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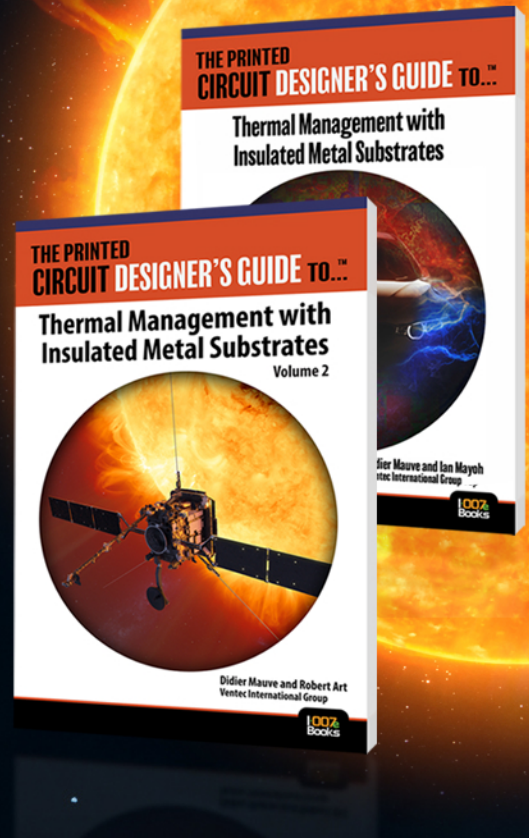
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Economic Headwinds

In this issue, the biggest names in PCB manufacturing share their economic outlook for the upcoming year and beyond. As you'll see, they were all bullish on our industry, but there was some apprehension as well. No one wants to get lost or sunk by another supply chain disruption.

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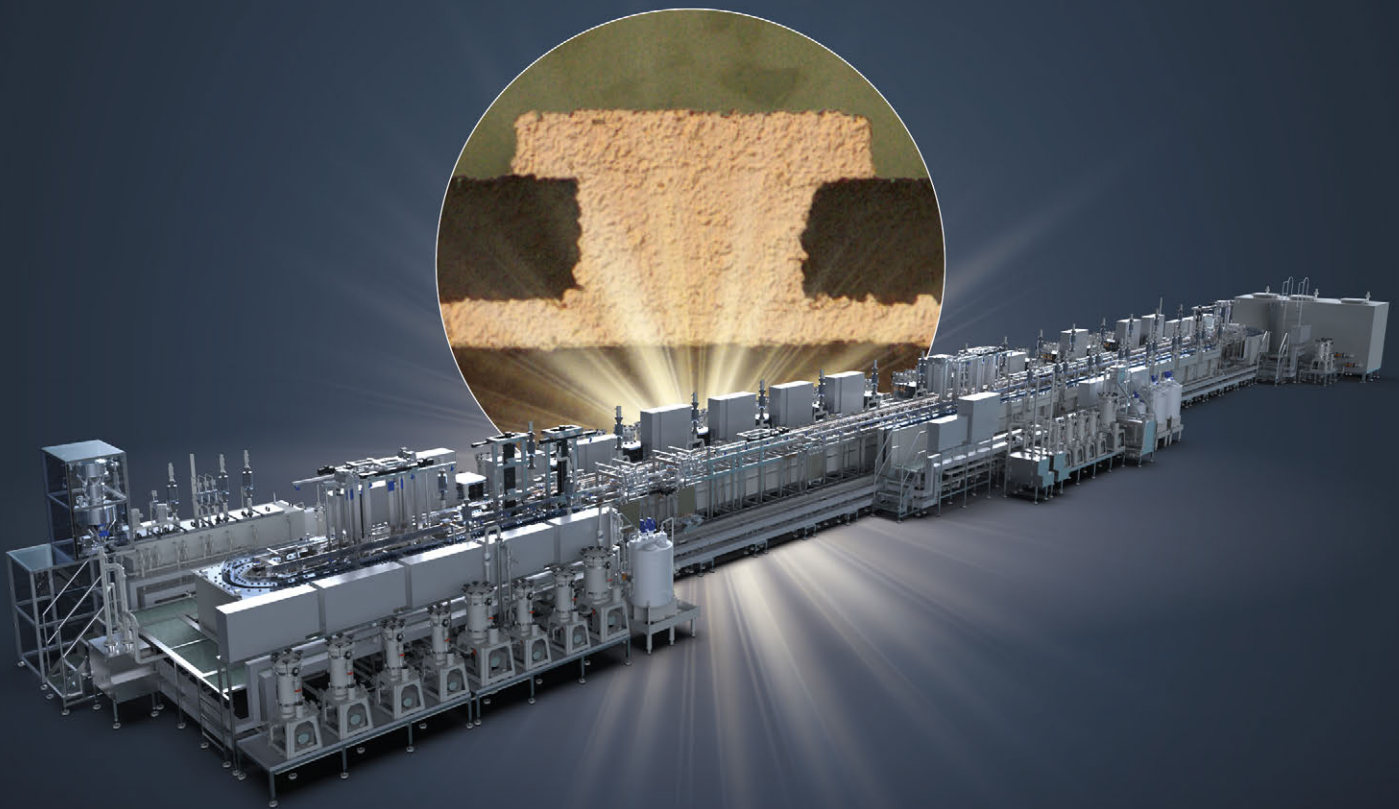


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The Winds of Change

The Shaughnessy Report

by Andy Shaughnessy, I-CONNECT007

When IPC APEX EXPO took place in San Diego, a few of us editors would occasionally rent a sailboat and head out for an afternoon on the water. We rarely checked the weather, because Southern California's weather is almost always perfect—75 degrees and sunny, with light winds. We didn't have much game plan; we just sailed around San Diego Bay for hours.

Worst-case scenario? A spilled drink.

But it's a different story for today's PCB fabricators, who need to check their forecasts constantly. The global economic seas can go from calm to choppy to stormy overnight. If you don't know the economic outlook for businesses like yours, your company might sink faster than the Titanic. But, as you'll learn in this month's issue, if you have an accurate economic outlook, you'll not only survive—you'll thrive. Your sailboat will be leading the regatta.

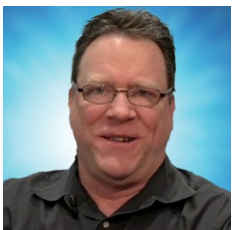


That's where *PCB007 Magazine* comes in. We recently spoke with some of the biggest names in PCB manufacturing, and they shared their economic outlooks for the upcoming year. I would sum up their overall outlook as "cautiously optimistic." They were all bullish on our industry, but there was some apprehension. No one wants to get burned by another supply chain debacle.

So, in this issue, our expert contributors share their thoughts on the economic outlook for 2024 and beyond. IPC Chief Economist Shawn DuBravac starts by providing his industry forecast for 2024. Consultant Joe O'Neil discusses some of his concerns as we move into the new year, but his overall outlook is very positive. IPC's John Mitchell describes his strategy for handling tough economic times as "blocking and tackling." Amitron's Aidan Salvi shares his global outlook for fabricators; he's recently visited fabricators in Asia and Europe, as well as in the U.S.

Accurate Circuit Engineering GM James Hofer explains why he's optimistic about the future of his company—and the overall industry. As James says, defense and aerospace are good segments to be working in today. Columnist Steve Williams has a few tips and techniques that can keep your business strong in a downturn. Philippe Leonard and Francisco Fourcade of IPC Europe discuss their plans to educate policymakers on the needs of our industry, and PCBAA's David Schild explains how government agencies—federal, state, and local—became willing to (finally) invest in American fabricators.

It's been a great 2023, and 2024 is looking pretty good too. Fair winds and following seas to you and yours. **PCB007**



Andy Shaughnessy is managing editor of *Design007 Magazine* and co-managing editor for *PCB007 Magazine*. He has been covering PCB design for 20 years. He can be reached by [clicking here](#).

Fond Memories of Lino Sousa



From Pluritec:

"It is with broken hearts, that we announce Lino Sousa passed away late last week. Whoever had the luck to meet Lino knows the unique person he was. Hard worker, trusted business partner, great father and grandfather. His contagious optimism and joy of life was inspiring to many. You will be greatly missed my friend. RIP."

From IEC:

"Lino, proud husband, father, grandfather, Christian, a consummate sales professional, as well as being a true and tremendous friend, will be missed by all of us whose lives he touched at IEC. We are so privileged that we were able to get to know him and be a part of his life. We will think of him often with great memories and with great affection."

From I-Connect007

"Lino was one of the first people I met in the industry, way back in 1990. His warmth, friendliness and mile-a-minute banter endeared him to me from the start. He was a salesman to his core—in the best way—but also generous, compassionate, whip smart and kind. I think of his family, church community, and our industry—what a huge hole he left, but what a legacy."

— Barb Hockaday

"A unique character in our industry. I've never known anyone as passionate and enthusiastic about what he was selling. I would end up as excited as Lino just by listening to him for a few minutes! And I was just an interviewer, never a sales prospect! So sorry to lose you, Lino."

— Pete Starkey



IPC Chief Economist's Industry Forecast for 2024

Feature Interview with the I-Connect007 Editorial Team

To better understand the current economic situation for electronics manufacturing, we brought in Shawn DuBravac, IPC chief economist, to provide an update with a high level global economic outlook. As you might expect, the seas have been a bit turbulent in the aftermath of the pandemic. Shawn breaks down the headwinds and the tailwinds of an economy in flux, and what it means for you.

Barry Matties: *Shawn, give us a brief review of 2023.*

Shawn DuBravac: The U.S. economy held up much better in 2023 than we anticipated and showed significant resiliency. Europe faltered somewhat, and that was not unexpected. In fact, we saw some growth in Europe, so one

might argue that Europe held up better last year than we had anticipated. Yet, headwinds remain in Europe. The conflict in Ukraine continues to weigh on Europe.

China has faced stiffer headwinds than many anticipated. There was the expectation that, following the reopening of China early in 2023, things would pick up. We saw an initial bounce, but things have since settled, and in fact, there are some very big warning signs coming out of China right now.

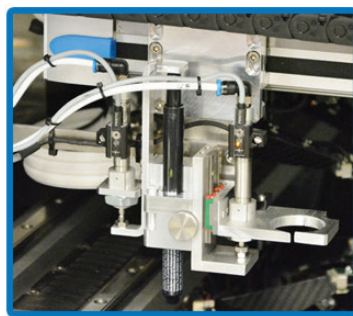
Matties: *When it comes to the economic forecast, what should we be concerned about?*

Looking ahead, industry should be thinking about a few things. First, where does growth

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Shawn DuBravac

go from here? There is concern that the U.S. market will slow. We've had interest rate hikes across the globe, not just from the Federal Reserve, but from the European Central Bank and others. Ultimately, this means slower growth, and a potential recession. Those risks remain acute.

Second, as we head into 2024, in every region—and certainly in the U.S. and Europe—there remains a big open question about shifting supply chains. Even with all the talk about building greater diversity and resiliency into supply chains, so far, the shifts have been quite subtle. What does that mean for the type of investments a company makes and when? What conversations should they have with their sourcing partners or distributors? There are still a lot of open questions.

Third is the topic of inventory management. In the aftermath of the pandemic, there was an idea we would move away from just-in-time to just-in-case. But, of course, just-in-case has a cost and it's a harder one to face when interest rates are high—presumably carrying costs are higher, and demand is slower. Company leaders should be fine-tuning their inventory man-

agement strategy as we move into 2024. This applies not just to inventory, but to equipment as well.

Ask yourself: What's my near-term demand? Long-term, what will happen to my demand in the years ahead as my company and customers look to potentially changing their regional exposure?

Nolan Johnson: Where do labor and staffing fit into these dynamics?

Overall, the demand for workers is starting to settle, but labor costs remain high. Inflation rates surpassed wage rates last year and much of this year. Labor groups are trying to recoup some of the purchasing power they've lost, which means that as we look ahead, wage rates will probably accelerate faster than inflation. Even when inflation comes down, we will probably continue to see wages moving up.

Another facet of higher labor costs is the higher cost of doing business overall. For example, UPS workers renegotiated their labor contract this year. The new deal increased wages and benefits by 3.3% over the life of the agreement, but 46% of that will show up in the first year. This will inevitably result in higher transportation costs for businesses.

Johnson: Shawn, what's your take on how we compare to U.S. manufacturing, in general?

On one level, a rising tide lifts all boats. Manufacturing has done well. We've seen job growth, an increase in output for many sectors, and general improvement across the manufacturing economy.

The defense and aerospace sectors have been growing pretty well, and that has benefited electronics manufacturers in the U.S. because we have pretty high exposure in those areas. Consumer electronics did very well right after the pandemic but have faced more headwinds this past year, and probably will next year as well. That impacts Asia more than the U.S. because it has more exposure to consumer electronics than the U.S. does. In some ways, all manufac-

turing has benefited from the changing sentiment in the world.

Matties: *I'm curious about risk factors as we move into 2024. What should assemblers and fabricators take into consideration regarding investment strategy?*

The number one risk factor is the significant shift in the economic environment. We have seen interest rates move higher and more quickly than in the past. Monetary policy tightening has been pronounced, and it often takes about six months for interest rate hikes to transmit fully through the economy. There is a significant risk of a real slowdown in economic growth next year. However, I'm optimistic there are still a lot of investment dollars in certain areas and electronics may benefit from that.

A second risk concerns the major geopolitical risks in areas like Ukraine and the Middle East. China is also facing some real economic headwinds with high unemployment among its youth. Companies are looking to shift their supply chains to investment in new geographic areas, like Southeast Asia and Mexico, which puts China at risk.

Matties: *Let's talk about board pricing. I often hear fabricators say they're getting beat up on price, so does the price of boards match reality? What do you see?*

Those battles will probably continue. The cost of materials, inputs, and labor is still high. We know that any destabilizing factors in the geopolitical environment can drive prices higher. Oil prices are high, and I don't think we will get back to the pre-pandemic level of \$35 a barrel anytime soon; the new norm is maybe \$60-\$70 a barrel. We see these dynamics playing out as input costs push higher while companies try to contain costs. All these factors contribute to a continued conversation about board pricing.

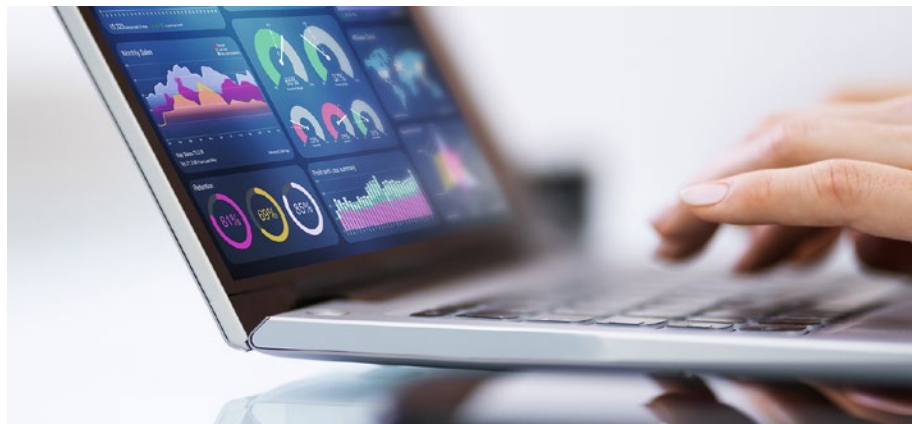
Matties: *Everything you're saying suggests now is the best time to focus on operational effectiveness. Lower your costs because, inherently, there's a lot of waste in the manufacturing process for those companies that aren't paying attention. That's one thing that you can absolutely control to drive costs down.*

That's right. As demand continues to improve in North America due to supply chain resiliency goals, companies will begin adding capacity, and by definition, the newest technology. It all means companies will be more productive and efficient.

Keep in mind that the U.S. and Europe aren't just competing with Asia like they were five to 10 years ago. Now you're competing against other companies in your part of the world that are building more efficient capacity through newer equipment. When you think about becoming more efficient with your resources, consider the cost perspective as well as what other companies in your geography are doing.

Johnson: *There's a lot of discussion here about the potential to grow through investment, but banking right now is somewhat unpredictable. What's the best way to handle this situation?*

Banking costs have gone up. It's not like the 2008-09 financial crisis, where big banks cut back on their lending. During that time, I would hear almost daily from companies that were having lending issues with banks. For example, a company would have a loan on a



warehouse. These were often financed as five-year balloons. When the five-year term ended, companies would just initiate a new five-year loan. But banks in 2008–09 were not renewing these loans and wouldn't let the companies roll them over. Companies would either have to sell the warehouse or find alternative sources of money. It produced accelerating sales of assets, often at discount prices, which then filtered back to the financial market. The Fed has learned from that, so they put in stopgaps to avoid it, and now it doesn't feel like the big national banks are creating an environment that forces asset sales. However, there is more pressure on regional banks.

If you're an EMS provider or a PCB fab and you're using a regional bank, it's always good to check in regularly with them to ensure your lines of credit are still intact and there are no unforeseen changes. Companies often rely on those lines of credit to buy the inventory in advance, and then they're not getting the payment until 30 days after they've shipped the box, so those lines of credit can be very important. My sense is many EMS companies have very good relationships with their banks, but it's worth making sure nothing has changed.

Because costs are up and it will be more costly to expand, we may see more merger activity; in some instances, it might be cheaper to buy out a competitor than to buy the equipment new.

Johnson: *So far, we've been talking about assemblers and fabricators, but what about the capital equipment manufacturers? How bullish or bearish is the economy for them?*

Capital equipment providers face unique challenges. Many are likely to see a shift in the geographies where they sell. Pre-pandemic, pre-trade embargoes, and pre-tariff, U.S. companies were likely selling a lot of equip-

ment to Asia. As Asia slowed, it tried to force their manufacturers and facilities to use more domestic capacity, capital, and machinery. But areas like Mexico, parts of Western and Eastern Europe, and the U.S. are growing. That's where that capital equipment is shifting. It's a tougher environment, though, so it will probably be harder to sell some of that equipment. The decision whether to increase capacity will be a big one to make in a slow growth environment with high interest and finance costs; it becomes a much more challenging decision.

Johnson: *There have been times when capital equipment manufacturers got into the finance business and carried the paper themselves. Is now the time for that tactic to return?*

We could see that. You see it already happening in the U.S. residential market, where builders are willing to buy down rates for buyers so they can get better rates. They're essentially putting money into the financing. Maybe they're not carrying the note, but they're paying down the rate. That could definitely make more sense now.

Equipment is more software-sensitive now. Much of the value is in the software and the services, not just in the metal and the hardware. Getting that recurring revenue by having customers pay for ongoing service contracts may be lucrative for the companies.

The other thing is the resale value, precisely because it's more software-dependent and can be updated and upgraded. If you needed to reclaim some of that equipment, you could probably place it at other facilities without a lot of heartache. If you had to take back used equipment, you could probably refurbish and resell it. The software would be up to date, so it's not like you're having to sell it for pennies on the dollar.



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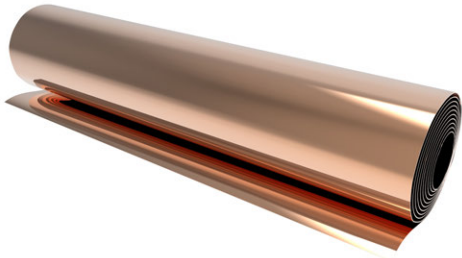
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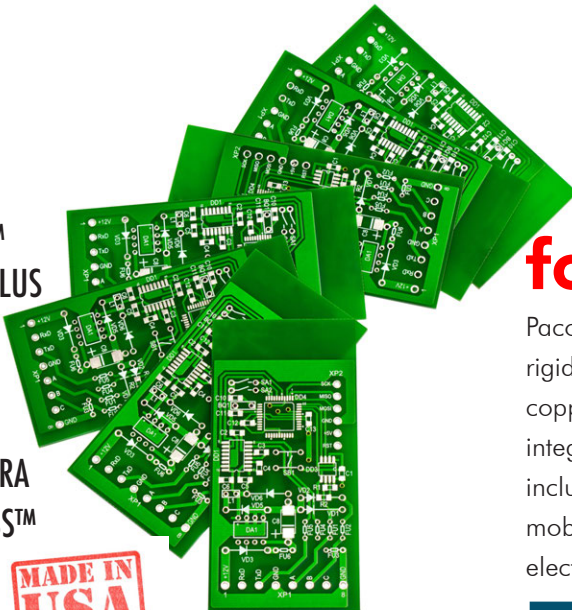
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Johnson: More software in the capital equipment means that carrying the paper makes sense, because so much more of the revenue stream would be from the support contract.

Matties: Yes, and spare parts. There is talk about the CHIPS Act as a big influence. Where do you put that in this economic equation? What should we expect from that?

With respect to the CHIPS Act and other industrial policies, the U.S. hasn't historically had much industrial policy, especially when it comes to electronics. I have a lot of hope for 2024 and 2025.

There are several reasons why the economy was stronger in 2023, but it wasn't driven in large part by government policy. Government action thus far probably hasn't yet shown up in any big way. Those things will show up, but it just takes a long time. Legislation like that is never shovel-ready.

Matties: Should companies factor that into their economic plans now?

Yes. They can count on some upside, some additional volume, and demand that will materialize. It's hard to know the timing of that demand, so that's the risk.

We should see that growth show up in construction, as well as some other areas, like the industrial side of the economy. The challenge is the timing, but it's definitely sitting there, and it will come. Companies will benefit across the economy.

Johnson: How do our readers take all this economic information and put together an action plan for 2024?

Higher interest rates mean higher discount rates. If you think about using discount rates to determine capital projects, like net present value, this environment means that future investments have much higher hurdles to be economically viable. They must take that into account.

Johnson: So, that shifts the calculation for your ROI?

Yes. Let's think of net present value and the internal rate of return. The internal rate of return is the rate at which net present value is zero—you're indifferent between taking or not taking the project. When you think about investing in a project, take all the future cash flows you expect from that project, and discount them back to today. If those cash flows are higher than the investment today, then you would make the investment.

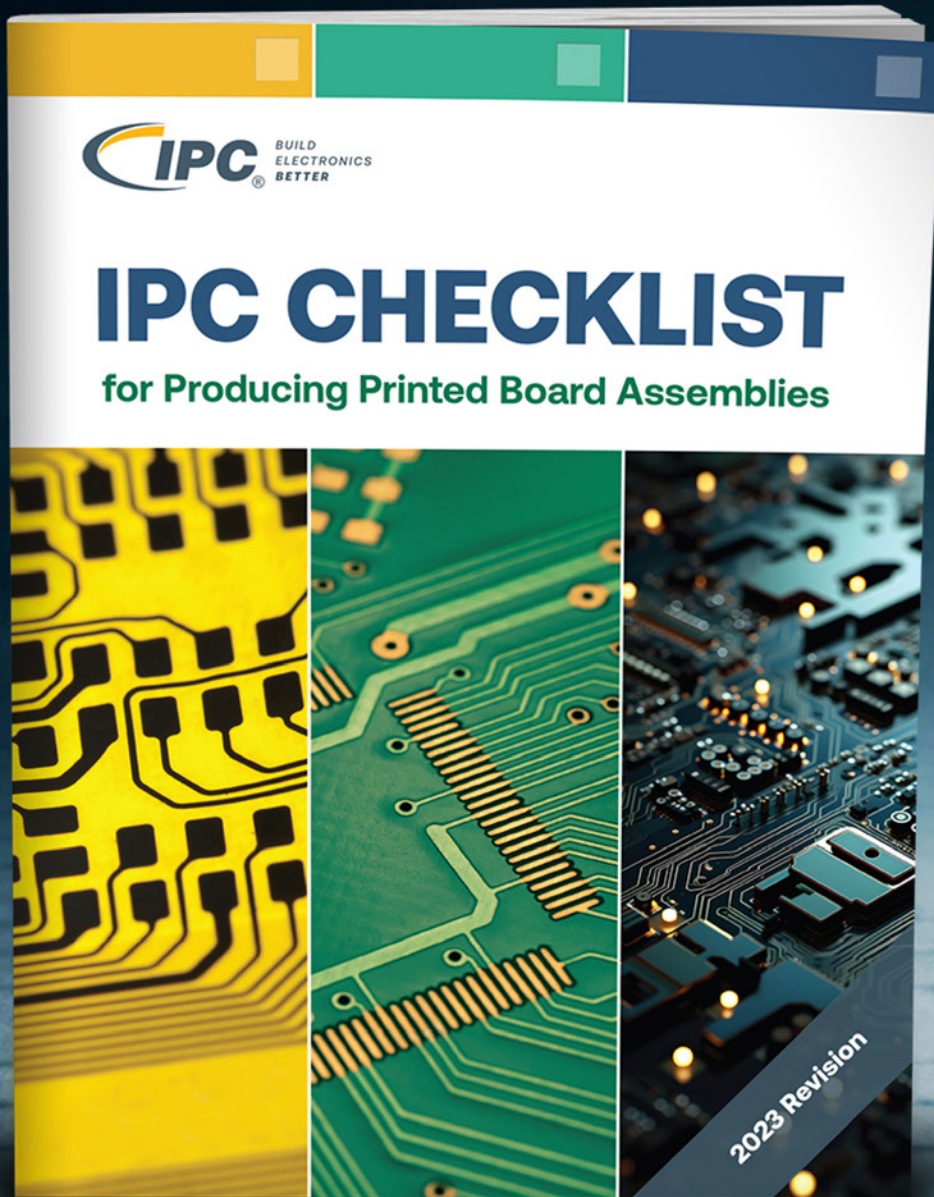
The discount rate you use is typically the risk-free rate, which is much higher now than it was pre-pandemic, and it will stay high. The 10-year treasury, which is often a risk-free rate used for a discount rate, is at, let's call it, a 15-year high. That means the hurdle for those investments is much higher, so the ROI must be higher. The way we do these financial calculations, projects will have to produce more cash flow than they had in the past. In other words, the framework in which they think about investment projects has changed; potential investments must be more lucrative.

Matties: All right, sir. Thank you very much.

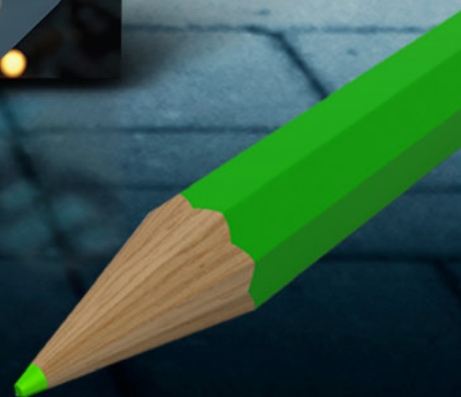
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Joe O'Neil Has More Optimism than Concerns



Joe O'Neil

Feature Q&A

Joe O'Neil's background includes operating both printed circuit fabrication and printed circuit assembly companies. In his current role, Joe contributes to the strategic initiatives at IPC, including his involvement in developing advanced fabrication technologies demonstration facilities in the U.S.

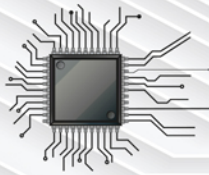
For 2024, how would you describe the economic outlook for the industry? What are you optimistic about? What are you worried about?

Joe O'Neil: The global economic outlook for the electronics industry in 2024 presents a mixed landscape. While there's a sense of flatness, several opportunities are emerging. One notable trend is the relocation of manufacturing from China to regions like Southeast Asia, Mexico, and the U.S., fostering a more diversified supply chain. I am particularly optimistic about the renewed focus on building a robust domestic electronics manufacturing base. New domestic activities across the value chain are on the rise and are expected to continue in the coming year.

There are, however, valid concerns. Rising interest rates, inflation, and other economic headwinds have the potential to delay these projects. Geopolitical tensions and increasing complexities in the industry are also worrisome factors.

What concerns you most in your growth plans: capabilities, capacity, or competition?

Actually, workforce is my main concern. I believe that there are talented, extremely bright young people coming up through our education system and entering the workforce. Can the electronics industry attract them? If so, I am not worried about developing and sustaining domestic capabilities and capacities and competing on a global scale. Without the workforce, none of that is possible. I see massive opportunities for bright, young engineers in our industry. The challenges are large, but the opportunities are large as well.



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Is inventory management and/or supply chain tying up capital that would otherwise be used for capital investments?

I think the increase in inventory buffers—which ballooned during the pandemic supply chain debacle—have begun to wind down and that is freeing up capital. There is a significant amount of activity in both the PCB and EMS equipment areas but that has slowed because of rising interest rates and ongoing concerns about the economy.

What’s your perspective on buying capital equipment with cash vs. financing?

I’ve always had a very conservative perspective on equipment purchases: If you can’t afford it today, why do you think you will be able to afford it tomorrow? With that said, financing at very low rates or with payments over time from your supplier allows you to maintain liquidity and more flexibility.

Technologies are hitting an inflection point in both the EMS supplier and PCB fabrication realm, where densities, complexity, and I/O counts are requiring increased placement and fabrication accuracy, inspection capabilities, accuracy, and speed and test capabilities. All these drivers are pushing companies to find a way to make these investments.

Whether paying cash or financing your capital investments, I would encourage all companies to ensure that they are receiving the full benefit of government incentives such as the R&D tax credit. There are several programs available, and they are there to encourage investment in our industry, especially for small- and medium-sized businesses.

Is the CHIPS Act trickling down yet?

While I don’t know the details of the funding status, I have seen the positive impact, renewed optimism, and lots of activity resulting from the effort. It seems there are ripples

ahead of the waves. There is a lot of confidence that those CHIPS Act dollars and the commitment to the U.S. electronics industry are real and long term. That seems to be driving activity in all areas, from reshoring to new factory investment, and it is having a real effect on U.S. business by reinvigorating the market.

Which process technologies hold the most opportunity for growth in the industry in 2024?

The industry is expected to witness substantial growth in Smart, connected factory advancements in 2024. These developments form the foundation for real-time data analytics and actionable insights, enabling more efficient and informed decision-making. The integration of artificial intelligence (AI) and machine learning is particularly exciting, with several AI companies working within the industry. Additionally, the expansion of robotics and automation into higher mix, lower volume manufacturing areas presents a significant opportunity. These technologies enhance repeatability and throughput, leading to a strong return on investment while allowing the workforce to focus on more valuable tasks.



How does “going green” factor into industry dynamics? Is it a cost of doing business or a selling point?

Embracing sustainability and “going green” is not just an option; it’s a necessity. New technologies, especially in PCB fabrication, are changing the economics of the business by reducing water and power requirements. Adopting green practices is not only socially responsible but also economically viable. It can serve as a selling point for environmentally conscious consumers. Companies should consider investing in green initiatives as it aligns with global sustainability goals and can contribute to cost savings in the long run. **PCB007**

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‘Blocking and Tackling’ During Tough Economic Times

One World, One Industry

Feature Column by Dr. John W. Mitchell, IPC

There never seems to be an easy time to work in the electronics industry. Supply chain challenges are prevalent and never seem to be solved, finding talent has been a challenge for 30 years, and constant pressure on margins means a business leader can never sit still as regulations and tariff rules change on a regular basis.

Not to mention just trying to manage the normal day-to-day challenges of finding new business and keeping current customers happy, then add an unpredictable economic climate, and the worry of a possible recession. No wonder many industry leaders are in a tailspin.

As IPC Chief Economist Shawn DuBravac shared with me, “We are about a month away from a recession, and I’ll tell you the same thing next month—until it happens.” In speaking with industry executives, I have heard some exclaim, “I wish we would just have the recession already, so we can get on with dealing with it and then moving past it.”

How are industry leaders handling all this stress? Here are a few blocking and tackling efforts that I have seen industry leaders undertake:

- **They take care of their people.** These are your greatest asset. We cannot expect that the



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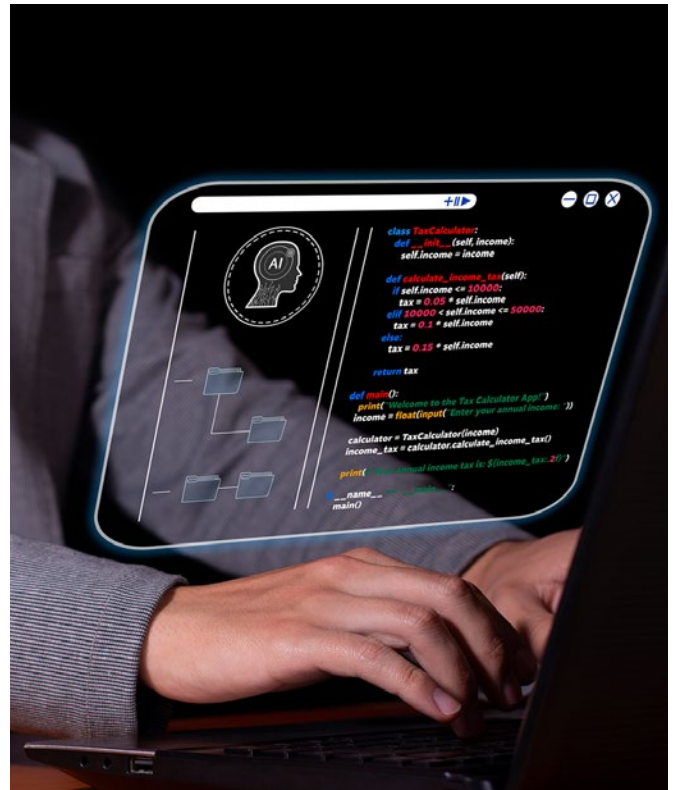
people we hire for the skills they possess will be as valuable if we don't continue to advance and expand those skills. Keep training your people. There are new tools and information available to offer your employees to encourage their growth. Invest in your people by making them more valuable. They are your greatest asset.

- **They embrace efficiency.** We have been given a great boon with the latest AI developments. Much of the routine work or initial ideation can be accomplished faster and with less effort than before with the help of AI. Make sure you are informed about the best tools available, and that your team is well versed in their usage. (See my first point about people.)

- **They look to IPC to supplement internal training.** If I am talking about training, let's talk about how you can get IPC training to supplement your internal training, and have it covered by government funding. IPC recently had some of its programs recognized by the U.S. government as official apprenticeship programs. This means you can get thousands of dollars from your local state to do IPC training and relevant internal training as well. Improving your people with other people's money sounds like a good idea to me.

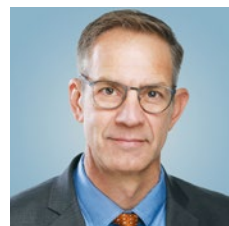
IPC PCB Fabricator Apprenticeship Curriculum

CORE COURSES	HOURS
Apprenticeship Employer Onboarding	16
ESD Control for Electronics	1
Safety for Electronics Manufacturing	1
Foreign Object Debris/Damage	1
Printed Circuit Board Fabrication for Operators	40
IPC 6012 for Operators	8
IPC 6012 Certification Endorsement (CIS)	40
IPC A 600 for Operators	8
IPC A 600 Certification Endorsement (CIS)	40
Total Hours	155



- **They are innovative.** Involve diverse segments of your team to attack challenging problems. Instead of only engaging engineers to solve a manufacturing problem, or just engaging business or finance staff on business challenges, add people from different parts of your organization to expand and broaden your innovation. People of different backgrounds, levels of experience, and parts of the business will increase the creativity needed to solve big problems.

While there seems to be a continual threat of recession or economic downturn, there are many positive ways to approach these challenges, particularly if you invest in your people and provide them with opportunities and challenges that will make them eager to help your company thrive. **PCB007**



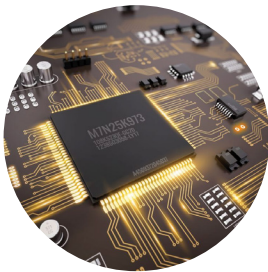
Dr. John W. Mitchell is president and CEO of IPC. To read past columns, [click here](#).



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Anaya Vardya: 2024 and Beyond



Anaya Vardya

Feature Q&A

Predicting what will happen in our industry (or any industry) is getting more difficult. There are too many moving parts and factors to make solid predictions.

Technological advancements, global market trends, and supply chain challenges are some of those factors. Many companies are optimistic about the growing demand for electronic devices, especially with the proliferation of IoT devices and 5G technology. However, there are many moving parts, such as supply chain disruptions, rising material costs, and global economic uncertainties.

I believe that the business outlook for individual companies will depend on their ability to adapt to these challenges, diversify their customer base, and innovate in response to changing market dynamics. That is certainly the way our company is looking at it. How we can manage and adapt to changing economic conditions will factor into how we perform in 2024. I suggest anyone who wants to succeed must do the same.

Here are some of the factors we are watching.

Inventory Management and Supply Chain

Inventory management and supply chain issues have become significant concerns in recent years, and those impact working capital. Tied-up capital in excess inventory or delays in receiving critical components can hinder a company's ability to invest in capital equipment or technology upgrades. Effective supply chain management and inventory optimization are essential strategies to free up capital for other investments. The better we can manage the supply chain, the better we will do.

Capital Equipment

I feel there is no choice but to keep up with the latest equipment. To maintain your company's lead in technology, you must have the best and most advanced equipment and tools on the market today. Buying capital equipment

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with cash or financing depends on a company's financial health, cash flow, and growth strategy. Using cash for equipment purchases can provide flexibility and reduce long-term interest costs. However, financing allows companies to conserve cash for other essential operations or investments. The choice between cash and financing should align with the company's financial objectives and risk tolerance.

The CHIPS Act

The CHIPS Act aims to support semiconductor manufacturing in the United States. While the primary focus is semiconductor manufacturing, it can indirectly impact the PCB industry by influencing the supply and cost of critical components. Depending on the extent of a company's reliance on domestic or international supply chains, the CHIPS Act could have varying effects. The PCB industry should get some of these funds. Our government should be supporting us as well as our customers.

Growth Plans

I have always advocated for the idea, "If you're not growing, you're dying." Growth plans should consider a balance of capabilities, capacity, and competition. Developing new capabilities can open doors to new markets and revenue streams. Expanding capacity is essential to meet increasing demand. However, competition is a significant concern, as the PCB industry is highly competitive. Differentiating through technology, quality, and customer service is crucial for sustainable growth. This is exactly the kind of strategy my company has employed for the past decade.

Green Initiatives

Green processes are increasingly important in the electronics industry. Sustainability


and environmental responsibility can be both a cost of doing business (CODB) and a selling point. Customers often prefer eco-friendly products and suppliers with green practices. Implementing sustainable manufacturing processes, reducing waste, and obtaining certifications like RoHS and REACH can enhance a company's reputation and competitiveness.

Process Technologies

The most promising process technologies for growth in the PCB and assembly industry in 2024 may include advancements in miniaturization, high-density interconnects (HDI), and flexible PCBs. Adopting Industry 4.0 practices, automation, and AI-driven quality control can optimize manufacturing processes and enhance competitiveness. At ASC, we are focused on the cutting edge of process technology. In the past year, we have delved deeply into ultra HDI, for example, and we are experiencing significant interest in this technology from our customers and potential customers.

In the end, companies in the PCB and assembly business need to stay agile, monitor industry trends, and adapt their strategies to navigate the evolving landscape successfully. Specific outlooks may vary depending on the company's size, market focus, and geographic location. But the point is always to work on your company regardless of what is happening worldwide. Our job is to play the cards we are dealt to the best of our abilities. **PCB007**

Anaya Vardya is the CEO of American Standard Circuits.



“ The CHIPS Act aims to support semiconductor manufacturing in the United States. ”



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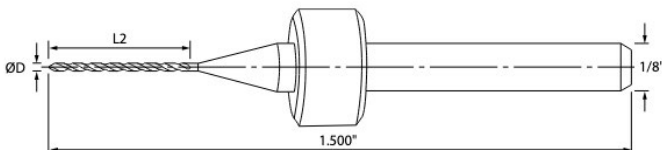


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4 Facet Point Geometry

REPOINTING will be a new service offered by Insulectro through Kyocera. The company has recently invested in automated, state-of-the-art equipment and all repointing will be done in Southern California.



MilAero007 Highlights



\$134.3M DoD Contract Expands Micross Advanced Interconnect OSAT Capabilities in the US ▶

Micross Components has received an award under the IBAS Cornerstone RESHAPE program made through the Department of Defense (DoD) to develop trusted, pure-play and open-access Advanced Packaging capabilities and capacity for low-volume/high-mix production of secure 2.5/3D Advanced System Integration and Packaging (ASIP) solutions.

Lockheed Martin Technology Demonstration to Showcase Faster On-Orbit Sensor Calibration ▶

Lockheed Martin will soon launch a unique wideband Electronically Steerable Antenna (ESA) payload demonstrator to show the company's investment in advanced technology to perform missions faster once in orbit. Based on an innovative, proprietary design, Lockheed Martin expects to calibrate this new ESA sensor in a fraction of the time it takes to operationalize traditional on-orbit sensors, which historically can take months to be powered on, fully calibrated and ready to perform their mission.

Airbus to Make Eurofighter Fit for Electronic Combat ▶

The Eurofighter EK (Electronic Combat) is coming. Following the recent parliamentary approval by the German budget committee, Airbus will equip 15 German Eurofighters for electronic combat—and equip them with a transmitter location and self-protection system from Saab, as well as “AARGM” anti-radar mis-

siles from the American company Northrop Grumman. The Eurofighter EK is to be NATO-certified by 2030 and will then replace the Tornado in the SEAD (Suppression of Enemy Air Defence) role.

Sierra Space Shooting Star Cargo Module Initiates Rigorous Testing at NASA's Neil Armstrong Test Facility ▶

Sierra Space, a leading pureplay commercial space company building the first end-to-end business and technology platform in space, announced the commencement of a comprehensive testing campaign for the Shooting Star™ cargo module at NASA's Neil Armstrong Test Facility in Sandusky, Ohio. This pivotal phase of testing aims to validate the spacecraft's resilience to the demands of launch and the challenging conditions of space as Shooting Star is readied for its inaugural mission to the International Space Station.

RTX to Improve DoD Supply Chain Resilience ▶

RTX will help the Department of Defense (DoD) address systemic risk in the procurement and delivery of supplies under an \$8 million DARPA contract. The work will be performed by the company's Raytheon BBN Technologies unit. Under the Resilient Supply-and-Demand Networks (RSDN) contract, Raytheon BBN will develop a robust modeling and simulation tool that uses historical and behavioral survey data to predict the impact of and develop mitigations for shocks to supply demand networks. This is the first global supply chain stress test framework created for this purpose.

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Elevating Fabrication: **Investing** in High-Tech Equipment, Processes, and Labor

Feature Interview by the I-Connect007 Editorial Team

Aidan Salvi is the chief transformation officer for Amitron. As such, he's visited fabricators in North America, Europe, and Asia in the past few years, and he's had a ringside seat to the challenges and opportunities facing fabricators around the globe. The I-Connect007 editorial team asked Aidan to share his economic outlook for PCB manufacturing as we head into 2024 and beyond. As he points out, companies are opening their pocketbooks to invest, particularly in high-tech processes.




Nolan Johnson: Aidan, I know that you've visited a number of facilities lately, domestic and abroad, and we'd like to hear your economic outlook for the industry going into 2024. Are PCB fabricators investing now, and

should they be investing? And if they are, are they borrowing money? If you're a manufacturer, what should you be worried about going forward?

Aidan Salvi: Certainly. I have a wealth of insights to offer on this topic. It has been truly enlightening for me, especially considering my extensive travels across various parts of the world. Earlier this year, I explored Europe, visiting numerous countries and diverse facilities in Germany, Italy, and other European nations. The experiences there were markedly distinct from what I observed during my recent visit to Asian markets. While there are commonalities across regions, as a North American manufacturer, gaining a global perspective has proven to be exceptionally insightful.

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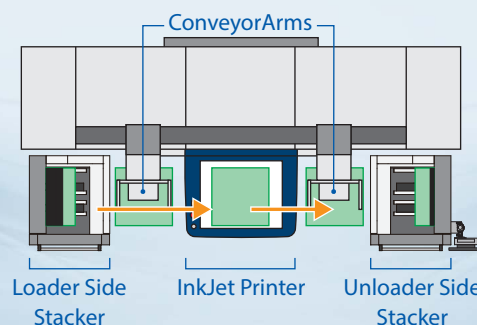


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Andy Shaughnessy: How would you describe the board market today?

The PCB market is indeed experiencing a noticeable softening, and this observation stems from various angles, including customers grappling with excess inventory and expressing concerns about the economic outlook, both in North America and globally. The unique perspective emerging in the North American market involves customers seeking companies with a more global footprint and the ability to scale effectively in North America and elsewhere to mitigate potential supply chain disruptions into the future.

During my visit to Europe earlier this year, the European market also showed signs of softening, with companies exploring the potential impact of the U.S. CHIPS Act on the PCB industry both locally and globally. I was able to travel through eight European countries, not exclusively related to printed circuit boards, to gain a broader perspective. Companies in Europe are anticipating significant investments from major players like Intel and others in the chip market, but as of yet, there are no substantial downstream effects.

However, I did observe European companies investing in and exploring HDI and ultra HDI technologies. They encountered similar challenges to North America, such as labor shortages, training issues, and generational knowledge transfer concerns. Rising raw material costs and transportation delays were also prevalent worries, echoing the sentiments in North America. Despite these challenges, the overall outlook for 2024 in Europe appeared optimistic with a mix of apprehension and positivity.

Shifting focus to the three prominent Asian countries that I visited this year—India, China,

and Taiwan—my experiences there provided a stark contrast to the North American market. These countries collectively represent nearly half of the world's population, with India standing out as a significant opportunity for growth due to both its large population and strategic importance. In India, China, and Taiwan, investments are notably directed toward higher technology and increased layer counts, all leading toward more sophistication and miniaturization.

Many Indian companies expressed interest in expanding into the North American markets, emphasizing advancements in technology, equipment manufacturing, and education efforts to enhance the production of higher-tech, higher-yield printed circuit boards.

Discussions in Asia primarily revolved around meeting future technology demands in the U.S. and global marketplace. These Asian countries are not only investing in technology but also in their workforce, strengthening customer relationships, and exploring diverse sectors that could contribute to the growth of the global PCB market. The industry in Asia appears uncertain about future growth, particularly in identifying where and how it will manifest, with the EV and AI sectors emerging as a potential frontrunner in the higher technology range.

The dynamics of the PCB market are multifaceted, encompassing softening trends, global perspectives, and strategic investments, with each region navigating its unique set of challenges and opportunities.

Shaughnessy: What was your take on automation in Europe?

As we stand on the precipice of the Factory 5.0 era, it's evident that Europe and North Ameri-



“ The PCB market is indeed experiencing a noticeable softening... ”

ca are taking distinct routes in embracing automation. While Europe has long integrated automation into its industrial DNA, North America is on the verge of a transformative journey, forging ahead with understanding how to implement its vision of automation. For me a critical examination reveals that the difference lies not just in the timeline of automation adoption but also in the underlying mindset and labor challenges surrounding implementation.

Shaughnessy: What was the overall mood among fabricators, here and abroad?

My observation and conversations have led to sentiment indicating a global inclination among companies to invest in technology. This trend is widespread and reflects a collective eagerness to embrace advancements. However, amid this enthusiasm, a notable degree of uncertainty looms. While there is a keen desire to invest in the future, the ambiguity surrounding what lies ahead necessitates a delicate balance of risk. Observing this scenario, it becomes ever more important that leaders are adopting a methodical approach to growth, with strategies tailored to navigate this intricate landscape.

In my observations, it's apparent that some companies are applying a broad general growth model, and in contrast, others are exhibiting a more nuanced and sophisticated approach, recognizing the multifaceted nature of the challenges and opportunities that lie ahead. As we look toward the future, it becomes increasingly clear that the evolving landscape will demand an ever more adapting approach. Tomorrow's success stories will be authored by those who can navigate the intricate dynamics of technology investment with strategic acumen and a forward-thinking mindset.

Johnson: Do you believe the U.S. is giving education and skill-building the same sort of attention that other countries do?

No, and I believe we face significant deficiencies in that area, possibly for a variety of rea-



Aidan Salvi

sons. By contrast, when you examine China, there are over 2,500 manufacturers, providing for a larger pool of individuals with extensive training in the PCB manufacturing process. Moreover, countries like India, China, and Taiwan are actively encouraging younger generations to embrace technology in manufacturing printed circuit boards. There exists a structured process for attracting more technical talent into the industry, generating heightened enthusiasm and abundant opportunities in Asia.

Conversely, in the United States, we struggle to generate comparable excitement for core manufacturing jobs, and this proves to be a challenging endeavor. Unfortunately, our younger generation in the U.S. isn't gravitating towards this sector, whether it be on the semiconductor or PCB side, leading to large generational knowledge gaps. Additionally, we lack well-established programs designed to educate and nurture younger manufacturing engineers. Consequently, we find ourselves falling behind in technology in the U.S., with the difficulty of locating the desired level of expertise being a persistent and overarching challenge.

Johnson: There seems to be a lot of wake-up happening in our industry now, with the CHIPS Act and other government initiatives for electronics. Are you hopeful for the industry in the U.S.?

I believe that the success of the PCB industry in the U.S. relies heavily on the support from our customers and their customers, making it a pivotal aspect of the entire ecosystem. Achieving comprehensive progress in the U.S. necessitates holistic support. The key question we need to address is how we can enhance our purchasing efficiency to achieve better unit costs and implement more effective automation. To rebuild the U.S. PCB industry, it is crucial to recognize that we have to create a balance of automation and human know-how to keep moving the process technology forward. We are surrounded by high mix, low volume, so adopting automation techniques from international markets won't lead to the best outcomes.

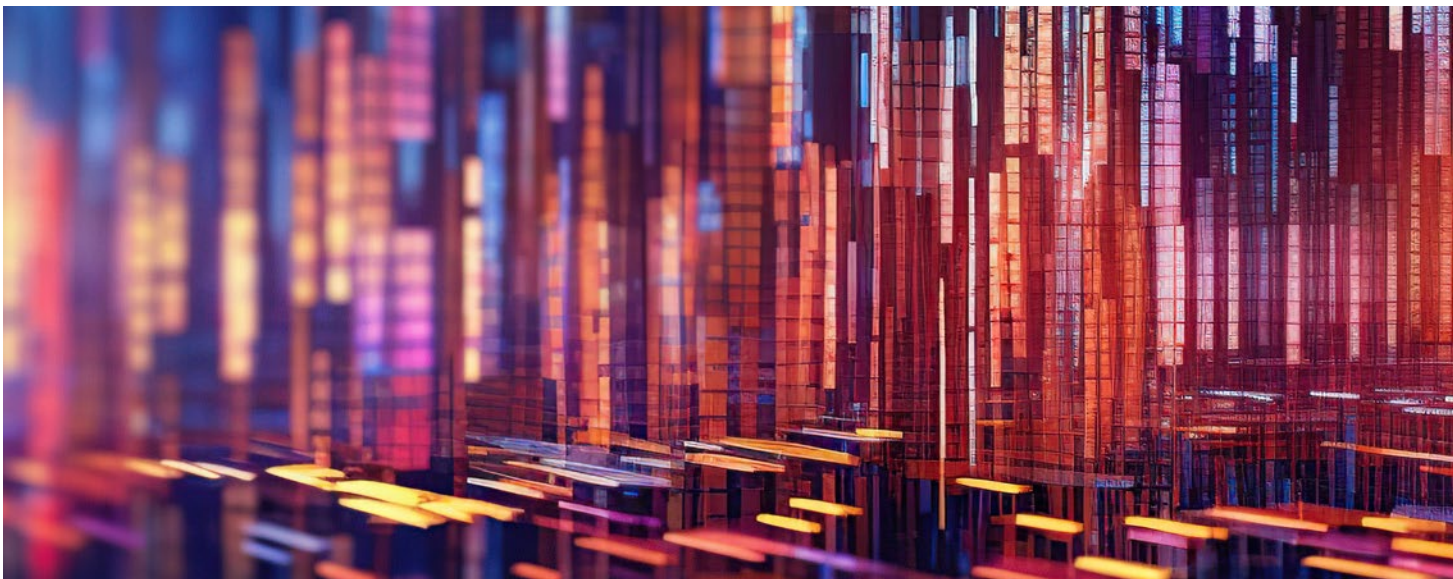
A notable limitation in the U.S. is the absence of a robust PCB equipment market, which significantly constrains our capabilities. We have to rely on global suppliers, and we all share in the challenges of machine uptime, slow and delayed response from equipment suppliers, challenges in procurement, and fabrication process customization. In contrast, regions like India and China benefit from

having local equipment manufacturers, offering more cost-effective solutions than those typically sourced from North American or European suppliers. The cost factor plays a substantial role in determining our ability to grow as an industry.

Having recently invested in 62 pieces of equipment, I stand by each purchase, as they were intended to build highly advanced products with an automation mindset and recipe-driven processes for consistency. The right equipment is integral to achieving a favorable return on investment (ROI). The U.S. lacks domestic manufacturers, making it difficult to scale effectively, especially when faced with lead times of eight to 12 months and sometimes even two years on critical pieces of equipment. This poses a significant hurdle to the overall industry's ability to sustain growth.

In my upcoming trip to Thailand, Vietnam, and South Korea, I aim to explore the expansion trends in these regions. This exploration is vital to understanding the evolving landscape and potential opportunities for growth and collaboration in the PCB industry, and for us to better support the electronic supply chain from idea to maturity.

Johnson: Right. Developing electronics manufacturing in a new area seems to come in three phases. The first phase seems to be



textiles and shoe companies like Nike and Adidas going into a marketplace and building some basic infrastructure, seeing that roads get built and that water and electricity become reliable. And then they move into semi-skilled manufacturing, which helps build up a bit more of a skilled labor set, with more education. Then you have to have a reliable infrastructure. I'm seeing reports of China going into areas in Northern and Central Africa and building roads and railways and starting to lay out some of that very basic infrastructure. But China's very good at playing the 100-year game.

When it comes to Africa, a significant challenge is the issue of brain drain. Highly educated individuals often find more lucrative opportunities elsewhere in the world, making it difficult for them to sustain a reasonable living in African countries. Then retaining the talent for necessary engineering expertise in these countries to foster market development becomes a challenge. Having visited three or four African countries in the last three years, I observed the same issues persisting across all of them.

“American fabricators can sometimes find themselves limited or confined to a specific mindset.”

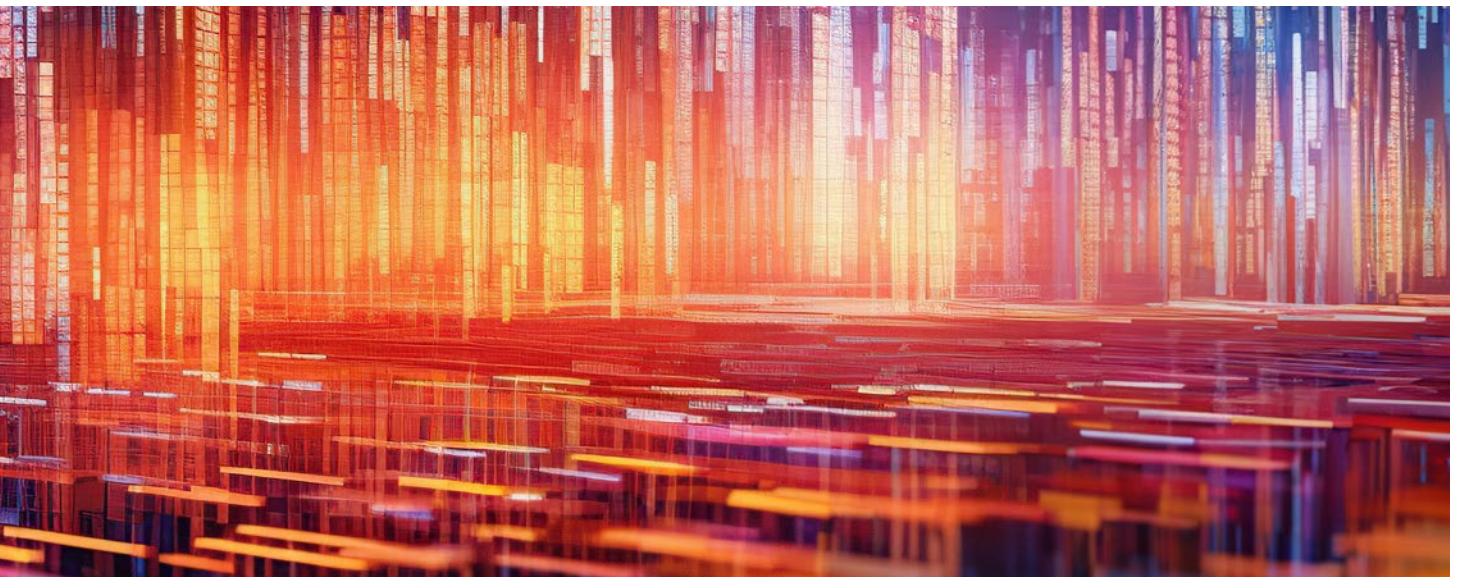
An opportunity that exists would be to establish a better governmental ecosystem to foster and develop global relationships with manufacturing firms looking for alternative labor pools, supported by infrastructure investments. Both could play a crucial role in keeping skilled professionals within these countries. Establishing these relationships could bring more opportunity to their local labor force, which could prevent many talented individuals from migrating to other European nations, exacerbating the issue of brain drain in the region.

Shaughnessy: Do you have any parting advice for fabricators?

Do your homework. It holds significance to delve into the available options worldwide. American fabricators can sometimes find themselves limited or confined to a specific mindset. It is important to broaden our perspectives and explore the global landscape especially in this ever-changing climate.

Johnson: Thank you so much, Aidan.

Thank you. PCB007





James Hofer: Mil/Aero Leading the Way in 2024



James Hofer

A Feature Q&A

We asked James Hofer, general manager of Accurate Circuit Engineering, to discuss the outlook for his company—and the overall fabrication segment—as we move into 2024. He’s bullish on fabrication, even though he does see a slowdown coming.

How would you describe your economic outlook for the industry and your company’s business outlook for 2024? What are you optimistic about, and worried about?

ACE has a big footprint in aerospace and defense; next year, I see that market segment increasing regardless of what the economy does. I feel the economy will slow down but that’s not an entirely bad thing. Prices on raw materials and consumables have skyrocketed in the past couple of years and surcharges are abundant in the industry. I am hopeful that a slowdown will spur the removal of those surcharges. ACE’s second largest customer base is with start-up companies with emerging technologies and, while I foresee a slowdown in this sector, I do not expect it to be significant.

Is inventory management and/or supply chain tying up capital you would otherwise use for capital investment?

ACE has been very proactive with our suppliers in establishing inventories at their facilities in the past few years. We are lucky to have fantastic suppliers we have worked with for years, so they have been very accommodating. ACE has always managed our supply base as partners, and we don’t jump ship to save a few bucks. That partnership and loyalty paid off when shortages were a thing, so we are not tying up cash on supply chain management.

What’s your perspective on buying capital equipment with cash vs. financing?

ACE pays cash for equipment. Even when we finance (which does have its advantages), we only finance what we can pay for out of pocket.

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What concerns you more in your growth plans: capabilities, capacity, or competition?

Capabilities always come first and foremost. Capacity is the next challenge. In the current economic situation, finding good team members is a challenge.

How does “going green” factor into your business plan? Is it a cost of doing business (CODB) or a selling point?

ACE has always been concerned with being as green as possible. I consider it neither a CODB nor a selling point but more of a responsibil-

ity. We all have families and I am sure I speak for all of us when I say that we want our grandchildren’s grandchildren to enjoy a walk in the park as much as we do—without a respirator.

Which process technologies hold the most opportunity for growth in the industry in 2024?

We are very interested in how AI will integrate into our processing. We are also very interested in watching the evolution of additive technologies. **PCB007**

Wireless in the Blood

First, there was the Internet of Things (IoT) and now, at the interface of computer science and biology, the Internet of Bio-Nano Things (IoBNT) promises to revolutionize medicine and healthcare. The IoBNT refers to biosensors that collect and process data, nano-scale Labs-on-a-Chip that run medical tests inside the body, the use of bacteria to design biological nano-machines that can detect pathogens, and nano-robots that swim through the bloodstream to perform targeted drug delivery and treatment.

“Overall, this is a very, very exciting research field,” explained Assistant Professor Haitham Al Hassanieh, head of the Laboratory of Sensing and Networking Systems in EPFL’s School of Computer and Communication Sciences (IC). “With advances in bio-engineering, synthetic biology, and nanotechnology, the idea is that nano-biosensors will revolutionize medicine because they can reach

places and do things that current devices or larger implants can’t,” he continued.

Yet no matter how exciting this cutting-edge research field is, there remains a huge, fundamental challenge – when you have a nano-robot in someone’s body, how will you communicate with it? Traditional techniques, like wireless radios, work well for large implants such as pacemakers or defibrillators but can’t be scaled to micro and nano-dimensions, and wireless signals don’t penetrate through body fluids.

Enter what’s being called biomolecular communication, inspired by the body itself. It doesn’t utilize electromagnetic waves but biological molecules both as carriers and as information, mimicking the existing communication mechanisms in biology. In its simplest form it encodes “1” and “0” bits by releasing or not releasing molecular particles into the bloodstream – similar to ON-OFF-Keying in wireless networks.

“Biomolecular communication has emerged as the most suitable paradigm for networking nano-implants. It’s an incredible idea that we can send data by encoding it into molecules which then go through the bloodstream and we can communicate with them, guiding them on where to go and when to release their treatments, just like hormones,” Al Hassanieh said.

(Source: EPFL)





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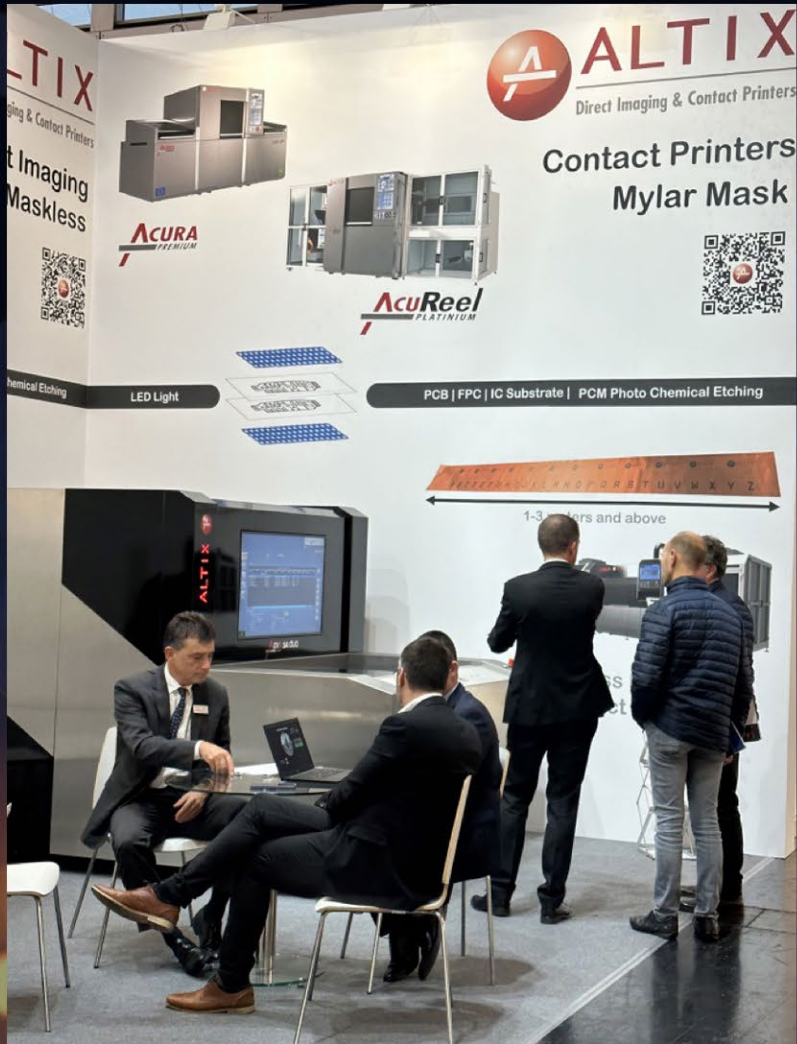
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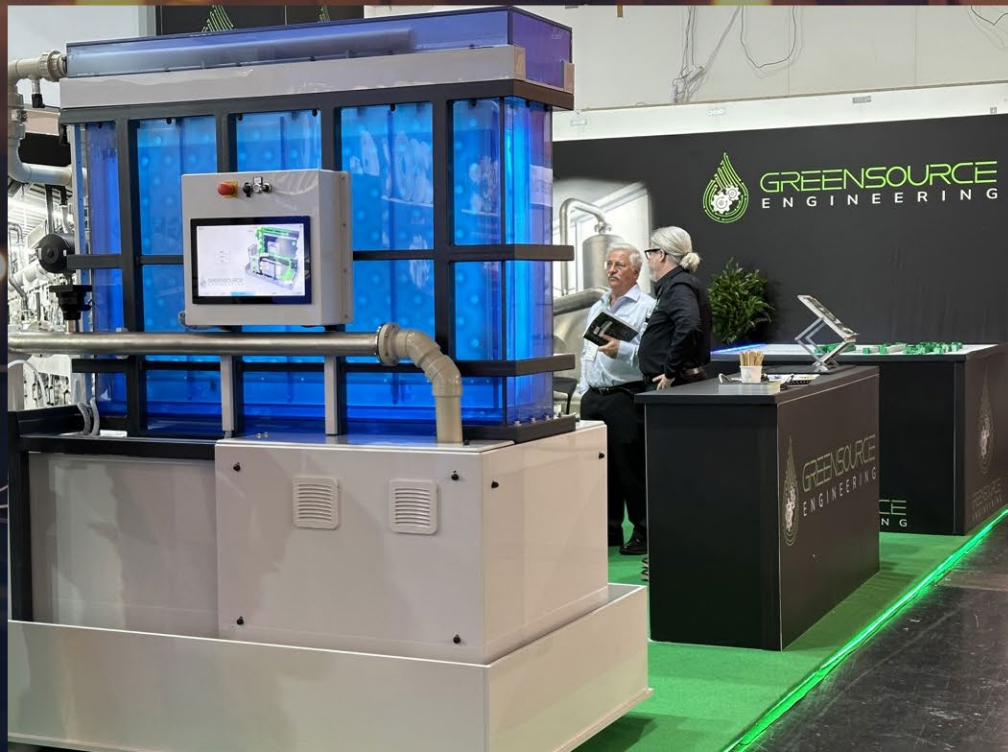


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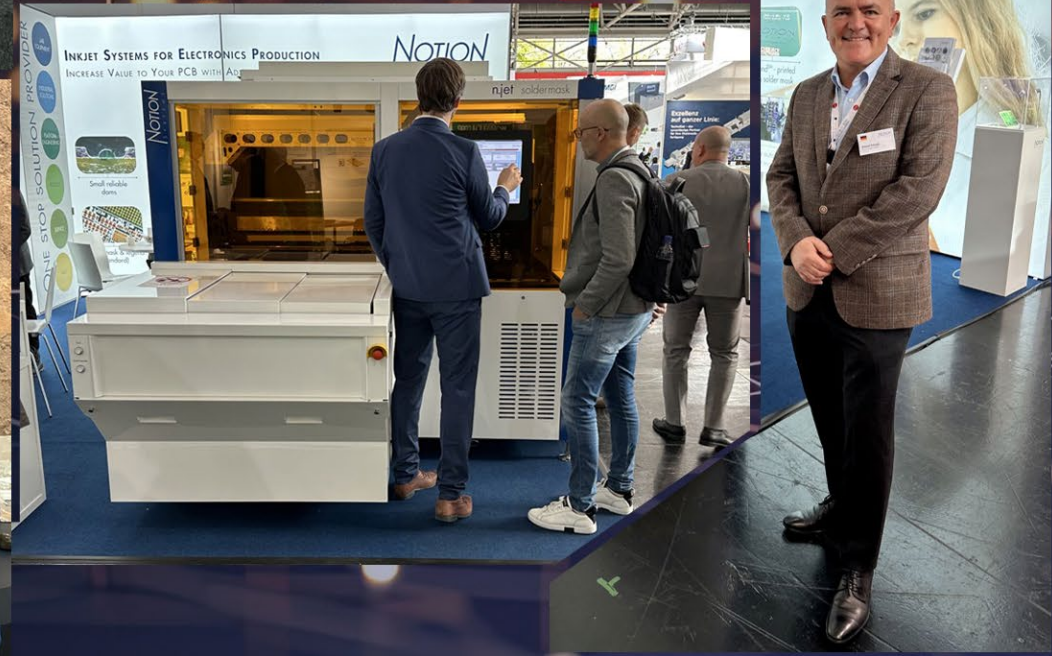


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Electrolytic Copper Plating, Part 5

Trouble in Your Tank

by Michael Carano, IPC CONSULTANT

In a previous column on the fundamentals of electrolytic copper plating of printed circuit boards, the subject matter covered the general function of organic addition agents and the role of these additives on the grain structure, plating uniformity, and physical properties of the subsequent copper deposit.

Here, I will explore the many other critical plating parameters that influence throwing power, copper deposit thickness, and metallurgical properties. In a future column, I will explore the additives and their functionality in more detail.

Key Plating Parameters

It is important to recognize and understand that these parameters can be controlled. First and foremost, the process engineering team must have a control plan in place to ensure these parameters remain in a tight operating window. These key parameters are listed in Table 1.

It is not only about the organic addition agents. Many other factors play significant roles. All the factors shown in Table 1 can be controlled or manipulated by the fabricator with the exception of the overall circuit board design (the circuit pattern) and the aspect ratio. With respect to the former, the fabricator can work with the circuit board designer to alter the design, if plausible, to enhance the overall manufacturability of the circuit board (also known as DFM). Aspect ratio (the thickness of the circuit board divided by the diameter of the via) is not as simple. The aspect ratio is determined by how many layers the board will have, along with the dielectric thickness of each layer as designed, as well as the diameter of the via (Figure 1). The higher the aspect ratio, the more difficult it will be to achieve optimal throwing power. Throwing power is defined as the thickness of the plated copper on the surface divided by the plating thickness in the center of the hole.

Anode to Cathode Ratio	Aspect Ratio of the PTH and Blind Via
Anode to Cathode Spacing	Condition of the Cables Connection the Power Supply (rectifier) to the Plating Cell
Plating Racks and the ability to conduct current	Operating Temperature
Cathode Current Density	Electrolyte Composition
Solution Movement (convection)	Plating Cell Design
The Circuit Pattern	Control of Contamination Build-up in Cell

Table 1: Key parameters for the process engineering team.

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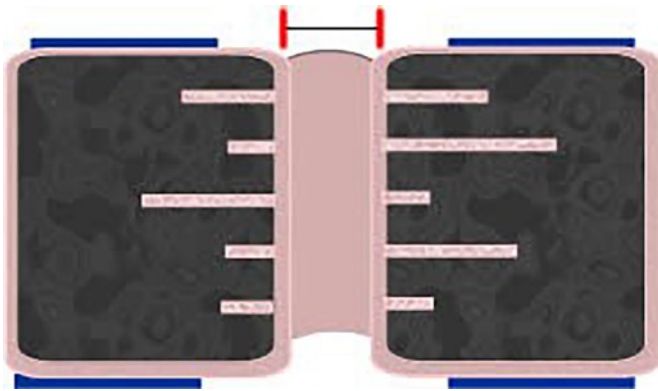


Figure 1: Through-hole illustration showing aspect ratio of 60-mil thick board and 10-mil diameter via. Aspect ratio = 60/10 = 6:1.

Why does aspect ratio and overall board thickness matter? As shown in Figure 2, the thicker the panel, the larger the current density difference between the surface of the board and the hole. This is particularly critical in achieving throwing power (TP), which is defined by the thickness of the plated copper in the center of the via divided by thickness of the plated copper on the surface.

While there are numerous factors that affect throwing power, including cathodic current density, solution conductivity (sulfuric acid to copper ion concentration), and other additives such as the chloride ion, the aspect ratio is a significant contributor as well. This includes the overall board thickness. As with any circuit board to be electrolytically plated, there is resistance to current flow into the hole vs. current flow on the surface. That is, there is a voltage drop as current flows from the surface through the hole. See an illustration of this in Figure 3.

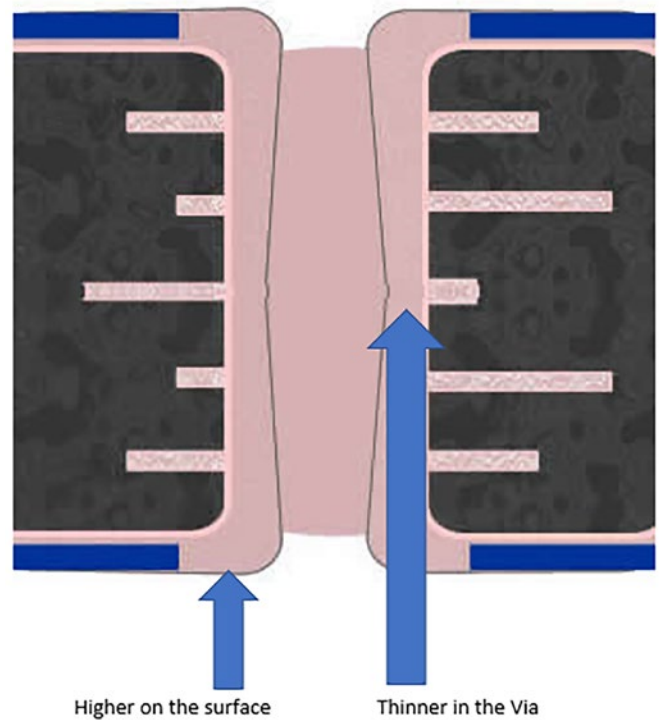


Figure 2: Measurement for throwing power. For example, assume 20.0 microns in center of hole and 25.0 microns on the surface, thus 20.0/25.0 = 80%.

It is important to note that the board thickness effect is not a simple linear influence. In Figure 3, one can see that board thickness is shown as a squared number, which adds to

Ohmic Resistance

Difficulty factor (potential drop down the hole)

$$E_{ir} = \frac{JL^2}{2kd}$$

Where E_{ir} = Voltage drop down hole (energy lost)

J = Current density

K = Solution resistance

d = Hole diameter

L = Length of hole

- For thick boards, there will be a limiting achievable ASF in the hole
- Not all aspect ratios are equal due to L^2 term

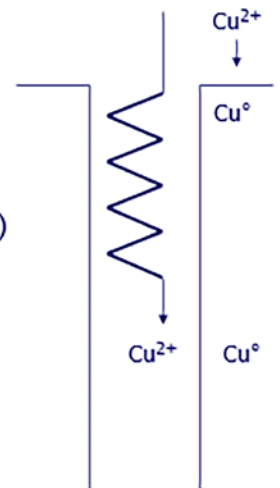
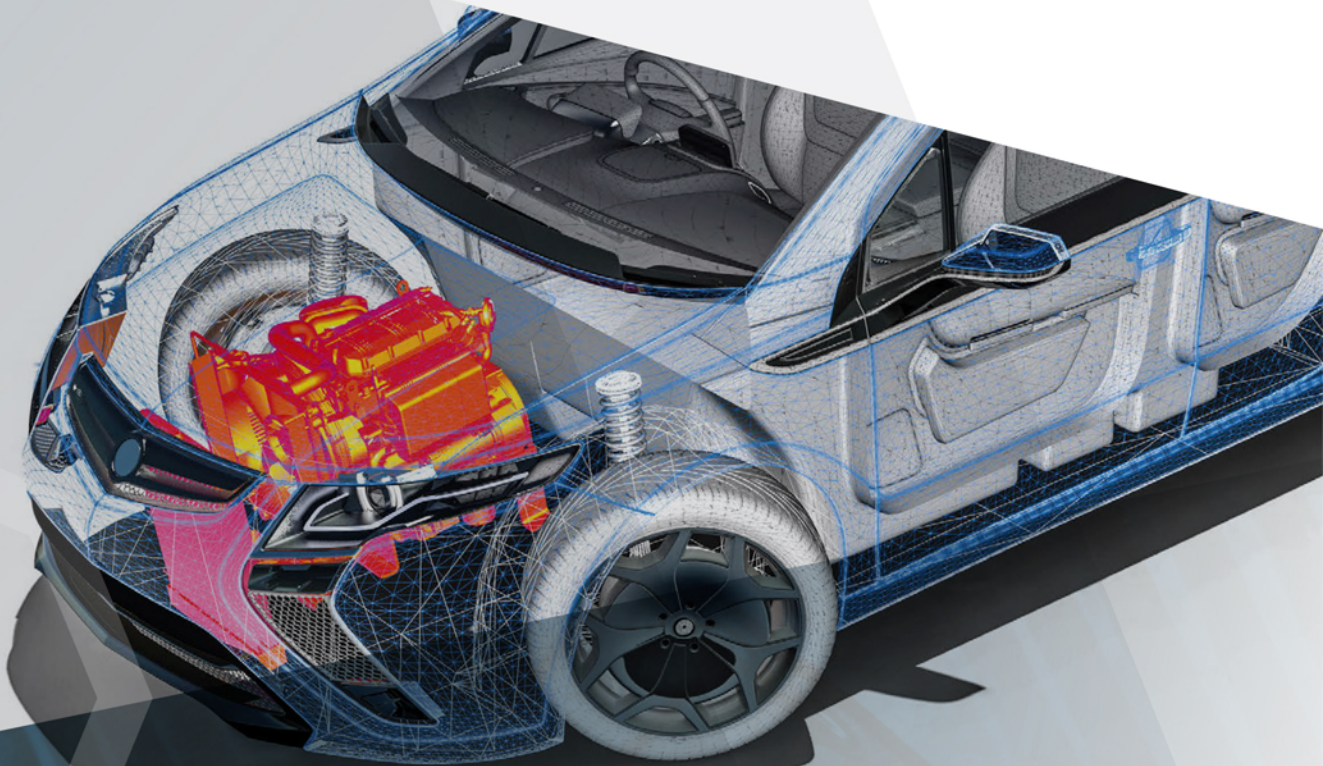


Figure 3: Ohmic resistance, Ohms law, $E = IR$.



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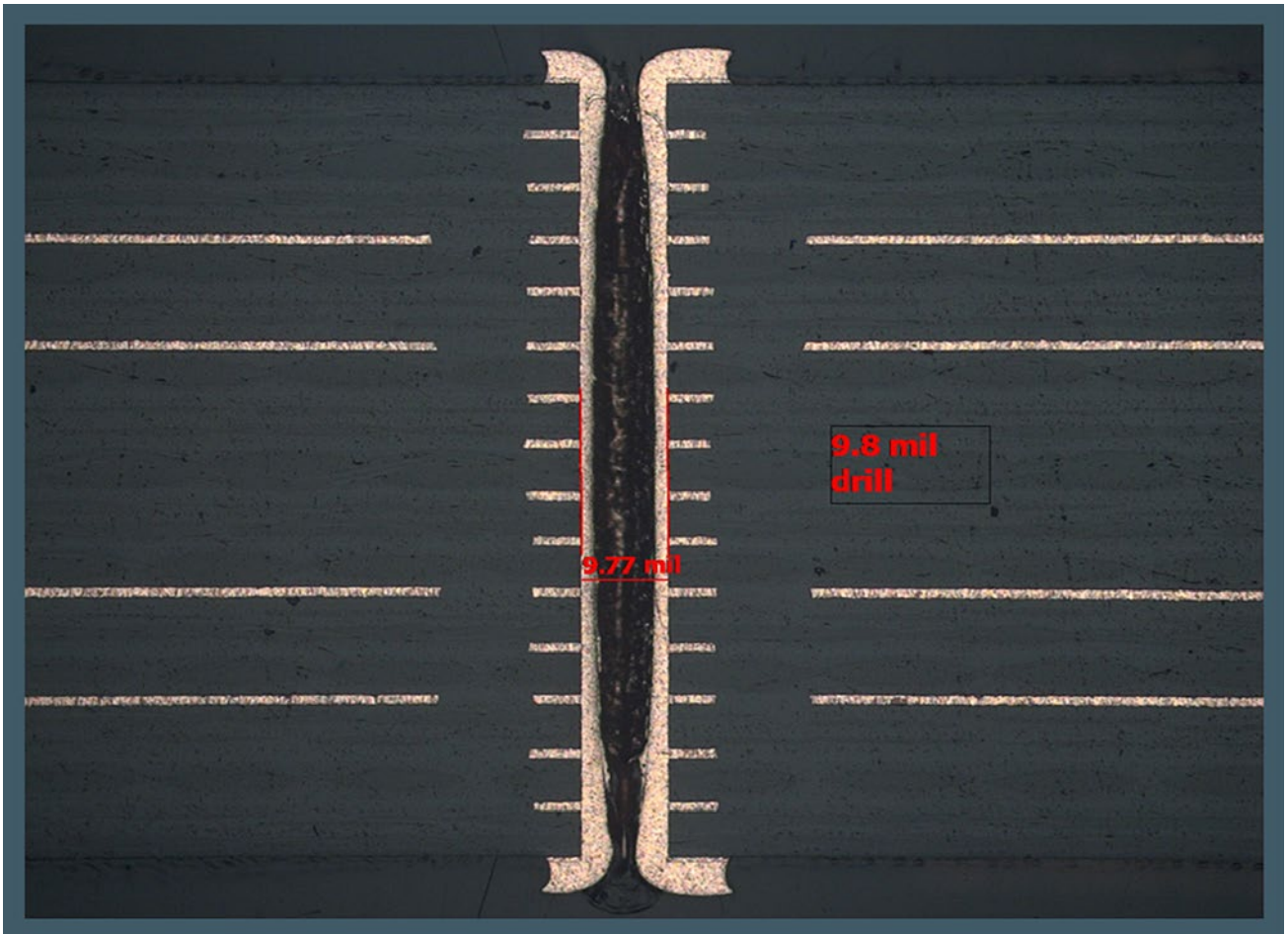


Figure 4: Tapered plating leading to lower copper plating in the via.

the degree of throwing power difficulty. The following examples compare two different board designs. For illustration, assume board one has thickness of 0.063" and a via diameter of 0.006", for an aspect ratio of approximately 10:1. Board two is 0.125" thick with a via diameter of 0.012—approximately the same aspect ratio of the thinner board. However, it has been shown that the two will not perform equally. Not all aspect ratios are equal due to the L2 factor in the Ohmic resistance model (Figure 3). The thicker board will be more difficult to achieve optimum throwing power vs. the thinner board of the same aspect ratio.

To understand this a bit better, Figure 4 depicts a high aspect ratio via. Note the tapering of the plated copper from the surface to the center of the via.

The condition shown in Figure 4 is known as “dog boning” for the tapered shape of the

plated copper in the via. As the copper plating becomes thinner in the via, the opportunity for copper cracking becomes much greater. Mitigating the “dog boning” is critical to ensuring long term reliability. More about how to optimize throwing power in a future column. **PCB007**



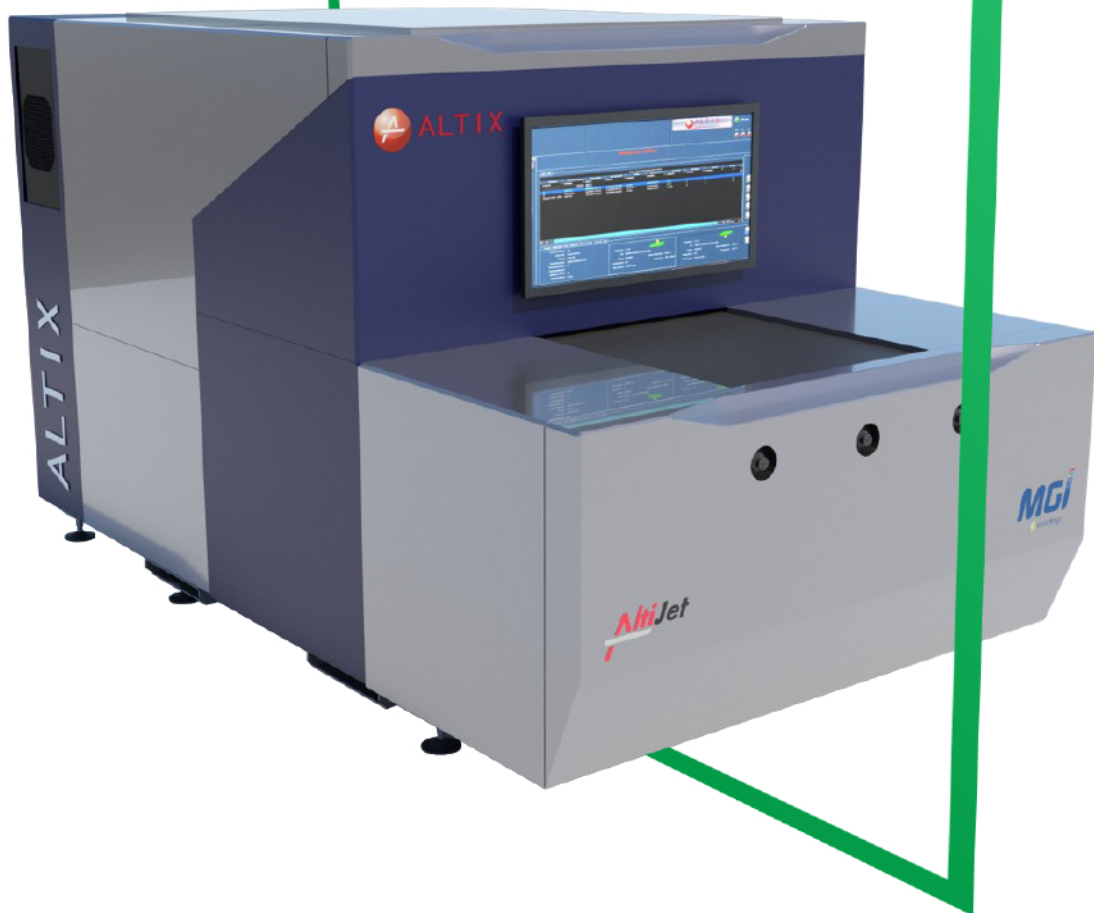
Michael Carano brings over 40 years of electronics industry experience with special expertise in manufacturing, performance chemicals, metals, semiconductors, medical devices, and advanced packaging.

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IPS automated dosing station at SEL's Idaho facility.

The Economics of Equipment Selection

Article by Barry Matties

I-CONNECT007

Financing capital equipment is certainly a large part of a fabricator's economic equation. However, the selection of your equipment has a long-term economic impact, especially if you overlook a few critical points.

As IPS President and CEO Mike Brask recently explained, the first step in this process



Mike Brask

is to really understand your technological needs and the flexibility that's required for your equipment to carry you into the future. For example, in a recent ENEPIG line that IPS delivered, the customer wanted the capability to add new chemistry tanks in the next few years, so IPS designed flexibility into a line that allowed for that upgrade down the road. By thinking beyond current needs, the customer will save a lot of money and valuable runtime.

If you are selecting equipment for a brown-field site bound by space constraints, working with your equipment supplier up front can really pay off. Equipment specialists will help you optimize the features you need and eliminate the ones you don't, all while working within the space constraints.

To that end, in the equipment selection process be sure to work with all your stakehold-

ers as a team. Look at the entire plan so that you are not a one-move chess player. Think about your needs beyond today's purchase and build a technology roadmap for future purchases as well. This will help you plan your utilities, venting, DI, water, and waste treatment, thus saving you resources and maximizing your runtime.

On the recent ENEPIG line delivered by IPS, the customer collaborated with IPS and the chemistry suppliers as the line was being designed. This allowed IPS to integrate the supplier's specific requirements and chemistry controllers into the line. For the customer, it meant big cost savings and a reduction in start-up time. In addition, the customer did not need to allocate additional floorspace or utilities for the chemistry support equipment. It also optimized the line's performance from the start.

When considering equipment maintenance, look for machines that provide your maintenance team with easy access to all necessary areas, including the bath. Consider incorporating auto-dosing systems into your lines; it will lower your total operating costs and improve



IPS automated dosing station at SEL's Idaho facility.

the operating parameters of the line. It also reduces the need (and risk) for your operators to move chemistry through hand pumps.

When contemplating new equipment, be sure to ask about the availability of spare parts. Downtime due to unavailable parts can be costly. Having commonalities of spare parts for your lines will minimize downtime and lower cost. Also, look at the service team the supplier has in place. Waiting for days for the service team to show up can be very costly.

While there are off-the-shelf lines available at lower sale prices, you very well could end up spending more over the service life of the equipment than you would have with a customized line that considers your needs today, tomorrow, and beyond. **PCB007**



Internal (left) and external view (right) of the impressive 81-foot IPS automated final finish line at SEL Idaho factory.

Five Tips to Keep Your Business **Strong** in an Economic Downturn

The Right Approach

Feature Column by Steve Williams, THE RIGHT APPROACH CONSULTING

Keeping your business strong during hard economic times requires careful planning and strategic actions. Here are five tips to help you navigate challenging economic conditions.

One

Employee retention: The only thing worse than navigating an economic downturn is losing employees, particularly those in key positions, because they are unsure of the company's future. Keep lines of communication open and regularly check in with employees to understand their concerns and address issues promptly.

Engaging and motivating your workforce as dedicated employees can be a significant asset during challenging times. Transparent communication, employee recognition, and support can foster loyalty and productivity. Involve employees in the decision-making process when feasible. Their insights and suggestions can provide valuable ideas for cost-saving measures and process improvements. Implement workforce flexibility by allowing remote work, cross-training employees, and leveraging part-time or contract workers. This can help you adapt to fluctuating demand without permanent layoffs.





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Two

Cost control and efficiency: These are critical aspects of managing a business, and they become even more crucial during economic downturns. When the economy faces challenges, businesses often experience reduced revenue and increased uncertainty. To weather these storms, companies must focus on controlling costs and improving efficiency. Scrutinize your expenses and look for opportunities to cut unnecessary costs without sacrificing the quality of your products or services. This might involve renegotiating contracts, optimizing your supply chain, or finding more cost-effective technologies.


In a prior role, when my team went to a supplier for a cost reduction, we would tell them we did not want the savings to come out of their margins. Instead, we would encourage the supplier to look at their internal processes to find opportunities for eliminating waste, streamline their processes through Lean best practices, and/or any design changes that would reduce costs.

Three

Build strong customer relationships: Building and maintaining strong customer relationships during an economic downturn is crucial for the long-term success of your business. When times are tough, customers are more discerning, and their loyalty becomes even more valuable. Invest in customer retention programs; it's always much more cost-effective to keep an existing customer than to find a new one. Provide exceptional customer service, offer incentives, and communicate with your customers regularly to understand their needs and concerns.

I'm dating myself, but I remember a very powerful commercial where the president had

gathered all his salespeople and told them, "We have become complacent." He then started handing out plane tickets for them to visit their customers and reengage the relationships. When one of the folks asked the president where he would be going, he replied, "I'm going to visit the customer that fired us last year." Again, it's easier to keep a customer than to replace one. Remember that building strong customer relationships during an economic downturn is an investment in your business's long-term success. Focus on creating lasting connections rather than short-term gains.



“When the economy faces challenges, businesses often experience reduced revenue and increased uncertainty.”

Four

Cash flow management: Monitor your cash flow closely and maintain a healthy cash reserve. Ensure you have enough working capital to cover operational expenses during economic downturns. Delay major capital expenditures if possible and consider short-term financing options, if necessary. Revisit your payment terms with your suppliers to avoid a gap in the payment terms with your customers. Effective cash flow management in an economic downturn requires a combination of proactive planning, conservative financial decision-making, and adaptability. Businesses that can successfully navigate these difficult periods will be able to capitalize on new opportunities as the economy recovers.

Five

Adapt and innovate: Be open to change and adapt to shifting market conditions. Innovate by embracing new technologies, processes, or business models that can give you a competitive edge. Use market research to stay informed about industry trends, consumer behavior, and emerging technologies. Be willing to pivot when necessary.

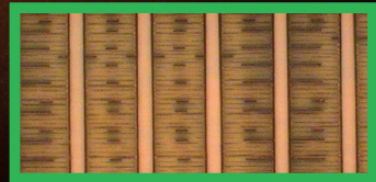
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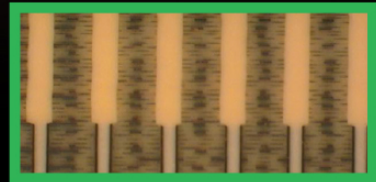
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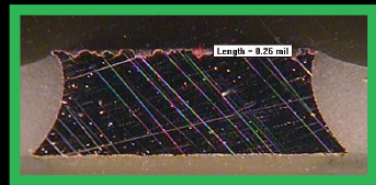
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Adjust your marketing efforts to reflect the current economic situation. Focus on cost-effective marketing channels, emphasize the value of your offerings, and consider targeted promotions. This knowledge can help you make informed decisions and seize opportunities as they arise.

Explore new product lines or services that are relevant to your core business. Diversification can help you reduce reliance on a single income source and mitigate the impact of economic downturns.

Consider targeting new customer segments, expanding into related markets, or adding new technologies or services that complement your existing offerings. This can help you cross-sell to existing customers and attract a broader customer base. If your current business is U.S.-based or regionally-centric, explore new geo-

graphic markets, both domestically and internationally, where there may be demand for your products or services.

In addition, it's crucial to stay informed about economic trends and seek advice from financial experts or business mentors. Being flexible and prepared for unexpected challenges will help your business weather economic downturns and emerge stronger on the other side. **PCB007**



Steve Williams is president of The Right Approach Consulting. He is also an independent certified coach, trainer, and speaker with the John Maxwell team. To read past columns, [click here](#).

What Does a Systems Engineer Do?

A systems engineer is in charge of designing, evaluating, and installing systems in manufacturing equipment. They are responsible for assessing systems, determining problems, providing solutions to issues that arise, designing systems, upgrading systems, maintaining systems and brainstorming possible improvements that can be made to a system in the future.

Systems engineers use computer-aided design (CAD) software to design the systems. They also analyze production processes and oversee the installation, repair, reassembly of equipment. Their ultimate objective is to ensure production processes are efficient and that products are produced at the lowest cost in the shortest time.



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IPC EUROPE: Raising the Industry Flag of Support

Interview by Barry Matties

I-CONNECT007

Barry Matties recently visited with Philippe Leonard, senior director for IPC Europe, and Francisco Fourcade, electronics technology standards manager for IPC Europe, about their priorities for IPC and the challenges they face moving into next year. The IPC Europe team has focused on collaboration, cooperation, and perhaps most importantly, educating policymakers on the impending needs of PCB and PCBA companies in Europe.

Barry Matties: *Philippe, what is your most important mission right now with the European side of IPC?*

Philippe Leonard: The priority for us in Europe is to raise the visibility of the IPC brand in the different territories and for the industry to identify IPC as the most supportive organization for them. We strive to promote engagement, which means getting more European companies to take ownership of IPC standards. As you know, IPC standards are made by the industry for the industry, and participation in IPC standardization committees is free. You don't need to be a member. Most of the industry players here don't know that, and we are advocating for that.



We have to make it clear to them that they are stakeholders, that they can have a voice. They can influence these standards because, even though by law IPC standards are not mandatory for their businesses, they are compulsory because their customers require them to be applied. So, European manufacturers need to know that they can have an influence on those requirements.

In an ideal world, to make it a fair game, all regions in the world would be involved in standards discussions. We are not there yet, but that is our goal. Further, we want IPC to be the unified voice of electronics manufacturers in Europe to the policymakers, the European Commission, and the governments, to make sure that the European Chips Act or any future framework conditions and legislation are friendly to this industry and allow for better development, success, and ultimately, a better European economy around the electronics industry.

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Francisco Fourcade

Leonard: Yes, a short train or car ride and you are in a completely different territory with a unique culture, food, and population. You have to comply with that to be effective. Although I still believe that the English language is appropriate when it comes to senior level management—and often at the engineering level—when it comes to the operator level, education and training become very challenging because the local language matters and translation can mean significant costs.

Francisco, what is the condition of the economic market here, and what do you see for the coming year?

Francisco Fourcade: Europe has been preparing itself economically, but a bit more slowly than the United States in terms of laying down a framework of legislation and then getting on with it. Europe is highly active in legislative terms but there are differences. For instance, the CHIPS Act in the U.S. is much different than pursuing the Chips Act here as we have 27 individual states in the European Union and a lot of bureaucracy between them. Everyone has to agree. You actually have very ingrained interests from each country that can sometimes create a political roller coaster. But we are gearing toward the same legisla-

tive momentum you are beginning to realize in the United States. It will just take a bit longer here.

In terms of the current market, the PCB business is suffering quite a lot. First, Chinese equipment and now deployment have bombarded us with lower Chinese prices, which has been slowly poisoning the European market for ages. European fabricators must follow European regulations to do business, and yet conditions are different in China. Chinese products are not taxed higher than products built here. There is no protection from the EU right now for European manufacturers, so it's not a level playing field. That is the feedback that I receive from the PCB fabricators, and we have fewer and fewer of them. That's really their main concern.

Do you think any of the 27 state governments will step in to identify the printed circuit board as a critical component? If you continue to lose shops, then your national security is at risk.

Leonard: Yes, that is exactly what we are doing. On the advocacy side, one of the main goals of our government relations team is to provide a sense of the big picture to the European Commission. We are pushing that button, and the European Commission is starting to listen.

The issue is that policymakers don't always know the details of what electronics manufacturing is about. They know electronics. They know computers. They know chips. But they don't know the whole ecosystem. So, it's our job to raise the flag and spread the word that what matters is more than chips; if you only have silicon, you have nothing. You cannot get silicon to work if you don't have the whole ecosystem around it.

We are pushing an agenda of preaching, teaching, and educating policymakers to understand that to make chips operate, you need PCBs and PCB assembly. You need materials and soldering. You need the full supply chain around it, and we need to

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Philippe Leonard

secure that. That's what we call the "silicon to system" perspective. IPC has been engaged for the past two years in advanced packaging, which has to do with miniaturization of capacities. But we have to take into consideration the whole supply chain, the whole ecosystem.

They speak about producing silicon in Europe, but what about the packaging and assembly? If you produce silicon here, ship it all to Taiwan to get the package, and then ship it back, what is the point? That fact is obvious for the super specialists of this industry, but not so much for the man on the street or for some policymakers. They can't always know what it takes to manufacture a PCBA or electronic circuits. We need to inform them and bring them the detail while working in the context of the boundaries of EU policy and the region's evolving approach to industrial strategy. That's the role we are taking on: striving to bring all the verticals in this industry together to speak with one voice.

So, are they now more receptive to listening and making change?

Leonard: I believe we reached an inflection point in April 2023 when we had a very important and interesting meeting at the EU

in Brussels, close to the European Parliament. IPC organized a meeting between PCB manufacturers and EMS companies and the European Commission and European members of the European Parliament. This is exactly the point we made, and it was a turning point. Following this meeting, policymakers went back to the industry to learn more and understand better, which was very positive. We consider this a success.

You mentioned IPC in Europe and the challenging role you have regarding the patchwork of Europe. How do you see IPC working alongside the associations that are more local to each individual country?

Leonard: We are working with them continuously and being totally inclusive. Several years ago, many local organizations saw IPC as a competitive organization and that was a challenge. We knew it was part of our job to address that, talk to them, and convince them that we are not their competitor. First, they are local organizations. IPC is international, a Pan-European organization. We serve the same verticals, the same customers. We have exactly the same objectives: to make this industry successful. We are in total alignment on that.

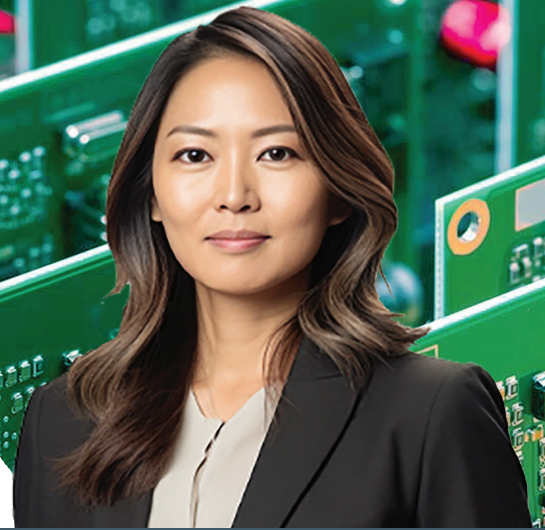
It's difficult for local associations because they are membership driven. IPC is a membership organization as well, but we don't compete for their members. It's not our bread and butter. Membership is important for IPC because it signals to the policymakers that we are credible as a stakeholder. But we don't compete; we don't want to steal a local organization's membership. Our point is engagement, and that's all free. We want to support them and work with them. Cooperation means that we are open to every effort that improves business conditions for the industry.

We certainly appreciate your time today. Thank you, Philippe and Francisco. PCB007

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PCB Design for Radio Frequency Boards	Jan. 22–Feb. 28	M/W	3:30 pm PT/6:30 pm ET	6
PCB Design I section 1	Jan. 23–Feb. 29	T/TH	8 am PT/11 am ET/5 pm CET	6
PCB Design for Manufacturability	Feb. 20–Mar. 7	T/TH	9 am PT/12 pm ET/6 pm CET	3
Certified Electronics Program Manager	Feb. 27–Apr. 4	T/TH	2:30 pm PT/5:30 pm ET	6
PCB Design II section 1	Mar. 18–May 15	M/W	8 am PT/11 am ET/5 pm CET	8
PCB Advanced Design Concepts	Mar. 18–May 15	M/W	3:30 pm PT/6:30 pm ET	8
PCB Design II section 2	Mar. 19–May 16	T/TH	3:30 pm PT/6:30 pm ET	8
PCB Design I (Brazil)	Apr. 22–May 29	M/W	7 pm BST/ 6 pm ET	6
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"I liked the approach the instructor took for full participation of all students."

"The recorded lectures help me to review the training materials at my convenient time."

Moving the **Needle** for Microelectronics in 2023

American Made Advocacy

by Travis Kelly, PCBAA

What a difference a year makes. In 2023, we saw remarkable progress toward securing critical supply chains and laying the groundwork to rebuild our defense industrial base and critical infrastructure. The passage of the CHIPS Act has spurred a deeper conversation about America's dependence on foreign sourcing and motivated our leaders to act after 30 years of complacency.

America invented the microelectronics that power the modern world, but over the past three decades we ceded our leadership in manufacturing these technologies to other nations. Twenty-five years ago, we produced 30% of the world's supply of printed circuit boards. Today that number is down to 4%. Commensurately, the number of domestic PCB manufacturers has decreased from 2,500 to only 145 compa-

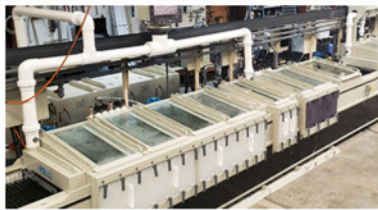
nies today. This manufacturing deficit creates a supply chain risk for everyday technologies as well as those critical to national security applications.

Here are the major developments we've seen this year:

1 In March, the President designated printed circuit boards and substrates as critical technologies under the Defense Production Act. This declaration drops red tape, creates funding vehicles inside the Defense Department, and allows the government to move faster to invest in and acquire critical microelectronics. For example, in November, DPA funding flowed to Calumet Electronics to help them produce high density build-up substrates. PCBAA and IPC continue to lead an effort in



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Congress to fully fund the DPA accounts, making sure our men and women in uniform have reliable access to next-generation systems built right here at home.

2 In April, the Protecting Circuit Boards and Substrates (PCBS) Act was reintroduced with bipartisan support by U.S. Reps. Blake Moore and Anna Eshoo. This legislation creates a \$3 billion fund—like the CHIPS Act—designed to give American companies the capital to build new factories, hire new workers, and expand capacity. Additionally, on the demand side, the PCBS Act creates a 25% tax credit for the buyers of American-made PCBs and substrates.

3 In June, as part of our annual meeting, PCBAA took our message directly to policymakers, spending two days with senior officials from the departments of Commerce and Defense. We also visited dozens of members of Congress representing the 26 states where you can still find microelectronics manufacturing. Our message was clear: Investments in semiconductors are an important first step, but “chips don’t float.” The government must act to support the rest of the technology stack and restore needed capacity to the entire microelectronics ecosystem.

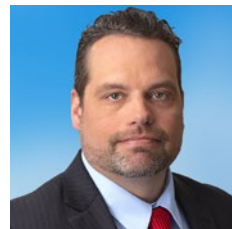
4 In November, Calumet Electronics and TTM Technologies announced significant expansions of their domestic PCB and substrate facilities, in partnership with Michi-

gan and New York. These investments by some of PCBAA’s founding members demonstrate that American PCB companies are willing to innovate and lead the charge to build more on our shores.

5 In December (we hope), Congress will pass and send to the President the FY2024 National Defense Authorization Act (NDAA), the bill that directs the actions of the Pentagon. The NDAA contains language which directs the Department of Defense to identify and remove microelectronics originating in adversary nations that we know are present in our commercial off-the-shelf (COTS) supply chains.

It has been a busy 12 months, and much work lies ahead if we are to recapture America’s microelectronics leadership.

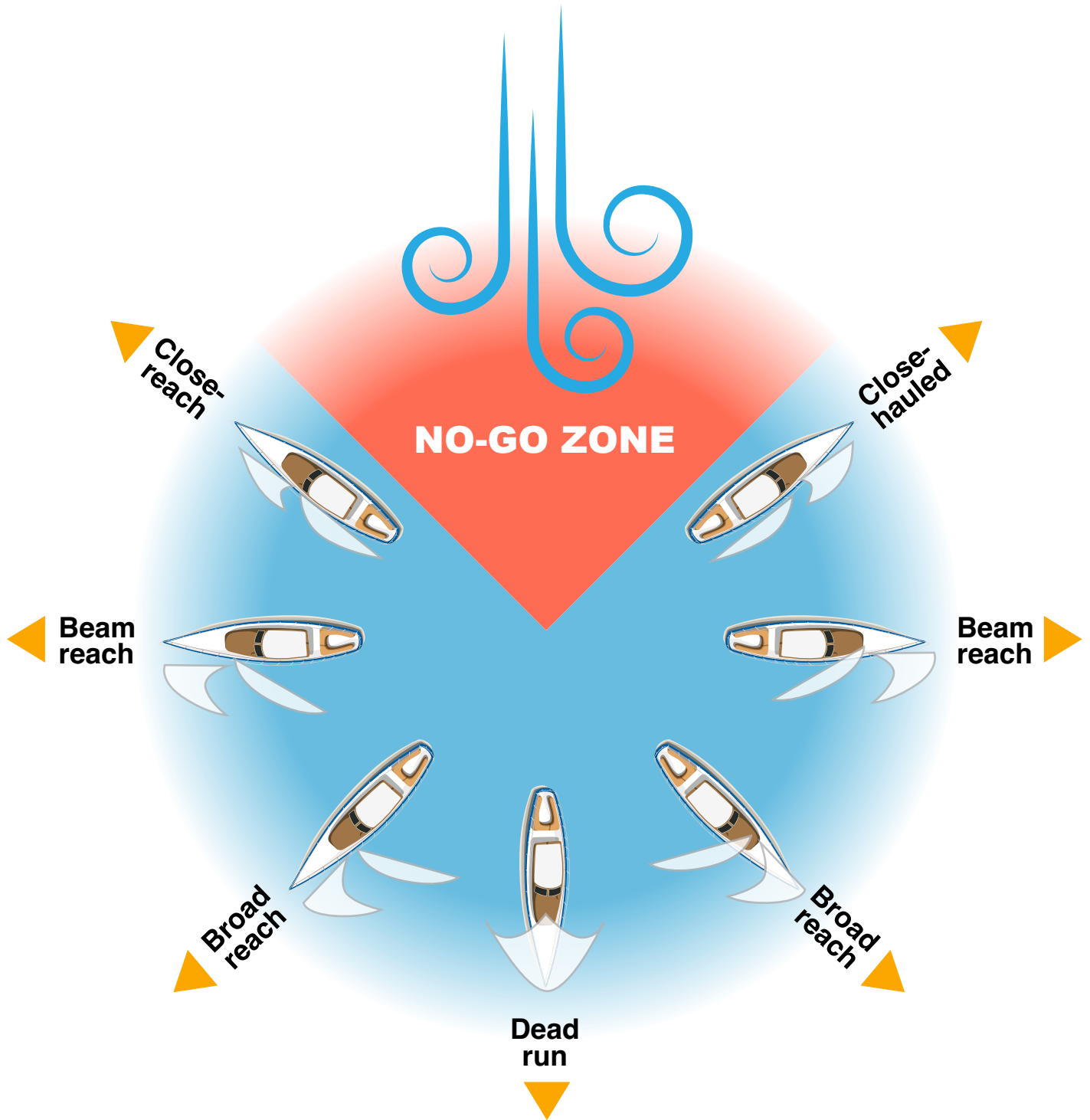
The PCBAA believes in and fights for market fairness and a level playing field on which U.S. PCB and substrate manufacturers can compete and win. Next year is the year to join our effort by visiting us online or contacting me directly. **PCB007**



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



Navigating Wind



Source: Royal Yachting Association

My Review of Happy Holden's '24 Essential Skills for Engineers'

The New Chapter

by Hannah Nelson, TEXAS INSTRUMENTS

Happy Holden has been an inspiration to me since I first met him at IPC APEX EXPO a few years ago. He is the father of the modern-day HDI PCB and former CTO at Foxconn. In his book, *24 Essentials Skills for Engineers*, Happy highlights the most important and viable skills for an engineer's success. These skills and traits are ones he saw most frequently throughout his career. They matter for an engineer, no matter where they're at in their career, from a new hire to a project manager, and I'm excited to review the ones that have resonated with me the most.

The Skill of Continuous Improvement

The first skill I want to highlight is knowledge of TQC, Six Sigma, and statistical tools. Happy argues that the TQC model and statistical anal-

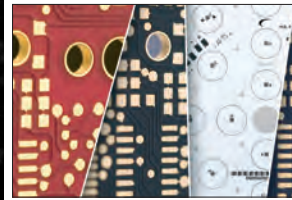
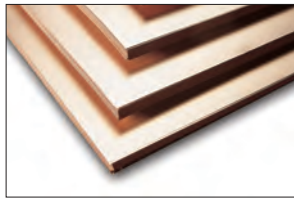
ysis tools stand as a foundation for the modern engineer's skill set. Continuous improvement as expressed through a TQC model should be at the forefront of every engineer's mind. The TQC's model is to "continuously improve processes by incorporating the knowledge and experiences of workers," he writes. Two of TQC's most important factors include process improvement and employee empowerment, which arguably go hand in hand.

When employees feel like they play a role in their organization, they are more likely to contribute to the success of that organization. On my team, we hold continuous improvements meetings for processes that may affect the way we collect data and prevent errors occurring in measurements. Happy writes brilliantly, "Mistakes may be made by people, but most of them



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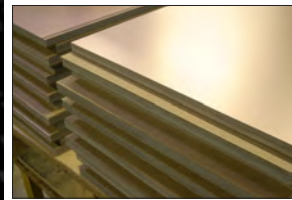


peters

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Coatings

CIRCUIT FOIL

Electro-deposited
Copper Foils

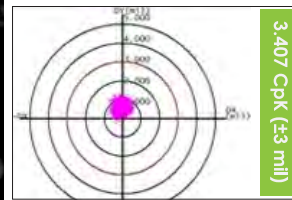


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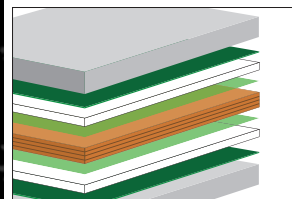
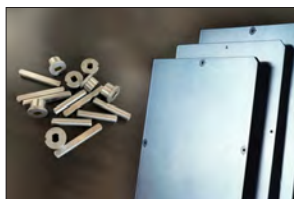


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are caused, or at least permitted, by faulty systems and processes. This means that the root cause of such mistakes can be identified and eliminated, and repetition can be prevented by changing the process.”

Through our team meetings on continuous improvement, we not only prevent mistakes from occurring in measurements, but we prevent repetition of the same mistake. However, this doesn’t just happen through a team meeting. Documentation and effective communication with your team helps ensure that the entire team is up to date as to where the problem stands. If the issue occurs again, then anyone on the team should be able to solve it, because we have good documentation.

Designing for manufacturing and assembly is a skill I’m working on at Texas Instruments. My team has a continual need to improve bench measurements, and I was asked to design the PCBs. In high school, I learned just how important designing a PCB is to understanding key concepts in electrical engineering, though I didn’t fully understand that, when designing a PCB, it is important to account for manufacturing and assembly constraints for possible rework. Rework is sometimes inevitable when designing for multiple use cases, even with team review. When designing for manufacturing and assembly, team reviews will help to ensure that reliable manufacturing is possible to increase product yield.

The Skill of Technical Writing

When Happy brought up technical writing as an important skill set for any engineer, I was ecstatic. In college, I was drawn to technical writing and learned that clear communication can directly impact the value of your work. Happy stresses that when writing a technical document, you must know your audience because it helps the level of depth that a tech-

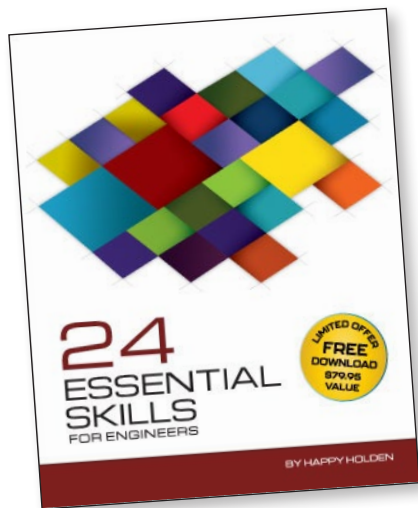
nical document is trying to express. For example, if you are writing an instruction manual for a new hire to understand, please cut out acronyms. A new hire barely understands the depth of their work, let alone company acronyms. Understanding the technical document’s audience alleviates questions that may be asked later, such as with a datasheet.

Happy says technical writing is best when it’s straightforward, and opinion and bias are left at the door. Although leaving bias out of a document is difficult, practice makes perfect. It’s important to continually perfect your writing through peer review, he says, and having several reviews before publishing a paper not only helps the writer improve their skills, but gain a better understanding of where there may be missing links in the writing.

What stood out to me in this chapter was Happy’s detailed description of his process while writing any technical paper. Happy describes how he creates a mind-map for every paper, which leads to making a presentation. Then he presents his slides and uses text-to-speech to write his paper. I had never thought about creating slides based on my ideas for each paper, let alone do I rarely mind-map any concepts that will be used in the papers I write. I believe all these tips will help me organize my papers more effectively.

The Skill of Distance Learning

While reading through 24 Essential Skills for Engineers, some concepts genuinely surprised me, such as the skill of online instruction and the distance learning section. Happy talks about how this not only shapes the education of future engineers, but the way organizational training can be approached. When evaluating the benefits of distance learning, Happy includes equations as to why distance



learning stands out. I thought this was incredibly interesting, because I had never thought about learning as having a computational curve to provide evidence for its benefit.

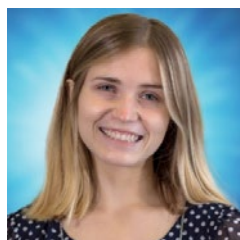
Conclusion

As I read through each essential skill, I learned more about topics I have yet to explore, such as Lean manufacturing and predictive engineering. For early engineers, our training is rigorous and thoroughly taught, but initial training cannot possibly teach every known concept in the industry, mostly due to the specificity of each job. Happy's 24 key concepts help bridge that gap.

He does an excellent job of incorporating skills that would benefit any level of engineer. If he decides to add any chapters, I would love to see something on effective communication and the presentation of data. The stereo-

type for an engineer holds true: Engineers love data, but sometimes can struggle to effectively communicate to their team, whether that's expressing a solution to a problem or presenting final data collection to their project teams. Another good chapter would be how to effectively lead meetings and keep a team on task, especially for someone interested in project management.

Overall, I thoroughly enjoyed this book. Thank you, Happy, for inspiring so many engineers. I'll let you know how these skills help me progress. **PCB007**



Hannah Nelson is a process engineer at Texas Instruments and in the IPC Emerging Engineer Program. To read past columns, [click here](#). Get yourself a copy of this Happy Holden book [here](#).

Nextgen Computing: Hard-to-move Quasiparticles Glide Up Pyramid Edges

A new kind of “wire” for moving excitons, developed at the University of Michigan, could help enable a new class of devices, perhaps including room temperature quantum computers.

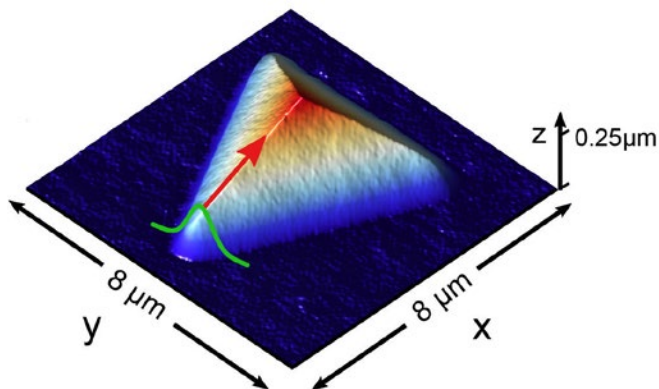
What's more, the team observed a dramatic violation of Einstein's relation, used to describe how particles spread out in space, and leveraged it to move excitons in much smaller packages than previously possible.

“Nature uses excitons in photosynthesis. We use excitons in OLED displays and some LEDs and solar cells,” said Parag Deotare, co-corresponding author

of the study in *ACS Nano* supervising the experimental work, and an associate professor of electrical and computer engineering. “The ability to move excitons where we want will help us improve the efficiency of devices that already use excitons and expand excitonics into computing.”

An exciton can be thought of as a particle (hence quasiparticle), but it's really an electron linked with a positively-charged empty space in the lattice of the material (a “hole”). Because an exciton has no net electrical charge, moving excitons are not affected by parasitic capacitances, an electrical interaction between neighboring components in a device that causes energy losses. Excitons are also easy to convert to and from light, so they open the way for extremely fast and efficient computers that use a combination of optics and excitonics, rather than electronics.

This combination could help enable room temperature quantum computing, said Mackillo Kira, co-corresponding author of the study supervising the theory, and a professor of electrical and computer engineering. (Source: University of Michigan)





A Progress Report:

Investing in U.S. PCB Fabricators

Feature Interview by Nolan Johnson

I-CONNECT007

In the geopolitical arena, the supply chain lessons learned during the pandemic continue to be addressed with long-range plans as well as short-term stopgaps. In this conversation, David Schild, executive director of the Printed Circuit Board Association of America (PCBAA), provides a progress update on the U.S. CHIPS Act, and some of the fan-out dynamics already playing out. As David explains, there is new investment in PCB fabrication that has nothing to do with the CHIPS Act.

Nolan Johnson: *David, we've recently seen investment news for Calumet Electronics and TTM. In Calumet's case, the cash is coming from DoD and the state of Michigan; in TTM's case, it's an internally funded project. What is the larger story here?*

David Schild: This is a signal that the industry is willing to put its money where its mouth is, and that governments at both the state and federal level want to help. I'm very happy to see this, but it underscores that this is just two companies and millions of dollars, when we need to be talking about dozens of companies and billions of dollars.

We're thrilled that Calumet has announced funding from both the state of Michigan and the Department of Defense to expand their organic substrate capabilities, and DoD-specific capabilities in the state of Michigan. TTM has announced a greenfield initiative to produce UHDI PCBs adjacent to its existing Syracuse facility. The industry is not sitting still. We're willing to actually invest dollars, but it won't put our manufacturing in a competitive position until we have government support.

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How do we make this happen?

A version of the CHIPS program for the domestic PCB and substrate industry would be ideal as we pursue different policy remedies for the industry. There's the language in the National Defense Authorization Act (NDAA), which says that by 2027, we need a plan to get foreign-restricted microelectronics out of the commercial off-the-shelf (COTS) supply chain. That's more of a prohibition. We all agree that we don't want microelectronics from Russia, China, Iran, or North Korea on our defense platforms. However, COTS technology is one way these components can leak into the supply chain.

The Defense Production Act (DPA), which was enacted in 1950 at the start of the Korean War, is a second way to incentivize the industry. If the president says—as he did in March—that printed circuit boards and substrates are critical national technologies and we need to remove federal barriers for purchasing and investment in those technology sets, then we need to fund that hunting license, if you will.

There were some unfortunate cuts to the DPA account at the Pentagon this year. It wasn't a reflection of Congress not believing in the DPA; it was a reflection of the Pentagon not spending that money very quickly. We're now partnering with IPC to get those cuts reversed. We're trying to get money added. That \$39.9 million going to Calumet is from the DPA account.

There are many companies in the United States that would like to do more work with organic substrates, UHDI, and other kinds of technologies. How is the DoD recognizing that?

The Pentagon recognized us as powering the next generation of defense technologies. You already see them doling out their portion of

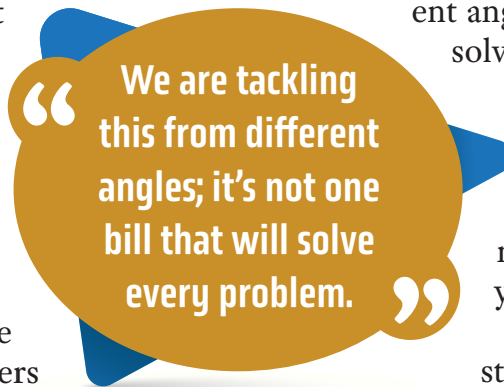
CHIPS Act money to semiconductor companies. In another announcement, this one from Intel, we learned it will use the money to do specific fab work for defense applications. The DoD is moving very quickly because it has an existential reason to want to win these technology races. Perhaps the second push is the use of the DPA.

The standalone legislation, the Protecting Circuit Boards and Substrates (PCBS) Act, which was introduced in the House, represents \$3 billion in funding and a 25% tax credit for the purchase of American-made PCBs. We need a Senate companion bill as well. We are tackling this from different

angles; it's not one bill that will solve every problem. We often say that it took more than three decades to dig this hole, and it will take more than three weeks, three months, or maybe even three years to dig our way out of it.

The market has demonstrated that private money follows public policy. Think about the \$450 billion that has come off the sidelines for the semiconductor industry in response to a \$52 billion commitment from the federal government. We're still in the application process, so most of that government money hasn't been disbursed; estimates are that it will take a decade to fully disperse the \$52 billion. So, private money is getting off the sidelines; they see a demand signal, and sustained support from the biggest buyer of electronics, the federal government. That private money will go into additional private investments, including greenfield initiatives, capacity, workforce initiatives, and partnerships with institutions such as ASU, Purdue, Ohio State, and others.

A great signal was when Michigan stepped up at Calumet, and said, "We'll partner with them so that they can build out more organic substrate production." The Michigan Economic Development Corporation put up the



money—almost \$7 million for 80 jobs in the Upper Peninsula that didn't exist before. It's a great example of a government partnership that builds out high tech manufacturing capability. Additionally, the DoD invested under the DPA almost \$40 million for Calumet to fabricate more advanced defense-specific PCBs. That is exactly what the DPA is for.

TTM is investing almost \$100 million of its own money to expand UHDI PCB capability in Syracuse, New York. It's a tremendous partnership that will create hundreds of new jobs in Syracuse. So, while we wait on Washington to do these other things, state governments and the Pentagon are acting, as is private industry.

It seems to me that the funding from the CHIPS Act, which is administered by the Department of Commerce, may be the slowest moving portion.

The journey of the CHIPS program, from ideation to signature on the president's desk, took almost four years. During that time, as Congress was discussing whether America should invest in semiconductor production capacity, the pandemic made it very clear where the supply chains were weak. We had customers waiting to buy pickup trucks because the factories couldn't get chips. The combination of scarcity and major interruptions in supply chain, on top of a political willingness to do industrial policy, is what got the CHIPS Act done.

Think about it: It took us four years to get the CHIPS Act signed, and we had some of the largest companies in the world—Intel, Micron, and TSMC, and an enormously powerful and influential trade association—pushing the President and the Secretary of Commerce.

By comparison, we hadn't even launched PCBAA yet, and it's been an organization very much borne out of this tumult. America will do industrial policy and restore and build out capacities for critical national technologies. Many members of our industry said, "Wait a minute, what about the rest of us? Will you really only invest in chips?" On Capitol Hill, we



David Schild

often hear, "Why didn't we include this in the chipset?" I don't have a good answer. Had our industry been organized at that time, maybe we would have pushed for inclusion in that bill.

Have you seen this discussion expand into the supplier side?

Yes, it now includes those in the raw material space: woven glass, copper foil, and rare earths, with even lithium extractor companies starting to say, "We should have been a part of this conversation as well." These facilities in Chandler (Arizona), Columbus (Ohio), and other locations are wonderful, but they're not the end of the story about technologies we invented here, and technologies where we still lead. It's the manufacturing which has largely been offshored. We're often asked, "What if we had to suddenly make more of these in a war-time or disaster environment?" The answer is that we're operating at capacity, and we would have a hard time sourcing.

I'm grateful for the work that the semiconductor industry has done. They helped form serious industrial policy in a bipartisan way. I am really proud that many Republicans and Democrats supported the CHIPS Act. There were a number of reasons to get on board. Some saw this through a national security lens,

others saw it through a jobs and economic security lens. Some didn't care for insecure and fragile supply chains, and some were just concerned about scarcity and price. That is the response we tend to get when we talk about the rest of the stack, whether it's boards or substrates. Each has their own motivation, but there are many reasons to tackle this problem.

So far, the money from the CHIPS Act is going toward the large players in the industry. To be resilient, though, we need a diverse supply chain and a variety of different sized companies and technical capabilities. How do we do that?

Two things are universally beneficial about the plans that we're pushing. First, the Buy America provision hits anybody who works here. If you can say to your customer, "There's a tax credit for buying American," that lands well. To tell your customer they can get a 25% tax break, it lands equally well.

With regards to the direct funding, there is no reason to think we would give preferential treatment to large companies over small. To apply, you need to meet certain criteria, and demonstrate a couple of key things: First, that this funding will be used for the purposes that Congress intended, and second, that it will be used domestically, among other conditions.

Who is at the head of the line?

It's the global foundries, and I'm not surprised, but will they exhaust all \$52 billion? No. For PCB manufacturers in the United States to buy a \$10 million piece of drilling equipment is a tremendous capital expenditure. The government may be able to help with those capital expenditures through direct funding.

The industry will not turn around on the proposed \$3 billion in the House's PCB bill. That's why we coupled a grant program with a tax credit. We want to be sure the government is buying, especially for national security applications, inside its American supply chain. We are very confident that when the Pentagon

audits its supply chain and does a more thorough job to eliminate foreign microelectronics, it will necessarily have to buy more American. Our members who are selling into Raytheon, Lockheed, Boeing, Honeywell, and such, could potentially see some growth.

The money seems to be moving quickly from the DoD and private sources rather than Commerce. Is this a situation where those funds might be more quickly available, perhaps helping a small boutique approach?

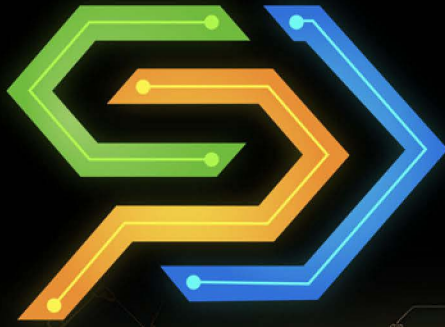
As a taxpayer, as well as the leader of a coalition of domestic producers, we should have a direct investment of government dollars in this industry. Having a domestic capacity to produce printed circuit boards and IC substrates is a national security concern.

You're right that government money tends to move slowly. The CHIPS Act took four years to implement, and it may take 10 years to disperse all those funds. It might even take 15 years from the time we first thought about giving semiconductor manufacturers money to the time we finally wrap it up. Fifteen years is an eternity.

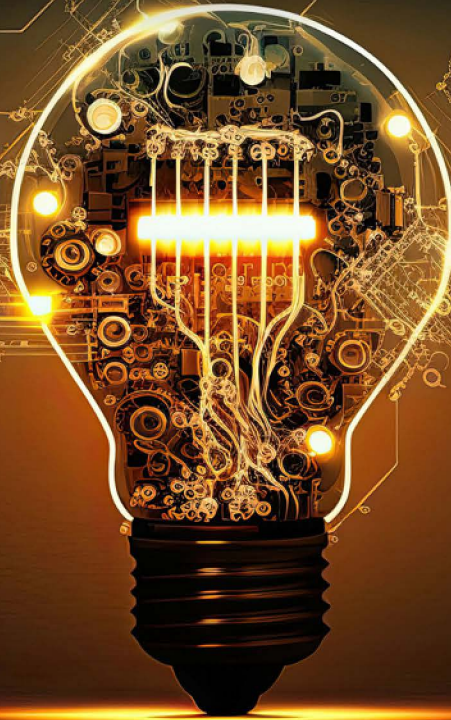
Our challenge is that private money doesn't see a demand signal. Private money sees a very healthy aerospace and defense market under an ITAR restriction requiring things to be made in America. But in the commercial space, where we have most of the offshoring, margin pressures still force sourcing. The challenge that private money faces is investing in our members and our domestic capacity without the obvious commercial demand signal.

Can you talk about a redefinition of critical infrastructure?

We talk a lot about how a board for a Javelin missile or radar must be made at a DoD-trusted U.S. site. That's an easily understood concept. But do we think that missiles and radars are the extent of the things that should have trusted microelectronics? What about banking software, the energy grid, and critical infrastruc-



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ture applications, or electrification and solar panels, windmills, and EV chargers? Is it healthy to have these other critical sectors of the economy largely or completely reliant on foreign sourcing? I would say no; that doesn't sound like a good idea at all. If, for manmade or natural disaster reasons, we suddenly can't get the substrates we need for banking software or medical devices or the energy grid, that's a huge exposure.

A great example is telecommunications deployment. There's been a lot of debate about whether American or foreign companies should build out the next 5G network, I would argue that if you select an American company that bases the network on foreign-produced microelectronics in their cell towers, then you haven't solved the problem you thought you solved. We have to start cracking open our devices, asking hard questions about our supply chains all the way down—not just one or two layers, but three or four layers deep. That redefinition of what the government buys and subsidizes would create that demand signal.

For many years, private money has been challenged to see the ROI. Of course, the government is not focused on return on investment as much as they are looking at national capacity, national security, jobs, etc. But there's a place where we can both be economically profitable and serve broader national interests.

In the U.S., we are playing catch-up in economic policy. Other nations have chosen over the last half-century to work diligently to control certain sectors of the economy like microelectronics, rare earths, and any number of economic verticals. That was a strategic choice. When you build a road for free for a company, put the workers in subsidized housing, and give away the land, you're making an economic policy decision. In Asia, Europe, and the Americas, some governments are saying, "We want



to have more of this. Let's enact policies to further it." This is our geopolitical competition.

There does seem to be increasing bullishness about funding this industry in the finance sectors. I've been talk-

ing to some folks who recommend looking at the state level to see whether assistance is available. Should business leaders be shaking those funding trees as well?

We should be encouraged by what some states have done, like Michigan, in partnership with Calumet. There are promising signals out of places like New York, Ohio, and Arizona, for example. We used to have board shops all over the country. Now my figures tell me that we have board and substrate work in at least 27 states. But certainly, our facilities could be everywhere. This is a good career with high-touch labor and a ready customer base. I'm encouraged to see states doing this; they see the immediate positive impact. They see jobs and new construction. Visit outside of Columbus, Ohio, for example, and see farmland being turned into subdivisions so that Intel workers—who have yet to graduate from college—will have a place to live. What a boon for the Central Ohio economy. If I was a state lawmaker, governor, or mayor, I would want to run that playbook in my districts.

My experience is that lawmakers are largely unaware of the tremendous economic footprint of the rest of the microelectronic stack. They're driving by facilities that make boards and substrates and raw material facilities, not even realizing what's in their district and their state. We're on a mission to walk them through those production lines to put the technology in their hands.

David, as always, thanks for the insight.

Thank you, Nolan. PCB007

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The High Cost of Etcher Non-maintenance

The Chemical Connection

by Don Ball, CHEMCUT

We all understand that day-to-day maintenance and long-term preventive maintenance of etching equipment is a good thing. However, the pressing need to get product out the door in the face of tough production schedules can sometimes cause us to delay necessary maintenance for long periods of time. In some cases, we become fixated on short-term production and forget about long-term stability. This can end up costing a fair amount of money in terms of repairs and lost production, most of which could have been prevented by taking the time to do some simple checks on equipment operation and chemistry conditions.

For example, I received a call from a customer some years ago complaining that his cupric chloride etcher had stopped etching. The Friday before the call, the etch rate started to drop off rapidly so they had to slow the conveyor speed continually. The following Mon-

day, the etcher was slow to heat up and when the pumps were turned on there was virtually no spray pressure even though the pump valves were wide open.

A few questions established that the color of the cupric was a bright green with an oxidation/reduction potential of over 900 mv but no chlorine odor. This was a bit of a surprise. I was expecting to hear that the color was almost black and the ORP down around the lower 500s, indicating a problem with the etchant regeneration, and accounting for the slowing etch rate. Also, with the ORP in the 900s, there should have been at least a strong chlorine smell around the etcher even if it wasn't enough to cause the room to be evacuated.

I had a sneaking suspicion about the problem and asked if they had the capability do a free acid titration. They did and their chemist reported that the titration showed almost no



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OUR FOCUS

TO CREATE A MORE RESILIENT AND SECURE SUPPLY CHAIN, WE NEED TO BRING PCB MANUFACTURING BACK TO AMERICA. PASSING H.R. 3249, THE PROTECTING CIRCUIT BOARDS AND SUBSTRATES (PCBS) ACT, WILL REINVIGORATE OUR INDUSTRY AND MAKE US MORE COMPETITIVE.

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free acid. This meant that the cuprous chloride byproduct from the etch reaction was not being kept in solution by the free acid and was precipitating to the bottom of the etch sump. The ORP, which is a ratio of cupric ions to cuprous ions in the etch bath, continued to increase as cuprous ions were removed from the etch solution. Thus, the regeneration unit did not add oxidizer or HCl to the system to regenerate the cuprous ions back to cupric ions. As the concentration of cupric ions decreased, so did the etch rate. Over the weekend, as the bath cooled down, any remaining cuprous chloride finished precipitating out of the etch solution to the bottom of the etcher sump, blocking the pump intakes.

Why did the free acid drop so much? The maintenance person responsible for checking the acid supply drum for the regeneration system took that Friday off and no one else was responsible for checking the drum.

By the time the problem was diagnosed, and remedies taken to redissolve the cuprous chloride and bring the chemistry back into specifications, the customer lost four days of production simply because they did not have a maintenance protocol to check the free acid level at least once in the morning and once in the early afternoon.

A somewhat similar problem occurred a few months ago to a customer etching copper and steel using ferric chloride as the etchant. We got a panicked call one day saying that the heaters in the etcher had “blown up” and they needed someone there immediately to identify the problem and fix it.

The problem was evident once the ferric chloride was removed from the etcher. There was six inches of muddy brown sludge in the bottom of the sump that covered the heaters, causing them to overheat and short out in a rather spectacular fashion.

Ferric chloride is a dirty etchant when etching copper and steel alloys. The sludge consisted mostly of insoluble metallic chlorides from the alloying metals in the steel. Free acid levels are difficult to determine in ferric because the alloying metals interfere with the acid titration. Even when the free acid levels are properly maintained there are always insoluble chlorides precipitating from the etch solution to the bottom of the sump.

It is generally recommended that the etcher be drained at least once a month and the bottom of the sump hosed out. In this case, the etchant was used as long as possible, then drained and the sump filled with new etchant but without hosing out the bottom (it took too long). More than a week of production was lost simply because they did not want to spend an extra 10 minutes cleaning out the bottom of the etch sump every time they refilled the etcher with fresh etchant.

And so it goes. Every equipment supplier can probably come up with many stories of major problems and expenses caused by failure to do even minimal equipment maintenance in the name of getting more product out the door.

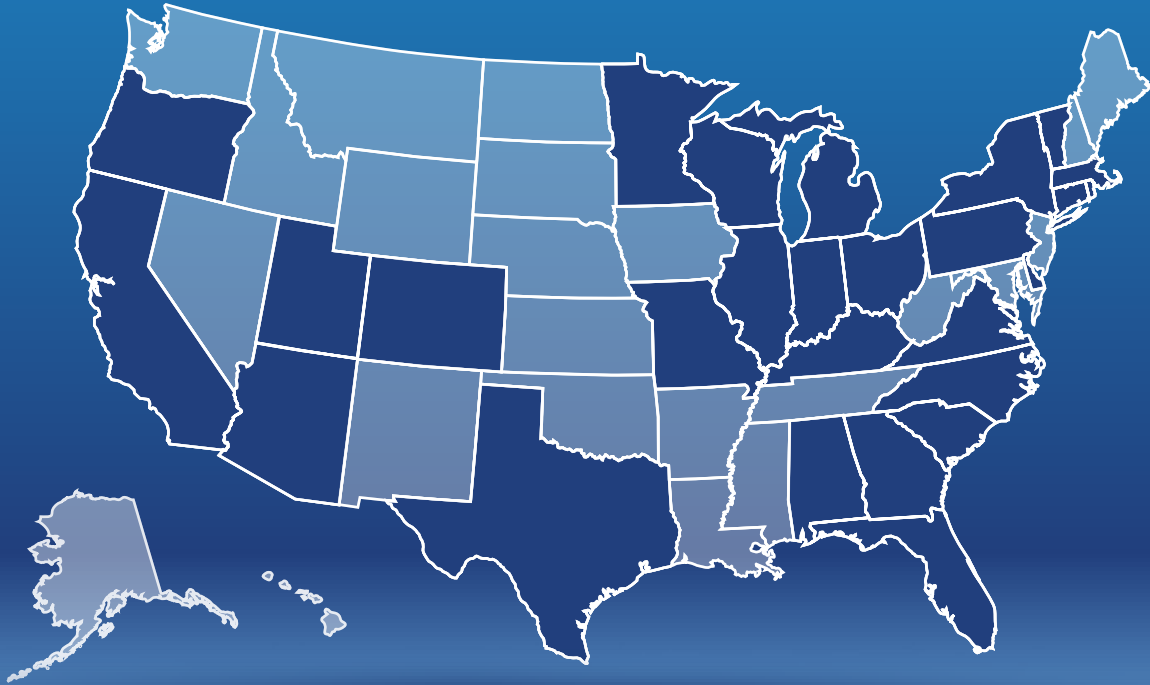
The time spent devising and running even a minimal daily check and maintenance protocol will quickly pay for itself by reducing downtime caused by easily preventable failures. It may be difficult to think about draining the swamp when you’re up to your butt in alligators; just remind yourself that when the swamp is drained, the alligators tend to disappear. **PCB007**

“ It is generally recommended that the etcher be drained at least once a month and the bottom of the sump hosed out. ”



Don Ball is a process engineer at Chemcut. To read past columns or contact Ball, [click here](#).

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27

States

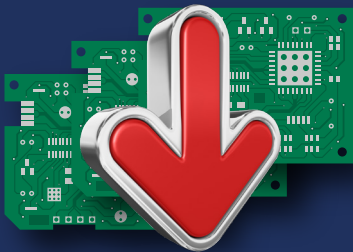
15,000+

Employees

\$15 billion+

to the US Economy

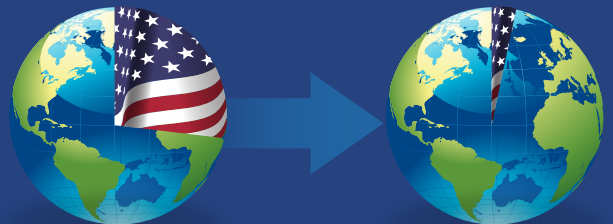
DOMESTIC PCB MANUFACTURERS



2002: 2,000

2023: 145

HELP US RESTORE OUR MARKET SHARE



2002: 30%

2023: 4%

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Amitron's Leap Into the AI Frontier

In a conversation with Aidan Salvi, Amitron's chief transformation officer, he spoke of the interaction of machine learning on registration. Amitron has been modernizing much of its manufacturing equipment, and Aidan points out that improving registration is a key objective. He sees registration as a holistic system. To make smart improvements, you need data.

Meet the IPS Workforce: Inoa Wahinehookae

While visiting the IPS facility in Cedar City, Utah, I interviewed mechanical design engineer Inoa Wahinehookae, who graduated two years ago from Southern Utah University with a bachelor's degree in mechanical engineering and a minor in CAD/CAM.



PCB Market to Grow by \$19.05 Billion from 2022 to 2027

The printed circuit board (PCB) market is set to grow by USD 19.05 billion from 2022 to 2027. The market is estimated to be progressing at a CAGR of 5.05% during the forecast period. The report offers an up-to-date analysis regarding the current global market scenario, the latest trends and drivers, and the overall market environment.

All Flex Solutions Installs New Inner Layer Factory

All Flex Solutions has purchased and installed a new inner layer factory in their Rigid Flex Center of Excellence located in Minneapolis. This continues their investments in plants and technology to support customers' needs for capability, speed and increased yield.



Materials Costs Continue to Improve but Labor Costs Remain a Pain Point for Electronics Manufacturers

Electronics industry sentiment improved during November with demand sentiment also taking a solid step up over the last 30 days per IPC's November 2023 Global Sentiment of the Electronics Supply Chain Report. And though materials costs continue to improve, labor costs remain a pain point. Three-fifths (62 percent) of electronics manufacturers say they are currently experiencing rising labor costs.

EPOCH Celebrates 30-Year Anniversary

Recently, EPOCH celebrated the company's 30th anniversary. The I-Connect007 China team covered the event, captured a conversation with EPOCH CEO Foad Ghalili during the celebration, and filed this video report.



American Made Advocacy: Member Profile on Hari Pillai

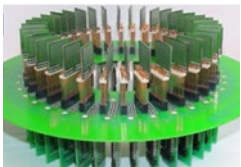
"I think I've had a good dose of luck throughout my career. But beyond luck, I had a vision to become a general manager as far back as my undergraduate years. I made all my career decisions based on that," said Hari Pillai, president of the Technology Components Group at Sanmina.

Punching Out: What Do Buyers Expect?



For sellers, the whole process is relatively simple: They may say it's not just about the money, but in truth, it is. Sellers also want a quick process, most of their money upfront, and a reasonable expectation that any deferred compensation will actually be paid. They're usually concerned that the buyer will take good care of their employees, customers, suppliers, and other stakeholders, and that the seller's responsibilities after closing, if any, be acceptable.

Happy's Tech Talk #24: Performance and Registration—Coupons to the Rescue



Registration is one of the most important features for any PCB fabricator, but the capability for multilayers is a lot of work on the fabricator's part. CAM settings, multilayer lamination, X-ray analysis, AOI measurements, imaging capability, and drill accuracy all play an important part in this capability. Software and panel parametric coupons are important because they aid in registration performance.

Standard of Excellence: The Perfect PCB Fab—A Vision for Five Years Ahead

To sustain a standard of excellence, it's equally important to look at both what we're doing today as well as what we'll do in the future. In other words, plan ahead. In that spirit, I thought it would be prudent to peek into the future and talk about what a printed circuit board fabrication facility with a "standard of excellence" will look like five years from now.

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Find Industry-experienced Candidates at jobConnect007

For just \$975, your 200-word, full-column ad will appear in the Career Opportunities section of all three of our monthly magazines, reaching circuit board designers, fabricators, assemblers, OEMs, suppliers and the academic community.

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Career Opportunities



Technical Sales Manager

Gen3, based in Farnborough, UK, who designs, manufactures and distributes test equipment to minimize risk of failure in the field, has an exciting opportunity for a Technical Sales Manager to join its team to drive growth in the southern half of the UK.

Responsibilities & Experience

- Promote Gen3's and its principles' equipment.
- Identify opportunities in existing and new customers.
- Report all commercial developments related to the activity of Gen3's customers, actively seeking the specification of Gen3's products, into new projects.
- Be fully familiar with all Gen3's products, technology, USPs, features, benefits and international standards.
- Follow up all enquiries for products and services; convert them into contracts/orders.
- Provide technical support – remotely and onsite.
- Be widely recognised and acknowledged as an "Industry Expert."
- Technical Sales and Account Management skills from an electronics background is desirable.
- Excellent sales, customer service, communication, presentation and negotiation skills.
- Recognised qualification in Electronics Engineering or related field.
- Knowledge of the electronics/SMT assembly process.
- Excellent written and verbal communication skills in English.
- Competent user of Microsoft Office applications.
- Ideally living in the Southern half of the UK.
- Willing and able to travel within and outside UK.
- A full, clean UK driving license is essential.

To apply, please contact John Barraclough at john.barraclough@gen3systems.com or by using the link below.

[apply now](#)



Senior Sales Representative Ventec Central Europe

Location: Kirchheimbolanden, Germany/Remote

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

Key Responsibilities

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

Job Requirements

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

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

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Career Opportunities



Technical Support Engineer USA Region

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

Key Responsibilities:

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

Qualifications & Requirements:

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

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Rewarding Careers

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

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

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

Associate Electronics Technician/ Engineer (ATE-MD)

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

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

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Career Opportunities



Europe Technical Sales Engineer

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

PRIMARY FUNCTION:

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

ESSENTIAL DUTIES:

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

QUALIFICATIONS / SKILLS:

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

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

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IPC Instructor Longmont, CO

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

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

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

Salary: Starting at \$30 per hour depending on experience

Benefits:

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

Schedule: Monday thru Friday, 8–5

Experience: Electronics Manufacturing: 5+ years (Required)

License/Certification: IPC Certification—Preferred, Not Required

Willingness to travel: 25% (Required)

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Career Opportunities



Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB manufacturer located in Tucson, AZ, is looking for sales representatives for the Southeastern U.S. territory. With 35+ years of experience, our PCB manufacturing capabilities reach far beyond that of your typical fabricator.

Reasons you should work with Prototron:

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

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

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Regional Manager Southwest Region

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



Technical Marketing Engineer

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

Requirements:

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

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

Send Resumes to: resumes@ema-eda.com

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MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

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

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

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

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

Valid driver's license is required, as well as a passport for travel.

Must be able to travel extensively.

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Career Opportunities



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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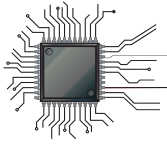
Are You Our Next Superstar?!

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

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

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Career Opportunities



MivaTek

Global

Field Service Technician

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

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

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

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

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

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eptac

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Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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Career Opportunities



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

The CAD/CAM Engineer is responsible for reviewing customer supplied data and drawings, performing design rule checks and creation of 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 Orbotech/Genflex CAM tooling software.

PHYSICAL DEMANDS

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

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APCT
Passion | Commitment | Trust

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

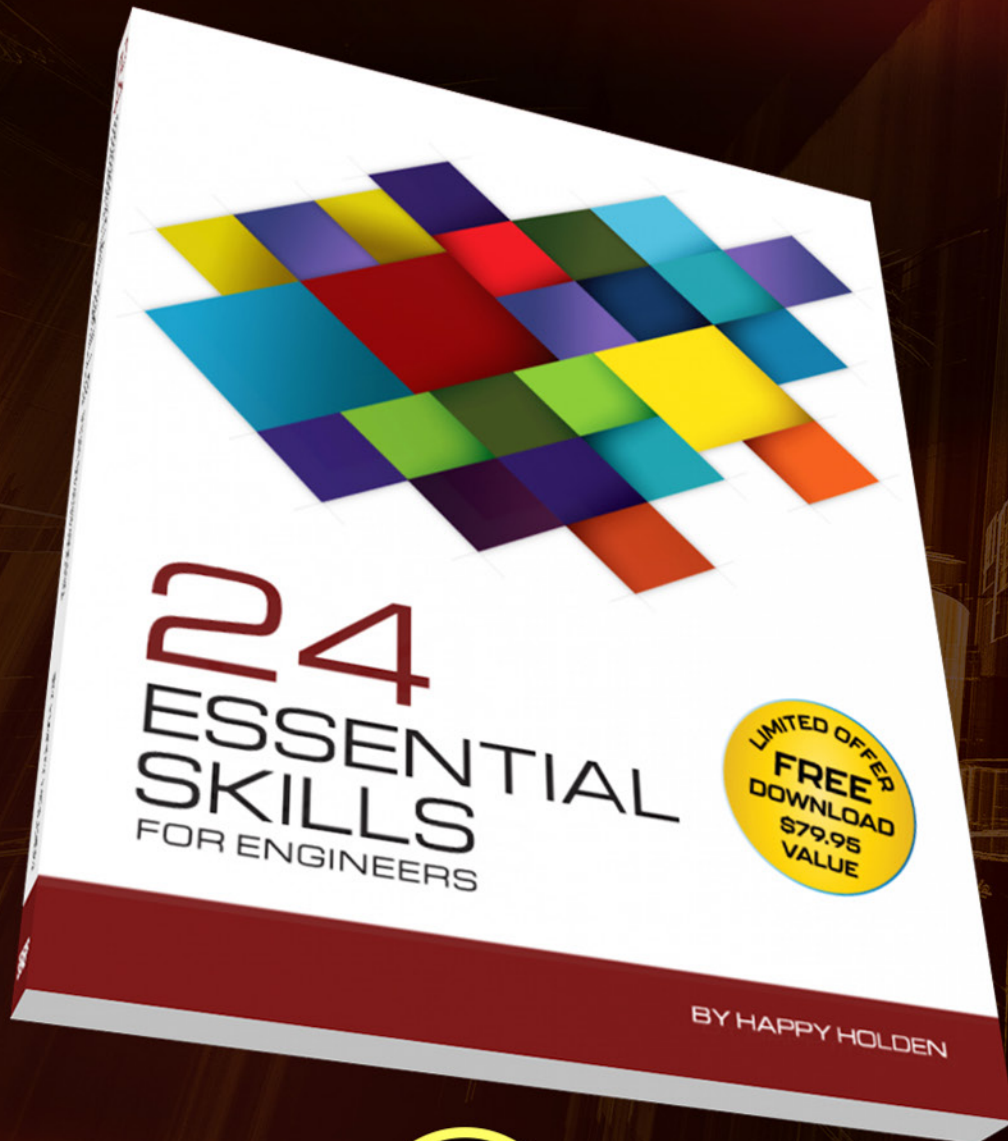
We invite you to read about APCT at APCT.com and encourage you to understand our core values of passion, commitment, and trust. If you can embrace these principles and what they entail, then you may be a great match to join our team! Peruse the opportunities by clicking the link below.

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

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Engineers: Here are 24 Real-world Skills You Didn't Learn in School

Industry veteran Happy Holden shares his strategies for overcoming engineering challenges.



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Books

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The Printed Circuit Designers Guide to... Manufacturing Driven Design

This book introduces a new process workflow for optimizing your design called Manufacturing Driven Design (MDD). This is a distinct evolution from DFM. Readers will learn how to utilize data-driven concepts to improve design capabilities. Visit I-007ebooks.com to get your copy today.



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Designing for Reality

by Matt Stevenson, Sunstone Circuits

Based on the wisdom of 50 years of PCB manufacturing at Sunstone Circuits, this book is a must-have reference for designers seeking to understand the PCB manufacturing process as it relates to their design. Designing for manufacturability requires understanding the production process fundamentals and factors within the process. [Read it now!](#)



Thermal Management with Insulated Metal Substrates, Vol. 2

by Didier Mauve and Robert Art, Ventec International Group

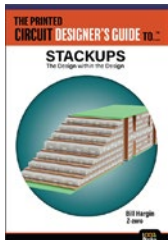
This book covers the latest developments in the field of thermal management, particularly in insulated metal substrates, using state-of-the-art products as examples and focusing on specific solutions and enhanced properties of IMS. [Add this essential book to your library.](#)



High Performance Materials

by Michael Gay, Isola

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CREATIVE TECHNOLOGIST: **BRYSON MATTIES**

COVER DESIGN: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK** © dpVUE.images

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MAGAZINE

PCB007 MAGAZINE®

is published by IPC Publishing Group, Inc.
3000 Lakeside Dr., Suite 105N, Bannockburn, IL 60015

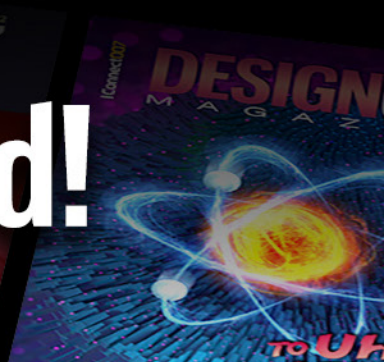
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December 2023, Volume 13, Number 12
PCB007 MAGAZINE is published monthly
by IPC Publishing Group., Inc., dba I-Connect007

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