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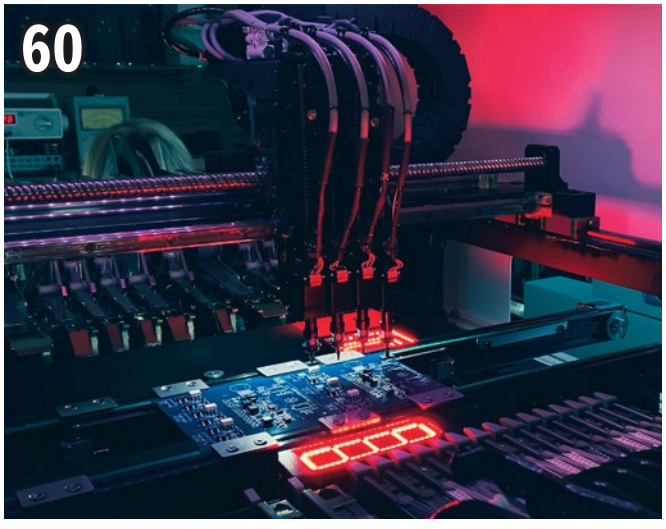

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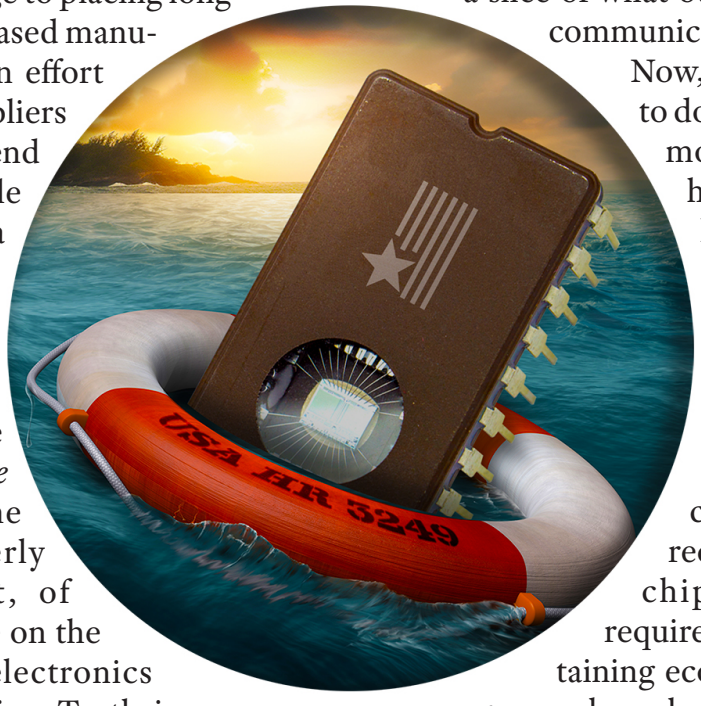
Chips Don't Float

Nolan's Notes

by Nolan Johnson, I-CONNECT007

Ronnie Chatterji is returning to academia. This is big news because Chatterji is the technology advisor to the Biden administration, and a central figure in shepherding the CHIPS and Science Act of 2022.

Steven Overly, writing in Politico on Aug. 2, 2023, says that Chatterji's return to Duke University "comes as the Biden administration's semiconductor strategy has evolved from a frenzied search for a short-term fix to the global chips shortage to placing long-term bets on the U.S.-based manufacturing facilities in an effort to depend less on suppliers in Taiwan."[1] I recommend reading Overly's article in its entirety; it's a good overview.



In fact, I had to smile a bit as I read the Politico piece. Our roadmap for this issue of *SMT007 Magazine* includes many of the same topics that Overly summarizes. Except, of course, we concentrate on the printed circuit and electronics manufacturing industries. Truth is, no matter the industry sector, many of the themes are the same.

Case in point: In this issue, we look at industry support legislation in both the U.S. and Europe. We start with an interview with Travis Kelly, Isola CEO and PCBAA president. From IPC, we have a report issued by Alison James of the IPC Europe office, and an update from Matt Kelly on setting objectives within the CHIPS Act. We're proud to bring you some high-caliber strategic thinking on the impact of how the investment should be distributed, among other topics.

One thing is emerging, though, and it's that the coordinated advocacy work in Washington, D.C., is making a difference. Legislators and their staff are increasingly savvy to the electronics supply chain. This month's issue is a slice of what our advocates have been communicating on our behalf.

Now, what does all this have to do with Chatterji? In fact, most everything. Before his departure, Chatterji helped the administrators at the Department of Commerce determine the strategic priorities for the CHIPS Act—namely, that a successful semiconductor supply chain requires more than just chip manufacturing. It requires a complete, self-sustaining ecosystem. Our advocacy groups have been doing the same, as evidenced in the Travis Kelly interview and the Matt Kelly update.

As you read through the conversations and articles in this issue, I'm sure you'll notice how often advanced packaging and substrates comes up in conversation. When it comes to the electronics ecosystem, packages and substrates are the weakest link—not just in the

U.S., but in Europe as well. In October 2022, for example, IPC hosted a two-day symposium on advanced packaging in D.C., helping to set the stage for educating government officials on the complexities of the electronics manufacturing ecosystem. This past April, IPC Europe hosted a silicon-to-systems meeting in Brussels, and plans a second symposium early next year on advanced packaging, also in Europe.

In this issue, I've included updates from U.S. Reps. Blake Moore and Anna Eshoo, the two originating sponsors for HR 3249, also known as the Protecting Circuit Boards and Substrates Act. We also include a summary and the opinion piece Rep. Eshoo wrote for the San Jose newspaper, and the announcement from Rep. Moore's office about the pending legislation. Finally, Kirk Thompson of Isola provides a more detailed look at advanced packaging, which continues to emerge as a key area of development related to CHIPS Act funding.

Personally, I continue to be impressed by the scale and persistence shown by all the organizations advocating for electronics manufacturing, particularly the groups educating government officials on printed circuit manufacturing technologies. If Chatterji worked to raise awareness from the top, it's our advocates who've been bringing the same awareness in, as it were, from the bottom. Thank you, Ronnie Chatterji, for your thoughtful and effective leadership; this will undoubtedly have an impact.

As KIC's Miles Moreau writes in his article, the CHIPS Act "ushers in an era of innovative manufacturing paradigms. Semiconductor manufacturers have the chance to explore cutting-edge processes, with technologies such as extreme ultraviolet (EUV) lithography and advanced packaging process advancements assuming center stage. This intersection of innovation and partnership with equipment suppliers is poised to shape the trajectory of these transformative processes, bridging the gap between theory and practical application."

Which brings me to our cover art this month. If you haven't already become familiar with the rallying cry for our advocates, it's "Chips don't float." Semiconductor manufacturing simply cannot exist in a vacuum, as we industry insiders know. But others outside the industry often are not aware. "Chips don't float" has been a highly effective takeaway, cementing the understanding that electronics manufacturing requires an ecosystem. Between advocacy and governmental subsidies, the dynamic is moving from an industry drowning to an industry with a life raft, heading toward firm, new footing in the future.

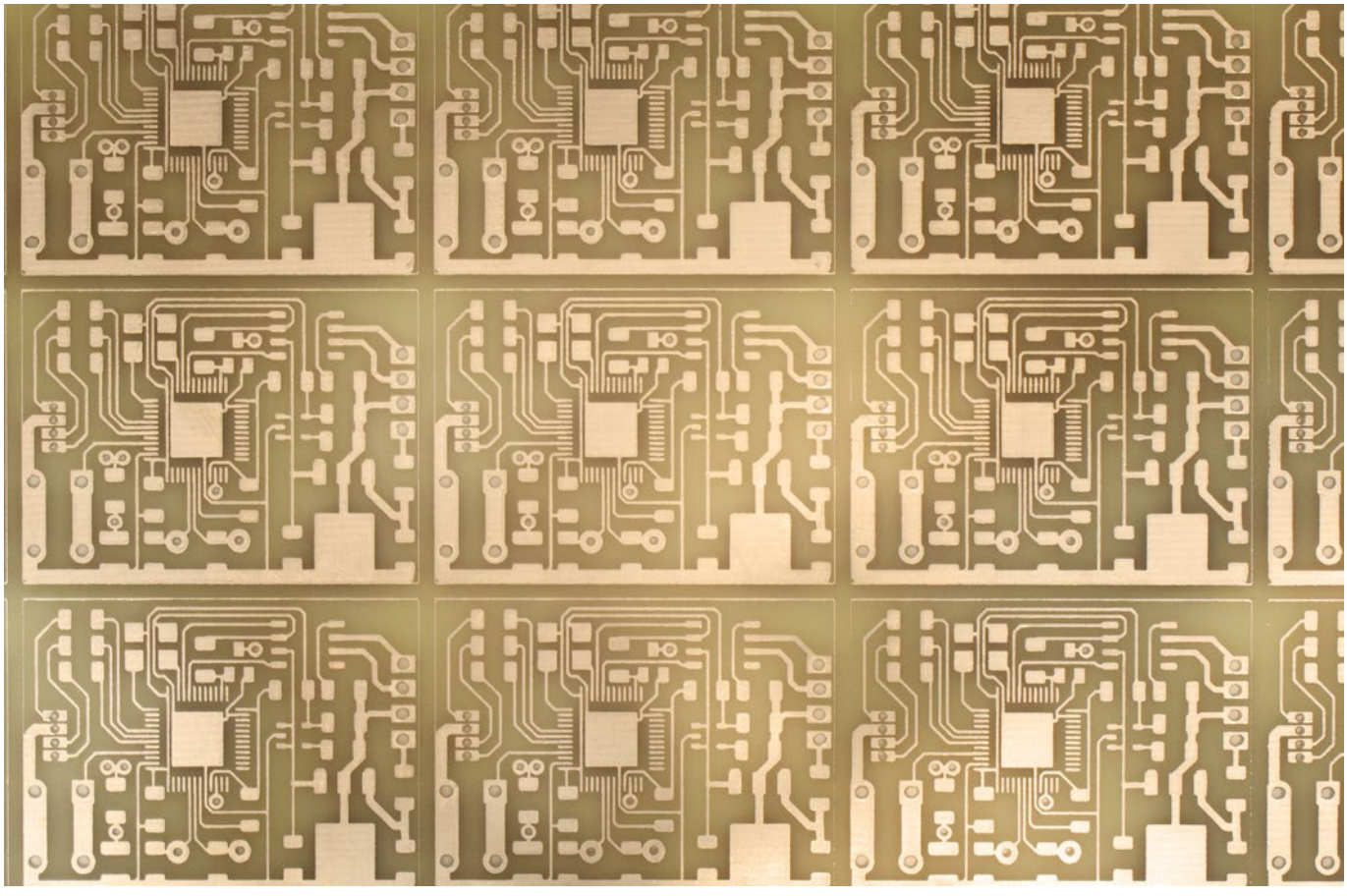
One might argue that circuit board assembly is just about soldering components to bare boards. We all know this will change the EMS industry. Just the advances in advanced packaging will present new challenges to assembly, inspection, test, and rework. Changes of this magnitude have a way of changing the entire ecosystem as well. So, where do we expect to see those changes? That's the question we begin to answer with this issue.

Not to be forgotten in all this is the upcoming SMTA International Conference and Exposition in early October in Minnesota. Inside this issue, you'll find a special section devoted to the conference, with a welcome from SMTA President Martin Anselm, details about the technical conference and Women's Leadership Program. In his column this month, Mike Konrad shares more details about the event's technical program. I hope to see you in Minneapolis. Stop by and say hello! **SMT007**

Reference

1. "White House Advisor on Microchips Steps Down, Politico.com.

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.



CHIPS Act, One Year On

Feature Interview with the I-Connect007 Editorial Team

Fresh off his annual meeting with the Printed Circuit Board Association of America (PCBAA), Travis Kelly, CEO at Isola Group and chairman of the PCBAA, gave us an update on government legislation in the United States that directly and indirectly affects the printed circuit board industry. Travis was candid in his remarks about funding from the CHIPS Act, what the PCB industry needs to do, and how a bill reintroduced into Congress this year might be just the ticket we need.

Nolan Johnson: Let's start with some detailed discussion about legislation for printed circuit boards and then follow up with how the CHIPS Act might be creating some follow-on effect?

We're very enthusiastic and happy to share that we have a bill called the Protecting Circuit Boards and Substrates Act (HR 3249). That bill was reintroduced in Congress this year by Rep. Blake Moore, a Republican from Utah, and Rep. Anna Eshoo, a Democrat from California. When you go to Capitol Hill, you need something to point to as you meet with representatives of Congress. Our task at PCBAA is to get more co-sponsors for that bipartisan bill and we've been successful; we just got roughly five co-sponsors for HR 3249, which continues the momentum.

HR 3249 is absolutely critical to creating that resilient and secure supply chain in the United States because it does two things. First, it's an immediate investment from the government

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Travis Kelly

of roughly $3 billion to look at R&D, on-the-job training, university training, and brick and mortar. How do we skill up as an industry for onshoring and nearshoring that will create more demand?

The second part, and this is key, is a tax credit. The tax credit is for OEMs; it's not for the fabricators or the substrate manufacturers. This is for Google, Amazon, and others—they would receive a tax credit for every American-made printed circuit board they purchase. Now, why is that so important? One, it creates a demand signal so the fabricators and the other businesses can invest, knowing that there will be a volume demand there. Two, it helps level the playing field for companies that are competing directly against other countries. If another country, for example, is subsidizing a certain industry, it's hard for an American company to be competitive. That 25% tax credit will help level that playing field, and we're excited about that.

Johnson: You mentioned that the tax credit should create a demand signal and trigger additional investment from PCB fabricators. Do you see action in that regard right now?

From an Isola perspective, we see that some fabricators are growing their businesses. They're introducing actual brick and mortar and scaling up for incremental capacity; people understand the momentum there. We are advocating and educating on behalf of this industry, so what does that demand signal look like? We know that aerospace and defense, with ITAR and everything else, will remain U.S.-based, for the most part. We're trying to understand what those other critical end segments are that we want for a secure and resilient supply chain. I'm referring to areas like the medical industry, banking, and infrastructure, like 5G.

If the government and private industry can sit down and identify the four or five segments where we want that resilient supply chain, it will create a demand signal. Right now, the U.S. has roughly 4% of the international global market share, but if you take those segments I just mentioned, it's roughly 26% of the global market share; the truth is probably somewhere in the middle and it's enough demand to create a sustainable industry. Just an investment from the government isn't enough to create a sustainable industry. We need that pull strategy that is generated from the demand signal, and we're looking forward to raising awareness, educating the government on those critical end segments, and then getting agreement around that.

Johnson: Years ago, there were many small and boutique shops doing a lot of work. PCB fabricators seemed to be everywhere. It's a much smaller market now. Do you see this investment encouraging more consolidation of the fabricators that are still out there? Could this new environment create new businesses?

I think it's both; we're already seeing consolidation. In 1999, there were roughly 2,000 fabricators in the United States. Now, there are fewer than 200 and only 10 really ten big ones. You're seeing where larger fabricators are tucking in other acquisitions, buying some of the

shops, and creating large conglomerates that have a lot of leverage in terms of their overall spend and revenue streams.

We will continue to see consolidation because it's what happens as markets shrink, but there will be new opportunities in the United States as it relates to substrates, not just ABF and build-up films or the actual substrate. There will be an opportunity for the materials suppliers.

You may see greenfield investments from current companies that are expanding into other capabilities and need more brick and mortar. You may also see more international entrants into the market. The U.S., thanks to nearshoring and onshoring, may become appealing to their investment, and they may want to have a footprint here. You may see some new companies actually start hanging shingles in the United States as well. There will be a nice cross-pollination of all those different scenarios.

Johnson: It sounds like the new and emerging technologies are much more attractive than building additional capacity for the well-known PCB fabrication technologies to supply demand.

That's right. That would be hard. At some point, not only do you need to scale up, you have to look at that demand signal on the upper echelon of technology. Our strength is innovation, and it will be hard to compete if you're manufacturing legacy or "commodity products."

As it relates to new semiconductors built in the United States and IC substrates from advanced packaging to be embedded on the board, I see new opportunities—not only for end products, but also your subassemblies and technology. When you think about mSAP and so forth, there will be convergence of all technology. Ultimately, a PCB will become more similar to substrates as you increase the ultra-density interconnect. It's the catalyst to get there quicker.

We can hypothesize that certain PCB fabricators will want to get into that market because there is funding available. It's a given, a necessity, that we will make chips in the United States, but we don't want to ship them back to Asia for packaging. So, how can fabricators get into the substrate market? That's a big opportunity for fabricators as they look to diversify their revenue streams. Defense is a revenue stream, but it's such a small part of their overall business. Commercial business in the U.S. is hard because you have competition from overseas, so the substrates may be very appealing to some of our fabricators.

Johnson: Earlier, you mentioned $3 billion of funding included in HR 3249. Where do you see that money going?

It will be across the board. Much of it will be for research and development, especially as it relates to substrates and multilayered printed circuit boards; while not new to the world, substrates and advanced packaging are obviously new to the U.S. market. It's not only the requirements and the capabilities that are required for substrates and the like, but it's also looking at how we get that know-how back into our country.

We're looking at STEM emphasis in the universities, as well as the technician jobs in this industry, where you don't need a four-year degree for all the open positions. This funding

will address that shortage well beyond microelectronics—even casting companies and others are struggling to find mechanical engineers, electrical engineers, and especially control engineers as more of our industry gets automated.

I am a director for numerous boards outside of microelectronics, such as automotive and industrial manufacturing, and I'm seeing similar trends. When I go into board meetings for different manufacturing companies, I see that they're having a hard time finding engineers and other skilled positions. So, I see that $3 billion spread across numerous aspects of the ecosystem, to help scale up and create the capability that we need.

> **Strategies are only as good as their execution, and that's the phase that we'll get to over the next several months.**

Johnson: Travis, the CHIPS Act is identifying where to spend the money. Do you have much visibility on their status?

Not particularly. We have met with the U.S. Department of Commerce, and at our annual meeting last week we had some speakers who talked about companies submitting a statement of interest relative to how they can support chip production. The focus is truly on chips.

They're broadening the aperture and discussing substrates and advanced packaging, but first and foremost, the focus is on chips. They have to sort through it. As you can imagine, there are many companies that will require funding. It will be interesting to see how it unfolds over the next several months, but my perception, having met with the Department of Commerce and others, is that they understand the ecosystem.

You can now say "printed circuit board" and they know what it is. Or you mention a substrate and they ask how you will package these chips coming out of Ohio and Arizona. They may not have all the answers, but they understand that is an area that must be addressed.

I'm bullish that we're getting to a good place. When I think about what USPAE and PCBAA have done with our legislative wins on the National Defense Authorization Act (NDAA), and obviously, having this new bill introduced again this year, I know we're all heading in the right direction.

Right now, it comes down to the execution. That's real. But strategies are only as good as their execution, and that's the phase that we'll get to over the next several months.

Barry Matties: I've heard you use the phrase "chips don't float." The better people understand that, the stronger the support will be across all of the ecosystem.

We try. You have to keep it at a high enough level that it resonates with your audience. When someone like Sen. Todd Young of Indiana comes in, as well as other congressional representatives, we can explain the ecosystem, but we're just trying to make them be conversant in the idea that it's complex.

Johnson: Let's assume HR 3249 gets passed and becomes a law. Are there some lessons learned from the CHIPS Act on how to administer it?

HR 3249 can take different shapes. Could it pass as a standalone bill? Maybe. If not, it might be attached to a vehicle like the NDAA/omnibus, etc. In the meantime, we will continue to garner bipartisan support and get cosponsors.

Once we get into the implementation phase, we must be very specific about where to direct those funds. At this stage, we can talk about

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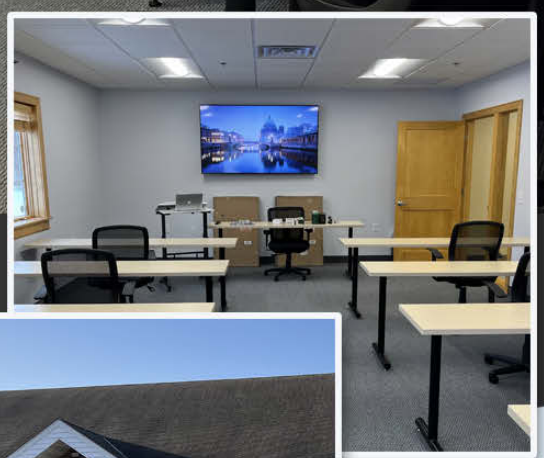

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it in the big buckets, and that's fine. But now it's peeling back the onion: Where exactly will those funds be spent? As the bill gains momentum, we need to develop a detailed plan for that. For example, here's where we see it going in terms of post-secondary education, on the job training, brick and mortar, R&D, etc.

Some companies will have to build out their facilities or make a new facility to scale up incremental demand. I'm sure there will be lessons learned after we do that. I'm not even sure $3 billion solves all the problems, but it's a good start. As we get into the scaling up and onshoring that we expect to happen, we'll find more issues and weaknesses. We'll find more single points of failure and further insight into what we need to get done to make that supply chain resilient.

When you look at what it costs for a fabricator to build something new or to retrofit current footprints, that number seems right in terms of what we hear from each fabricator.

When you get into substrates, it's the capability in the machines and equipment and Class 100 cleanrooms that require millions of dollars. That's why it's good to see the momentum because you have both the CHIPS Act and HR 3249. You also have DPA Title III funding, where President Biden classified printed circuit boards in January as part of the microelectronics ecosystem. Now you have Defense Production Act funding Title III for PCBs. So, if you look at getting into substrates in whatever fashion, you can actually file white papers for that funding. You now have different vehicles within the government to help create that resilient supply chain, so it's all coming together.

There will likely be numerous white papers submitted from many different companies within the ecosystem, not just from fabricators. The government recognizes there's an issue, and that it's more than just chips. It's really been in the past 18 months where we're being invited into meetings, as opposed to us forcing ourselves upon people on the Hill.

Johnson: There has been a trend in this industry toward more private equity involvement. Does this legislative work create an environment that is more attractive for banking and private equity?

Private equity will base most of their decisions on the return on invested capital. If they see an industry like this, it can be appealing to them. The strategy probably would be one of consolidation, doing a lot of the tuck-ins. Smaller shops are still out there and if there's no succession planning, they would probably be more apt to sell than someone else.

So, if a private equity firm buys a platform—a good-sized fabricator—and does a lot of bolt-on acquisitions, there can be money made; you really have to believe in the investment thesis because, at some point, private equity will sell. If the industry continues to shrink, the government won't approve monopolies, so that can be a tough exit strategy.

Do you want to do an IPO? It's hard because the fabrication markets are cyclical. You must show three years of positive growth, but because there are peaks and valleys in this industry, it's hard to do that and get the timing right. If you're a private equity firm, you could definitely underwrite a business case for this market. How will you get in? How will you show organic growth, and how you will leverage bolt-ons?

Look at what private equity is doing right now for dentist offices, and such. They buy a platform, or they get a big office, and they start consolidating all the smaller offices; you get the returns on scale. There's nothing unique about the playbook. There are probably a lot of things within microelectronics and printed circuit boards that would be attractive to a private equity firm.

Matties: Now that we're seeing some of the greener sustainability initiatives, such as zero-discharge facilities, that adds to the appeal.
That's right. Many people don't recognize that about private equity, but it gets its funds to buy companies from all over, such as pension funds for firefighters, police, teachers, sovereign states, individual wealthy people; but when the day ends, they have ESG requirements as well. If a private equity firm wants to raise a multi-billion-dollar fund, there is a good chance their fund docs have an ESG component to it. So, you're absolutely right, Barry, ESG is a big discussion across all industries domestically. Microelectronics is no different in that we're seeing many companies within this industry becoming more compliant each year. That's also appealing.

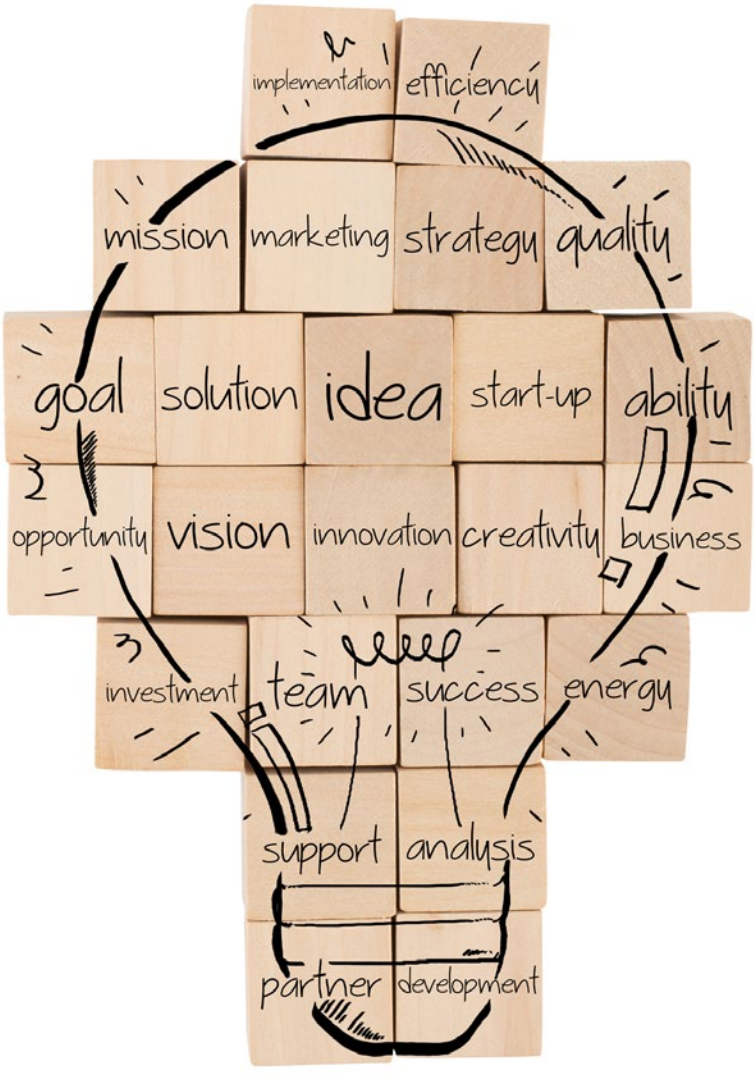
Matties: With the associations you've mentioned—USPAE, IPC, PCBAA—do you think that collective voice has raised the awareness further than it's ever been? Is the result what you're describing? How are these associations coordinating and working together?
It has definitely raised awareness. We work closely with the leaders of these organizations, including John Mitchell, Chris Mitchell, Nathan Edwards, and Chris Peters, although our missions are somewhat different. IPC is an international governing body with a broad view on the overall electronics industry. USPAE is domestically focused and takes up some very important topics outside of what the PCBAA is doing. It's all complementary. The organizations work together and frequently co-sign letters that go up to the president or Congress. The three organizations really leverage and support each other. Numbers speak in Washington; we can talk about our 28 corporate members and several individual members, and how we represent over $15 billion of economics, but when you couple that with USPAE and IPC, it is a powerful voice in Washington.

Matties: It's great to hear that we're getting the clout that is so needed and deserved.
I feel we have more momentum than we've had in a long time—even before I joined microelectronics. Industry leaders will tell me, "Travis, it's never been this way. It hasn't felt this good in a long time." We're seeing investment within the U.S., even outside of government funding. I think it will be a good time.

Like I said recently in Washington, I truly believe we have 36 months to make something happen. As a group of organizations—PCBAA, IPC and USPAE—we need to get something done in the next 36 months.

Johnson: Travis, thanks so much.
Kelly: It's been a great conversation. **SMT007**

A Catalyst for Advanced Packaging and Substrates



Feature Article by Kirk Thompson
ISOLA GROUP

Despite being a leader in R&D investment in semiconductors and packaging with greater than $50 billion per year, the U.S. has seen its market share decrease to less than 3% in areas like advanced packaging and advanced substrates. The cause for this market share erosion was a laser focus in Asian countries to attract semiconductors and advanced packaging investment through ecosystem development and incentives. If the U.S. is serious about changing the momentum in onshoring advanced packaging and advanced substrates, an ecosystem approach to innovation and manufacturing incentives must be employed. It is not enough to have the most innovative technology if the supply chain and manufacturing economics do not deliver competitive commercial opportunities.

To establish a U.S. ecosystem that enables innovation and commercialization of new technologies, we must establish a viable path to profitability at product launch and at high volume manufacturing with multiple points in the value chain, including materials, equipment, components, fabrication, and device manufacturing. Technology leadership can enable profitable business by being first to market and delivering differentiated value by solving unmet needs. Advanced packaging and advanced substrates present a unique opportunity to develop diverse discrete ecosystems as the needs for different technologies—ranging from 2.5D, 3D, panel level packaging, embedded designs, and advanced substrates—are unique and offer specific opportunities for multiple differentiated ecosystems.

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Advanced substrates are essential to critical infrastructure and defense applications in the United States. Many of today's leading brand owners and OEMs are here and looking for new device architectures that deliver best-in-class electrical properties, improved yield, and speed to market. Today, the ecosystem is very Asia-centric, and this creates supply chain risks and barriers to innovation. To establish an ecosystem here, we must identify specific unmet needs or challenges that are tied to an OEM or brand owner. These unmet needs are likely derived from improved electronic properties such as reduced loss, improved signal fidelity, or higher feature density.

> **Advanced substrates are essential to critical infrastructure and defense applications in the United States.**

Design engineers should contemplate how to improve electronic properties and offer solutions to challenges for an emerging ecosystem that delivers a new architecture meant to achieve the targeted electrical properties and the required yield and cost. Using an ecosystem approach at the system level offers best-in-class solutions to these needs and challenge. The best solutions will not come from one component of the value chain, but from multiple groups within the value chain. Feature sizes for advanced substrates are getting increasingly smaller, with thinner layers, higher layer counts, and more stringent electrical demands. Delivering thinner, lower loss, high reliability materials requires collaboration among materials, equipment, fabrication, and design. Materials companies deliver materials that meet the electrical, dimensional, and reliability performances. Equipment companies develop equipment and process flow that deliver the tolerances, electrical performance, and yield based on current and next generation materials. Brand owners/OEMs provide direction on future technology challenges and technology tradeoffs that are always required.

This ecosystem must break down conventional silos to deliver technology faster; provide world class expertise on design, materials, and equipment; and approach high value challenges with innovative system level thinking.

Although these ecosystems are valuable on their own merit, they can be accelerated through incentive programs like the CHIPS Act. Incentives have worked in countries like China to attract ecosystems and increase market share. A great example of that is the solar industry where China has invested $50 billion since 2011, which resulted in 300,000 jobs and enabled an 80% market share in solar panels[1]. The U.S. has made a similar commitment with the CHIPS Act. To be successful, we need to create discrete ecosystems that are targeting specific high value challenges that have been articulated by the leading OEM and brand owners. There needs to be U.S. capability to deliver fast material prototypes, and new equipment processes. The U.S. is a leader in device design, equipment, and materials technology. To win in advanced packaging and advanced substrates, we must have improved capability in materials and equipment prototyping and fabrication. The CHIPS Act is a catalyst, and the industry needs to rally around this to develop the right ecosystems and system approach to solving high value advanced packaging and substrate challenges. **SMT007**

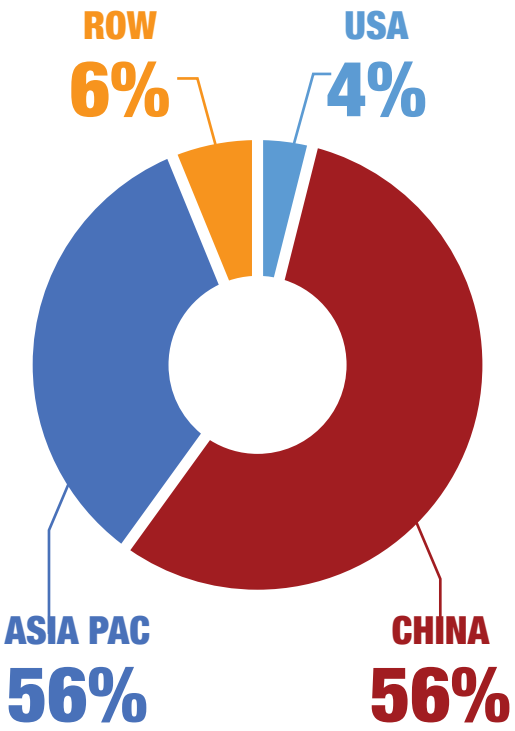
References

1. "China currently dominates global solar PV supply chains, International Energy Agency.

Kirk Thompson is chief technology officer at Isola Group.

21st Century Shifts in U.S. PCB Production

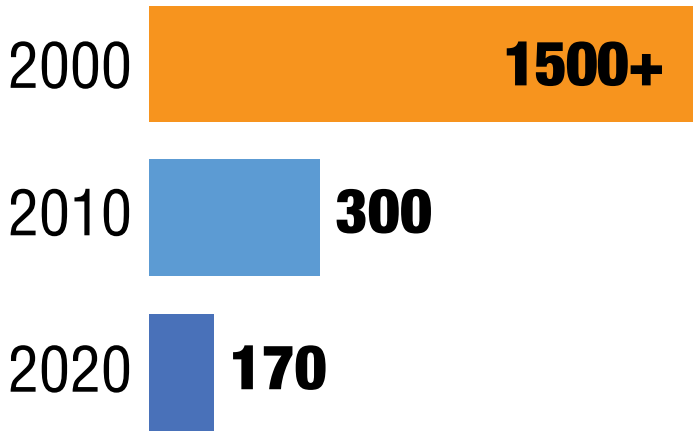
30% Market Share in 2000



2020 Global Market Share

Source: IPC

90% fewer fabs since 2000



Domestic PCB manufacturers

Source: GP Ventures

Bipartisan Legislation Reintroduced to Bring Electronics Manufacturing to America and Strengthen Supply Chains

This is a reprint of a press release published on blakemoore.house.gov.

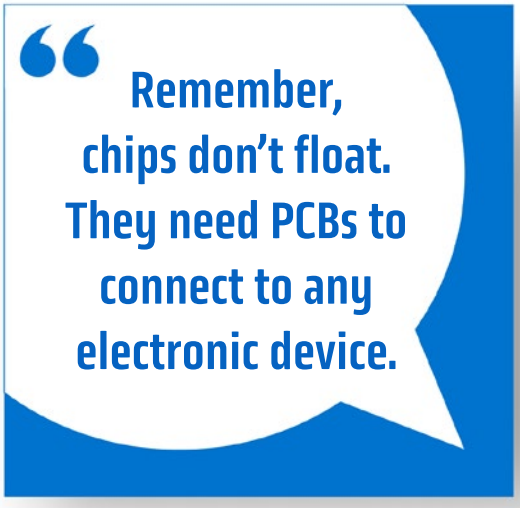
On May 11, U.S. Reps. Blake Moore (R-UT) and Anna G. Eshoo (D-CA) reintroduced bipartisan legislation to bolster domestic printed circuit board (PCB) production and strengthen supply chain security. The Protecting Circuit Boards and Substrates Act will complement semiconductor incentives by encouraging domestic PCB manufacturing and R&D to reduce supply chain disruptions, address national security concerns related to foreign PCB production, and further enhance America's economic leadership.

"Now is the moment for Congress to take decisive action by furthering robust legislation to reshore our manufacturing, strengthen our supply chains, and prioritize national security," said Congressman Moore. "The Protecting Circuit Boards and Substrates Act provides a tried-and-true approach to incentivizing American companies to produce printed circuit boards here at home, which will maintain the integrity of military and national security commercial materials, boost our economy and workforce, and usher in a new era of American manufacturing. The progress we have made on semiconductors is a significant step in the right direction, but congressional support for the entire microelectronics ecosystem is needed to reduce reliance on China. I am grateful to reintroduce this bill with Congresswoman Eshoo and am hopeful this bipartisan effort will successfully move through the legislative process."

"Printed circuit boards (PCBs) are critical components of almost every piece of electronics used today," said Congresswoman Eshoo. "However, over the past two decades, a vast majority of PCB manufacturing has

moved offshore, making PCBs vulnerable to tampering by foreign adversaries, and only 4% of PCBs are manufactured in the United States. If we want to ensure technological superiority across the global stage and strengthen national security, we need to bring PCB production back to America, which is exactly what my bipartisan bill does."

"Remember, chips don't float. They need PCBs to connect to any electronic device. With production of American-made semiconductors ramping up, PCBs are a key ingredient in revitalizing the nation's microelectronics ecosystem," said Travis Kelly, chairman of the Printed Circuit Board Association of America (PCBAA). "Without a robust domestic supply chain, we have become almost entirely reliant on foreign suppliers for the PCBs we need."



"From F-35s to F-150s, the modern world is built on printed circuit boards, and we need to make more of them in America," said David Schild, executive director of PCBAA. "This bill will lead to new factories, high paying jobs, and an ecosystem to support the work being done by our colleagues in the semiconductor industry."

"This bipartisan bill addresses well-known vulnerabilities in U.S. electronics manufacturing, taking a 'silicon-to-systems' approach that prioritizes greater innovation and resiliency across the entire industry," said John W. Mitchell, president and CEO of IPC. "We thank Reps. Moore and Eshoo for their leadership, and we call on all members of Congress to support this bill."

"We are excited to see the introduction of the PCBS Act today," said Tom Edman, CEO of TTM Technologies. "We believe that the passage of this Act will provide our global customers the opportunity to better afford the purchase of U.S. manufactured printed circuit boards and substrates."

"Our industry is grateful for this bipartisan support for American-made microelectronics," said Will Marsh, president of PCBAA and vice president of TTM Technologies. "This is the right response to years of offshoring and a dangerous dependence on foreign sourcing."

Background

PCBs are the material on which semiconductors sit (often the green-colored surface in images of chips) and are a critical part of the supply chain. An assessment from the departments of Commerce and Homeland Security called for domestic investment and production of key information and communications technology products such as PCBs.

The Protecting Circuit Boards and Substrates Act does the following to incentivize domestic PCB manufacturing and R&D:

- Provides a 25% tax credit for the purchase or acquisition of American-made PCBs
- Establishes a financial assistance program, modeled on the CHIPS for America Act, for American facilities manufacturing or researching PCBs
- Requires a Presidential determination for single financial awards over $150 million
- Provides for delay and technology claw backs of award funds in the event that funding is not used efficiently or used in a manner that raises national security concerns
- Authorizes appropriations of $3 billion to carry out the program

SMT007

The Smart Business Case for Local PCB Manufacturing

Smart Factory Insights

Feature Column by Michael Ford, AEGIS SOFTWARE

The PCB has become a neglected component from the Smart assembly manufacturing perspective, wrongly regarded as just a "given" material. We need to put it right. PCB manufacturing needs to become Smart in order to make the local fabrication business model work as part of the holistic electronics' "smarter, secure, and sustainable" approach—what I'm calling the new three Ss of manufacturing.

Advanced chip packaging and printed circuit boards share a common attribute in that they are not simple materials, but rather subassemblies in their own right. Packaged semiconductors are essentially 3D assemblies comprised of several different chip components, as well as others, in a kind of "PCB-less" assembly. PCBs are similarly fabricated using a range of different processes and materials. Whereas semiconductor packages may inherit Smart processes, either from regular semiconductor or discrete assembly manufacturing, PCB fabrication has seen relatively little evolution.

Technologies involved in PCB performance continue to evolve gradually: The subject of several key IPC standards updates as quality and long-term reliability is sought with higher frequencies and power profiles in harsher environments and conditions. Though much of the

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Cultivating Connections

fabrication process is automated, communication of data exchange has somehow been neglected.

Challenge No. 1: Generating Unique IDs

One of the challenges behind this is the lack of a practical mechanism to generate unique IDs for each panel and board, as well as consuming key materials. In the past, these efforts included the use of etched labels and embedded RFID devices, but nothing was widely successful. Without IDs, traceability remains, at best, at date or lot level. This limits the effectiveness should quality issues occur. Inner layers of PCBs are frequent contributors to product quality issues, where incorrect, out-of-date materials (or even counterfeits of inferior quality) have been used. It is, after all, very difficult to inspect the inside of multilayered PCBs. New technologies, including automated generation of IDs using visual features, are now available for PCBs, with other technologies also evolving to meet this challenge. Solving this challenge in isolation, however, is not enough to make Smart PCB fabrication.

"CAM tools are quite evolved but are limited due to the design data compromise."

Challenge No. 2: Transfer of Data

The second key challenge that must be addressed is the very poor, archaic method that prevails in the industry for the transfer of PCB layout data between design and fabrication. There has been a long and convoluted history dating back to the time that layout shapes were made using a physical plotter with altered dimensions, to compensate for the old-fashioned etching process. Engineering practices associated with this type of Gerber data persist in an unbelievable 75% of fabrication engineering operations today. Such design data is represented in the form of several files, all of which need to be reengineered into a single dataset that is then used to fabricate the PCBs. It takes a great deal of manual effort to translate and resolve conflicts in the data, where the fabricator is responsible for any missed issues, as well as to re-compensate for process variations. As such, the engineering reference data needed for context against which operational data is exchanged, based on the IDs of products and materials during execution, is often flawed, inaccurate, and of little use beyond the immediate instance where and when it is collected. This has been the state for the art of PCB fabrication for far too many years.

It's easily possible to avoid this compromise, and key to enabling the automation of engineering processes for fabrication, thus reducing mistakes, costs, and lead-time. CAM tools are quite evolved but are limited due to the design data compromise. The IPC-2581 open standard PCB layout format is available in almost all design tools as standard, which creates a single, true, digital data file (as opposed to analog data in digital format, such as a PDF) that accurately represents the complete design specification of the PCB insofar as manufacturing requires. The use of IPC-2581 enables almost total CAM tool automation. It would appear to be a no-brainer as to why IPC-2581 is not used in all cases, until you realize that something very important was forgotten and that plagues the whole of digital Smart manufacturing.

Heads are buried in the sand, as they have been for many years since PCB fabrication moved to remote locations. To make the product, its design needs to be shared, but this could be appropriated by bad actors. With data shared using old-fashioned analog form,

distributed over many documents, the risk appears acceptable, or at least unavoidable. A modern, digital format, however, means the whole data is in one place and could be copied onto a USB stick very easily, running the risk that clones or copies of products could be produced instantly. Both analog and digital approaches represent a real security risk, but the slightly lower risk approach remains the better in this respect. The key lesson for anyone involved in digitalization of engineering and manufacturing data is that unless security is built into tools that transfer, access, or process data, the risk to adopt them may be too great. Having PCB fabrication onshore reduces the overall risk substantially, in that violations of trust can more easily be brought to account.

Improvements Are Needed

To make digital format design data exchange acceptable, a step-change improvement is needed. A new, simple concept has been created using IPC-2581. The design files associated with each product remain securely within the OEM domain, and are not simply sent to the manufacturing partner. A secure messaging solution, such as IPC-CFX with end-to-end encryption, provides certain elements of the data to fabrication CAM systems as needed, as well as for other uses in manufacturing, such as for machines to use as a contextual reference. Each authorized party requests only the elements of the design data needed to fulfill their roles without the need for local storage of the design data. In this way, there is no opportunity for design IP leakage. The knowledge of the product is the resultant operational data, not the design information. This is more practically achieved where there is automation of design data processing, as is uniquely possible with IPC-2581 files.

Resolving these two challenges in PCB fabrication, collecting information related to material and product IDs, with the ability to contextualize against solid engineering data, opens the floodgates for Smart manufacturing within the PCB fabrication space. Values of enhanced productivity, quality, and agility associated with the analysis of data can be made, supporting the local fabrication business case. There is also a profound value for the assembly of the PCB.

Individual IDs for PCBs are currently created once they are introduced onto an assembly line. These IDs are not material IDs but are, in fact, product IDs with all subsequent assembly activities traced on the basis of this identifier, the root of traceability into the final product. Traceability of the PCB itself, therefore, is very limited only back to the manufacturing batch, and hence the rough date that the fabrication was completed.

Smart fabrication enables enhanced traceability. Process variation and defects identified during assembly, for example, by the AOI process will be connected to a root cause in PCB fabrication, refining quality and productivity, as well as reducing the overall waste in the fabrication process. Common issues, such as warping, stretching, non-vertical drilling, and many other potential issues, can be qualified as part of the holistic, active quality solution.

Many will argue that fabrication and assembly were once done relatively adjacently, and the business case for local fabrication was very poor when compared to the costs and scale of remote fabrication. With the use of secure precision automation in terms of engineering data processing and contextual analysis of manufacturing data, this move of fabrication back to assembly locations can be very attractive with a solid business case. If approached correctly, it will allow us to move ever closer toward zero defects and zero waste, thereby supporting our sustainability credentials. **SMT007**

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

PCBs Garnering Legislative Support

Feature Article by Nolan Johnson
I-CONNECT007

In an op-ed published in San Jose's *Mercury News*[1], U.S. Rep. Anna Eshoo (D-CA) speaks to the importance of the electronics manufacturing ecosystems in the United States. Eshoo's constituency is California's 16th district, based in Silicon Valley. Along with Rep. Blake Moore (R-UT), Eshoo introduced HR 3249, the Protecting Circuit Boards and Substrates Act, a bill supporting the U.S. printed circuit board manufacturing industry.

In her opinion piece, Eshoo begins by reminding readers that U.S. production of semiconductors has dropped from 40% to 12% in the past 30 years, leaving our supply chains fragile and easily disrupted. She states:

"To revitalize our domestic semiconductor industry, Congress passed the CHIPS and Science Act last year, and last week, the House of Representatives built on that investment by passing my bipartisan bill, the Securing Semiconductor Supply Chains Act. This bill will ensure that the government develops strategies to attract investment in semiconductors here in the United States to bring our country back to No. 1 in the world in semiconductor manufacturing and to maintain our leadership in technological innovation.

"While these bills are needed to reduce our reliance on foreign manufacturers and boost domestic investment, chips are just one source

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of vulnerability in the microelectronics supply chain. Chips sit on printed circuit boards (PCBs), critical and complex components of almost every piece of electronics used today. All chips are mounted on PCBs, which allow them to communicate with the systems they power. Currently, as with semiconductors, China dominates PCB production, creating 45% of PCBs globally, while the U.S. market share is only 4%."

The Securing Semiconductor Supply Chains Act of 2023[2] "requires the SelectUSA program to solicit comments from state economic development organizations regarding federal efforts to increase foreign direct investment in semiconductor-related manufacturing and production. SelectUSA must then report to Congress on such comments and the strategies that SelectUSA may employ to increase such investment and to secure the U.S. semiconductor supply chain. SelectUSA is a Department of Commerce program established to coordinate federal efforts to attract and retain business investment in the United States."

As a long-standing former member of the House Intelligence Committee, Eshoo then points out she knows "the risks of foreign-made products embedded in the technology that powers everything from the medical devices that keep us healthy to the military equipment our servicemembers rely on to protect our nation. This dependence on foreign suppliers gives our adversaries the opportunity to compromise our phones, computers, and other electronics by inserting malicious components into PCBs."

In response to this risk, Eshoo, states why she introduced the bipartisan HR 3249. "My bill is modeled on the CHIPS program for semiconductors by providing incentives for the PCB and substrate industries to invest in domestic PCB manufacturing facilities," she writes. "These new facilities will support thousands of high-quality jobs and help train workers across the country, all while bringing PCB production back to the U.S." **SMT007**

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1. "Eshoo: Why we must bring back chip manufacturing to the U.S.," by Anna G. Eshoo, *The Mercury News,* Aug. 1, 2023.
2. HR 752, Securing Semiconductor Supply Chains Act of 2023, introduced by Rep. Anna Eshoo, congress.gov.

Op-ed Reprinted from *The Mercury News*

Eshoo: Why we must bring back chip manufacturing to the U.S.

Chips are just one source of vulnerability in the microelectronics supply chain.

My congressional district was named for the materials that semiconductors are made of—Silicon Valley. But although chips are now found in everything from smartwatches to fighter jets, few semiconductors are made in the valley or anywhere in the United States.

Thirty years ago, the United States manufactured nearly 40% of all semiconductor chips, but today we produce only 12%. The industry's supply chains are fragile, leaving our economy and national security vulnerable to disruption by adversarial foreign governments and supply chain shocks, and we experienced this firsthand throughout the pandemic and over the past few years with the scarcity of the products we rely on.

To revitalize our domestic semiconductor industry, Congress passed the CHIPS and Science Act last year, and last week, the House of Representatives built on that investment by

passing my bipartisan bill, the Securing Semiconductor Supply Chains Act. This bill will ensure that the government develops strategies to attract investment in semiconductors here in the United States to bring our country back to No. 1 in the world in semiconductor manufacturing and to maintain our leadership in technological innovation.

While these bills are needed to reduce our reliance on foreign manufacturers and boost domestic investment, chips are just one source of vulnerability in the microelectronics supply chain. Chips sit on printed circuit boards (PCBs), critical and complex components of almost every piece of electronics used today. All chips are mounted on PCBs, which allow them to communicate with the systems they power. Currently, as with semiconductors, China dominates PCB production, creating 45% of PCBs globally, while the U.S. market share is only 4%.

From my near decade of service on the House Intelligence Committee, I know firsthand the vulnerabilities of foreign-made products in our supply chains and the risks of foreign-made products embedded in the technology that powers everything from the medical devices that keep us healthy to the military equipment our servicemembers rely on to protect our nation. This dependence on foreign suppliers gives our adversaries the opportunity to compromise our phones, computers and other electronics by inserting malicious components into PCBs.

That's why I'm proud to lead the way on investing in PCBs and why I introduced the bipartisan Protecting Circuit Boards and Substrates Act. My bill is modeled on the CHIPS program for semiconductors by providing incentives for the PCB and substrate industries to invest in domestic PCB manufacturing facilities. These new facilities will support thousands of high-quality jobs and help train workers across the country, all while bringing PCB production back to the U.S. **SMT007**

Aluminum Materials Show Promising Performance for Safer, Cheaper, More Powerful Batteries

A good battery needs high energy density to power devices, and stability, so it can be safely and reliably recharged thousands of times. For the past three decades, lithium-ion batteries have reigned supreme—proving their performance in smartphones, laptops, and electric vehicles.

But battery researchers have begun to approach the limits of lithium-ion. As next-generation long-range vehicles and electric aircraft start to arrive on the market, the search for safer, cheaper, and more powerful battery systems that can outperform lithium-ion is ramping up.

A team of researchers from the Georgia Institute of Technology, led by Matthew McDowell, is using aluminum foil to create batteries with higher energy density and greater stability. The team's new battery system, detailed in *Nature Communications,* could enable electric vehicles to run longer on a single charge and would be cheaper to manufacture—all while having a positive impact on the environment.

"We are always looking for batteries with higher energy density, which would enable electric vehicles to drive for longer distances on a charge," McDowell said. "It's interesting that we can use aluminum as a battery material, because it's cost-effective, highly recyclable, and easy to work with."

(Source: Georgia Institute of Technology)

MilAero007 Highlights

And Now, a Word About Sustainability With Stanley Merritt, Northrup Grumman ▸

IPC Community spoke with several members of IPC's Sustainability for Electronics Leadership Council on their company's sustainability mission, reasons for joining IPC's Council, and future Council leadership projects.

Mil-Aero Design: Not Just Another High-rel Board ▸

Meijing Liu, CID+, is a senior PCB designer for Microart Services, an EMS company in Markham, Ontario, Canada. She recently took a six-week mil-aero PCB design class from IPC's Kris Moyer, and she was surprised at how much content she was able to absorb in such a short time. I spoke with Meijing and we discussed some of her takeaways from the class, and how it has inspired her to pursue more design education in the future.

Lockheed Martin: Flying High With Digital Twin ▸

While at a conference in Dallas, Barry Matties listened to a presentation on digital twin from Don Kinard, a senior fellow at Lockheed Martin. Later, we reached out to Don, who was happy to provide a deeper understanding of the role of the digital twin in the manufacturing space. What does digital twin mean when the product your manufacture is an eight- or nine-figure combat aircraft packed full of electronics?

Good News for U.S. National Security ▸

In case you missed it, President Joe Biden recently issued a presidential determination that prioritizes the domestic development of printed circuit boards (PCBs) under the Defense Production Act (DPA). Translation: It is now a tenet of U.S. policy that manufacturing more of the building blocks of modern electronics in the United States is essential to America's economic and national security.

American Made Advocacy: Taking the Fight to Capitol Hill ▸

PCBAA hosted its second annual meeting, June 13–14, in Washington, D.C. It was great to see our founding members as well as many new corporate and individual members. On the first day, we heard from senior officials at the Departments of Commerce and Defense, as well as several members of the House and Senate. We spent the second day on Capitol Hill lobbying for the Protecting Circuit Boards and Substrates Act (PCBS).

Northrop Grumman Opens Taipei Office, Names Country Executive ▸

Global aerospace and defense leader Northrop Grumman has opened an office in Taiwan to accelerate access to the company's technologies and strengthen partnerships with customers and local industry.

From AI to Nuclear: The Technologies Driving UK Space Exploration ▸

The Space Exploration Technology Roadmap will guide research and development activity and future funding decisions over the next decade, putting the UK's growing space sector in a stronger position to collaborate with international partners including NASA, the European Space Agency and JAXA (Japan's space agency).

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Towards a Silicon to Systems Industrial Strategy

A Featured IPC Report by Alison James
IPC EUROPE

Introduction

Electronics systems are at the heart of almost all modern technology. The performance and functionality of these systems have increased at breathtaking speed, chiefly as a result of advancements in semiconductor technology. Semiconductors do not function in isolation. They gain functionality through electronic interconnection with other components on printed circuit boards (PCBs). These electronics systems feature prominently in key sectors like defence, aerospace, space, automotive, medical, and high-performance computing, but electronics are vital to every industry and are central to a variety of EU priorities, including the twin digital and green transitions and Europe's technological sovereignty.

There is near universal agreement on the importance of the European electronics manufacturing base among companies that manufacture and purchase electronics. A survey fielded in July 2023 by IPC and partners across market sectors indicates more than 95% of companies believe a robust European electronics ecosystem, including PCB and EMS industries, is critical to regional security, industrial resiliency, and economic competitiveness. Yet, a clear majority also believes the EU lacks key PCB (88%) and EMS (61%) capabilities. Survey respondents signalled a strong inter-

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est in new EU policy measures to strengthen the global competitiveness of the European PCB and EMS industries.

This article draws on survey results, expert opinion, and cross-sectoral dialogue to assess the state of the PCB and EMS industries and lays out options for EU policymakers to pursue a silicon-to-systems industrial strategy. A silicon-to-systems industrial strategy is a government policy focused on cultivating a robust ecosystem of semiconductor, PCB, EMS, and supplier companies capable of producing electronics systems necessary for Europe's regional security and economic competitiveness.

Alison James

Report Background and Survey Results

The European Commission's Directorate General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW) led a workshop and structured dialogue on June 23, 2023, focused on how to support the resilience of the electronics value chain. At the meeting, a working group of stakeholders was established and tasked with producing this industry report outlining the critical nature of the electronics assembly sector in European value chains; an analysis of PCB and EMS strengths, weaknesses, opportunities, and threats (SWOT); and policy recommendations for future actions and initiatives at the European level.

As part of this research, the working group fielded a survey to companies, associations, and other stakeholders. The survey received 122 responses from PCB companies (34% of respondents), EMS (34%), OEM (18%), and other stakeholders including trade unions (14%). Half (50%) of respondents employ more than 250 workers, and nearly a quarter (23%) report annual global revenue in excess of €500 million. The respondents collectively report having manufacturing operations in all EU member states.

Downstream Implications

European companies were once market leaders in electronics manufacturing, but fierce competition from Asia and elsewhere has led them to specialize in higher-value, lower-volume production, including embedded systems found in medical technologies, industrial equipment, defence, space, aerospace, and automobiles. But by ceding to Asia the volume manufacturing, largely associated with consumer products, European electronics manufacturers have seen their overall market share and profitability decline. This decline in profitability has significant implications for supply chain resiliency and technological sovereignty.

Embedded systems are a growth market as electronics become integral to just about everything, fueling industry's digital and green transitions. For Europe's global leadership in key market segments—like clean energy, connected and autonomous mobility, industrial Internet of Things (IoT), Industry 4.0, and cybersecurity—it increasingly makes sense to locate related manufacturing activities in close proximity. These markets have specific production needs that can make interaction between customer and supplier important, if not essential. To meet regional defence and space requirements, this becomes ever more critical, particularly as data protection and security are paramount in these industries. Global supply chain volatility, escalating trade wars, health crises, and natural disasters underscore the importance of resilient regional supply chains. Companies are increasingly taking steps to diversify and regionalise their supply chains because their existing supply chains have growing exposure to these risks.

The EU nonetheless has—and risks future—increasing international dependencies for PCB and EMS. The loss of volume for PCB manufacturers has led to insufficient capac-

ity to reinvest in their businesses, their equipment, and the latest technology shifts. PCB manufacturing in Europe has declined to 2% of the global market. In turn, EMS companies, while poised to partner to deliver on Europe's manufacturing needs, also face capacity constraints.

The grit and creativity that allowed many companies to survive over the past 20 years simply will not work over the next 20 years. Advancements in semiconductor technology are further placing daunting, stringent, and costly new demands on both PCB and EMS companies.

Demand for electronics globally, driven by global megatrends, is growing steadily. But this growth risks largely bypassing Europe, as OEMs seek greater capabilities and capacities from the most sophisticated manufacturing facilities in Asia. Without significant change, the electronics industry in Europe will experience limitations in capacity and innovation capability, increased lead times, and higher prices on allocations for PCBAs in all modules and systems impacting semifinished and final products across all industries.

European PCB SWOT

PCB Industry Snapshot: PCB fabricators produce the boards that mechanically support and electrically connect components, including chips, using conductive copper traces, pads, and vias on laminates. Without PCBs, the hardware and software found in every electronics system cannot function. PCBs are becoming increasingly sophisticated to accommodate ever smaller, more powerful electronics.

Today, the PCB is no longer a passive base where components are placed, but an integral part of the final product. Michael Gasch of Data4PCB estimates annual PCB production in the EU is approximately €2 billion Euros or roughly 2% of global production. This is a steep decline from the 1990s when the EU commanded approximately 20% of global production. In the past 20 years, according to Data4PCB, the number of EU PCB fabricators has also decreased precipitously, falling two-thirds, to fewer than 180 facilities and employing approximately 15,000 workers. Over this time, the EU has become highly dependent on China, which now accounts for some 65% of total EU PCB requirements.

STRENGTHS	WEAKNESSES
• Longstanding OEM-EMS-PCB relationships • Technical capabilities • Prototyping capabilities • Skilled workforce • Lead times • Data security	• Cost • Manufacturing capacity • Regional supply chains for base materials • Engagement with the global supply chain • Regional supply chains for chemistries • R&D investment
OPPORTUNITIES	**THREATS**
• Economy-wide green transition • Product innovation • Process innovation • Smart manufacturing / Factory of the Future • Government industrial base support	• Cost of Labour • Lack of skilled workforce • Supply chain disruptions • Weak domestic and/or regional electronics manufacturing ecosystems • Government regulation/compliance

Figure 1.

PCB SWOT Analysis, Consensus Views

Strengths

The European PCB industry has established a stable presence in the European market, backed by hard-earned and longstanding relationships with their EMS and OEM customers. Customers value the manufacturing quality and security associated with sourcing from a European PCB supplier, as well as simplified logistics that come with proximity. The PCB industry has a small, but highly skilled workforce comprising individuals with strong backgrounds in engineering and manufacturing. A few European PCB companies have leveraged this workforce, along with investments in R&D and new equipment, to produce state-of-the-art PCBs and integrated circuit (IC) substrates. Proximity to customers gives European PCB fabricators an advantage in prototyping, given the paramount importance of speed, IP protection, and technical support.

> "The unavailability of a strong regional supply chain for materials and chemistries remains a top concern.

The European industry also has a strong customer base in the industrial, aerospace, space, defence, medical, and automotive sectors.

Weaknesses

The erosion of the PCB industrial base is becoming increasingly dire. Since 2000, the number of European PCB companies has fallen from approximately 560 companies to fewer than 175 and total revenue has fallen by two-thirds. The industry is highly fragmented, comprising primarily small companies. Nearly 65% of European PCB companies had revenues in 2020 of less than €10 million Euros. The decline in European PCB production is largely the result of the region's higher cost of manufacturing and lack of capital investment. Marketplace competition drove many OEMs to source lower-cost electronics from Asia, which led the European PCB industry to focus increasingly on high-mix, low-volume production, including prototyping and specialist industries (e.g., aerospace and defence). The decline in volume relative to Asia has had a compounding effect on costs and the ability to invest. Most suppliers of materials, chemistries, parts, and components moved offshore, saddling European PCB fabricators with the "low-volume disadvantage" offered from Asia. The unavailability of a strong regional supply chain for materials and chemistries remains a top concern.

The European PCB industry faces technical challenges as well. Most companies have limited resources to undertake R&D and few opportunities to partner with global materials and equipment manufacturers due to the lack of regional, high-volume production. Acquisition of new equipment is also challenging due to cost, lack of confidence in market demand, and lack of medium- to long-term forecasts. Simply put, capital investment carries significant risk. The lack of sufficient investment in R&D and capital investment is slowing down industry efforts to embrace technological advances. For example, a recent Eurospace white paper highlighted concerns about the systematic reliability of microvias in high density interconnect (HDI) PCB technology.

PCB companies continue to rank workforce dynamics as one of their top concerns. A significant percentage of the industry is at or nearing retirement; companies cannot hire sufficient numbers to replace those retiring and grow their businesses. The industry also faces high turnover, increasing training costs, and lower-

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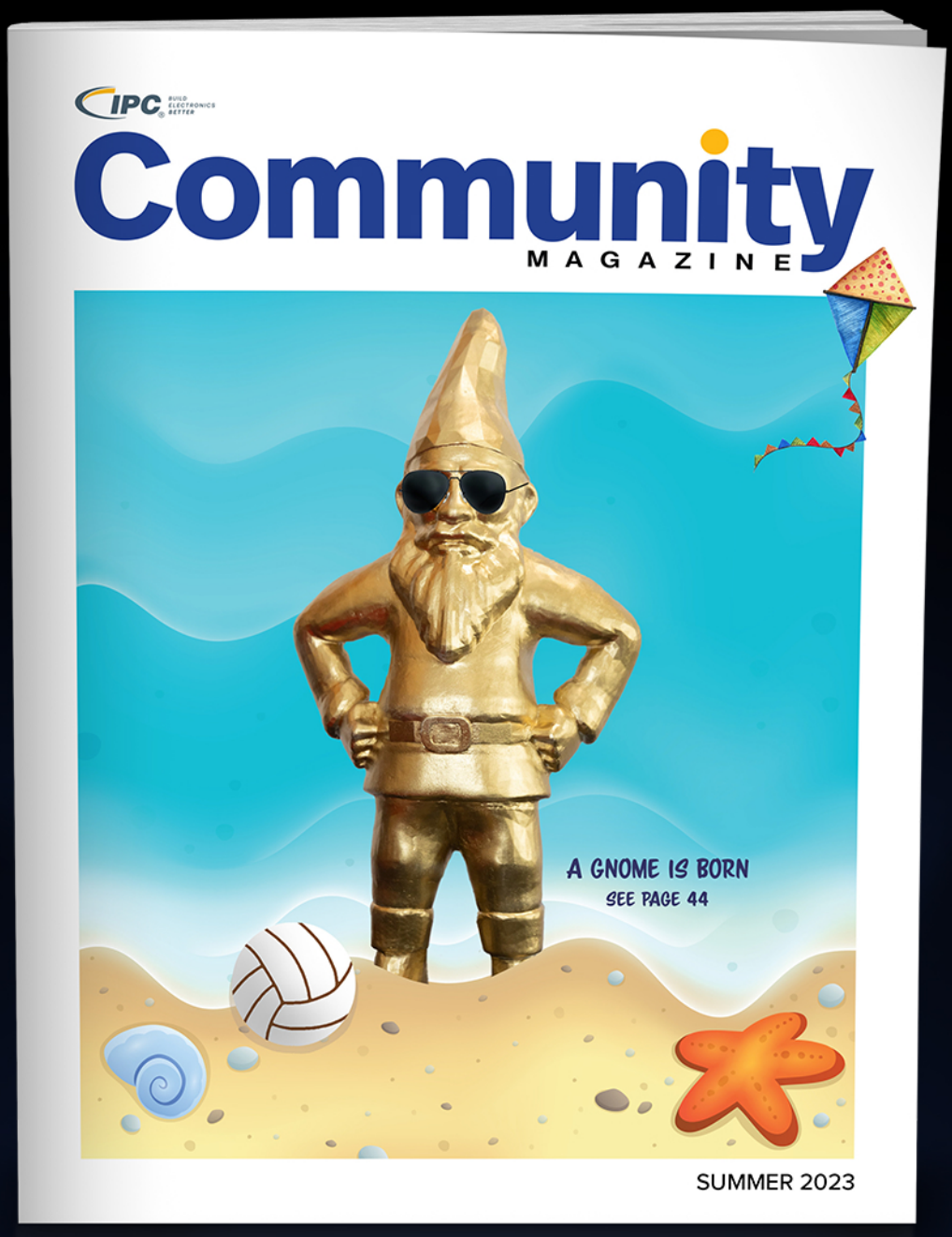

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ing productivity. In the PCB industry, experience matters greatly on technical operations and business strategy given the sudden shifts in business cycles and technical requirements. Companies must respond to fluctuations in end-market demand by anticipating industry needs and adjusting their capabilities accordingly. Investment planning is difficult as most companies do not have long-term committed orders due to the focus on high-mix, low-volume orders. The U.S. PCB industry is weakened as well, but companies there can depend on big defence budgets for financial stability.

Opportunities

Heightened interest in the electronics supply chain among policymakers has spurred cautious hope across the PCB industry that the EU and Member States will dedicate new resources and policy support to help bolster the industry. Accordingly, survey participants ranked government industrial base support as one of the industry's top opportunities. This ranking reflects the industry's belief that government action is necessary and can be transformational over the long- term. The concluding section of this paper outlines policy options that governments can pursue to strengthen the PCB industry. These policy options bring into alignment top industry and EU priorities. For example, the green and digital transitions will necessarily create increased European demand for electronics. This increasing demand is largely being met by foreign suppliers, but the EU has an opportunity to promote European made electronics as a key enabler of these transitions.

Likewise, the EU should engage the broader technology community about how to leverage the Chips Act to support broad-based growth across the electronics sector. It is not enough to support the fabrication of silicon in Europe. The region should also ensure, through implementation of the Chips Act, that silicon can be packaged in Europe and that the resulting semiconductor component can be assembled onto European-made PCBs. This goal should be implemented in the interest of regional industrial resiliency and economic competitiveness, while still acknowledging that, in many commercial applications, PCBs will continue to be manufactured offshore.

European PCB companies are also focused on process innovation and the migration to the factory of the future. Underlying these opportunities is the recognition that the PCB industry must modernize their manufacturing operations to bring costs down and productivity up, while offering customers greater capabilities, quality, and transparency. This innovation also creates new opportunities to advance important environmental goals as the industry is both energy and water intensive.

With greater government support and industry investment in the factory of the future, the cost of European PCB fabrication is likely to become more globally competitive, but European PCBs will generally remain more expensive than imported boards. There are opportunities to promote greater price tolerance among PCB customers by strengthening the European industry's value proposition in the context of risk managed sourcing. This can be done through the development of industry-driven, voluntary commercial trusted supply chain standards for PCBs and PCBAs.

Threats

A few European PCB fabricators are growing and competing globally, but the European PCB industry is on a downward trajectory. Only a small number of European companies can meet the technological requirements driven by semiconductor advancements. Even though the industry's total revenue is expected to grow modestly over the next few years, the total number of fabricators will decline.

Electronics is a cost-sensitive business that requires continual investment in equipment and talent. Survey participants identify cost of labour as the top threat to the PCB industry. The PCB industry in Europe is particularly sen-

sitive to increased labour costs because, unlike modern PCB manufacturing in other parts of the world, European PCB fabrication remains a labour-intensive manufacturing process due to lack of investment. Increased labour costs make European PCB fabricators less competitive. Stakeholders also voice concern about supply chain disruptions and the unavailability of equipment, materials, parts, and components regionally.

European PCB companies report that they are disadvantaged by EU customs tariffs. Companies pay tariffs on the import of base materials used to produce PCBs, but there are no tariffs on bare PCBs that are imported for assembly. Base materials must be imported as local supply chains cannot fulfill the demand. Government regulation remains a concern. Participants expressed a desire for greater regulatory restraint and greater harmonization of regulations. Other participants volunteered that energy costs constitute a serious threat to their business.

Final Note

EU action to support the industry must address supply and demand. Support to bolster capacity will be unsustainable unless demand increases concurrently.

European EMS SWOT

EMS Industry Snapshot

EMS companies mount, connect, and assemble electronic components on bare PCB boards to make printed circuit assemblies. Increasingly EMS companies further provide additional services and expertise along the whole product lifecycle, design, and industrialisation, acting as pivotal partners in the digitalization process. Some European original equipment manufacturers (OEMs) assemble their own electronics, but many outsource their production to EMS companies, making them crucial players in the electronics value chain. According to Dieter Weiss at in4ma, the EU EMS ecosystem accounts for roughly €52 billion in revenue each year, which represents about 8.2% of global production. His research shows 2,197 EMS facilities in the EU belonging to 1,881 companies. Some 80% of all EMS companies in Europe have less than €10 million in revenues and have a market share of the total European revenues of 11.2%.

STRENGTHS	WEAKNESSES
• OEM-EMS-PCB relationships • Technical capabilities • Skilled workforce • Prototyping capabilities • Lead times	• Cost • Manufacturing capacity • Regional supply chains for base materials • Skilled workforce • Engagement with the global supply chain
OPPORTUNITIES	**THREATS**
• Smart manufacturing / Factory of the Future • Process innovation • Economy-wide green transition • Product innovation • Economy-wide digital transition	• Supply chain disruptions • Cost of labour • Lack of skilled workforce • Geopolitical tensions • Cost of materials, parts, and/or components • Government Regulation/compliance

Figure 2.

Germany, Czech Republic, Hungary, France, and Poland are the top five EMS producing countries in the EU. Despite solid growth in recent years, the EU imports roughly 90% of required EMS products and services, and this proportion reaches 97% for consumer applications and telecommunications.

EMS SWOT Analysis, Consensus Views

Strengths

Much like European PCB fabricators, EMS companies also enjoy strong relationships with their customers and suppliers in Europe. These relationships led to trust and longstanding business activity, in turn leading to continuous product innovation and global competitiveness. Importantly, the EMS industry represents about 41% of electronic goods manufacturing in Europe; OEMs manufacture the remaining 59%. While OEMs are responsible for a greater share of electronics manufacturing than EMS companies, the trend is toward greater reliance on EMS companies. As a result, EMS companies have seen nearly 5% annual growth and an increasing expansion into activities normally undertaken by OEMs or other third parties. These activities include product development, design services, component sourcing, system manufacturing, final system assembly, logistics, and after sales services.

The European EMS industry also boasts a skilled workforce and prototyping capabilities, but unlike the PCB industry, many stakeholders believe Europe has sufficient state-of-the-art electronics assembly capabilities. Stakeholders would like greater capacity, but the market demand must exist to justify investments. Notably, the EMS sector is far more interconnected with the global supply chain than their PCB counterparts. This is not surprising as EMS companies of all sizes must have global supply chains to source components, parts, and chemistries.

Weaknesses

European EMS companies continue to specialize in high-mix and low-volume orders. This focus helps to explain the European EMS industry's revenue relative to competitors in Asia. According to in4ma, 80% of European EMS companies have annual revenues of less than €10 million. Among the global top 20 EMS, there is not a single European company. Volume is important in the EMS industry as profit margins are notoriously thin; volume offers a path to greater profits that can be reinvested in the business. Today, only the larger EMS companies are well-positioned to invest in new technologies, further vertical integration, and higher capacity. Most companies lack sufficient cash as well as skilled labour to buy and leverage the latest equipment. The financial picture is further complicated by prime rates, inflation, and labour cost increases. Whereas in the past, most companies have been able to compensate labour cost increases of about 2% annually with productivity increases, this is nearly impossible with wage increases averaging 5% to 5.5% today.

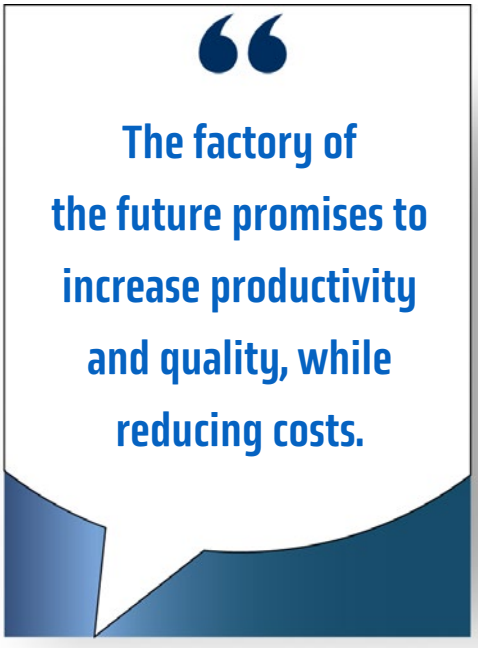
Opportunities

Like the PCB industry, EMS companies are welcoming the renewed interest in supply chain resiliency and are keen to see the EU and Member States take action to bolster the electronics manufacturing ecosystem. Survey participants selected government support for industrial resiliency just outside the top five opportunities. The top five opportunities, however, shared a common theme: transition. All five speak to significant changes taking place in the electronics industry and across the economy. The EMS industry, for example, sees significant opportunities in the transition to the factory of the future, which is critical to its globally competitiveness.

As discussed earlier, the factory of the future—comprising a suite of technologies, processes, and talent—offers tremendous

operational and capability benefits for EMS companies and their customers. The factory of the future promises to increase productivity and quality, while reducing costs. It also empowers manufacturers to strengthen collaboration with their customers to ensure the product is meeting specifications.

Investments in the factory of the future are also helping to drive product and process innovation, both of which EMS companies cite as top opportunities. On the product side, companies report that semiconductor advancements are placing daunting new requirements on EMS companies. Electronic assemblies must incorporate increasingly sophisticated chips with greater functionality, performance, and security—often in smaller packages. The design and manufacturing obstacles are challenging every segment of the industry, but EMS companies, leveraging their technical expertise and global supply chains, are increasingly well positioned to partner with their OEM customers to ensure that product requirements are achieved using the latest technologies. Process innovation is critical to product innovation to ensure that the products can be manufactured at a price point and with the quality and reliability that customers expect.



The migration to the factory of the future is also aligned with the EU's drive for economy-wide digitization and for an ambitious set of environmental goals. Factories will increasingly integrate automation, sensors, big data, and AI and the result will be a greater stewardship of natural resources. These twin transitions will also create a need for greater use of electronics across the economy, which European EMS companies are eager to meet with the right government incentives.

Threats

The low-volume disadvantage, coupled with other economic realities, are making it more difficult for many small EMS companies to remain solvent. As a result, the industry is seeing a wave of closures, as well as consolidation through acquisition. In4ma reports 100 fewer European EMS companies over the last eight years. This trend is likely to continue as EMS companies face a host of external pressures, many of which are driven by their reliance on global supply chains. Although the shortage of chips has been most acute, companies report shortages in many components, parts, and materials. This led to a hoarding of supplies which might have to be devaluated as prices have fallen for several of these components. Moreover, measuring true demand and supply remains a challenge, making European EMS companies heavily reliant on global sources and especially vulnerable to supply chain disruptions.

The industry is concerned about workforce shortages. Aging workers are retiring, and companies cannot attract new workers in sufficient numbers to replace those retiring and to facilitate the growth of their businesses. Cost pressures weigh heavily on hiring and labour costs are much higher in Europe than low-cost regions in Asia and the Americas.

Companies are also concerned about the breadth and scope of government regulations. They are especially burdened by reporting obligations related to their global supply chains. Companies are worried by the patchwork of regulatory requirements across the EU and the way the EU's laudable, but broad drive toward the circular economy may disadvantage the region's manufacturers. The green transition necessitates a stronger and more

integrated industrial strategy for the electronics industry. Otherwise, the semiconductor fabrication spurred by the Chips Act will lead to chips being sent offshore for assembly, thereby lengthening and weakening European supply chains.

Recommendations

By any metric, Europe is highly dependent on electronics produced offshore for end-systems critical to Europe's security, vitality, and strategic goals, including the dual transition. This dependency poses a serious risk to Europe's strategic autonomy given that a massive global supply chain disruption could deplete inventories for critically needed goods and bring manufacturing across most economic sectors to a standstill. Europe would not be able to meet existing demand for electronics and manufacturing capacity and infrastructure are not built overnight.

Industry has identified several initial recommendations to strengthen the EMS and PCB industries in Europe. These options address the issues raised in the SWOT analysis and reflect the industry's view that both government funding support and policies that drive demand for EU-produced electronics are required to strengthen European electronics manufacturing.

In addition to these immediate recommendations, the industry also outlines next steps to expand on the empirical research and pursuit of longer-term goals.

1. Declarations of Strategic Importance

The industry is seeking from the EU and Member States clear, affirmative declarations that electronics manufacturing is strategically important for Europe and that bolstering Europe's PCB and EMS sectors is essential to European strategic autonomy. This can take the following shape:

- Highlighted as strategic dependencies in the EU's Industrial strategy and upcoming industrial communications due to the critical nature of the sectors for all industries incorporating electronics
- Highlighted for capacity building as part of the EU's Digital Decade under the secure and sustainable digital infrastructure pillar, and the EU's long-term competitiveness focus

2. Strategic Alignment with Chips Initiatives

As part of the European Chips Act implementation, the industry stakeholders encourage the European Commission to leverage the Act to help support growth and innovation across the electronics industry. This could be achieved by helping the PCB and EMS industries increase the capabilities and capacities to place chips on European-made boards. The upcoming Chips Joint Undertaking offers an immediate opportunity to include this objective in scope.

3. Supporting Factory Modernization

The industry recommends public sector financial support to help PCB and EMS companies purchase advanced machinery and equipment to increase production capabilities, capacities, efficiency, and innovation and to support the EU's digital and green transitions.

- For PCB companies, this means enabling and supporting up-front investment in equipment needed to meet technological shifts. The investment in equipment will respond to the current lack of sufficient production capacity and capabilities in a continuously growing market and stimulate market demand.
- For EMS companies, significant investments are required to keep pace with developments in manufacturing technologies. Government loan programmes will support the acquisition of equipment in response increasing demand, but support

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is necessary to accelerate process innovation and the migration to the factory of the future, which promises to further stimulate regional demand.

4. Ensuring a Skilled Workforce

Supporting the existing workforce needs while also preparing the next generation workforce is a significant challenge across Europe's manufacturing base. There is a need to address the potential shortage of skilled employees in EMS and PCB manufacturing:

- To increase the visibility and the attractiveness of these fields while at the same time kick-starting new initiatives to attract both technicians and graduates in these industries
- To develop and implement training programs to provide students and workers with in-depth knowledge of the manufacturing processes required to achieve complex designs and to keep up with new technologies and processes
- To have lifelong training, up-skilling and reskilling of the workforce in order to make full use of workforce availability

5. Ensuring a Level Playing Field in Global Trade

European PCB companies report that they are disadvantaged by EU customs tariffs. Companies pay tariffs on the import of base materials used to produce PCBs, but there are no tariffs on bare PCBs that are imported for assembly. Base materials must be imported as local supply chains cannot fulfill the demand. This disparity makes it even more difficult for European PCB companies to compete with foreign competitors on price. This disparity could be addressed by consideration of a:

- Tariff Suspension with End Use for PCB manufacturing for the import of base materials necessary for PCB production:
  - 7409190000: Copper-clad epoxy impregnated glass fabric base material: Tariff 4.80%
  - 74102100: Copper-clad: Tariff 5.2%
  - 3921190099: Rolls of epoxy impregnated glass fabric (prepreg): Tariff 6.5%

Further dialogue among industry and government leaders is needed to find solutions that will provide a more level playing field in a competitive global marketplace and enable sustainable re-industrialisation of the EU. Many governments offer subsidies and domestic sourcing requirements that disadvantage European companies.

6. RD&I

In addition to equipment/machinery there will be an increasing need for investments in RD&I to ensure that European PCB and EMS companies can continue to accommodate advancements in semiconductor fabrication and other technological advancements. Dedicated programmes for PCB and EMS are required. This RD&I should focus on:

- Ultra high density interconnect (UHDI) PCBs
- IC substrates, IC substrate-like PCBs and advanced packaging
- Ultra high density electronic assemblies
- Next generation materials
- Ecodesign

Next Steps

The stakeholder group also underscores the importance of a follow-up meeting of the Electronics Dialogue this Autumn to further build on initial policy recommendations and finalize private sector commitments and policy recommendations. Specifically, the meeting and industry's work in advance should serve to:

1. Set targets for the European share of global EMS and PCB production: The Chips Act sets an ambitious and much-needed Euro-

pean goal of fabricating within the region 20% of global production by 2030. These chips will largely be sent offshore unless Europe strives to increase EMS and PCB production in similar fashion.

To complement the EU's chips' goal, industry recommends the establishment of targets for European PCB and EMS by 2035 (which will also include the projected demand of European OEM partners).

2. Determine a trusted supply chain for critical systems: Industry recommends government and the industry work closely together to cultivate trusted supply chains for PCBs and electronics assemblies integrated into critical electronics systems.

3. Further data collection on end-market needs: More data is needed to quantify and assess the strategic relationship between European PCB and EMS industries and European OEM partners. This will be in light of the identified critical systems and projected European demand.

4. Initiate an industry roadmap that aligns EMS and PCB capabilities/capacities: The electronics industry is dynamic with technological innovation taking place constantly. A technical roadmap, led by industry, should be completed to help guide EU investments in R&D for the EMS and PCB industries.

5. Establish a standing mechanism for industry/government dialogue on electronics manufacturing: The issues faced by electronics manufacturing are challenging and there are no quick and easy solutions. An ongoing commitment on the part of industry and government to strengthen European electronics manufacturing is key to meeting EU goals related to security, resiliency, and innovation. For this reason, the industry recommends the establishment of a standing dialogue between industry and government to ensure that both can be responsive to the concerns raised by the other. **SMT007**

Alison James is senior director of IPC Europe. To draft this stakeholder report, she enlisted participation from peer trade associations, companies across the economic sectors, and trade unions.

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The industry stakeholders are indebted to Dieter Weiss of in4ma and Michael Gasch of Data4PCB for their data and insights on the EMS and PCB industries, respectively.

CHIPS Act Priorities

Feature Q&A With Matt Kelly

As expected, the U.S. Department of Commerce is actively administering the $53 billion of funding in the CHIPS Act. A key committee in this process is the CHIPS Act Industrial Advisory Committee (IAC). IPC Vice President and Chief Technology Officer Matt Kelly offered a printed circuit board and system-wide perspective to the IAC, part of the ongoing advocacy efforts being undertaken by IPC and other organizations, and later answered some questions about what he presented and how it was received.

You recently made a presentation to the CHIPS Act Industrial Advisory Committee. How does this group fit into the CHIPS Act administration?

Matt Kelly: It's best to share it straight from the Industrial Advisory Committee at nist.gov[1]:

"The Industrial Advisory Committee was established by Congress in the William M. (Mac) Thornberry National Defense Authorization Act of 2021 (FY 2021 NDAA). The committee will provide advice on the science and technology needs of the nation's domestic microelectronics industry, the national strategy on microelectronics research, the research and development programs and other advanced microelectronics activities funded through CHIPS for America, and opportunities for new public-private partnerships.

"The committee comprises leaders from a broad range of disciplines in the microelectronics field, including academia, the semiconductor industry, federal laboratories and other areas."[1]

Your message to the IAC hinged on two key ideas: getting the Problem Statement right and deciding what the true objective is for the CHIPS Act. Could you walk us through the problem statement?

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Certainly. In two key slides from the presentation, I made the point that too much emphasis continues to be placed on semiconductors. While this is absolutely important, it is insufficient.

The U.S. has no substrate capability; this is not a "bring it back" issue. We face a "bring it here for the first time" challenge. From a packaging and assembly perspective, we have limited capacity. If we do not look at it from a holistic standpoint, recognizing we do not have substrate or assembly packaging capabilities, then the new foundries being built in the southwest U.S. right now will actually lengthen the supply chain, not shorten it. Once that silicon is produced, it will board a plane destined for somewhere in Asia or Southeast Asia.

Which brings us to our grand challenge: We need to build an efficient, resilient domestic electronics manufacturing ecosystem for critical systems. This is a very important point. If we're going to do that, we need to:

- First establish U.S. IC substrate capability and capacity with a longer-term R&D runway
- Strengthen that existing packaging, assembly, and test capability to produce a certain category of critical components
- Look on the system side from a printed circuit board/ultra HDI printed circuit board capability so we can join these devices into the system
- Enable domestic final system assembly for identified critical systems now

Clearly, the argument is that we need this for defense types of applications. But there are other applications: HPC data centers, 5G and 6G wireless communications, medical, and automotive.

The feedback that we're getting is that we need to spend more time on clearly identifying the overall CHIPS Act objective. There are three main options that we see (Figure 1).

Option 1: If the objective is to protect and advance U.S. semiconductor dominance—which we have—then we need to invest in semiconductor fabrication exclusively and continue working with allied nations within the global supply chain just as we have been for

Critical to clearly define CHIPS overall objective:

Option 1	**IF objective is to protect and advance US semiconductor dominance** THEN, invest in semiconductor fabrication only (Si, GaN, SiC) microelectronics and power electronics AND, continue working within global supply chain, with allied nations (ITAR waivers) globally source substrates, package assembly, PCBs, and final systems
Option 2	**IF objective is to domestically manufacture active components (CPU, GPU, NPU, memory)** THEN, need to invest in semiconductors + substrates + component assembly and test
Option 3	**IF objective is to domestically build mission critical systems (defense, HPC, medical, etc.)** THEN, need to invest in semiconductors + substrates + component assembly + uHDI printed circuit boards + printed circuit board assembly + final system assembly

Objective sets overall strategy and investment decisions—still unclear

Figure 1.

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Matt Kelly

the past 20-plus years. For defense, that means ITAR waivers and such, so that we continue globally sourcing substrates, package assembly, printed circuit boards, and final systems.

Option 2: If the objective is to domestically manufacture active components—this is a certain class of components such as CPUs, GPUs, neural processing units for AI memory—then the equation gets a little bit longer; we need to invest in semiconductors plus substrates, and component assembly and test.

However, if the objective of the CHIPS Act is to domestically build mission critical systems, defense, HPC, medical, or whatever, the equation gets even longer. We'll need to invest in semiconductors, substrates, component assembly, ultra HDI printed circuit boards, printed circuit board assembly, and final system assembly.

The objectives that we choose will set the overall strategy and investment decisions to be made. Unfortunately, this is still largely unclear. Now, you may disagree, but that is what we hear from our members, as well as direct feedback at an industry level. I've drawn a line here between option one and option two. This is the proverbial "line in the sand." What we see from all the work we've been doing is that most of the focus is being poured into the first option. It's extremely important, as we outline our argument, that if we're going to build an ecosystem, we need to think beyond just semiconductors.

After your meeting, what seemed to be the response from IAC?

IPC recommendations were highly regarded by the committee. It was rated one of the top contributions and was widely distributed among all IAC workgroups. Two key recommendations from IPC were carried forward to the June 6 IAC recommendation listing including:

- The need to establish domestic substrate capability, minimum viable R&D and production capabilities
- The need to grow/advance capacity and capability for domestic package assembly and test facilities

What is the key takeaway from your discussion of possible objectives?

The key takeaway is that after two years of working closely with several U.S.-based coalitions, consortiums, and policy makers, it appears that implementation of the CHIPS Act will likely be focused on protecting and advancing U.S. semiconductor dominance (Figure 2).

Observations made to date indicate that domestic semiconductor advancements will indeed be made by component makers, but those same companies are very likely to continue to globally source substrates, component packaging/assembly/test (IDM, OSAT), PCB fabrication, and EMS system assembly. Many market-leading OEM component makers are

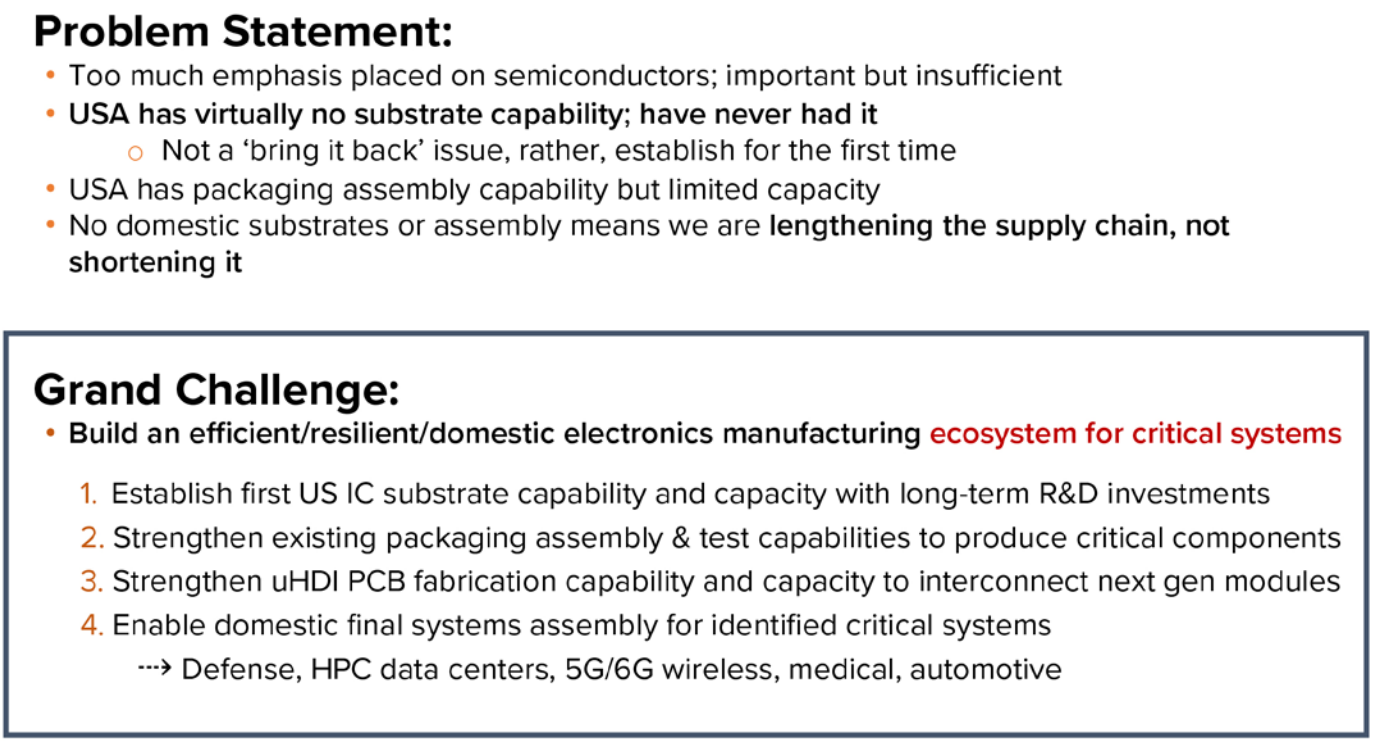


Figure 2.

very likely to continue utilizing the global outsourcing model to Asia that has developed over the past 25 years.

For defense applications, expect some improved capabilities for North American-based substrates, packaging, and final system assembly, but also expect continued discussions and partnerships with U.S. allied nations such as Japan, South Korea, and Taiwan to provide trusted high-quality supply of substrates and package assembly.

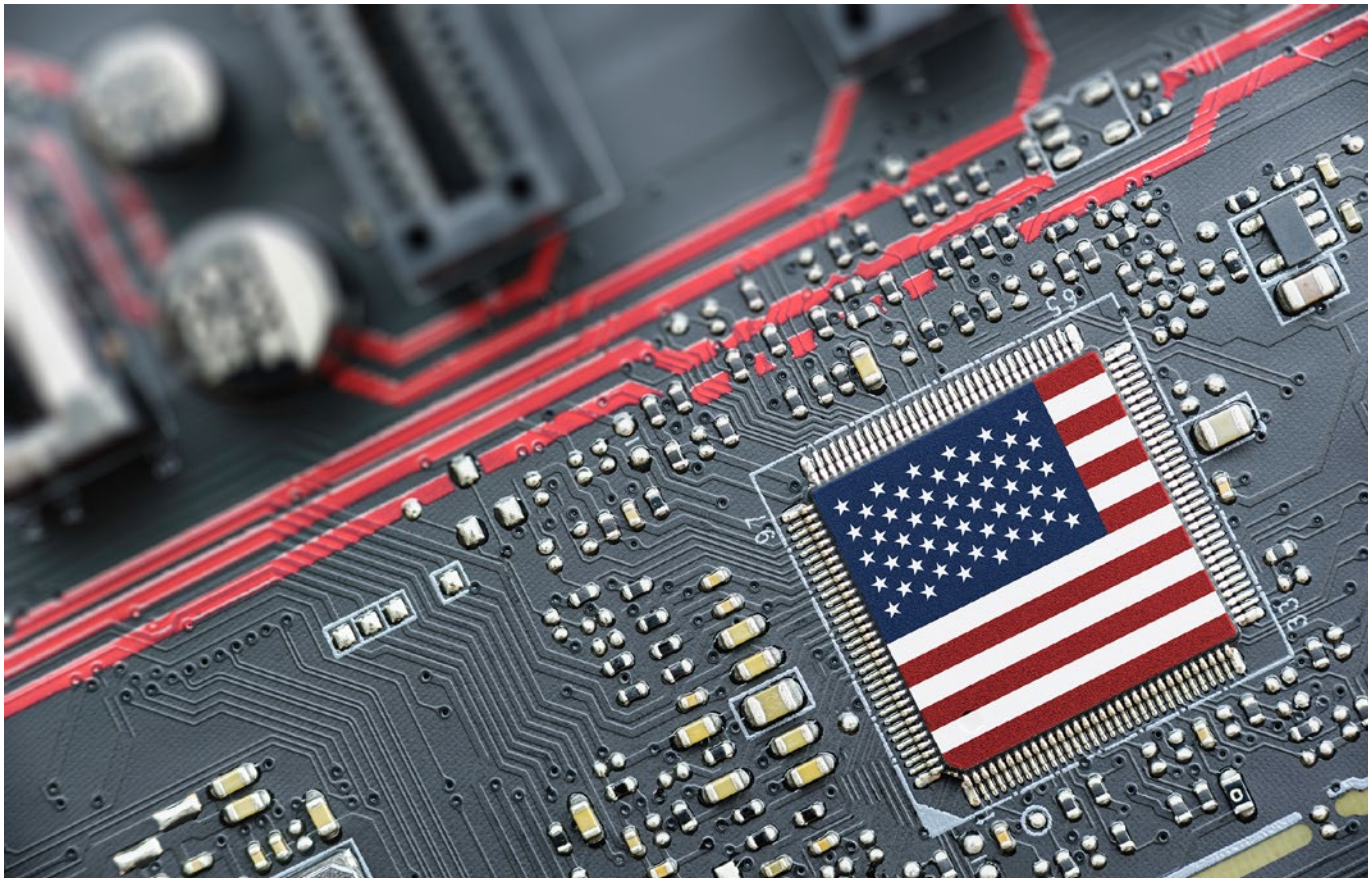
U.S. CHIPS Act 9902 Incentives Program investments are largely geared toward near-term SiC-based semiconductors for microelectronic applications (e.g., CPUs, GPUs, memory). GaN and SiC-based semiconductor development for power electronics is a focus for longer-term U.S. CHIPS Act 9906 R&D investments, along with next generation Si-based R&D.

Beyond these observations, it is imperative the CHIPS Act enables a broader U.S. semiconductor ecosystem supporting mission critical systems. To claim success, the objective of the CHIPS Act needs to support a robust, resilient, sustainable (over the longer-term) domestic ecosystem—enabling not just semiconductor fabrication, but also minimum viable capability for substrates, package assembly, and final system assembly.

IPC continues to work with industry and policy makers to adopt a "silicon-to-systems" approach building "regional plus global" supply chains, where investments in semiconductors are supported by additional critical investments in component packaging including substrate fabrication, and component assembly and test. In addition, high density interconnect (HDI) printed circuit boards, and complex integrated systems require investment. All these elements are critical, not just silicon. **SMT007**

References

1. To learn more about the IAC, visit nist.gov/chips/industrial-advisory-committee.



Unlocking Synergies

The U.S. CHIPS Act Propels Collaboration Between Semiconductor Manufacturers and Equipment Suppliers

Feature Article by Miles Moreau
KIC

Introduction: Embracing Collaboration in Semiconductor Manufacturing

In today's rapidly evolving world, the semiconductor industry stands as a driving force across economies and industries, propelling progress through technological advancements. The U.S. CHIPS Act emerges as a game-changing legislation aimed at redefining America's semiconductor manufacturing prowess. The Act sets forth a clear mission: bolster domestic chip production, reinforce national security, and stimulate economic growth.

As the echoes of the U.S. CHIPS Act ripple through the industry, a pivotal juncture arises for both semiconductor manufacturers and equipment suppliers. This legislation has captivated the attention of industry leaders, government bodies, and astute investors. Industry giants like Intel, TSMC, Samsung, and GlobalFoundries have committed substantial investments to U.S. semiconductor manufacturing and advanced packaging. These visionary leaders are primed to reshape the landscape of chip production on American soil.

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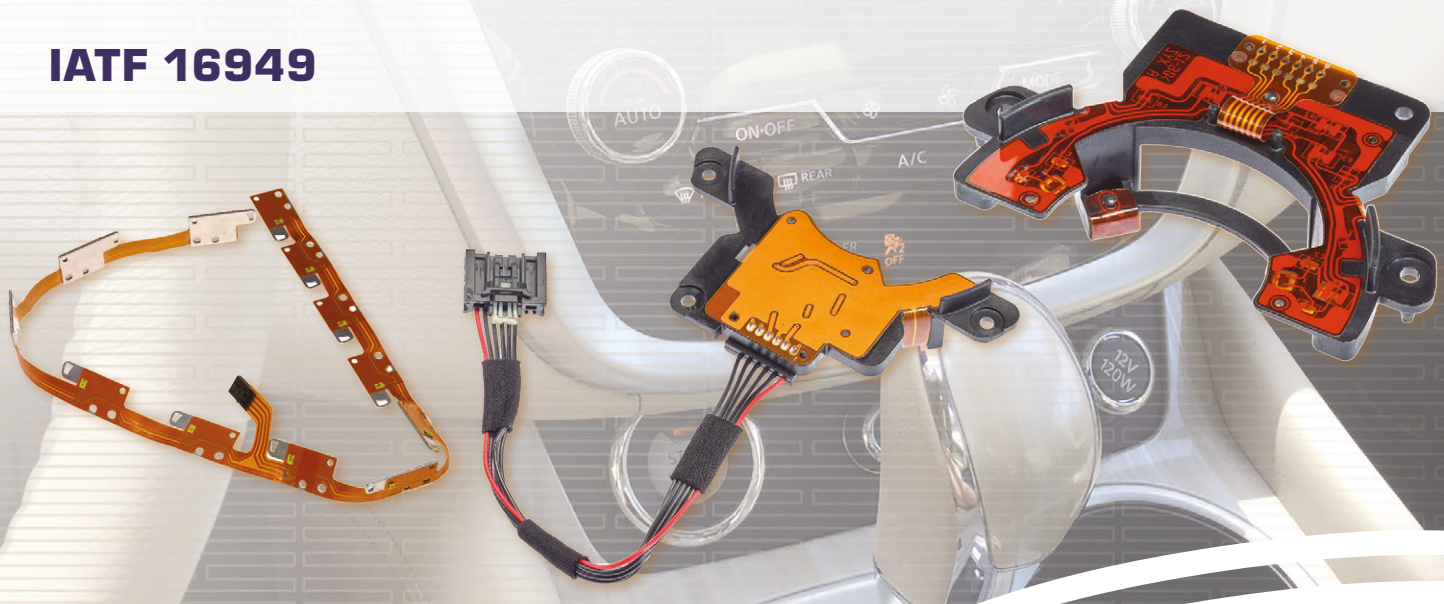

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Seizing Opportunities: The Synergy of Collaboration

With the U.S. CHIPS Act heralding a new era, semiconductor manufacturers find themselves at a crossroads. This juncture holds both opportunities and the potential for transformation, where stronger and closer collaboration between manufacturers and equipment suppliers emerges as a promising path forward. Along with the investment and commitment of the global semiconductor behemoths, suppliers like KIC, global leaders in soldering and curing automated thermal process metrology solutions, are setting a visionary path lit by the bright lights of innovation.

Navigating the Landscape for Semiconductor Manufacturers

1. Innovation takes the lead: The U.S. CHIPS Act ushers in an era of innovative manufacturing paradigms. Semiconductor manufacturers have the chance to explore cutting-edge processes, with technologies such as extreme ultraviolet (EUV) lithography and advanced packaging process advancements assuming center stage. This intersection of innovation and partnership with equipment suppliers is poised to shape the trajectory of these transformative processes, bridging the gap between theory and practical application.

Furthermore, the limelight extends to advanced packaging soldering and thermal processes. KIC has been the dominant market leader in innovative technologies and solutions for thermal process optimization and real-time process monitoring and inspection. The soldering and curing processes play a key role in semiconductor advanced packaging. Innovation, a key component of KIC's business model, facilitates collaboration with the manufacturers, allowing for prodigious improvements to refine chip integration methods. By integrating new sensing technologies and AI-driven data analytics, powered by KIC, manufacturers gain insights into their production processes. This insight empowers them to optimize operations, thereby boosting efficiency and producing higher quality chips.

Miles Moreau

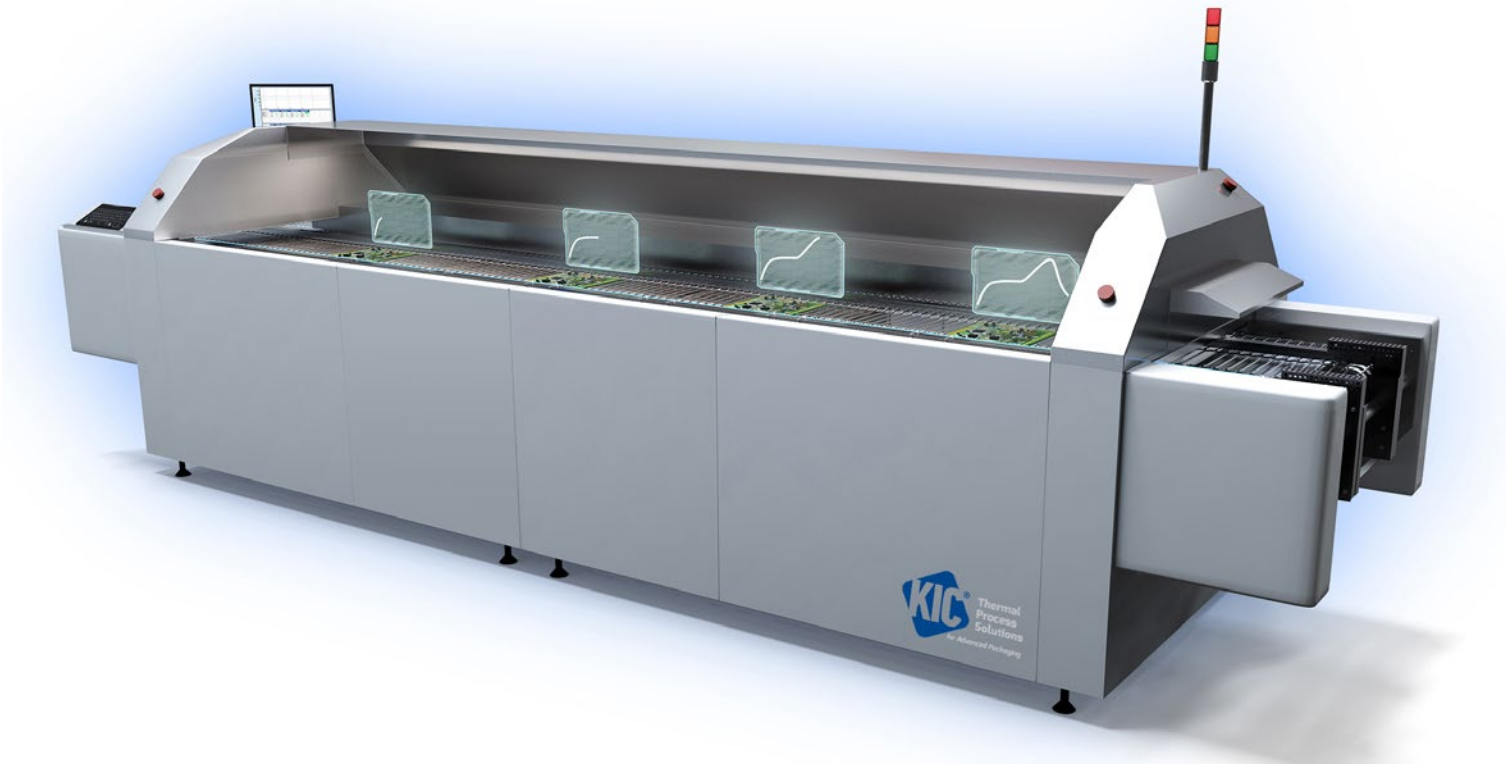
2. Powering progress through collaboration: Collaboration gives life to resilience—a maxim deeply entrenched within the semiconductor ecosystem. Semiconductor manufacturers possess the opportunity to cultivate mutually beneficial partnerships with equipment suppliers. KIC, whose innovative technologies and solutions have played a key role in advanced packaging process efficiencies and quality, has developed strong relationships with its manufacturing partners. A key to KIC's success has been the close collaboration with its customer-partners to push innovation and meet the demands of an ever-expanding market segment. These partnerships are rooted in transparent communication, fostering a full comprehension of unique manufacturing needs. Such collaboration yields equipment and technologies tailored to surmount singular manufacturing challenges. With KIC

as the dominant and most innovative solution for semiconductor advanced packaging thermal process monitoring and optimization, the addition of collaboration with such leading-edge entities allows for leaps rather than steps in bringing solutions to market and into the manufacturing workflow.

3. Championing sustainability: Sustainability is no longer a mere buzzword; it's an imperative. Semiconductor manufacturers are tasked with infusing eco-conscious practices into their operational fabric. This ethical commitment dovetails with the industry's mounting emphasis on environmentally conscious manufacturing. Initiatives embracing energy-efficient processes and waste reduction not only enhance reputation but also amplify operational efficiency. Suppliers like KIC have introduced capabilities in their solutions to match this sustainability initiative with features to improve the processes both in terms of quality and energy efficiency.

4. Nurturing skilled talents: The surge in domestic semiconductor production translates to a parallel increase in the demand for a skilled workforce. In response, manufacturers are gearing up to channel investments into training programs and skill enhancement initiatives. This investment nurtures a pool of proficient talents that steer industry growth and harness the latent potential of advanced equipment. In tandem, suppliers must incorporate user-friendly interfaces and methods to facilitate an accelerated and simple learning curve for this incoming workforce.

5. The art of adaptability: The semiconductor realm is synonymous with swift technological metamorphosis. Manufacturers must instill robust flexibility, seamlessly adapting to technological shifts, supply chain dynamics, and global market shifts. Correspondingly, equipment suppliers must synchronize their strides with manufacturers', maintaining pace with their partners in this dynamic environment. Take, for example, the situation of KIC as a supplier to this market segment. KIC is first and foremost a customized solution provider with an expertise in thermal processes, process control, and traceability. To progress with the opportunities the CHIPS Act presents, this solution provider mentality has allowed KIC to be primed to work and innovate with our partners, rather than just offer a product from a catalog.



The Specific Provisions of the U.S. CHIPS Act Relevant to Equipment Suppliers: Balancing R&D Customization with Scalability

Delving into the specifics of the U.S. CHIPS Act, several provisions directly impact equipment suppliers. The Act's focus on bolstering domestic chip production and advanced packaging presents equipment suppliers with a prime opportunity to align their innovations with the Act's mandates. For instance, provisions related to research and development incentives and support for advanced manufacturing processes resonate deeply with equipment suppliers aiming to offer cutting-edge solutions tailored to semiconductor manufacturers' evolving needs.

The challenge of balancing customization with scalability looms large. To address this, suppliers are leveraging modular design principles, enabling them to swiftly tailor equipment features while maintaining cost-effectiveness during larger-scale deployment. The synergy between customization and scalability empowers manufacturers to benefit from bespoke solutions without compromising operational efficiency.

A Glimpse Into the Horizon: Advanced Manufacturing and Collective Transformation

The semiconductor industry's projected growth presents a favorable outlook for both manufacturer and supplier. With the implementation of the U.S. CHIPS Act stimulating domestic chip production and advanced packaging, the demand for cutting-edge equipment is poised to rise. Projections indicate a significant uptick in equipment orders as manufacturers strive to align with the Act's mandates.

Furthermore, the Act paves the way for advanced manufacturing processes, heralding a transformed landscape. Enterprises investing in domestic semiconductor manufacturing and advanced packaging stand are poised to delve into an array of cutting-edge methodologies aligned with the Act's mandate.

Central to this transformation lies the bedrock of evolutionary technologies, epitomized by extreme ultraviolet (EUV) lithography—an intrinsic leap that refines chip design intricacies. Furthermore, this paradigm shift extends to real-time process control in advanced packaging, as demonstrated by KIC's solutions, encapsulating pivotal stages like soldering and curing processes. This platform provides equipment suppliers the opportunity to showcase their prowess. Simultaneously, the Act's emphasis on security through robust packaging techniques propels the ascent of equipment suppliers specializing in wafer-level packaging and the integration of automation into metrology and real-time systems. The nexus between manufacturers and suppliers emerges as a dynamic poised to surmount the intricacies of packaging challenges.

Navigating Supplier Dynamics in an Evolving Landscape

However, even within the realm of possibilities, challenges persist. The execution of the U.S. CHIPS Act remains susceptible to the influence of geopolitical and economic variables. These elements can impact investment trends, technology exchange, and the fluidity of supply chain operations. Organization and preparation are key. KIC's sponsorship of the IPC Advanced Packaging Symposium in Washington, D.C., in 2022 showed our commitment to preparing for the upcoming wave of activities and challenges.

In this context, equipment suppliers occupy a pivotal role, necessitating strategic recalibration that extends beyond the ordinary. Supplier sustainability hinges on the diversification of supply chains and the cultivation of relationships between manufacturers. Keen vigilance over geopolitical transitions, coupled with a keen anticipation of economic fluctuations, forms the bedrock of supplier resilience.

Conclusion: A Prelude to Collaborative Progress

The U.S. CHIPS Act transcends mere ink on paper—it extends an invitation to semiconductor manufacturers and equipment suppliers to come together in a collaborative venture of innovation and partnership. Amid the sweeping investments by industry giants, equipment suppliers emerge as architects of transformation, armed to shape the future.

As manufacturers and suppliers stand on the threshold of a new era, the narrative that unfolds will be defined by collaboration, innovation, and unity. This isn't just a period of change; it's an epoch where two distinct domains coalesce to forge a shared destiny—one that lauds American ingenuity, resilience, and the unwavering spirit of progress. **SMT007**

Miles Moreau is general manager at KIC, a solution provider for advanced packaging and assembly.

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What is the Profit Potential?

Maggie Benson's Journey

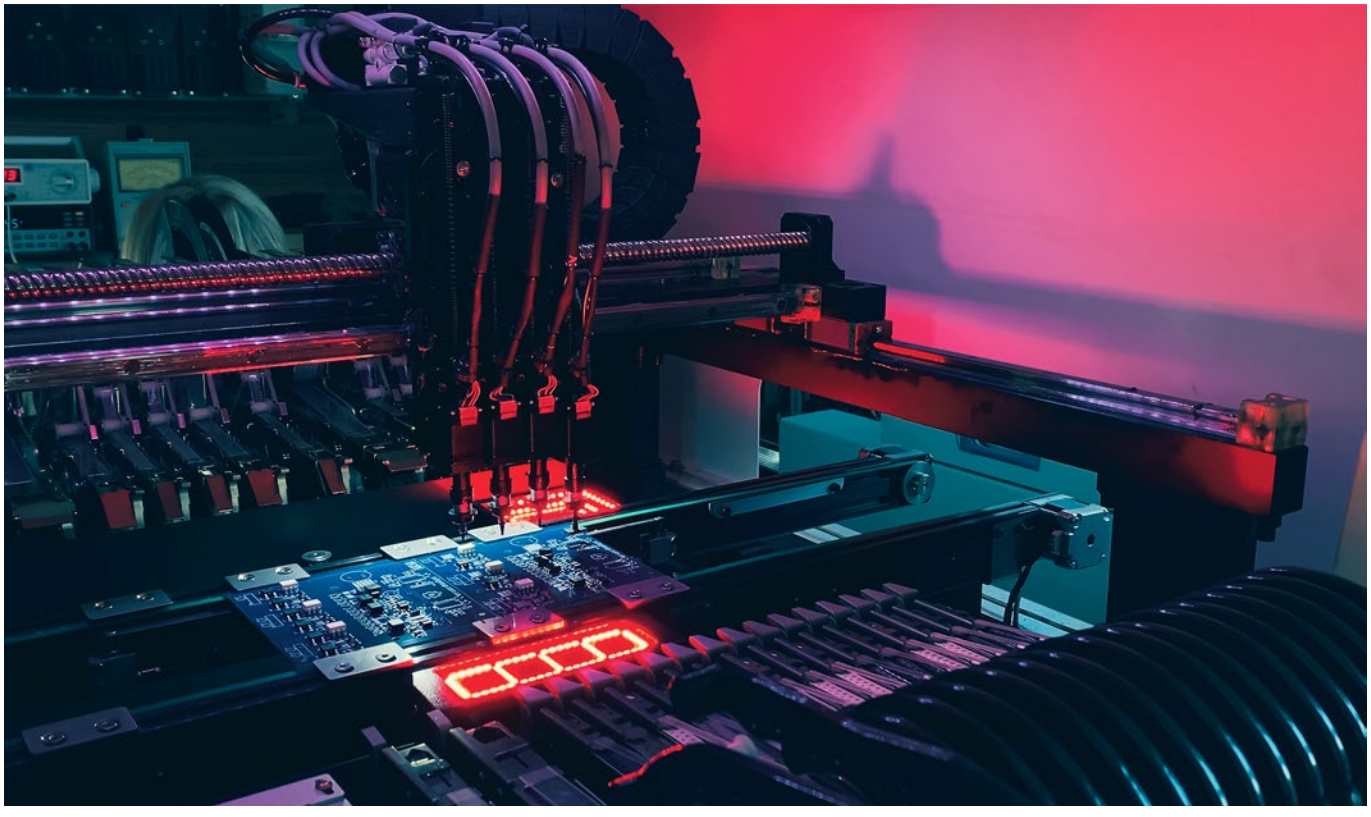
by Dr. Ronald C. Lasky, INDIUM CORPORATION

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.

Paul LaCroix had worked hard on his profitability potential analysis of component placement machines (CPMs).

He was comparing CPMs from Excel and Pinnacle. The Excel machines only cost $599,000, whereas the Pinnacle machines were $999,000. Paul was able to talk to five assemblers that had used both brands of CPMs. The Excel customers were happy with the low sales price but were disappointed in the performance. The machines were slow in their assembly speeds and constantly needed repairs. In addition, the service teams were usually late and required more time than they estimated to repair the machines. As a result, the assembly lines were often down.

The assemblers that used Pinnacle CPMs told the opposite story. Although the original purchase price was much higher than the others, the machines assembled much faster. They



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seldom required maintenance and when they did, the service team was prompt and required less time than they predicted to make the repairs. These assemblers were curious about Paul's project as they had hoped to use the results in their explanation to their management as to why Pinnacles had the best bang for the buck.

Paul was quite good at math and was enjoying this project. He thought it might be best to perform a rough calculation to start. The Pinnacle's placement speed was 30% faster than the Excel's. From discussions he had with other assemblers, he estimated that with the Pinnacles, the line was down 3% of the time for repairs; for the Excels, the line was down 5% of the time. Paul estimated that this benefit added another 2% to the speed of the Pinnacles, making them 32% faster than the Excels. Dr. Maggie (he still didn't know if Maggie had a PhD, but he felt it was best to err on the high side) told him she expected that this type of line would make a profit of about $500,000 a year.

In his rough calculation, he estimated that since the Pinnacles were 32% faster, they would produce 32% more profit, all other things considered equal. Therefore, the Pinnacles should generate 32% of $500,000, which equaled $160,000 more profit than the Excels. If the equipment was to be amortized over five years, that would be $200,000 for the Pinnacles and $120,000 for the Excels—a difference of $80,000. So, the $160,000 more in profit outweighs the difference in amortized price.

Paul still felt he was missing something, so he decided to chat with Sue and Andy. They met for ice cream after work. Paul reviewed what he had done.

"I think I am missing something," Paul summarized to the couple.

"Why don't we develop a list of income and expenses and see what it says?" Andy suggested, and Sue said, "Maggie said a line like this one would generate about $500,000 in profit over a year. A typical board sells for $50. Most of Benson Electronic (BE) lines produce about 100,000 to 200,000 boards per year. Let's assume the Excel line produces 120,000 boards per year and the Pinnacle line does 32% more or 158,400."

"Sue and I have been performing some financial modeling of lines," Andy added, "and we know that labor costs about $850,000 per year, with rent and utilities about $100,000 per year."

"Whoa, our spreadsheet shows the Pinnacle line generating $769,880 in profit, whereas the Excel line generates only $327,000," Paul said. "That can't be right." Sue and Andy chuckled in unison, and Andy said, "The spreadsheet is

	Line with Excel	Line with Pinnacle
Sales Price/BD	$ 50.00	$ 50.00
BDs produced per year	120,000	158,400
Total Sales per Year	$ 6,000,000.00	$ 7,920,000.00
Machine Amortizaion	$ 357,000.00	$ 437,000.00
Labor	$ 850,000.00	$ 850,000.00
Components, PCBs, etc	$ 4,366,000.00	$ 5,763,120.00
Rent	$ 100,000.00	$ 100,000.00
Profit	$ 327,000.00	$ 769,880.00

Figure 1: Paul, Sue, and Andy developed a spreadsheet. Note how much more profit the Pinnacle machines produced.

correct. Why don't you take some time and see if you can understand it?"

"We'll give you a hint," Sue said, teasing. "Look at the labor and the rent."

Paul looked at the spreadsheet and then it hit him: "The labor and rent are constant, even though the Pinnacle line produced more boards," he exclaimed.

Andy tried to draw out more of Paul's conclusions, and asked, "And what else?"

"The labor and rent cost per board is less on the Pinnacle line because it produces so many more boards," Paul said. "I'm surprised how much difference it makes in total profit—over $442,000!"

"So, 'profit potential' is much more important than 'cost of ownership,'" Paul opined.

A meeting is scheduled soon to explain the results that so favor Pinnacle CPMs. Will Paul be able to explain it? What will Hal Lindsay say? Stay tuned to find out. **SMT007**

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

Supercomputing for Superconductors

Researchers at Georgia Tech and Hanoi University have capitalized on a powerful supercomputer to build a database that could identify new superconducting materials that work at room temperature.

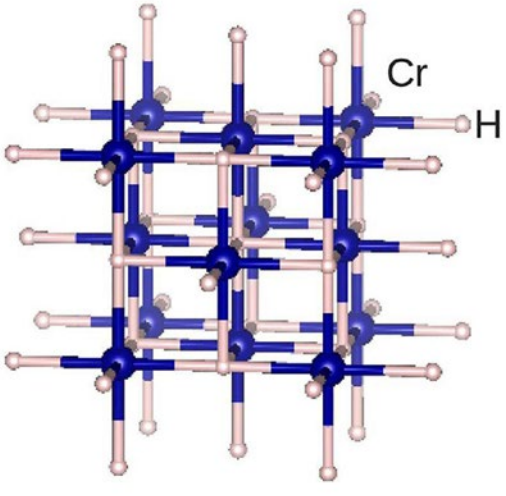
The team has identified two possible candidates using new machine learning models they developed and deployed with the capabilities of the San Diego Supercomputer Center at the University of California, San Diego. They published their progress recently in the journal Physical Review Materials.

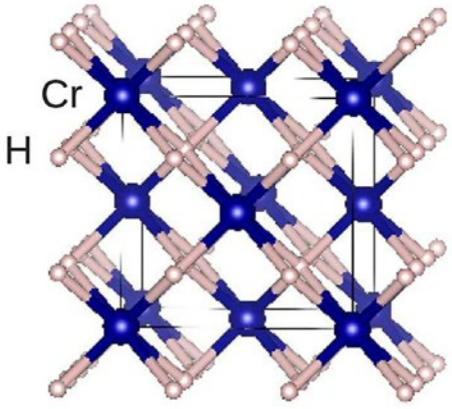
Superconductors allow electricity to pass with no resistance, but conventional materials require temperatures near absolute zero (nearly -460 degrees Fahrenheit). For more than a century, scientists have been searching for materials able to accomplish the feat at room temperature and ambient pressure.

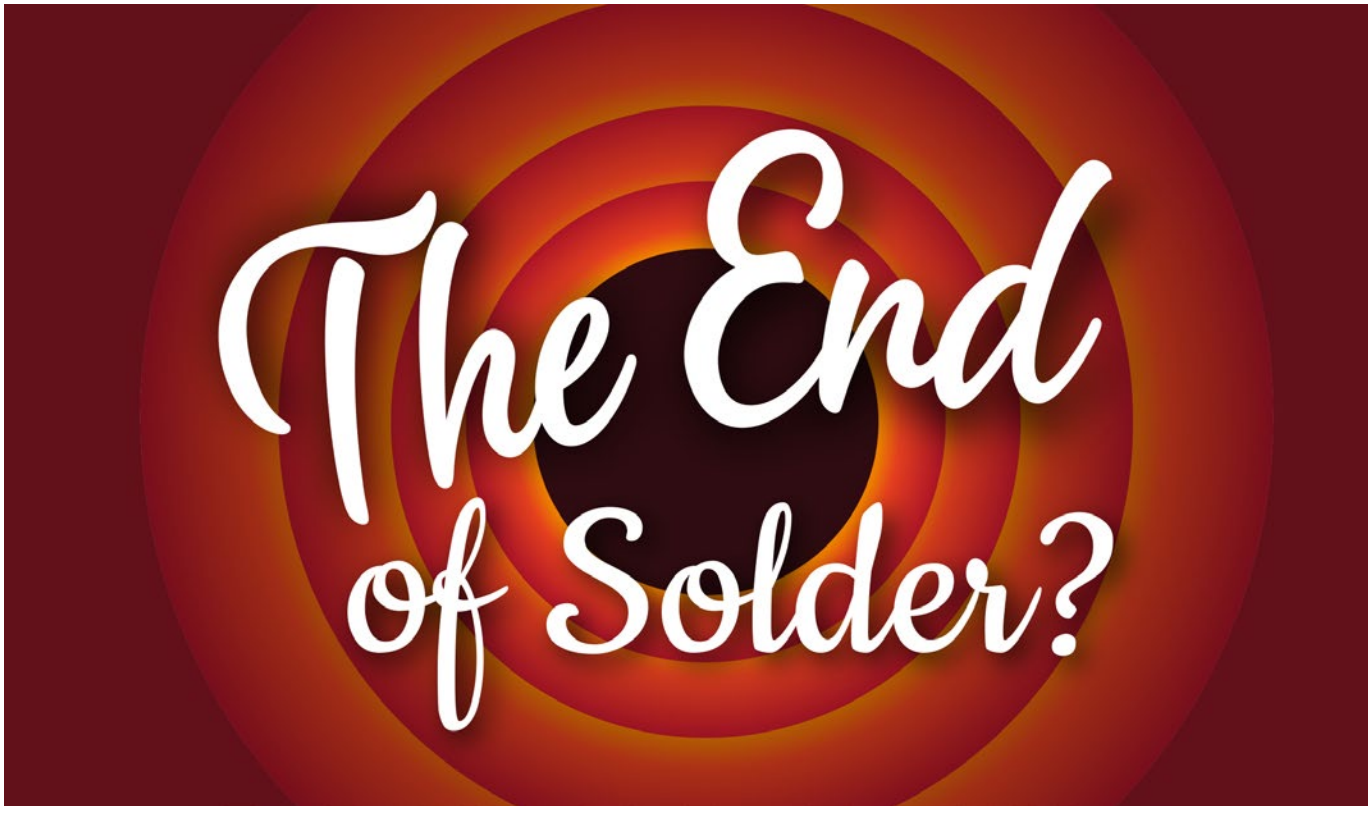
"The main challenge of the [artificial intelligence/machine learning] method is that we need, but never have, the desired database of superconductors," said Huan Tran, senior research scientist in the Georgia Tech School of Materials Science and Engineering. "All previous works relied on databases that are sometimes large enough, but completely lacking in atomic-level information—which is absolutely crucial for accurate predictions."

Tran and Tuoc Vu from Hanoi University have been building a database with that atomic-level information, filling in a critical gap in available data so they can train machine learning models to accurately predict promising superconductive materials.

(Source: Georgia Tech)







Feature Interview by Nolan Johnson
I-CONNECT007

The practical question around CHIPS Act development and electronics assembly is, "Will this change how we do business?" Indium Corporation's Dr. Andy Mackie sat down with Nolan Johnson to share what he sees as emerging answers to that question from his perspective as an expert in electronics assembly and packaging, and as a participant in standards development through IPC, JEDEC, and SEMI.

When we talk about the CHIPS Act, that leads to a discussion about the assembly process, as they seem so interrelated.

Certainly. As the CHIPS Act money started rolling out last year, IPC hosted a conference in Washington, D.C. to point out that semiconductor chips do not exist in a vacuum; they are part of an electronics ecosystem that includes interconnection and protection. Therefore, U.S.-based packaging and assembly would be needed, alongside U.S. chip fabrication. This appeared to be news to many. The role of solder in advanced packaging has been changing over the years, but solder will continue to be needed.

Take first level interconnect (FLI) flip-chip solder, which has been around for a long time as solder bumps, then bumped copper pillars, and has reached the end of its run for really advanced assemblies. But at what point (pitch) that happens depends on who you talk to, and engineers are notorious for sticking to what they know works. Five years ago, Intel was predicting the end of FLI solder at 20-micron pitch. However, when putting silicon die on a silicon interposer, there's no CTE mismatch between the chip and the substrate, so thermal cycling stresses are much less of a concern. Obviously, that lower silicon is bonded and electrically interconnected to something—probably organic in the near term—so there are CTE mismatches at that lower level. Note that 10-micron pitch flip-chip solder has been used by TSMC several years now for silicon on silicon.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The imec roadmap for solder-based FLI with pre-applied underfill shows that most flip chip solder interconnects will reach the lower limit at around 7, possibly 5-micron pitch. Everything after will be copper-copper hybrid bonding.


Dr. Andy Mackie

How will advanced packaging change the life of the typical EMS company?

Let's focus on automotive, where the role of the former Tier 1s (direct EMS suppliers to the automotive OEMs) is changing dramatically as OEMs move to cozier direct relations with the semiconductor suppliers. The nature of the supply chain is therefore changing dramatically.

From a reliability aspect, if you're talking about electronics assemblies and systems that, say, you're putting into a car, it will always be difficult to have electronics that are large and monolithic. There are more thermal and external physical stresses than there are in a standard dielectric liquid-cooled server, so it's difficult to see how to reliably integrate very large heterogeneously integrated modules into a car without some form of mechanical decoupling. That means there will almost always be a need for distributed computing within the vehicle.

Rather than vehicle compute and control being a completely centralized thing, with each sensor running to a central brain, as a purely "software defined vehicle," it's much more likely that we will see a central processing unit receiving inputs from "edge compute" (or maybe more accurately vehicle "corner compute") sensor clusters integrating lidar and radar and the other kinds of sensor inputs. These clusters will probably be located on the corners of the car using machine learning algorithms to parse sensor inputs into a data format where the central processor assembly can make decisions and drive actuation. Of course, in a car vs. a drone, it's relatively simple: You're talking about merely controlling direction and the speed that you're moving at, and there really isn't much more needed than that.

If your application is more data center-oriented, you're not so concerned about environmental stresses on your design. That takes you in a certain direction with more room for the use of very large advanced packages. Is that over the horizon for EMS companies—a need to choose a path and specialize?

Yes, absolutely. However, not everyone needs a Class1 cleanroom and a hybrid bonder; flip chip and wire bonding aren't going away. Just as there will always be some room for wave soldering, you must be in a market with an appreciable profit margin. For example, most wire bonding is being done for the consumer, industrial, and automotive markets, simply because of its known good reliability. Customers will need flexibility and technology that's well understood in terms of failure modes and reliability.

With regard to the challenges in the U.S., EMS providers are way behind in their ability to supply locally because of offshoring. Only something like 2–3% of the packaging industry is based in the United States, with some companies planning to bring advanced packaging back (or more appropriately to develop new abilities, to compete with Asia and Europe) to the U.S. These players are looking to develop the capabilities to manufacture cutting edge assemblies, to be able to do difficult heterogeneous integration, and to actually manufacture the very high-end substrates that will be needed, in increasingly cleanroom environments.

To compete with the low-cost areas of the world, we'll be using more automation. By automating processes, we can reduce manpower costs and make it economically feasible because, at the end of the day, we can pour

CHIPS Act taxpayer money—$52 billion—into this to prime the pump (getting manufacturers ready to supply electronic devices), but you must have something to pump (that is, an economically sustainable U.S.-based electronics ecosystem).

Larger and "in-process" heterogeneous assemblies are increasingly fragile. They're a lot more vibration and environmentally sensitive. It's a lot more problematic to move them around the world, say, shipping from a fab to an OSAT on the other side of the planet. This is why we see TSMC, Intel, and others (Samsung is already there) essentially moving into the OSAT space—and potentially into the EMS space as assembly for high end electronics increasingly resembles a series of post-BEOL integration processes.

> "Summing up, the pressure is on U.S.-based OSATs and EMS suppliers.

How do all these dynamics put pressure on solder to change?

Solder usage is expanding and evolving into a whole series of different types of materials, not just alloys, but different formats like various shapes and ultrafine powder sizes for solder paste, and new technologies like mixed powder types.

People have been talking about sintering as an alternative in some instances, but it will always be a "near net shape" material; there's no wetting or flow like you see with solder, which is what makes solder so durable and easy to apply. In many applications, such as very high-power die attach, large die (such as IGBT die), high current density type applications, sintering really is a great way to move forward, though it's relatively slow and expensive. This is the basis of a power die, where the bottom of the die is attached to a substrate and large amounts of current then flow in the Z-axis through the die, and heat flows out.

Regarding high temp solder (HTS), we're seeing that for some of these high-reliability applications, high-lead (Pb) is actually still being used as an allowance from ROHS. Let's say you have a diode that must survive SMT reflow; the die attach solder inside the package must not re-melt until it's over 265°C, so you use a known-good, high-reliability, high-lead solder. Sintering (usually Ag or Cu) or, preferably, a Pb-free solder, is desirable to finally kick out one of the last bastions of allowed high-lead solder. Indium Corporation is enabling that capability in solder, so that's an example of a need for a high-temperature solder.

In medium-temperature solder (MTS), we're working on environmental sustainability by reducing the energy costs of reflowing solder by moving to lower temperatures—from SAC305 reflow temperatures (maybe 260°C max) to those associated with more 63Sn (220°C), but using Pb-free solders.

With low temperature solders, there is also a move to reflow lower than 195°C, to protect some increasingly delicate devices and subassemblies.

Reducing solder temperatures also has a benefit in reducing stress on large assemblies, so there are benefits other than simple power cost reduction.

Summing up, the pressure is on U.S.-based OSATs and EMS suppliers to reduce costs through automation, enable and optimize low temperature assembly, build and operate cleanrooms, and adopt fine pitch heterogeneous integration. Most EMS companies are already accustomed to supply chain issues so that won't be anathema to them.

Andy, thank you for this insightful conversation.

I appreciate the opportunity to talk. Thanks Nolan. **SMT007**

An Invitation from SMTA President Martin Anselm

Feature Article by Martin Anselm
SMTA

As the current president of SMTA, I'd like to extend an invitation to everyone in the electronics manufacturing industry to join us Oct. 9-12 at the Minneapolis Convention Center in Minnesota for our flagship event, SMTA International Conference and Exposition. This event is once again co-located with MD&M Minneapolis, providing an intriguing mix of related manufacturing technology cross-over among the respective shows.

SMTA International remains one of the best opportunities to learn and network with industry peers during the year. I look forward to hearing all the presentations about new

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Martin Anselm, president of SMTA

research, the chance to ask questions directly of the authors, and to see the technological innovations on display throughout the expo hall. I want to thank all the participants who make this possible, from our committee members and exhibitors to the speakers and session chairs. I'm also thankful for the support from corporate members who value our mission of knowledge sharing, skill building, and developing solutions in the electronics manufacturing industry.

As a professor at a research institute and a member of the technical committee for the conference, I'm always excited to see the finalized conference program and this year has been no exception. An entire session has been dedicated to artificial intelligence (AI) and how it can be applied in a manufacturing environment, which is of great interest to many of us after the surprising breakthroughs that technology made in headlines earlier this year. That session is titled "INS1: AI and Machine Learning: Current Electronics Manufacturing Inspection Applications," and is scheduled for the morning of Wednesday, Oct. 11.

I'm also very proud of the Women's Leadership Program. Not only does it support an important cause—diversity in engineering fields—but it is free to attend and open to everyone. The theme is "The Power of Personal Branding" and it features several presentations from women leaders sure to inspire you both professionally and personally. Of course, there is plenty of other important work being presented each day and it is worth spending time to review the entire program yourself.

With more than 70 exhibitors in the SMTAI exposition, and hundreds more in the hall as part of MD&M Minneapolis, the show floor is equally as exciting as the technical conference. Every year, I have an opportunity to catch up on the latest equipment, technology, and materials innovations our industry has to offer. This is an incredible occasion to connect with the service providers that can answer questions on challenges in manufacturing and test. We even have a great program called "Passport to the World of SMT" for those who are new to the industry and want to get acquainted with various assembly processes and solutions providers. You can sign up for free when you register, and you will have a chance to win some great prizes in addition to picking up the helpful guide to electronics assembly.

This coming year is my last one as president, and I know it will be a year of growth and success for the association and the industry at large. For that reason, I look forward to seeing everyone in Minneapolis and hearing your thoughts about the future of SMTA. Please stop me and say hello if you see me walking the exhibit hall or in a conference session. **SMT007**

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General Information

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Monday, October 9
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Tuesday, October 10–Thursday, October 12
7:30 a.m.–5 p.m.

Conference Hours

Monday, October 9
1:30–5 p.m.

Wednesday, October 11
8:30 a.m.–4 p.m.

Tuesday, October 10
8:15 a.m.–5:30 p.m.

Thursday, October 12
8:30 a.m.–3 p.m.

Exhibit Hours

Tuesday, October 10
10 a.m.–5 p.m.

Wednesday, October 11
10 a.m.–4 p.m.

Location

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1301 Second Avenue South
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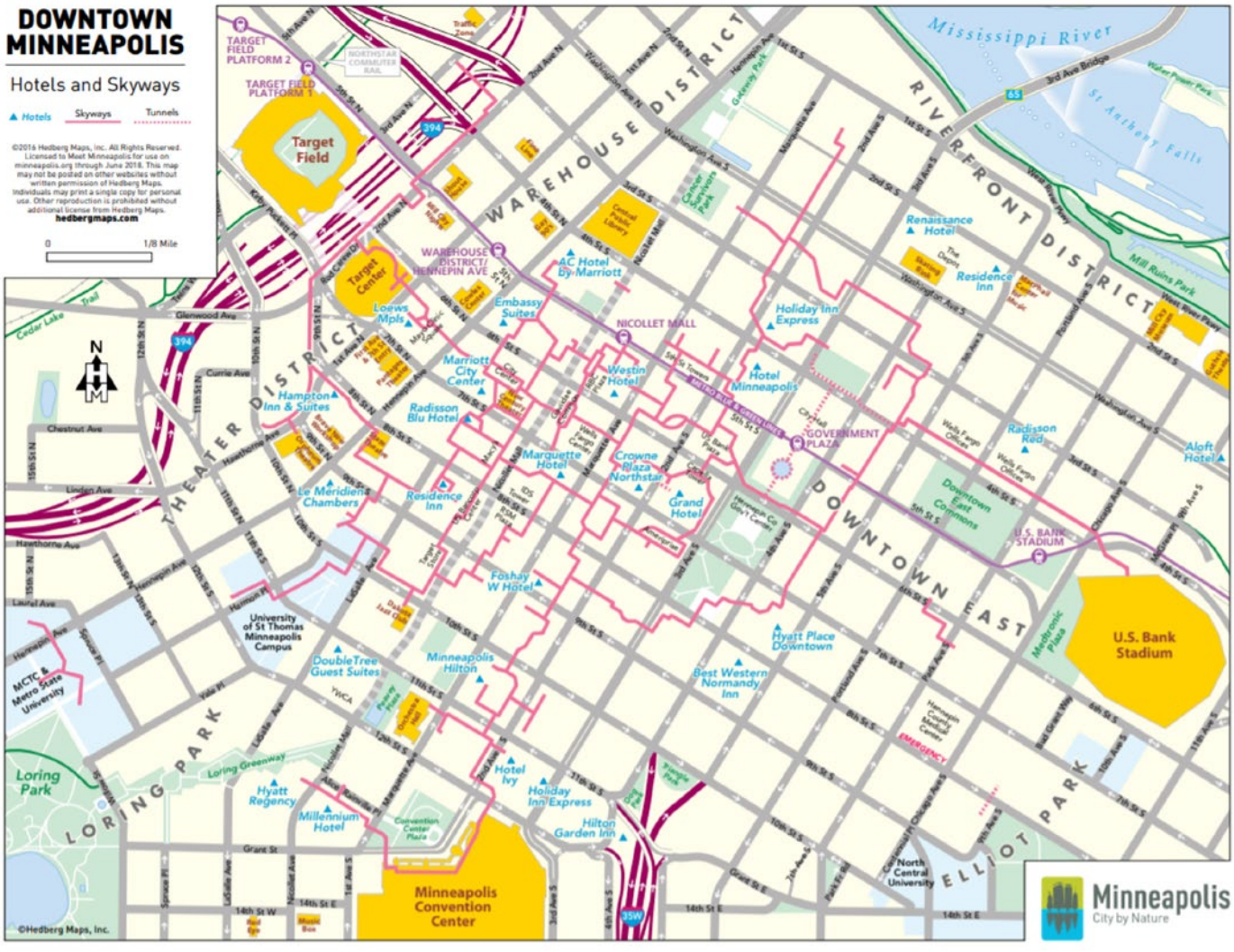
Parking and Directions

Parking is easy to find at the Minneapolis Convention Center. The MCC offers metered parking, a wide selection of off-street parking, and parking ramps that are connected to the Minneapolis Convention Center by skyway.



Walking in Downtown Minneapolis (Skyway System)

In response to the low temperatures endured for many months of the year, downtown Minneapolis has developed a substantial skyway system. Linking most of downtown with above-ground climate-controlled walkways, the system will get you from the Minneapolis Convention Center to most spots in downtown Minneapolis without ever stepping outside.

Click here for skyway guide.

Getting to Minneapolis by Plane

All air travel would arrive at Minneapolis/St. Paul (MSP) Airport in either Terminal 1 Lindbergh Station and Terminal 2 Humphrey Station and you would have the following ground transportation options at both terminals:

- Car Rental
- Lyft/Uber Services
- Metro Transit (city bus and light rail services)

A Closer Look at SMTAI's Technical Program

The Knowledge Base

by Mike Konrad, SMTA

The Surface Mount Technology Association's annual Conference and Exposition (SMTAI) takes place Oct. 9–12 in Minneapolis, Minnesota. Co-located with the Minneapolis Medical Design & Manufacturing (MD&M) trade show, SMTAI is the Midwest's largest electronics manufacturing show and technical conference.

The technical program is curated by the SMTAI Technical Committee. Now that the conference's technical program has been finalized, I invited two members of the Technical Committee to provide information and insight on the specific conference presentations taking place in Minneapolis.

First, let's discuss the conference from a 30,000-foot perspective. How many presentations make up the technical conference?
Raiyo Aspandiar: There are 94 presentations.

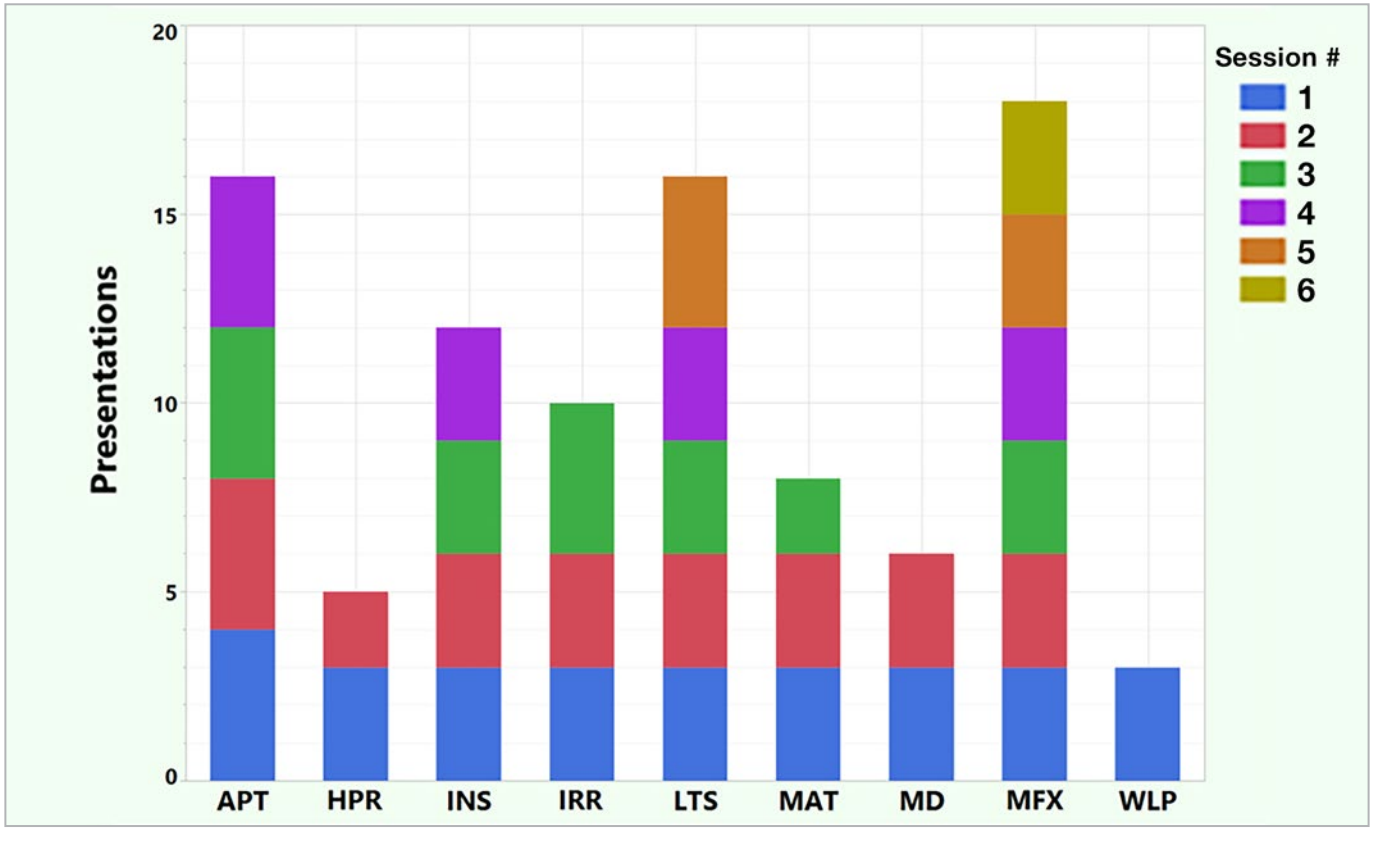


Figure 1: APT: Advanced Packaging; HPR: High Performance and Reliability; IRR: Interconnect Research and Reliability; LTS: Low Temperature Solder; MFX: Manufacturing Excellence; MAT: Materials for Electronics; MD: Medical & Defense Symposium; INS: Test and Inspection; WLP: Women's Leadership Program.

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Raiyo Aspandiar

Like many other conferences, subjects are grouped into technical tracks. What are the technical tracks at SMTAI and what types of presentations can we expect in each track?

Aspandiar: There are nine tracks, 30 sessions, and 11 Professional Development Courses. Figure 1 shows the current distributions of tracks, sessions, and presentations.

Julie Silk: Reliable electronics are a focus from different angles for several of the tracks. The High Performance and Reliability track covers electronics used in harsh environments with temperature extremes and mechanical stresses, such as automotive and military uses.

The Medical and Defense track includes papers on the importance of cleanliness and process control.

The Interconnect Reliability and Research track takes a deep dive into solder alloy studies and includes design considerations.

The Low Temperature Solder track has reliability studies for solders which melt below 200°C. These have a reputation for brittleness and new research covers improvements and advantages.

Papers on surface finishes, protective coatings, thermal interface materials, adhesives, and more are included in the Materials for Electronics track.

The Test and Inspection track covers test methods for wafers, flux residues, components, and solder joints, plus failure analysis and the use of artificial intelligence.

AI use and data analytics are themes in the Manufacturing Excellence track, which includes papers on improving control and quality throughout a multitude of manufacturing processes.

Advancements in component manufacturing, such as wafer bonding, attach processes, filling materials, and thermal interfaces are covered in the Advanced Packaging Technology track.

Our industry is experiencing a technical evolution: the adoption of artificial intelligence, the proliferation of electric vehicles, big data, IoT, and 3D printing, to name a few. What presentations stand out as representing evolutionary technology?

Silk: New technologies and electronics in "everything" put pressure on manufacturing to up their game, to push the boundaries of what is achievable in mass production. The MFX track has several papers that demonstrate the use of data analytics and AI to improve manufacturing. That is, not just the theoretical application, but real-life examples.

Aspandiar: One Professional Development Course titled "Artificial Intelligence, Opportunities, Challenges, and Possibilities" stands out as topical.

What particular presentations, either based on revolutionary/evolutionary or legacy technology, stand out in your minds?

Aspandiar: There are quite a few presentations in the technical program on recent innovative and evolutionary developments. These include new thermal interface materials in the APT track, low temperature solder metallur-

gies in the LTS track, corrosion protection nano-materials in the MAT track, and new 3D Microscopy as well as X-ray Technology Source in the INS track.

Our industry, like many others, is facing a "silver tsunami." A high number of experienced engineers are entering retirement, most frequently replaced by young engineers. What advice can you give to emerging engineers within our industry relative to continuing education?

Silk: Attend the Professional Development courses for a deeper dive into topics that are of interest to you, then talk to the authors about their presentations. This will help you make connections and give you a new network of experts to call on when the next strange problem comes up that you need to solve. Bring lots of business cards to hand out and collect from the people you meet. Make notes on their areas of expertise. Join the clusters of people talking about the new stuff they have learned, and you'll hear about the challenges that remain while hearing about their experiences and knowledge on the subject.

Aspandiar: There is a session on Tuesday afternoon titled "Growing the Future Workforce" where one can learn about how the electronics manufacturing industry is helping shape academic programs to develop young engineers in the field of electronics assembly.

While technical conferences are known for their educational value, there are also opportunities for networking. Can you share more about the various organized networking opportunities planned for SMTAI?

Silk: The Women's Leadership Program is an opportunity for those of us underrepresented in the electronics industry to get together, learn from amazing women leaders, and have some fun together.

Julie Silk

For someone who is considering speaking at a local or international expo, what advice can you give them?

Silk: Start by attending, and then becoming a reviewer, session chair, or co-chair. You'll figure out how it works and that will make it more comfortable. Follow the paper format and commercialism guidelines. Know your material and talk to the audience as if you're speaking to a colleague—because they are colleagues.They are there to learn and they listen with a goal to understand. They are not scary.

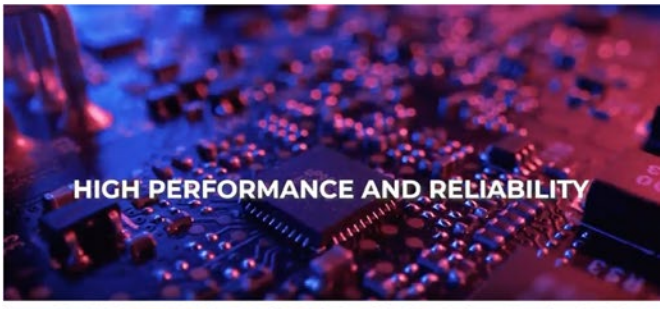
Thanks to both of you. SMT007

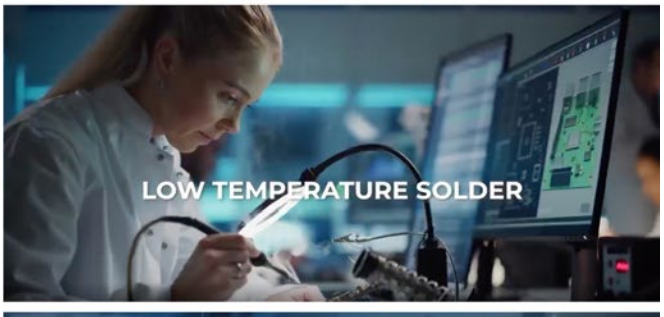
Julie Silk is a material reliability program manager and environmental compliance program manager for Keysight Technologies. She is a member of the SMTA Global Board of Directors and a member of the SMTAI Technical Conference Committee.

Raiyo Aspandiar works for Intel and is a member of the SMTAI Technical Conference Committee.

Mike Konrad is founder and CEO of Aqueous Technologies, and vice president of communications for SMTA. To read past columns, click here.

Conference Program Highlights





The program for the SMTA International Technical Conference is finalized with 90 great papers presented across 30+ sessions. Each session features two to four presentations on a related topic and is organized into the following tracks:

Advanced Packaging (APT):
Advances in first-level packaging and assembly

High Performance and Reliability (HPR):
Addressing unique needs of electronics operating at more strenuous levels and in harsh environments

Interconnect Research and Reliability (IRR):
Reliability testing and evaluation of soldering

Low Temperature Solder (LTS):
Developments that can be reflow soldered below 200°C

Manufacturing Excellence (MFX):
Current project work in manufacturing process areas

Materials for Electronics (MAT):
New materials used in electronics assembly

Medical & Defense Symposium (MD):
Reliability in mission-critical applications

Technical Innovations (TI):
Manufacturing and materials that innovate the manufacturability and reliability of electronic circuit board assemblies and systems

Test and Inspection (INS):
Ensuring product reliability short- and long-term

Women's Leadership Program (WLP):
Promote diversity in engineering fields

There is industry buzz around "advanced packaging" and the 2023 Advanced Packaging (APT) track addresses some critical aspects of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the topic. This year, APT has papers on new package materials and processes, including hybrid bonding and heterogeneous integration. There also are several papers on board level and package reliability.

The High Performance and Reliability (HPR) track has two sessions dedicated to hardware ruggedization for extreme environments. The research presented is applicable to manufacturers in the automotive and power electronics sectors, among others.

The Interconnect Research and Reliability (IRR) track has an interesting session on alloy development and considerations for high reliability. IRR also has a session discussing programs for high reliability for mission critical applications. This session would be of interest to anyone wondering how the avionics and military/defense industries are addressing the need to convert to Pb-free manufacturing.

The Low Temperature Solder (LTS) track continues to have multiple, strong sessions addressing all aspects of low temperature soldering with Sn-Bi alloys, such as thermal cycling performance, reliability assessment of new alloys, effects of elemental additions, electromigration, shear and drop shock assessment, and improving process yield, quality, and reliability.

The Test and Inspection (INS) track has its strongest program in years with four diverse sessions addressing AI, machine learning, advanced imaging techniques, applications, and case studies.

The Manufacturing Excellence (MFX) track addresses several interesting and tangible topics including manufacturing operations, product assembly challenges, printing challenges, cleaning challenges, new product introduction (NPI), and more.

For more in-depth training, there are 11 half-day **Professional Development Courses (PDCs)** on electronics reliability and process-specific topics instructed by industry experts.

Monday, Oct. 9 options:

- Artificial Intelligence: Opportunities, Challenges and Possibilities
- Weeding Out PCB Defects Prior to Assembly
- Best Practices for Improving Manufacturing Productivity
- Reflow Profiling Simplified

Tuesday, Oct. 10 options:

- Flex Circuit Design for Manufacturing Principles
- Solder Joint Reliability: Principle and Practice
- How to Select a Solder Paste for High Reliability and Yields

Wednesday, Oct. 11 options:

- Selection Criteria of Surface Finishes for Better Reliability of Electronic Assemblies
- Fan-Out, Chiplet, and Heterogenous Integration Packaging
- ESD Concept to Reduce Electrostatic Charges in Manufacturing Processes
- Failure Analysis of Electronic Devices

Selecting the conference bundle when you register will provide the best value to attend both the conference sessions and courses.

New this year is a free session called Translating the Technology. This session will provide an overview of PCB design, fabrication, and assembly, with a panel discussion focused on the impact that strong communication throughout the full process can have on project success. Humorous faux pas, lessons learned, and success stories will be shared as this expert panel fields questions and imparts wisdom.

Following the panel discussion, we will break into interest groups to chat with experts on topics ranging from PCB design, fab, and assembly, to PCB and PCBA purchasing best practices, and how robotics is revolutioniz-

ing manufacturing. While not a technical deep dive into a specific technology segment, participants will leave with an understanding of the manufacturing processes and learn the importance of communication in today's electronics manufacturing environment.

Of course, none of this would have been possible without the work of the SMTA International Technical Advisory Committee (TAC.) The committee, comprised of distinguished electronics manufacturing and packaging industry experts, designed the conference program to ensure that today's latest trends and developments are fully addressed.

We look forward to seeing you Oct. 9–12 in Minneapolis, Minnesota. More details and the complete technical program can be found on the conference website here. SMT007

Thank You!

We'd like to thank the following volunteers from the 2023 SMTAI TAC:

- **Dudi Amir,** Intel Corporation
- **Colette Anctil,** Collins Aerospace
- **Martin Anselm, Ph.D.,** Rochester Institute of Technology
- **Babak Arfaei, Ph.D.,** Juniper
- **Raiyo Aspandiar, Ph.D.,** Intel Corporation
- **Nilesh Badwe, Ph.D.,** Indian Institute of Technology, Kanpur
- **Jasbir Bath,** Bath Consultancy
- **Andy Behr,** Panasonic
- **Elizabeth Benedetto,** HP Inc.
- **Mike Bixenman, DBA, MBA,** KYZEN Corporation
- **Lars Boettcher,** Fraunhofer IZM Berlin
- **Robert Boguski,** Datest Corporation
- **Richard Brooks,** Spartronics
- **Keith Bryant,** KB Consultancy
- **Kevin Bryd,** Intel Corporation
- **Bill Capen,** Honeywell FM&T
- **Bill Cardoso, Ph.D.,** Creative Electron, Inc.
- **Burton Carpenter,** NXP Semiconductors
- **Srinivas Chada, Ph.D.,** Project Kuiper-Amazon
- **Lenora Clark,** MacDermid Alpha Electronics Solutions
- **Jean-Paul Clech,** EPSI, Inc.
- **Marie Cole,** IBM Corporation (retired)
- **William Cooper,** John Deere Electronics Solutions Inc.
- **Eric Cotts, Ph.D.,** Binghamton University
- **Richard Coyle, Ph.D.,** Nokia Bell Labs
- **Priyanka Dobriyal, Ph.D.,** Intel Corporation
- **Michael Ford,** Aegis Software
- **Trevor Galbraith,** Global SMT & Packaging
- **James Elliott Fowler, Ph.D.,** Sandia National Laboratories
- **Jie Geng, Ph.D.,** Indium Corporation
- **Faramarz Hadian, Ph.D.,** Binghamton University
- **Sa'd Hamasha, Ph.D.,** Auburn University
- **Carol Handwerker, Ph.D.,** Purdue University
- **Md Hasnine, Ph.D.,** Qorvo, Inc.
- **David Hillman,** Collins Aerospace (Retired)
- **Jason Keeping,** Celestica, Inc.
- **Jeffrey Kennedy,** ZESTRON Corporation
- **Robert Kinyanjui, Ph.D.,** John Deere Electronics Solutions Inc.
- **Richard Kraszewski,** Plexus Corp.
- **Pradeep Lall, Ph.D.,** Auburn University
- **Dale Lee,** Plexus Corp.
- **Tanya Martin,** SMTA
- **Andrew Mawer,** NXP Semiconductors
- **Tim Pearson,** Collins Aerospace
- **Scott Priore,** Cisco
- **Anto Raj,** Medtronic
- **Chrys Shea,** Shea Engineering Services
- **Rajen Sidhu, Ph.D.,** AMD
- **Julie Silk,** Keysight Technologies
- **Gregory Vance,** Rockwell Automation
- **Charles Woychik, Ph.D.,** Skywater Technologies

Women's Leadership Program

The Women's Leadership Program is a popular, annually recurring event hosted during SMTA International. This year's event is scheduled for Monday, Oct. 9, at the Minneapolis Convention Center and is free for all participants at SMTA International. The theme for this year's program is "Personal Branding: Creating an Authentic and Sustainable Perception."

The program will start with three presentations from women leaders in the electronics and medical industry. Each leader has charted a unique career journey that made her invaluable in the organizations she leads. Since our 2023 program theme focuses on personal branding, we asked our speakers to share their experiences, learnings, and personal branding journeys in their presentations.

The presentations will be followed by speed mentoring sessions, delving into the 5 C's: clarity, content, connection, creativity, and community. These crucial aspects encompass all the important facets of personal branding, allowing attendees to effectively characterize and refine their own unique brand.

A Connection Reception social will conclude the Women's Leadership Program. This annual gathering provides a relaxed atmosphere to continue the conversations from the earlier segments of the WLP, fostering new and renewed connections across the SMTA community of organizers, speakers, exhibitors and attendees.

This Year's Presenters

"Growing a Semiconductor Start-up to a Mid-sized Business"

Stephanie Pusch

Executive VP and Co-Founder, Trusted Semiconductor Solutions

Stephanie Pusch has BS and MS degrees in electrical engineering from University of Wisconsin and Illinois Institute of Technology, respectively. She started her career at Motorola designing printed circuit boards, FPGAs, and ASICs for cellular phones and infrastructure. She then joined Cadence Design Systems as an applications engineer, where she supported its system level design tools, then she moved into technical sales. Following Cadence, she worked in business development at Honeywell for its microelectronics business unit and radiation-hardened semiconductor foundry. She and a Honeywell colleague started Trusted Semiconductor Solutions 17 years ago to offer U.S.-designed and manufactured custom integrated circuits to the high-reliability marketplace.

"After 20 Years, STILL Working on My Brand"

Jennifer Fischer

CMO, Northfield Hospital

Dr. Jennifer Fischer is a distinguished medical professional, renowned for her remarkable contributions to the healthcare industry as a staff physician at Northfield Hospital. Throughout her career, she has held several key positions, including emergency department (ED) medical director and EMS medical director, demonstrating her unwavering commitment to improving medical services and patient care. Moreover, her dedication extends beyond her roles at the hospital, as she has actively participated in various county and state work groups concerning opioid use concerns, COVID response, disaster response, and EMS, striving to make a positive impact in her community and beyond.

"Your Personal Brand Exists; It's Up to YOU to Manage It!"

Michelle Gebbie

Strategic Mktg. and Ops. Senior Manager, 3M Electronics Materials Solutions Division

Michelle Gebbie has over 25 years in branding, advertising, marketing, and communications; 17 of those years were spent working at 3M across various divisions and corporate teams. The beloved Post-it® Brand and Scotch® Brand are on the roster, but she's also worked on 3M's employment brand and most recently has been working in 3M's Display Materials & Systems Division (a much more technical area of 3M, but geeky, tech stuff is up her alley). Mid-point in her career at 3M, she chose to spend some of her "3M 15% time" to develop a simplified "how to" approach for building one's personal brand. She thoroughly enjoys opportunities to inspire people to rethink what's possible—in both their professional and personal lives—and presenting on personal brand around 3M for the past 10+ years has been extremely gratifying. She cannot wait to promote the value of one's personal brand and talk about how to unleash it in this upcoming event. **SMT007**

Schedule at a Glance

SMTA International provides your best chance to reconnect with the global electronics manufacturing community and to stay competitive, identify challenges, innovate, and exceed expectations.

We invite you to attend the SMTA International Conference and Exhibition, Oct. 9–12, at the Minneapolis Convention Center in Minnesota. We are proud of our legacy of providing outstanding networking and learning experiences and this year will be no different. The conference and exhibition are a unique opportunity for us to connect, discover, and learn from each other and industry experts.

The teamwork and collaboration that goes into developing the conference and exhibition are exceptional. Our technical program contains papers and presentations from true subject matter experts covering a wide range of electronic manufacturing topics.

The Technical Advisory Committee and the SMTA staff, Chapter Officers, and Global Board of Directors sincerely hope that SMTA International is a valuable and enjoyable experience for you. Register today.

The Industry's Strongest Technical Program

SMTA International remains an exceptional event as we attract an outstanding group of authors, speakers, and exhibitors. Our technical program contains papers and presentations from true subject matter experts covering a wide range of electronics manufacturing topics. SMTA International consistently welcomes 90 speakers into the technical program each year, along with offering professional development courses.

The Largest Audience of Engineers and Manufacturing Professionals

We are excited to co-locate with Medical Design & Manufacturing Minneapolis (MD&M) at the Minneapolis Convention Center again this October. Together, the events bring one of the largest audiences of engineering and manufacturing professionals to the Midwest.

The Exposition

SMTA International will co-locate with Medical Design & Manufacturing (MD&M) Minneapolis, bringing together one of the largest audiences of engineering and manufacturing professionals in the Midwest.

All six trade shows share the expo floor in Minneapolis. It's a one-stop experience delivering design to manufacturing solutions at every stage of the manufacturing process—design, materials, manufacturing, automation, cleaning, and packaging—in top manufacturing sectors.

Current Exhibitors

AIM Solder
Akrometrix, LLC
Alltemated
ANDA Technologies USA, Inc.
ASMPT
ASYS Group Americas, Inc.
BlueRing Stencils
BTU International, Inc.
CalcuQuote
Celestica, Inc.
Conductive Containers
CTI Systems
DarwinAI
Dymax Corporation
Europlacer Americas
Finetech
Fuji America Corporation
Garland Service Company
Glenbrook Technologies
GlobalSMT
Heraeus Electronics
HX Circuit Technology Co., Ltd
I-Connect007
IDENTCO
Inovaxe Corporation
Insituware
IPC
KIC
Koh Young Technology, Inc.
Kulicke & Soffa PTE. LTD.
KYZEN Corporation
MacDermid Alpha Electronics Solutions
Magnalytix
Metallic Resources, Inc.
Microtech Laboratories, LLC
Mid America Taping & Reeling, Inc.
Mirtec Corporation
Mycronic, Inc.
Nano Dimension U.S.
Nihon Superior Company, Ltd.
NPI Services, Inc.
NSW Automation, Sdn. Bhd.
Omron Inspection Systems
Panasonic
PARMI USA, Inc.
Pillarhouse USA, Inc.
Printed Circuit Engineering Assoc.
Seika Machinery, Inc.
SMarTsol Technologies
SMT Corp
SMT Today
SMTXTRA USA, Inc.
SPEA America
Specialty Coating Systems, Inc.
StaticStop
Staticworx
Test Research, Inc.
Texmac/Takaya, Inc.
Tintronics
Trans-Tec America
Universal Instruments
U.S. Tech
Viscom
VisiConsult X-Ray Solutions America Corp.
Vitrox
Von Roll USA, Inc.
ZESTRON Corporation
Zymet, Inc.

Professional Development Courses

Half-day (3.5 hours) educational courses are led by internationally respected professionals with extensive experience in the subject area.

Course instructors deliver focused, in-depth presentations on topics of current importance to the industry, based on their research and industry experience. Professional Development Courses are application oriented and structured to combine field experience with scientific research to solve everyday problems.

Monday, October 9

1:30 p.m.–5:00 p.m.

"Artificial Intelligence–Opportunities, Challenges, and Possibilities"
Presenter: Jennie Hwang, Ph.D., H-Technologies Group
View full course outline

"Weeding out PCB Defects Prior to Assembly"
Presenter: Bihari Patel, BP SMT Connections Inc.
View full course outline

"Best Practices for Improving Manufacturing Productivity"
Presenters: Phil Zarrow and Jim Hall, ITM Consulting
View full course outline

"Reflow Profiling Simplified"
Presenter: Robert Rowland, Axiom Electronics LLC
View full course outline

Tuesday, October 10

1:30–5:00 p.m.

"Flex Circuit 'Design for Manufacturing Principles' Circuit Design, Fabrication, and SMT Assembly Processing"
Presenter: Vern Solberg, Solberg Technical Consulting
View full course outline

"Solder Joint Reliability—Principle and Practice"
Presenter: Jennie Hwang, Ph.D., H-Technologies Group
View full course outline

"How to Select a Solder Paste for High Reliability and Yields"
Presenter: Ron Lasky, P.E., Indium Corporation
View full course outline

Wednesday, October 11

1:30–5:00 p.m.

"Selection Criteria of Surface Finishes for Better Reliability of Electronic Assemblies"
Presenter: Kunal Shah, Ph.D., Lilotree
View full course outline

"Fan-Out, Chiplet, and Heterogenous Integration Packaging"
Presenter: John Lau, Ph.D., Unimicron
View full course outline

"ESD Concept to Reduce Electrostatic Charges in Manufacturing Processes"
Presenter: Hartmut Berndt, B.E. STAT ESD Competence Centre
View full course outline

"Failure Analysis of Electronic Devices"
Presenter: Martine Simard-Normandin, Ph.D., MuAnalysis Inc.
View full course outline

Technical Conference Program

Technical Conference Program

*Schedule subject to change. Check event website for latest details: smtai.org/conference-program

HPR1: Hardware Ruggedization for Extreme Environments I

Monday, October 9

1:30–3:00 p.m. CDT

Chair: Mike Bixenman, DBA, MBA, Magnalytix LLC

"Comparative study of Lead-free Solder Materials for Power Module Packaging Assembly"
Tyler Richmond, Hongwen Zhang, Ph.D., Francis Mutuku, Jie Geng, Huaguang Wang, and Kyle Aserian, Indium Corporation

"Managing Thermomechanical Behaviour in Automotive Electronics"
Presenter: Maurice Dore, Valeo

"Utilizing SIR and Analytical Tools to Determine Impact to Reliability for Process Improvements"
Presenter: Denis Barbini, Ph.D., ZESTRON Corporation; Jamie Boutwell, Cirtronics

MD1

Monday, October 9

1:30–3:00 p.m. CDT

"Cleaning In the High Reliability World: The Hidden Cost of Cleaning PCBs"
Presenter: Bill Capen, Honeywell FM&T

"Engineering Curiosity and Why it is a Must for Mission Critical Manufacturing"
Presenter: Adam Klett, L3Harris

"Mechanical Energy, Cleaning Solution, and Rinse: The three main ingredients to cleaning of circuit boards"
Presenter: Bill Capen, Honeywell FM&T

Women's Leadership Program: Invited Presentations

Monday, October 9

1:30–3:45 p.m. CDT

Chairs: Amanda Brawthen, John Deere Electronic Solutions; Marie Cole, formerly with IBM Corporation. Free for all attendees. (See page 80).

PDC 1: Artificial Intelligence—Opportunities, Challenges and Possibilities

Monday, October 9

1:30–5:00 p.m. CDT

Instructors: Jennie Hwang, Ph.D., H-Technologies Group; George Karniadakis, Ph.D., Brown University and MIT

PDC 2: Weeding Out PCB Fabrication Defects Before Assembly

Monday, October 9

1:30 p.m.–5:00 p.m. CDT

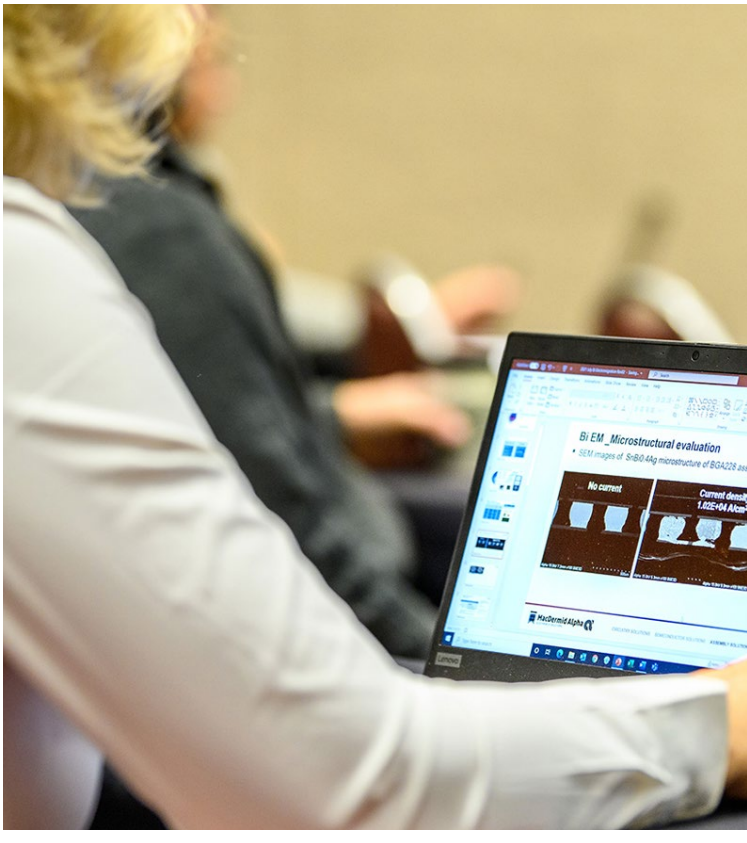
Instructor: Bihari Patel, BP SMT Connections Inc

PDC 3: Assembly- Best Practices for Improving Manufacturing Productivity

Monday, October 9

1:30 p.m.–5:00 p.m. CDT

Instructors: Phil Zarrow and Jim Hall, ITM Consulting



PDC 4: Reflow Profiling Simplified

Monday, October 9

1:30 p.m.–5 p.m. CDT

Instructor: Rob Rowland, Axiom Electronics

HPR2: Hardware Ruggedization for Extreme Environments II

Monday, October 9

3:30–5:00 p.m. CDT

Chair: Sa'd Hamasha, Ph.D., Auburn University

"Electrical-plus Functional Testing is Instrumental in Designing Electronics That Survive Harsh Conditions"

Presenter: Mike Bixenman, MBA, DBA, Magnalytix, LLC; Terry Munson, Foresite Labs

"Shear, Shock, Vibration and Thermo-cyclic Mechanical Testing of Next Generation Pb-Free Solder Pastes"

Presenter: Norman Armendariz, Ph.D., RTX Raytheon

MD2

Monday, October 9

3:30–5:00 p.m. CDT

"The Importance of Having a Clean Slate in the SMT Assembly Process for High-Density and Fine-Pitch Applications"

Presenters: Charlie Fujikawa, Max Bernard, Michelle Ogihara, Seika Machinery, Inc.

"Process Control of Rework Used in High Reliability World"

Presenter: Rachel-Anne Stupp, Honeywell FM&T

"Recognizing the Root Cause of Solder Joint Failures"

Presenter: Martine Simard-Normandin, Ph.D., MuAnalysis Inc.

WLP: Speed Mentoring and Round Table Discussions

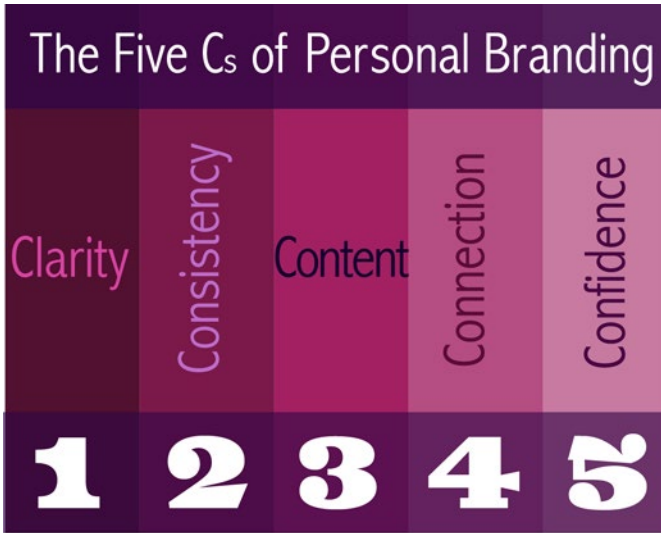
Monday, October 9

4:00–5:00 p.m. CDT

Free for all attendees

Chairs: Jessica Molloy, ZESTRON Corporation; Julie Silk, Keysight Technologies; Debbie Carboni, KYZEN Corporation

The invited presentations will be followed by a speed mentoring session where attendees rotate through a selection of five tables hosted by SMTA female chapter leaders and male allies on topics related to personal branding.



WLP: Connection Reception

Monday, October 9

5:00–6:00 p.m. CDT

We will wrap up the Women's Leadership Program with our annual Connection Reception. Join us as we mingle and connect with fellow attendees! More details coming soon. Wine and appetizers will be served.

APT1: Package Assembly Process 1

Tuesday October 10

11:00 a.m.–12:30 p.m. CDT

"Wafer-to-Wafer (W2W) Hybrid Bonding—The Next Generation of Advanced Packaging Assembly"

Presenters: Ermily Duvall, Charles Woychik, Chris Nichols, Skywater Technologies

"High-Density RDL Technologies for Substrates and PLP"

Presenter: Lars Boettcher, Fraunhofer IZM

"Process Development to Achieve a High Yield Wafer-to-Wafer (W2W) Hybrid Bond"

Presenters: Victor Vilar, Elan Herrera, Sangchae Kim, Chris Nichols and Charles Woychik, Skywater Technology, Inc.

IRR1: Programs Addressing High Reliability and Mission Critcial Applications

Tuesday, October 10

11 a.m.–12:30 p.m. CDT

"A Collaborative Consortia Project to Assess the Effect of Thermal Cycling Dwell Time on the Reliability of High-Performance Solder Alloys"
Presenter: Richard Coyle, Nokia Bell Lab

"The USPAE Solder Performance and Reliability Assurance Project: Test Plan"
Presenter: Michael Osterman, Ph.D., University of Maryland-CALCE-EPSC

"Graphical Representations of Challenges Regarding Implementation of Pb-free Materials in Aerospace and Defense Electronics"
Presenter: Anthony Rafanelli, Raytheon Technologies

MAT1

Tuesday, October 10

11 a.m.–12:30 p.m. CDT

"The Intermediate Diffusion Barrier Performance of Electroless Co-W-B / Ni-P Stacked Deposits Between Cu and Solder Joint"
Presenter: Yoshihito Li, Hiroki Okubo, Shoichi Hukui, Tetsuji Ishida, Shoji Iguchi, Katsuhisa Tanabe, Shigeo Hashimoto, C. Uyemura & Co., Ltd.

"Thermal Properties and Reliability of Liquid Metal Alloys Containing Organic Additive as Thermal Interface Materials for Computing Electronics Device"
Presenters: Guangyu Fan, Jeffrey Kurish, John Lamb, Indium Corporation; Michael Beam, Jacob Wicker, Wakerley Banker, Alexander Bonacci, SUNY Polytechnic Institute

"Selecting the Right Adhesive for Your Electronics Application"
Presenter: David Spitz, Ansys, Inc.

APT2: Package Assembly Process 2

Tuesday, October 10

1:30–3:00 p.m. CDT

"Using Piezoelectric Sensors to Measure Dynamic Force in Semiconductor Applications"
Presenter: Robert Hillinger, Kistler Instrumente

"Assembly Solutions for Cost-Effective Heterogeneous Integration with Disparate Die Types"
Presenter: Glenn Farris, Universal Instruments

"Innovative Soldering Materials for Ball-Attach Processes on Advanced Packages"
Presenter: Evan Griffith, Indium Corporation

IRR2: Design Considerations for Reliability

Tuesday, October 10

1:30–3:00 p.m. CDT

"Impact of BGA Escape Trace Design on Thermo-Mechanical Performance of Solder Joint"
Presenters: Cheng-Hao Chin, Gnyaneshwar Ramakrishna, Cisco Systems

"Design Considerations That Influence LED Solder Joint Reliability on IMS Printed Circuit Boards"
Presenter: Michael Blattau, Ansys, Inc.

"Next-Generation Pin-in-Ball and Non-Solder Ball Grid Arrays Demonstrate Advancements in Surface-Mount Area Array Solder Joint Attachment With the Capacity to Satisfy IPC-A-610 and IPC J-STD-001 Class 3 Criteria"
Presenters: Robbie Huffman, David Decker, Samtec, Inc.

MAT2

Tuesday, October 10

1:30–3:00 p.m. CDT

"Sustainable Nanocoating Technology for Corrosion Protection of Electronics"
Presenter: Rakesh Kumar, Frank Ke and Dustin England, Specialty Coating Systems, Inc.

"Restoration of Tin-Over-Copper Plating on Electronic Components and Circuit Boards Exhibiting Cu-Sn Intermetallic Breakthrough and Severe Surface Oxidation"
Presenter: Scott Nelson, SemiPack Services Inc; Dana Imler, Superior Flux

"A Novel Surface Finish Can Achieve Robustness Against Copper Creep Corrosion for Better Reliability of Printed Circuit Boards (PCBs)"
Presenters: Kunal Shah, Lilotree; Dem Lee, Jeffrey Lee, Integrated Service Technology Inc.

PDC 5: Flex Circuit 'Design for Manufacturing Principles' Circuit Design, Fabrication and SMT Assembly Processing

Tuesday, October 10

1:30–5:00 p.m. CDT
Instructor: Vern Solberg, Solberg Technical Consulting

PDC 6: Solder Joint Reliability—Principle and Practice

Tuesday, October 10

1:30–5:00 p.m. CDT
Instructor: Jennie S. Hwang, Ph.D., D.Sc., H-Technologies Group

PDC 7: How to Select a Solder Paste for High Reliability and Yields

Tuesday October 10

1:30-5 p.m. CDT
Instructor: Ron Lasky, Ph.D., P.E., Indium Corporation

MAT3

Tuesday, October 10

3:30-4:30 p.m. CDT
"Not All Things Are Created Equal: OSP and Cleaning Chemistries"
Presenters: Frank Xu Ph.D., John Fudala, Michael Orsini and Martin Bunce, MacDermid Alpha Electronic Solutions; Haley Reid, KYZEN Corporation

"Z-Axis Carbon Fiber-Indium Composite Thermal Interface Material with Ultra-High Thermal Conductivity for High Performance Computing"
Presenter: Rafael Padilla, Chunzhou Pan, Juan Pino, Boston Materials Inc.

APT3: Package Materials

Tuesday, October 10

3:30-5 p.m. CDT
"Cu Conductive Paste as Via Filling Materials for Various Substrates"
Presenters: Yoshinori Ejiri, Masumi Sakamoto, Chiaki Shimizu, Resonac Co., Ltd.

"Performance Evaluation of Pure Indium Thermal Interface Material (TIM) under Different Operating Conditions in Single-Phase Immersion Cooling"
Presenter: Rohit Suthar, University of Texas at Arlington

"Study of the FCBGA Package Interfaces Reliability Under Monotonic and Fatigue Loads after Sustained High Temperature"
Presenters: Pradeep Lall, Ph.D., Padmanava Choudhury, Aathi Pandurangan, Madhu Kasturi, Auburn University

WFD: Growing the Future Workforce

Tuesday, October 10

3:30-5 p.m. CDT

IRR3: Alloy Development and Considerations for High Reliability

Tuesday, October 10

3:30-5:00 p.m. CDT
"Thermal Shock Testing of Third Generation High-Reliability Solder Alloys from -40°C to 150°C"
Presenter: Jayse McLean, John Deere Electronics Solutions

"Low-Voiding High-reliability Lead-free Solder Paste for Automotive Applications"
Presenter: Jie Geng, Indium Corporation

"Effect of Bi-Addition on the High Strain Rate Properties of SnAgCu Solders under Wide Temperature Extremes and Prolonged Exposure to High Temperature"
Presenter: Pradeep Lall, Ph.D., Vishal Mehta, Mrinmoy Saha, Auburn University

"Intermetallic Compounds in Solder Alloys: Common Misconceptions"
Presenter: David Hillman, Hillman Electronic Assembly Solutions; Tim Pearson, Collins Aerospace

APT4: Advanced Packaging and Reliability

Wednesday, October 11

8:30-10:00 a.m. CDT
"Board Level Reliability Parametric Study for Automotive FCBGA"
Presenters: Richard Lai, Nishant Lakhera, Sandeep Shantaram, Varun Thukral, NXP Semiconductors

"Si-Interposers for 3D Heterogeneous Integration"
Charles Woychik, Ph.D., Chris Nichols, Alan Huffman, SkyWater Technology; John Allgair, BRIDG

TBD
Presenter: Andrew Mawer, NXP Semiconductors

LTS1: Thermal Cycling Performance of LTS Sn-BI Solder Joints with and without Aging

Wednesday, October 11

8:30-10 a.m. CDT
Chair: Vasu Vasudevan, Dell Corp
Co-Chair: Mehdi Hamid, IBM

"The Thermal Cycling Performance of Hybrid Low Temperature Solder Joints Tested at a High Homologous Temperature"
Presenter: Richard Coyle, Ph.D., Nokia Bell Labs

"The Effect of Thermal Cycling Profile on Thermal Fatigue Performance of an 84-Pin Thin Core BGA with Hybrid, Homogeneous, and Resin Reinforced Low Temperature Solder Interconnects"
Presenter: Dan Burkholder, Intel Corporation

"Reliability Performance Impacts of Isothermal Aging on Homogenous Low Temperature Solder Joints"
Presenters: Jason Stafford, Kevin Byrd, Jeffrey Cook, Brian Franco, Intel Corporation

MFX1: Manufacturing Operations Excellence

Wednesday, October 11

8:30-10 a.m. CDT
"Enabling Global SMT Line Efficiency Evaluation through Advanced Data Analytics"
Presenter: Cameron Sobie, Ph.D., Arch Systems

"The Challenges and Common Pitfalls of Deploying Artificial Intelligence in Manufacturing"
Presenter: Audrey Chung, Darwin AI

"How Generative AI Can Be Used in Electronics Manufacturing"
Presenter: Sheldon Fernandez, Darwin AI

INS1: AI and Machine Learning: Current Electronics Manufacturing Inspection Applications

Wednesday, October 11

11 a.m.-12:30 p.m. CDT
Chair: Robert Boguski, Datest Corporation
"Realtime Control 4.0: How AI supports Process Control"
Presenter: Ivan Aduna, Axel Lindloff, Koh Young Technology
"Discover the AI Deployment in Verification Tool for Inspection Equipment Towards Smart Manufacturing"
Presenter: Piet Gek Tan, ViTrox

"Using Deep Learning to Help Automate Golden Board Programming for Visual Inspection of PCB Components"
Presenter: Francis Li, Mahmoud Famouri, Mohammad Javad Shafiee, Alexander Wong, Darwin AI

LTS2: Reliability Assessment of New Low Temperature Sn-Bi Alloys

Wednesday, October 11

11 a.m.-12:30 p.m. CDT
Chair: Richard Coyle, Ph.D., Nokia Bell Labs
Co-Chair: Anna Lifton, MacDermid Alpha Electronics Solutions

"Reliability Performance of a Fourth Generation Low Temperature Solder Alloy in Homogeneous and Hybrid Solder Joints, Part 2"
Presenter: Morgana Ribas, Ph.D., MacDermid Alpha Electronics Solutions

"A Near Eutectic Sn-Bi based LTS with High Thermal Fatigue Performance"
Presenters: Francis Mutuku, Hongwen Zhang, Huaguang Wanb, Jie Geng, Indium Corporation

"Investigation of Compatibility and Reliability in Low Temperature Soldering for Ball Grid Array Components"
Presenters: Watson Tseng, Chunyu Chang, Coti Chung, Keith Lee, Ken Lin, Shenmao America, Inc.

MFX2: Product Assembly Challenges

Wednesday, October 11

11 a.m.-12:30 p.m. CDT

"Fill the Void VI: A Study of the Impact of Solder Alloy on Voiding in Solder Joints"
Presenter: Tony Lentz, FCT Assembly

"Establishing Design Rules for the Laser Depaneling of Printed Circuit Boards"
Presenters: Patrick Stockbruegger, M.Sc., Stephan Schmidt, LPKF Laser & Electronics North America

"Modern Methods of PCB Depanelization and the Associated Considerations With a Focus on Low Impact Depanelization for Improved Reliability"
Presenters: Max Bernard, Michelle Ogihara, Steven Yukutake, Yoshito Kanayama, Seika Machinery, Inc.

PDC 10: ESD Concept to Reduce Electrostatic Charges in Manufacturing Processes—ESD Assessment

Wednesday, October 11

1:30-5 p.m. CDT
Instructor: Hartmut Berndt, Dipl.-Ing., B.E. STAT European ESD Competence Centre

PDC 11: Failure Analysis of Electronic Devices

Wednesday, October 11

1:30-5 p.m. CDT
Instructor: Martine Simard-Normandin, Ph.D., MuAnalysis Inc.

PDC 8: Selection Criteria of Surface Finishes for Better Reliability of Electronic Assemblies

Wednesday, October 11

1:30-5 p.m. CDT
Instructor: Kunal Shah, Lilotree

PDC 9: Fan-Out, Chiplet, and Heterogenous Integration Packaging

Wednesday, October 11

1:30-5 p.m. CDT
Instructor: John H Lau, Unimicron Technology Corporation

INS2: Advanced Imaging Applications—X-ray, SEM, Optical Microscopy—for Manufacturing and Failure Analysis

Wednesday, October 11

2-3:30 p.m. CDT

"Assessing Electronic Devices with Advanced 3D X-ray Microscopy Techniques and Electron Microscopy"
Presenter: Herminso Villarraga-Gómez, ZEISS

"In-Situ Thermal Radiographic Failure Analysis of Capacitor Encapsulant Fracturing"
Presenter: Norman Armendariz, RTX Raytheon

"A New X-ray Source Technology for Demanding SMT Inspection"
Presenter: Keith Bryant, KB Consultancy

LTS3: Effects of Elemental Additions to Sn-Bi Solder Alloys

Wednesday, October 11

2-3:30 p.m. CDT
Chair: Morgana Ribas, Ph.D., MacDermid Alpha Electronics Solutions
Co-Chair: Francis Mutuku, Indium Corporation

"A Path to Ductile Low Temperature Solders for Mass Production of Electronic Assemblies?"
Presenters: Keith Sweatman, P.E., Xin Fu Tan, Qichao Hao, Stuart D. McDonald, Michael Bermingham, Kazuhiro Nogita, The University of Queensland; Qinfen Gu, ANSTO; Tetsuro Nishimura, Nihon Superior Co., Ltd.

"The Effect of Sb and Ag Addition on the Melting, Undercooling, and Mechanical Behavior of Sn-Bi LTS"
Presenters: Hannah Fowler, Yifan Wu, Purdue University

"Microstructure Modification for SnBi Low Temperature Solder Alloy"
Presenters: Albert Wu, National Central University; Chao-Chin Chang, Tsao-Cheng Huang, Yu-Cheng Chen, Formosa Plastics Corporation; Chang-Meng Wang, Shenmao Technology Inc.

MFX3: Printing Challenges

Wednesday, October 11

2-3:30 p.m. CDT

"Vapor Deposited Stencil Nano-Coatings—A New Break Through or Just Another Coating?"
Presenter: Greg Smith, BlueRing Stencils

"An Exploratory Review of Variables Affecting Solder Paste Volume and Reliability in the Stencil Printing Process"
Presenter: Matthew Simeroth, ACC Electronix, Inc.

"Performance Comparison of Contemporary Stencil Coatings and Under Wipe Solvents on 0.4 mm BGA Packages"
Presenters: Chrys Shea, Shea Engineering Services; John Hanerhoff, Debbie Carboni, KYZEN Corporation

INS3: Unique and Challenging Test/Inspection Applications

Thursday, October 12

8:30-10 a.m. CDT
Chair: Keith Bryant, KB Consultancy

"Case Studies in the Evolution of FPGA Counterfeiting"
Presenter: Jason Romano, Nicholas Williams, SMT Corp

"The Trade-offs in Visual Quality Inspection in a Mixed Assembly Environment"
Presenter: Andrew Hryniowski, Darwin AI

"Flying Probe Card Design for Medical and Other Challenging Applications: a Case Study in Wafer Testing"
Presenter: Luca Fanelli, SPEA

LTS4: Electromigration, Shear and Drop Shock Assessment of Low Temperature Sn-Bi Solder Joints

Thursday, October 12

8:30-10 a.m. CDT
Chair: Rajen Sidhu, AMD
Co-Chair: Babak Arfaei, Juniper Network

"Comparison of Electromigration in Tin-Bismuth Planar and Bottom-Terminated Component Solder Joints"
Presenter: Prabjit Singh, IBM Corporation

"Low Temperature Solder Joint Shear Strength of Components in SMT Assembly"
Presenters: Saurabh Gupta, Howlit Chng, James M Wade, Kyle Davidson, Todd Smith, Kevin J Byrd, Jose I Hernandez, Juan Landeros, Intel Corporation

"Investigation into Low Temperature Solder Reliability"
Presenter: Michael Osterman, Ph.D., University of Maryland-CALCE-EPSC

MFX4: Interesting and Tangible Topics

Thursday, October 12

8:30-10:00 a.m. CDT

"Case Study: Analyzing 0402 Capacitor Defects With Stencil Printing Misalignment When Using Water Soluble and No-Clean Solder Pastes, Part 2"
Presenter: Zachary Slater, *Martin Anselm, Ph.D., Rochester Institute of Technology

"Adiabatic and Isothermal Humidification for Electronics Manufacturing: The Science of Humidity Control in Manufacturing"
Presenter: Richard Williams, Carel USA

"Recent Advancements in Hot Bar Soldering"
Presenters: Ron Lasky, Ph.D., P.E., Dean Payne, Chris Nash, Indium Corporation

INS4: Advanced Process Test and Inspection Applications and Case Studies

Thursday, October 12

10:30 a.m.-12 p.m. CDT

"Quantifying the Relationship Between Water-Soluble Flux Residue Time on a PCB and SIR Performance"
Presenters: Joshua Dobransky, Thuy Nguyen, Indium Corporation

"Accelerated Corrosion Testing of DRAM Modules for Data Centers: Investigation of Methodology Approach and Corrosion Mitigation Solution"
Presenters: Kwangwon Seo, Ph.D., Dongmin Jang, Jaeseok Jang, Seungyeong Lee, Samsung Electronics

"Correlation of Solder Paste Reflow Defects and Electrochemical Impedance Spectroscopy Measurements"
Presenters: Carson Burt, Adam Murling, Indium Corporation; Morgan Miller, Insituware

LTS5: Improving Process Yield, Quality and Reliability with Low Temperature Solders

Thursday, October 12

10:30 a.m.-12 p.m. CDT
Chair: Prabjit Singh, IBM Corporation
Co-Chair: Hannah Fowler, Purdue University

"Complex Board Design Induced Solder Separation Failure: Mechanism and Mitigation Using Low Melting Temperature Interconnects"
Presenters: Tae-Kyu Lee, Gnyaneshwar Ramakrishna, Cisco Systems; Jonghyun Nam, Daljin Yoon, Heera Roh, SK Hynix

"A Study on the Improvement of Module Assembly Process and Reliability Using Sn-Bi Low Temperature Solder Paste"
Presenters: Jinwoo Jang, Dongmin Jang, Jaeseok Jang, Seungyeong Lee, Samsung Electronics

"Homogeneous Low Temperature Solder Technology - Quality and Reliability Considerations for Ball Grid Array Components"
Presenter: Rajen Sidhu, Ph.D., AMD

MFX5: Cleaning Challenges

Thursday, October 12

10:30 a.m.-12 p.m. CDT

"Revolutionizing PCB Assembly Cleaning: The Next Generation of pH-Neutral Defluxing Agents"
Presenter: Ravi Parthasarathy, M.S.Ch.E., ZESTRON Corporation

"Qualifying and Validating the SMT Cleaning Process using a Glass Test Vehicle"
Presenter: Vladimir Sitko, PBT Works s.r.o.; Mike Bixenman, DBA, DBA, Magnalytix, LLC

"Molecular Fingerprint of Condensate Residues in the Soldering Process: Detailed FT-IR Spectroscopic Analyses and Identification of Reaction Partners"
Presenter: Viktoria Rawinski, Rawinski GMBH

MFX6: NPI Challenges

Thursday, October 12

1-3 p.m. CDT

"Highlighting Component-Related Gaps to Ensure a Seamless PCBA Design-to-Manufacturing and Reliability"
Presenters: Arnaud Grivon, Shaïma Enouz-Vedrenne, Raphaël Hudé, Thales Global Services

"Conquering the Bogeyman: Mitigating Obsolescence Challenges Before They Occur"
Presenters: Vernon Densler, Katy Ackerman, Sourceability LLC

"3D Printing for Electronics Tooling"
Presenters: Dan Migley, Impossible Objects

ALL EPISODES AVAILABLE

sustainability podcast

From logistics, manufacturing, and personnel, to cloud-based applications, there are many aspects of sustainability that should be considered. I-Connect007 brings to our listeners a six-part series on Sustainability. Siemens topic experts explore how each of these areas are impacted by the effort to go green.

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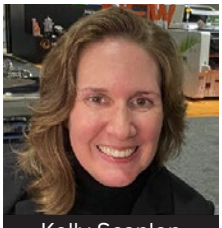
TOP TEN EDITOR'S PICKS

Solving the Challenge of the Workforce Pipeline: A New Resource to Careers in Electronics

An aerospace engineer walks onto the job at $72,770 and can double their salary in just a few years. In fact, careers in the electronics industry can provide a sizable salary, but exactly how much will you make? A new resource from the IPC Education Foundation breaks down the most common career paths in electronics manufacturing, from operators to owners. What jobs are available? What does someone in the electronics industry even do?

Team Players: A New Industry Leadership Council Seeks Sustainability Solutions


Kelly Scanlon

The work on sustainability in electronics at IPC continues and a new leadership council is one result of those efforts. In March 2023, IPC convened a Sustainability for Electronics Leadership Council to offer peer review and direction to IPC. The council is a response to the industry's requests for more attention on environmental, social, and corporate sustainability in IPC's industry standards, education, and advocacy.

Lockheed Martin: Flying High With Digital Twin


Don Kinard

While at a conference in Dallas, Barry Matties listened to a presentation on digital twin from Don Kinard, a senior fellow at Lockheed Martin. Later, we reached out to Don, who was happy to provide a deeper understanding of the role of the digital twin in the manufacturing space. What does digital twin mean when the product your manufacture is an eight- or nine-figure combat aircraft packed full of electronics?

Introducing the SMTA International Technical Program for Advancing Electronics Manufacturing

SMTA announced that the technical program of their annual conference, SMTA International, is finalized and registration is now open. The event will be held Oct, 9–12, 2023 at the Minneapolis Convention Center in Minneapolis, Minnesota.

Critical Manufacturing Focuses on the Impact of Digital Transformation at MES & Industry 4.0 International Summit

Critical Manufacturing, a global leader in next-level automation and manufacturing execution systems (MES), has announced a stellar slate of speakers and panelists for its upcoming MES & Industry 4.0 (MESI) International Summit.

Foundations of the Future: Increased Impact With Student Engagement

As the IPC Education Foundation reflects on hosting its largest IPC APEX EXPO STEM Outreach Event this past January, we realize that the activities we planned for the more than 550 students who attended allowed them to engage and connect with real industry representatives, as well as hear and learn about the unique career journeys of industry. What were the results of these efforts?

Book Excerpt: *'The Printed Circuit Assembler's Guide to... Process Control'*

The Printed Circuit Assembler's Guide to... Process Control is a new book from Gen3 Systems. An electronic assembly, by definition, has a circuit with current flowing. If by corrosion that circuit is changed, open circuit or short circuit, then the assembly will most likely be non-functional and will have failed. Dendrites are fragile metal filaments that can easily fuse when completing a circuit. Hence, an intermittent fault is observed.

Smart Factory Insights: Manufacturing Digital Twin—Spanners in the Works

Current thinking says legacy simulation of manufacturing is obsolete and the use of operational manufacturing digital twins is too expensive. The technology that replaces these approaches, however, is somewhat exciting. In the manufacturing world, we all know that unexpected changes are unwelcome, yet we endlessly strive to control them. The new normal of frequent product revision updates and more personalized production renders the optimization of continuous flow obsolete.

North American EMS Industry Up 0.9% in June

IPC announced the June 2023 findings from its North American Electronics Manufacturing Services (EMS) Statistical Program. The book-to-bill ratio stands at 1.24.

Latest Advancements in Safety and Reliability Requirements Take Center Stage at IPC's High Reliability Forum

The critical reliability of electronic prosthetics in the brain to help restore movement to a paralyzed hand, enhancing the durability of EV automotive infrastructure, testing criteria and challenges of working with lead-free materials, at IPC's High Reliability Forum October 17-19 in Linthicum (Baltimore), Maryland.

Career Opportunities

Find Industry-experienced Candidates at jobConnect007

For just $975, 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.

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Career Opportunities

Senior Sales Representative

Ventec Central Europe

Location: Kirchheimbolanden, Germany/Remote

We are looking for a self-motivated Senior Sales Representative—Ventec Central Europe, ideally with experience in the PCB industry. This position requires significant selling experience (15+ years) in the electronics and PCB industries. Candidates must possess a proven & consistent history of proactive sales growth with OEM customers. Most notably, they must be able to connect with OEM contacts that have decision-making capabilities.

Key Responsibilities

- Promote, sell, and close business for all Ventec product lines with focus on key OEM and PCB manufacturing customers.
- Track projects and submit monthly updates to management.
- Coordinate cross-functional resources when applicable.
- Assist in coordination and set-up of relevant trade show events.
- Assist in strategic planning initiatives.
- Assist in market and customer intelligence gathering.
- Recommend pricing strategies.

Job Requirements

- Entrepreneurial spirit, positive, high energy, and desire to win.
- Proactive and self-motivated work strategy to develop and win business for all business units.
- Excellent written and oral communication skills in German and English
- Excellent computer skills (Microsoft Office, especially Excel).
- Proven track record securing new business at OEM accounts.

Please apply in the strictest confidence, enclosing your CV, to: accountingde@ventec-europe.com

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Technical Support Engineer

USA Region

ViTrox aims to be the world's most trusted technology company in providing innovative, advanced, and cost-effective automated Machine Vision Inspection Solutions for the semiconductor and electronics packaging industries. Located in Hayward, California, ViTrox Americas Inc. is actively looking for talent to join our expanding team.

Key Responsibilities:

- Delivering excellent and creative problem-solving skills for servicing, maintaining, machine buy-off, and troubleshooting advanced vision inspection machines at customer sites. Providing remote customer support to minimize machine downtime.
- Cultivating strong customer relationships and ensuring comprehensive customer service to drive repeat orders and support business development in machine evaluation.
- Proactively understanding customer needs and feedback to drive continuous improvement in existing technologies and new product development.

Qualifications & Requirements:

- A recognized diploma/advanced diploma/degree in Science and Engineering, preferably in Electrical & Electronics/Computer Science/Computer Studies or equivalent.
- 3+ years of relevant experience in servicing automated inspection equipment (SPI, AOI, and AXI).
- Strong communication and troubleshooting skills.
- Willingness to travel extensively across the USA.
- Positive attitude and flexibility to accommodate conference calls with headquarters.
- Applicants from the USA and Canada are welcome to apply.
- Training will be provided at our headquarters in Penang, Malaysia.

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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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TAIYO AMERICA

Europe Technical Sales Engineer

Taiyo is the world leader in solder mask products and inkjet technology, offering specialty dielectric inks and via filling inks for use with microvia and build-up technologies, as well as thermal-cure and UV-cure solder masks and inkjet and packaging inks.

PRIMARY FUNCTION:

1. To promote, demonstrate, sell, and service Taiyo's products
2. Assist colleagues with quotes for new customers from a technical perspective
3. Serve as primary technical point of contact to customers providing both pre- and post-sales advice
4. Interact regularly with other Taiyo team members, such as: Product design, development, production, purchasing, quality, and senior company managers from Taiyo group of companies

ESSENTIAL DUTIES:

1. Maintain existing business and pursue new business to meet the sales goals
2. Build strong relationships with existing and new customers
3. Troubleshoot customer problems
4. Provide consultative sales solutions to customer's technical issues
5. Write monthly reports
6. Conduct technical audits
7. Conduct product evaluations

QUALIFICATIONS / SKILLS:

1. College degree preferred, with solid knowledge of chemistry
2. Five years' technical sales experience, preferably in the PCB industry
3. Computer knowledge
4. Sales skills
5. Good interpersonal relationship skills
6. Bilingual (German/English) preferred

To apply, email: BobW@Taiyo-america.com with a subject line of "Application for Technical Sales Engineer".

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Career Opportunities

BLACKFOX
Premier Training & Certification

IPC Instructor
Longmont, CO

This position is responsible for delivering effective electronics manufacturing training, including IPC certification, to adult 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 primarily conduct training at our public training center in Longmont, Colo., or will travel directly to the customer's facility. It is highly preferred that the candidate be willing to travel 25–50% of the time. Several IPC certification courses can be taught remotely and require no travel or in-person training.

Required: A minimum of 5 years' experience in electronics manufacturing and familiarity with IPC standards. Candidate with current IPC CIS or CIT Trainer Specialist certifications are highly preferred.

Salary: Starting at $30 per hour depending on experience

Benefits:
- 401k and 401k matching
- Dental and Vision Insurance
- Employee Assistance Program
- Flexible Spending Account
- Health Insurance
- Health Savings Account
- Life Insurance
- Paid Time Off

Schedule: Monday thru Friday, 8–5

Experience: Electronics Manufacturing: 5+ years (Required)

License/Certification: IPC Certification–Preferred, Not Required

Willingness to travel: 25% (Required)

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Prototron Circuits

Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB manufacturer located in Tucson, AZ, is looking for sales representatives for the Utah/Colorado, and Northern California territories. With 35+ years of experience, our PCB manufacturing capabilities reach far beyond that of your typical fabricator.

Reasons you should work with Prototron:
- Solid reputation for on-time delivery (98+% on-time)
- Capacity for growth
- Excellent quality
- Production quality quick-turn services in as little as 24 hours
- 5-day standard lead time
- RF/microwave and special materials
- AS9100D
- MIL-PRF- 31032
- ITAR
- Global sourcing option (Taiwan)
- Engineering consultation, impedance modeling
- Completely customer focused team

Interested? Please contact Russ Adams at (206) 351-0281 or russa@prototron.com.

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Career Opportunities

KYZEN
Where Science and Care Converge.

Regional Manager

Southwest Region

General Summary: Manages sales of the company's products and services, Electronics and Industrial, within the Southwest Region. Reports directly to Americas Manager. Collaborates with the Americas Manager to ensure consistent, profitable growth in sales revenues through positive planning, deploy-ment 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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EMA Design Automation®

Technical Marketing Engineer

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

Requirements:

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

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

Send Resumes to: resumes@ema-eda.com

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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 for travel.

Must be able to travel extensively.

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KOH YOUNG AMERICA

Technical Service & Applications Engineer

Full-Time — Flexible Location

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

Responsibilities

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

Skills and Qualifications

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

Benefits

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

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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

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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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Career Opportunities

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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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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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.

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APCT
Passion | Commitment | Trust

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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IPC BUILD ELECTRONICS BETTER®

PCB DESIGN COURSES

DRIVE QUALITY AND INNOVATION

PCB Design for Manufacturability 9/12 to 9/28	**Introduction to PCB Design I** 10/10 to 11/16	**Introduction to PCB Design II** 10/9 to 11/29
Introdução a projeto de PCB II IN PORTUGUESE 9/25 to 11/20	**PCB Advanced Design Concepts** 10/9 to 11/29	**PCB Design for Military, Aerospace & Other Extreme Applications** 10/10 to 11/16

PCB Fab and Assembly Troubleshooting

- PCB Troubleshooting & Defect Analysis
  Led by Mike Carano — September 12 to October 5

NEW

- Troubleshooting & Defect Analysis for Electronics Assembly
  Led by Jim Hall & Phil Zarrow — September 19 to September 28

Learn more about our PCB Design Courses.

ON DEMAND! Free 12-part Webinar Series

Smarter Manufacturing Enabled with Inspection Data

with expert Ivan Aduna

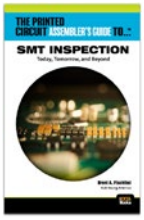
A smart factory is created from many parts, and inspection systems will play a critical role for process optimization in the next industrial revolution. Accurate, reliable 3D measurement-based data is essential, and a key element for a true smart factory. In this 12-part webinar series, viewers will learn about secure data collection, AI-powered solutions to manage and analyze data, and how to leverage the IPC CFX-QPL to succeed in the transformation to Industry 4.0.

I-007eBooks *The Printed Circuit Assembler's Guide to...*

Process Control

by Chris Hunt and Graham K. Naisbitt, GEN3

In this book, the authors examine the role of SEC test and how it is used in maintaining process control and support for objective evidence (OE.) Issues, including solution choices, solution sensitivities, and test duration are explored.



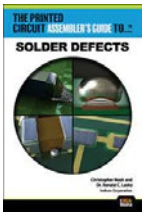
SMT Inspection: Today, Tomorrow, and Beyond

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.

The Companion Guide to... SMT Inspection: Today, Tomorrow, and Beyond

Advances in artificial intelligence have been limited exclusively to the human world until now, but there are far-reaching applications within the manufacturing sector, too. In this guide book, learn how equipment providers like Koh Young are enabling the Smart Factory of the Future by adopting AI to generate "knowledge" from "experience."



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.

PODCAST! On the Line with...

...is available now on Spotify. In this podcast, we speak with industry experts to get the latest insights and perspectives on the most relevant topics in the electronics industry today. The first series of On the Line with... features conversations on sustainability.

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