center applications, of course.

Heat management, signal integrity, and crosstalk issues are other possible challenges, but these aren't really within the scope of the assembly house. Sure, these issues may raise their heads during testing, but the solution is an OEM redesign concern.

Can we find new efficiencies or higher yields if we break some old rules to make new ones? It's certainly an intriguing question, harkening back to continuous improvement thinking. Where are the increased efficiencies, the better margins, the faster build times, and the resulting increases in capacity? Can the build steps be reduced? How does or doesn't automation help? Can the machinery keep up with the shrinking component sizes?



Pondering these questions led me back to thinking about my undergraduate days. While pursuing my computer science degree at Oregon State University, my academic advisor recommended a "soft science" course. So, I enrolled in Sociology 201, your typical survey course. "Soft science" is a term uses for scientific study which is generally understandable without needing the rigors of mathematics. Categories include sociology, psychology, political science, and the like. But is it really science? Is it science if it's the study of, say, interpersonal relationships or societal dynamics, or are the soft sciences more closely aligned with philos-

ophy? This was on my mind as I recalled that course.

At the time I started the course, I thought sociology was more akin to philosophy. But as the professor's lectures set up the methods and objectives of social science, I learned to accept the value of the soft sciences; the process of going through that course tore down my inadvertent elitism about science in general. I went in with assumptions that I treated as beliefs and came out better able to recognize when I was using an assumption as a truth. I don't remember much about the material in the lectures, but the process of surveying the social sciences did change my critical thinking. Maybe that was why my advisor pointed me in that direction. My perspective had been changed and I looked at other questions in front of me in a different way.

As a result, I added some other soft science, specifically psychology courses. One of those, "Behavioral Psychology," was commonly known on campus as "Rat Lab." If any of you have heard Happy Holden speak about his career, he often includes the story of designing interface cards for a PDP 8 computer while a student at Oregon State. These interface cards were to enable the PDP to operate a series of "Skinner boxes" for the Rat Lab, and were still in use when I took the course 20+ years later. After a handful of introductory lectures, we were assigned a lab rat, which was to be kept slightly dehydrated, creating motivation to learn. Each day, we had to care for our rat, and teach it to push a lever in the Skinner box to deliver a small amount of water. The behaviors that the rat had to learn became increasingly complex and involved. But the basic tenets of positive and negative reinforcement were made quite clear during the course. When confronted with challenges, we find a way to make things work.

So, as we sought answers to our current questions about high mix, low volume, we asked how many of these topics are making life difficult for EMS firms, and how they are coping with all these challenges. What we learned was that the high-density challenges were actually few and far between. Like my sociology class, we went in with one set of expectations and came out with a different understanding than we anticipated. And like my psychology class, we found ourselves documenting the pressures that are motivating new thinking and potential new methods on the shop floor.

Specifically, as the requirements for assembly continue to move toward smaller components and higher densities, the most common challenges are with supply chain, inventory management, and part feeder technologies. Most of the issues we thought we'd be talking about weren't the pain points we thought they would be. At least, not right at this very moment. So, what did we learn?

In this issue, you'll find a two interviews with Axiom, one exploring high-density issues, and the other the data format effect on business costs." You'll see how some of Axiom's concerns likely line up with your own. Duane Benson of Screaming Circuits shares the challenges of quoting because of the instability of the supply chain, and I-Connect007 columnist Emmalee Gagnon helps us understand the unique ability of your machines to optimize throughput in a high-mix, low-volume environment.

Like the rats I mentioned in my psychology class, building high-density boards in today's post-pandemic world makes us "thirsty" for stability and accuracy. See the obstacle as the way and use this issue to recognize and overcome your own challenges.

What will be your takeaways from what you read here? I'd love to hear from you. **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.

Critical Materials: A Compelling Case, Part 2

SMT Prospects & Perspectives

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

When I wrote Part 1 on this topic in January, the global geopolitical landscape could be characterized as "status quo"—testy, challenging, yet absent of "war" in any region of the world. Now with Russia's invasion of Ukraine, which elevates the peril and uncertainty of metals, minerals and materials into overdrive, the title of the article may warrant: "Critical Materials—A Precariously Escalated Compelling Case."

How uncertain? Take nickel (Ni) as an example. Its price soared on March 8, 2022, reaching the record $100,000 a metric ton on the London Metals Exchange (LME); however, it pulled back later. Its dramatic pricing volatility made the LME pause the trading on March 8 and trading resumed on March 16 (the episode is under review by regulators and LME). Nickel is not a "fancy" metal, but it is a key ingredient for stainless steel and lithium-ion batteries that power electric vehicles (EV), among others. Russia is a major supplier of nickel (China is another supplier), not to mention the oil, gas, and other minerals and materials.

Russia is also a major supplier of precious metals including palladium (Pd), which is an essential element being used in catalytic converters and semiconductor manufacturing. It is reported that about one-third of the world's palladium comes from Russia. Within the semiconductor industry, some sources of production of raw materials are concentrated in Russia and Ukraine. For instance, the two countries are major sources of neon gas, which is used for making circuitry on silicon. It is estimated about one-quarter to one-half

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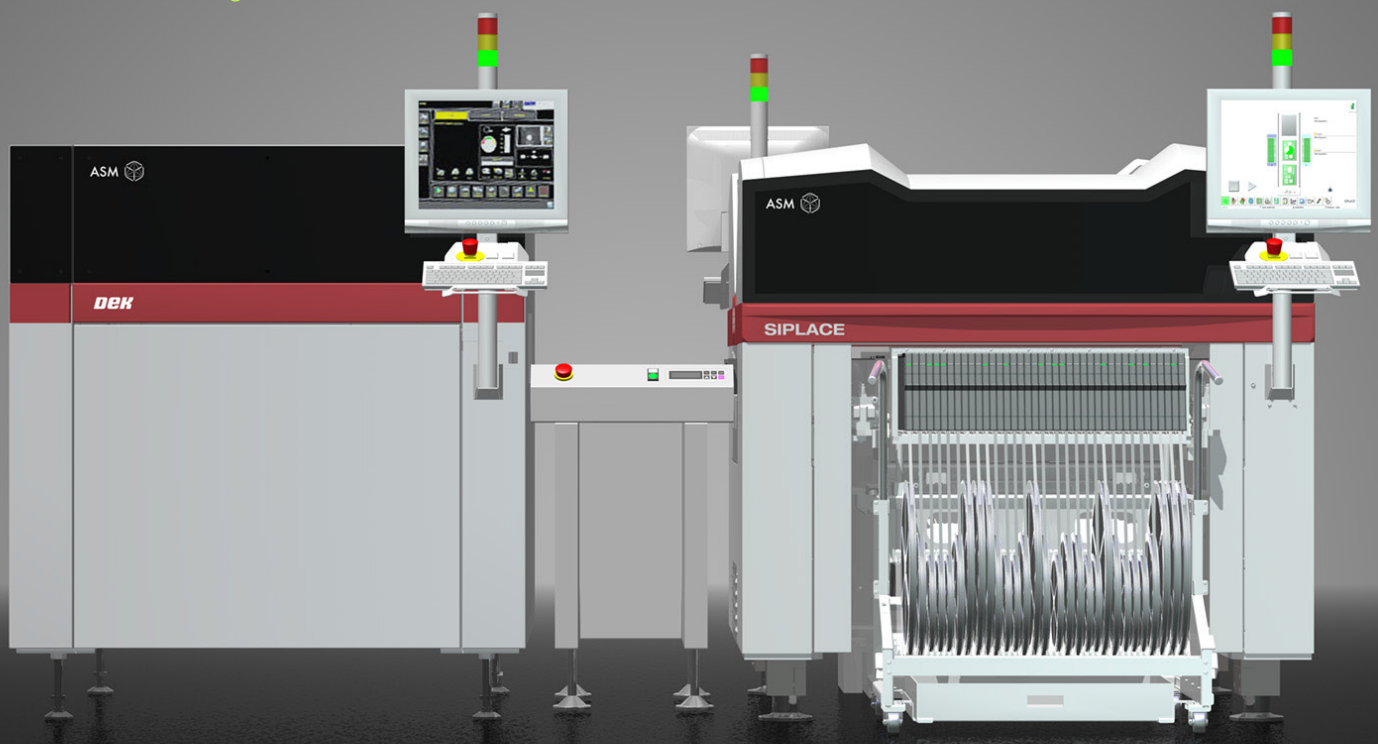

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of the world's neon supply comes from Russia and Ukraine. Although neon gas is a small fraction of semiconductor manufacturing in dollar value, a close-knit operation cannot tolerate any missing link in the chain.

Other metals, such as titanium (Ti) that is crucial for manufacturing jet airplanes and military aircraft, has been heavily sourced from Russia. By its high strength, light weight and corrosion-resistance, titanium is a unique metal and cannot be readily substituted. Even though some materials may not risk the direct exposure, indirect impact is expected to trickle down throughout the global supply chain.

Other metals, such as titanium (Ti) that is crucial for manufacturing jet airplanes and military aircraft, has been heavily sourced from Russia.

There is a slight bright side. Reportedly, semiconductor manufacturers may not experience the immediate threat resulting from the Russian invasion of Ukraine. The major manufacturers have been compelled to shore up inventory on key supplies by reassessing their supply chains and to improve the way to manage logistics during the coronavirus pandemic to minimize the uncertainties and shortage of supplies.

The escalated vulnerability and uncertainties of essential and critical metals, minerals, and materials may potentially exasperate the adverse impact on the assurance of the nation's economy and national security.

Accordingly, what are the specific metals, minerals, and materials that should be deemed critical to a robust economy and impeccable national security? What should constitute the key strategic tenets? What are effective, logical tactics and, more importantly, the decisive actions to be taken?

Critical Metals and Elements

Criticality of elements, materials, and minerals goes to those that the U.S. has little control of, such as those lacking or absent of domestic natural resources, and those import-centric. Additionally, criticality also goes to those required for mission-critical end-uses.

I have spared no effort to not put the Periodic Table here. Essentially, three of the top groups of elements on my list include:

- Essential elements, such as, Ti, W, Mo, Co, Ni, Cu
- Minor metals and precious metals, such as Ga, In, Te, Li, Pd
- Rare earth elements (REE), particularly the light rare earth elements among the 17 REE

Taking the rare-earths group into examination, the 17-element group valued for their magnetic and conductive intrinsic properties, serves critical functions in a wide range of technologies and applications as the basic materials for making components in smartphones, electric cars, and missile defense systems. It is estimated that China mines a majority of the world's rare earths minerals, which ranges from 55–90%, varying with the source and methodology of estimates. The rare earths' refining process is also dominated by China. Recently, China further enhanced its position by merging rare-earths assets in the nation; this tactic further strengthens its pricing power and avoids infighting among domestic companies.[1]

Strategic Considerations

The essence of the U.S. strategy should focus on the end-game, i.e., how to become less vulnerable, more self-controlled, increasingly self-reliant, and to be positioned for ready access and competitive cost structure to ensure a

robust economy and resilient national security.

Here is a strategy to be formulated from 16 vantage points:

1. From a supply-side consideration: Strategy to ensure a dependable, reliable supply of the critical materials where the U.S. does not have adequate or reliable sources, especially for those materials that are abundant in the countries that are or might be deemed existential or potential adversaries.
2. From a demand-side consideration: Strategy to identify the critical metals, minerals, and materials.
3. From a perspective of a new world: Strategy to secure strategic metals by revisiting the criteria in defining strategic metals in the new world in terms of geopolitics and a new landscape in the digital era.
4. From a perspective of import-intense metals: Strategy to "govern" the metals and minerals that essentially rely on imports, i.e., domestic production/mining/refining is scarce or nil; particularly how to ensure resiliently cost-effective sources. This will engage the U.S. Department of Commerce, the International Trade Commission, and other agencies. What are deemed to be productive and effective policies and/or incentives to give companies that are in the position to produce the critical metals/minerals/materials? A farsighted strategic calculus may need to be a variation from those in points 1, 2, and 3.
5. From an economic standpoint: The role and the positioning of technological overmatch for today and the future (e.g., five- or 20-year time horizons). Strategy to cultivate a sustainable ecosystem and infrastructure to transition critical materials to useful products, thus adding value to the national economic well-being.
6. From a national defense and national security standpoint: Strategy to transition the critical materials to the capabilities for national defense and national security including combat capabilities in the new multi-domain combat environment that the U.S. Army and the Department of Defense have recently been focusing on.
7. From a national investment and international trade standpoint: Under the intensifying clean-energy and environment-conscious climate, a strategy for national investment to reach a more self-reliant or less import-dependent conditions calls for an open debate with an open mind. This requires engagement from multiple federal agencies and subordinate agencies.
8. To anticipate potentially emerging conflict minerals (metals) that are naturally abundant in conflict-affected and high-risk areas (countries, regions), and the strategy to "manage" such.
9. From the technology standpoint, to incentivize developing gaming-changing technologies. One good example is the technology that enables the use of less pure-grade (lower cost) nickel for batteries.
10. From an alternative material/element standpoint: Strategy to invest and develop technologies alternative to currently-defined critical materials that can meet the designated criteria.
11. From a viewpoint of competitive race, the plan to leverage new and leading technologies (e.g., AI) to speed up the discovery of new mining deposits of essential metals and minerals (e.g., Co, Ni, Cu, Li).
12. From the "integrated bi-focus" of environment (climate-change) and economics standpoints with pragmatism: Strategy to revisit the priority of recycling

and processing technologies to reduce import dependency and to mitigate foreign-dependent vulnerability.

13. Strategy to advance the recycling technology to build a true closed-loop system: To the environment-enthusiasts, for example, metals such as steel and aluminum are even important for renewable energy (perhaps counter-intuitively).
14. From free-markets point of view, a strategy to ensure that solutions are not worse than the problems—immensely paramount to tackling critical materials.
15. Again, nothing can beat the human ingenuity for breakthrough innovations to either advance the functions or reduce the cost or both. For example, explore the potential of nickel to serve as a catalyst in lieu of palladium to catalyze chemical reactions like cross-couplings. Its success will cut cost tremendously, not to mention the enhanced "security" of resources.
16. For protecting the "brain" that goes into all "modern" commercial and military products, watch diligently for, act prudently on the materials going into the chips (semiconductors) manufacturing. This is a sound strategy for what the role of the government should be and how the government can play effectively.

None of the above should be or can be viewed and attended monolithically. To accomplish (8), the strategy to "manage" the current and potentially future conflict minerals calls for embracing both environmental and geopolitical considerations.[2]

More to Do

Recently, President Biden's executive order identified risks in four key categories of critical materials: semiconductors, rare earth minerals, active pharmaceutical ingredients, and large capacity batteries. Nonetheless, the efficient and effective plan of action is yet to be carved out. Identification is a starting step, not an endgame; a key question goes to the remedies or solutions, both strategically and tactically, in covering near-term and long-term time horizons, to secure or to establish alternate sources of critical metals, minerals, and materials. This calls for a decisive push forward.

As any alternate source of metals, minerals, and materials must go through a rigorous validation and verification process, the question also goes to how long it takes to come up with the plan and action. Is it "fast" enough? Additionally, in the long run, what kind of incentives can justifiably come from the government, federally and locally?

As any alternate source of metals, minerals, and materials must go through a rigorous validation and verification process, the question also goes to how long it takes to come up with the plan and action.

Multiple initiatives to address the challenges of global supply chain are in the works; yet, the supply chain of knowledge should be fortified, in parallel.

In a nutshell, staying the same is not an option; the reality remains the same: to deliver a holistic, all-encompassing approach by "amalgamating" my 16 points and other envisaged areas to reach a set of executable actions, and to forthrightly act now.

The bottom-line is to not rely on unreliable sources; and the ultimate challenge is to not create solutions that are worse than the problems. **SMT007**

References

1. "China Set to Create New State-Owned Rare-Earths Giant," by Keith Zhai, Wall Street Journal, Dec. 3, 2021.
2. "Conflict Minerals: A Snapshot," by Jennie S. Hwang, SMT Magazine, March 2013.

Appearances

Dr. Jennie Hwang will deliver a professional development course on "An Overview of PoP and BTC Package and Assembly: Material, Process and Reliability–Part 1 and Part 2," 8 to 11 p.m. May 25 and 26, 20th Electronic Packaging Convention, Asia.

Dr. Jennie S. Hwang—an international businesswoman and speaker and a business and technology advisor—is a pioneer and long-standing leader to SMT manufacturing since its inception as well as to the development and implementation of lead-free electronics technology. Among her many awards and honors, she was inducted to the International Hall of Fame–Women in Technology, elected to the National Academy of Engineering, named an R&D Star to Watch, and received a YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., and SCM Corp., she was the CEO of International Electronic Materials Corp. and is currently CEO of H-Technologies Group, providing business, technology, and manufacturing solutions. She has served on the board of Fortune-500 NYSE companies and civic and university boards; the Commerce Department's Export Council; the National Materials and Manufacturing Board; the NIST Assessment Board; as the chairman of the Assessment Board of DoD Army Research Laboratory and the chairman of the Assessment Board of Army Engineering Centers; and various national panels/committees and international leadership positions. She is the author of 600+ publications and several books and is a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees, as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, visit JennieHwang.com. To read past columns or contact Hwang, click here.

MIT Launches New Robotics Manipulation Course

Last fall, MIT's Department of Electrical Engineering and Computer Science launched a new course, 6.800 (Robotic Manipulation) to help engineering students broadly survey the latest advancements in robotics while troubleshooting real industry problems. It's a unique course that can provide an inroad into robotics for students with no robotics experience at all.

Students learn fundamental algorithmic approaches to build robot systems capable of autonomously manipulating objects in unstructured environments. Exploring topics like perception, planning, dynamics, and control, students solve problem sets to guide themselves through developing a software stack, typically using the permissively licensed open-source software Drake. Not focused on quizzes and final exams, the course culminates instead with a final project where students can explore any problem in robotic manipulation that fascinates them.

Professor Russ Tedrake's course notes provide students with a window to peer across the professor's own mental landscape of the field. Students say they are unlike any course notes they've ever seen—providing a constantly updated roadmap of what it would take to advance robotics as a field.

He says there's rampant industry interest in engineers skilled in manipulation, and that demand helped motivate him to launch the course. "Manipulation is just kind of exploding in the field," Tedrake says, adding that recently, "it's less of a niche area, everybody's got an eye on making robots do things with their hands." Right now, the big companies are investing. (Source: MIT News)

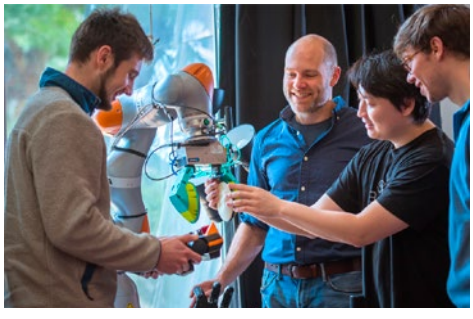
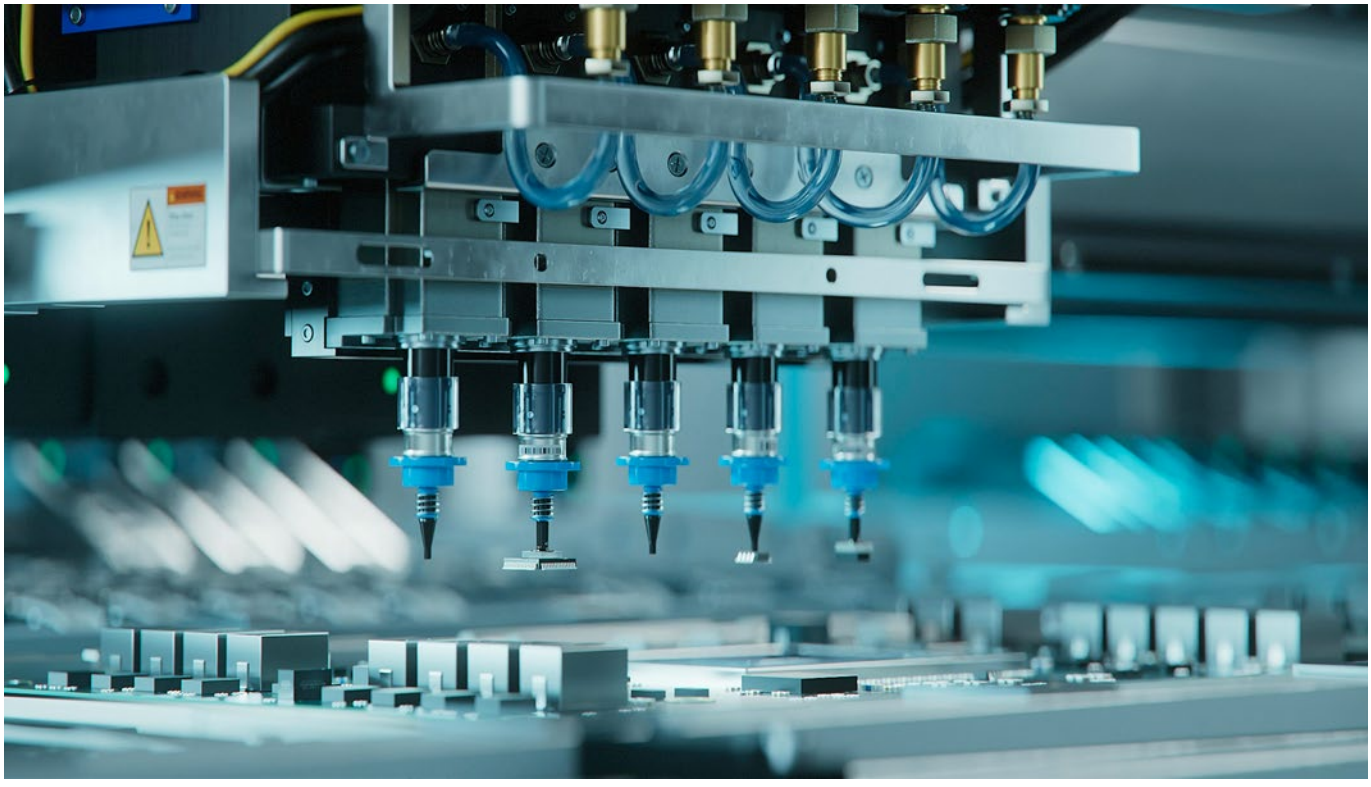


Photo: Professor Russ Tedrake (second from left) examines a robotic arm with students from 6.800 (Robotic Manipulation). Tedrake designed the course in response to the growing need for engineers to survey the latest advancements in robotics while gaining experience in troubleshooting real industry problems. (Photo: Gretchen Ertl)



Exploring High Density With Axiom

Feature Interview by the I-Connect007 Editorial Team

Nolan Johnson and Barry Matties talk with Axiom's Rob Rowland and Kevin Bennett about the current high-density challenges facing EMS manufacturing. In this interview, Bennett and Rowland zero in on component packaging and feeder technology as critical areas in need of improvement.

Nolan Johnson: Rob, please introduce us to Axiom.

Rob Rowland: Axiom has been an EMS provider for about 30 years. We primarily focus on military, aerospace, space products, and any other high-reliability application type of customers, building the more complex, high-density type of boards. Kevin has been doing placement for over 20 years, both as a machine programmer and a process engineer. We probably handle a wider diversity of unique components than many companies doing board build. Our board sizes range from what you would call a memory module size, up to boards in the 18-by-20-inch size range, so we handle a large variety of different sizes.

Johnson: Is it fair to assume that it's a mostly high-mix, low-volume setup?

Rowland: Yes. Our expertise is the higher mix, lower volume, with a typical run in the 30- to 50-board range. We have a couple of runs where we're building in the hundreds, and occasionally into the thousands, but it's usually jobs fewer than 100 boards. One interesting aspect when talking about placement machines is that most companies in the U.S. are dealing with higher mix, lower volume.

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Rob Rowland

It's fair to say there's a big distinction between what you need to do for different production mixes. As I talk with my peers in the industry, one of our biggest challenges for the higher mix, lower volume placement is component packaging.

Packaging—Tape, Reels, and Tubes… Oh My!

Barry Matties: When we talk about packaging, do you mean part of the components?

Rowland: In this case, we're specifically talking about tape and reel vs. matrix tray vs. tubes. The ideal scenario if you're running high volumes is to buy full-size reels. When you're in the high-mix business, you're typically dealing with much shorter strips of tape, and not all the machines on the market are well-designed to deal with that. It's a major challenge for domestic companies, and one that the placement industry has not stepped up to address as much as I would like. We had to develop a process that enables us to deal with shorter strips of tape; it's typically one of our bigger headaches from a board build standpoint.

Johnson: Is that sort of packaging challenge worse when you're dealing with very small components or is it consistent across the board?

Kevin Bennett: It's worse when you're dealing with smaller components, because there are different methods for loading them onto the placement machine. The components are presented in the pockets of the carrier tape with cover tape over the top of each pocket to keep them from falling out. When you have a short strip of tape, there needs to be enough carrier tape length for the feeder to advance correctly. In that case you must prep the strip with an extra length of cover tape, so the mechanism that peels the cover tape back will expose the component for the nozzle to pick from.

If you're placing short strips of tape on a matrix tray platform, the entire length of cover tape needs to be peeled back before attempting to pick. If the short strip contains small components, a slight bump could cause all the components to come out of the carrier tape with potential loss due to attrition.

Johnson: Even a stray gust of air can do that.

Bennett: Exactly. Ideally with short strips of tape, you want to use tape-and-reel feeders, so the cover tape keeps the components in the carrier tape until they're ready to be picked. Feeder types vary by equipment manufacturers. Non-mechanical feeders are small and have a peeling method for the cover tape as the base they're mounted in advances the carrier tape. Mechanical feeders tend to be large and require a longer length of cover tape to weave through the feeder so it will advance correctly.

Increasingly Smaller Components

Johnson: What are some of the other challenges happening specific to high density compared to more traditional, larger-sized component work?

Bennett: Components are getting smaller as time goes on. The smallest package size we place here is 0201, which is 0.6 millimeters by 0.3 millimeters. We're capable of placing a component half that size, which is called a 01005. By comparison, a human hair is about 0.1 millimeters, so these components are just slightly larger than a human hair.

Johnson: What technology picks up something that small?

Bennett: Machines use vacuum nozzles to pick and place most component packages. Large and odd shaped components can be picked with mechanical gripper nozzles. A downward-looking camera is used to teach pick points on individual feeders. When the same reel of components is loaded on a different feeder, the pick point will have to be taught again to compensate for inconsistencies in feeder position tolerance in any given feeder slot. The smaller the component, the less room there is for error.

Matties: Does it slow down the overall assembly process with parts that small, or can you use the standard rate?

Bennett: Small components are placed at a higher speed, while some larger components need to be placed at a slower speed. Routine maintenance is required to keep the nozzles functioning correctly. If the nozzles become clogged, you will experience pick issues. The machines run smoothly when you have the correct nozzle size and type to pick the components.

Matties: When you're talking about the packaging and the short jobs, how many pieces are in the order? Maybe 50, or 500 pieces? When does packaging become an issue?

Rowland: A typical job size for us is 30 to 50 boards and where you typically get into shorter strips of tape. Once you get above 100 pieces, you're able to use longer strips of tape. With anything less than 100, the shorter tape issue can typically be a problem.

Kevin Bennett

Placement Density

Matties: With the density and the smaller components that we're talking about, are you seeing more challenges in the overall setup?

Rowland: One aspect of density is how many different part numbers there are on the board, which relates directly to how many feeder inputs you have available. You need to have enough feeder inputs to be able to handle all the different component package types that you load onto the machine. The other piece is just how densely packed the components are on the board.

Job Setup Complexity

Johnson: Earlier, you said that larger components can slow down the job?

Bennett: Larger components like ball grid arrays that have a standard matrix of rows and columns with the same pitch in the X and Y are easier to program than a variable-pitched BGA

The inside of a random access matrix tray handler showing the elevator and tray handling unit.

with multiple-size balls on it. Variable pitches between rows and columns are more of a challenge to program.

Cameras and Vision Systems

Johnson: How do vision systems help in these small component situations?

Bennett: For each component package type, the camera is programmed to recognize the components based on their shape. The challenge with the more densely populated boards is the time it requires to program a machine to handle all the various package types. At the machine level, extra time is required to debug a program due to the variety of packages.

Johnson: So, complexity, variety, and packages create significantly more labor on the front end during job setup. Is that the biggest time sink overall as far as labor goes?

Bennett: We program each job offline, so while a current job order is running on the SMT line, we're programming an upcoming job order that will be scheduled to run a few days later. During a setup with a large quantity of feeder inputs and multiple package types, the potential for extra debugging time increases. If there are discrepancies with component dimensions programmed offline vs. the actual component loaded onto the machine, it will add more time to debug the program during setup. We do our best up front to locate datasheets with component dimensions before it gets to the production level.

Matties: Package discrepancies and lighting issues must make learning a component tricky. Does increased camera resolution help?

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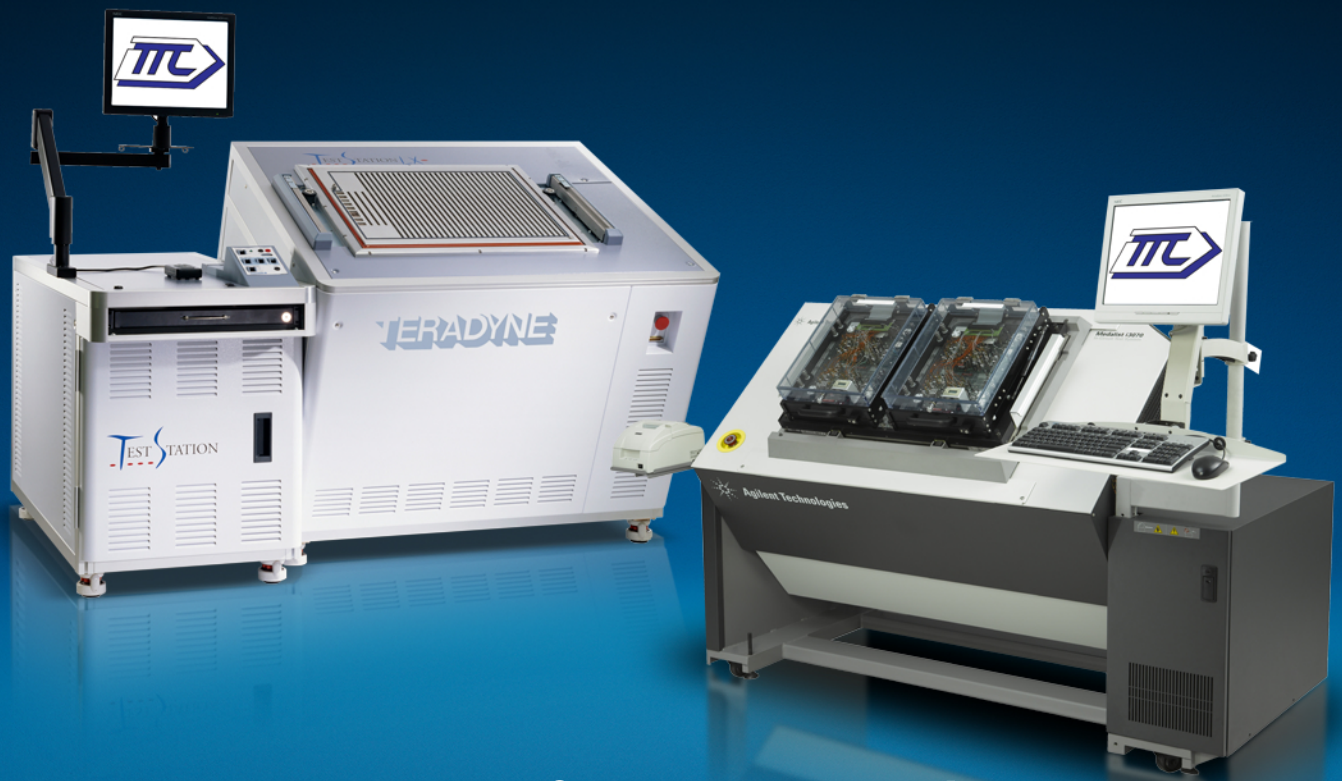

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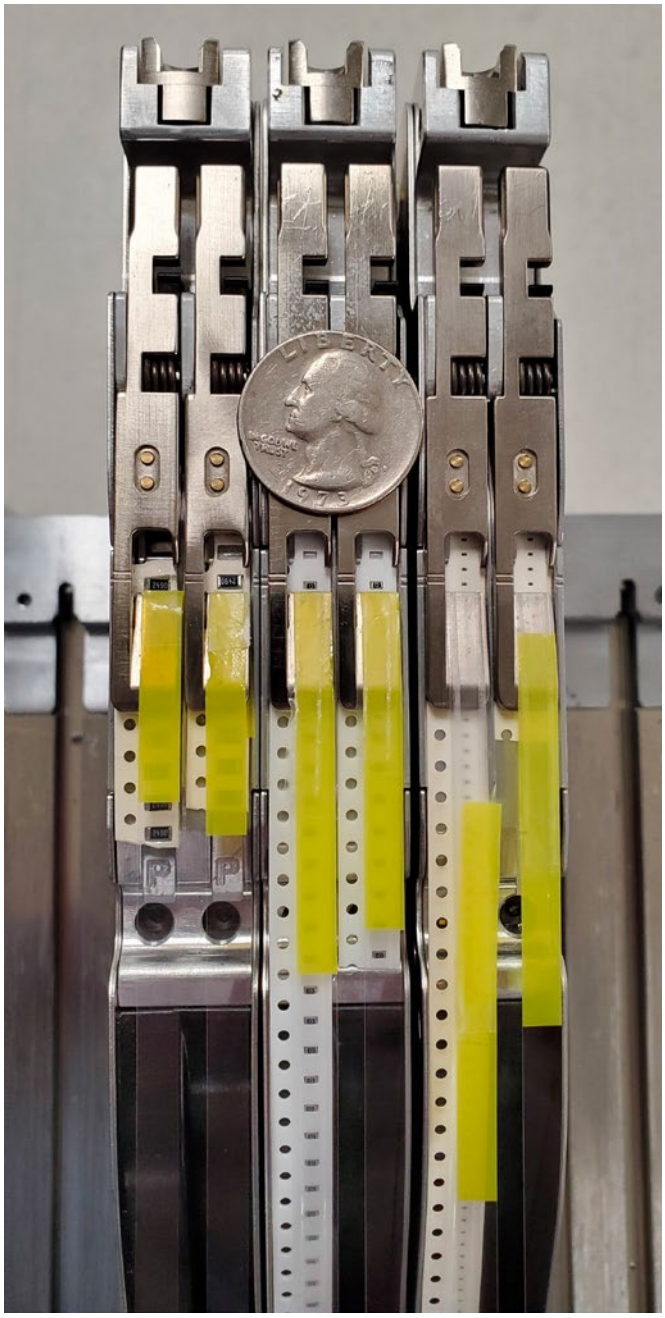
Bennett: Yes, lighting issues do create challenges. If the component body and terminations are similar in color, like on a ceramic BGA, it can be difficult to achieve proper contrast with the vision system. Cameras with higher resolution are used when the component features are small, like fine pitch leaded devices or micro BGAs.



Tape feeders with a combination of very short and long strips of (white) carrier tape. A yellow cover tape leader has been added to the cover tape so it can pulled to the take up spool.

Rowland: Kevin is the expert here, but there are two issues when you talk about cameras. One is the actual resolution of the camera to be able to image the size of the device that you're dealing with, but then an integral part of the camera system is lighting. In general, lighting tends to be a bigger issue than the resolution of the camera.

Bennett: I would agree with that. It goes back to the contrast. The cameras we use have three different lighting angles: top, side, and angled view. Sometimes it's a trial-and-error process to find the right combination of lighting to achieve the desired contrast so the camera can distinguish the features of the component.

Johnson: Do you have to change these settings job by job?

Bennett: Once a component package is defined, we can test to make sure it will consistently pass with the vision system. If the same component package is used on another job, the settings do not have to be adjusted.

Rowland: Devices like QFNs and ball grid arrays are the most challenging because, with a typical package—resistors, capacitors, things like that—you're looking at an outline that is easy to set up to get a clean outline. When you're dealing with something on the bottom of the component, it comes down to contrast. Getting the lighting such that you can spot the contrast differences is a big challenge, right?

Bennett: That's correct. Another factor to consider is symmetry. If a component is symmetrical—for example, a leadless device where all the terminations have the same geometry on all four sides, the camera will recognize the component even if the polarity is incorrect. The component will be placed on the board in the wrong orientation because there isn't a unique feature for the camera to distinguish as a polarity indicator.

The Labor Economics for Programming Placement

Johnson: From the time you start programming offline for a typical board until you've completed debugging on the machine, what's the timeframe?

Bennett: Typically, it takes about eight hours to program a medium complexity board offline and the debug time on the machine is 30 to 60 minutes.

Johnson: That's quite a bit of time when you're in a high-mix environment.

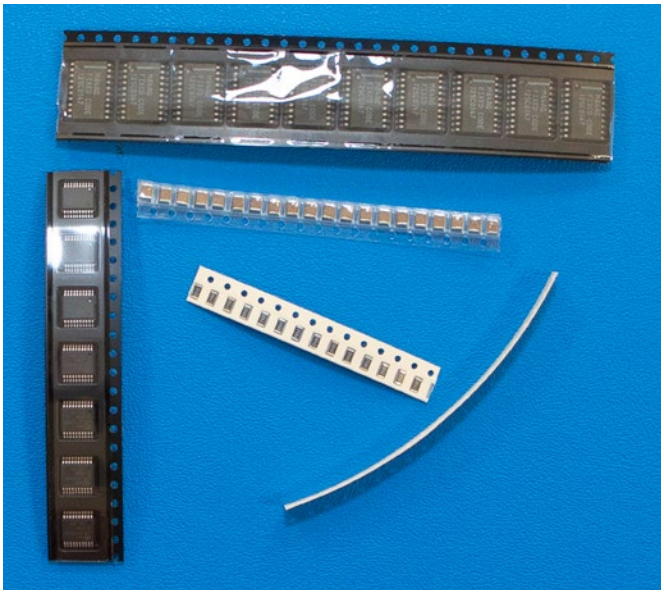
Bennett: That's correct. With small job order quantities, we're able to perform three changeovers within an eight-hour shift on any given SMT line.

Johnson: You said earlier that good programming up front improves the backend. Talk about that inter-relationship, especially from the perspective of working with the high-density boards.

Bennett: Programming a high-density board is labor intensive for placement and AOI. The data provided to the AOI programmer comes directly from the placement program. Data from the same source will reduce inconsistencies between the components placed on a board and AOI verification. If the placement programmer and AOI programmer each start from scratch with the data provided by the customer, there is more risk of mixed results between the placement program and the AOI program.

High Density and Profit Margins

Matties: Do you think that the more profitable work is in the higher density kind of work, even though you have to put more effort into the front end?



Short tapes of components can be problematic to feed into today's automatic feeder mechanisms.

Rowland: Generally, the more complex the board is, the more we need to charge because more effort goes into programming and manufacturing it. Generally, the profit margin is higher on jobs that are more complex because they are more difficult to build.

Matties: How do you gauge this without giving away your secrets? When you're looking at your factory, are you at a dollar throughput per station or does that act as a guide for the type of work that you're taking?

Rowland: We've developed a pretty comprehensive module that we use to quote the labor it takes to build and test a product. It contains all the processes that we have here. If it's a good fit for our services and processes we will quote it, otherwise we would no-bid it.

Over the years, we've learned it doesn't make good business sense to try to do everything for everybody. We were trying to do that years ago and it ended up being a no-win model, especially if there's a sizable capital investment that's required. In the last couple of years, we've taken a different approach, looking at the services and processes we want to offer and excel at. If it doesn't fit our model,

then we would no-bid because you just can't be everything to everybody.

Some companies try to be everything to everybody and ultimately you come to the realization that it's not necessarily a profitable model that you can pursue.

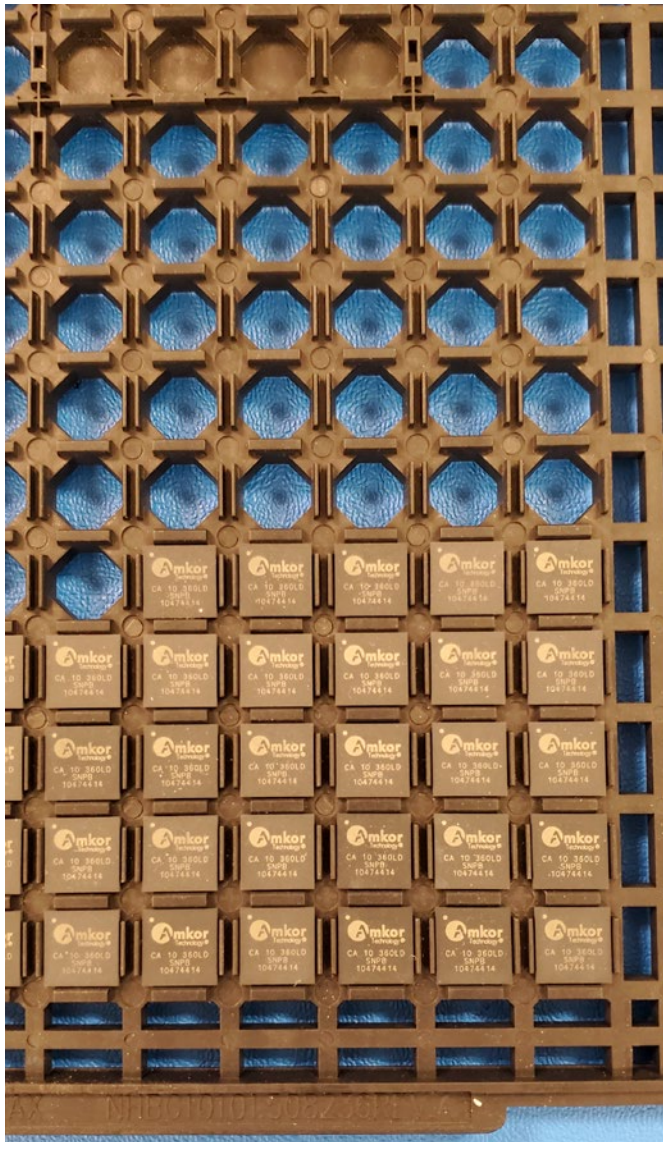
Challenges in General, Not Just High Density

Matties: What are the greatest challenges you have in your operations?

Bennett: It goes back to the component packaging. In addition to the short strips of tape, another challenge we have is with components that come packaged in tubes; in general, the industry doesn't have the best feeders to address tubes. I've seen basically three types in my career. First, there are the vibratory feeders that vibrate components into place. The challenges with those feeders are different size packages loaded on the same feeder base. Let's say there are six different tubes in one given feeder, then each lane has its own vibratory setting. It's a challenge to get the vibration of one component not to affect the adjacent component in a negative way. Next, there's the gravity-fed type; once again, depending on the size and weight of a component, the smaller the component, the more challenging it is to transition to the pick position without coming out of the track.

The third type, and the best design I've seen, is called the short stroke linear drive. There are multiple lanes of components, and the feeder just nudges a component forward without affecting the adjacent components. It seems to be the best method for tubes, but in general, dealing with components in tubes is a lot more challenging than tape and reel.

Matrix trays are another type of packaging. There are two types of matrix tray handlers: the direct pick method and the shuttle pick method. The advantage of a direct pick is you can pick the component out of a tray directly with the placement head. The shuttle method is a separate machine. There's a separate nozzle that picks the component out of the matrix tray, and then loads it onto a shuttle conveyor to a staging area, to where the placement head will pick the component.



Matrix trays, such as this example, ease access to individual parts, but add complexity to the pick process.

There are pros and cons with each handler. With the shuttle method there's one nozzle size so it may be good for larger components, but it's not good for components that are, say, 10 millimeters or less. The other thing about direct pick handlers is they take up feeder capacity that you would like to use for tape-and-reel feeders. One type of component that you can

only use a direct pick with is a connector that has guide pins. With the shuttle method they don't sit flat on the transfer belt and therefore they cannot be picked with a vacuum nozzle.

Another challenge we see is inconsistent orientation of how components are placed in the carrier tape by suppliers; they don't always follow the EIA standard. From supplier A, we may have a leadless device where the polarity is at a zero orientation and supplier B has the polarity in a 270 orientation. It requires more debugging time for those types of situations.

Rowland: One issue we encounter in low-volume SMT assembly is re-taping of components by the seller. Sometimes they don't follow the EIA standard for tape and reel. It clearly calls out what the orientation (polarity) of the components in the carrier tape should be. Some companies aren't familiar with the standard, so they don't follow it, and randomly put components in the carrier tape, not thinking about the impact it causes for people during assembly.

Johnson: How do you catch that before AOI?

Bennett: That is done by machine operators during setup. The operator teaches each pickup point with the camera while simultaneously verifying the orientation of the component within the carrier tape. Nomenclature on the top of components can be difficult to see with the camera. Polarity indicators may not be distinguished with lighting adjustments to achieve proper contrast. More time is required to inspect the board after it's been placed with components with hard-to-read nomenclature.

HD Isn't the Challenge, But Picking the Components Is

Johnson: It sounds like there's still a challenge with all the technology involved in picking.

Rowland: Yes. From a complexity or density standpoint, we don't really run into many issues there. Any of the high-end machine manufacturers are going to have machines that can deal with components that are placed closely together on a board. The technology is mature to the point where accuracy and repeatability of the machines is not that big of an issue. But as Kevin has mentioned, the packaging format impacts us the most. If you survey other EMS companies in the U.S., they will probably say component packaging is one of their biggest issues.

Johnson: Where do you currently see your steps in the process today? Where do you see the most potential for you to make a change and get an improvement in your business process?

Rowland: The biggest challenge for placement machine manufacturers is coming up with feeders that are easier to use and more compatible with shorter strips of tape. That's an area where I think the industry has generally failed to meet the needs of users. Some manufacturers have tried to address the issues with shorter strips of tape and feeders. Many of the feeders on the market are designed for seven-inch reels with thousands of components, vs. a five-inch strip of tape. Many feeders just don't work very well with the latter scenario.

Bennett: I agree completely. Large feeders with mechanical parts require the cover tape to weave through it to get it to perform correctly. The shorter the strip of tape, the more challenging it is.

Johnson: Are you laying down a challenge to the placement manufacturers to fix the feeder technology?

Rowland: Yes, this is feedback we've given to many placement machine manufacturers over the years.

Matties: This has been really good. We certainly thank you for your input. SMT007

Finding Solutions in the Quoting Process

Feature Article by Duane Benson

It's easy to frame all our supply chain woes around the COVID-19 pandemic. However, at Screaming Circuits, we started receiving dire warnings about component shortages in early 2018. At that time, we were told that the supply upheaval could last years and that we should expect it to get much worse before it got better. Now, four years later, I would say those warnings nailed it.

A bit ironically, these problems have success at their root, not structural problems within our industry. The same prognosticators I just mentioned gave the explosion in wearable internet-connected devices and electronics in cars as the driving factors behind the wayward silicon. I might add that despite these shortages, trade wars, pandemics, and now actual war, worldwide electronics manufacturing output has continued to increase. Our predicament is being caused by dramatic growth rather than a systemic breakdown.

We've certainly seen our own business grow along with the industry, and that's great for us, but it's no consolation for the engineer trying to get some boards built with parts 52 weeks out. Nor is it any fun for the folks on the front lines of quoting those assembly jobs.

In the quick-turn and on-demand manufacturing world, time is often more important than money and time is where these shortages will bite. An all too common scenario has us receiving a bill of materials (BOM) to quote

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along with an assembly order. We'll check with our suppliers, get costs on most line items, but find that a few are not available and need subs. We'll send the list back to the customer, either with proposed alternates or with the request to give us alternates. Once we receive the updated BOM, we will requote and find that a handful of parts that were available at the first go-round have since gone out of stock. This cycle can be repeated multiple times before we get a complete BOM quoted and approved. This can add days or weeks to the total build time.

Sole-sourced or highly popular components can turn this difficult process into an impossible one. I could give you a long list of components that have lead times ranging from 52 weeks up to "you will never see this part again, so just give up." The manufacturing industry has had to look for creative solutions to keep the machines running.

One of the most important improvements is automating the data connection with components distributors. By directly connecting an online BOM quote system with multiple vendors, much of that quote cycle I described above can take place before the BOM is delivered to a purchasing department. Screaming Circuits and Macrofab have both recently announced an increase in the number of distributors that are automatically queried during the online quote process.

Transparency tools are also helpful aids. Our online quote system will list the maximum stocking quantity that we find and any minimum order quantities (MOQ), then display icons to indicate if a component is out of stock or in short supply. The short supply indication helps the customer determine the sense of urgency. Good supply usually means that there are enough around so the risk of it going out of stock in the next few days is minimal. A low-stock indicator can be used to incentivise a speedier approval cycle.

At high volume forecasted EMS providers, inventory holding costs become the major challenge. If three parts on a BOM are not available, but the other 97 are, the supply uncertainties may dictate that a manufacturer, or the OEM client, buy as much of the available parts as possible. If they don't do that, many other components may become unavailable while waiting on the first three.

This may lead to buying and sitting on a year or more of components stock with no ability to build and sell until the final components come in. Multiple product lines under the same conditions can lead to a financial burden that is simply untenable.

The use of automated tools, like our in-house developments or those from external software vendors, like CalcuQuote, go a long way toward easing the strain of extreme shortages. We are all competing to buy the same parts, but automation and faster communications between contract manufacturers, parts vendors, and OEM customers can make the difference between shipping finished goods and sitting on WIP (work in progress) while the bank nervously eyes a decaying cash flow position.

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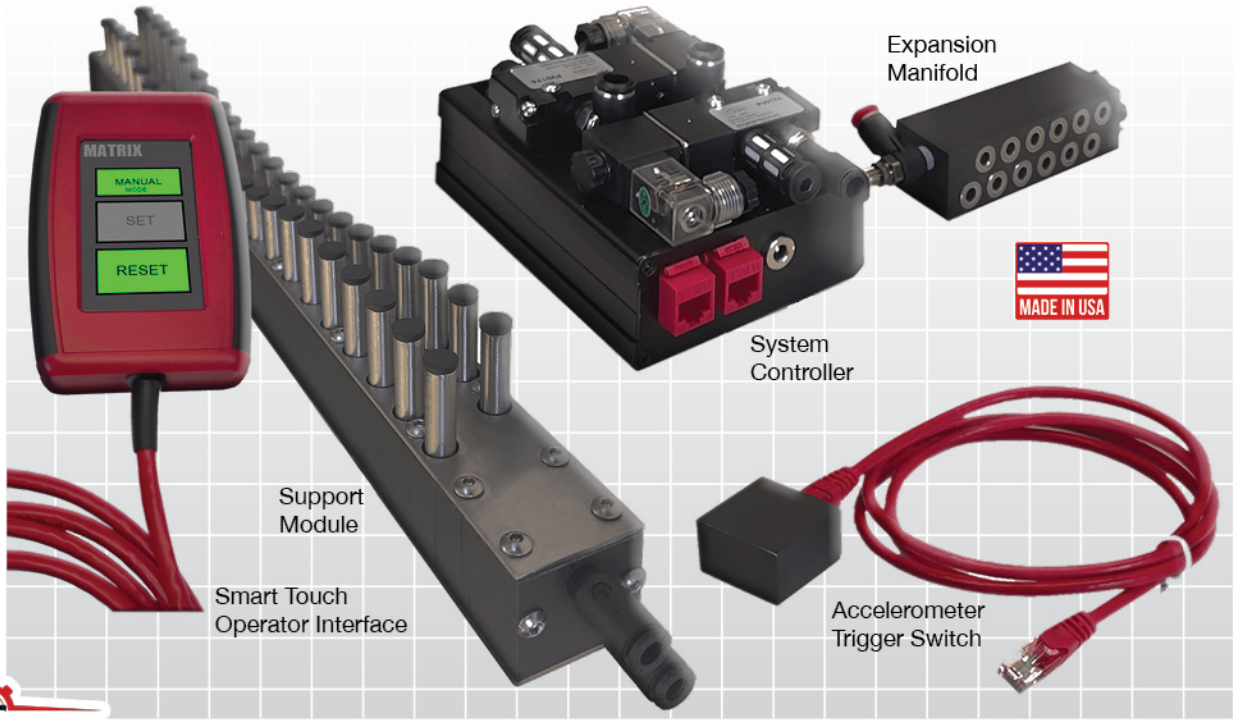

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To that end, the EMS provider industry has had to put increased emphasis on good customer service and efficient communications tools. This applies equally within the quick-turn and traditional EMS settings. No one wants to be the bearer of bad news, but if the news is bad, the best thing to do is to get out front with it. In fact, bad news is usually more important than good, and we treat it that way.

The sooner a manufacturing program manager or customer service agent can get to a customer, the sooner work can begin on solutions. There is no room for slow communications in today's unstable supply chain environment. All the internal teams need to be working together on this. In the past, a sales manager might be tasked with getting the sale and moving on, with the nuts and bolts left to program management. Today, sales, purchasing, support, and program management all need to work together to keep the manufacturer/customer relationship strong and keep the production lines moving.

Supplying alternates has long been standard practice in volume manufacturing. It's just as important now. In fact, having extra approved substitutions is recommended practice. In the quick-turn world, engineers often relied on any given component being available from DigiKey, Mouser or one of a handful of distributors that sell in small quantities. That's not good enough anymore. Everyone needs to think about substitutes before sending the design package off for a quote.

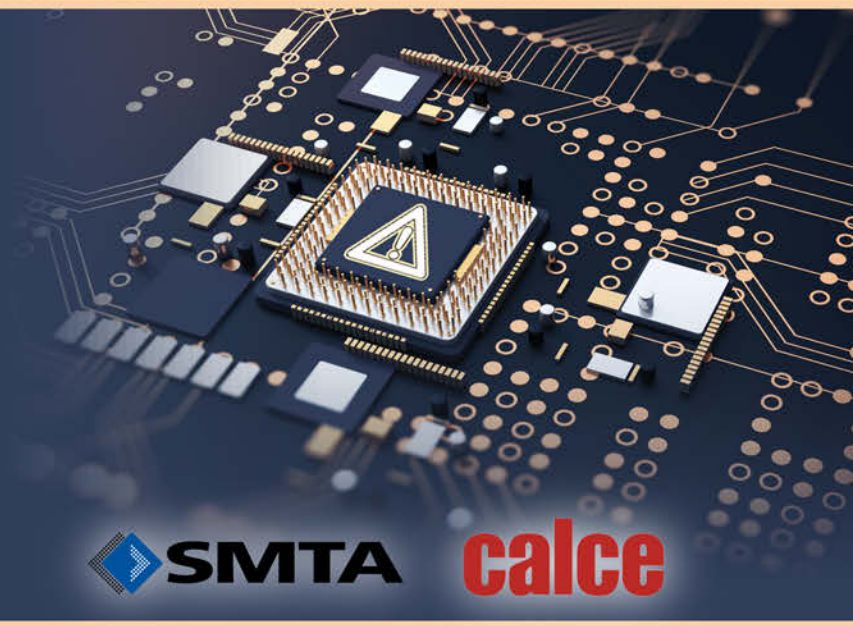
Another concept we are seeing more of is the "wait vs. modify" decision. Designers need to be willing to consider a small redesign to fit a chip package that's more available. Sometimes a new highly integrated component may need to be taken out and replaced with multiple components. This can result in changes to the board real estate and case design. That may seem extreme, but if the fancy chip is out 52 weeks or more, obstinance could result in loss of competitive advantage and revenue.

I don't see our supply chain getting back to where it was pre-2018 any time soon. Designers and builders need to be flexible and quick to communicate. Components manufacturers have a hand in the solution too. Giving a microcontroller eight different part numbers, differing only in the amount of memory, instead of a one or two size fits all solution, gives six or seven more opportunities for an engineer to pick a variety that is not available.

The best advice I can give is to be flexible, automate, communicate as fast as possible, and hang in there. We will get through this, and when we do, it will be a pretty exciting new world. **SMT007**

Duane Benson is director of marketing for Milwaukee Electronics and Screaming Circuits.

Symposium on Counterfeit Parts and Materials



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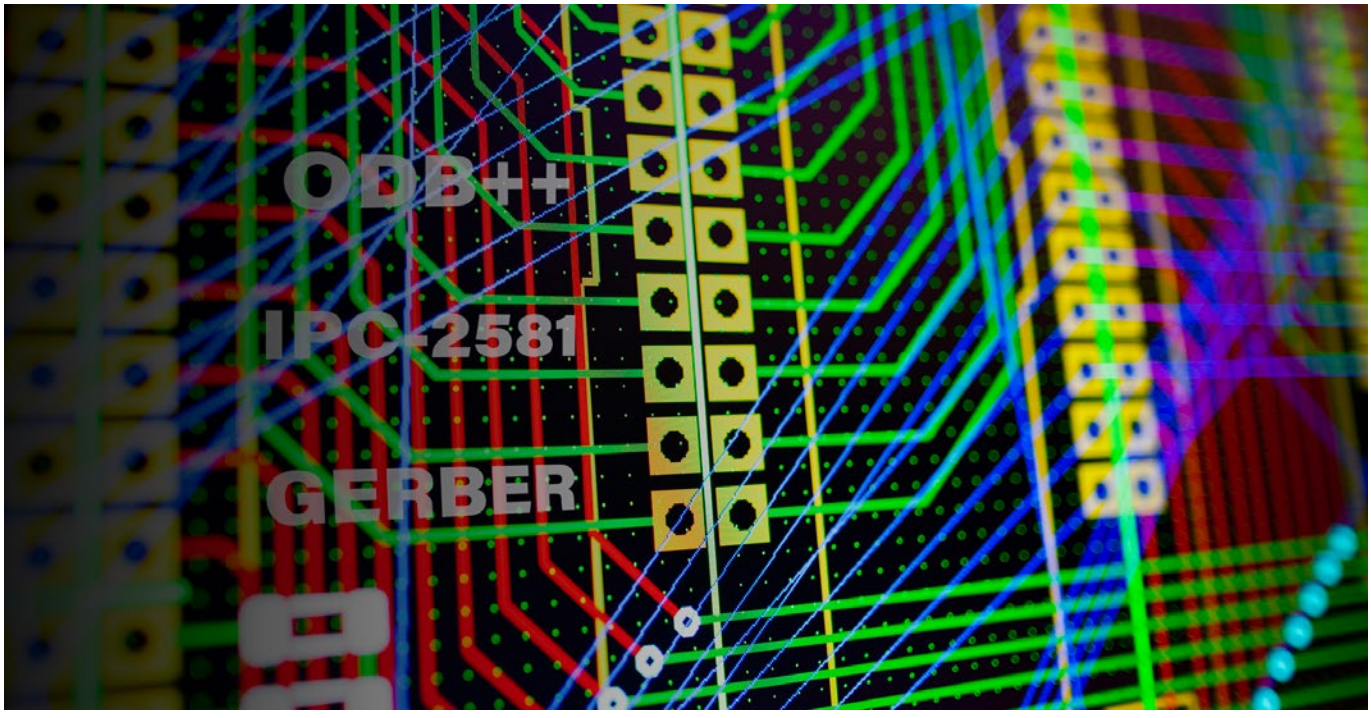

The Data Format Effect on Business Costs

Feature Interview by the I-Connect007 Editorial Team

In this part of the conversation with Axiom's Rob Rowland and Kevin Bennett, the pair discuss the impact of data file formats on pricing, manufacturing, and quality.

Barry Matties: Does it matter what the data format is or the data coming in?

Rob Rowland: Yes, absolutely. There are three formats we usually get from our customers: Gerber, ODB++, and IPC-2581.

Kevin Bennett: The ideal formats would be IPC-2581 or ODB++ because everything needed for programming is within one file. It only takes a couple of clicks to import those file types. The next step is to merge the bill of materials, and from that point you're pretty much ready to export that data to the machine you're going to program it on. But when it comes to Gerber data, which is unintelligent data, much more manual manipulation is required to get it to the same point as importing a comprehensive CAD file, like an ODB++. Gerber makes for a labor-intensive manual process. Basically, you draw a box over any given component footprint and then you must type the reference designator for each location. The extra steps make a huge difference in the time required to complete the offline programming.

Nolan Johnson: How much influence do you have over the file format your customers provide you?

Rowland: In general, we don't have a lot of influence. Many years ago, we put together a document that articulates the differences between the three file formats and highlights the fact that we really need to get ODB++ or IPC-2581 file formats for programming. Over the years, we've tried to educate our customers on the

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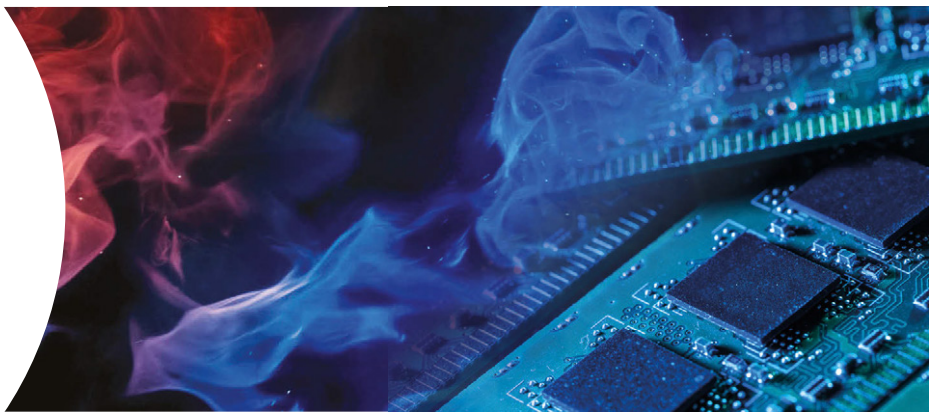

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extra programming effort to accurately and efficiently get the file formats right. Our customers try to accommodate our request and most of the time we get ODB++ or IPC-2581 files.

In our business, we also build boards that were designed 15 or 20 years ago and all they have are the Gerber files. As Kevin mentioned, when we do those, which might be 10% of the time, it takes Kevin and our other programmer three to four times longer to program a board with Gerber than it would if we had received either of the other two file formats.

Matties: Does your pricing change based on file format?

Rowland: Yes. If we get Gerber, we try to cover the additional cost. Programming is not an area we try to make a profit on, but we need to be able to cover our cost. If it takes us three to four times longer with a Gerber file, we need to cover the expense that we incur in doing that.

Matties: Do the customers realize that they would save money by changing the file format?

Rowland: Yes, if they're able to, that is. We have some boards that are so old all they have are Gerber files. We work with what they have available to them. One of our engineers was on the original IPC-2581 committee and is an expert with that file format. He helped some of our customers understand the 2581 format and we showed their design groups how to output the 2581 file format.

Matties: Ultimately, it simplifies your customer's life as well with fewer questions on the back end and so on.

Rowland: Yes, absolutely. If they give us what we need, then we don't call them as many times, if at all, because we have what we need vs. having a lot of questions because the file format isn't very good.

Matties: When we did a survey, Gerber was by far the one people are using most often. They're familiar with it and there's no significant penalty to keep using it or changing.

Rowland: Yes, I agree with you. In some cases, people don't understand there are better file formats for programming than Gerber. Gerber files are best suited for PCB fabrication; this format was never intended for programming SMT machines. That's why we work with our customers and try to educate them as much as we can so that we get the preferred file formats.

Matties: Yes, that's very smart.

Bennett: There is a higher risk of quality-related issues with Gerber because it's such a manual process to program. The potential for error increases all the way through the process. If you receive a good CAD file, like 2581 or ODB++, the component orientation angles are already embedded in those file types upon import. Less verification is required to compare component orientation to customer assembly drawings.

Rowland: If we're asked to quote a board build and all they have are Gerber files, we may no-bid the request because of the time it takes to do the programming.

Johnson: I'm curious about the customer reaction to not bidding the Gerber files. How do they respond?

Rowland: Fortunately, this doesn't come up very often. They are probably getting quotes from at least two or three different companies and there may be an EMS provider that is willing to work with Gerber files. We have reached a point where it's not always a good fit for us, however we always try to work with our customers and provide the best service we can. SMT007


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Optimize Throughput: High-Mix, Low-Volume Manufacturing

The Mannifest

Feature Column by Emmalee Gagnon, MANNCORP

For manufacturers who have high-mix, low-volume production, there are certain pieces of equipment that can help optimize your throughput potential. For an application with high-mix boards, the most important thing is to choose a pick-and-place machine that can support many feeders. If you are unsure of the number of feeder slots your production level requires, it is best to speak with an expert who will review your bill of materials (at no extra charge) to determine exact equipment requirements.

In general, our team recommends pick-and-place machines with 128 feeder ports or higher for high-mix production. This number of feeders (or higher, if needed) allows for optimized throughput potential. For example, one company was able to have all the feeders needed for six different products loaded onto a single pick-and-place machine, thanks to its 128 feeder ports. This allowed them to do very short runs and quickly change from job to job.

A high-quality batch oven can simulate a much larger oven while taking up a fraction of the space. Choose a model that is single phase, simulates up to five zones, and uses around 30 amps of power. A small, manual stencil printer will meet the needs of low-volume, high-mix applications without breaking the bank; just choose a printer able to accommodate a stencil up to 29" x 29" and that provides fine-pitch printing (down to 12 mil recommended).

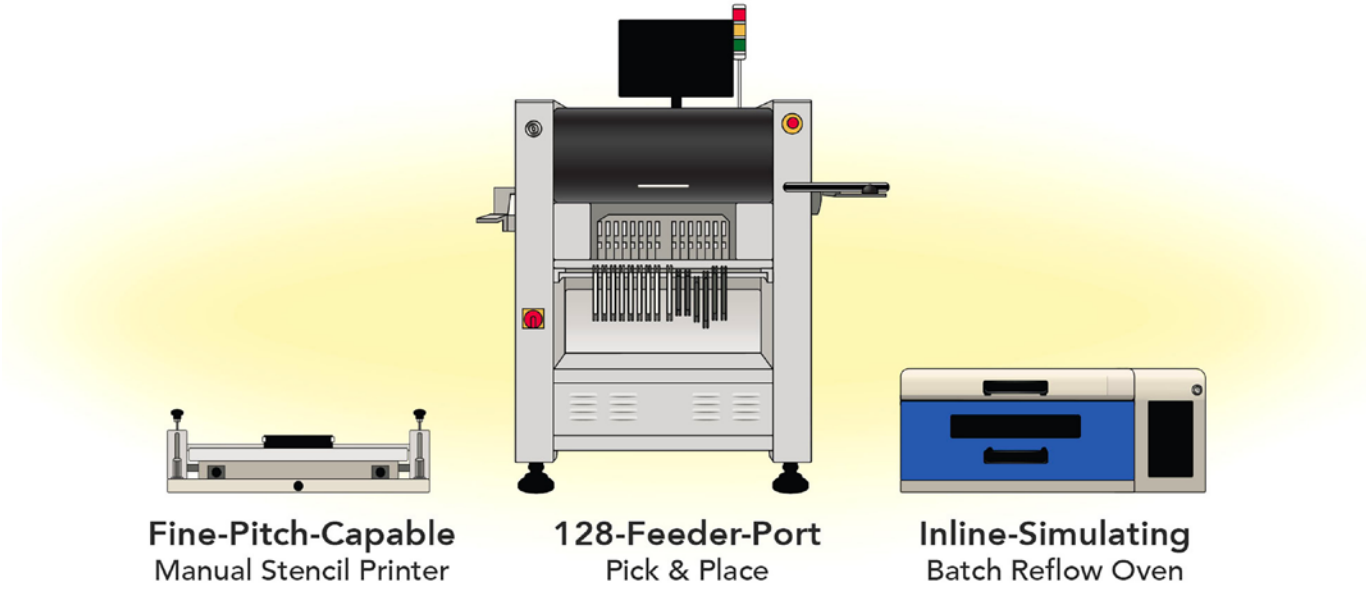

Figure 1: The high-mix, low-volume line provides partial automation for speeding up production while operating in a small space.

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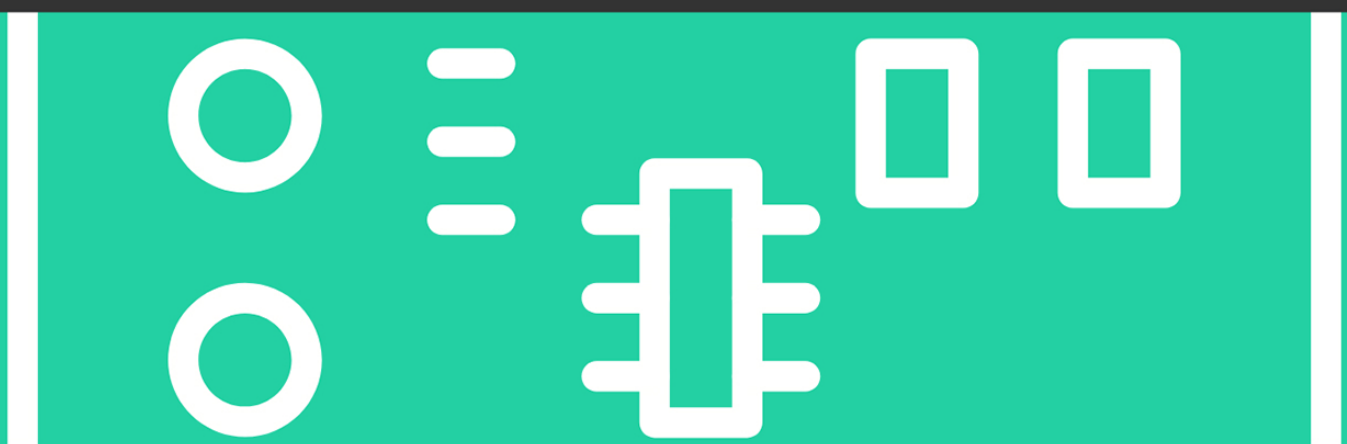

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Figure 2: The Critter & Guitari high-mix production setup with a 160-feeder port pick-and-place machine.

To get an upgrade, choose a quality oven with inline ability. It will help improve speed and reduce the number of boards wasted during testing through features like predictive profiling software. To boost throughput even further, you can go with the two-head pick-and-place. Robert Keeley Electronics runs the two-head version of our 128-feeder-port machine, with great results for its on-demand-production guitar effect pedals.

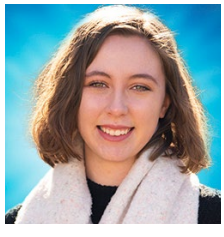
Another equipment line option for high-mix, low-volume is what music company Critter & Guitari is currently running. It has a standout pick-and-place option for high-mix applications since it can handle up to 160 feeder ports (96 feeder ports when used as inline). This allows their operators to have feeders for multiple jobs resident on the same machine, thus reducing changeover time.

When asked about their lineup, designer and founder of Critter & Guitari, Owen Osborn said, "This mix of equipment provides us with a small-footprint PCB assembly line. It really only took a few days to set up and it is easy to get up and running each day."

If inline ability is important to you, but you don't want to sacrifice feeder ports, you could go with a larger pick-and-place that allows for 250+ feeder ports when used as a batch machine, so it will still have 190+ ports available when operating with inline capability. Having this high number of feeder ports is a game changer for high-mix applications, and the ability to have conveyors can reduce the number of mishaps that can happen on boards during transport to the oven.

Expert Tip: Choosing a Smart feeder can help you get the most out of the feeders you use with your pick-and-place machine. Having a built-in screen for monitoring part quantities, feeder slot locations, part numbers, part values, and more—all while the machine is in-use or offline—can greatly improve throughput.

By choosing equipment that can help maximize your feeder capacity, you will be able to optimize your throughput ability. **SMT007**



Emmalee Gagnon writes about SMT-related topics and customer stories for Manncorp. To read past columns or contact Gagnon, click here.

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ABSTRACTS DUE

MONDAY, **JUNE 20, 2022**

View more details

Electronics Industry News and Market Highlights

Vuzix, Acty AR Software Solution Partner on Video Remote Assistance ▸

Vuzix Corporation, a leading supplier of Smart Glasses and Augmented Reality (AR) technology and products, announced a new partnership with Icona Srl, a provider of innovative software platforms, including Acty, its remote video assistance software.

Siemens' SynthAI Revolutionizes Machine Vision Training with Artificial Intelligence ▸

SynthAI automatically generates thousands of randomized annotated synthetic images from 3D CAD data within minutes without the specialist knowledge typically required.

ARC Collaborates with AWS to Support the Internet of Battlefield Things ▸

Armaments Research Company, Inc. (ARC) is pleased to announce its collaboration with the Amazon Web Services (AWS) Federal Small Business Team.

ORNL Multimodal Study Sheds New Light on Promising Photovoltaic Material ▸

A study by researchers at the U.S. Department of Energy's Oak Ridge National Laboratory takes a fresh look at what could become the first step toward a new generation of solar batteries.

Cadence Selected by Microsoft for RAMP Phase II Program ▸

Cadence Design Systems, Inc. announced that it was selected to participate in the Microsoft Rapid Assured Microelectronics Prototypes (RAMP) Phase II initiative.

SIA Endorses FABS Act Introduced in House ▸

The Semiconductor Industry Association (SIA) applauded introduction in the House of Representatives of the Facilitating American-Built Semiconductors (FABS) Act, bipartisan legislation that would establish an investment tax credit to incentivize semiconductor manufacturing, design, and research in the United States.

Argonne Pioneers New Processes to Create Materials for Batteries, Biofuels ▸

When recycling cans and bottles, at some point it becomes necessary to separate out plastic from metal. When recycling car batteries, getting out the most valuable metals also requires a separation, but this time it entails a specific kind of chemical separation process.

iNEMI Packaging Tech Topic Series: Quantum Computing Use Cases for Electronics Packaging ▸

Quantum computing has matured to the point that the electronics industry can consider how the potential power of quantum computers may be applied to help solve some of the biggest challenges in electronics packaging and assembly.

Intel, Community College District in Arizona Launch First-of-its-kind AI Lab ▸

Intel and Arizona's Maricopa County Community College District (MCCCD) announced a new artificial intelligence (AI) incubator lab for students aspiring to land jobs in areas ranging from business to nursing to healthcare—and other professions that increasingly draw on AI technology.

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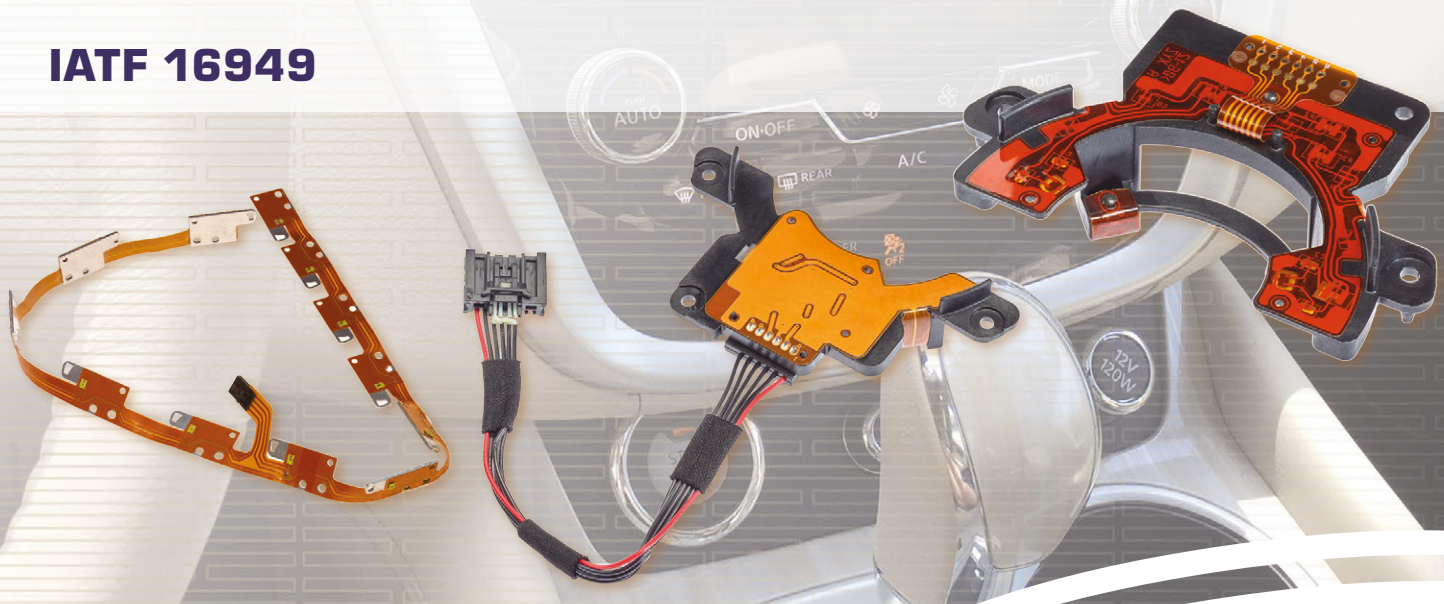

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Fractional Materials and High-Mix Manufacturing

Smart Factory Insights

Feature Column by Michael Ford, AEGIS SOFTWARE

We used to discuss manufacturing paradigms in terms of high- or low-mix, coupled with high- or low-volume, with many shades of grey in between. Now, we have a new dimension, that of high-volatility, as key dependencies on labour, materials, and logistics contribute challenges to production, which in turn, is subject to the volatility of customer demand. More than ever, material management is either the key enabler for business success, or your nemesis in not being able to achieve the necessary recovery plan if not thought out properly.

One unique aspect of electronics manufacturing is that there are simply too many materials to individually manage. Obviously, we use carriers for those materials, whether collected

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on reels, in trays, bags, boxes, or other containers. These are used not only for discrete components, but also for materials measured using fractions of their initial content, such as volumes of liquids for dispensing, coating, cleaning, and solder paste, as well as lengths of wires and cables. For mass production, carriers are very convenient for simple logistics, but as you look deeper at other production paradigms, these carriers introduce a very complex logistical challenge.

Other than high-volume manufacturing, production often does not consume the entire quantity of materials within each carrier, leaving partly-used carriers of remaining materials, and which require specialist management. This very simple fact greatly contributed to productivity levels decreasing from 90% with high-volume production, to some extreme, high-mix cases of only 10%. Whatever benefits have come from mechanically automated production (the dream of the third industrial revolution) have become the proverbial nightmare.

As the market has slowly transitioned from high-volume to high-mix, manufacturing has become gradually accustomed to tweaking existing operations and practices. It creates continuous strain but never breaks. Today's sudden increased volatility in the market takes us beyond that point. As many manufacturers face mounting questions daily of what can or should be built, the least concern should be how—but that is not the case. Consider the increased overhead on what has become routine decision-making in terms of material management:

- Which carriers of material are the most suitable carriers to use?
- What quantity/length/volume of material is remaining, and will it satisfy the needs of the work order without lost time of additional replenishment?
- How accurate is that assessment, bearing in mind the many opportunities for spoilage over the times that this material carrier has been used? There are cases, for example, where a reel of specialized chips was used once a week over a period of several months, each time using a very small number of pieces. Each time the material was set up, spoilage occurred, resulting in around 30% true spoilage rates. It is very challenging to find out that suddenly there are no remaining materials for the next few months of committed production, and nothing on order in the supply chain.
- How "old" are the materials, bearing in mind the many transportations and changing environments that they have been put through as part of their unused collective whilst in their carrier? Moving between environments with different humidity and temperatures causes issues with many types of material.
- Where are the carriers? Most often, partly-used carriers of materials remain in manufacturing between work orders. These are being managed, more often than not, by a team people who are working different shifts, moving things around, and using materials for other work orders. It is extremely difficult to keep track of specific partly-used material carriers, especially with most ERP and MES solutions not keeping track of such materials to this degree of granularity.

These used to be minor, infrequent issues, mainly occurring in between very long production runs, and therefore deemed insignificant. Today, these issues occur frequently, even daily. The management of these issues impacts our decision-making process in terms of deciding what products can be made, and affects the quality with which those products are made. Work that has been absorbed in outdated practices and procedures is human-augmented material management: those few people who could be relied on to find and make things happen. With the current levels of vola-

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tility, this coping mechanism is no longer a viable model.

This situation highlights the need and value of digital transformation. Having a modern MES that understands every idiosyncrasy of the complexities of material management provides the software-based automation that is required. Bear in mind that there are many other complexities involved, such as the management of moisture-sensitive devices and end-of-life materials, as well as multiple part-numbers, owners and statuses for identical materials belonging to different customers in, for example, the EMS environment. These things are currently being managed, and are dependent upon, in most cases, by an extremely undervalued human resource, or by artificially imposed, complex inefficient restrictions and practices that have invisibly accumulated over time.

Digital transformation may appear to be a big step to take at a time when other challenges are pushing the limits of what can be coped with, but this must be seen from the point of view as the compelling need to change, rather than something that is put off until things settle down. The market does not appear to be going back to what it was any time soon, and whenever that is, the recovery opportunity may well have passed by for those who continue to wait. **SMT007**

Michael Ford is the senior director of emerging industry strategy for Aegis Software. To read past columns or contact Ford, click here.

A Game Plan for Upskilling Your Fab Workforce

Interview by the I-Connect Editorial Team

There's been a lot of talk among PCB manufacturers about the need to upskill their workforce. But where do you start—do you set up your own program or send staff to third-party training centers?

The I-Connect007 Editorial Team recently asked David Hernandez, IPC vice president of education, to weigh in on this topic, and the criteria that goes into creating IPC training programs. In addition to upskilling strategies, David also delves into the need for our industry to develop a labor pipeline, as well as the challenges we face in hiring, training, and retaining employees in this industry during a tight labor market.

Nolan Johnson: Dave, our conversation is on upskilling and how the circuit board fabricators should be looking at that situation. This is a big issue for the industry as we deal with staffing issues.

David Hernandez: We are seeing challenges for companies trying to hire at the operator level, the unskilled or low-skill level, but also seeing the same challenges at the high-skill levels, like engineering, as well. Now, there are different challenges in each one, but the consistent theme across the board is that we don't have a pipeline that is feeding talent directly into the industry, and therefore industry is struggling to identify ways to bring in talent. Once they bring in the talent, they're having challenges to onboard and level-set that talent, because they're not pre-trained. They are also having challenges just keeping talent in the industry.

Finally, and it's a big part of what this conversation is about: Once they have that talent in the industry and they're able to keep them, how are they able to continually upskill them to new technologies, new processes, and best practices? When we talk about these challenges, it's not one thing; it's really a culmination of these different challenges throughout the industry coming together at the same time.

To read the entire interview, which originally appeared in the April 2022 issue of *PCB007 Magazine*, **click here.**

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Electronics products are becoming ubiquitous in many aspects of modern life, including smart devices, internet of everything, wearables and self-driving vehicles, as well as the more established (but still growing areas) of communications, entertainment, medical devices, lighting, automotive, avionics and computing. The growth is largely driven by the continued increase in density of integrated circuits, the applications that utilize the greater functionality, and by steadily decreasing power consumption and cost.

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Peter Jacob
EMPA

Tolerance Mistaken: DFM impacts of not properly addressing limitations of material, industry standards and assembly process limitations

Dale Lee
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Design for Reliability and Reliability Testing of Electronic Interconnects

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Supplier Highlights

CalcuQuote's Breakthrough Quoting Solution ▸

While at SMTA Expo Dallas, I learned more about CalcuQuote's automated quoting and purchasing software from CalcuQuote president, Chintan Sutaria. As Chintan explains, in these days of supply chain challenges, having an automated system that easily and efficiently searches for—and purchases—components can be a game-changer for EMS companies.

Murata Completes Acquisition of Resonant Inc. ▸

Murata Manufacturing Co., Ltd. is pleased to announce that the acquisition of Resonant Inc., a leading company in RF filter design, was completed on March 28, 2022.

Gen3 Provides Key Tools for Electric Vehicles ▸

UK Manufacturer of test and measurement equipment for the electronics industry, Gen3 is working overtime to produce enough of its systems to meet the rapidly growing demand for both their AutoSIR2+ and AutoCAF2+ Systems.

MacDermid Alpha Appoints New Global Product Managers for Electrolube Brand Resins and Coatings ▸

MacDermid Alpha Electronics Solutions, a global supplier of integrated solutions from our Circuitry, Assembly and Semiconductor divisions that provides unmatched capabilities in electronics design and manufacturing, has announced the appointments of Saskia Hogan and Beth Massey as new global product managers for the Electrolube brand.

Indium Expert Named to iNEMI Board of Directors ▸

Indium Corporation Principal Engineer and Manager for Thermal Interface Materials Applications Andy Mackie, Ph.D., M.Sc., has taken on a new role on the iNEMI Board of Directors.

SCS Announces Opening of New Vietnam Site ▸

Specialty Coating Systems, Inc. (SCS) is pleased to announce the addition of Specialty Coating Systems (Vietnam) Co. Ltd. The ISO 9001:2015-certified facility provides conformal coating services to customers across the consumer and industrial electronics, transportation, aerospace, and medical device industries.

Koh Young America Strengthens Operational Excellence with New Team Members ▸

In a direct response to the unprecedented level of demand for its inspection and smart factory solutions across the Americas, Koh Young, an industry leader in True3D measurement-based inspection solutions, is proud to announce several new additions to the team supporting North and South America.

CyberOptics Receives $1.9 Million Order for 3D MX3000 Systems ▸

CyberOptics Corporation, a leading global developer and manufacturer of high precision sensing technology solutions, announced that it has received an order valued at $1.9 million from a recurring customer for its 3D MX3000 memory module inspection systems, powered by Multi-Reflection Suppression (MRS) sensors.

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Automating the X-ray Inspection Process

Interview by Nolan Johnson
I-CONNECT007

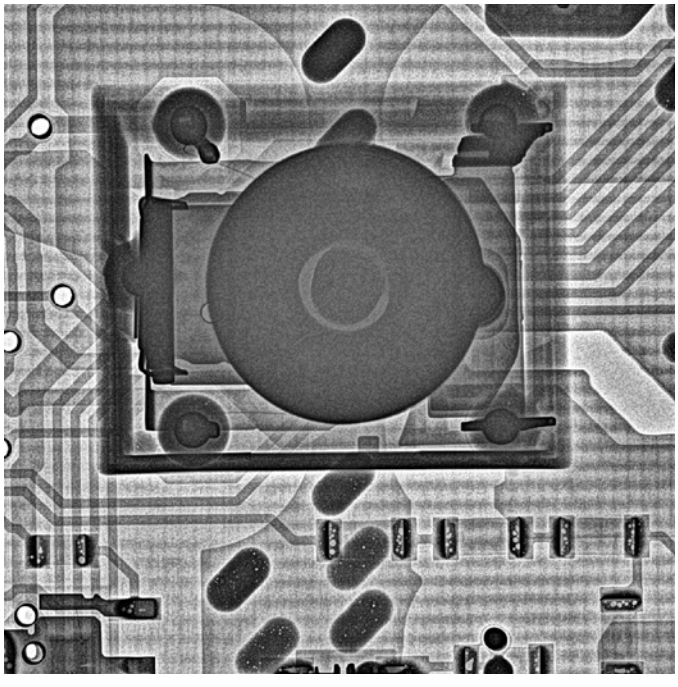
VJ Electronix's Brennan Caissie shares the benefits of a new inspection tool that can be used on a variety of boards, with an automated system that takes the pressure off the manufacturing floor operators and can provide feedback all the way to the design process.

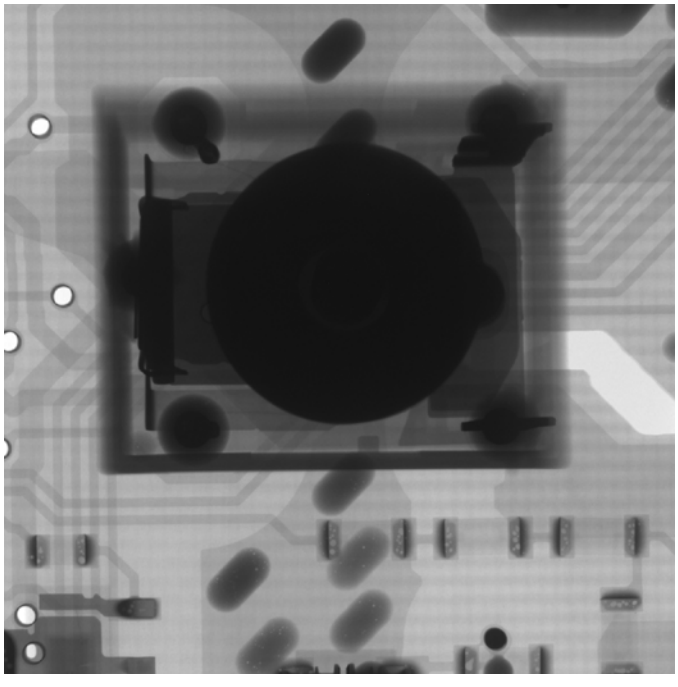
Nolan Johnson: Brennan, can you explain what you do as an applications engineer?

Brennan Caissie: Yes. I interact with customers, working with them to find their needs, translate that back to our engineering group and come up with solutions for customer applications. VJ Electronix specializes in X-ray inspection, X-ray counting for components, and rework machines.

Johnson: You have some news coming out of VJE about some new products. Could you fill us in?

Caissie: Sure. We have a new product coming out called the Apogee 90, which is a 90-kilo-Volt PCB inspection machine. The Apogee 90 is primarily aimed at customers generating consumer electronics, medical components, products with smaller and lighter boards. This machine is going to have some software capabilities that are new for us. There's BGA analysis, for example. We also have some automated filters and automated inspection routines. We can tilt the detector in the machine to get angled images. There are quite a few new features we are bringing to this machine.





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Johnson: Angled images? In that regard, are you starting to rely on more than just 2D contrast for identification? Are you starting to use a little bit of a 3D angle at this?

Brennan Caissie

Caissie: That's right. It's not quite 3D, but more than a top-down 2D image. We can tilt the detector in the machine up to 45 degrees so we can get an angled image so you can see the top and bottom of structures like vias, to see exactly where the solder is placed in three dimensions.

Johnson: What's the advantage to these angled images?

Caissie: In boards where you have multiple layers, it is sometimes helpful to look inside through-holes and vias just to see if the solder is completely filling those areas with no voids in the solder.

Johnson: The additional angles certainly help you get a more complete picture of what's going on there.

Caissie: That's right. You can also use that feature to look around some tall components that might be blocking your view. You can angle the detector to see around those types of components as well.

Johnson: You have some capabilities within the Apogee to handle some different types of boards. What makes that challenging? Why does that require you to do something different?

Caissie: We have a 90-kiloVolt system, which is good for smaller, thinner boards. When you get into the larger boards with multiple layers, it does get a little more difficult for that X-ray to penetrate all the way through. We have a 130-kiloVolt version coming that will be more appropriate for those types of applications.

Johnson: Because of the board type, you need to optimize. One system is not going to work for every board thickness.

Caissie: That's right. We typically use the higher power system for applications like server boards and automotive components. Those thicker boards are going to require more power to penetrate through those boards to see all the different layers.

Johnson: With this new capability and trying to work at this market where you're dealing with the smaller, lighter boards, what are some of the key market drivers? Obviously, you need a slightly different X-ray system to optimize to those sorts of boards, but what are your customers looking for?

Caissie: We typically see customers asking for automated routines to inspect a number of different locations on a board, to bring that data into automatic reports, and to load that data into a database. We also see a lot of customers looking for BGA analysis tools and inspection analysis that will automatically generate reports on things like solder fill, solder voiding, etc.

Johnson: Now we're starting to talk about data collection.

Caissie: Yes. These machines can automate inspection and generate reports. We can save that information into custom locations or into a customer database. We can include different information, like the X-ray settings used or image annotations, in those reports as well.

Johnson: What are some of the new things a manufacturing floor supervisor and manage-

ment should be able to access through this new software reporting capability?

Caissie: They can use the software to program a number of different locations into the machine so that when they initiate a routine, it will go through and inspect each of those locations. Each of those locations can have custom settings for the X-ray power, the zoom positioning of the source and detector, and the detector angle. It also can perform automated BGA analysis, generate reports, and save that information.

We have several different filters we can apply to the images. We have one that is called the automatic defect enhancement filter that saves the full 16 bits of data that we get out of that detector, and it uses the full range of that data to produce a high contrast image. (On some monitors that you're looking at these images on are only eight bit which compresses the viewable range.) That's a nice way to bring that information together in a very visible way for an operator.

Johnson: What are the implications this new data gathering capability brings to business analysis? Does this data provide feedback to the programmers who are setting up the jobs for the OEM or the design team, to help them understand where they may have a weakness in their design and their layout? How far back upstream can you feed this information, Brennan?

Caissie: This can go all the way back to the design phase when you're designing for repairability, designing for ease of manufacturing. If you're looking at some of these BGA analysis tools, for instance, and you see that there are many contacts with bridged solder, misplaced solder, or missing solder, you can feed that back into the design team and say, "Perhaps there's some layout changes we can make." You can feed that back to the manufacturing floor and tell them that maybe there's something wrong with your solder process, where it's not creating a full fill on these components. It can really affect everything from design through manufacturing.

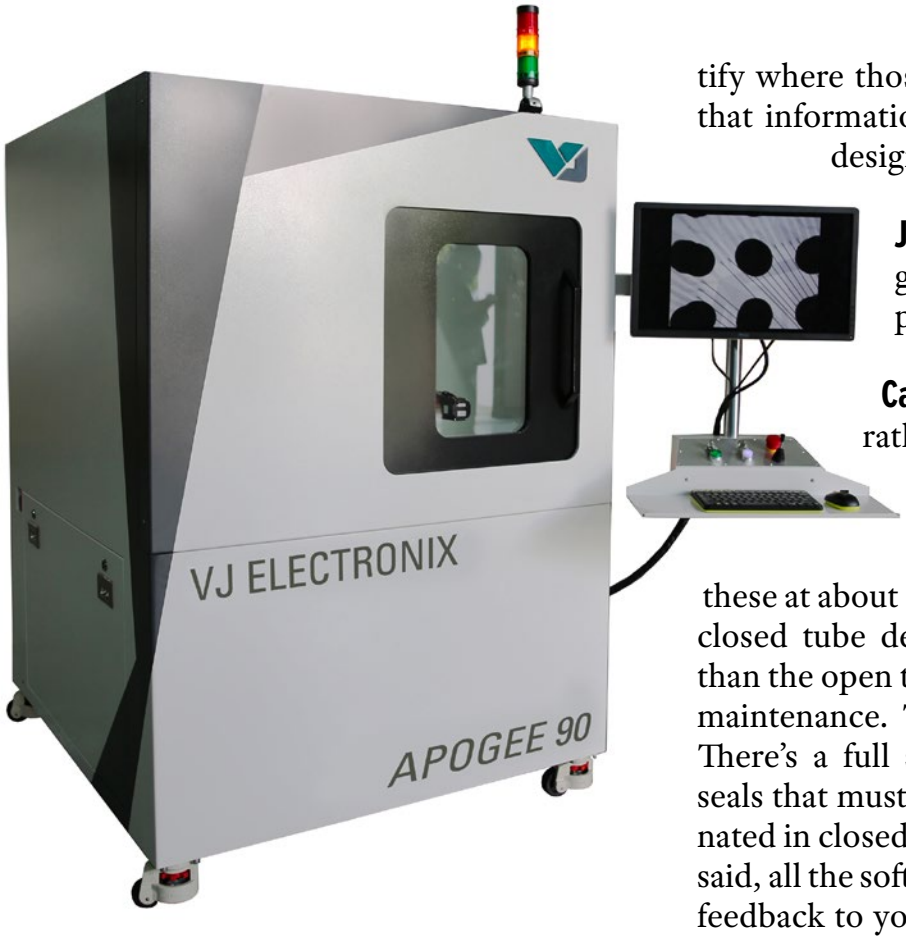
Johnson: Right. When you have a piece of equipment like this on the factory floor, that conversation inevitably leads to return on investment. What are some of the key elements for this Apogee machine in delivering a rapid ROI for the customer?

Caissie: Sure. It's a bit hard to quantify if a machine is targeted for inspection for sampling. What you're really doing is preventing errors down the line and optimizing a process to avoid any costly situations where you would have to either bring in a lot of rework or even scrap boards because they're not being manufactured correctly. Within a few years, the money you save from being able to prevent those kinds of errors should outweigh the cost of the machine.

Within a few years, the money you save from being able to prevent those kinds of errors should outweigh the cost of the machine.

Johnson: The actual ROI comes out of saved labor and material in resolving manufacturing issues.

Caissie: Exactly. It makes it a lot easier to identify issues early and to prevent them. If you're using it as a sampling device, you can prevent errors in manufacturing by catching them early. As you say, it reduces labor and wasted material quite a bit.



Johnson: It seems to me the key is in the data and being able to use that data to make iterative changes that make it more efficient for higher yield on the manufacturing floor and so forth. This takes us back again to sending the data back up and down the whole flow of the design.

Caissie: Right. You can feed those automated reports that you're going to get out of the machine, showing the analysis of the component placement, the solder fill, and you can feed that back into manufacturing, where they can use that data and adjust the process accordingly to bring that yield up.

Johnson: It's interesting right now, how X-ray inspection used to be a point solution. It was historically a pass/fail. Now it can be very much a part of the feedback loop.

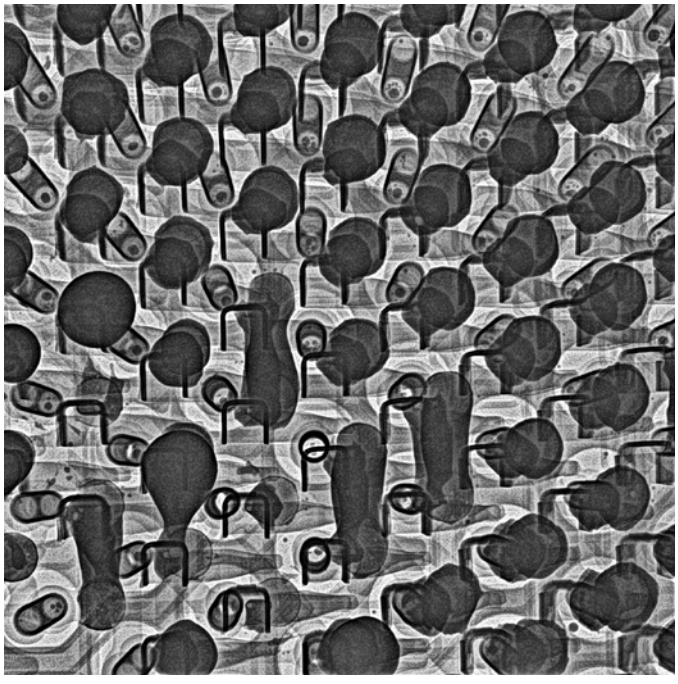
Caissie: Absolutely. We have several great tools built into the software to make it easy to identify where those problem areas are and bring that information back to the attention of the design and manufacturing teams.

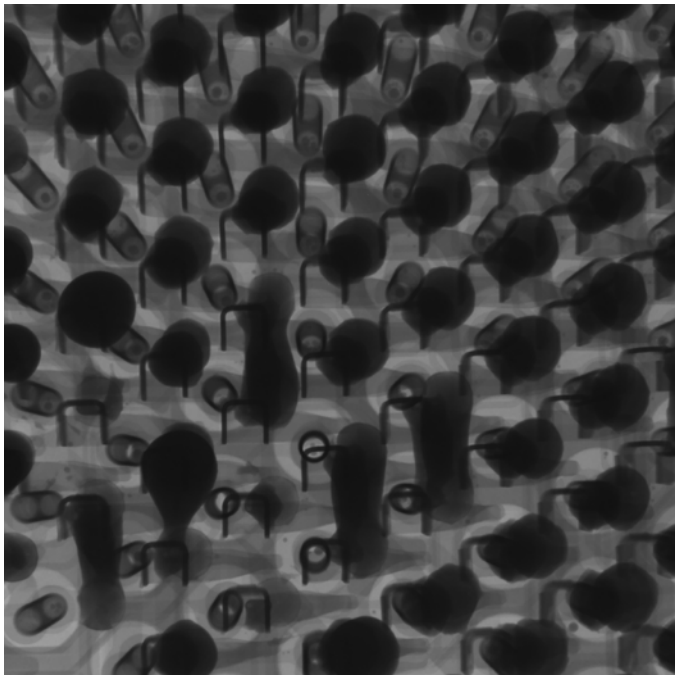
Johnson: What makes the Apogee itself such a compelling product?

Caissie: It's a closed tube design rather than an open tube design. It's going to have less maintenance, lower costs, and it's reliable. We typically rate these at about 10,000 hours of service on these closed tube designs, which is a lot different than the open tube designs that require a lot of maintenance. They require cycling vacuums. There's a full system of vacuum pumps and seals that must be maintained. That's all eliminated in closed tube designs. We also have, as I said, all the software that is key to bringing that feedback to your manufacturing line and preventing any issues that might impact or lower your yield.

Johnson: In the current market, there is plenty of demand for EMS manufacturing right now. At the same time, it's difficult to find staff, which creates a conundrum in which you have work to be done, but your old processes required too much on-hand operators, and processes need to change. What's your vision for helping automate the processes?

Caissie: There's definitely a focus on automation with our products going forward. We have the ability to automate a number of different routines within the Apogee. We have some more features planned down the line to import CAD files and be able to identify within that file the components that you're interested in inspecting so that you don't have to manually program these routines. All these features reduce the need for an operator to spend time manually inspecting components and solder joints.





Johnson: Keeping machinery doing what it should be doing, inspecting boards rather than getting programmed.

Caissie: That's right.

Johnson: Throughput is always a concern. New machinery doesn't have as much value, frankly, if it's slowing down the throughput. How are you attacking that? Is there a throughput bump-up with the Apogee that we're talking about today?

Caissie: There are a couple different things to discuss. As far as throughput, this is an at-line machine rather than inline. When you're using it, you're sampling for inspections of products off the line. You're typically not inspecting every board. You're also, through the automation, speeding up the individual inspection task. You're not manually moving the boards around or adjusting all the settings and saving all the data. That does save quite a bit of time as well. As a closed tube design, it does like to stay powered up. You can save a lot of time in power cycling the machine if you can just leave it active.

Johnson: What do you see as primary market drivers for your customers right now? What are they challenged with?

Caissie: Automation and making it easier to place a board in the machine, hit "go," have all the data collected, analyzed, and passed out to the appropriate data collection areas. We see a lot of customers worried about exposure to X-ray on sensitive parts, but that's one of the reasons why we offer both the 90 kV version and the 130 kV version.

Johnson: Who is the ideal customer right now?

Caissie: If you're worried about your yield numbers, have a need for sample inspection or automated inspection and analysis of your solder processes, I think we're a great value.

Johnson: Thanks, Brennan. **SMT007**

MilAero007 Highlights

American Made Advocacy: What Happens in Washington Happens to Us All ▸

Like many of you, I've spent the last few years grappling with the challenges posed by a global pandemic. Whether it's staffing a production line or obtaining key materials, PCB manufacturers and their suppliers have had to adapt quickly to a radically changed environment. We're more than 700 days into this new world, but as an industry, we cannot allow our day-to-day focus on operations to distract us from what is happening in Washington and what it means to the microelectronics ecosystem.

Testing Todd: Has Universal Fixture Testing Gone the Way of the Dodo? ▸

Although flying probe testers have become common place in today's manufacturing theatre, one must wonder if the fixture tester, specifically the universal grid or "pin in hole" fixture has any valuable use in the electrical test arena? The advancements in flying probe technology are undisputed with the new abilities to do many of the tests that benchtop testing historically required.

Catching Up With Alpha Circuit's Prashant Patel ▸

There is plenty of evidence that the American PCB industry is going through a revitalization. While a few new companies are being established, others are being rejuvenated as investors gain more interest and confidence in domestic PCB companies. I reached out to Prashant Patel, owner and president of Alpha Circuit Corporation in the greater Chicago area. I wanted to hear about his investment and the unique path he took to owning a PCB shop.

Flexible Hybrid Electronics Design: Reducing Time to Market ▸

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DARPA's Novel Orbital Moon Manufacturing, Materials, and Mass Efficient Design program is underway with eight industry and university research teams on contract. The selected teams are tasked to provide foundational proofs of concept in materials science, manufacturing, and design technologies to enable production of future space structures on orbit without the volume constraints imposed by launch. All manufacturing would be done in orbital construction facilities and the results utilized in orbital applications.

Prototron Circuits Installs Maskless Model 5600 LED Direct Imager ▸

Prototron Circuits of Tucson, Arizona, has recently installed a Maskless Model 5600 LED Direct Imaging machine. The Maskless Model 5600 allows for processing .003 mil lines on most applications.

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Take Your Assembly Skills to the Next Level

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.

Ivy Benson operators Andy Connors, age 20, and Sue March, age 19, have become a little more than friends. Let's look in on them having pizza after a movie near Ivy Benson Electronics.

"Well, tomorrow is the first SMT class that Chuck Tower will be giving us," Andy said, and then jokingly, "And the good news—it's on overtime."

"I brought the SMT test that Chuck gave," Sue responded. "Let's see if we can answer the first five questions together and then check the answers online."

"I was hoping for a little romance," Andy said, teasingly.

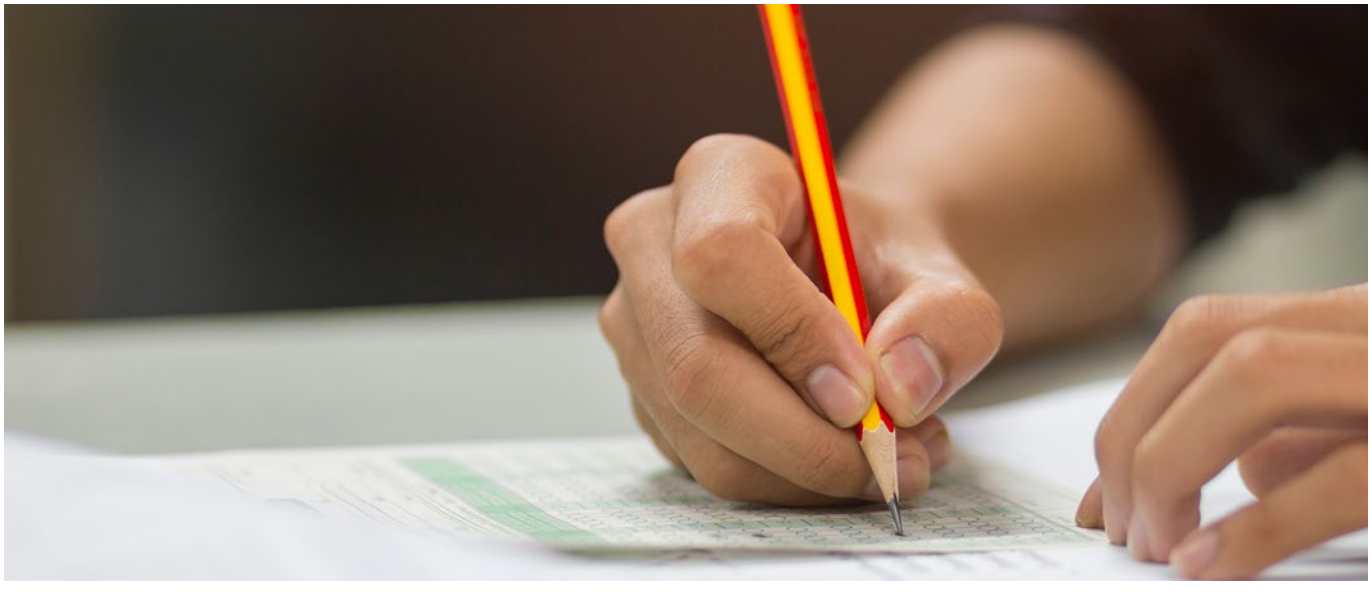
Sue teased back. "Okay, Romeo, how about this? If we feel confident that we can answer four out of the first five of these questions, I'll let you hold my hand when we walk to the parking lot."

Andy groaned a little, but then smirked, "Okay, Juliet, let's look at the test!"

Sue laid the test on the table and started reading the questions. Question 1 said:

1. How much copper is in SAC305 solder?

a. 3.0 %
b. 0.3%
c. 3.5%
d. 0.5%
e. None of the above



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"Let's see if we can figure out the questions first without looking them up," Sue suggested.

"Good idea," Andy said. "We already know that SAC means S = tin (from Sn), A = silver (from Ag), and C = copper (from Cu). I also remember hearing Chuck say that tin is the fundamental metal for solders, and almost all solders start with tin."

"So what about SAC305? Isn't silver expensive?" Sue mused. "If so, there probably isn't that much silver in it or the solder paste would be under lock and key."

Andy responded, "You know Pete Smith, right? He's really smart. He once mentioned that there are solder pastes with only silver and no copper, so I'm thinking the amount of copper is likely very small."

They hemmed and hawed as they spiritedly debated on the answer. First, it was 30% silver and 5% copper, but those seemed too high. After a few minutes, they settled on 3.0% silver and 0.5% copper since they felt the numbers would be in order with the letters SAC.

"Okay, let's use our phones to look up the answers," Sue suggested.

She entered the search and found a website[1] with the answer.

"We were right!" she said loudly. "This is kind of fun."

"I agree," Andy said, laughing. "Let's look at the next question."

2. The formula for aspect ratio (AR) for a stencil aperture is: d/t, where t is the stencil thickness and d is the line width. Assuming the stencil is 5 mils thick, what is the finest line that can be reliably printed? A rule of thumb is the AR should be 1.5.

a. 5.5 mils
b. 3.5 mils
c. 7.5 mils
d. 10 mils
e. 4.5 mils

"That's obvious, the answer is C. 7.5 mils," Sue exclaimed.

"Whoa, wait a minute, how could you get the answer so fast?" Andy asked, feeling a bit dejected.

"Well, look at the formula," she responded brightly. "If t = 5 mils and AR is 1.5 = d/t, d must be 1.5 times t or 7.5."

"Yikes, I see it now, but not nearly as fast as you did," Andy said, letting out an audible groan.

"Even though I didn't see its value at the time, I was a good student in Mrs. McGillicuddy's ninth grade algebra class," Sue shared.

Upon hearing this from Sue, Andy started thinking he needed to "up his game," and then suggested they look at the next question.

3. Assume that component placement is the "gate" in an SMT assembly process line, which has one chip shooter and one flexible placement machine. The chip shooter takes 60 seconds to place its components while the flexible placer takes 45 seconds. Some chips are being placed by the flexible placer. To improve productivity, what should be done?

a. Nothing, everything is fine.
b. Chips should be taken off the flexible placer and put on the chip shooter as chip shooters are best to place chips.
c. Chips should be removed from the chip shooter and placed on the flexible placer to time balance the line.
d. The chip shooter is so slow, so move all the components to the flexible placer.

"That one is obvious, right? The answer is C," Andy exclaimed.

"I agree," said Sue. "Chuck had talked about this from the first day Maggie and John took over the company. 'The line should be time balanced,' he would say."

"It's sort of hard to understand how someone would not see this," Andy said. "You will assemble more boards if the line cycle time is at minimum, and it is minimized by time balancing the component placement machines."

Sue was excited as she explained her answer. "The challenge is to know how many components to move from the chip shooter to the flexible placer. That requires using algebra. I actually think I know how to do that."

Andy's heart sank. He wanted to impress Sue but didn't even know where to begin to solve this problem.

Sensing his apprehension, Sue suggested they had mastered the third question and it was time to move on to the next one.

4. What is a fiducial on a printed wiring board (PWB)?

a. It shows the PWB manufacturer that the etching process is within specification.
b. It is used to align the PWB to the assembly equipment.
c. It is needed as a reference for solder mask.
d. It is the most cost-effective way to minimize PWB warpage.

"I've got this one," Andy said. "The answer is B. I work on the stencil printer most of the time and we need to align the PWB to the printer. When Sam Reynolds was teaching me to do this, he said, 'Andy, this step is called aligning the PWB fiducials to the printer.'"

"Well, I work mostly on the reflow oven and setting the kits up for the next jobs, so that is a new one to me," Sue responded as they moved on to the final question.

5. What is closest to SAC305's melting point?

a. 230°C
b. 210°C
c. 183°C
d. 220°C
e. 200°C

"Since you are the reflow, hotshot, you should know this one," Andy teased.

"The peak temperature of our reflow ovens is between 240°C and 245°C," Sue mused.

Figure 1: Sue March works on a reflow oven like this one.

"So maybe 230°C is the answer?" Andy suggested.

"I'm not sure," Sue responded. "I remember Chuck Tower commenting that the peak reflow temperature needed to be at least 20°C over the melting point of the solder to assure that it melts. So, I think the best answer is 220°C."

While she was talking, Andy looked it up on the website.

"Google says it is 217°C, so you were right, Ms. Superstar," Andy teased.

"Wow, five for five, but I think we were a bit lucky," Sue said.

Andy chuckled and said, "Agreed."

Sue became a bit pensive, adding, "I wish I could be like Maggie Benson. She is so smart and confident and 'with it.'"

"Why can't you be?" Andy asked.

"Don't tease me," Sue said.

"You'll hurt my feelings."

"No, seriously," he replied. "You're only 19, she's in her mid-20s, and you're smart, too."

"Why do you say I'm smart?" Sue asked.

"You did that stencil aperture ratio problem in your head, for Pete's sake," Andy exclaimed.

"Wow, thanks," Sue said softly as she beamed a little.

"Look, today is the first day of the rest of our lives," Andy said, his confidence growing. "Let's take the offered training at work and go to night school at Tech. In about four years, we will have our AS degree and then maybe we can go to Ivy U and get our BS in four more years."

Sue blinked at him slightly incredulously and said, "That's eight years total! Do you know how old I'll be in eight years? I'll be 27."

"How old will you be in eight years if you don't go to college?" Andy asked with a chuckle.

Sue got the point and gently punched Andy in the arm.

"Okay, Romeo, let's make a pact to both charge ahead and get our BS in eight years," Sue declared.

With that, she grabbed Andy's hand as they walked toward the parking lot.

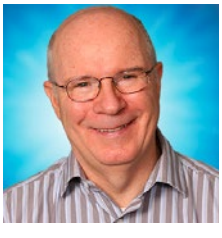
Okay, some readers will think this vignette is too corny. I disagree. Being a professor at Dartmouth College and working with the wonderful folks at Indium Corporation, I have many opportunities to mentor young engineers and professionals. It is a rewarding calling. I encourage all readers to recognize the Sues and Andys in their lives and be a mentor to them.

Best wishes, Dr. Ron **SMT007**

References

1. "SAC305 May Not Become De-Facto Standard," by Ron Lasky, Indium Corporation.

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, or contact Lasky, click here.



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2/3 of electronic industry companies have difficulty finding production workers.[1]

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[1] IPC. (2017). Findings on the Skills Gap in U.S. Electronics Manufacturing.

KIC Adds Wave Monitoring Technology to Industry 4.0 Ecosystem for Thermal Processes

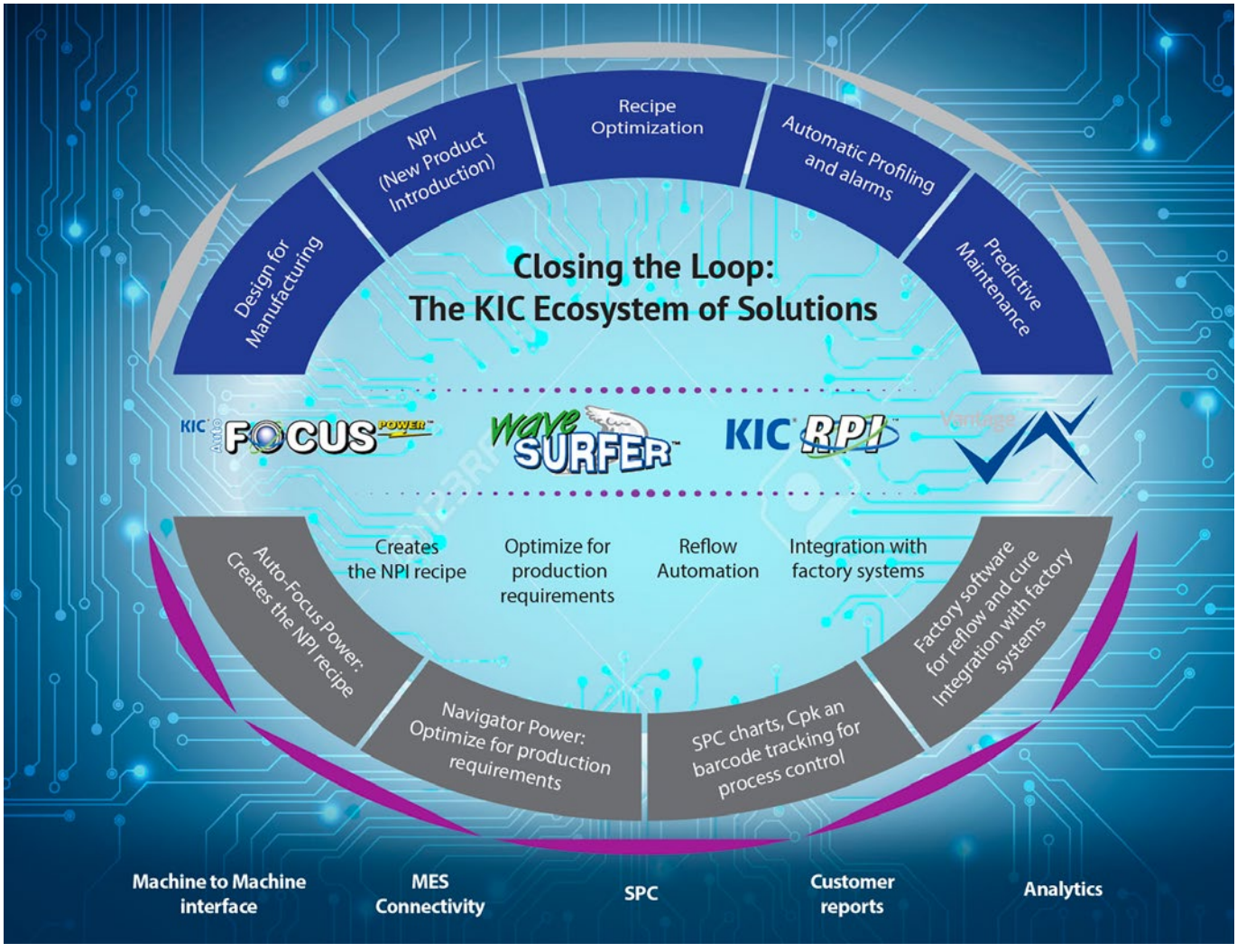
Interview by Andy Shaughnessy
I-CONNECT007

At the SMTA Dallas Expo, Andy Shaughnessy sat down with Miles Moreau of KIC to discuss the company's latest offering in wave process inspection technology. Miles also explains how KIC's early focus on automated real-time process monitoring has enabled them to become a leader in Smart factory implementation.

Andy Shaughnessy: How's it going, Miles? Good to see you here in Dallas.

Miles Moreau: The show is going well. It's good to get out to these SMTA tabletop shows again. We did a couple of them in the fall and now the spring season is starting up. People are happy to get out and be face to face with customers.

Shaughnessy: You have a couple of new processes that you've been working on. Why don't you tell us about the latest things you have going on?



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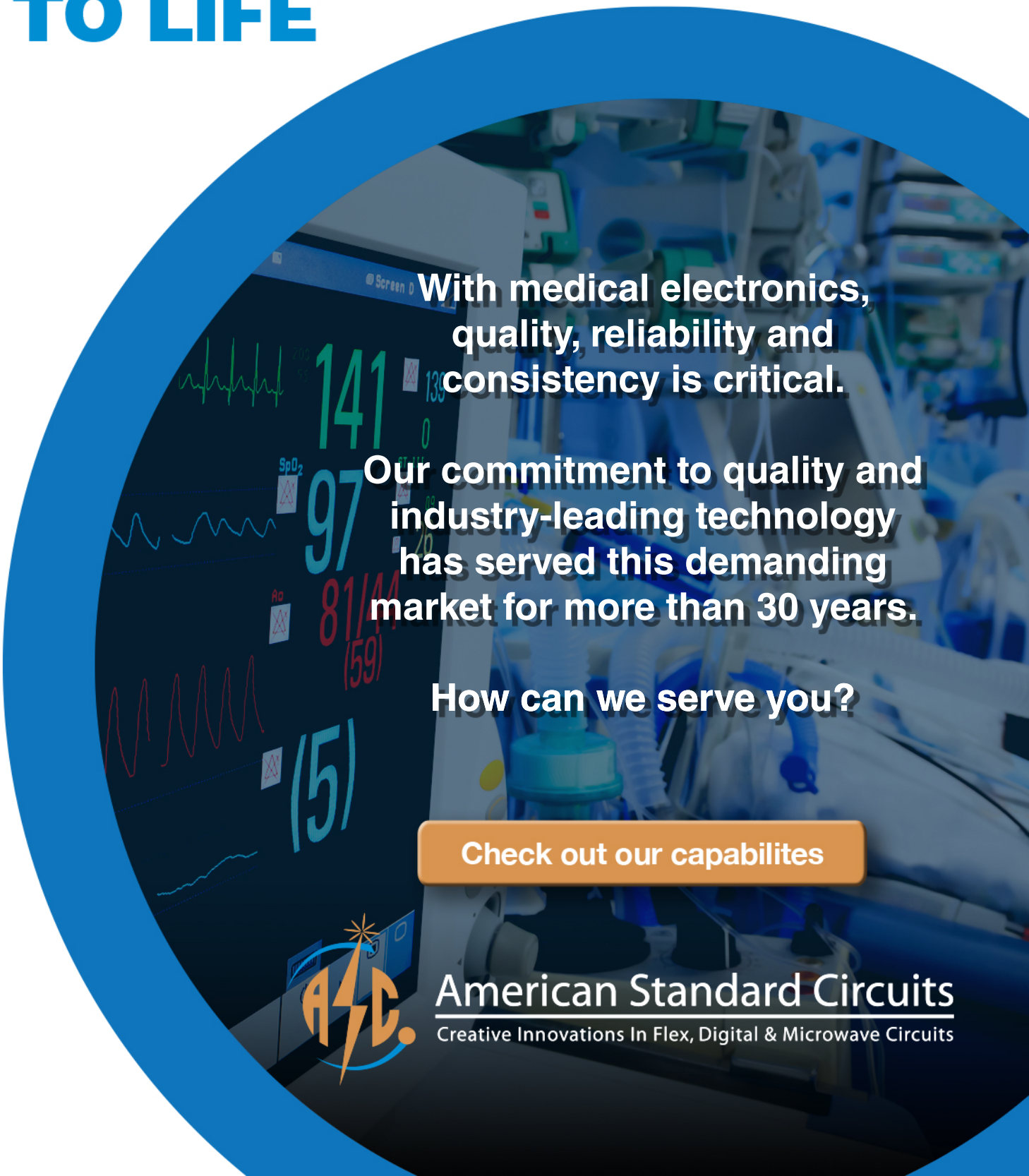


Miles Moreau

Moreau: KIC has always had monitoring systems. It's been our bread-and-butter core technology for the past 40 years. This past year we added wave process inspection (WPI) as our latest state-of-the-art next generation system. We're not only monitoring the preheat of the wave or the temperature, but we're monitoring aspects of the wave. We have profile data throughout the entire process: through the wave, and peak temperatures on the wave, as well as the preheat during production. We also have an industry first: measuring the dwell time in the wave soldering process for every production board.

That's the big addition to our technology this past year; it fills the suite of what we have, what we call the thermal process component of inspection, where you have your SPI monitoring what's happening on the paste print. You have AOI post placement and AOI at the end of the line, but there's always that missing segment from reflow and wave. That's only been handled by the occasional pass-through profile, and with the KIC RPI system, we fill that final void in the whole process of inspecting as you go down the line.

Shaughnessy: That's really interesting. It must be something to have to write the software that can do this.

Moreau: Yes. From the beginning of KIC, we have had analytics and AI based on sensor technology. There are other systems available that do some type of monitoring, but we've had embedded systems, which are sensors embedded into the ovens, accurately tracking the product, knowing the speed it's going through and the temperatures along the board path. Because of that, for 40 years of having that amount of experience and data, and being out in the field with our customers, we've been able to develop very accurate algorithms and modeling. Our software is very powerful and able to accurately tell the temperature profile of every single production.

Shaughnessy: If it gets sent overseas to some huge volume shop, you can automatically sense what kind of oven it is and figure out what's going on?

Moreau: Right. Because we have this unique metric that we use in our software called process window index (PWI), it gives the indication of that temperature profile: how well it fits in the process. So, if you are a company with just the development products here in the United States, building up the processes to hand off to either Eastern Europe, Mexico, or over to Asia, the technology transfer for the reflow process becomes very simple because regardless of what oven the other manufacturer has, if you integrate that KIC system in there, now you're comparing apples to apples and can easily transfer that technology and that process over.

Shaughnessy: They have access to the data when they need it, and in a format that they prefer.

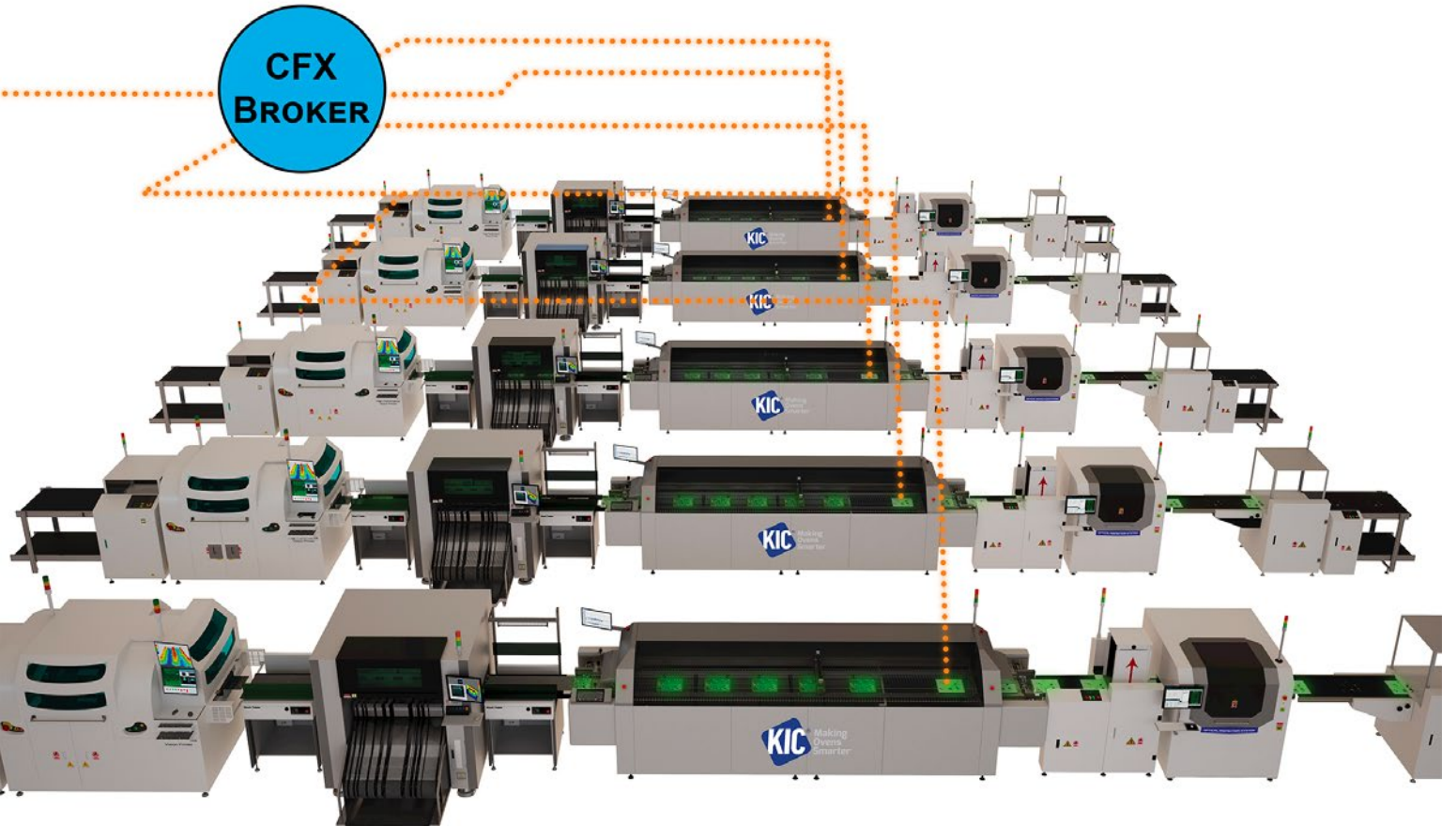
Moreau: You can compare and then push the data up along with the other inspection data, looking at Industry 4.0, for instance, where you're trying to not only manage the quality of the processes during production, but have smart systems that can correlate that data and act on it. Our RPI and WPI systems can do this; if an electronics manufacturer is noticing a particular defect from end of line AOI or functional test, they're not just having to go machine by machine, one by one, and do some data collection to find the problem. In almost real-time, they can do some comparisons and see whether it was related to reflow. Was that print related? Was it a combination of both? There's no way you can do that if you're missing a full set of data from one of the processes, the thermal process. That's where this real-time monitoring on the reflow process inspection becomes important.

Shaughnessy: It's like the missing link.

Moreau: Yes, exactly.

Shaughnessy: This fits in well with CFX, Hermes, and all these other formats as well?

Moreau: The whole idea of a smart factory and how it would be accomplished started probably eight or nine years ago. KIC was a founding member of the IPC-CFX standards committee. We were also one of the original 17 companies developing the Hermes standard. Now we have standards that are keyed in on Industry 4.0, so you have a common set of data where all the equipment and processes are doing things in the same way, almost like a plug-and-play smart factory. Then, you can utilize those systems to automate the factory, so it's a self-improving manufacturing line. KIC is the only company focused on thermal process inspection that is listed on the IPC CFX qualified product list (QPL) and is Hermes capable as well.



Shaughnessy: Right. That's really cool.

Moreau: For the longest time, it was an educational process for the customers. They understand running a profile to see what the temperature of the board is, but why do you need to monitor the process in real-time? Why do you need to know what every single board is seeing? For the past 20 years, we've been showing them, "This is why, here's the value you gain, we can improve your quality by automating, and you reduce your cost." We demonstrated this to help the customer justify what the value is. Now, as the smart factories come on, the KIC solution is the perfect fit, and the customer is seeing that.

Shaughnessy: You were already there, right?

Moreau: Maybe we were even a little bit before our time.

Shaughnessy: You had a foot in the door.

Moreau: It has worked out well to be involved in developing those standards because our system is a key to that whole smart factory solution.

Shaughnessy: Everybody says they want to evolve, but when you talk to them and you hear about the pain of change, you realize they don't really want to change. But you did and it's working out.

Moreau: It's exciting because we're looking at newer technologies and seeing how we can be more integrated into the manufacturing process so that even at the automating, at the NPI level, we have tools where high-mix factories have to change boards four or five times a day. They get new customers coming in. They might have 10 assemblies they need to set up every week or every couple weeks. How do you get the process ready?

We look at how we can automate that. How can we have another solution for our customers? We focus on machine maintenance, of having this strong core technology to monitor and improve the process, but also all the areas of thermal process in the manufacturing enterprise. When looking at design for manufacturing all the way through to the final board, we ask, "Where is the thermal process involved and how can KIC provide a solution there?" We try to interconnect the full ecosystem of solutions so we can see what the customer needs and provide value.

Shaughnessy: Is there anything else you want to mention?

Moreau: Today we had a lot of visits to our booth, and it really hit two areas which we've discussed here. A couple of customers were looking for the automation. They run profiles now and they see that this is a much better way. Because they can automate, they might only have to run a profile every few months.

We've also had some customers in the areas of high-reliability products in automotive and so forth that need the traceability requirements for those products that they're building for their end customers. We had those conversations at IPC APEX EXPO, and here at SMTA Dallas, so it continues.

Shaughnessy: Thank you, Miles. It was good to see you again.

Moreau: Thank you as well. **SMT007**

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Reworking of SMT Connectors With Center Ground Connection

Knocking Down the Bone Pile

by Bob Wettermann, BEST INC.

Connectors such as those pictured in Figure 1 are challenging to rework as they generally have a high density, and tight spacing of connector pins as well as a ground connection running through the center of the body of the part. The generic term for these types of connectors is "surface mount center ground connector." These surface mount connectors are designed for parallel board-to-board, flex-to-board, and cable-to-board configurations, and are generally compatible with both infrared and forced air convection rework heating methods. Specifically, a popular type of this connector configuration is a mezzanine connector which connects two parallel printed circuit boards in a stacking configuration.

The rework of a component such as this requires that the assembly be handled by keeping in mind ESD 2020 guidelines for static control, including but not limited to operator grounding, proper packaging, and proper keep-out zones with respect to insulators that can generate and/or hold an electrostatic charge.

When components such as this (Figure 2) are connected to a ground plane, it is imperative that the right amount of heat be imparted to the component during the removal process, especially when connected to a large ground plane. After properly supporting the assembly in the rework system, apply paste flux with your preferred chemistry to the component leads. The next step is making sure that the neighboring components are shielded to make sure all the components which need to be are thermally shielded. Components to be particularly watchful of include (but are not limited to) plastic-bodied connectors, ceramic

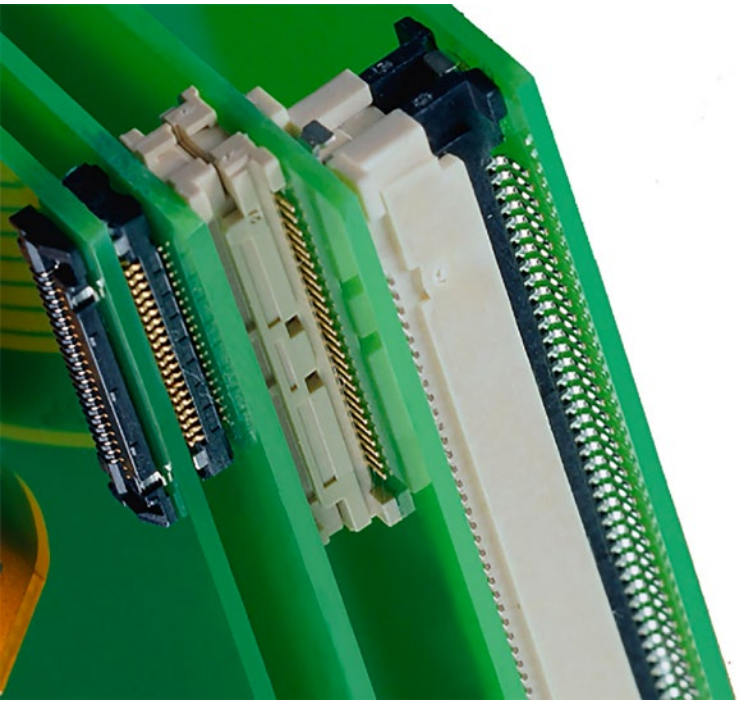

Figure 1: Board-to-board connector. (Source: Molex Corp.)

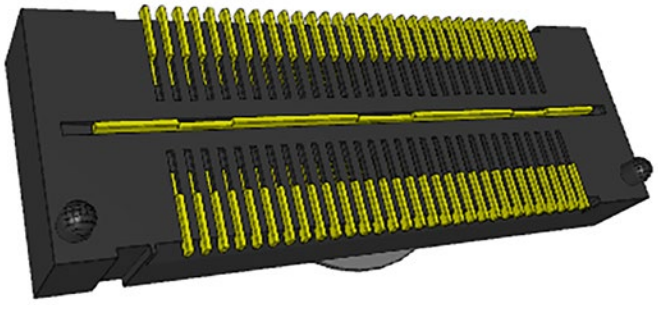

Figure 2: SMT connector with center ground-board view.

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capacitors, LEDs, glass bodied fuses, and others which are near the rework area. Make sure to examine the side opposite of the component to protect neighboring components from thermal damage prior to using heat to remove the component.

Prior to removing the component, it is always good practice to develop a profile board. In a profile board, thermocouples are embedded in key locations at and around the component location (on a process development board) to measure board and soldering temperatures at various locations. Typical locations to place these thermocouples are at the ground plane pad and at least two locations opposite one another on the connector. More thermocouples may be added at locations near heat-sensitive devices.

Prior to removing the component, it is always good practice to develop a profile board.

The rework removal profile can be more aggressive than typical reflow norms since in most cases, the component will be scrapped. Make sure the bottom side of the board is between125–150°C through heating of a bottom heater. Both IR and hot air sources can be used as a rework heat source. When profiling, make sure that the solder has turned into the liquidus phase by carefully observing the component either on the video feed provided by the rework station or by carefully peering at the solder/board interface using a flashlight. Once you can observe that the solder has obtained the liquidus state, activate the removal cycle and pick up the connector.

As in other area array or more complex component rework processes, after the assembly comes down to room temperature it is time to prep the site by wicking solder from the pads and cleaning the location. Finally, the pads should be inspected for damage.

For these component body styles it is best to use a miniature stencil or a programmable solder paste dispenser to affix the replacement connector to the PCB. The adhesive-backed stencil method is the least time-consuming method for selectively re-applying solder paste to the pads. The center ground pattern may need to be "window paned" to prevent too much solder from "lifting up" the connector leads. After peeling off the release liner from the stencil, align the stencil apertures, starting at one of the corners. Make the final fine alignment adjustments taking advantage of the repositionable adhesive which will keep also serve to affix the stencil into place once aligned. Using a small squeegee, roll solder paste through the apertures and then slowly peel up the stencil making sure it is perpendicular to the board surface. Examine the solder "bricks" formed on the PCB to make sure the solder paste has been applied to all locations consistently.

Another approach for stenciling is to use a "mini" stainless stencil that mimics the original stencil design at the rework location. This technique takes a great deal more skill to get right and not "smear" the solder paste. A programmable dispenser, while taking some time to set up and program, will also provide for a consistent solder paste volume at each of the pads. After the solder paste is deposited, place the PCB onto the rework station making sure the PCB is properly supported. Recall the proper reflow profile in the rework station and begin the reflow cycle.

After reflow, a few more steps need to be taken to compete the rework process. After the board has cooled and the assembly has been removed from the rework machine, the rework area needs to be cleaned and then visually inspected per the IPC-A-610 standards. Since the ground connection is a non-inspectable area of the connector, this rework needs

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to be placed into an X-ray machine in order to confirm the solder connection of the component to the PCB. Final inspection also includes the "fit up" with a header that will plug into the receptable on the board to make sure that the connector will function properly and has not been damaged in the rework process.

While the rework of high density SMT connectors with ground planes is challenging, the right process with the right controls in place and completed with properly trained personal will provide for a high yield. SMT007

Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. For more information, contact info@solder.net. To read past columns or contact Wettermann, click here.

COLUMN EXCERPT: Lean Digital Thread

Closing the Loop on Manufacturing

by Zac Elliott
SIEMENS

Throughout this series of articles, we have looked at the benefits of implementing a digital thread for electronics manufacturing. In this edition, I would like to close the loop (pun very much intended) on the lean digital thread and discuss closed-loop manufacturing.

What is Closed-Loop Manufacturing?

In closed-loop manufacturing (CLM) the systems and business processes used to design, plan, manufacture, and use a product are connected, thus enabling continuous improvement and self-organization of production processes. Each step along the value chain constantly feeds data back to the preceding stages so that simulations can be refined, and decisions improved. At the same time, data is automatically pushed forward to the downstream processes, to ensure production plans and manufacturing processes are up to date. This creates a continuous cycle to improve quality, efficiency, and profitability.

The Role of the Digital Twin

Closed-loop manufacturing depends on the ability to share information between different business processes using a digital twin. A digital twin is simply a virtual version of a product that can be used to simulate and test how a device will be built and used in the real world.

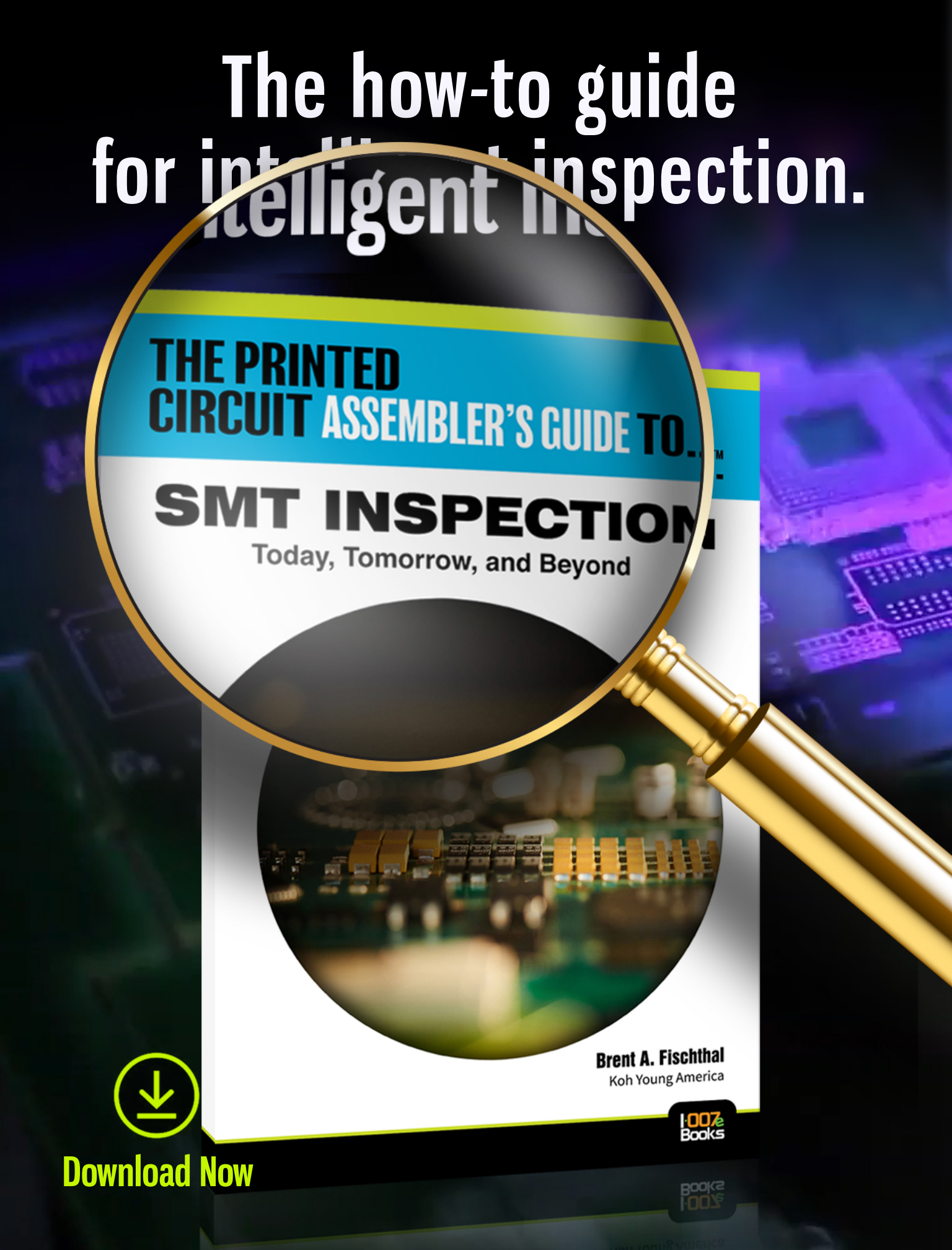
There are several digital twins for a given product:

- **Digital twin of the design:** The digital twin of the design is all the data that can be used to visualize and simulate the final end-product. This includes the mechanical and electrical designs, schematics, etc.
- **Digital twin of the process:** The digital twin of the process defines the manufacturing sequence and steps needed to build the product. This includes the machine technology, recipes, work instructions, and other information needed to simulate and improve the manufacturing flow.
- **Digital twin of production:** The digital twin of production includes all the data aggregated during the manufacturing process of a device, including all records of test results, traceability, parametric readings from assembly equipment and the environment, and any exceptions encountered during manufacturing of the device.

Having multiple versions of the digital twin allows specialized software to be used during the various stages of the manufacturing flow. Software that is optimized to design a PCB is not the same software that is optimized to collect the test results from an ICT machine that tests the PCB. Each type of software has completely different inputs and outputs. But they don't work in isolation. The design information is needed to develop the ICT test protocol and the aggregated test results can be used to improve the product design.

To read the entire column, click here.

The how-to guide for int[illegible]elligent ins[illegible]pection.



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TOP TEN

EDITOR'S PICKS

The New Chapter:
Our Introduction to the Electronics Industry

Paige Fiet and Hannah Nelson

IPC's Board of Directors' previous student liaison, Paige Fiet, and current student liaison, Hannah Nelson, are combining their talents as new columnists for I-Connect007. Through their column, they will share their thoughts and experiences as student engineers and the transition to the workforce. In this first column, they discuss their backgrounds in the electronics industry and their position on the Board of Directors.

José Servin Receives IPC Dieter Bergman Fellowship Award


José Servin

The Dieter Bergman IPC Fellowship Award is given to individuals who have fostered a collaborative spirit, made significant contributions to standards development, and have consistently demonstrated a commitment to global standardization efforts and the electronics industry. José Servin has worked as an IPC member for more than 14 years in the development of the Electronics Assembly Norms.

Matt Kelly:
The Digital Factory is Now

The I-Connect007 Editorial Team spoke with Matt Kelly, IPC chief technologist, about Factory of the Future. In this wide-ranging conversation, the team starts with the premise that factory automation is no longer a future topic, but a concern for right now. The conversation takes a closer look at the need for digitization, upskilling the workforce, ensuring ROI is gained from digitizing the factory and, at the center of it all, the need for a strong commitment to move forward as a company.

Dave Hillman on Living Your Passion

Barry Matties leads this engaging retrospective conversation with Dave Hillman, a Fellow, Materials and Process engineer at Collins Aerospace, who talks about mentorship, pandemic changes, and solder. "Soldering is soldering," Dave says. "But how we do that keeps evolving in response to the new technologies and smaller packages." What's the key to his success and longevity? "Find your passion." Here's how he's done it.

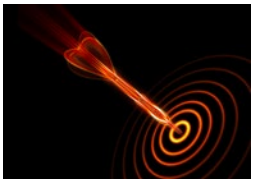
Real Time with... IPC APEX EXPO 2022: Material Technology for Automotive

Nicholas Huffer of Acuity Electronics discusses with Nolan Johnson the use of IoT for material traceability for automotive and aerospace compliance. He explains how Acuity provides solutions, when used in tandem, represent a unified platform for electronics manufacturers.

Nolan's Notes: The Legislative Chokepoint

There's no getting around having to send chips overseas for packaging. But how many trips around the globe does a chip need to make before it's ready? And can our defense suppliers rely on such supply chain methods?

How to Minimize Quoting Time and Increase Accuracy in EMS Production



New product introductions (NPIs) and customization have been increasing rapidly over the past few years—with the results that the already-small profit margins in electronics assembly are shrinking even further. Fifteen years ago, the PCB was the product. Today, most products are a system, with multiple PCBs, cables, and enclosures.

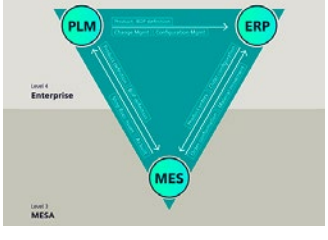
The Future is Driven by Data

When we visited Rocket EMS in 2013 to observe a DIY 4.0 factory data collection and management system in action, we were very impressed. This was clearly a factory of the future, even then. We recently followed up with Rocket's president, Michael Kottke, to discuss how this work has given the company a huge advantage over the competition.

LITE-ON Technology Reports Consolidated March Sales of NT$15.15 Billion

LITE-ON Technology reported its March consolidated revenue of NT$15.15 billion, up 31% M-o-M and 14% YOY, hitting a record high of the same period in 4 years. Thanks to continuous optimization of product mix and the stable demand from its core business, cumulative sales for January to March totaled NT$41.23 billion, up 9% YOY.

Lean Digital Thread: Closing the Loop on Manufacturing



In this edition, I would like to "close the loop" on the lean digital thread and discuss closed-loop manufacturing. In closed-loop manufacturing, the systems and business processes used to design, plan, manufacture, and use a product are connected, thus enabling continuous improvement and self-organization of production processes.

Career Opportunities

Is your team growing?

Find industry-experienced candidates at I-Connect007.

For just $750, your 200-word, full-column ad will appear in the Career Opportunities section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs, suppliers and the academic community.

In addition, your ad will:

- be featured in at least one of our newsletters
- appear on our jobConnect007.com board, which is promoted in every newsletter
- appear in our monthly Careers Guide, emailed to 26,000 potential candidates

Potential candidates can click on your ad and submit a resume directly to the email address you provide, or be directed to the URL of your choice.

No contract required. Just send over your copy and company logo and we'll do the rest!

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Career Opportunities

Los Alamos NATIONAL LABORATORY

Printed Circuit Board (PCB) Layout Designer (Designer-Drafter 3/4)

Los Alamos National Laboratory
Los Alamos, New Mexico

Los Alamos National Laboratory (LANL) is a multidisciplinary research institution engaged in science and engineering on behalf of national security. The ISR-5 Space Instrument Realization Group is currently seeking an entry level Printed Circuit Board (PCB) Layout Designer. You'll design and develop rigid and flexible PCBs directly supporting the design, prototyping and manufacturing of innovative space satellites for a variety of important scientific and national security missions.

Requirements:

- 3-5 years relevant experience
- Associate's in engineering or technical field (or an additional 2 years related experience)
- Working knowledge of PCB fabrication or electronics assembly requirements
- Familiarity with PCB layout CAD design tools
- Demonstrated commitment to safety, security environment and quality

Desired Qualifications:

- Basic experience using software tools to produce models, drawings, layouts and sketches of components/systems
- Familiarity with PCB design concepts, IPC design and performance standards
- Experience using PCB design software, such as Eagle, Altium or Mentor Graphics

Apply now: lanl.jobs, search IRC102937lanl.gov/careers

Los Alamos National Laboratory is an EO employer – Veterans/Disabled and other protected categories. Qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, sexual orientation, gender identity, disability or protected veteran status.

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Los Alamos NATIONAL LABORATORY

Printed Circuit Board (PCB) Technologist (Engineering Technologist 1 / 2)

Los Alamos National Laboratory
Los Alamos, New Mexico

Los Alamos National Laboratory (LANL) is a multidisciplinary research institution focused on solving national security challenges. The Intelligence and Space Research Division is seeking an experienced Printed Circuit Board (PCB) Layout Technologist to directly support the design, prototyping and manufacturing of innovative space instruments for important science and national security missions.

Requirements:

- 2 -5 years related experience
- Bachelor's in engineering technology, science or math (or an additional 8 years of related experience)
- Advanced knowledge of PCB layout CAD design tools/current best practices
- Ability to determine technical requirements/ objectives for new PCB designs
- Ability to identify problems, create solutions and effectively navigate institutional systems

Desired Qualifications:

- Experience using Siemens (Mentor Graphics) Xpedition PB design flow software
- Experience interpreting and applying IPC-6012 and IPC-6013 qualification and performance standards
- Experience designing high-speed, controlled-impedance PCBs for digital and RF applications
- Experience designing PCBs for space flight applications

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Los Alamos National Laboratory is an EO employer – Veterans/Disabled and other protected categories. Qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, sexual orientation, gender identity, disability or protected veteran status.

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Career Opportunities

ALTIX
Direct Imaging & Contact Printers

Sales Technical Engineer

ALTIX, a French company, designs, manufactures, markets and services exposure equipment for the printed circuit board, flexible circuit, metal etching, touch panel and other industries. The U.S. subsidiary, focused on the sale and service of Altix equipment in North America, is looking for a sales technical engineer to support their growth.

Responsibilities

- Promote Altix's products by visiting customers
- Serve as a technical lead & product expert to provide technical recommendations to customers
- Gather on-the-ground market intelligence through customer contact
- Ensure sustainable growth in sales, profits, and market presence
- Develop new business and achieve targets for market penetration, sales and profit
- Manage sales partners

Skills & Qualifications

- Minimum 2 to 5 years' experience in sales for capital equipment in the PCB market or related industries
- Business development and marketing background preferred
- 5+ years' North American business leadership experience in related field
- Strong leadership, decision-making and communication skills.
- Proficiency in standard computer software applications such as Microsoft Office
- Excellent written and oral communication skills
- Willingness to travel within the US, Canada and to France for training

Email contact: sylvain.dromaint@altix.us

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INDIUM CORPORATION®

Global Account Manager, e-Mobility & Infrastructure

Location: AZ, CA, TX (remote)

Job Summary:

The Global Account Manager, e-Mobility & Infrastructure is a key position for the sales organization, serving as Indium Corporation's lead sales contact responsible for developing targeted accounts in the e-Mobility and related infrastructure space.

Responsibilities will include:

- sourcing for new global business opportunities
- implementing effective sales strategies
- interfacing with customers' senior management
- execution of action plans through the regional teams
- interaction with internal customers (R&D; Inside Sales; Technical Support; Logistics; Product Management; Operations; Engineering; Quality; etc.) resulting in evaluation, qualification, specification, and maximum customer share for designated customers
- providing risk assessment of the business to senior management

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Career Opportunities

ventec INTERNATIONAL GROUP 騰輝電子

Operations Supervisor

Elk Grove Village IL, USA

As operations supervisor at Ventec USA LLC, you will have a hands-on and quality-driven approach to coordinating and overseeing the operations in Elk Grove Village, Illinois. You will plan, organize, and implement the day-to-day warehouse activities to ensure customer expectations are met. Tasks will include planning, implementing performance improvement measures, procuring materials and resources, and assuring compliance to the Quality Management System. You will be a mentor to team members, find ways to maintain and improve the highest quality of customer service, and implement best practices across all levels to help the company remain compliant, efficient, and profitable.

Skills and abilities required:

- Proven experience as operations supervisor or similar role
- Knowledge of organizational effectiveness and warehouse management
- Experience with ISO9001 or similar QMS
- Experience in budgeting and forecasting/ familiarity with business and financial principles
- Excellent leadership ability and communication skills (English)
- Outstanding organizational skills
- Qualification in distribution, logistics, transportation, or business studies is preferential

What's on offer:

- Excellent salary & benefits commensurate with experience

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits. Please forward your resume to **HR@Ventec-usa.com** and mention (Operations Supervisor) in the subject line.

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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

Flexible Circuit Technologies is a premier global supplier providing design, prototyping and production of flexible circuits, rigid flex circuits, flexible heaters, and membrane switches.

Application Engineer/ Program Management

Responsibilities

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

Qualifications

- Demonstrated experience: PCB/FPCB/rigid-flex designer including expertise in design rules, IPC
- Demonstrated success in attaining business
- Ability to work in fast-paced environment, on broad range of projects, while maintaining a sense of urgency
- Ability to work as a team player
- Excellent written and verbal communication skills
- Must be willing to travel for sales support activities, customer program support and more.

FCT offers a competitive salary, bonus program, and benefits package. Preferred location Minneapolis, MN area. www.flexiblecircuit.com

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Electrical Engineer/PCB/CAD Design, BOM Component & Quality Support

Responsibilities

- Learn the properties, applications, advantages/ disadvantages of flex circuits
- Learn the intricacies of flex circuit layout best practices
- Learn IPC guidelines: Flex circuits/assemblies
- Create flexible PCB designs/files to meet engineering/customer requirements
- Review customer prints and Gerber files to ensure they meet manufacturing and IPC requirements
- Review mechanical designs for mfg, including circuit and assembly requirements, BOM/component needs and help to identify alternate components if needed
- Prepare and document changes to customer prints/ files. Work with app engrs, customers and mfg. engrs. to finalize and optimize designs for manufacturing
- Work with quality manager to learn quality systems, requirements, and support manager with assistance

Qualifications

- Electrical Engineering degree with 2+ years of CAD/PCB design experience
- IPC CID or CID+ certification or desire to obtain
- Knowledge of flexible PCB materials, properties, or willingness to learn
- Experience with CAD software: Altium or other
- Knowledge of IPC standards for PCB industry, or willingness to learn
- Microsoft Office products

FCT offers a competitive salary, bonus program, and benefits package. Preferred location Minneapolis, MN area. www.flexiblecircuit.com

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Career Opportunities

CHEMCUT

Director of Operations

State College, PA

Chemcut Corp., a world leader in wet processing equipment for the manufacture of printed circuit boards and chemical etching of various metals, is seeking a Director of Operations.

Objectives of the Role:

- Collaborate with the CEO in setting and driving organizational vision, operational strategy, and hiring needs.
- Oversee manufacturing operations and employee productivity, building a highly inclusive culture ensuring team members thrive and organizational outcomes are met.
- Directly oversee manufacturing operations, production planning, purchasing, maintenance & customer service (product support) and partner with the CEO and controller on sales management to budget for sufficient investment capital to achieve growth targets.
- Aggressively manage capital investment and expenses to ensure the company achieves investor targets relative to growth and profitability.

Qualifications:

- Bachelor's degree in mechanical, electrical, or related fields
- 5+ years' experience in leadership positions
- Leadership skills, with steadfast resolve and personal integrity
- Understanding of advanced business planning and regulatory issues
- A solid grasp of data analysis and performance metrics
- Ability to diagnose problems quickly and have foresight into potential issues

Preferred Qualifications:

- Master's degree in business or related field
- International business experience

To apply, please submit a cover letter and resume to hr@chemcut.net

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KYZEN
Where Science and Care Converge.

Regional Manager

Midwest Region

General Summary: Manages sales of the company's products and services, Electronics and Industrial, within the States of IL, IN & MI. Reports directly to Americas Manager. Collaborates with the Americas Manager to ensure consistent, profitable growth in sales revenues through positive planning, deployment and management of sales reps. Identifies objectives, strategies and action plans to improve short- and long-term sales and earnings for all product lines.

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

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Career Opportunities

American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

Wet Process Engineer

ASC, the largest independent PCB manufacturer in the Midwest, is looking to expand our manufacturing controls and capabilities within our Process Engineering department. The person selected will be responsible for the process design, setup, operating parameters, and maintenance of three key areas—imaging, plating, etching--within the facility. This is an engineering function. No management of personnel required.

Essential Responsibilities

Qualified candidates must be able to organize their own functions to match the goals of the company.

Responsible for:

- panel preparation, dry film lamination, exposure, development and the processes, equipment setup and maintenance programs
- automated (PAL line) electrolytic copper plating process and the equipment setup and maintenance programs
- both the cupric (acid) etching and the ammoniacal (alkaline) etching processes and the equipment setups and maintenance programs

Ability to:

- perform basic lab analysis and trouble-shooting as required
- use measurement and analytical equipment as necessary
- work alongside managers, department supervisors and operators to cooperatively resolve issues
- effectively problem-solve
- manage multiple projects concurrently
- read and speak English
- communicate effectively/interface at every level of the organization

Organizational Relationships

Reports to the Technical Director.

Qualifications

Degree in Engineering (BChE or I.E. preferred). Equivalent work experience considered. High school diploma required. Literate and functional with most common business software systems MS Office, Excel, Word, PowerPoint are required. Microsoft Access and basics of statistics and SPC a plus.

Physical Demands

Exertion of up to 50 lbs. of force occasionally may be required. Good manual dexterity for the use of common office equipment and hand tools.

- Ability to stand for long periods.

Work Environment

This position is in a manufacturing setting with exposure to noise, dirt, and chemicals.

Click on 'apply now' buttton below to send in your application.

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Career Opportunities

pluritec®
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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MacDermid Alpha ELECTRONICS SOLUTIONS

R&D Scientist III
Orange, CT

Job Description: The scientist will be a leader in technology for plating chemistry development, electrolytes, and additives. The position is hands-on, where the ideal candidate will enjoy creating and testing new aqueous plating processes and materials to meet the most demanding semiconductor applications related to Wafer-Level Packaging and Damascene. The qualified candidate will work as part of the R&D team while interacting with scientists, product management, and application engineers to commercialize new products for the advanced electronic solution business.

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Technical Marketing Specialist
Waterbury, CT

This position provides information from the product team to the marketing communications team. It is a multifunctional role that requires some experience within electronics manufacturing supply chain or knowledge of how electronic devices are manufactured, specifically PCBs, semiconductors, and the chemical processes utilized therein. The primary function of this role is to help in the generation of product marketing collateral, but also includes assisting in tradeshow content development, advertising, and launches.

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Career Opportunities

Printed Circuits, a fast-growing printed circuit board fabricator, offers:

- Excellent opportunities for advancement and growth
- Dynamic manufacturing environment
- Excellent health, dental and other benefits
- Annual profit-sharing plan
- Signing bonus
- Additional incentives at the leadership level
- Clean facility with state-of-the-art manufacturing equipment
- Highly collaborative corporate and manufacturing culture that values employee contributions

Laminator Technician

Nature of Duties/Responsibilities

- Layup cover lay
- Layup rigid flex
- Layup multilayer/CU core boards
- Oxide treat/cobra treatment of all layers/CU cores
- Shear flex layer edges
- Rout of machine panel edges and buff
- Remove oxide/cobra treatment (strip panels)
- Serialize panels
- Pre-tac Kapton windows on flex layers (bikini process)
- Layup Kapton bonds
- Prep materials: B-stage, Kapton, release sheet
- Breakdown: flex layers, and caps
- Power scrub: boards, layers, and caps
- Laminate insulators, stiffeners, and heatsinks
- Plasma cleans and dry flex layers B-stage (Dry)
- Booking layers and materials, ready for lamination process
- Other duties as deemed necessary by supervisor

Education/Experience

- High school diploma or GED
- Must be a team player
- Must demonstrate the ability to read and write English and complete simple mathematical equations
- Must be able to follow strict policy and OSHA guidelines
- Must be able to lift 50 lbs
- Must have attention to detail

Wet Process/Plating Technician

Position is 3rd shift (11:00PM to 7:30AM, Sunday through Friday)

Purpose

To carry out departmental activities which result in producing quality product that conforms to customer requirements. To operate and maintain a safe working environment.

Nature of Duties/Responsibilities

- Load and unload electroplating equipment
- Fasten circuit boards to racks and cathode bars
- Immerse work pieces in series of cleaning, plating and rinsing tanks, following timed cycles manually or using hoists
- Carry work pieces between departments through electroplating processes
- Set temperature and maintains proper liquid levels in the plating tanks
- Remove work pieces from racks, and examine work pieces for plating defects, such as nodules, thin plating or burned plating
- Place work pieces on racks to be moved to next operation
- Check completed boards
- Drain solutions from and clean and refill tanks; fill anode baskets as needed
- Remove buildup of plating metal from racks using chemical bath

Education and Experience

- High school diploma or GED required
- Good organizational skills and the ability to follow instructions
- Ability to maintain a regular and reliable attendance record
- Must be able to work independently and learn quickly
- Organized, self-motivated, and action-oriented, with the ability to adapt quickly to new challenges/opportunities
- Prior plating experience a plus

Production Scheduler

Main Responsibilities

- Development and deployment of a level-loaded production plan
- Establish manufacturing plan which results in "best possible" use of resources to maximize asset utilization
- Analyze production capacity of manufacturing processes, equipment and human resource requirements needed to produce required products
- Plan operation manufacturing sequences in weekly time segments utilizing production labor standards
- Maintain, align, and communicate regularly with internal suppliers/customers and customer service on key order metrics as per their requirements
- Frequently compare current and anticipated orders with available inventory and creates replenishment plan
- Maintain master distribution schedule for the assigned facility, revise as needed and alert appropriate staff of schedule changes or delays
- Participate in periodic forecasting meetings
- Lead or participate in planning and status meetings with production, shipping, purchasing, customer service and/or other related departments
- Follow all good manufacturing practices (GMPs)
- Answer company communications, fax, copy and file paperwork

Education and Experience

- High school diploma or GED
- Experience in manufacturing preferred/3 years in scheduling
- Resourceful and good problem-solving skills
- Ability to make high pressure decisions
- Excellent written and verbal communication skills
- Strong computer skills including ERP, Excel, Word, MS Office
- Detailed and meticulous with good organizational skills
- Must be articulate, tactful and professional at all times
- Self-motivated

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Career Opportunities

INSULECTRO

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.

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Manncorp™

SMT Field Technician
Hatboro, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

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Career Opportunities

The Test Connection, Inc.

Rewarding Careers

Take advantage of the opportunities we are offering for careers with a growing test engineering firm. We currently have several openings at every stage of our operation.

The Test Connection, Inc. is a test engineering firm. We are family owned and operated with solid growth goals and strategies. We have an established workforce with seasoned professionals who are committed to meeting the demands of high-quality, low-cost and fast delivery.

TTCI is an Equal Opportunity Employer. We offer careers that include skills-based compensation. We are always looking for talented, experienced test engineers, test technicians, quote technicians, electronics interns, and front office staff to further our customer-oriented mission.

Associate Electronics Technician/ Engineer (ATE-MD)

TTCI is adding electronics technician/engineer to our team for production test support.

- Candidates would operate the test systems and inspect circuit card assemblies (CCA) and will work under the direction of engineering staff, following established procedures to accomplish assigned tasks.
- Test, troubleshoot, repair, and modify developmental and production electronics.
- Working knowledge of theories of electronics, electrical circuitry, engineering mathematics, electronic and electrical testing desired.
- Advancement opportunities available.
- Must be a US citizen or resident.

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Test Engineer (TE-MD)

In this role, you will specialize in the development of in-circuit test (ICT) sets for Keysight 3070 (formerly HP) and/or Teradyne (formerly GenRad) TestStation/228X test systems.

- Candidates must have at least three years of experience with in-circuit test equipment. A candidate would develop and debug our test systems and install in-circuit test sets remotely online or at customer's manufacturing locations nationwide.
- Candidates would also help support production testing and implement Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks.
- Some travel required and these positions are available in the Hunt Valley, Md., office.

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Sr. Test Engineer (STE-MD)

- Candidate would specialize in the development of in-circuit test (ICT) sets for Keysight 3070 (formerly Agilent & HP), Teradyne/ GenRad, and Flying Probe test systems.
- Strong candidates will have more than five years of experience with in-circuit test equipment. Some experience with flying probe test equipment is preferred. A candidate would develop, and debug on our test systems and install in-circuit test sets remotely online or at customer's manufacturing locations nationwide.
- Proficient working knowledge of Flash/ISP programming, MAC Address and Boundary Scan required. The candidate would also help support production testing implementing Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks. An understanding of stand-alone boundary scan and flying probe desired.
- Some travel required. Positions are available in the Hunt Valley, Md., office.

Contact us today to learn about the rewarding careers we are offering. Please email resumes with a short message describing your relevant experience and any questions to careers@ttci.com. Please, no phone calls.

We proudly serve customers nationwide and around the world.

TTCI is an ITAR registered and JCP DD2345 certified company that is NIST 800-171 compliant.

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Career Opportunities

Prototron Circuits

Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB shop, is looking for sales representatives for all territories.

Reasons you should work with Prototron:

- Serving the PCB industry for over 30 years
- Solid reputation for on-time delivery (99% on-time)
- Excellent quality
- Production quality quick-turn services in as little as 24 hours
- AS9100
- MIL-PRF- 31032
- ITAR
- Global sourcing
- Engineering consultation
- Completely customer focused team

Interested? Let's have a talk.
Call Dan Beaulieu at
207-649-0879
or email to
danbbeaulieu@aol.com

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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SIEMENS

Siemens EDA Sr. Applications Engineer

Support consultative sales efforts at world's leading semiconductor and electronic equipment manufacturers. You will be responsible for securing EM Analysis & Simulation technical wins with the industry-leading HyperLynx Analysis product family as part of the Xpedition Enterprise design flow.

Will deliver technical presentations, conduct product demonstrations and benchmarks, and participate in the development of account sales strategies leading to market share gains.

- PCB design competency required
- BEE, MSEE preferred
- Prior experience with Signal Integrity, Power Integrity, EM & SPICE circuit analysis tools
- Experience with HyperLynx, Ansys, Keysight and/or Sigrity
- A minimum of 5 years' hands-on experience with EM Analysis & Simulation, printed circuit board design, engineering technology or similar field
- Moderate domestic travel required
- Possess passion to learn and perform at the cutting edge of technology
- Desire to broaden exposure to the business aspects of the technical design world
- Possess a demonstrated ability to build strong rapport and credibility with customer organizations while maintaining an internal network of contacts
- Enjoy contributing to the success of a phenomenal team

***Qualified applicants will not require employer-sponsored work authorization now or in the future for employment in the United States. Qualified Applicants must be legally authorized for employment in the United States.*

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Career Opportunities

ARLON ELECTRONIC MATERIALS

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

apply now

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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Career Opportunities

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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BLACKFOX
Premier Training & Certification

IPC Instructor

Longmont, CO; Phoenix, AZ; U.S.-based remote

Independent contractor, possible full-time employment

Job Description

This position is responsible for delivering effective electronics manufacturing training, including IPC Certification, to students from the electronics manufacturing industry. IPC instructors primarily train and certify operators, inspectors, engineers, and other trainers to one of six IPC Certification Programs: IPC-A-600, IPC-A-610, IPC/WHMA-A-620, IPC J-STD-001, IPC 7711/7721, and IPC-6012.

IPC instructors will conduct training at one of our public training centers or will travel directly to the customer's facility. A candidate's close proximity to Longmont, CO, or Phoenix, AZ, is a plus. Several IPC Certification Courses can be taught remotely and require no travel.

Qualifications

Candidates must have a minimum of five years of electronics manufacturing experience. This experience can include printed circuit board fabrication, circuit board assembly, and/or wire and cable harness assembly. Soldering experience of through-hole and/or surface-mount components is highly preferred.

Candidate must have IPC training experience, either currently or in the past. A current and valid certified IPC trainer certificate holder is highly preferred.

Applicants must have the ability to work with little to no supervision and make appropriate and professional decisions.

Send resumes to Sharon Montana-Beard at sharonm@blackfox.com.

apply now

Career Opportunities

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.

apply now

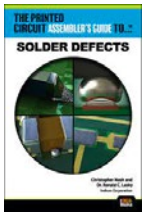
WATCH AND LEARN

Predicting Reliability in Electronics

In this engaging, 11-part micro webinar series, topic experts Graham Naisbitt and Chris Hunt examine the history of the influences of electrochemical migration (ECM) and the evolving use of Surface Insulation Resistance (SIR) testing that has been developed over the past 25 years by GEN3 and its association with the British National Physical Laboratory. GEN3 and NPL have created the standard that has now been in widespread use around the world since the turn of the millennium.

I-007e Books

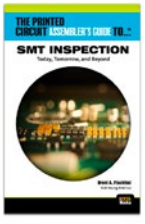
The Printed Circuit Assembler's Guide to...



Solder Defects

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

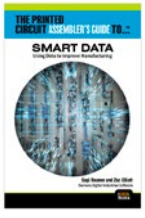
This book is specifically dedicated to educating the printed circuit board assembly sector and serves as a valuable resource for people seeking the most relevant information available.



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

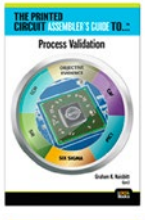
An in-depth insight into new and exciting true 3D inspection technology is provided in this book, along with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



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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