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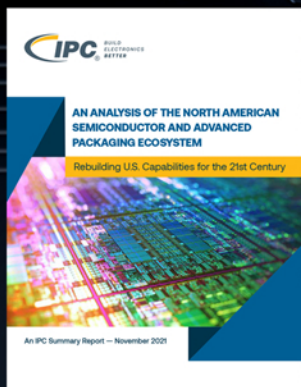
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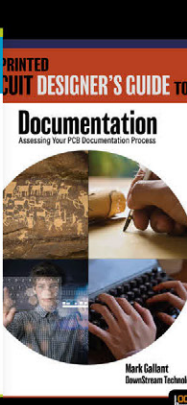
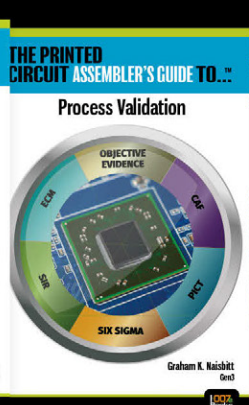
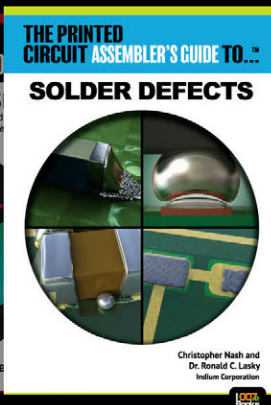
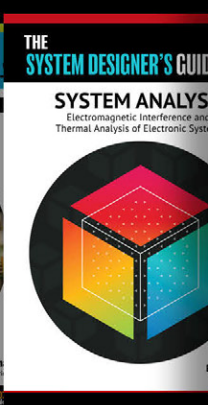
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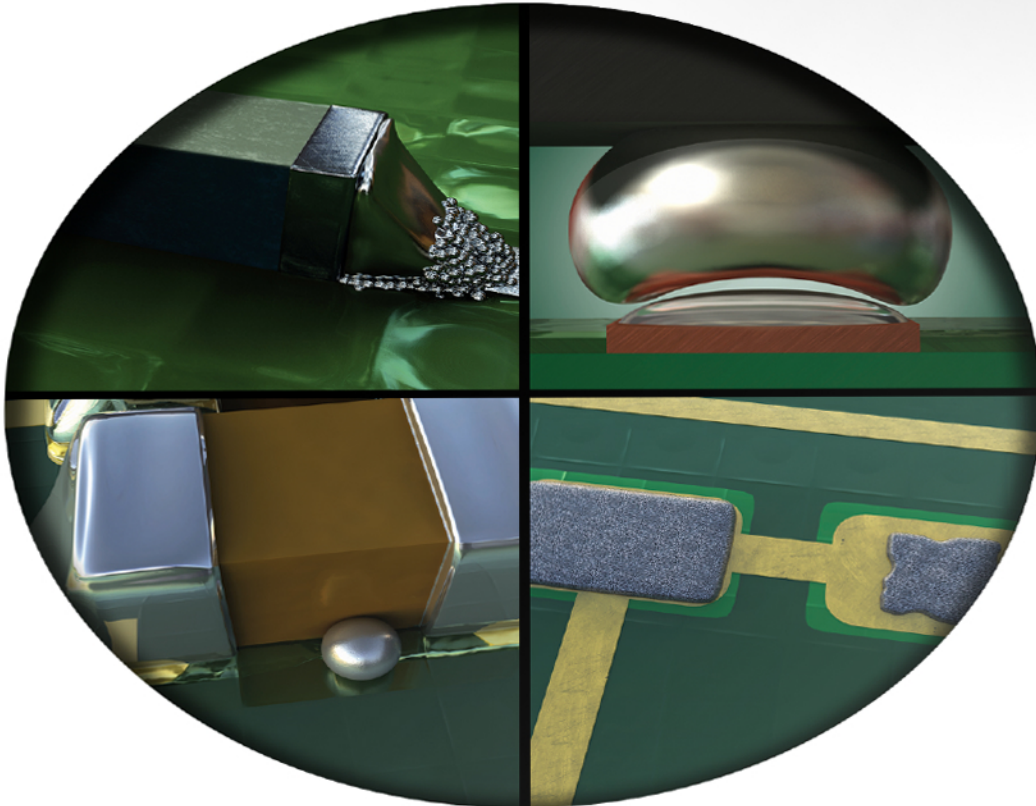


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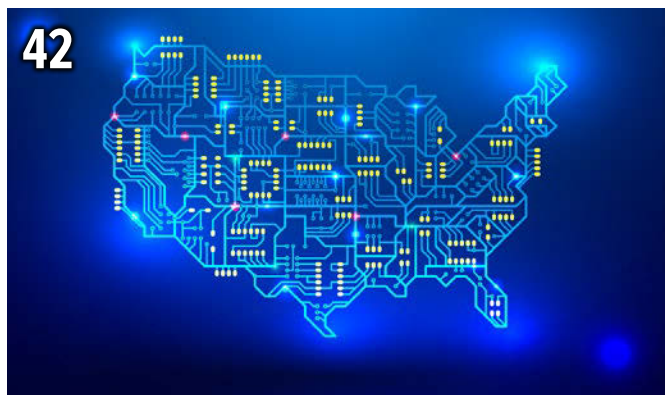
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State of the Industry

Two high-profile pieces of legislation in the United States and Europe seek to encourage semiconductor capacity but leave out the equally important reliance on printed board fabrication and assembly. In this issue, we look at the state of the industry: What is being done about the supply chain? Will governments recognize what's missing? And can the U.S. ever gain back what it once had?



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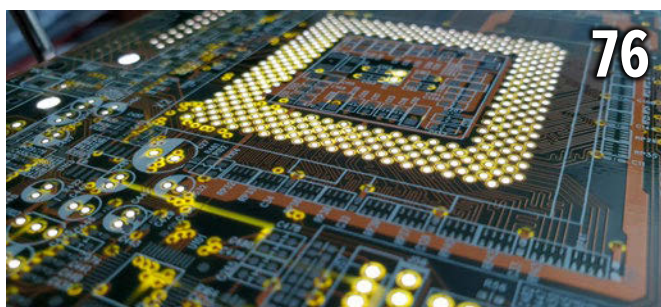
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The Legislative Chokepoint

Nolan's Notes

by Nolan Johnson, I-CONNECT007

“Not every country plays by the same rules,” Happy Holden stated during a magazine planning meeting for this issue. We were discussing the recent news regarding the CHIPS for America Act that moved through the U.S. Congress last year. He continued, “The laws for banking and financing aren’t the same everywhere, you know.”

He’s right, of course. Individual countries finance and subsidize industry development to their own laws and restrictions. There’s nothing new in this situation, really. It’s always been this way; countries have often taken whatever measures were necessary to develop an industry they saw as lucrative, crucial to their economic development, or strategically important to their defense.

This observation from Happy, however, was particularly timely, since we were discussing the U.S. legislation to bolster “the

electronics industry,” but which only seems to focus on semiconductor manufacturing. Anyone reading this magazine already knows that simply making more semiconductor components is not a solution to the problem, that the chips are not useful until integrated into the entire system, and that it takes chip packaging, printed circuit board fabrication, and assembly services to create the completed electronics assemblies. However, the policy makers on Capitol Hill generally seem to be unaware of this connection. The result? Investment in only a portion of the supply chain.

Study the rationale for the strategic investment, and you’ll see that the U.S. now wishes to fix gaps in the domestic supply chain. One literally cannot manufacture a semiconductor component for production entirely within the North American borders—effectively all production semiconductors must be shipped



across an ocean to be placed into packaging. Should diplomatic relations turn sour with any of the countries who have chip packaging capability, and U.S. tech is stuck, unable to make product.

The state of printed circuit manufacturing is not quite as dire as chip packaging, but the situation is quite serious. In a recent IPC analysis, Joe O'Neil points out that North America's total PCB manufacturing capacity is not enough to manufacture the number of iPhones imported to the continent. Think about that: Apple's circuit board appetite alone could bury the U.S. manufacturing infrastructure.

Depending upon what the U.S. government wishes to accomplish with strategic investment, a massive buildout of PCB fabrication capacity may not be the intended goal. If the goal were, for example, to ensure that the U.S. could manufacture all defense-related electronics within U.S. borders, then iPhone volumes are probably not necessary. Still, the last two or three years have taught us all that the supply chain can become too optimized, too single-sourced. Added capacity of all types will benefit the ability of the U.S. to maintain a resilient supply chain.

There's also a skills gap when a country's scientists and engineers can design something but cannot build it themselves because they don't have that expertise.

I-Connect007 has covered this topic in the past, and it has been an ongoing topic of outreach to the U.S. government as well. But

here's a point to ponder: It's not just a North American issue, as other regions face many of the same chokepoints in their manufacturing chain as well.

To that end, our March issue expands beyond just the U.S. strategic investment legislation by including some perspective on the European Union's approach to similar legislation. We also bring you an M&A perspective from Tom Kastner, and an article on how to minimize quoting time from Mark Laing. ICAPE's Stanley Bentley posts a piece answering the question, "Where Have All the Board Shops Gone?"

Columnists this month include Michael Ford, Bob Wettermann, and Dr. Ron Lasky, as well as a new column from Hannah Nelson and Paige Fiet.

We've taken care to sprinkle some theme-appropriate video interviews from IPC APEX EXPO in this issue; to see all the interviews, be sure to pop over to www.realtimewith.com. In addition, the 2022 edition of the *Real Time with... IPC APEX EXPO Show & Tell Magazine* is now available for download. This special edition provides comprehensive coverage of the industry's biggest show, and is not to be missed. **SMT007**



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

A banner for JobConnect007. The text "jobCONNECT007" is in large, bold letters, with "job" in blue, "CONNECT" in white, and "007" in yellow. Below it, the text "Companies seeking talent with circuit board industry experience post their jobs with us." is in white. On the right, a magnifying glass graphic is shown, with the website "jobconnect007.com" inside the lens.

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Special Section: IPC Semiconductor Packaging Gap Analysis Report

In November 2021, IPC released a study detailing the current state of advanced semiconductor packaging in North America. In announcing the report, IPC stated that the study “is a thorough, data-driven analysis of the global semiconductor and advanced packaging ecosystem.”

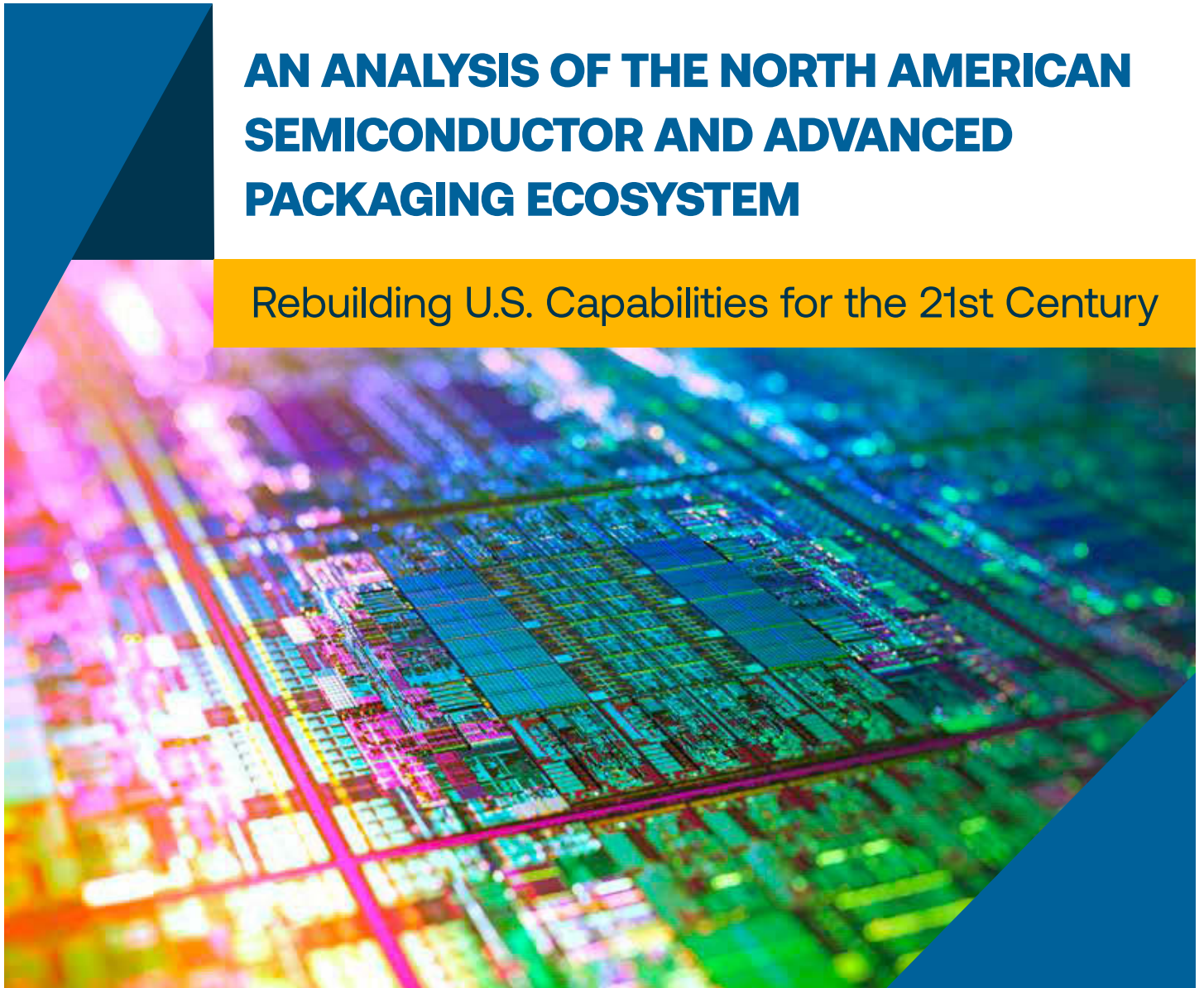
In its entirety, this 100+ page report, IPC explained that it “makes the case for congressional appropriations of more than \$50 billion to support U.S. semiconductor manufacturing, while also underscoring the need to expand advanced packaging capabilities to support the increased production of chips.”

In this special section, we’ve received permission to reprint IPC’s report summary in its entirety.



AN ANALYSIS OF THE NORTH AMERICAN SEMICONDUCTOR AND ADVANCED PACKAGING ECOSYSTEM

Rebuilding U.S. Capabilities for the 21st Century



An IPC Summary Report — November 2021

Study Overview

IPC has undertaken a thorough, data-driven analysis of the global semiconductor and advanced packaging ecosystem and makes recommendations to address capability and capacity gaps within North America. This study is intended to help inform government policy and investment strategy to strengthen the North American advanced packaging ecosystem. This Summary Report is a synopsis of the key findings and recommendations of the [Full Report](#), which runs 115 pages.

Key Findings

- After more than two decades of outsourcing, North America now finds itself in a worrisome predicament: it can design the most cutting-edge electronics but cannot manufacture them.
- The offshoring of manufacturing spans the entire electronics ecosystem, including the advanced packaging of semiconductor chips for which the North American share of global production is just 3 percent.
- To achieve greater innovation, resiliency, and security within the semiconductor supply chain, federal investments in semiconductors must be paired with robust, multibillion dollar federal investments in advanced packaging.
- Most urgently, the United States needs to invest in development and production of advanced integrated circuit (IC) substrates for which there are only nascent capabilities domestically.
- The United States has more than 25 outsourced semiconductor assembly and test (OSAT) companies, many with impressive capabilities. However, U.S. OSATs lack capacity to meet increased demand.
- Failing to strengthen U.S. advanced packaging capabilities while boosting production of chips will lengthen the existing semiconductor supply chain, as manufacturers will be forced to send their chips abroad for packaging and assembly.
- The U.S. must move toward a “silicon to systems” approach that strengthens the entire U.S. electronics manufacturing ecosystem (including printed circuit board manufacturing and hardware assembly) as a necessary means to a secure, resilient supply chain and ongoing U.S. leadership in technological innovation.

SEMICONDUCTOR ADVANCEMENTS

In the mid-1960s, future Intel founder Gordon Moore discerned that the number of transistors that could fit onto an integrated circuit could be doubled every two years, allowing the production of ever more powerful semiconductor chips with greater cost efficiencies. As an empirical claim, Moore's Law held true for more than half a century. But the days of keeping pace with Moore's law are over. Silicon advancements have slowed, along with economic efficiencies. Instead, semiconductor designers are increasingly taking advantage of advancement of electronic interconnection within the packaging to achieve greater functionality and economic efficiencies they previously realized through silicon scaling.

WHAT IS ADVANCED PACKAGING?

Semiconductor chips are fragile and must be protected from thermal and mechanical stresses during operation. To provide this protection, chips are "packaged" using several different materials, mainly plastics. Once packaged, chips become active logic devices that perform computing and/or memory functions. Chips are just one of many different types of essential components within an electronic system.

Protecting chips remains critically important, but advancements in packaging are now being driven by the need to leverage "on package integration" as an alternative technological path to the promise of Moore's Law. On-package integration is commonly referred to as heterogeneous integration which involves integrating multiple chiplets (logic or memory) in a single package. A chiplet is a functional circuit block fabricated on a wafer, typically in a smaller size than what would be possible in a system on chip. The chiplet can be applied to a substrate in a 2D configuration or stacked one on top of the other in a 3D configuration within a package to produce greater functionality and greater processing speed.

ELECTRONICS ADVANCED PACKAGING: THINK OF A DENSE, MULTI-USE BUILDING



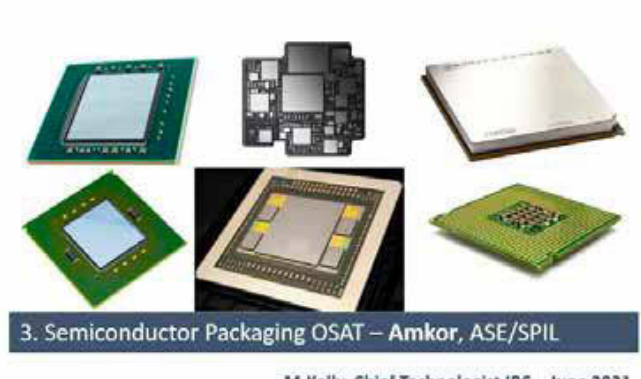
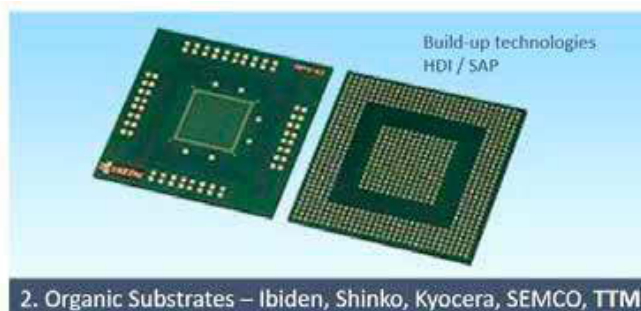
One way to understand advanced packaging is by comparison to urban design. Simple business districts are characterized by modest structures with one purpose and simple connections internally (electrical, plumbing, telecom) and externally (streets, public utilities). In denser urban settings, designers need to make more efficient use of limited real estate, leading to taller building with more complex internal feature (elevators, energy and security systems) as well as external connections to support an increased number of occupants and business activities (e.g., higher-capacity utilities, streets and highways, parking systems).

Likewise, simple electronics components may have relatively few internal parts and may be connected to one another via basic infrastructure such as printed circuit boards and wiring. More complex electronic systems require designers to pack more functionality into the semiconductor packages via more parts, layers, and interconnections. Connecting more chips within a multilayer package comes with new technological hurdles. Interconnects within a package can be as small as nine microns – on fifteenth the width of a human hair.

SEMICONDUCTOR MANUFACTURING ECOSYSTEM

Semiconductor manufacturing has three principal segments: semiconductor fabrication, IC-substrate fabrication, and OSAT assembly.

- **Silicon Fabrication:** Chip manufacturers produce thin pieces of silicon upon which thousands, millions or even billions of transistors are etched. These silicon chips are responsible for the computing power and/or memory commonly associated with integrated circuits and, by extension, all technologies that rely on electronics.
- **Integrated Circuit Substrates:** IC substrate manufacturers produce base layers used in the packaging of integrated circuit chips. The substrate connects chips with each other and with the printed circuit board (PCB), in addition to protecting, reinforcing, and supporting the IC chip.
- **Outsourced semiconductor assembly and test (OSAT):** OSAT companies offer IC-packaging and test services for chip manufacturers. Their role comes into play at the end stage of the semiconductor manufacturing process following wafer and IC-substrate fabrication. These companies offer packaging and/or assembly solutions that turn bare semiconductors into finished semiconductor packages. These solutions help to protect the tiny circuit on each chip as well as facilitate electrical connections and heat dissipation. After packaging, final testing is conducted to ensure that finished semiconductor packages meet quality, reliability, and performance requirements.



M.Kelly, Chief Technologist IPC – June 2021

SEMICONDUCTOR SUPPLY BASE

The semiconductor ecosystem is built upon a robust mix of local, regional, and global suppliers. Next-generation package designs and architectures are made possible by continuous improvements in base materials, manufacturing equipment, and process advancements that span all sectors of the supply chain. Addressing all these areas is necessary if the goal is to achieve a sustainable and resilient North American semiconductor ecosystem. IPC's advanced packaging [full report](#) discusses the need for strong materials, design, and equipment supply chain that underpins the supply base.

GLOBAL SEMICONDUCTOR INDUSTRIAL ASSESSMENT

Companies headquartered in Asia are global leaders across the entire semiconductor supply chain, with the top companies dominating market share in semiconductor fabrication (TSMC, Samsung); advanced IC-substrate fabrication (Unimicron, Ibiden, SEMCO, Nan Ya, Shinko); and OSAT assembly and test, (in which Taiwan is the leader with nine companies including ASE+SPIL and Powertech Technology). North America lags behind Asia in capacity, but technical capability is a source of concern as well. Asian manufacturers also dominate the printed circuit board (PCB) and electronic manufacturing services (EMS/ODM) sectors, where outsourcing and off-shoring have been prevalent over the past 20 years. Asia's dominance in electronics arises from the region's breadth of manufacturing capabilities from chips through advanced packaging through PCB fabrication and final hardware / system assembly capability.



North American electronics manufacturing capabilities.

Source: U.S. Department of Defense

NORTH AMERICAN ADVANCED PACKAGING ASSESSMENT

After more than two decades of outsourcing, North America now finds itself in a worrisome predicament: it can design the most cutting-edge electronics but cannot manufacture them. This trend spans across the entire electronics ecosystem, but it has been driven in recent years by the semiconductor industry's embrace of the "fabless" business model. A fabless company designs technologies for which it holds the intellectual property but outsources the manufacturing to third parties. For all the benefits of the fabless model, it places companies in the difficult, long-term position of being unable to physically produce semiconductor chips. As chip manufacturing has moved increasingly to third-party foundries offshore, so too have the supply chains that support and leverage silicon fabrication. Today, the North American share of advanced packaging of semiconductor chips constitutes just 3% of global production.

Semiconductor Fabrication

Chip plants run 24 hours a day, seven days a week. They do that for one reason: cost. Building an entry-level factory that produces 50,000 silicon wafers per month costs about \$15 billion. Most of this is spent on specialized equipment, a market that exceeded \$60 billion in sales in 2020. Three companies—Intel, Samsung and TSMC—account for most of this output. Their factories are more advanced and cost over \$20 billion each. This year, TSMC is expected to spend as much as \$28 billion on new plants and equipment.

Even more daunting, these facilities can become obsolete in five years or less. Chipmakers must generate significant profit to reinvest in their facilities to stay current with ever advancing technology demands. Only the biggest companies can afford to build multiple plants, which is important for companies engaged in high-volume manufacturing. The more a company manufactures, the better they get at it. Yield—the percentage of chips that are accepted and not discarded—is the key measure, and anything less than 90% is considered a problem. But chipmakers can only exceed that level by learning expensive lessons over and over and building on that knowledge. These brutal economics mean very few companies can afford to keep up and/or break in.

Overall, the level of recent or expected investment in U.S. semiconductor fabrication is strong although a significant percentage of that expected investment is premised on federal support. We strongly support the bipartisan effort to appropriate more than \$50 billion for CHIPS for America Act. Failure to do so will signal a lack of U.S. commitment to U.S. semiconductor manufacturing and innovation.

IC Substrates

The lack of IC substrate manufacturing in North America is the biggest issue identified in this study.

There is almost no capability in the United States to produce the most advanced IC substrates, called Flip Chip Ball Grid Array (FCBGA) or Flip Chip Chip Scale Package (FCCSP). The U.S. also has very limited capability and capacity to produce lower-end wire bonded substrates.

The U.S. needs to invest in IC substrates most urgently. There are significant barriers to entry for FCBGA manufacturing, including an estimated \$1 billion investment per factory and a need to address a 20+ year market leader know-how gap, weak sub-tier supply, skilled workforce shortage (1,000 workers / facility), and lack of raw materials. We are aware of leading IC substrate manufacturers that are surveying opportunities in North America, and that domestic PCB suppliers are attempting to enter the market to produce substrates. While new entrants are expected, leveraging innovative new technologies, caution is advised, depending upon the complexity of substrates to be produced. Advanced IC-substrates require state-of-the-art know-how, equipment, materials, and processes to produce.

Adding domestic semiconductor fabs/foundries without a domestic IC-substrate supply and OSAT assembly will lengthen the supply chain, not shorten it. Chips produced in North America will still need to be shipped to Asia for substrates and assembly just as they are today. If the United States is spending \$25 billion on semiconductors, then it should spend at least \$1 billion on substrates to stand up world-class manufacturing facilities.

OSAT

Amkor is the only U.S.-headquartered OSAT provider in the top 20 globally; it is second overall. While Amkor is headquartered in the United States, it does not have assembly plants in North America. The U.S. also has more than 25 small and medium-sized OSAT companies, many with high capability. The main issue is limited capacity. North American facilities offer small to medium volume production, often for specific markets like the defense sector. Nearly all OSAT providers are currently running at full capacity, raising questions about their ability to meet increased demand for high performance computing and other leading-edge technologies.

At least one of the top 10 OSATs could be persuaded to locate operations in North America with a favorable mix of government and private support. Some EMS companies also are attempting to develop OSAT services in addition to their traditional offerings. Thus, while there are clear opportunities to be seized here, significant capital investment and government support will be needed to expand U.S. OSAT production capacity.

Companies that expand OSAT operations in the U.S. also will need to contend with a tight labor market with an inadequately skilled workforce. Addressing workforce training demands will require more urgent, extensive, and sustained partnerships between federal, state, and local governments, educational institutions and the private sector.

GLOBAL SEMICONDUCTOR ECOSYSTEM MAPPING

As part of this study, IPC created an [online mapping tool](#) for visualizing the location of market-leading companies in the semiconductor and advanced packaging ecosystem. The intent of the mapping tool is to show the regional and global ecosystems that are at work today. Layers can be turned on or off, showing the proximity between semiconductor fabs, IC-substrate suppliers, OSATs, and other layers of the supply chain.



Source: [IPC, An Analysis of the North American Semiconductor and Advanced Packaging Ecosystem](#) (report), November 2021

KEY RECOMMENDATIONS

In the [Full Report](#), IPC offers a complete list of 28 recommendations to rebuild the U.S. advanced packaging ecosystem and reinforce the effort to expand domestic semiconductor manufacturing. The following recommendations are the most pressing for policymakers and the public to understand.

- 1. Domestic IC Substrate Capabilities Is Challenge #1:** The expansion of advanced silicon production in North America by 2024 will require complementary expansion in regional substrate and assembly production, or else the effort to reduce supply chain risks will be for naught. The core challenge is the lack of infrastructure to support substrate manufacturing, long two-year equipment lead times, and the lack of skilled labor at competitive cost. The U.S. Government needs to help establish a domestic commercial IC-substrate capability and capacity. Failure to do so will lengthen, not shorten, the semiconductor and electronics supply chain. The cost of standing up a high-volume IC substrate manufacturing facility with cutting edge capabilities is likely to cost \$1 billion or more. New technologies, however, potentially offer low-volume, high-mix manufacturers new capabilities at lower price points.
- 2. Support Domestic OSAT Champions:** The U.S. Government should identify EMS/ODM companies and existing North American OSAT companies that could potentially fulfill assembly requirements and increase capacity for North American advanced packaging needs. However, significant investment in infrastructure will be needed including Class 10K (or better) cleanrooms and advanced manufacturing technologies. We encourage the U.S. Government to support this sector through new and existing programs, like the DoD Manufacturing Technology (ManTech) Program.
- 3. Critical Sectors:** The U.S. Government should focus a significant portion of its own investments and those it stimulates on the Aerospace, Defense, and High-Performance Computing markets. The volumes and demands represented by these markets (worth a combined \$90+ billion) will help justify the investments needed to increase North American capability and capacity. These markets are also the most critical to U.S. national and economic security.
- 4. National Electronics Manufacturing Institute:** The U.S. Government should invest in a manufacturing institute for electronic interconnection that serves to support innovation in advanced packaging, as well as printed circuit board fabrication and electronic assembly. The institute should emphasize the importance of “factory of the future” manufacturing.
- 5. Allies and Friends:** The United States can complement the development of domestic supply chains with the development of strong, trusted global partners. It would be unrealistic and impractical to onshore the entire electronics manufacturing supply chain or locate it within a single region. Efforts like those underway in the US-EU Trade and Technology Council are critical to the emergence of secure, resilient, and dynamic supply chains for critical sectors.
- 6. Pursue Next Generation Technologies:** The U.S. Executive Branch must continue to perform its deep-dive analysis of the semiconductor and electronics supply chains. The participating agencies should leverage this report and other sources of data and analysis — and draw upon the expertise of all key stakeholders — to identify specific needs and requirements for near-term and long-term technologies spanning semiconductors, advanced packaging, and assembly. The focus should be on leapfrogging current technologies to achieve next-generation semiconductor advancements including Silicon Integrated Photonics. Playing catch-up is a strategy for perpetual competitive disadvantage.

TOWARD A SILICON TO SYSTEMS APPROACH

Semiconductor chips—as marvelous as they may be—do not float in the air. They are useless on their own. So, too, are the advanced IC-substrates that the chips are bonded to. While they too are important and critical pieces of an electronic system, they are intermediate steps in a much larger process of designing and manufacturing final products and systems such as mobile phones, online games, HPC mainframe computers, and aircraft navigation. It is not until the final package is assembled — when semiconductor chips are bonded to substrates, encapsulated, and tested – when an advanced package becomes functional, valuable, and available to be integrated into electronic systems and products.

Advancements in semiconductor packaging also have direct impacts on PCB technology and fabrication. The more sophisticated IC packages become, the more complex PCB designs must become. Final system-level assembly by EMS/ODM providers is where the final product comes to life; it's where electronics are assembled, powered-on, burned-in, firmware/software loaded, and final system tests are performed. Both PCB and EMS/ODM providers play a critical role in final system delivery and availability.

A healthy, capable assembly ecosystem is needed to bring a wide variety of technologies together to manufacture finished products. Any disruptions or bottlenecks within this end-to-end ecosystem can lead to delays in new products and innovations. Therefore, it takes all elements within the supply chain—from silicon to systems—to successfully produce electronic hardware products and to meet customer and market demands.

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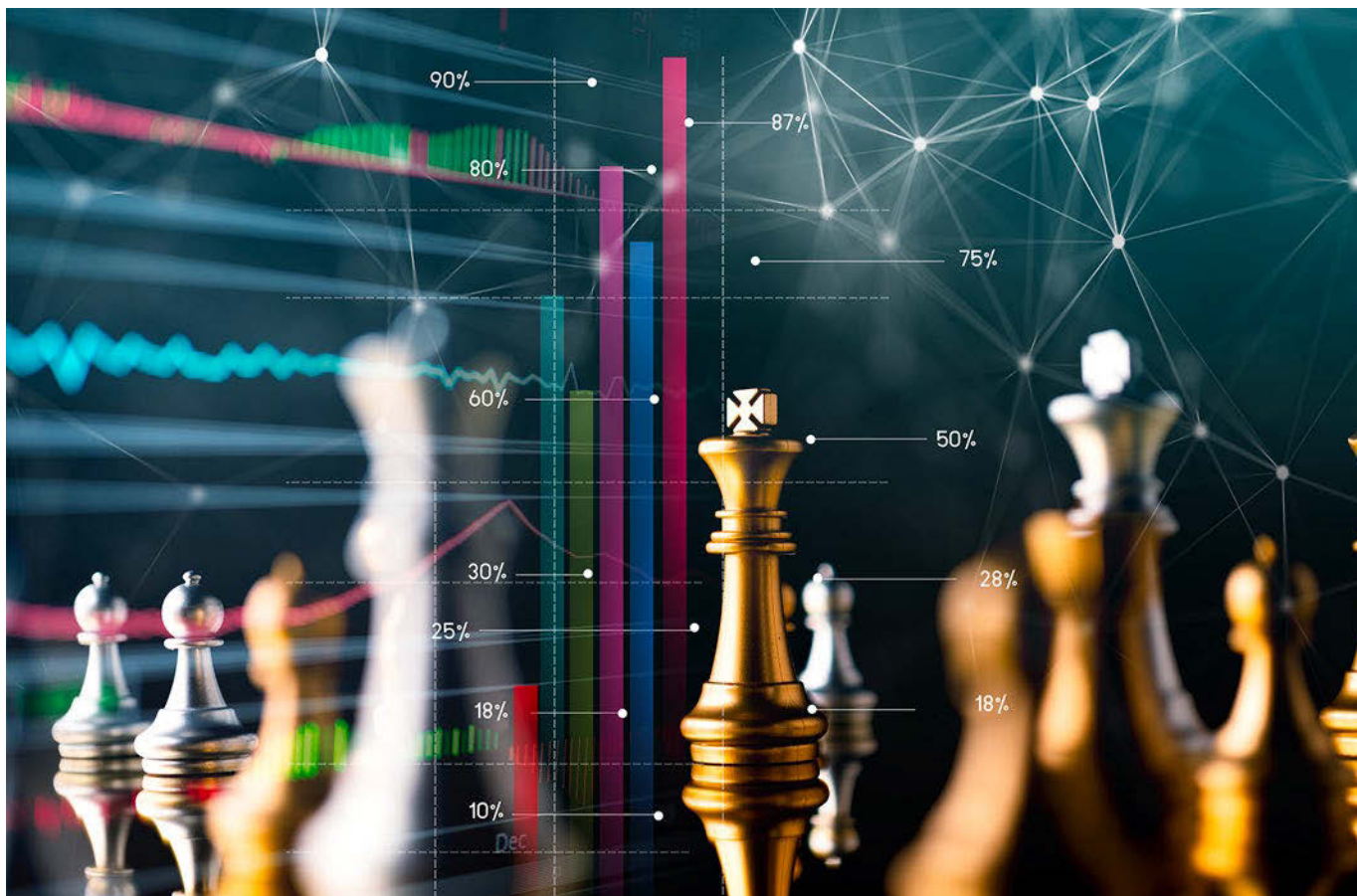
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A Hard Look at Strategic **Chip Investment**

Feature Interview by the I-Connect007
Editorial Team

Jan Vardaman is a key contributing author to an IPC report detailing the capabilities gap in advanced packaging capabilities in the U.S. manufacturing ecosystem. We talked with Jan about the report and the current dynamics in the U.S. market. Jan's comments provide additional detail and insight to the findings published in the report.

Nolan Johnson: Jan, how do we take that huge report on gap analysis with IPC and put it into context?

Jan Vardaman: The bottom line is you can put all the silicon fab capability you want in the U.S., but if your goal is to not be dependent

on going overseas for your semiconductors, and you don't have the packaging and assembly done here, you've defeated that purpose. It all depends on your goal. We have found there are several smaller outfits here that can do assembly quite capably on a small scale. When there's large volume, however, it typically goes to Asia where there's large volume capability and where the investment has been made.

The report indicates there are not any substrate manufacturers that use the ABF material—a buildup film to create substrates here in the U.S. that would serve the high-performance computing market. If you want the buildup substrate to do the assembly, you must go overseas.

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There are some people who have assembly capability here for some of their planned activities. For example, Intel says that it is putting its Foveros—basically a 3D chiplet stack with microbumps that goes into a package—assembly in the U.S. The substrates would still be made overseas. Even if they put that assembly facility in New Mexico, your substrate would still not be made here.

Now, it's a global supply chain and you can make use of the global supply chain if you want to. But if your goal is to have everything done in the U.S., then the plan does not currently achieve the goal.

Johnson: That really does set up the issue, doesn't it? You can make all the chips you want, but if you can't get them packaged, then what?

Vardaman: Then what's the point? What's the point of spending \$52 billion on silicon foundry capability if you're just going to send it back over to Asia for packaging and assembly?

What's the point of spending \$52 billion on silicon foundry capability if you're just going to send it back over to Asia for packaging and assembly?

You can capture this in a quick couple of sentences: First, "We're going to use our global supply chain." That's fine. But you need to recognize that you are not bringing everything back to the U.S. It's much more expensive to do things here. For example, manufacturing is done here for medical and defense purposes, but the costs are much higher. Assembly and other manufacturing in the U.S. are also more expensive, which is

why companies moved overseas in the first place.

In the beginning, we manufactured in the United States. Apple had a huge board assembly plant in Fremont, California, that received visitors from all over the world. I'm here in Austin, Texas, and we have board level assembly for a lot of the Cisco routers. When people talk about electronics manufacturing you need to understand every aspect of the supply chain.

Many people read the report and concluded, "I guess we're going to put in substrate capabilities." Not quite, that's very expensive. If you're targeting this high-performance market, the feature sizes will require you to produce substrate in a cleanroom. Intel says that putting in a state-of-the-art substrate facility using the build-up film would require about a billion dollars in investment. The equipment suppliers are not in the U.S., typically. The equipment lead-times are two years. Even if you start today, you wouldn't have that high performance buildup film capability until 2024.

It's fine to say, "We're just going to use the global supply chain." But everybody needs to be on the same page and understand what we're doing here.

Johnson: On Capitol Hill, one of the motivations for the legislation is the fact that we don't have all the manufacturing capability on hand to support our own military, as well as create a more diverse supply chain. How does this play together?

Vardaman: The problem with defense is it's a small volume market. It's very hard to justify spending the amount of money it would take to put in the capability to serve that market at such a small volume. It doesn't make business sense. Some companies have put in their own bumping. The substrate, though, is a real problem because there's a substrate shortage.

Why is that? These more complex devices like the server CPUs and network switches

need increasingly larger substrates that have more buildup layers. As those substrates get larger, they consume more substrate per assembly. Companies were afraid to invest too much and create overcapacity.

Right now, we're constrained by the availability of substrates in our markets. If you don't already have a relationship with a substrate supplier, you're not likely to get your substrates or be able to ship product.

If you invest in substrate manufacturing here in the U.S., you want to make sure that you build a facility that two years from now will be state of the art. If it takes two years to put it in and you put in something for yesterday's market, what's the point of that? That's the billion-dollar question, if you will.

Johnson: Is there anybody working on that right now?

Vardaman: There are some people looking at it. But is there enough volume here to justify a billion-dollar investment? Bless their hearts, I don't think the people on the Hill understand the complexity of this.

Johnson: Are you involved in the conversations with the Hill?

Vardaman: IPC has a great program to discuss those things. I believe that some of the information that we've put together has been presented to people in government. We're trying to explain the complexity of the situation, but to my knowledge, nobody has held hearings on this. Maybe they need to hear from some experts and have this situation explained to the policymakers. I mean, this is not the first time we've talked about investing in the electronics industry in the U.S. We go in waves. It doesn't matter which political party you're talking about. People pay attention, and then 20 years later, they don't pay attention anymore.

I've worked in and with many organizations set up for improving the competitiveness with



Jan Vardaman

the U.S. electronics industry, including Microelectronics and Computer Technology Corporation, and Sematech. But we get going on it, and then we suffer from what I call "benign neglect." I've written articles about this. This is not a situation where you can throw some money at this problem for a year and then ignore it. This is a commitment to improving the competitiveness of the industry. But it's also important to recognize that we have a global industry, a global supply chain. We need to figure out how to work better together for the benefit of everyone.

Johnson: There are other governments across the globe that are presumably investing in this technology and the capability to manufacture key materials for electronics manufacture. Are we, in the free market U.S., holding ourselves back?

Vardaman: Do you want to create an environment where your electronics industry thrives? If so, then some think you ought to have subsidies. I'm not in favor of subsidies. I'm in favor of having skin in the game: tax credits, R&D tax credits, manufacturing tax credits, things like that. You want to encourage the manufacturer,

but you want it to be sustainable. Subsidies don't lend themselves to continuation over the long haul. It's not in the taxpayer's best interest. We don't seem to have long-term views on things in this country anymore. We've lost the ability to think long term.

Johnson: Do you see long-term thinking as something that the U.S. business culture needs to get back in touch with?

Vardaman: Wall Street likes quarters. Everybody is looking for that quarterly return and you're rewarded on that. I can't tell you how many CEOs had a long-term vision which got penalized by Wall Street. The only way you can have a long-term vision is if you're private and don't have anybody to tell you what to do.

Johnson: Meanwhile, there are companies that want to be competitive, grow their capabilities, and move forward. Where do they look for strategic direction?

You must understand the complexities of this industry, what market you want to serve, and your strategy to serve that market.

Vardaman: They will have to do their own research. It takes good information to make good decisions. You must understand the complexities of this industry, what market you want to serve, and your strategy to serve that market. What is your expected rate of return on your investment?

Barry Matties: What's the motivation for individuals—or for a country—to do this? First, it

must be recognized as a critical component or critical to the well-being of the nation, whatever nation it happens to be.

Vardaman: I think the public got the message when they couldn't buy a car because there weren't enough semiconductors. But then everyone concludes, "Oh, it's a semiconductor, so put money in semiconductors," without understanding the whole supply chain. It's a level of education that's required.

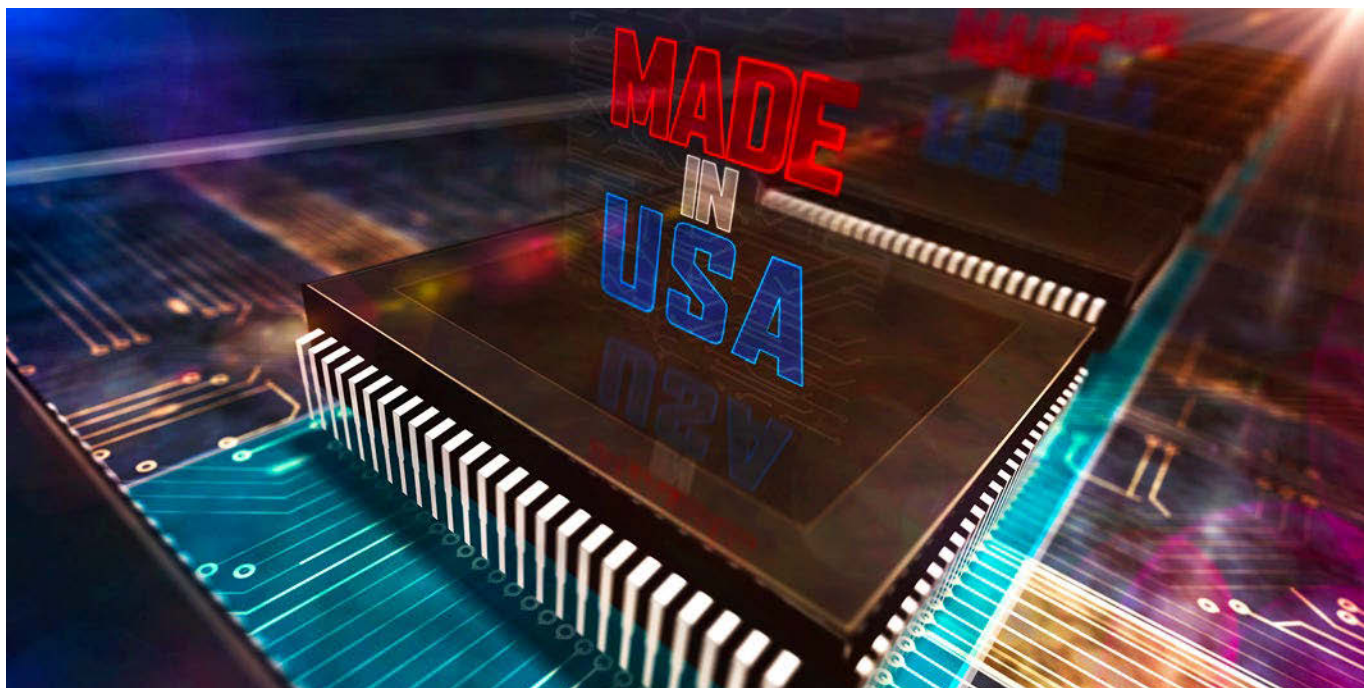
Matties: It's hard to know, but maybe they are being educated on supply chain as they walk through their grocery stores and see shelves empty, they try to buy other items, and there are massive delays.

Vardaman: You know why there are shipping delays? Nobody on the West Coast invested in modernizing the logistics control in the ports. Look at the upgrades that were made in the port of Rotterdam or the upgrades made in some of the East Coast ports vs. the West Coast ports. Logistics and communication are key to how you get that done. Why shouldn't you have a system that allows things to move more smoothly?

Matties: You're talking about a shift in culture and thinking so grand and so large, covering so many sectors. Do you expect it to happen?

Vardaman: Not unless this country comes together and figures out that there's a problem greater than us. If we stick together, we're a lot more likely to solve these problems than if we start picking at each other. Electronics manufacturing and technology, and the emphasis on education, are very important issues.

Matties: If you're in manufacturing today, specifically electronics, everybody understands the complexity of the supply chain. Now, OEMs may have a different view. Nevertheless, when we're trying to get base material or other components, we've all been dealing with supply issues.



But what you're talking about, though, is more than the awareness of the immediate; it's the awareness of a long-term remedy. First, you need a moment to catch your breath to even look at the long term, as you're scrambling to deal with the short-term crisis. That's the catch-22. Then, there's the mentality of quarterly reports that gets in the way of what you're suggesting.

Johnson: For our readers who are in the industry, looking at the complexity of the supply chain and knowing that something needs to be done in the U.S., how do they get involved?

Vardaman: First, you need to understand the complexity and have a conversation about whether it can be done. Is there a large enough market in the U.S. to support, for example, substrate manufacturing? What should that substrate manufacturing be? Making those roadmaps clearer would probably be a first step.

The other thing is you've got to have a customer base that's willing to commit to bringing up volumes; that's part of the issue. It's a combination of things. There are business issues and technology issues. They all must be aligned, so it's a complex situation.

The complexity is that you've got to have a market, investment, and the right material set. You've got to have a customer base, and good management. They must all be combined at the same time.

Matties: Where do you see the greatest opportunity for a company that might be thinking differently?

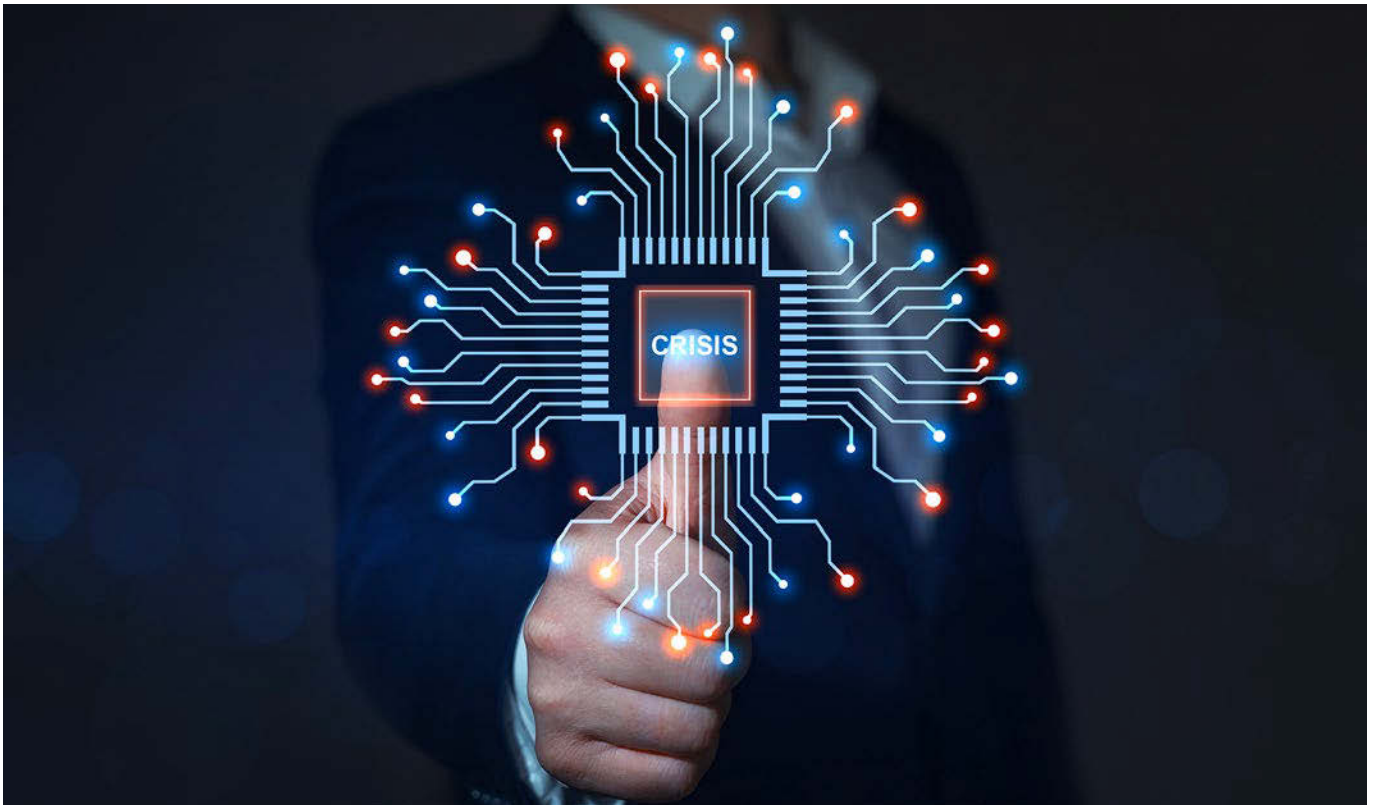
Vardaman: I see it within the infrastructure of the assembly. They need to get a commitment from the people who would have the chips fabricated at these places.

Johnson: Based on that comment, the greatest need for investment in this part of the supply chain is to put the cut die into the final packaging.

Vardaman: That's what that report takes a first step at doing. I think it's a good step.

Johnson: Thanks, Jan.

Vardaman: Take care. SMT007



More Than a Supply Chain Problem

Feature Article by Nolan Johnson

I-CONNECT007

By now, the topic is practically a trope: Supply chain problems abound, and they aren't going away any time soon. Transportation and logistics are a key part of the challenge, meaning that the shorter we can make the shipping distance, the more resilient the chain will be overall.

But that's only part of the problem. It is currently not possible to simply shorten the chain; there are key elements of the electronics manufacturing process that are only available in a very few places on the planet.

Semiconductor chips, for example, need to make at least one roundtrip to Asia to be put into a package. Depending upon their specific supply chain, they may then get sold to an international firm and shipped somewhere across an ocean again. As the finished board assembly

goes to its customer, that chip just might make a long-haul international flight a final time.

PCBs produced in volume will make at least one transoceanic trip as well, either as bare boards, assembled components, or as a finished product.

The unadorned truth is that if you start with the first manufacture of the components on a circuit board assembly, it becomes clear that a finished, populated printed circuit board simply cannot be developed by a North American company without a significant amount of international shipment sprinkled throughout the supply chain.

IPC Reports Outline the Issues

Two high-profile pieces of legislation in Europe and the United States, both using the

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“CHIPS” moniker, seek to encourage semiconductor capacity within their respective regions. But at the moment, making more chips still means they get shipped overseas for packaging. Organizations such as IPC, USPAE, and PCBAA are working in their own areas of specialty to educate government representatives on this vulnerability in the entire supply chain.

Recently, IPC’s Thought Leadership Council issued two separate but coordinated reports to help illustrate these points:

- “North American Advanced Packaging Ecosystem Gap Assessment: Critical Systems, Capability, Capacity Analysis and Recommendations,” authored by Jan Vardaman and Matt Kelly
- “Printed Circuit Boards Matter: Rebuilding the U.S. Electronics Supply Chain,” prepared by Joe O’Neil



Joe O’Neil

IPC Thought Leadership Council’s Mike Carano also published a report aimed at the manufacturing companies themselves, titled “Jumping the Technology Curve: Collaboration With Your Competition.” These documents strive to deliver a holistic view of our manufacturing process, and provide guidance on how to strengthen the chain, not just a single link.

O’Neil states what has become obvious to most of us in the industry. “The United States has lost its historic dominance in a foundational area of electronics technology, namely, the printed circuit board (PCB) fabrication industry,” he writes. “In the halls of government, most of the attention is on semiconductors, due to the shortages triggered by the COVID-19 pandemic, combined with strong demand for all kinds of goods and services that contain chips.” Vardaman and Kelly also recognize the issue, writing, “Given recent increased focus and investment by the United States Government and firms to improve North American semiconductor foundry capability, IPC is establishing a Government Relations advocacy position that encourages greater policy focus and investment on growing the wider advanced packaging ecosystem, not just semiconductor fabrication.”

The goal, they say, is “to improve North American advanced packaging capability and capacity, with the United States, Canada, and Mexico as potential options. Overall, the goal was to create a healthy climate to foster North American advancement across the larger electronics manufacturing ecosystem including semiconductors, advanced packaging, PCB fabrication, and hardware systems assembly.”

O’Neil notes that the pandemic revealed the extent to which the world is dependent on Chinese-made electronics, “as evidenced by the difficulty of ramping up U.S. manufacturing of ventilators when Chinese sources dried up.”

He continues, explaining that what was once considered low technology, the PCB has evolved into a high-technology, application-



specific product, and that the term “printed circuit board” is actually a misnomer, “because making one is not as simple as printing a piece of paper. PCB manufacturing requires multiple types of costly capital equipment, plus well-trained workers, and anywhere from 50 to 100-plus steps in the manufacturing process. Many high-speed, miniaturized PCBs are manufactured in cleanrooms under tightly controlled conditions.”

Contrary to common perception, O’Neil says, PCBs are not off-the-shelf components. “The PCB has a one-to-one relationship between design and use; the semiconductor has a one-to-many relationship in which one chip can be utilized in thousands of product designs. Without the custom PCB, there is no product, no system, no application. This means that any interruptions in global trade could present a real risk that the United States could lose the ability to produce many kinds of electronics.”

While much of this regional specialization has been driven by pressure from OEMs to discount prices, that wasn’t the only cause. The “Just in Time” delivery processes are thought

to play a major part in this situation as well. While these JIT disciplines succeeded in driving down the prices on finished electronic goods, and optimized many manufacturing processes by reducing or eliminating the pooling of excess incoming inventory, in some cases, key supporting functions in the chain were simply optimized down to one or two global providers.

In the U.S., for example, many semiconductor companies avoided the staggering costs of building their own semiconductor fab by going “fabless,” contracting out their work to large overseas semiconductor fabs hungry for a steady flow of work to keep the factory operating. On paper, this plan made financial sense, in that an innovative semiconductor technology startup could be brought to market with a much smaller amount of venture capital investment. But its dark side was that it siphoned off manufacturing capacity.

O’Neil’s report shares this data as a measure to this dynamic in action. “From a global competitive perspective, the United States and China have a comparable share of global semiconductor production, at 12% and 11%, respec-

tively,” he says. “A majority of the semiconductor market is supplied by three U.S.-friendly trade partners: Japan, South Korea, and Taiwan.

While it may be in the best interests of the U.S. to bolster capacity in semiconductors, O’Neil says it has an adverse effect. “Meanwhile, the U.S. share of the PCB market has dropped from more than 30% to just 4% since 2000. China now dominates that market, supplying close to 50% of the global total. A loss of access to Chinese PCB production would cripple U.S. manufacturing, as computers, telecommunications networks, medical equipment, aerospace, cars and trucks, and other industries are already dependent on Chinese electronics suppliers.

This, on top of the packaging gap, paints a stark picture. Elsewhere in the report, O’Neil says that the entire capacity of U.S PCB manufacturing wouldn’t be enough to satisfy the U.S. demand for Apple iPhones, let alone all the rest of our electronics. The semiconductors are not the real problem.

Is It Too Late to Stage a Comeback?

So, recognizing this problem, industry leaders question whether the PCB manufacturing sector can regain its position in the market that it once had. Ultimately, rebuilding capacity and capability will require strategic investment programs. Carano’s report speaks to that need directly.

Interestingly, most executives today are looking for significant government funds to maintain and enhance their companies’ competitiveness on the global stage,” Carano says. “While this may be viable for some of the largest companies, the smaller enabling firms that are critical to the supply chain are often left



Michael Carano

out of the discussion. Certainly, the behemoth firms in the semiconductor and medical industries feel they can go it alone if only there were enough cash and tax breaks forthcoming. The arguments put forth are in the vein of national security, job creation, and technological leadership, and they have their merits.”

He wonders whether taxpayer funds could be deployed in other ways to spur innovation and employment growth. Perhaps additional investments in workforce training and

skills development will help close the gap and provide the necessary impetus for technology firms to innovate and compete successfully with the low-cost locales, Carano says. And with all this said, how can smaller firms leverage their respective techniques and know-how through collaboration?

These concerns have not gone unnoticed by U.S. fabricators. In a February *PCB007 Magazine* interview with Barry Matties, Calumet’s Todd Brassard and Meredith LaBeau address their lobbying efforts through the newly-formed PCBAA.

Brassard said, “The U.S. government will very likely be required to bootstrap U.S. PCB and substrate manufacturers at a cost somewhere between \$1-3 billion in funding to help close the gap with Asia. The real question is, when will the U.S. government and Department of Defense figure this out and start looking at the entire electronics ecosystem and not just the chips? Matties stated that the PCBAA is driving some of this awareness in Washington and asked whether Calumet is part of that impetus.

“Yes, we are a founding member of the PCBAA which is a new association laser-focused on rebuilding the PCB industry in

America, our industry,” Brassard responded. “The member companies of the PCBAA, which include a rapidly growing list of PCB manufacturers and PCB supply chain companies, are committed to raising awareness and driving a resurgence of PCB manufacturing in the United States.”

LaBeau shared that the U.S. Partnership for Assured Electronics (USPAE) is also gaining traction and playing an important role in providing the DoD with an interface to industry experts and channeling program funding. “USPAE leadership provides expert guidance, advice, and opportunities to meet other organizations and people from the industry and government who are working to solve the same problems,” she said. “The DoD’s Executive Agent for PCB and electronic interconnect technology is also providing leadership at a critical time for the industry. After two challenging decades for the PCB industry, the uptick of activities of these and other organizations is a good sign.”

O’Neil’s report offers a different perspective, based on his expertise in accounting practices as well as printed circuit manufacturing. “The U.S. PCB fabrication industry has long been a shining example of American ingenuity and applied R&D, from the 1950s through today,” he wrote in his report. “However, a major shortfall throughout that period is that the PCB industry does not define itself as an R&D enterprise. As we will show here, PCB fabrication has become dominated by research and development with some select, low-volume production.”

He instructs PCB manufacturers to re-evaluate their business model and their value proposition; specifically, “they need to better allocate costs between customization per order



Todd Brassard

and R&D,” he says. “Rather than attempting to provide commoditized solutions in an unsustainable model in which R&D is treated as operational expenditures, a better model would be to invest in standardization through appropriate R&D spending. Taking full advantage of R&D tax credits could help many companies fund the investments required to achieve consistent yields and sufficient capacities of advanced PCB fabrication.”

O’Neil’s report says the USICA and related proposals to boost U.S. investment in R&D aim to reinforce and revive the United States as the global leader in semiconductors, while improving strategic autonomy. He also says that expanding the scope of these bills and the subsequent public-private R&D programs to include PCB fabrication is an even more pressing challenge.

“This is not a matter of pitting the semiconductor and PCB industries against one another; it is quite the opposite,” O’Neil says. “The U.S. government and all stakeholders need to recognize that each sector is vitally important to the other, and the success of both is critical to reestablishing long-term strength and resiliency.”

Reviewing the three IPC reports, as well as following the work of the USPAE and PCBAA, the need for well-informed strategic direction from Congress becomes apparent. But O’Neil and Carano remind us that we’re an ingenious industry, well adapted to overcoming constraints. It’s a certainty that the U.S.-focused organizations, such as PCBAA and USPAE, would welcome as much of Carano’s suggested collaboration as they can get. **SMT007**



Lean on Me: A U.S.-Europe Partnership

Feature Interview by Nolan Johnson

I-CONNECT007

The United States is not the only region to feel the sting of losing the bulk of its printed circuit board manufacturing to Asia. European countries, such as France, recognize the dire need to modernize their factories, upskill their labor force, and provide for a more secure supply chain. But what are governments doing to help? In this conversation with Nolan Johnson, IPC Europe's Alison James breaks down the tremendous potential for a partnership between the U.S. and Europe and what that means for a stronger global industry.

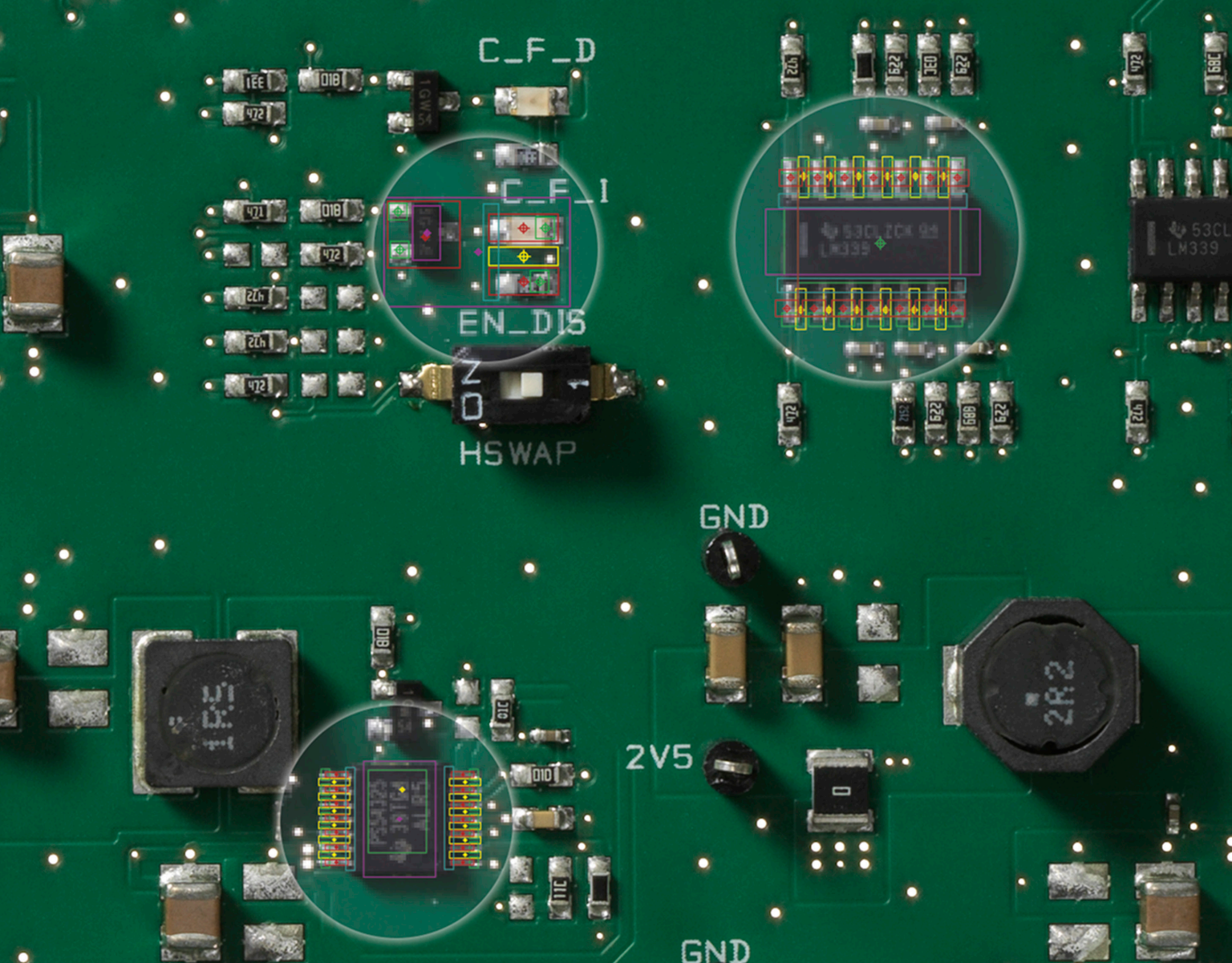
Nolan Johnson: Alison, I'm looking for some insight regarding the European perspective on strategic government investment. How are regions outside the United States handling this same sort of a challenge, compared to the U.S.?

Alison James: I presume you're looking at the CHIPS for America Act for this context?

Johnson: I believe there are three pieces of legislation that have language for semiconductor development. Of course, IPC is very involved in the conversation, trying to communicate that one can't just focus on chips. A similar conversation certainly must be going on elsewhere. I keep hearing about the French legislation, for example.

James: It absolutely is. I'll give you a tiny bit of perspective. The silicon-to-systems approach that we're taking in Europe is the approach that IPC takes everywhere.

Last week, the European Commission proposed a European CHIPS Act that, in theory, is going in a similar direction as the United States. In Europe, everybody's still looking at the details of this proposal because it's a large package. On a really positive note, the EU recognizes in its proposal the importance of advanced packaging.



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Alison James

If you are looking then at a national level you asked specifically about France. The government is very focused on these discussions around strategic autonomy and strategic industries. A couple of years ago, they recognized electronics across the chain with a strategic committee that includes EMS companies and that has engaged printed circuit board companies. As part of their recovery package in 2020, they put money into various areas of technology and, more broadly, into re-industrialization. They aim to bring industries back and modernize them. Some printed circuit board companies have received funds from their recovery package to upgrade production lines amongst other projects. It's detailed on the government websites but talking to individual companies gives a much clearer idea of the projects concerned.

Now, some of these investments are linked to European funding, but France is relatively unique in looking across the chain. It does get complicated as you need to look at what each company is doing. How much are you involved in microelectronics? Are you engaging in European projects? Second, as we were saying, the

European CHIPS Act is not just chips; it's also advanced packaging. There are a few things going on.

Johnson: So far, we've talked about semiconductor fabrication and packaging in Europe. What about board fab and assembly?

James: Well, exactly. What about fabrication and assembly? It's not the primary focus of the European CHIPS Act. But is there a specific action at the European level specifically around printed circuit boards? No. Europe has the same issue as the United States. We are down to about 4.4% share of global production in Europe, and that's down from 20–30% in the '80s. We've continued to go down over the last 20 years. Similar to the United States, it certainly should be prioritized a lot more. It doesn't get the focus that the chips get by any means.

And that's something that the industry would obviously like to see across Europe—a medium- to long-term perspective on reinvigorating the industry in Europe. With assembly, they haven't spelled out something specifically on EMS in any measure. But it's complicated because Europe is doing quite a lot with modernization of factories, what we would call Factory of the Future with measures around AI and data. Of course, EMS companies want to have access to semiconductor chips, but they would also like to have access and make sure there's a secure supply of printed circuit boards. It's a bit disjointed; there isn't, "Here is a measure, which is dedicated to EMS." We don't have that, but Europe does a lot on digitization, Industry 4.0, or Factory of the Future.

Johnson: That's in a general sense, across all industries?

James: Yes. In our silicon-to-systems approach, we would like to see a full-blown electronics strategy to reinvigorate the industry so that you're not just making chips, but making sure you have a secure supply of the boards, that the

printed circuit board industry is brought along, and is able to continue to innovate. Additionally, you are able to do assembly here—not that it's an obligation, but that you have the capacity if you choose to.

Johnson: That's where the supply chain resilience comes from, doesn't it?

James: Yes, that's certainly part of it.

Johnson: Why is the thinking in France so different?

James: I don't know what the origin of that is. It's just different countries, different thinking. France is much more about making sure you have what you need. Europe, generally, is very divided because Europe is very open to trade. It's also not this history of pumping in state subsidies into building up big industries. Rather, it's, "Let's make sure we have fair competition, that everybody can compete, that we don't have lots and lots of state subsidies that are not controlled."

In one way, now there's this growing recognition which is relatively new in Europe, since COVID and in light of geopolitical tensions, you have to make sure you have what you need. I'll specify that in Europe, when they're talking about that, they're also talking about industries and technologies needed for the future that will help achieve what Europe calls its dual transition—the digital and the green transition. That's why Europe also recognizes semiconductors as being very important to increased energy efficiency, and contributing to digitalizing and greening of all industries and to strategic technologies. Even when they are shoring up industries, it's what's strategic and what will help achieve that dual transition. But even that is relatively new in the last couple years, crystallized by the pandemic in many ways. Now you're starting to see, "Where are our strategic dependencies? What is it that we need, and how can we bring what is necessary back into Europe or build it up?"

It's not just government money, though. The approach here is public/private—the industry, government, and external stakeholders working together. It will always be mixed with the messaging around openness to trade. It's not, "We're going to do everything on our own, be isolated and self-sufficient." Rather, it's, "Where do we need to make sure that we have access to what we need for our strategic industries?" That's the approach.

It's not just government money, though. The approach here is public/private—the industry, government, and external stakeholders working together.

I don't know the historical reasons, but France leans more into re-industrialization, premised on the idea that the country has lost far too much of its industrial base and needs to rebuild it. But that's not the approach all across Europe.

Johnson: Do you think France is doing enough?

James: Is anybody doing enough? I mean, they've done a lot for their industries during the COVID pandemic but you'd have to talk to the printed circuit board companies in France and ask them if they think enough is being done. It's not all up to the government, but is enough being done in terms of strategizing around what's needed for the industry in the long term? That's a good question for France's printed circuit board industries, but I think most organizations and most companies would say we need to do more because it's not getting better. There's been such a drain in the

last 20 to 30 years that it's definitely the time to shore up the industry.

Johnson: So, if France isn't necessarily doing enough, then we can pretty much assume that the European Union needs to do more. As you watch Europe, and the rest of the world, what is the European opinion on what the U.S. is doing? Are we doing the right thing with the plans that we have in place with these acts? Are we missing the mark?

James: Maybe I should suggest looking at this from a different angle; the European Union and the U.S. are looking to partner more, which is why they've set up this trade and technology council. They want to say, "How can we do this in partnership, so that if there's a need and it's not in our region, then we can find it in your region or in another partner region?" But they also have to strike that balance between being able to complement each other, and also making sure that they're not on some kind of subsidy race between the two regions.

With the United States and the European Union, it's more about a partnership.

With the United States and the European Union, it's more about a partnership. That's an important focus for this year. As both regions look to build out their respective CHIPS acts, how can they complement what each region is doing as strategic partners? Supply chain security and resiliency is an objective.

Johnson: For those of us who watch government programs and investment, these programs always have intended consequences from the legislation. But then you have the unintended, unanticipated outcomes.

James: We come back to the silicon-to-systems approach. Despite the energy behind CHIPS acts, which policymakers are pursuing a silicon-to-systems approach in the context of regional industrial resiliency.

Johnson: Regional, but with a global mindset at the same time.

James: Yes. You don't have to do everything in one region, but that you have the option. Europe needs to have skilled workers, as well as modern, cutting edge factories that can manufacture at scale in a cost-competitive manner. But let's face it, the industry will never be tied to one country or one region. The supply chain is too complex. With the critical minerals, materials, and everything that you need, to have all of that in one region is not anybody's ambition. No government wants that; they are being smart about what capabilities should exist internally and what capabilities should exist with trusted supply chain partners.

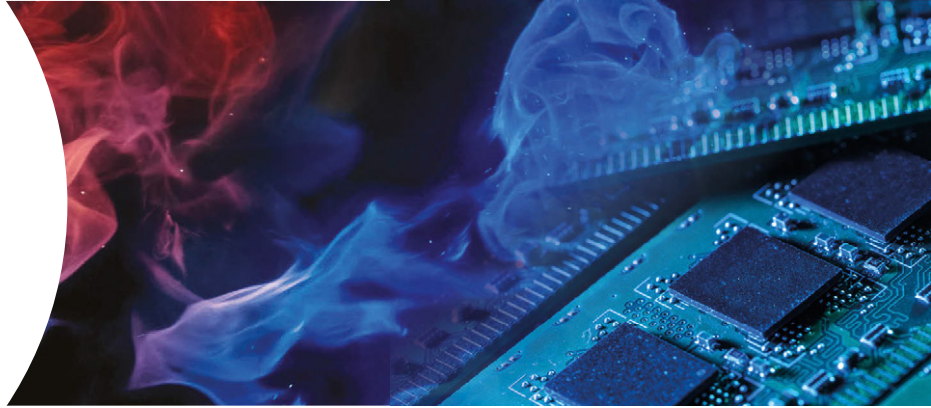
That's why the European Union and the U.S. partnership is important. How can they work together? But our point is that in looking at the resiliency and the security of supply chains between the two regions, that you're looking across the whole of the industry.

Johnson: Any closing thoughts?

James: Policymakers in Europe, the United States and elsewhere are making great strides in bolstering the semiconductor supply chain. We must not leave the rest of the industry behind, because doing so undermines the real goal, which is to sustain the capabilities to manufacture cutting edge electronics. These capabilities are necessary to supply chain resiliency and security, as well as technological innovation.

Johnson: Thank you, Alison. SMT007

Alison James is senior director of IPC Europe.



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ein Electronics Industry News and Market Highlights



Siemens Collaborates with UMC on Design Kits for Automotive, Power Applications ►

Siemens Digital Industries Software has collaborated with United Microelectronics Corporation (UMC) to develop process design kits (PDKs) for the foundry's 110-nanometer (nm) and 180-nm BCD technology platforms.

ELISE Low-code Engineering Platform Joins the Altair Partner Alliance ►

Altair, a global leader in computational engineering and intelligence, announced that ELISE GmbH has joined the Altair Partner Alliance (APA). This agreement makes ELISE's low-code engineering platform available via the APA and accessible via Altair's patented licensing system.

Vodafone UK, Samsung Switch on First 5G Open RAN Site in the United Kingdom ►

Samsung Electronics and Vodafone UK announced the companies have switched on the United Kingdom's first 5G Open RAN site carrying live customer traffic.

U.S. Manufacturers Embracing Digital Transformation to Meet Changing Demands, Challenges ►

Service providers are aiding the transformation of manufacturing in several industries in the U.S., allowing firms to increase automation, efficiency and resiliency, according to a new research report published by Information Services Group (ISG), a global technology research and advisory firm.

China Aims for Global Leadership in Robotics with New Five-year Plan ►

The new five-year plan for the robotics industry in China, released by the Ministry of Industry and Information Technology (MIIT) in Beijing, focuses on promoting innovation-making China a global leader for robot technology and industrial advancement.

Keysight Unveils Self-Service Enterprise Agreement Licensing Portal ►

Keysight Technologies, Inc., a leading technology company that delivers advanced design and validation solutions to help accelerate innovation to connect and secure the world, unveiled a new self-service Enterprise Agreement Licensing portal.

European Manufacturers Embrace Cloud to Improve Agility ►

European manufacturing firms are embracing cloud-based technologies and services to accelerate their go-to-market plans and improve digital marketing efforts, according to a new report published today by Information Services Group (ISG) (Nasdaq: III), a leading global technology research and advisory firm.

Lightweight Engine Launched into Space ►

Aliena, a tech spin-off from NTU Singapore, has deployed into space a nanosatellite fitted with a fuel-efficient engine it has developed. The nanosatellite was sent from the SpaceX Falcon 9's Transporter-3 mission which launched from Cape Canaveral Space Force Station, Florida, U.S.



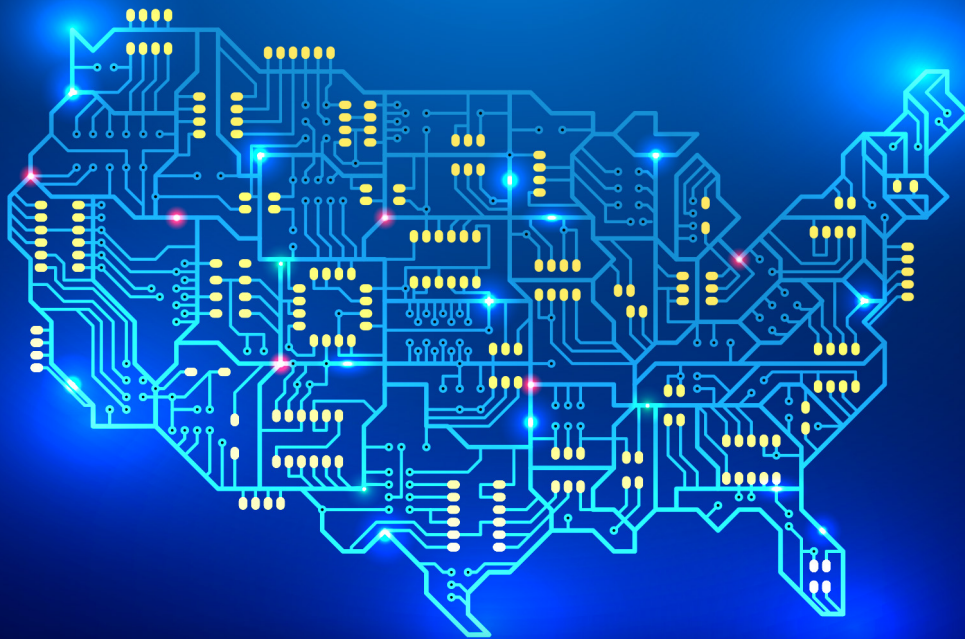
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It's Time for Government to **Step Up** to the Plate

Feature Article by Chris Mitchell

IPC

Politics is a business that's prone to hyperbole. But I believe it is no exaggeration to say that the future of U.S. electronics manufacturing—amid the fiercest global competition we've ever seen—may come down to a series of government policy decisions being made in Washington in 2022.

And no one is going to secure our industry's future if we don't fight for it ourselves.

The locus of the debate is a sprawling battle over two pieces of legislation: the America COMPETES Act, passed by the U.S. House in February, and the U.S. Innovation and Competitiveness Act (USICA), passed by the U.S. Senate last June. Both enjoy bipartisan support and industry backing.

Both bills aim to boost federal investment in a variety of cutting-edge technologies and keep the United States in the lead versus China and other rising competitors. Both contain \$52 billion to strengthen the U.S. semiconductor industry and implement the CHIPS for Amer-

ica Act of 2021. Both are complex and far-reaching.

If all the parties involved can come together over the next few months and enact a final version of the bill—and if they stay on task and implement the new law in a sustained way—then it will launch a new era of federal government partnership with the electronics industry and several emerging technologies.

If they don't, then it's anybody's guess when the political forces will be aligned again to make such legislation possible.

On the Brink of Extinction?

The Biden administration has called for urgent action on semiconductors, as have leaders in both parties. News headlines have been broadcasting the chips shortage for months.

But what is usually overlooked in the debate is that chips do not function on their own. The USICA bill does not even include the word "electronics."

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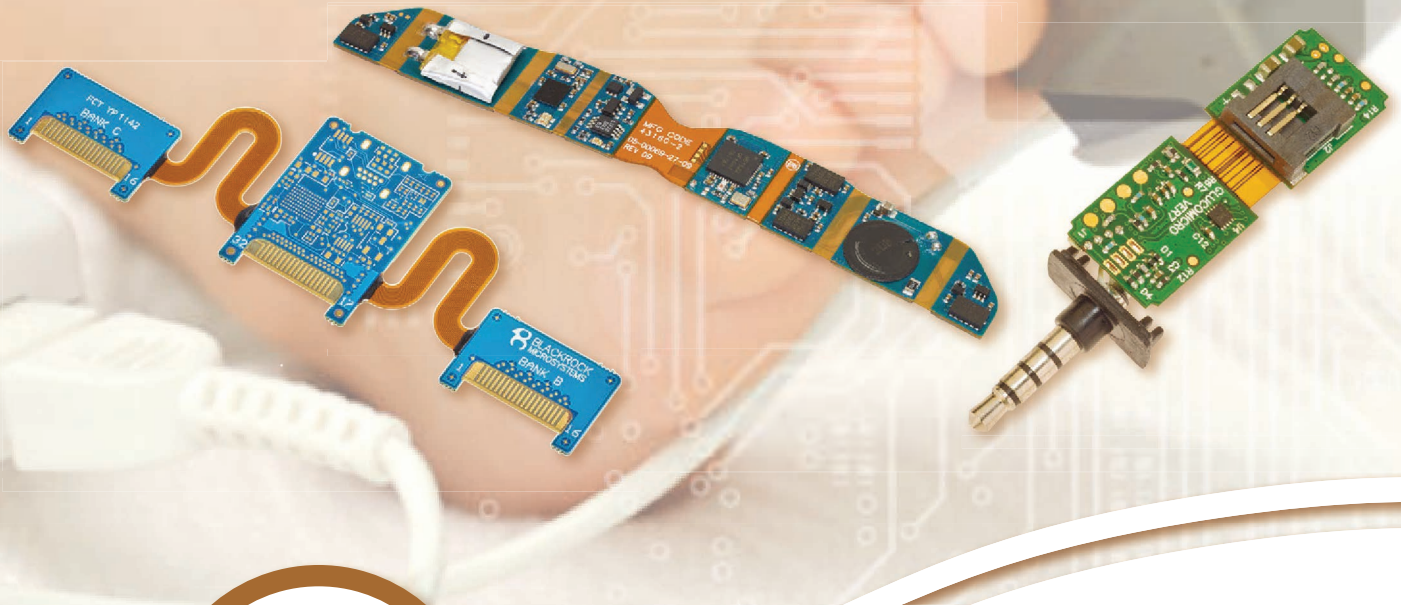
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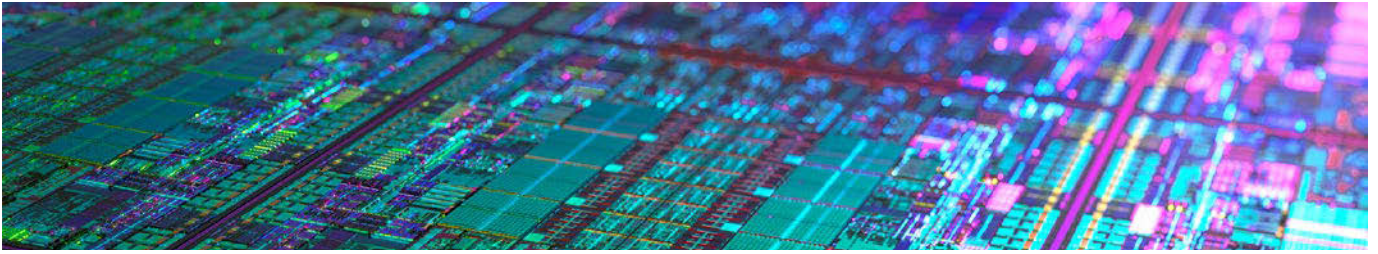
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Recent IPC studies and our advocacy efforts have urged Congress to combine investments in U.S. semiconductor manufacturing with additional support for advanced packaging, printed circuit boards (PCBs), and the related EMS technologies that bring it all together and enable chips to work their magic. Without such action, U.S.-made chips will still need to be sent offshore to be manufactured into finished products, leaving the U.S. vulnerable to supply chain shocks like those triggered by the coronavirus.

Indeed, IPC's recent report on the PCB sector concluded that the United States has already lost its historic dominance in PCBs, and the lack of any significant U.S. government support for the sector is leaving the nation's economy and national security dangerously reliant on foreign suppliers.

In one bright spot, the House bill would appropriate at least \$2.5 billion in fiscal 2023 for advanced packaging R&D, aimed at helping U.S.-based companies adopt new techniques to electronically connect multiple chips in a single package through integrated circuit substrates. As most electronics engineers know—but very few others do—in a post-Moore's Law world, with the pace of improvements in chips slowing down, advanced packaging offers an alternative way to achieve more computing power and economic efficiency.

The one-time funding for advanced packaging in the House bill is a good start, but it's only a start. Most urgently, the U.S. needs to invest in long-term development and production of advanced integrated circuit substrates—the base layers used in the packaging of integrated circuit chips—for which there are only nascent capabilities domestically.

The Human Element

Another urgent need is developing the human element: the workforce of the future to staff the factory of the future. Here again, I am not aware of any U.S. federal, state, or local government agency that has a plan to increase the supply of skilled workers for this critically important sector. Why would there be, after decades of neglect and outsourcing?

As a result, private companies are left on their own to compete for a limited quantity of highly educated and skilled workers, and to invest some of their small profit margins in training for entry-level and mid-level workers. IPC's Education Program is growing and doing all it can to fill the gaps, but the U.S. industry needs more.

And not only do we need to fill the gaps of today. Our industry is changing rapidly as it migrates to the factory of the future, which entails a suite of technologies, processes and people that will make manufacturing more sophisticated, efficient, and environmentally friendly. But we will need new kinds of skilled workers to run these factories of the future. We need to be building the education and training tracks for these new roles now to help accelerate the transition in the United States.

Other Nations Not Waiting

Other nations are not waiting for the United States to catch up. China has prioritized electronics manufacturing for decades. India recently unveiled a plan to increase its electronics output to more than \$300 billion per year over the next four years, including specially crafted industrial zones with modern infrastructure, as well as nearby housing and social supports for tens of thousands of workers. The

European Union is also crafting its own European Chips Act, including strong support for advanced packaging.

Has the U.S. government ever had a strategy to propel the success of this strategically vital industry in the United States? Perhaps briefly and partially during moments like World War II and the Space Race. But generally, the answer is no.

That said, the current effort to complete the biggest piece of competitiveness legislation in U.S. history is a perfect opportunity for the U.S. government to begin having a strategy.

Let Them Hear You

And that's where you come in, dear reader. I lead IPC's professional government relations (GR) team, and we are here for you year-round. But the success of our work depends on the active engagement of IPC members.

IPC's advocacy work is rooted in an ongoing dialogue with our members. For example, IPC's North American and European GR Committees are composed of a cross-section of company executives who provide IPC with their input throughout the year. Likewise, IPC's environmental policy priorities are determined with input from our Environment & Health Strategic Management Team (ENV SMT). We also invite all members to [fill out our five-question, five-minute policy survey](#), or just call or write us with your concerns.

With member input in hand, IPC's GR staff reaches out and communicates directly with key policy makers, presenting the best case for our positions. To the extent we are persuasive, we increase the likelihood that the final policies enacted will be supportive of the industry.

IPC also facilitates direct communications between our members and government officials, whether it is through in-person or virtual meetings. IPC also coordinates in-person or virtual visits by government officials to IPC member facilities—so that when IPC's interests are at stake in policy debates, we already have local relationships that we can leverage to have greater influence.

On the regulatory front, IPC continuously monitors the rules being developed at agencies like EPA and OSHA, and we provide timely information to both government officials, to help inform their decisions, and to IPC members, so that you can make informed business decisions.

Finally, we build public support for our positions. For example, IPC cultivates helpful, accurate news coverage by the news media, and we engage actively on social media, all with the goal of building broader public support for our policy agenda.

Here's What You Can Do

If you care about the shrinkage and potential extinction of the U.S. electronics manufacturing sector, if you believe like me that the U.S. government needs to be an active partner in our success and not a passive bystander to our decline, then I challenge you to take these three steps:

1. **Stay informed on the issues.** Subscribe to IPC's Global Advocacy Report. If you're an IPC member, you can manage your e-mail preferences and opt in to receive "Advocacy" updates. If you are not an IPC member, or you're not sure, send a note to friends@ipc.org, and our staff will add you to the list. You can also follow IPC on LinkedIn and Twitter for occasional updates.



2. Join our grassroots advocacy team.

Visit our online advocacy center; enter or update your contact details; and watch for opportunities to participate in our grassroots campaigns on USICA/COMPETES and other key issues.

3. Be in contact with your elected representatives. Send emails, make phone calls, or ask for a meeting at the local coffee shop or district office. If you happen to have a relationship with one of your elected officials, let us know. Otherwise, we'll help you develop those relationships, helping to arrange the meetings and providing you with talking points and "leave-behind" materials. Take it a step further and invite an elected official to one of your facilities. You can offer an in-person or virtual tour, a briefing, and/or a demo, and give them a chance to speak to your employees. This is your opportunity to be a high-impact advocacy champion for our industry.

These three steps will be an investment in your future success and that of the wider electronics manufacturing community. There is power in our individual company stories and in coming together in a united front. If we don't do this for ourselves, no one else will do it for us.

Every other industry is out there advocating for their interests, and we must do the same. Grassroots or "grasstops" constituents like you are our industry's most effective advocates.

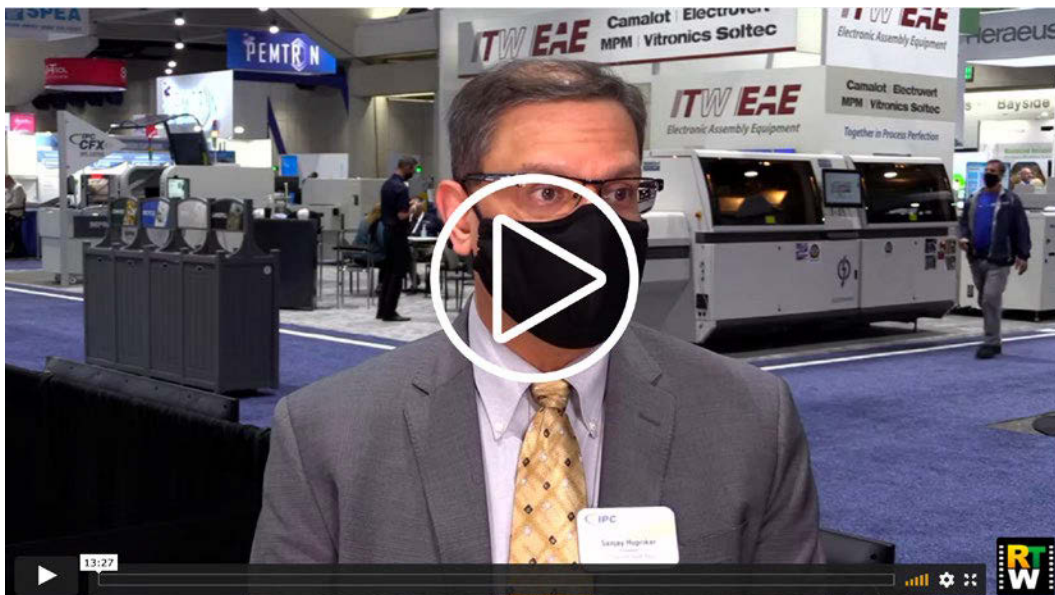
IPC works hard to secure you a seat at the table, where we can educate policy makers and advocate for our industry. But we need your help at this crucial moment. The future of our industry is literally at stake. Don't just stand there; do something. **SMT007**



Chris Mitchell is IPC's VP of global government affairs, and an I-Connect007 columnist. To read previous columns, or contact Mitchell, [click here](#).

Real Time with... IPC: A Global Collaboration

Sanjay Huprikar, IPC's President of Europe and South Asia Operations, describes IPC's globalization initiative to expand the association's standards, education and advocacy support to Europe, with an emphasis on collaboration.



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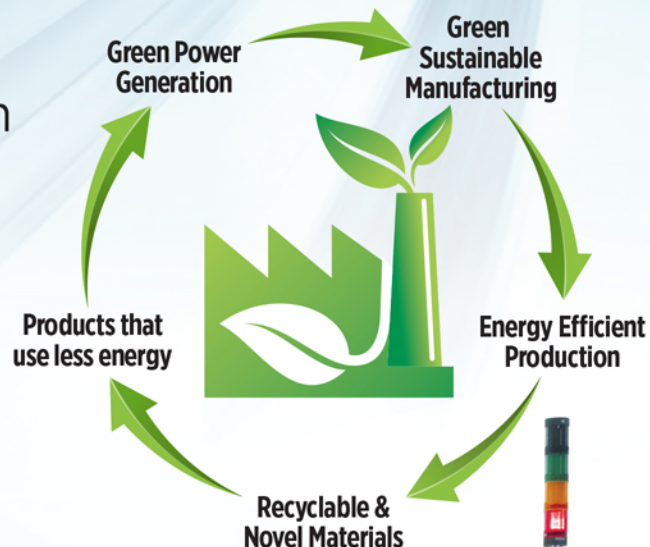


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It is not my work
it is my passion

Dave Hillman on Living Your **Passion**

Interview by Barry Matties

I-CONNECT007

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

Barry Matties: Dave, you have been in the same position with the same company for nearly 40 years. That type of thing doesn’t even exist anymore.

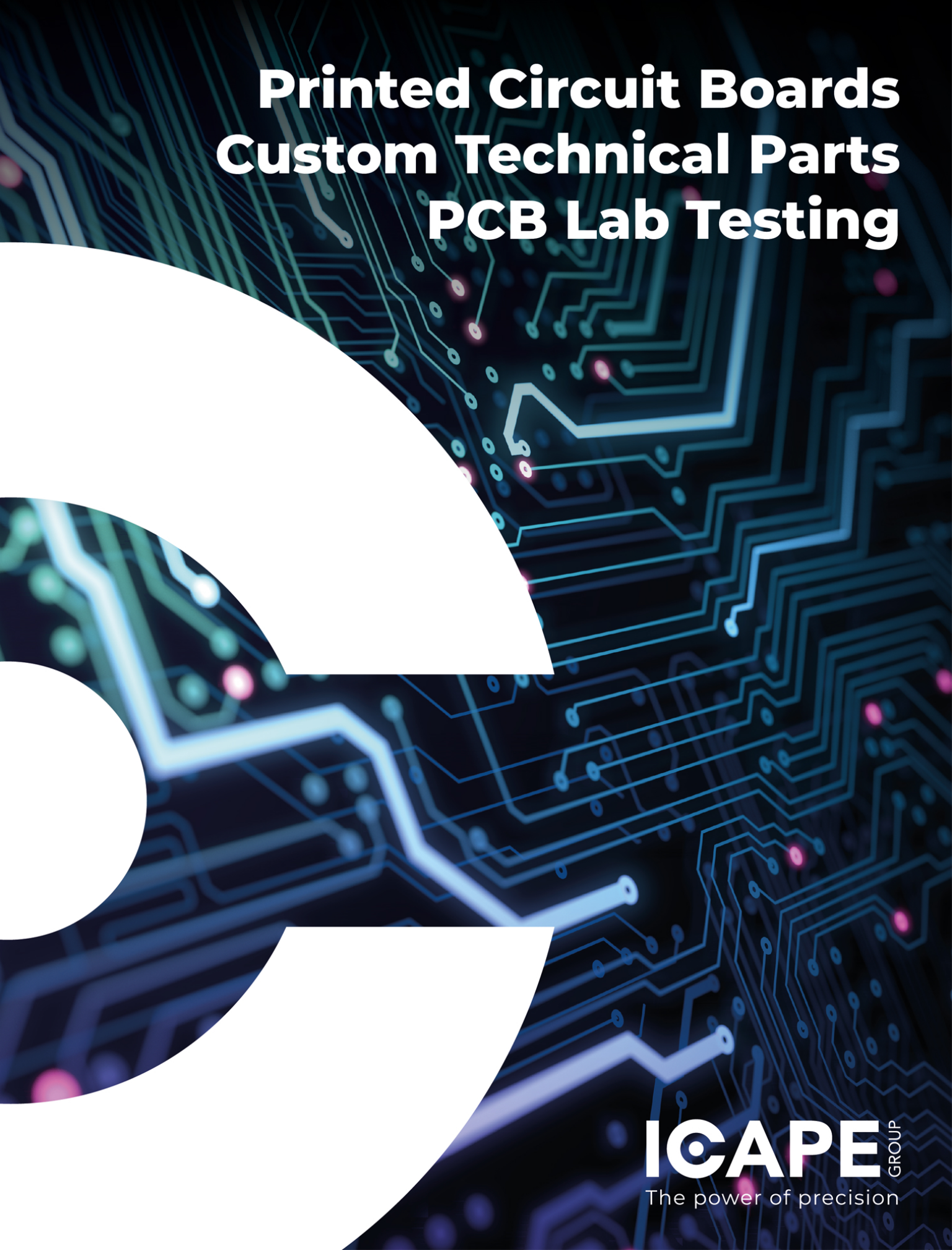
Dave Hillman: I’ve been really privileged to be able to do so. We have a co-op program at Collins, and I’ve been able to mentor. We get four co-ops a year, two for spring/summer, and then two for summer/fall. About 150 kids to date. A lot of them now are industry colleagues, both in and outside Collins. It’s been fun to watch

that transition, to watch them grow, to see the technology changing.

I think it’s interesting how my mentors have always talked about how big a shift it was from plated through-hole to surface mount and how that was revolutionary for the industry. Well, lead-free is doing the same thing. It’s challenging our material sets. What do you do? How do you get there? Collins is one of the few defense contractors that has been building lead-free for 10 years and it’s been very successful. I think the real trick is that we’re engineers. It’s a problem; go solve it.

Matties: Your expertise was in soldering, correct?

Hillman: Correct. I attended Iowa State University for my bachelor’s, then went back 10 or 15 years later for my master’s. I function as the soldering subject matter expert in terms of metallurgy, alloys and processes, troubleshooting, that sort of thing. It’s been a lot of



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fun. Our industry seems to like to replay the lessons of the past; gold embrittlement is probably this sexiest topic ever on the planet because we just keep talking about it.

Matties: One of the things that we hear constantly is that field defects primarily come down to the solder and solder joints. As an expert, would you validate that statement?

Hillman: I do. If you don't want defects, it comes down to making sure a design is producible. For instance, why would you have three different product design teams that are using the same part with three different footprints? You don't need three footprints. You need one footprint because for the manufacturing guys that will be efficiency on their end and uniformity in the solder joints.



Dave Hillman

"keep your inventory low." Then COVID hits and suddenly we don't have anything in stock. We have no security backup. That "just in time" philosophy works when things are coming together as planned. I think we all underrated how critical it is to a process.

Matties: We're seeing a new trend in how we're melting solder as opposed to the tradi-

tional reflow processes. How do you view these new technologies in terms of market acceptability and performance?

Hillman: I remember my mentors telling me early in my career, "Here's the wave solder machine, but don't pay much attention to it. It'll be gone in about five, six years. We're not using it very much." Yet, we still have wave solder. Our soldering processes have evolved to deliver what's needed.

Look at vacuum reflow, the new components, QFNs, and more importantly, LEDs. We definitely don't want voids in the solder joints for these components, and the reflow oven manufacturers figured out how to put a mini vacuum system inside the reflow oven to increase throughput. The assemblers did not want to have batch processes because of process volume/process flow.

The equipment evolves. Soldering is soldering. I take a metal, I use flux to get rid of the oxides, and I create an intermetallic connection. But how we do that keeps evolving in response to the new technologies and smaller packages. I think we will continue to see new innovations just because engineers like to solve problems. And we've got plenty of those to go after.

Matties: With the soldering process, there are a lot of ways it can go wrong.

Hillman: I think it's interesting that we had this huge drive for "just in time," "no WIP," and

Matties: Some of the core benefits, at least from what I understand, is that when you're using these new technologies, you're not heating up all the material around the target area. You're

If you don't want defects, it comes down to making sure a design is producible.

As my friend Doug Pauls would say, you can design the most beautiful thing on the planet, but if you can't build it, what good is it? This industry no longer designs something, then throws it over the wall. Nowadays, the design teams and the manufacturing teams are very much connected.

precisely focused on the target area, which then adds to the overall reliability because you're not inducing a thermal stress cycle on the adjacent material.

Hillman: Yes, exactly. You're minimizing collateral damage as things get smaller and smaller. It used to be, when the pitch was 1.25 mm, you had lots of room to do things. But now with tolerances so tight, it's very easy to have a process issue. That means we just need to be more surgical.

Matties: You talked about the mentorships that you had early on. For young engineers coming into the industry today, what advice do you have for them regarding the soldering process? What they should prepare and plan for?

Hillman: I think that's a really interesting question because both the SMTA and the IPC are working hard to create mentorship and assistance programs for new engineers. University of Maryland, with CALCE and CAVE3 down at Auburn, are doing their best to graduate talent that then can be used by the industry immediately.

But there's a pretty big herd of gray-haired folks, and we're not going to be around forever. School only teaches you how to learn; it doesn't teach you what to learn. I was privileged to have some great mentors around me who guided me and answered questions.

For the new engineers, the first thing is wherever you land, find your mentor. Who can you talk to and ask questions? It may not be somebody in the company but possibly through one of the associations—SMTA, Universal, IPC, IEEE. Talk to other professionals. We're a small industry. We won't talk about IP and competitive advantage topics, but we can discuss general topics. There are a lot of people out there who can help.

The other trick is to be open to opportunity. When I accepted the position at Rockwell Collins, I was the third person that they

interviewed. The first two people turned down the job, for whatever wild reason, so I may not have been where I am today just out of pure luck. One needs to be open to possibilities and where those might lead in one's career.

Matties: You stayed in one spot for 35 years. Do you have any regrets for doing that?

Hillman: Oh, heck no. I'm a lab rat. It was suggested during my career that maybe I should go into management. I know I can manage people, but I really think my strength, my passion, is solving problems and working on technical issues. Being in one group, one spot, has been exactly where I wanted to be.

That may be the other point to ponder for those coming into the industry. What is your passion? If you're really into putting process flows together, you like linking equipment, or programming a process, if you love what you do, the rest of it falls into place no matter where it is and under any circumstances.

If you're really into putting process flows together, you like linking equipment, or programming a process, if you love what you do, the rest of it falls into place no matter where it is and under any circumstances.

Matties: Dave, I really keyed in on your passion. If you can wake up every day and live your passion, I believe you have won the game.

Hillman: Exactly. I've told my co-op students over the years that engineering is easy, people are hard. In our relationships with cowork-

ers and senior leadership, there will be ups and downs, good and the bad. If, at the heart of it, you're solving problems and you like what you're doing, all the rest of the stuff around is just noise and you'll work through it. If you're happy solving the problems, whatever you're doing technically, I think that makes for a great career.

Matties: You may have been fortunate to land in an organization where the culture and your values aligned between the organization and yourself, because a big part of staying in one spot is working in an environment where you can really thrive in the culture.

Hillman: Exactly. I've been very privileged. Rockwell Collins never participated in the mergers and spinouts. We were divested from Rockwell International and then it became

Rockwell Collins. We stayed that way for a long, long time. That helps in terms of career development and company culture.

As a bigger company, there are advantages and disadvantages to that. I believe that you need to make your own happiness and, as long as you are chasing what you like to do, you'll find ways to deal with being in a large company; you cope and accept it or work to change something you think needs changed. If you're happy with what you do, everything else works out.

Matties: Dave, I really appreciate you taking the time for this conversation today. I see there's a lot of knowledge you have, and I think it's great to share this.

Hillman: My pleasure. SMT007

Real Time with... IPC: Advanced Packaging Report

Matt Kelly, chief technologist at IPC, provides a quick assessment of APEX, reviews the technical programs, and talks about the importance of the Factory of the Future.



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MilAero007 Highlights



Catching Up With RBP Chemical and Schlötter ▶

It's always great to see two very good companies form a mutually beneficial alliance. I was lucky enough to watch this particular strategic partnership come to fruition this year between RBP Chemical and Schlötter. I sat down with Matthias Hampel, global executive representative-PCB and electronics at Schlötter, and Ernest Litynski, president of RBP Chemical Technology, to get the inside story.

EIPC Technical Snapshot: Considering Supply Chain and Defense ▶

Continuing the highly successful series of EIPC's Technical Snapshots, and featuring a programme that attracted a record attendance, the 14th online event was held on January 19. The opening presentation came from the ever-cheerful Didrik Bech, of Elmatica, who promised to provide thoughts and ideas about how to secure the supply chain to ensure compliance.

Flaws in U.S. Approach to Electronics Manufacturing Require Urgent Changes ▶

The United States has lost its historic dominance in a foundational area of electronics technology—printed circuit boards—and the lack of any significant U.S. government support for the sector is leaving the nation's economy and national security dangerously reliant on foreign suppliers.

High-Voltage Circuit Design Guidelines and Materials ▶

The Hubble telescope, the Cassini-Huygens mission, and other exploratory spacecraft

utilize high-voltage DC power supplies for everything from vidicon camera tubes and mass spectrometers to radar and laser technologies. NASA has experienced performance problems with the 1.5 kV supplies because—as a 2006 report stated—“designers did not take the high-voltage problems seriously in the initial design.”

Real Time with... IPC APEX EXPO: Update From PCBAA ▶

PCBAA Chairman Travis Kelly talks with Nolan Johnson about the new association's recent activities and plans. The Printed Circuit Board Association of America is focused on advocating for manufacturing in America.

Nano Dimension Establishes First AME NanoLab Facility ▶

Nano Dimension Ltd., an industry leader in Additively Manufactured Electronics (AME), Printed Electronics (PE), and Micro Additive Manufacturing (Micro-AM) announced a collaboration with TTM Technologies, Inc. to open its first AME NanoLab at TTM's Advanced Manufacturing Center in Stafford Springs, CT.

Eltek Receives \$1.4 Million Letter of Intent for a Purchase Order from Existing Defense Customer ▶

Eltek Ltd., a global manufacturer and supplier of technologically advanced solutions in the field of printed circuit boards, announced that the company has received a letter of intent for a purchase order in the amount of \$1.4 million from an existing customer in the defense sector.



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Our Introduction to the Electronics Industry

The New Chapter

NEW COLUMN by Paige Fiet and Hannah Nelson

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

Paige Fiet: My name is Paige Fiet. I recently graduated from Michigan Technological University with my Bachelor of Science in elec-

trical engineering. In January 2022, I joined TTM-Logan as a process engineer in the solder mask department. Prior to graduating from MTU, I served as president of the IPC Electronics Club at MTU as well as the student board member on IPC's Board of Directors.

Hannah Nelson: My name is Hannah Nelson. I am currently a junior electrical engineering major at Valparaiso University with a minor in mathematics. I am the president of the IPC student chapter at Valpo, and I currently work as a co-op engineer for Caterpillar Inc. I am also

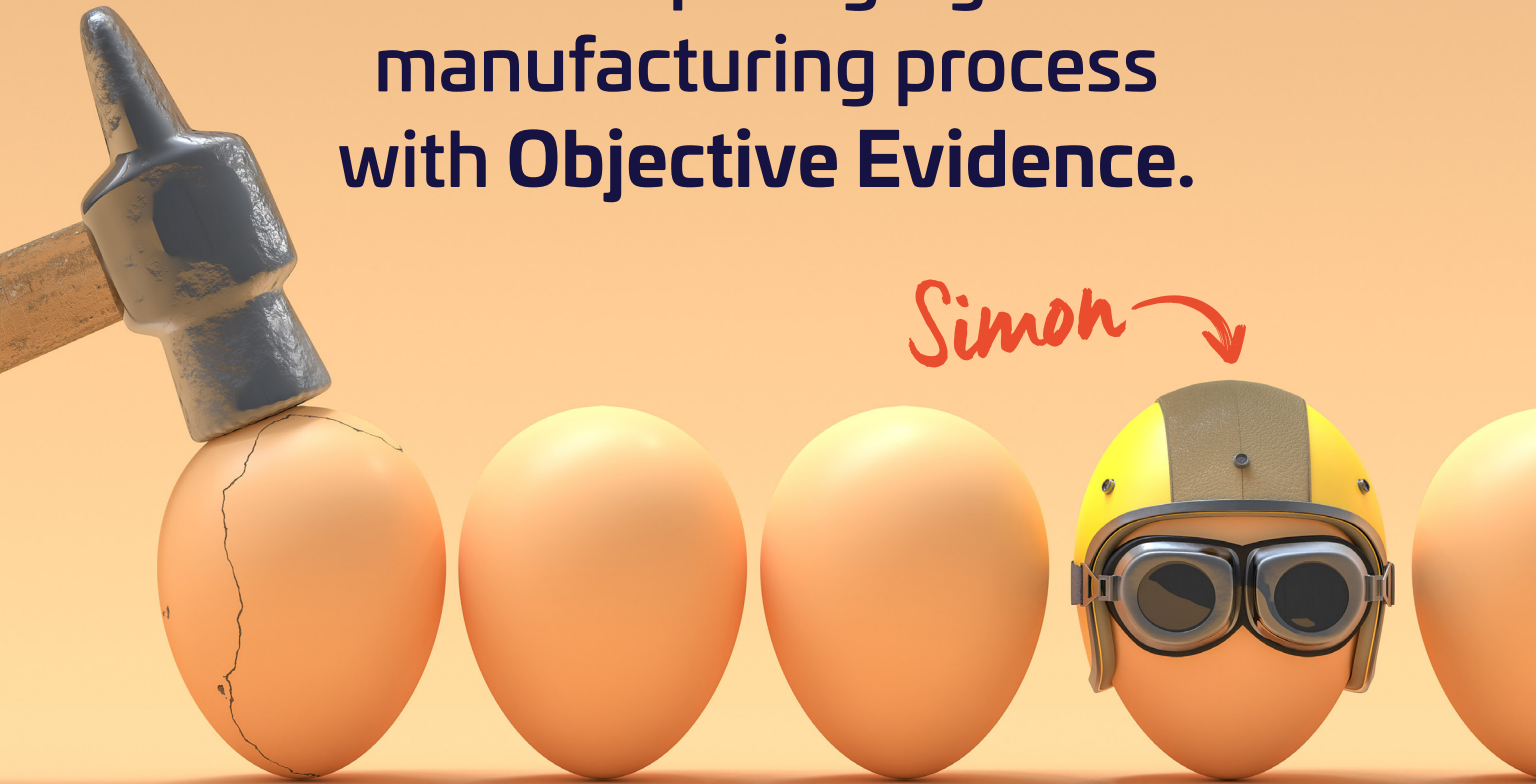


Paige Fiet



Hannah Nelson

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Hannah Nelson, Wendy Gaston and Paige Fiet at the Women in Electronics event at IPC APEX EXPO 2022.

serving one term as the IPC Student Director on IPC's Board of Directors.

Fiet: I was first introduced to the electronics industry via my first two internships at Avon Protection Systems in Cadillac, Michigan and Calumet Electronics in Calumet, Michigan. How about you, Hannah?

Nelson: My first introduction to the electronics industry was leading Valpo's student IPC chapter, although I did not become fully immersed in the industry until the IPC APEX EXPO 2022. What made you want to pursue engineering?

Fiet: Engineering was an easy choice for me. Both my father and brother are engineers. I always liked problem solving and "getting my hands dirty" so engineering just came naturally. What made you choose engineering?

Nelson: Engineering, to me, is a way I can creatively innovate my own thoughts and ideas into physical technology, but it hasn't always been that way. I originally resented engineering and thought of the career as a chore that my mother wanted me to pursue, but as soon as I stepped on the Valparaiso University campus, I knew the career I chose

was my vocation. The career choice soon began to engulf every aspect of my life—how I spent my time, who my friends were, and how I spoke to my peers. I know we both have experience serving as presidents of our IPC student chapters. What was that like for you?

Fiet: I spent a year as president of the IPC Student Chapter at MTU. Unfortunately, the year of my presidency began in parallel with the COVID-19 pandemic. However, I saw the resilience in my peers as we met with sponsor companies and industry experts to learn more about the electronics industry. The IPC Education Foundation was incredible in working to develop online content for our students. We were able to watch webinars for career panels and take training classes through their website.

Nelson: As the president of Valpo's chapter, it is incredible to see the growth in the program. As the chapter continues to grow, it seems like the creativity of our students also grows, as do the programs that they are presented with. There is still so much growth for skills that students need before they enter the workforce, but that is what our chapter is trying to help.

Fiet: I'm so glad you've had that experience. When I was a junior in college, I was just starting to figure out what I wanted to do post-graduation. What part of the electronics industry are you thinking about working in?

Nelson: Well, as a current junior, I graduate May 2023 and I am honestly still trying to figure out my future career. Currently though, I am passionate about exploring the renewable energy and aerospace divisions of the electronics industry.

Fiet: You have a really bright future ahead of you. I am very impressed with what I've seen so far, and I could not have chosen a better successor for my position on IPC's Board of Directors. The Board was wonderful to work with and I really learned a lot about the varying aspects of the industry and what's important to each of them. It was also exciting to share feedback from a student's perspective. What did you think when you first met the Board at IPC APEX EXPO?

Nelson: My first time meeting the board was incredible. The best part was understanding that even though they are well respected in their careers, they are people too. They have not only mentored me to find my passion in the

electronics industry, but they have also given me the opportunity to help bridge the gaps that I see in my own education. How was the transition from college to a professional career?

Fiet: I think the transition was made easier due to my internship experiences. I was able to learn from industry professionals who mentored me on workplace etiquette, enhanced my problem-solving skills, and who support me even now. You have some internship experiences, don't you Hannah? What has that been like?

Nelson: At first, I thought the transition between school and my internship was difficult, but what helped me was networking with other company employees. I was not only able to learn more about Caterpillar's company culture, but I was also able to realize that these individuals were there to help me grow throughout my internship.

Fiet: It's been nice getting to know you, Hannah.

Nelson: You as well, I'll see you at IPC SummerCom. **SMT007**

Paige Fiet is a process engineer at TTM-Logan. **Hannah Nelson** is a student at Valparaiso University. Both are in the IPC Emerging Engineer Program.





M&A Activity: Keep Your Eye on the Ball

Feature Interview by Dan Beaulieu

D.B. MANAGEMENT GROUP

M&A activity is on the rise and shows no indication of slowing down, even if interest rates climb. In the past two years, there were more than 45 deals. Where does your company fit in? In this interview with Dan Beaulieu, M&A expert Tom Kastner breaks down the market and who benefits most when it comes to buyers, sellers, and where you live.

Dan Beaulieu: Tom, please tell us a little about yourself and your company.

Tom Kastner: My firm, GP Ventures, is focused on M&A advisory services for tech and electronics companies. I started the firm in 2008. My background is in the PCB and electronics industries, having worked for Hakuto, a manufacturer of cut-sheet laminators. I worked for them in both operations and strategic investments. GP Ventures now has five people—four

in Chicago and one in Japan. We work on both sell-side and buy-side projects.

Beaulieu: Tell me about some of the deals you have done in our industry.

Kastner: I have completed over 10 deals in both the PCB and the EMS industries. We are currently working on several sell-side and buy-side deals at the moment.

Beaulieu: What do you see right now when it comes to M&A activity in North America? Why is there so much action?

Kastner: There is a lot of activity in the sector. I believe the main reasons are 1) an abundance of capital available for deals; 2) low interest rates; 3) the average age of owners is at or above retirement; 4) buyer confidence in man-

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ufacturing in the U.S. due to reshoring and government policies. This is a lot of activity, especially considering the COVID pandemic and travel restrictions.

According to our records, in North America there were 13 PCB deals in 2021 and nine in 2020. For the EMS sector, there were 24 deals in both 2021 and 2020. I think that the number of deals in the PCB sector will be around the same in 2022; there would be more, but there are fewer and fewer shops to buy. In the EMS sector, I expect the number of deals to be above 30.

Beaulieu: Is there interest in other countries buying in North America? Asian or European companies?

Kastner: Yes, we are seeing a lot of interest from European companies. Not so much from Asian companies yet, mostly due to COVID.

Beaulieu: How does the current legislation in Congress, which seems to be targeting semiconductor manufacturing, affect the PCB fab and EMS providers? How might governmental investment into our market change the M&A landscape?

Kastner: I've heard from a lot of buyers that they are bullish on the current direction of U.S. manufacturing. My feeling is that if even a small portion of the market comes back to the U.S., that would be a big lift to U.S. manufacturers. As long as the pending legislation and policy changes encourage investment, it would be a positive for both U.S. manufacturers and M&A activity.

Beaulieu: What kind of deals are happening? Is this a buyer's or a seller's market?



Tom Kastner

Kastner: I think it is a seller's market for "larger" deals (above \$20 million in revenue or so) especially if the seller's company is profitable and does not have many issues. It is more of an even market for smaller deals or for under-performing companies.

Beaulieu: Who is doing this buying? Are private equity groups involved? Are money people buying into our industry?

Kastner: Private equity groups were involved in most deals in 2021 in both the PCB and EMS industries. This is a strong vote of confidence in the industry, and I expect this to continue for some time.

Beaulieu: What advice would you give to someone who is trying to sell their company?

Kastner: Preparation and education are the big keys for getting a good deal and having it go smoothly. Owners should work with their advisory team, such as their attorney, CPA/tax advisor, wealth advisor, and M&A professional.

Beaulieu: Same question but for buyers. What advice would you give someone looking to buy a company?

Kastner: Sellers are inundated with calls and e-mails from potential buyers, so it is important to try to stand out from others.

Beaulieu: I hear a lot about rollups or consolidations. Please explain what those are and how they work?

Kastner: That generally refers to the situation in which the buyer moves the seller's business

into the buyer's. This typically happens with smaller deals, but it can happen with any size deal. It also usually happens more when the two businesses are geographically close and when the seller is performing below average. It can be a great way for a seller to get more for the business since the buyer may be willing to pay more than if they had to take over the seller's facility.

Beaulieu: How do you see the future? Is this trend going to continue?

Kastner: I think the current conditions will last for some time, at least a year or two. PE firms continue to raise funds, interest rates may rise but should still be relatively low, the economy continues to chug along, and government policies are both providing extra stimulus as well as incentives to increase U.S. manufacturing.

Beaulieu: Any last comments?

Kastner: Just a few comments on the direction of the industry. Both the PCB and EMS industries look like they will continue to consolidate. The acquiring companies will be stronger, larger, more professional, and capable of investing in equipment and technology. Smaller companies will need to focus more on niches and customer service to survive. Larger, public companies are looking to diversify to grow, so there is a fair amount of opportunity for companies in the middle who are looking to take advantage of the re-shoring and consolidation that is going on.

Beaulieu: Very good information. Tom, thank you for your time.

Kastner: No problem, Dan. My pleasure. SMT007

Real Time with... IPC: Update From PCBAA

PCBAA Chairman Travis Kelly discusses with Nolan Johnson the latest updates on the new association's activities. The Printed Circuit Board Association of America is focused on advocating for manufacturing in America.



What **Happens** in Washington **Happens** to Us All

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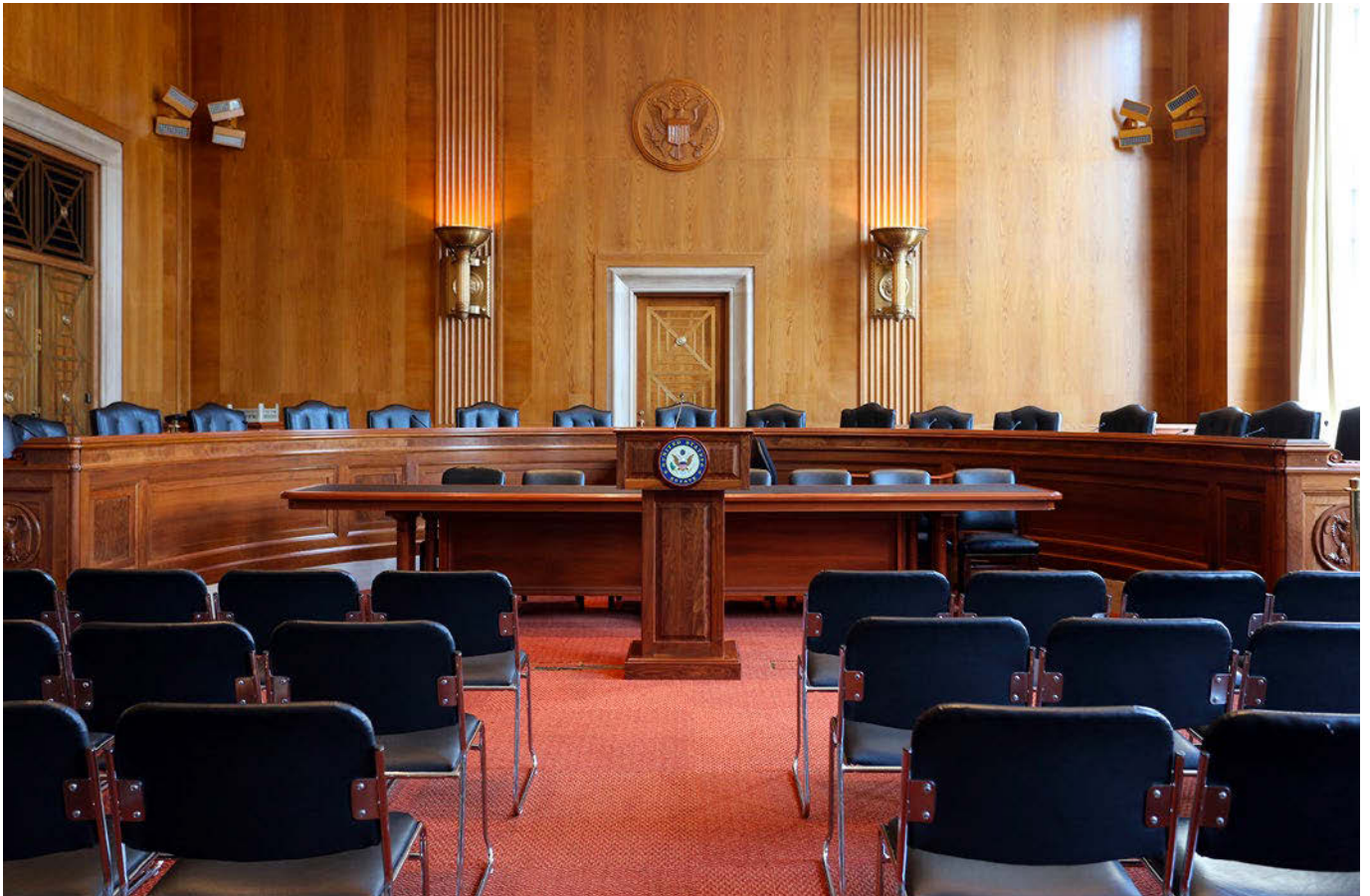
Feature Column by Travis Kelly, PCBAA

Like many of you, I've spent the last few years grappling with the challenges posed by a global pandemic. Whether it's staffing a production line or obtaining key materials, PCB manufacturers and their suppliers have had to adapt quickly to a radically changed environment.

We're more than 700 days into this new world, but as an industry, we cannot allow our day-to-day focus on operations distract us from

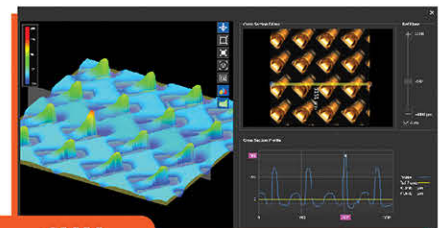
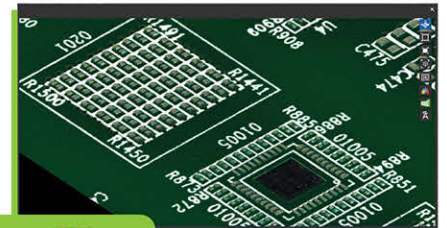
what is happening in Washington and what it means to the microelectronics ecosystem.

Independent of the COVID-19 crisis, our industry is experiencing a decades-long shift that needs to be addressed by a strong public/private partnership. Even as more and more technology in our daily lives is dependent on microelectronics, the U.S. has seen its share of the global PCB market shrink from 26% in 2000 to only 4% today. As policymakers



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rightly sound the alarm over a 13% American share of the semiconductor market, we are working to remind them that “chips don’t float”—and a truly resilient supply chain must reflect that reality.

Formed in 2021, the Printed Circuit Board Association of America (PCBAA) is focused on legislative and regulatory initiatives in Washington. Here are examples of the activities we are watching carefully and, in some cases, advocating for passage.

- **The annual federal budgeting process.**

Beginning with the release of the President’s Budget in the spring and continuing through the fall in most years, Congress works to authorize and appropriate funds for everything from national parks to the post office to the Department of Defense. In the last fiscal year this budget represented nearly \$4.8 trillion in federal spending. Not surprisingly, tens of thousands of interest groups are focused on this multi-month process, lobbying for their piece of this enormous pie.

- **Stand-alone economic development bills.**

Outside of the annual budget process, Congress often acts to address specific problems, like those currently being felt by American consumers. Shortages of semiconductors have hit American markets hard, and in response, Congress and the administration are pushing for investment in domestic

manufacturing through bills like the CHIPS for America Act and the U.S. Innovation and Competitive-ness Act (USICA). These bills represent hundreds of billions of additional dollars in spending and incentives.

- **Federal rule-making and regulatory policy.**

It’s not just Capitol Hill where we need to pay attention. At federal agencies like the Department of Commerce and the Department of Defense, leaders in the executive branch are writing rules and regulations which guide our customers in the national security space and shape the international markets we operate in.

These are just a few examples of the ways that the federal government influences American competitiveness and the health of our industry. They are also potent reminders of why a sustained and focused PCB industry presence in Washington is so important.

We cannot assume policymakers will understand our issues and our technologies. We cannot take for granted that our elected officials will be sympathetic to our arguments. It is incumbent upon us to educate, advocate, and legislate for the outcomes we want. Therefore, the PCBAA was formed.

Our growing association believes in, and continues to fight for, market fairness and a level playing field on which U.S. PCB manufacturers, assemblers and critical material suppliers can compete and win. If you’re interested in joining our effort, please visit us online or contact me directly. **SMT007**



Travis Kelly is the CEO of Isola-Group, current chairman of the Printed Circuit Board Association of America, and an I-Connect007 columnist. To read past columns or contact Kelly, [click here](#).

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Supplier Highlights



SVTronics Makes KYZEN its Cleaning Chemistry Standard ▶

SVTronics, a leading manufacturing services company, is pleased to announce that it has made KYZEN its cleaning chemistry standard for its manufacturing facility in Plano, Texas.

Koh Young Reinforces its Global Smart Factory Focus by Promoting Ivan Aduna to Global MES Leader ▶

Following a successful return to live trade shows at IPC APEX EXPO in San Diego, Koh Young announced it has reinforced its dedication to helping customers create a smart factory by promoting Ivan Aduna to Global MES Leader. In this expanded role, Ivan will develop and manage MES (Manufacturing Execution Systems) software and application deployments on a global level for Koh Young.

Rehm Thermal Systems Launching New Distribution in Switzerland ▶

Rehm Thermal Systems GmbH began the new year with a new sales partner. Hilpert electronics AG has taken over the marketing of production equipment for the electronics industry in Switzerland.

MacDermid Alpha's Electrolube Awarded NextGen Best Paper ▶

MacDermid Alpha Electronics Solutions, a global supplier of integrated solutions from our Circuitry, Assembly and Semiconductor divisions, is pleased to announce that Electrolube's senior technical manager, Beth Turner, has been awarded NextGen Best Paper.

Mek Adds New Distributor in India ▶

Mek (Marantz Electronics), a leading provider of Automatic Optical Inspection solutions, has recently expanded its global distribution and service network with the addition of Indian company ACD Renaissance LLP.

Element Solutions Acquires Chemical Developer HSO ▶

Element Solutions Inc announced that it has acquired HSO Herbert Schmidt GmbH & Co. KG (HSO), a privately held, multinational developer of surface finishing technology and chemistry, headquartered in Solingen, Germany.

Dynamic Source Manufacturing Partners with Juki ▶

Juki Automation Systems (JAS), Inc., a leading provider of automated assembly products and systems and subsidiary of Juki Corporation, is pleased to announce that Dynamic Source Manufacturing Inc. (DSM) has purchased its fourth ISM3600 Storage Tower.

Mycronic Posts 30% Sales Growth in Q4 2021 ▶

Mycronic releases its year-end report for January-December 2021. Net sales increased 30% to SEK 1,295 (992) million. Based on constant exchange rates, net sales increased 27%

Z-AXIS Benefits from AAT's HydroJet In-line Cleaning System ▶


Z-AXIS, Inc. utilizes the HydroJet® In-line cleaning system from Austin American Technology to clean under tightly spaced components at its ISO 9001:2015 certified design and manufacturing facility.



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How to Minimize Quote Time and Increase **Accuracy** in EMS Production

Article by Mark Laing

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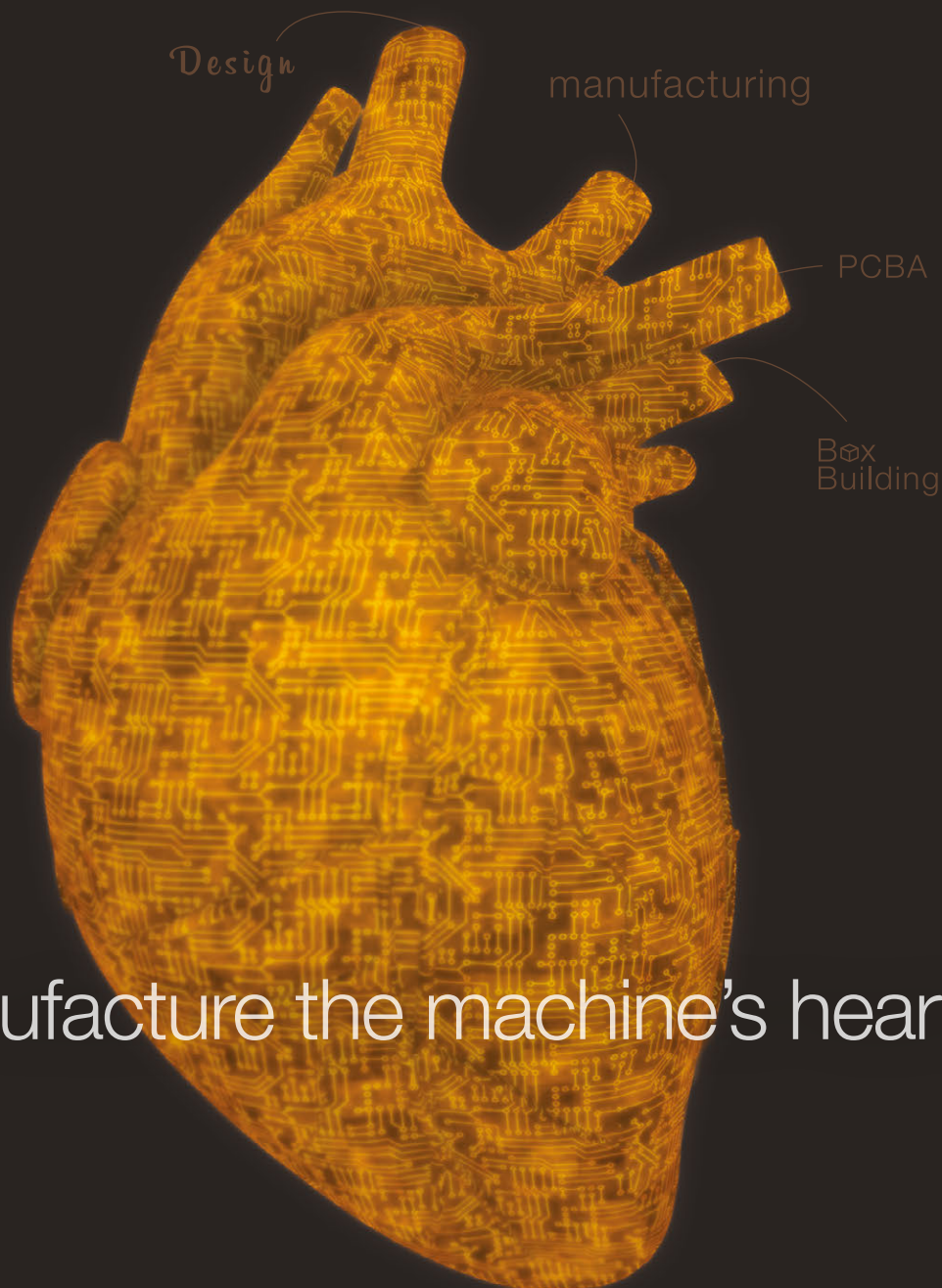
New product introductions (NPIs) and customization have been increasing rapidly over the past few years—with the results that the already-small profit margins in electronics assembly are shrinking even further. Fifteen years ago, the PCB was the product. Today, most products are a system, with multiple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

Accurate quoting is more critical than ever, but, as any electronics manufacturer knows, that's no easy task. PCB assembly bill-of-materials (BOM) file types, formats (text, XML, database), and accuracy vary greatly, and OEMs are forced to invest significant resources in cleaning the data and validating the content

before creating a quote. Even after they are extracted, there is no way to validate the manufacturer part numbers, no assurance that it is available for purchase, and no way to check whether there is an accessible alternative option that is less expensive. These challenges lead to inaccurate quotes and problems during sourcing and production.

Traditionally, electronic manufacturing services (EMS) companies rely on manual activities and Excel macros to quote PCB projects. But, as process engineering solutions continue to advance, a more efficient way is needed to verify the design, source components, and accurately cost out the project.

Given the small profit margins in electronics assembly, accurate quoting is critical. However, because design companies generally



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send out several requests for quote (RFQs) for each project, manufacturers end up providing quotes for many more projects than make it into production. Just like for OEMs, EMS companies deal with the differing BOM file types, formats, and content for each customer, which can lead to inaccurate quotes and problems during production runs. Because of the sheer volume, the ability to create accurate quotes quickly, without tying up process engineers, is vital.

EMS Quoting Not Just about Pricing

Errors in the source data cause delays in quoting or expensive production costs. Global events are also affecting component supply, adding eight to 30 months to the delivery time. Identifying obsolete parts or those near end-of-life is key to effective purchasing. Getting reliable pricing and lead time information is a cumbersome, manual process if done “the old way.” Quoting is performed by a costing/purchasing department, not part of manufacturing. OEMs deal with many of these issues as well, even if under more “controlled” circumstances.

The **Valor BOM Connector** tool was created to address these challenges and reduce the time needed to create accurate quotations for PCB assemblies. The tool imports and creates templates for BOM files to output a BOM that connects directly to the manufacturer’s ERP system. When used with Valor Process Preparation, consistency is ensured with the CAD file so that it can be used to confirm that all parts are appropriate for the board.

The software provides online connectivity to component suppliers, making it simple for manufacturers to check pricing and availability in real time. They can see which parts match existing inventory in the ERP system, which need to be sourced from component suppliers and, when available, minimum order discount levels. The system can connect with credentialed suppliers to conduct automated online searches and queries based on part descriptions and ensure that preferential pricing and deliveries are available (Figure 1).

The tool also enables keeping a history for each customer. Once a design is received and components are listed, the data can be saved for future projects. Storing the data so

The screenshot displays the Valor BOM Connector interface. At the top, there's a header bar with navigation links like 'Suche', 'ABC', 'IPN', 'Beschreibung', 'Menge', 'Kommentar', 'PROTO', 'PROTO-2', 'SERIE', 'SERIE-2', 'Distributoren', and 'CPN-Memo'. Below this, a table lists components with columns for these fields. A specific component is highlighted: 'NC7WZU04' with a quantity of 1 and a price of 0.04700 €.

Below the main table, there's a section titled 'Zugeordnete Angebote (PROTO) Fairchild: NC7WZU04P6X'. This section contains a table with columns: 'Quelle', 'Bestmge', 'Aktionen', 'Distributor', 'MPN', 'Lieferzeit', 'Bestand', 'Gebindeart', 'VE', 'MinMenge', 'Menge', 'Preis', 'Menge', 'Preis', 'Menge', 'Preis', 'Gültig bis', 'Währung', and 'Beschreibung'. Two suppliers are listed: 'Arrow Central Europe GmbH' and 'EBV Elektronik GmbH & Co. KG', both offering the component at a price of 0.03840 €.

At the bottom, there's a search bar labeled 'Suche' and a table with columns: 'Quelle', 'Distributor', 'MPN', 'MCOODE', 'Liefer...', 'Besta...', 'Gebindeart', 'VE', 'Menge', 'Preis', 'Menge', 'Preis', 'Menge', 'Preis', 'RoHS', 'NCNR', and 'Automat'. This table lists various suppliers and their component details, including 'Farnell', 'Digi-Key', and 'Future Electronics'.

Figure 1: Component suppliers have access to give up-to-date pricing and availability information for each part.



Figure 2: SMT line and production and assembly at BMK Group.

it is ready to use for the customer's next order saves time and ensures accuracy for future orders.

Case Study: Improving the BOM Process

The following is an example of how this tool has been used by BMK Group, a provider of electronic engineering and manufacturing services for the life cycle of electronic assemblies. The company's service portfolio includes the development, manufacturing, and end-of-life management of electronic assemblies and finished units for customers in the industrial, energy, vehicle, telecom, and medical sectors (Figure 2). Headquartered in Augsburg, Germany, the company's operations include facilities in the Czech Republic, Israel, and China. As a pioneer in the field of manufacturing automation, BMK was recently awarded Germany's Digital Champion Prize by *Focus Money Magazine* for the industrial sector based on its commitment to digitally transforming operations, business models, and company culture.

Given the industry trend toward high-mix, low-volume production, BMK faces the challenge of fulfilling more frequent NPIs and engineering change orders (ECOs) while attempting to increase efficiency and maintain profitability levels. To accomplish this, it expanded its digitization efforts to include manually performed manufacturing processes.

BMK is a regular participant in Valor's roundtable meetings sponsored by Siemens and its regional partner, CircuitByte, to consult with other PCB assembly specialists on how to improve operational efficiency via automation. During these meetings, Siemens and CircuitByte offered to replace BMK's legacy Unicam NPI tool with Valor Process Preparation software.

Robert Rudolph, BMK's head of process enhancement and senior NPI project leader (Figure 3), explained, "The decision to adopt the Valor system was a 'no-brainer' because of its extensive NPI feature set and comprehensive parts library." They integrated Valor Process Preparation into their process flow for



Figure 3: Robert Rudolph, BMK's head of process enhancement and senior NPI project leader.

generating stencil data generation, creating SMT machine programs, generating manufacturing documents, and validating components using the Valor Parts Library (VPL).

Jürgen Gagesch, SMT production engineer at BMK added, "With this solution, we can generate the missing CAD data from Gerber files and then import the accurate physical models of the electronic components from the VPL database. These are capabilities that we haven't had before."

They create the stencil data so they can achieve a higher quality level for the SMT process. With the new integration, they were able to improve this data prep process so that they can generate these data quicker and more automatically. Their challenge is to obtain an identical footprint for all instances of a specific component that is to be mounted on the board. Now, they only have to check a footprint once, and they use that same footprint for all instances of the component. The stencil module lets them create their own footprint database, and then reuse footprints from previous assemblies in new projects, which saves a lot of time.

Finally, they adopted Valor BOM Connector for improving their BOM preparation process. This new tool is designed to make it easier to load, prepare, scrub, format, check, and compare BOM data. They found they could create more accurate quotes much faster, and it provided them with a powerful database "backend" to track and reuse work for future projects.

The benefits were measurable. They noted that layout errors and incorrect assemblies were increasingly identified before the production stage. Their entire SMT process was accelerated by 10%. Stencil preparation is now 30% quicker than before. They can run the increasing number NPIs in less time, without additional staff, and they can more easily run high-complexity NPIs. **SMT007**



Mark Laing is business development manager for Siemens Digital Industries Software, and an I-Connect007 columnist. To read past columns or contact Laing, [click here](#).

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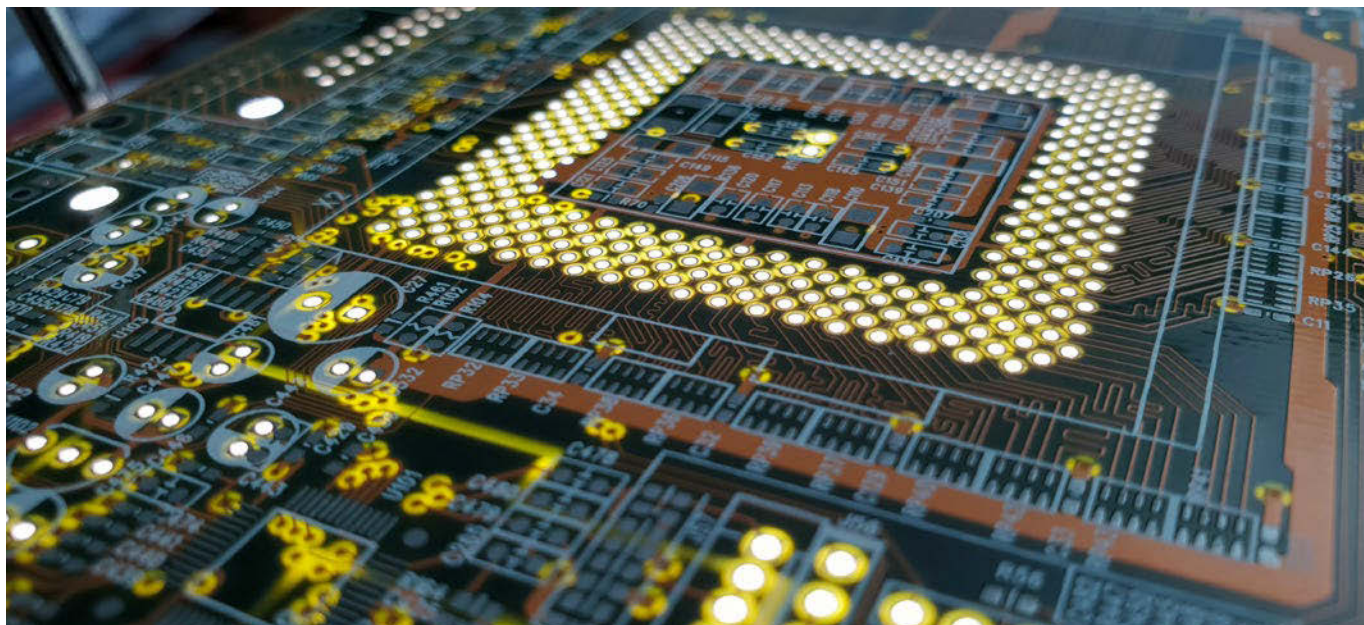
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Where Have All the Board Shops Gone?

Article by Stanley Bentley

ICAPE GROUP

When I look at the landscape of U.S.-based PCB fabricators, the title of this article reminds me of a 1960s protest song. If you don't remember the song or that era, you have some interesting research to do. As well, a Hank Williams, Jr., song comes to mind, *"All my rowdy friends have settled..."* Seriously, I am pleased to see many of my old friends taking advantage of the present opportunities.

The U.S. PCB industry is seeing a third wave of activity that is removing PCB shops from the general marketplace. In the late 1990s and early 2000s, there was a wave of closures as the PCB business quickly transitioned to Asia. This move was so sudden that many shops could not transition fast enough to remain in business.

The second wave, which happened around 2005, was what I call "The Key Takers"; these were ruthless raiders that promised struggling shops a way to preserve their business, protect their employees, and maintain a comfortable lifestyle. None of that was true, as their only desire was to obtain the customers without

investing any cash. The shops were auctioned, the customers transferred to an outsourcing agent, and the owners discharged (while keeping the debt).

Now, the third wave is gaining momentum. There seems to be two different groups gobbling up the remaining U.S. shops. The first are the investment groups that are "rolling up" shops into one entity. This is an activity that is common for fragmented industries. The only question is why it took so long in the PCB space. The other is a bit of a surprise. We are seeing M&A brokers approaching independent shops on behalf of an OEM. The apparent motive is not about earnings or vertical integration, but rather a way of stabilizing their supply chain for PCBs. Ironically, the PCB industry in the U.S. began that way with the shops owned by large OEMs. It is unclear whether either of these trends is good for the consumer. Investor groups don't buy things with any regard to the public good. They are looking for profits and the multiple those profits create in stock price.



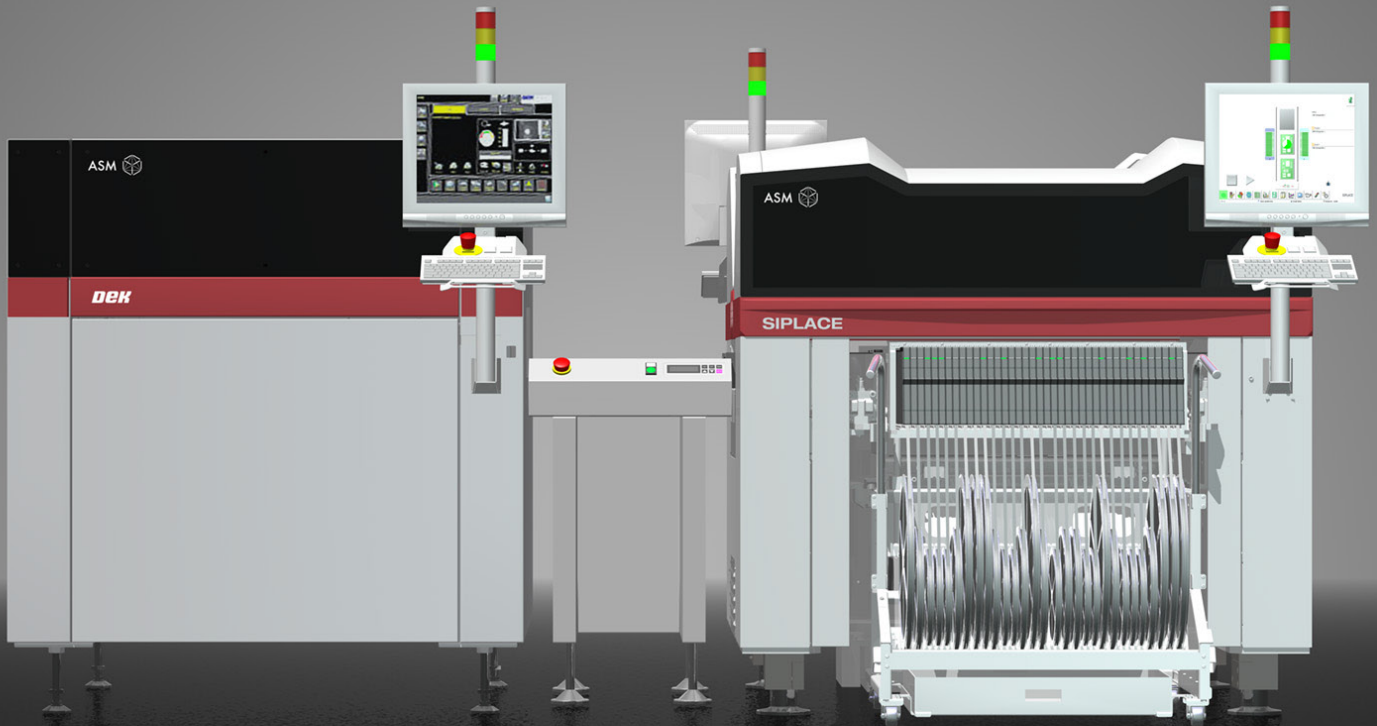
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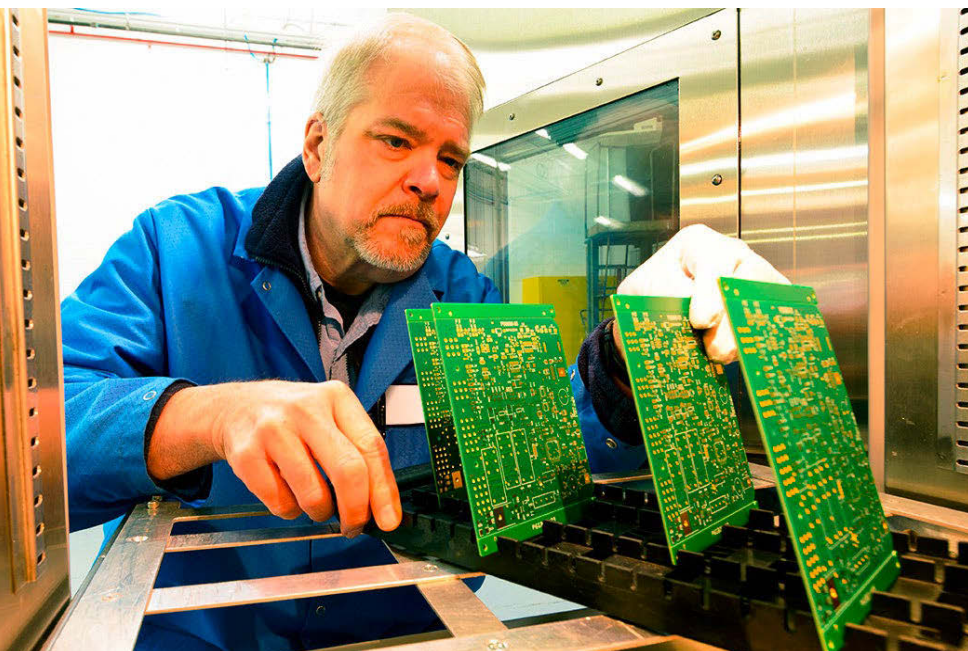
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a roll up are left more independent and the holes in their processes are filled (which requires investment), the disruption to the customer is minimized. If there is an immediate move to “fix them,” the results are usually not good. Every fab shop has its own “secret sauce,” and that secret is often confined to a few key individuals. (“Momma’s spaghetti can’t be made with store-bought sauce.”)

The OEM acquisition has its own difficulties. It would be rare for the OEM to need 100% of the capacity of the shop they

ing. An OEM purchase does little for the industry as it removes capacity and options.

So, where does this leave the consumer? Only time can really answer that question. But in the short term, the expected result is more confusion. Rolling up shops looks simple to investors. In fact, it is an easy “picture to paint.” In reality, it is very difficult to combine PCB shops without impacting customers. The reason is a unique part of the business that does not have a “column” in a financial analysis. No two shops have the same process technology. In areas like California and Chicago, many of the shops are spinoffs from other shops, so there is some commonality. However, as the time between the spinoff increases, these common elements begin to disappear. Since most of the spinoffs happened 10 to 20 years ago, the similarities are greatly reduced. For the shops that are not a spinoff, there is virtually no commonality. In a traditional roll up, the common functions are (immediately) combined to reduce overhead costs and smaller acquisitions are absorbed into the larger to fill excess capacity. Fab shops that have survived to this point do not have excess capacity. This is particularly true of the higher technology processes such as laser drilling, laser direct imaging, via filling, reverse pulse plating, and so on. If the shops in

acquired. Therefore, the acquisition strategy likely includes a plan to continue to satisfy existing customers and use that revenue to pay for the acquisition. Rarely does the OEM consider the continued investments that must be made to service the technology advances of the general market. The probable result is that they will gravitate to a wholly captive situation to reduce the investment. This will have the effect of displacing customers who must seek other suppliers.

One solution to the market disruption is to look for stable solutions that have been in the marketplace for enough years to allow the customers to evaluate their performance. The predominant model that has emerged over the past 20 years is the PCB trading partner. This model has shown very significant growth in the post pandemic recovery. There are a variety of reasons why this model offers viable solutions.

Technology Explosion

The technology for the PCB must evolve to remain compatible with the increasing demand for speed, performance, and lower cost. This is a struggle for a general-purpose shop due to the massive equipment and process costs that are part of each increase in technology. As a result, there is a strong trend for fab shops to special-



ize in a particular technology. A shop that has always supplied the routine six- to eight-layer PCBs may not be the best choice for an eight-layer HDI PCB.

If a customer must seek an additional supplier for their changing technology needs, they have a daunting task as everyone claims they are the answer. The roll ups can look like the solution as they have a variety of shops in their portfolio. However, never forget the charismatic insurance salesman that is confident that their portfolio is “exactly” what you need. Perhaps someone who can look at all portfolios might have more objective advice.

Volume vs. High Mix vs. Prototype

The equipment and the culture are very different between these three types of shops. It can be argued that if the shop is technology capable, it can certainly provide the pro-

totypes and the high mix. They can provide volume within the absolute panel capacity of the shop. However, the cost model for each of these types of shops is different. In all cases, when a shop steps outside its cost model, it will lose money.

I recall an opportunity from an automotive Tier 1 for a double-sided PCB. The volume was staggering, and they were willing to sign a multi-year deal. The revenue would have been almost 25% of our gross. The sales team was ecstatic about a huge single-part-number order. Manufacturing was relieved to be able to “just run” the same thing without all the issues of a high-mix shop. Unfortunately, the margin from this revenue was only one half of our usual margin and it consumed 50% of our drilling and plating capacity. Basically, within the first year, we would have been out of cash and out of business. The lesson is to properly match



the opportunity to the supplier. This task is easier with an objective partner that is knowledgeable about the PCB landscape.

Technical Resources to Assist in Decisions

One of the casualties of the drop in the number of independent PCB shops is the trusted partner that was willing (and able) to invest time and expertise in its customers. Early in the industry, this was how PCBs were sold. Today, those customer-focused technical resources are not considered profitable as more of the outside-facing resources are dedicated to pure sales. There is no doubt that good salespeople are concerned, smart, and available to the customers. These attributes are perfect for their profession. Unfortunately, understanding PCBs to a level that is required to offer design assistance to the customer (on a timetable they need) takes two things: the years of experience at a technical level (not just knowing the buzz words), and having a job description that is dedicated to customer support. The knowledgeable technical resources within today's fab shops are their most precious asset and diverting them to spend hours with design engineers is not practical. In the modern mar-

ket, it is more critical than ever that the PCB supplier has in-country resources that are technically competent and view its primary responsibility as supporting design engineers. However, addressing this customer need is seldom a part of the acquisition strategy.

Third-party Problem Resolution

The value of an independent partner to handle problem resolution cannot be overstated. The simple fact is that when a business-critical issue happens with a supplier, the top resources of the company are immediately re-directed to resolving the dispute. It would be a very rare company that had executives with the authority to make critical decisions that were not urgently needed within the business.

The conclusion is that when a company is looking for solutions and stability in the PCB market, it is wise to consider a partner relationship that does not have a vested interest in their physical investment. It is also wise to determine the value-added services that a partner brings that can improve long term opportunities for the customer. My recommendation is a partner with in-country experts, long-term business stability, and domestic and international relationships to offer the "best" solution, not just "their" solution. **SMT007**

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Stanley Bentley is the technical director for ICAPE Group in the Americas. He is a 50-year veteran of the electronics industry. He is a registered professional engineer.

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WORLDWIDE ENVIRONMENTALLY RESPONSIBLE CLEANING TECHNOLOGIES

Solder Mask Repair Techniques for PCB Repair

Knocking Down the Bone Pile

by Bob Wettermann, BEST INC.

One of the most common physical repairs¹ (restoring functional capability of a defective PCB while not complying to meet original specifications) on a PCB is the repair of solder mask. Solder mask's purpose is to prevent solder from flowing from one point to another during the original assembly process. Damage to solder mask (Figure 1) can be aesthetic or functional in nature, such as the case when the mask preventing solder from flowing down the “dog bone” of a BGA causes the BGA ball solder joint to be “starved,” thereby causing a defect.

There are several ways in which solder mask can become damaged. Missing mask can occur due to a breakdown in the mask adhesion to the PCB. Mask can also become damaged when an uncontrolled heat source and solder braid is used to remove solder from a pad location, thereby scratching off the mask. In cases where the mask is exposed to a high number of heat cycles, the mask can become brittle and break down (Figure 2). Poorly adhered solder mask may cause solder shorts, other soldering anomalies, or result in solder mask flowing down the dog bone from a BGA pad.

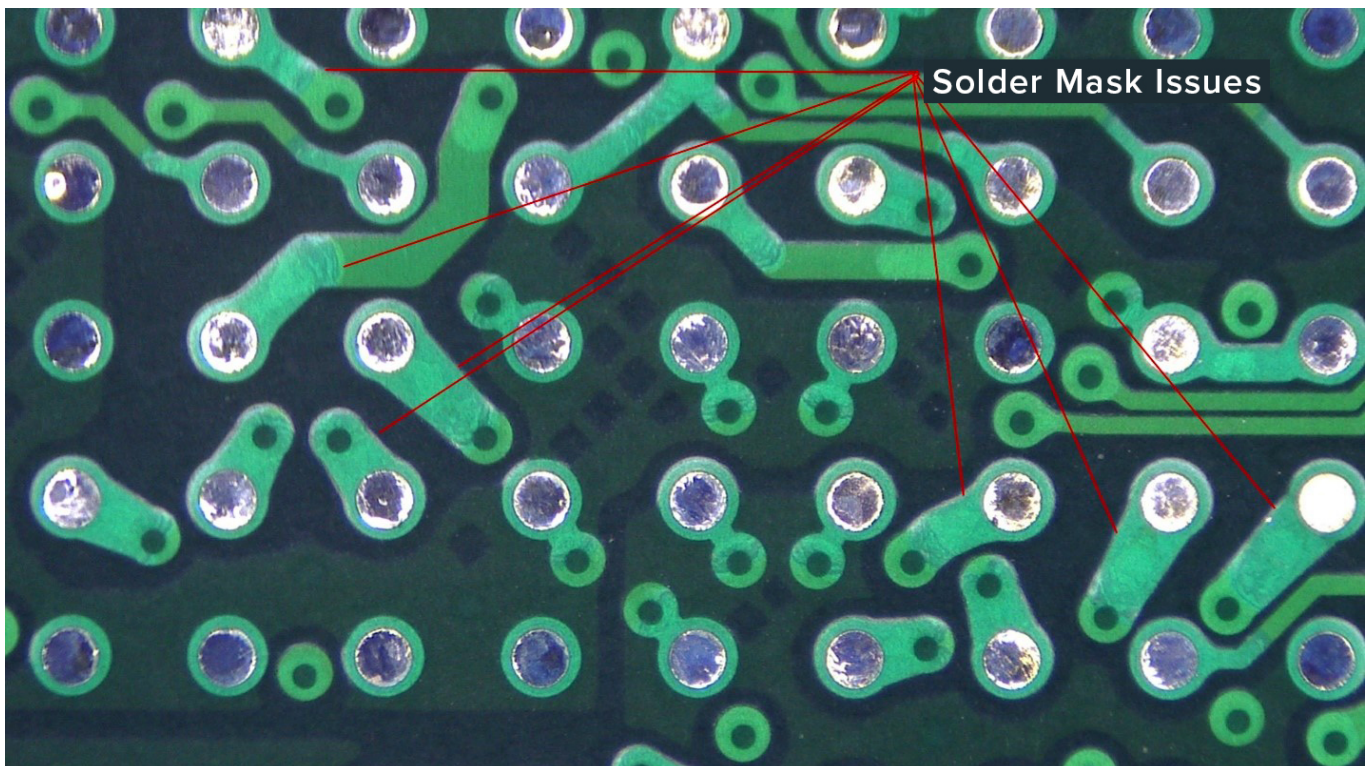
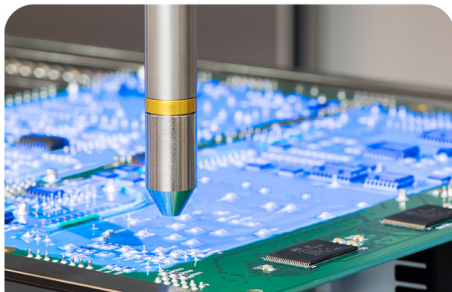


Figure 1: Solder mask defects.

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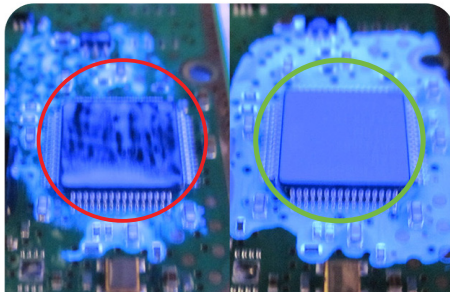


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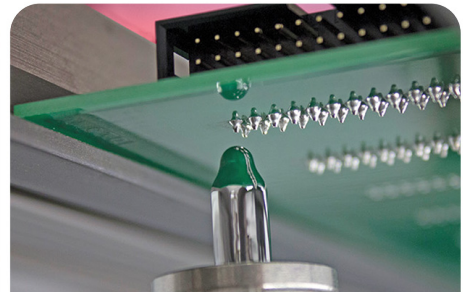
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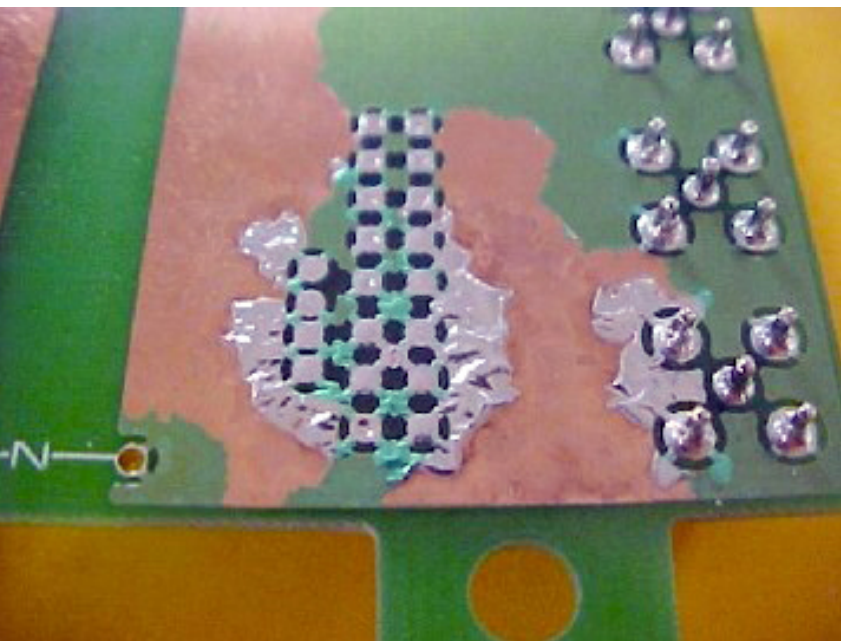


Figure 2: Example of solder mask adhesion problems.

Solder mask can be repaired using one of several different techniques, each with its own advantages and disadvantages. One method, as outlined in IPC 7721 2.4.1, is via the use of liquid solder mask. This can be spread onto the areas that need repair. This replacement mask is then either heat- or UV-cured. After read-

ing the manufacturer's directions, UV-cured solder mask is selectively applied and placed underneath the UV lamp of the right wavelength. Based on the output of the UV lamp (which can be measured using a radiometer) a cure time for the given solder mask along with lamp-mask distance, a controlled process can be documented by the repair technician.

Another method (Figure 3) is a simple technique for "spot" solder mask repair by using a repair "pen" (IPC 7721 2.4.1) which is typically cured by air drying or a bakeout cycle. The liquid oozes out of the soft-tipped pen and then can be air- or heat-cured. The pen tips themselves are large with respect

to the size of modern BGA pads, making it a challenge to precisely dispense the mask material. Due to the porous nature of the dispensing tip, it tends to pick up debris from the board (including flux residue, remnant mask, and cleaning agents). This soaked-up debris then can re-contaminate other areas of the board.

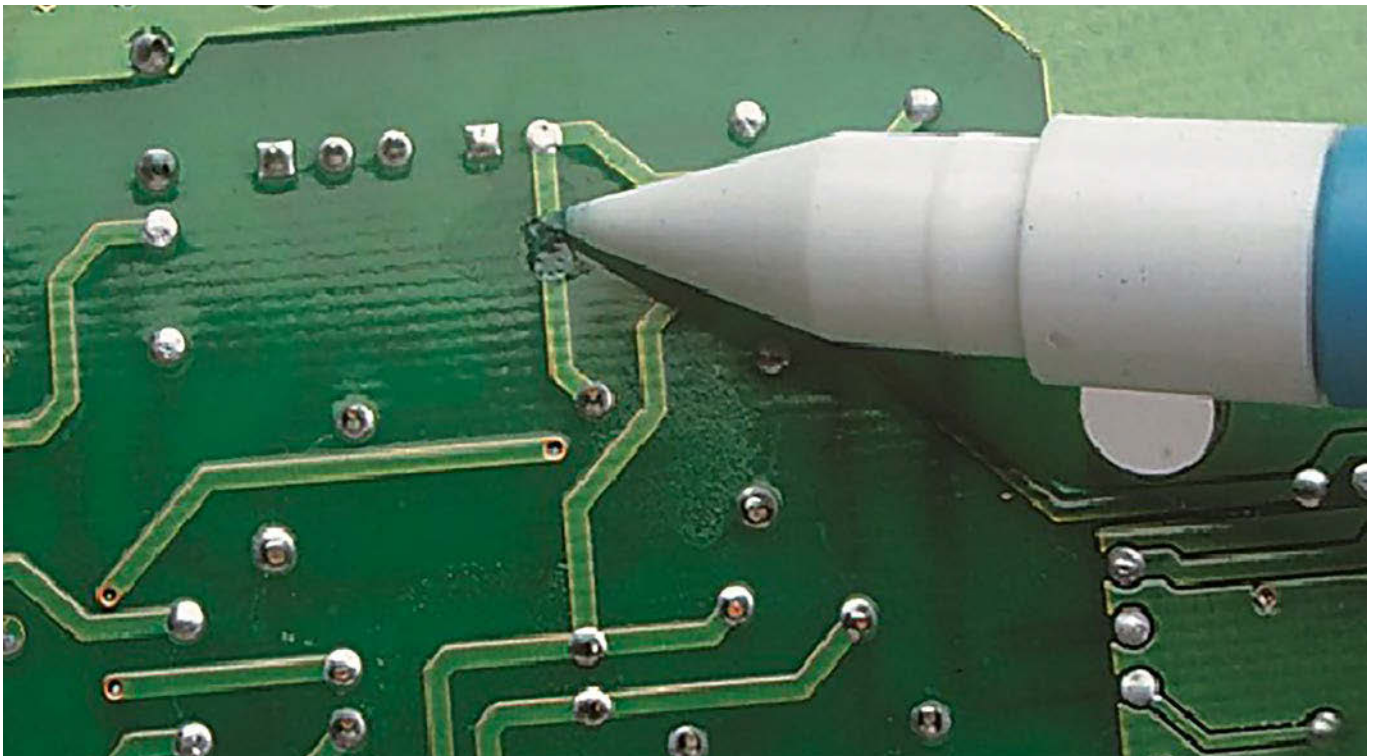


Figure 3: Spot solder mask repair with repair pen. (Source: Chemtronics)



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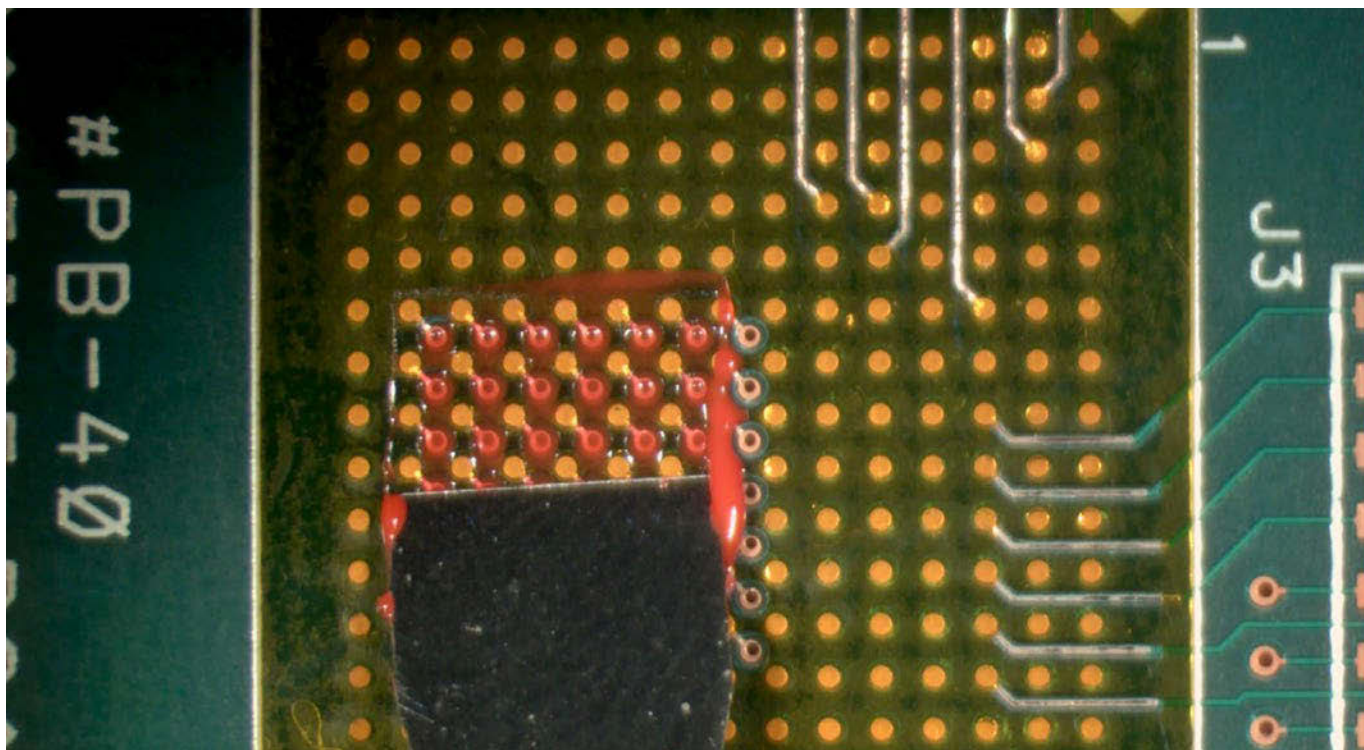


Figure 4: Stenciling technique for multiple location solder mask repair.

The skill level for someone making solder mask repairs using this technique will need to be at the advanced level and, even so, the repair aesthetics tend to be low compared to the technique outlined in IPC 7721 2.4.1.

In addition to this repair pen method there is another technique which repairs the mask underneath the BGA using a polyimide, adhesive-backed, stay-in-place stencil. This serves as a reliable way to place the BGA while simultaneously repairing the mask. This stencil, while having the benefit of being a simple way to place a BGA, also provides isolation between pads and prevents shorting between the IO. This will fix the standoff height between the base of the BGA and the PCB to control collapse height, while serving as a mask “band-aid.” Once in place, the stencil acts like a solder mask repair stencil. This allows even the beginning repair technicians to repair damaged solder mask underneath the BGA.

Lastly, there is the mask repair stenciling technique (Figure 4). This method saves repair time when a large area requires mask repair. An ultra-thin stencil defines the area where

the mask is repaired. Replacement mask material is squeezed into the stencil apertures and then cured. Post curing, the stencil is peeled away, leaving hardened replacement mask in its path. This method, while time saving for multiple boards requiring the exact same area of repair or for a very complex large area of repair, requires a repair technician with an advanced skill level.

Like all PCB repairs, the customer must need to be informed if mask repair is called for in repairing the PCB. There are many techniques depending on the purpose of the assembly, the cost, and the complexity of the mask repair required. **SMT007**

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1. “Rework, Modification and Repair of Electronic Assemblies,” IPC-7711C/7721C, IPC January 2017.



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

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

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

CFX IIoT Open-Source Hardware

Smart Factory Insights

by Michael Ford, AEGIS SOFTWARE

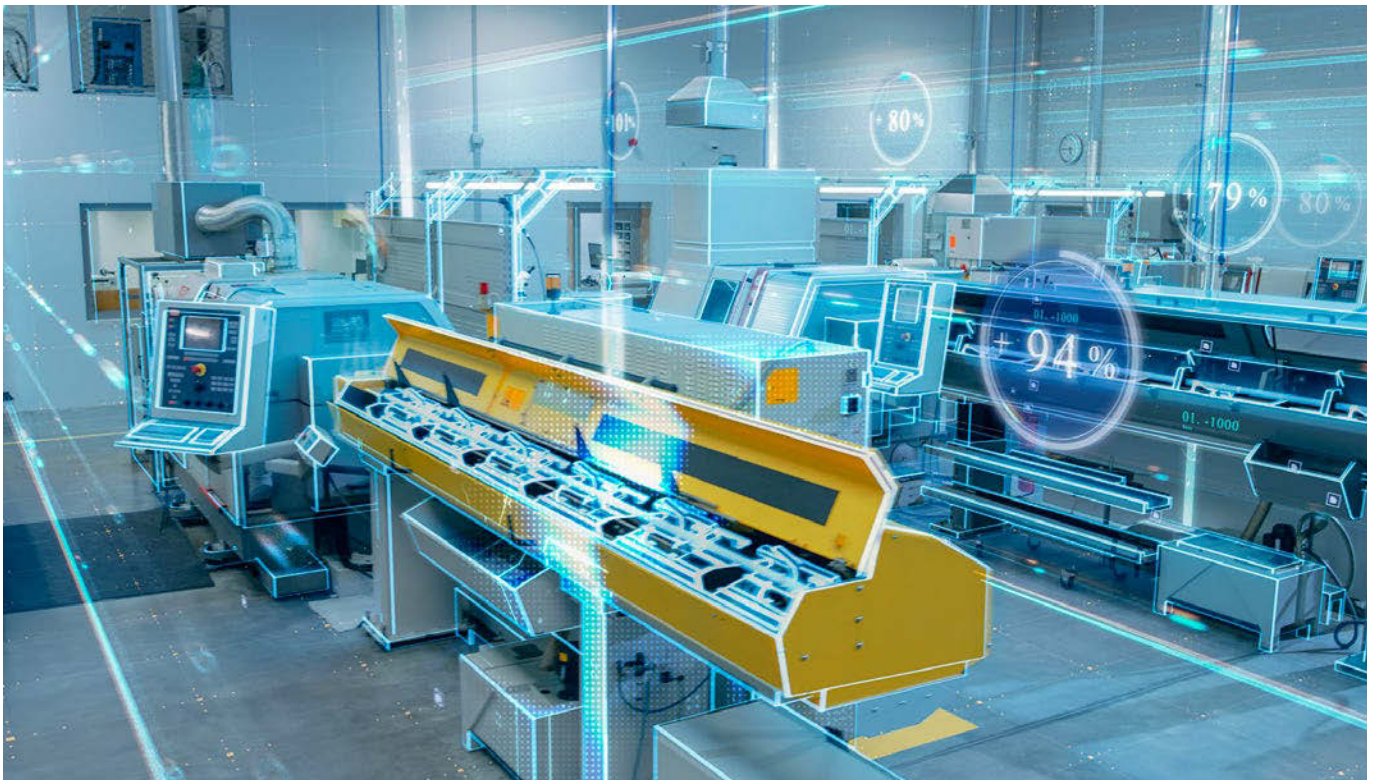
The IPC Connected Factory Exchange standard (CFX) has triggered a rapid evolution in the way that industrial machines communicate in a secure, IIoT-based, plug and play environment. Attention now is on how CFX can be connected to older, “dumber” machines, bringing 100% visibility and control across the whole manufacturing floor, thereby avoiding the numerous technical and financial pitfalls historically experienced.

The Problem

Is it a realistic expectation that something new can be applied to things that are very old?

Windows 11, for example, only works on personal computers that have a certain Trusted Platform hardware module, which, though available, had not been included on most personal computers until the requirement was announced. Almost every PC in use today is therefore destined to be scrapped or remain on legacy versions of Windows forever.

Though some would argue that this may create somewhat of a shock to the environment, PCs are far more replaceable than are industrial machines in manufacturing, where we see many cases of machines working well after 25 years or more of use. For sure, these machines



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are not the fastest or most accurate, but if they are fit for purpose, any machine that has been amortized costs only the floor-space on which it stands, the energy it uses, and the odd bit of maintenance, all of which can make it very cost effective. Are the potentials of modern, digital communication, visibility, and control enough to justify a replacement of a machine, or for the machine vendor to go back and develop CFX support as an option? In many cases, especially beyond the SMT manufacturing area, the answer is “no.”

Almost every PC in use today is therefore destined to be scrapped or remain on legacy versions of Windows forever.

Historically, as computers became increasingly used in manufacturing, we have seen valiant efforts where users try to extract useful information or establish a form of remote control with machines that are without the ability to communicate, often to the detriment of the machine, sometimes in catastrophic ways. The cost and risk of customized hardware and software, as well as the increasing need for middleware, all contribute to ensuring that communication in such cases has remained basic, inaccurate, and unreliable, as well as a risk to the performance of the machine.

The CFX standard is intended to replace all that. With the free open-source, community-supported Software Development Kit, CFX can be provided with a fraction of the development effort required for bespoke interfaces or the support of other standards. The CFX fully-defined single language for data ensures that middleware is not needed. The IPC qualification program ensures that, when buying new

machines, manufacturers have the assurance that they can genuinely plug the machine into the CFX network, and the communication works. No coding needed, no customization, and no unexpected costs or delays. Machine vendors are increasingly embedding CFX into their new machines, and where capable, retrofitting it to recent models. This does leave however, a third category of machines, usually older models, where the native support of CFX is seen as ranging from uneconomic to technically impossible.

As such, MES and other smart, analytics-based solutions that use CFX data are left with gaps in their visibility and control, reducing the overall value potential. Existing mature solutions do offer alternative machine interfaces that fill in some of the gaps, which is effective in those cases where CFX will be provided by the vendor at some point. Looking at assembly beyond SMT, there is a far higher proportion of machines that have no communication ability or use a bespoke method without interoperability or compatibility. Where there is no way to extract useful data, custom third-party or in-house hardware solutions have been created and attached to the machine mechanics and electrical systems, that derive data from specific signals and actions. These have proven to be quite costly both to develop as a case-by-case customized item, and to purchase and maintain. They are usually developed in isolation from the machine vendor, with end-users left to bear the consequences of their actions.

The Solution

Applying the same principles to a hardware-based solution, as has been applied to software, the key “gotchas” of additional hardware/middleware solutions can be avoided. Creating open-source hardware means that predominantly off-the-shelf components can be assembled in a standard way to create a proven modular, flexible interface, driven internally by software based on the existing CFX SDK with additional firmware. This project has been started

with a design based on the very popular, powerful, and affordable Raspberry Pi computer, with flexible, modular I/O connections that utilize the CAN-BUS interface. Small CAN modules can be located around a specific target machine, each equipped with sensor connections that derive information about the various machine operations. This can be achieved using non-invasive technologies, to not require any electrical connection to the machine other than through designated ports where available.

All intellectual property (IP) related to this solution, in terms of both hardware and software, is to be free and open-source, available for anyone to utilize, and for anyone to contribute to. This removes the duplication of effort designing the various modules that are needed to support a wide range of different machines that are out there. This is intended for use in different ways:

1. Manufacturers can take the designs and quickly and reliably create CFX interfaces for equipment they own that has no native CFX vendor support.
2. Machine vendors can take the designs to make their own approved CFX boxes in a cost-effective way, providing CFX solutions for those machines which cannot be natively supported with CFX software alone.
3. Hardware/software solution creators can provide standards-based CFX machine connection services for a range of equipment.

Working together, machine vendors, solution providers, and their manufacturing customers work to ensure that CFX hardware-based endpoints are created that are consistent, interoperable, cost effective, posing no risk to the machine operation, and provide enough functionality through CFX to fill the gaps in the smart factory network. It is likely that such hardware-based interfaces could become fully CFX qualified, as sensors and designs are devel-

oped and built upon within the community. Collectable information potentially includes:

Basic

- Sensors for:
 - Active machine operation and status (e.g., light-tower sensor)
 - Product arrival, movement, departure from the endpoint
 - Material setup sensing
 - Error conditions
- Barcode reader:
 - Product ID reading and confirmation for tracking and route enforcement
 - Material verification
 - Operator login
- Machine port connection:
 - RS-232, RS-485, Ethernet and SMEMA, Hermes connections
- Isolated contacts for:
 - Setting machine operation mode (start/stop)
- Local terminal:
 - Configuration and setup

Advanced

- Sensors for:
 - Predictive maintenance: temperature, vibration, energy patterns, specific mechanism cycle count
 - Routing confirmation
- Local terminal for:
 - Online/offline mode recognition
 - Debug and diagnostics
 - Local machine learning
- Inter-standards gateway:
 - OPC-UA/MT-Connect/CAM-X, etc., conversion to CFX

The key to the success of this project is to gain the involvement of many influencers across the industry, including end-users, machine vendors and solution providers. There is already a small team involved, including experts from

the Raspberry Pi design team, the UK's Manufacturing Technology Centre (MTC), Aegis software, and of course, the IPC. The team is focused on creating an open standard set of hardware and software, driven by industry consensus, following the guidelines and principles of IPC standards development.

The fundamental value of this initiative is to open and enable Industry 4.0 digital manufacturing in areas that native CFX software alone cannot penetrate. Providing open source of hardware design, components, and software means that all potential applications of CFX can be considered, with pitfalls of cost and risk associated with bespoke design and deployment avoided. In particular, we would encourage machine vendors to see this as an opportu-

nity to expand their Industry 4.0 footprint for older machines, with low risk and cost, but significant value to customers.

The outreach is to any company or individual that may be interested, to contact the team, to help with the initial hardware and software framework development, as well as the testing and trialing of prototypes to be used as show-cases. **SMT007**



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

Real Time with... IPC: Advocacy in Washington

Nolan Johnson talks with Chris Mitchell, vice president of Global Government Relations at IPC, on industry advocacy in Washington to educate Congress on our key issues. Their conversation also covers the growth in global advocacy.





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A Tale of Two Perspectives

Maggie Benson's Journey

by 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.

The workers at Ivy Electronics felt nervous. Because their company had recently been sold, many expected that the new management would lay them off. They worried their backgrounds and experience at Ivy Electronics did not provide them with enough skills to land a new job, even in the current surplus environment. The workers gathered on the shop floor to hear from the new owners. Ned Price, the previous owner, was not present.

A tall, confident woman entered the shop floor. "Hello everyone, I'm Maggie Benson,

your new co-worker at what will now be called Ivy Benson Electronics."

Everyone held their breath, expecting the worst.

"I want to start by reassuring anyone who may be concerned that you will be able to keep your jobs," Maggie announced to the group, adding, "All employees will also receive an immediate 20% raise."

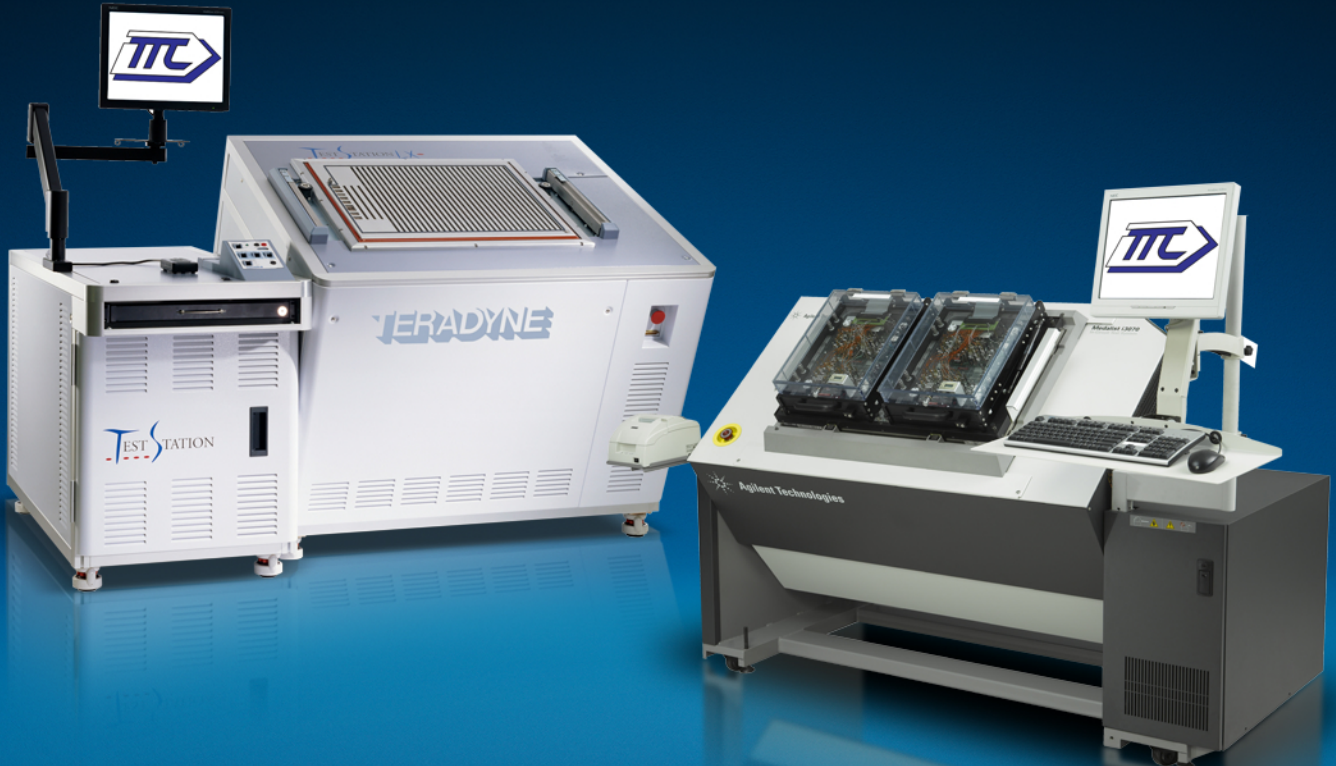
The room was quiet enough to hear a pin drop. The workers were so stunned that no one said anything. Maggie was unsure how to read the silence, so she continued speaking.

"We feel we should close the shop for two weeks, starting tomorrow," she said. "The time will be used to repair the restrooms, remodel the break room, and for general cleaning and organizing of the shop floor. We will all work



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together to accomplish these much-needed tasks. We have hired a few plumbers, electricians, and carpenters. As you may know, these folks are hard to come by, so these specialists have requested some help from us to do the work. I plan to be on the cleaning and painting crew.” As pointed to John, Maggie said, “My fiancé John will work with the plumber, as he worked as a plumber’s assistant while in college.”

John then spoke up: “There is coffee and donuts in the break room for all. We will be there to answer questions.”

Everyone proceeded to the break room, many still stunned by the good news. Expected questions were asked and answered. It was shared with the employees that Ivy Benson Electronics would be offering training for their employees, and even tuition assistance at the local colleges. Maggie and John introduced Chuck Tower as the general manager, and Tanya Brooks as a lead engineer, who would be sharing these duties with Phil Consol.

It took three weeks to prepare Ivy Benson Electronics to be reborn. The new restrooms were immaculate with completely new fixtures and repaired plumbing (Figure 1). The break room was remodeled beautifully. It included

vending machines that sold food and drinks at cost, Wi-Fi for smartphones, and two computers for email and web surfing during breaks (Figure 2).

The workers pitched in to create these new changes. When the shop was back up and running, 5S had been implemented at all repair work stations and in the two manufacturing lines. The manufacturing processes were streamlined to eliminate any of the 8 Mudas, and spaghetti diagrams¹ were used to minimize wasted motion. From lessons learned in improving productivity and quality at Benson Electronics, the uptime and first pass yield were at 30% and 95%, respectively, soon after production began anew. To support these improvements, Pareto charts were used to track defects and assembly line uptime was measured continuously.

About three months later, things were humming at Ivy Benson Electronics. So many new orders were coming in that Maggie and John had to hire new workers. Employee morale was terrific because of the improvements in the facility, training, and after-work reimbursed education at the local colleges.

Maggie was working in her office when she was startled by the phone ringing.

“Hello, this is Maggie at Benson Electronics. How many I help?” Maggie cheerfully answered.

“This is Ned Price. I wondered if I could meet with you and John and get a tour of what you have done to my factory and the workers?” Ned asked gruffly.

Maggie agreed and suggested they meet at Ivy Benson and then “do lunch.” A few days later, on the appointed day and time, Ned showed up at Ivy Benson. He seemed angry.

“Why don’t you just give me a tour, and I won’t say anything,” Ned began.

Maggie and John were a bit surprised by Ned’s approach but welcomed him into the factory.

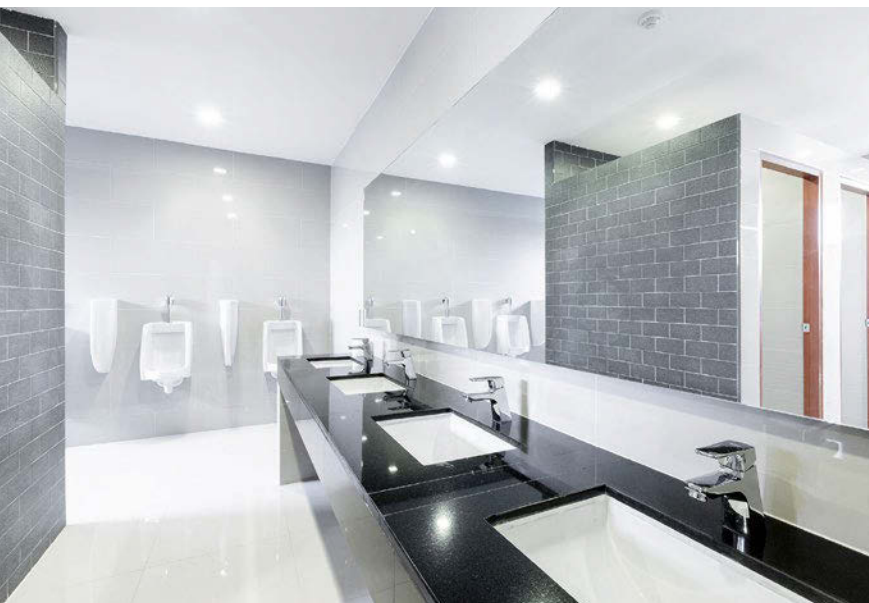


Figure 1: The restrooms at Ivy Benson Electronics after the improvements.

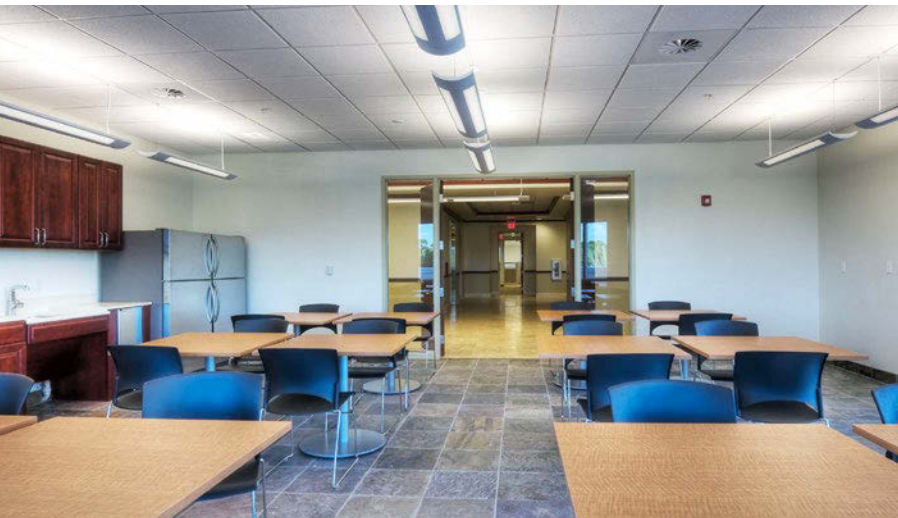


Figure 2: The renovated breakroom was appreciated by the team at Ivy Benson.

“As you can see, we organized the shop floor using 5S and addressing 8 Muda issues. The rework stations all have shadow graphs for the tools, and we have encouraged the staff to keep them neat. We have been impressed with the many helpful suggestions the workers have made to help us achieve an effective workflow,” John said.

“Everyone chipped in and worked with a few plumbers, carpenters, and electricians to update the restrooms, the break rooms, and the basic structure of the two buildings. I think all of us did a lot of painting,” Maggie added with a chuckle.

“We have had several meetings to explain the importance of uptime, quality, and productivity in general,” she continued. “We have daily Pareto charts posted to show yield fallout, and graphs to demonstrate important productivity metrics. We have made a considerable effort to help us understand what makes Ivy Benson productive with quality products.”

As they walked, John told Ned, “We are training the operators to understand how the machines work, and how to operate them most effectively. All operators can be cross-trained on as many machines as they like. We have been really impressed by how enthusiastic the staff has been with these opportunities. On a side note, the solder paste being used was

inexpensive, but it had response-to-pause and yield issues, so we replaced it with a more expensive, but better one.”

The one-way chatting continued as they walked to the breakroom. Ned looked around at the new vending machines. His eyes wandered over the low prices. He looked at the two computers. He looked angry.

“We have installed Wi-Fi in the facility for the workers to use during their breaks,” Maggie proudly stated.

They then headed to the restrooms, ensuring they were empty first. Ned glared at the attractive new fixtures and the overall bright, cheery appearance. Neither Maggie nor John knew if he noticed that the bad odor was gone.

As it was obvious that they were finished, Ned began to speak. “You two have ruined my masterpiece! I was determined to deliver to my customers the lowest possible price, and I did it by reducing my costs. You two have gone crazy by spending all this money to make the place look fancy and by coddling the workers. They will just take advantage of you.”

As his face turned red, he continued, “Subsidized vending machines and Wi-Fi? Are you daft? The workers will be in the break room all day goofing off. And educating them? What a joke! These aren’t the kind of people that you educate. When you do, they will just leave for other companies.

“I have a mind to start a new business to take care of my customers since you two have abandoned them,” he finished with rage in his voice.

There was silence for a moment, then John responded, “Our colleague, Frank Emory, has performed a cost and profit analysis of the business when you owned it vs. after we took over. By improving uptime, productivity, and quality, we have reduced our manufacturing costs considerably and have passed some of these savings on to our, not your, customers.”

"We can also show that improving the working conditions and educating the workers has reduced turnover and absenteeism, also reducing costs," Maggie said. "We forgot to mention that we have a year-end bonus program for the workers that is tied to our profitability. The workers have really bought into it, and it has helped the bottom line."

Ned Price was beside himself. "You 'Ivory Tower' types are all the same. There's no sense taking me to lunch. You should save the money to offset the losses you will accrue with your big spending practices," he said.

With that final comment, he huffed and walked out the door. As Maggie and John watched Ned leave, three workers approached them. They looked extremely troubled.

Finally, one spoke. "Is Mr. Price coming back?" Sam Berzinski asked, his chin appearing to quiver.

"No, Sam, Ned Price is not coming back," John answered. Sam was impressed that John knew his name.

"We're so relieved," said Rachel Goodman, another of the three.

"Ever since you took over, we have been excited to come into work," said Lucy Concha, the third member of the group. "It is so pleasant here, and you and Chuck treat us so well. We all want to work very hard to make Ivy Benson as successful as possible. We are also so grateful for the educational opportunities you have given us. We've never been treated so well by an employer in our lives."

Sam, Lucy, and Rachel chatted for a few more minutes with John and Maggie, and then suggested that they should get back to work.

"How can something so obvious be missed by someone like Ned Price?" John asked Maggie.

"I think I know what you mean, but can you elaborate?" she responded.

"Well, isn't it obvious that by treating the team at Ivy Benson well and providing good working conditions and opportunities for education, that the company will make the most profit?" John asked.

"And it's the right thing to do as a human being," Maggie added.

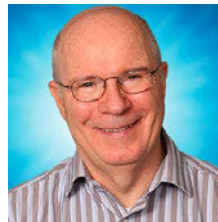
A bit overcome with emotion by the comments of Sam, Rachel, and Lucy, Maggie was simultaneously reminded of her gratitude for John. How fortunate she was to have such a wonderful life partner. Without thinking, she pulled John toward her, and gave him a substantial kiss. She didn't care that all the workers cheered.

Stay tuned for the next episode, as Maggie and John visit Maggie's grandparents to summarize the improvements at Benson and Ivy Benson Electronics.

Note: I imagine many readers are chuckling or groaning as they read how outrageous and non-perceptive Ned Price was. However, Ivy Electronics, before Maggie and John took over, is a composite of several of the assembly facilities I have audited among the scores I have visited worldwide. The descriptions of the restrooms and mistreatment of the people was real. Luckily, there were only a few facilities as described in the last few episodes. Most troubling, however, is that in some parts of the world, educating or training workers is frowned upon. I was involved in several cases where free training was offered and turned down as management was concerned that the newly trained workers would leave and go to competitors. SMT007

References

1. What is a Spaghetti Diagram?, ASQ.org.



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

Lasky, [click here](#).

Download [The Printed Circuit Assembler's Guide to... Solder Defects](#) by Christopher Nash and Dr. Ronald C. Lasky. You can also view other titles in our full I-007e Book library [here](#).



MEETINGS
& COURSES

Jan. 21-26

CONFERENCE
& EXHIBITION

Jan. 24-26

SAN DIEGO CONVENTION CENTER | CA

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cyber security

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networking

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Advance in a new era of electronics manufacturing at IPC APEX EXPO 2023. Hear from the best minds in the industry, discover what is new and next, and collaborate with your peers at North America's largest gathering of electronics manufacturing professionals.

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THANK YOU TO OUR SPONSORS, EXHIBITORS, SPEAKERS AND ATTENDEES
FOR MAKING 2022 A SUCCESS!

The Government Circuit: Ready to Tackle 2022

As anticipated, it was a busy close to 2021 in Washington, and we saw resolutions on several major legislative priorities, including the annual defense authorization bill, which affects billions in future defense electronics spending. Meanwhile, negotiations on the U.S. Innovation and Competitiveness Act (USICA) remain on the back burner but could heat up in Q1. Read on for some of the recent highlights from 2021 and a look forward to 2022.



Chris Mitchell

Real Time with... IPC APEX EXPO 2022: Quoting, the Supply Chain, and BOMs



During this conversation, Business Development Manager Mark Laing of Siemens Digital Industries Software and Editor

Nolan Johnson discuss the latest in EMS quoting and a variety of challenges in the supply chain. They also discuss the quality and accuracy of BOM data supplied to EMS companies.

Standard of Excellence: Partnerships Made Us Stronger

It's a brand-new year; things are going to be different. We have now settled into the COVID life. But the good news is that we have learned how to do things effectively during these especially challenging times. Some of us have increased our marketing, others have found different ways to communicate with our customers, and many of us, much to our surprise, have found that our top numbers have been actually increasing in the past two years.

Real Time with... IPC APEX EXPO: Advocacy in Washington

Editor Nolan Johnson sits down for an interview with Chris Mitchell, Vice President of Global Government Relations at IPC. They discuss the industry's advocacy in Washington to educate Congress on our key issues, as well as the growth in global advocacy by IPC.



IPC: High Material, Labor Costs Continue to Challenge the Electronics Manufacturing Industry



New data from IPC show that supply chain challenges remain acute, but may have peaked, while lead times remain high. IPC's February economic update and global electronics manufacturing supply chain sentiment reports found that high material and labor costs are expected to continue for at least six months while recruiting and finding skilled talent continues to be difficult.

X-Rayted Files: Nine and a Half Facts About Unknown Radiation

Yes, the pandemic still here, inflation is kicking in, labor shortages are an issue, supply chains are still disrupted. But let's take a break from all that and have some fun with X-rays. How about going over some facts that you may (or may not) know about X-rays?

Foundations of the Future: 2021 Scholarships and Awards Overview

One of the programs the IPC Education Foundation is proud of is the IPC Scholarships and Awards program. 2021 was a year in which students and teachers were recognized for their commitment to the electronics manufacturing industry. A total of \$38,000 was awarded.

Three Long-time IPC Volunteers Receive Dieter Bergman IPC Fellowship Award

Three IPC volunteers who have fostered a collaborative spirit, made significant contributions to standards development, and have consistently demonstrated a commitment to global standardization efforts, were presented with Dieter Bergman IPC Fellowship awards at IPC APEX EXPO 2022.



Real Time with... IPC APEX EXPO 2022: Connecting the Digital Thread



Jason Spera of Aegis Software has an interesting conversation with Nolan Johnson on the Industrial Internet of Things (IIOT) digital thread connected data flow.

As the move to smarter factories accelerates, the need for managing and optimizing interconnected sensors, instruments, and other devices networked together increases.

Real Time with... IPC APEX EXPO: ICAPE Continues to Expand

ICAPE's Paulo Franca and Editor Andy Shaughnessy discuss the company's recent acquisitions around the globe, including a PCB fabrication facility in South Africa.



For the latest news and information, visit [SMT007.com](https://www.smt007.com)

Career Opportunities



Is your team growing?

Find industry-experienced candidates at I-Connect007.

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

In addition, your ad will:

- be featured in at least one of our newsletters
- appear on our jobConnect007.com board, which is promoted in every newsletter
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Contact barb@iconnect007.com to get your ad posted today!

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I-Connect007
GOOD FOR THE INDUSTRY



Career Opportunities



R&D Scientist III, Orange, CT

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

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Prototype Engineer, Sawanee, GA

Job Description: The purpose of this position is to provide direct technical and customer support for the Electronic Polymers (EP) product line of the Semiconductor Solutions Group for existing products as well as new and developmental products. The position is responsible for leading the team with customer builds and proof of concept designs directly engaging with customers. The position will lead a variety of technical, customer support, quality, marketing, process, and production related projects.

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Regional Manager Midwest Region

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

DETAILS OF FUNCTION:

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

QUALIFICATIONS:

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

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

fernando_rueda@kyzen.com

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Career Opportunities



MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

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

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

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

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

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

Must be able to travel extensively.

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ventec

INTERNATIONAL GROUP

騰輝電子

Customer Service Representative

Fullerton (CA) USA

(and) Elk Grove Village (IL) USA

Ventec is looking to expand our Customer Service/Internal Sales team at our facility in Fullerton, California, and Elk Grove Village, Illinois.. As Customer Service Representative you will provide great sales and customer service support and respond to the needs of clients from industries including Aerospace, Defense, Automotive and Pharmaceutical. Duties include:

- Maintain and develop both existing and new customers through individual account support
- Make rapid accurate cost calculations and provide customers with quotations
- Accurately input customer orders through the company's bespoke MRP System
- Assist the sales team with reporting, sales analysis, and other items at their request
- Liaise with colleagues at Asia HQ and Overseas Business Units to manage domestic and international requirements

Required Skills and Abilities

The ideal candidate is a proactive self-starter with a strong customer service background. Friendly, approachable, and confident, you should have a good phone mannerism and be computer literate.

- Previous experience in a Customer Service background, ideally management or supervisor role
- Experience with MRP Systems
- Good working knowledge of Microsoft Office Tools such as Outlook, Excel etc

What's on Offer

- Excellent salary & benefits commensurate with experience

This is a fantastic opportunity to become part of a successful brand and leading team with excellent benefits.

Please forward your resume to:
Jvance@ventec-usa.com

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Career Opportunities



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

Application Engineer/ Program Management

Responsibilities

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

Qualifications

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

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

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

Responsibilities

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

Qualifications

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

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

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Career Opportunities



Engineering Project Manager Graphics/Film

The primary purpose of this position is to manage Process Development, Process Scale Up and Capital projects in the Global Process Engineering Group (GPEG) function.

THIS INCLUDES:

- Managing the complete life cycle of the highly complex projects including approval of the projects, the planning and execution of the projects, and then the closeout of the projects to ensure planned results are achieved on a timely basis.
- Develop budgets timelines, and ensure progress to plan, as well as tracking project achievements.
- Define projects' objectives and ensure progress to plan, as well as tracking project achievements.
- Interface with internal customers to agree upon specifications, deliverables, and milestones.
- Represent project and the team and present project results to customers and internal management.
- Recommend new process and tools to achieve advanced project management.
- Manage project status in the form of formal briefings, project update meetings, and written, electronic, and graphic reports.
- Address problems through risk management and contingency planning and present solutions and/or options to executive management.

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Technical Marketing Specialist Waterbury, CT

JOB DESCRIPTION:

Responsible for providing technical knowledge and support to marketing communications professionals. Cross training and acting as liaison between the Innovation and the Marketing Communications teams for both Circuitry Solutions and Semiconductor Solutions.

Chemist 1 Waterbury, CT

JOB DESCRIPTION:

Perform analysis—both chemical and mechanical—of customer-supplied samples. These include both structural and chemical testing using various instruments such as SEM, Instron, ICP, and titration methods. Perform various failure analysis functions, including, but not limited to, chemical analysis, SEM analysis of customer parts, and cross-section evaluation.

Applications Manager Waterbury, CT/New England Region

JOB DESCRIPTION:

Applications Manager in the Electronics Specialties/Circuitry Solutions group to provide applications process knowledge, training and technical support of new products leading to sales revenue growth. Requires working through the existing sales and technical service organizations to leverage this knowledge globally. Experience in multilayer bonding along with dry film and solder mask adhesion processes a plus.

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Career Opportunities



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

Wet Process Engineer

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

Essential Responsibilities

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

Responsible for:

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

Ability to:

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

Organizational Relationships

Reports to the Technical Director.

Qualifications

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

Physical Demands

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

- Ability to stand for long periods.

Work Environment

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

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

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Career Opportunities



Sales Engineer

Germany, Austria, Switzerland,
Southeastern Europe e.g. Italy

Ucamco is looking for a sales engineer for our front-end software in the German-speaking area (Germany, Austria, German Switzerland) as well as adjacent markets in the South and East.

Ucamco is a market leader in PCB CAM, pre-CAM software and laser photoplotters with more than 35 years' experience developing and supporting leading-edge, front-end tooling solutions for the global PCB industry.

Responsibilities:

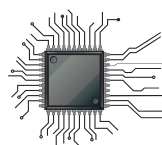
- Selling software solutions
- Selling support contracts and upgrades
- Developing and implementing customer acquisition plan
- Organizing and taking part in roadshows, seminars, exhibitions
- Follow up of current customers and sales
- Contributing insights into the marketing plan
- Reporting to Ucamco's sales director

Requirements:

- Fluent in German, good knowledge of English; other languages a plus
- Frequent traveling to prospects and customers—live contact is important
- Feeling for technical software
- Motivated to succeed as a solution seller
- Strong empathy for the customer
- Self-starter, able to work independently, organized
- Honest, trustworthy, dependable, credible
- Sales and technical expertise in PCB industry a big plus
- Knowledge of market and customer base in German speaking area a big plus
- Used to working from home office
- Traveling to headquarters in Gent (Belgium) for sales and customer meetings
- Good feeling for software is more important than strong sales experience

This is a salary-based position with a commission plan, company car, expense reimbursement, and benefits like health insurance.

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MivaTek

Global

Field Service Technician

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

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

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

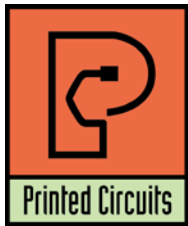
Do you have 3 years' experience working with direct imaging or capital equipment? Enjoy travel? Want to make a difference to our customers? Send your resume to N.Hogan@MivaTek.Global for consideration.

More About Us

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

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Career Opportunities



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

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

Laminator Technician

Nature of Duties/Responsibilities

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

Education/Experience

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

Wet Process/Plating Technician

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

Purpose

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

Nature of Duties/Responsibilities

- Load and unload electroplating equipment
- Fasten circuit boards to racks and cathode bars
- Immerse work pieces in series of cleaning, plating and rinsing tanks, following timed cycles manually or using hoists
- Carry work pieces between departments through electroplating processes
- Set temperature and maintains proper liquid levels in the plating tanks
- Remove work pieces from racks, and examine work pieces for plating defects, such as nodules, thin plating or burned plating
- Place work pieces on racks to be moved to next operation

- Check completed boards
- Drain solutions from and clean and refill tanks; fill anode baskets as needed
- Remove buildup of plating metal from racks using chemical bath

Education and Experience

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

Production Scheduler

Main Responsibilities

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

Education and Experience

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

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Career Opportunities



SMT Operator Hatboro, PA

Manncorp, a leader in the electronics assembly industry, is looking for a **surface-mount technology (SMT) operator** to join their growing team in Hatboro, PA!

The **SMT operator** will be part of a collaborative team and operate the latest Manncorp equipment in our brand-new demonstration center.

Duties and Responsibilities:

- Set up and operate automated SMT assembly equipment
- Prepare component kits for manufacturing
- Perform visual inspection of SMT assembly
- Participate in directing the expansion and further development of our SMT capabilities
- Some mechanical assembly of lighting fixtures
- Assist Manncorp sales with customer demos

Requirements and Qualifications:

- Prior experience with SMT equipment or equivalent technical degree preferred; will consider recent graduates or those new to the industry
- Windows computer knowledge required
- Strong mechanical and electrical troubleshooting skills
- Experience programming machinery or demonstrated willingness to learn
- Positive self-starter attitude with a good work ethic
- Ability to work with minimal supervision
- Ability to lift up to 50 lbs. repetitively

We Offer:

- Competitive pay
- Medical and dental insurance
- Retirement fund matching
- Continued training as the industry develops

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SMT Field Technician Hatboro, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

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Career Opportunities



Account Manager (SPI | AOI | AXI)

Omron Automation Americas is actively seeking an energetic and focused Account Manager to help support our Automated Inspection Solutions product business (SPI, AOI and AXI).

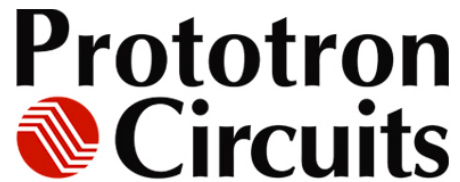
This position is based within any major city covering the Western-US region (including Dallas, Austin, Phoenix and Northern/Southern California). The goal is to work independently and alongside our strong rep. partners in the territory to further expand our business in industries and market segments where we have high potential for continued success and growth.

This is a rare opportunity to join the dynamic team of professionals at Omron and work for a true, industry leader.

To learn more about this exciting role, please contact us directly via:

shawn.arbid@omron.com

[apply now](#)



Sales Representatives

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

Reasons you should work with Prototron:

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

Interested? Let's have a talk.

Call Dan Beaulieu at

207-649-0879

or email to

danbbeaulieu@aol.com

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Career Opportunities



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.

[apply now](#)

Test Engineer (TE-MD)

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

- Candidates must have at least three years of experience with in-circuit test equipment. A candidate would develop and debug our test systems and install in-circuit test sets remotely online or at customer's manufactur-

ing locations nationwide.

- Candidates would also help support production testing and implement Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks.
- Some travel required and these positions are available in the Hunt Valley, Md., office.

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Sr. Test Engineer (STE-MD)

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

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

We proudly serve customers nationwide and around the world.

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

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Career Opportunities



PCB Field Engineer– North America Operations

ICAPE Group is a European leader for printed circuits boards and custom-made electro-mechanical parts. Headquartered in Paris, France, we have over 500 employees located in more than 70 countries serving our +2500 customers.

To support our growth in the American market, we are looking for a PCB Field Engineer.

You will work in our North America technical center, including our U.S. technical laboratory, and will be responsible for providing technical and quality support to our American sales team.

You will have direct customer contact during all phases of the sales process and provide follow-on support as required.

RESPONSIBILITIES INCLUDE

- Feasibility recommendations
- Fabricator questions and liaison
- Quality resolutions
- Technical explanation (for the customer) of proposals, laboratory analysis or technology challenges

REQUIREMENTS

- Engineering degree or equivalent industry experience
- 5 years' experience with PCB manufacturing (including CAM)
- Excellent technical understanding of PCBs
- Experience with quality tools (FAI, PPAP and 8-D)
- Good communication skills (written and oral)

Communication skills are essential to assist the customer with navigation of the complex process of matching the PCB to the application.

SALARY

Competitive, based on profile and experience. Position is full time in Indianapolis, Ind.

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American Standard Circuits
Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

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Career Opportunities

SIEMENS

Siemens EDA Sr. Applications Engineer

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

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

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

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

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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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Career Opportunities



eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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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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Career Opportunities



IPC Instructor

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

*Independent contractor,
possible full-time employment*

Job Description

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

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

Qualifications

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

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

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

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

[apply now](#)



Plating Supervisor

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

Competitive benefits package.

Pay will be commensurate
with experience.

Mail to:
mfariba@uscircuit.com

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Electronics in Harsh Environments Conference



Session Topics Include

- Automotive Reliability
- Reliability of Leadless and Bottom Terminated Components
- Electronics Reliability
- Climatic Reliability
- Solder Material Advancement for Harsh Environments

17-19 May 2022

Amsterdam, Netherlands

www.smta.org/harsh



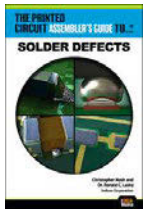
WATCH AND LEARN

Predicting Reliability in Electronics

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



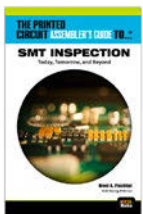
The Printed Circuit Assembler's Guide to...



Solder Defects

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

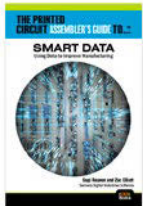
This book is specifically dedicated to educating the printed circuit board assembly sector and serves as a valuable resource for people seeking the most relevant information available.



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

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



Smart Data: Using Data to Improve Manufacturing

by Sagi Reuven and Zac Elliott, Siemens Digital Industries Software

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



Process Validation

by Graham K. Naisbitt, Gen3

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



Advanced Manufacturing in the Digital Age

by Oren Manor, Siemens Digital Industries Software

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

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