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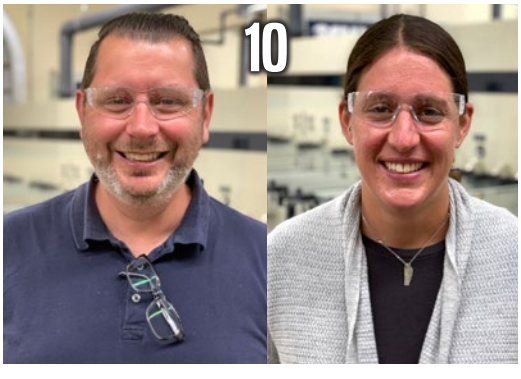

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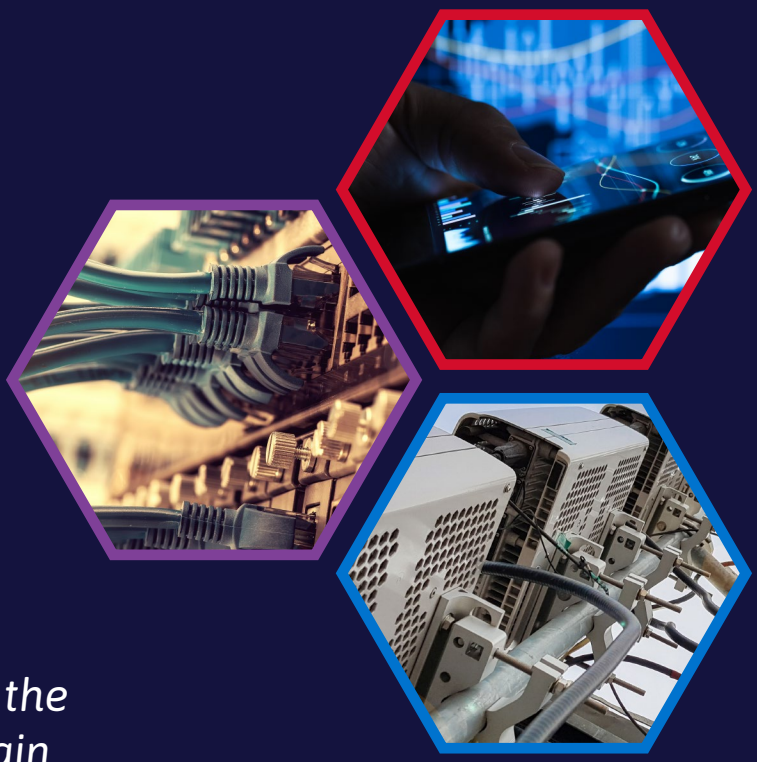

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Leadership in Today's World

Nolan's Notes

by Nolan Johnson, I-CONNECT007

"The greatest leader is not necessarily the one who does the greatest things. He is the one that gets the people to do the greatest things." —Ronald Reagan

Ronald Reagan certainly understood the power of unifying people into a movement. And moving forward is a key part of leadership, as our I-Connect007 Research Team's recent survey indicated. Much as we in the electronics manufacturing industry prefer stability, consistency, and reproducible results on the manufacturing floor, ours is an industry of innovation. And innovation can bloom from anywhere, including from you. Empower your functional team to create outstanding results within your company and watch your company begin to overtake the competition. Move to the front of the pack in the marketplace as a result, and suddenly, you're a visionary disrupting the market. As we watched companies respond to the challenges of 2020, we asked, "What makes for a good leader?" Not satisfied with our own answers, we took the initiative to ask you, our readers.

We start this month with a report on the leadership survey we conducted. Much of what the survey revealed confirms our usual beliefs, but there were some surprise insights among the data as well.

Next, we found leaders who were creating movement by empowering others to effect change: Blue Box and Calumet Electronics. Jim Metropoulos, the founder of Blue Box, shares his experiences in developing a new process for HVAC system cleaning that has significant potential benefits for manufacturing, as well as healthcare, hospitals, and large buildings of all types. His persistence has set

his company up to be quite disruptive in the HVAC industry. Persistence and belief can be large influences in a leader's effectiveness.

Then, we share a conversation with Meredith LeBeau and Todd Brassard from Calumet Electronics. Changing market dynamics have been leading the way for the company's upgrade decision-making process. Kevin Jobsky posts an article on how to navigate the unusual challenges facing companies at this time. We spoke to ICM Controls earlier this year, and this article continues that conversation.

Because leadership has emerged as a theme throughout 2020, we also link back to related discussions that have been previously published by I-Connect007. Look for insights from IPC's Dr. John Mitchell; Susan Mucha, president of Powell-Mucha Consulting, and IPC's Carlos Plaza; and KYZEN's Tom Forsythe.

We also get technical with an article from Frank Gäbler on laser depaneling and a discussion of pure palladium plating for ENEPIG from a team of Atotech researchers. We also bring you a cadre of columnists, including John Mitchell, Mike Carano, Didrik Bech, Steve Williams, and Todd Kolmodin.

Finally, on the theme of empowerment, Woodrow Wilson, the 28th President of the United States, said the following about leadership. Though Wilson's time in office was 100 years ago, it's almost as if he is speaking to our industry today: "You are not here merely to make a living. You are here in order to enable the world to live more amply, with greater vision, with a finer spirit of hope and achievement. You are here to enrich the world, and you impoverish yourself if you forget the errand."

With those words to ponder, enjoy this issue.

PCB007

Nolan Johnson is managing editor of *PCB007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing.
To contact Johnson, click here.

IPC's Dr. John Mitchell: Leadership in Crisis

On May 13, Barry Matties spoke with Dr. John Mitchell, IPC president and CEO, in another installment in our series of industry updates.

In this interview, Mitchell and Matties discussed the challenges of leadership in crisis situations. In his role at the helm of IPC, Mitchell brought unique insights into the power of leadership. He pointed out that a good leader will assemble a strong team, get out the team's way, and concentrate on breaking down obstacles.

Other observations from Mitchell included the balance of communicating with optimism and realism, and that while COVID-19 is testing leadership skills, it is also providing an opportunity for innovation within organizations. Mitchell concluded by sharing ways in which industry leaders are regularly networking, supporting each other, and sharing successful strategies.

View the full transcript here.

Thoughtful and Nimble Leadership

at Calumet Electronics

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 editorial team spoke with Todd Brassard, VP/COO, and Meredith LeBeau, director of process engineering, from Calumet Electronics about the growth this Michigan board manufacturer has seen during the COVID-19 pandemic, with their panel output increasing by 20–30% in response to surges in demand. They discuss many of the unanticipated opportunities that have arisen from the pandemic, and the effect it's had on their OEM customers.

Barry Matties: A lot of lessons are being learned through this pandemic, and I heard you were quite busy with ventilator work. Is that the case?

Todd Brassard: I first became aware of supply chain issues with sourcing ventilator PCBs from reading an article in *Wired Magazine,* which stated that China-based supply chains were being disrupted. I was puzzled because manufacturing capacity in China is enormous, and ventilator PCBs are relatively simple to manufacture. Apparently, manufacturing capacity in China was shut down, reduced, or otherwise redirected due to the COVID-19 pandemic. Later, we would also learn there were only a handful of PCB shops in the U.S. credentialed by medical OEMs to manufacture ventilator PCBs.

Meredith LaBeau: For medical boards, FDA approval is a long and cost-intensive process that creates a reluctance to re-qualify new suppliers. Other PCB shops were apparently ready to help by producing ventilator boards, but medical OEMs were likely not positioned to relax their qualification processes or able to travel during the height of the lockdowns in order to visit, audit, and qualify additional PCB manufacturers.

Brassard: Our first hint that Calumet Electronics had a role to play in the pandemic was when our sales team received that first email, stating, "Urgent, urgent, urgent," for a rush order of ventilator boards. We thought, "Wow, we have an important role to play in this pandemic." In the following months, we produced PCBs for seven customers and 36 unique part

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numbers and were on track to source around 200,000 boards for COVID-19 related equipment.

Matties: How did the COVID-19 pandemic impact Calumet's operations?

LaBeau: Prior to COVID-19 spreading across the U.S. and before Michigan entered a state of lockdown, we were already experiencing a large uptick in demand. When COVID-19 hit in March, demand surged to almost twice our production capacity. Like many businesses, we were concerned about workforce attrition and working to understand if our operation would be considered critical manufacturing. Then, we adjusted our perspective on the problem. Instead of planning for reduced capacity, we realized we had a job to do. We had to push our output beyond its normal limit to meet the needs of our customers and bolster the supply of PCBs for life-saving medical equipment. Instead of being defeated by the uncertainty of COVID-19, we had to push our hardest to be part of the solution.

Todd Brassard

Matties: We have this saying: "What if we really tried?"

Brassard: Exactly. What could we do if we pulled out all the stops? It was not business as usual; we simply had to do better and do it quickly. In just a few days, we had a plan that moved office staff with manufacturing experience back onto the floor, we leveraged employee cross-training and moved people around with agility to ensure proper staffing, and we started a campaign to hire and grow our manufacturing workforce. For a period, output grew by 39%, eventually settling between 20–25%.

LaBeau: We have been able to sustain a 23% increase. That's not a small accomplishment for a PCB shop.

Matties: It's about mindset. You had to change your mindset to really make the best of this opportunity. Your workforce knew they were a part of something special, especially when making the ventilator boards, and that they were really contributing to the well-being of the world.

LaBeau: Our employees found pride in being able to supply these ventilator boards, especially in a time of crisis for the nation. Fundamentally, it was a reset on what our jobs meant at Calumet. We all had to understand where we could cross-train, rapidly move resources, and support manufacturing by solving bottlenecks and outages instantly. We are still using many of those tactics from March and April, which is helping us sustain the increase in output, but we also have plans to increase manufacturing output again by the start of 2021 as demand continues to be strong and we continue to invest in people, equipment, and our facility.

Brassard: It's very much about mindset. We found solidarity of purpose and focused on what we do best—manufacturing PCBs. The principles we committed to at the onset of COVID-19 were simple. First, keep our workforce healthy and safe. Second, we understood the value and importance of having jobs when so many of our friends and family are unemployed. Finally, we understood that our role in the electronics supply chain was incredibly important, that our customers and their employees were equally relying on Calumet not to fall down during a crisis.

Matties: As a leader, what lessons have you learned, and how have you changed?

Brassard: That success requires leadership, not just from top management, but at every level within a company. That a business is often full of talented and capable people, and it's impor-

tant to tap into that capability. Also, it is important to see deeply into the problems holding you back. Empowering people provides the best opportunities to solve problems quickly at the spot where they occur. That distributed leadership is very powerful when an entire workforce is focused on accomplishing a small set of important and clearly defined goals. You need to get buy-in from your workforce by being transparent and solid with communication and purpose.

Meredith LaBeau

Matties: Tell us what you've learned, Meredith, and how it applies.

LaBeau: I learned that people could not wait for someone to fix a problem for them. It's important to teach employees it's their time to shine when a solvable problem presents itself. Grab the bull by the horns and try something. Make small reversible changes resulting in small improvements. Fortunately, during the height of pandemic uncertainty, our executive management team didn't put up a square box for us to exist in. Instead, they said, "We have to do this. How do we get there?" We used creativity to solve problems quickly and with grace to continue increasing production capacity.

Matties: You're describing a work environment of empowerment, which doesn't happen in many companies. You're creating that space, and great things are happening.

Brassard: Empowerment is difficult, and the results are not always immediately forthcoming. Sometimes, it is the leadership; other times, the employees can't break out of old patterns. We have seen the benefits to our company and our people as we move down the path of empowerment, but you work for every inch of progress with respect to culture change.

For example, one of our youngest engineers shelved her R&D responsibilities for a time to run manufacturing equipment in our solder mask department for several months as the company strived to surge output. The experience was very disruptive to her life, and we thought it might break her spirit because she couldn't see the light at the end of the tunnel, and the old patterns of operation were, to her, inefficient, frustrating, and improving too slowly.

But she pressed forward, and with a little encouragement from Meredith, she engaged her co-workers to solve the problems. The result was a white paper and slide deck on how to improve employee training and career paths within the organization. Her ideas are now being implemented company wide. This is an example of how empowered employees can change an entire organization. That the best changes do not necessarily come from the top down but rather within an empowered workforce.

Matties: Pre-COVID-19, it seems to me that you were doing a lot of training. How are you continuing those training efforts now?

Brassard: There are two major initiatives we are working on with respect to workforce training. First is cross-training to enable a highly reliable and agile workforce. The second is developing employees that are ready and able to manufacture the very complex technologies of tomorrow. The phrase "very complex" comes from a number of DoD prime OEMs, referencing circuit board designs that are almost impossible to manufacture in North America, especially at needed volumes, lead-times, and competitive prices. This was an outcome of the United States failing to maintain state-of-the-art engineering and manufacturing capabilities as outlined in a Department of Commerce survey results delivered in early 2018.

LaBeau: We are recognizing that the domestic PCB manufacturing industry is not as strong as it needs to be for producing very complex

technologies at necessary volumes now or in the near future. Calumet is active in the fight to strengthen American manufacturing for electronics because there are serious concerns about the domestic industry's ability to reliably produce the most advanced technologies, technologies that must otherwise be sourced offshore.

Brassard: A couple of years ago, DoD prime OEMs would be asking for quotes and lead-times on their most advanced technologies, treating PCB manufacturers as build-to-print operations. It was reported to us by OEMs that many to most PCB manufacturers are no-bidding the most advanced technologies. Today, the OEMs are asking different questions, "How close are you to having this capability?" or "What do you need to develop this capability more quickly?" Based on our direct activity with several OEMs, it's clear there is great interest or pressure to build state-of-the-art boards in North America, often for security reasons. OEMs require a standard volume of very complex technologies, if not today, certainly within the next 2–3 years.

Calumet Electronics is located in Michigan.

From 2003 to 2015, offshoring decimated the domestic PCB manufacturing industry. Although the industry has recovered to some extent since 2015, it wouldn't appear our industry is ready to provide the necessary combination of capability, capacity, lead-time, and price increasingly desired by OEMs. Over the past two years, we have experienced OEMs being much more interested in partnerships to develop or advance manufacturing capabilities and technologies than ever in the past.

Matties: That's a new model. We've talked about this partnership for years, but it's really taking root now.

Brassard: There is an aerospace OEM that has been reaching out to us every six months over the last several years. Their inquiries evolved from "Can we place an order for this with you?" to "What would it take to develop this technology with your company?" Again, it was about going from build-to-print to being a solution provider.

For example, manufacturing phased-array antenna boards was not on Calumet's technology roadmap until we were approached by an OEM with a proposal for partnership. This was after they had done an exhaustive search of PCBs shops interested or capable of partnering to develop this specific manufacturing capability and left wanting. It was a challenging technology to manufacture—a large, 7-pound, ½-inch design with buried resistance, back-drill, controlled depth routing, sequential lamination design with a few additional proprietary elements—and must be manufactured onshore.

Happy Holden: When I had to build radar boards, we were flabbergasted that the design group would come back with eight more versions, each with a slight millimeter movement of certain geometries. We said, "What is this?" They had to admit, "This is 80% trial-and-error engineering. We don't have modeling in these kinds of design tools. And frankly, we can't predict it. We have to have all eight of these built to find out which one works better." The problem isn't building it; the real problem is engineering and designing it, and that's a lot of fun.

Brassard: Exactly. Happy is right on. The design asks for process and manufacturing engineers from all sides to come together and often, through an iterative design process, to find

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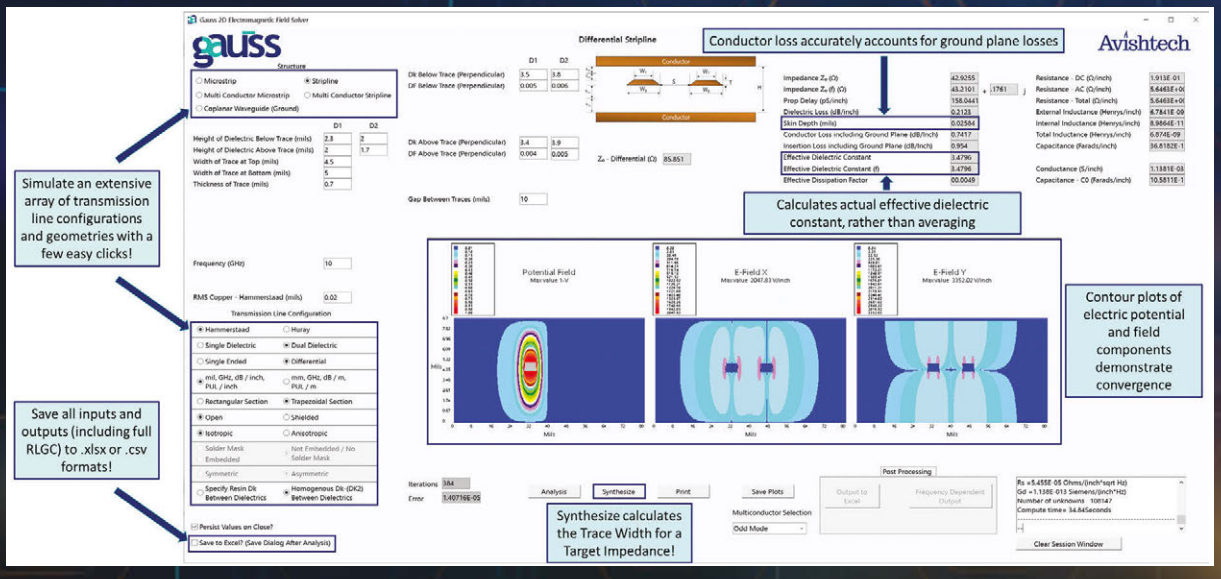

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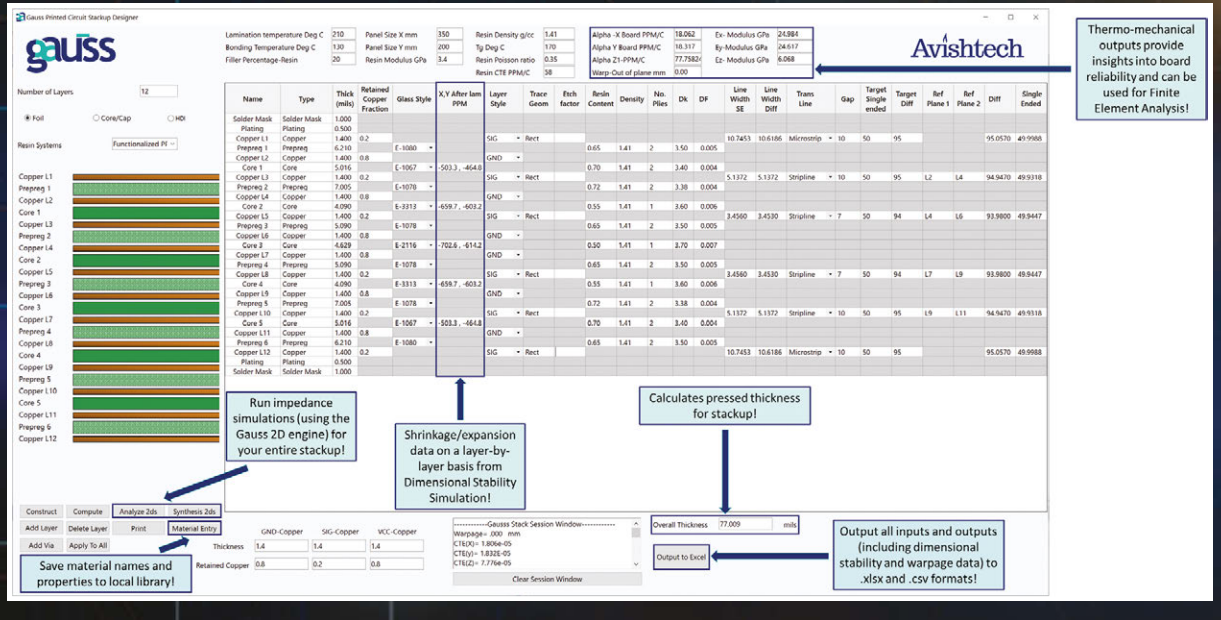

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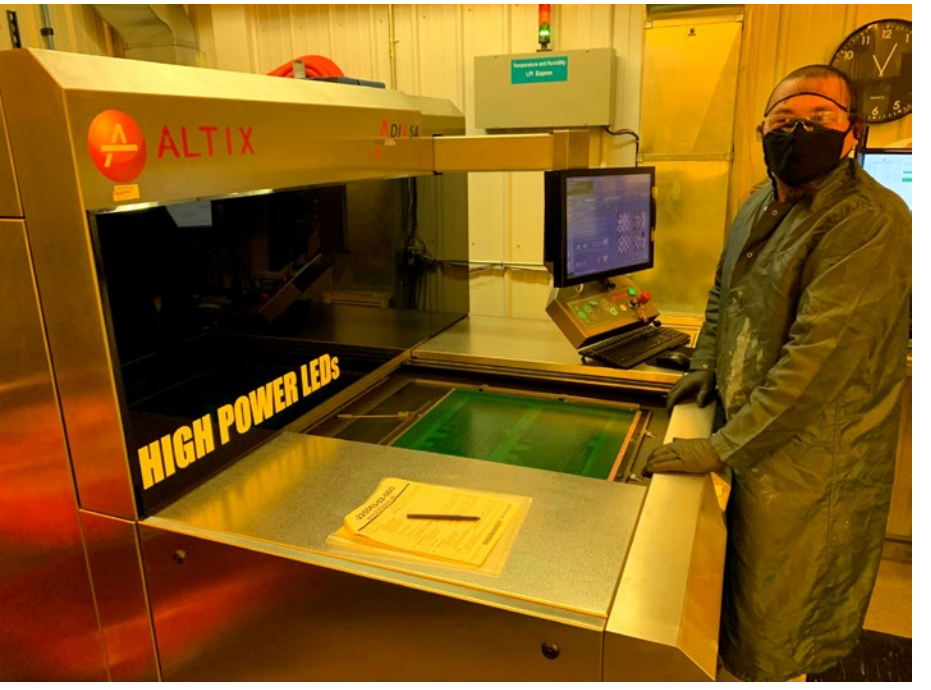

COVID-compliant safety at Calumet.

robust and repeatable manufacturing methods. The good news is with each failure and success, the next challenging design characteristic is not as big of a leap, and our capability grows with each build.

Matties: What makes a board like that so challenging to manufacture?

LaBeau: It's gaining new engineering and manufacturing competencies and stacking of tolerances when bringing many different technologies together in a single design. It requires necessary handholding from process engineering. That will be the future for us in the higher technology. One aerospace and defense company we are engaged with expects that its very complex designs will require process engineering handholding during standard manufacturing.

Brassard: With the phased array design, we no longer think it's especially difficult to manufacture. When we first saw the design, we said, "We can't build this, we don't have all of the necessary processes, and it's too big of a leap from our current capabilities," not to mention concern about the current lack of market. Then we took on a similar and more difficult design. We gained the necessary core competencies and had our first build in nine months.

Matties: From a technology point of view, what sort of investment in equipment are you making?

LaBeau: We are focused on capability and capacity, which typically come hand in hand with any capital investment. Our recent investments include LED imaging for solder mask, an electric fusion press, a couple of Wise pre-clean lines, high capacity plating line with advanced micro-via plating capability, ENIG/ENEPIG line, score/rout/drill machines with optical capabilities, and finally, automation equipment, including a number of robotic arms for materials handling.

Matties: We see a lot of talk about the smart factory on the EMS and assembly side. We don't hear much about that on the PCB bare fab side. How important is the digital factory to Calumet?

Brassard: That's a tough one. I have an education in electrical engineering and a career in software engineering and systems integration. I have taught courses on relational database design, am fascinated with robots, and am an avid fan of science fiction. I have a big imagination when it comes to the possibilities and practical issues with lights-out operations. With data bundles unpacking into universal hierarchical manufacturing frameworks, communication protocols, transmission methods, and the supply chain-wide feedback loops that would be necessary to support iterative design-to-realization processes—not to mention the wide array of security vulnerabilities that would persist in a complex smart factory environment—it will take decades before we have the manufacturing processes that begin to resemble those on display in movies like

"Ironman," and I'm not sure it would be for the best.

Many domestic PCB manufacturers have been working to simply survive offshore competition, let alone have any time to think about making their factories smart. For those interested and able to progress toward a smart factory, the one-off very complex builds may not be conducive to over-automation.

However, a traditional PCB factory can be increasingly automated over time, step by step—for example, the process of putting the solder mask and legend on the panel. Put a single unit in one end of a series of linked machines and processes, and a single board comes out the back end—single unit flow, a pillar of Lean manufacturing. This type of conversion is possible with traditional domestic factories like ours.

Take 50 PCB independent manufacturing processes and start organizing them into subsets, automating them, and putting teams of people in charge of them. In world-class manufacturing terms, we call these responsibility centers. But we believe the idea of taking people completely out of the equation is fundamentally flawed. Automation does not adapt easily or quickly when problems emerge in real-time. People can and do adapt to solving problems at the time and spot where they occur.

Automation solves many problems with respect to product handling, leveling workflow, reducing errors, reducing human fatigue, and reducing cost, but it's the amalgamation of cognitive humans combined with automation technology that is going to make manufacturing processes that are robust, single-unit flow, lean, and adaptable.

Matties: There are two sides to this: one is moving the panel through the process with robotic arms and loaders and unloaders and such, but then there's the digital process control where you may have an inline AOI on your etcher, for example, to make real-time adjustments based on live input.

Brassard: Many PCB shops already have feedback loops in their manufacturing processes. One of the most common is layer-to-layer registration, but this feedback loop is long. What you are describing is a short feedback loop within a set of connected and automated processes making decisions and processing tweaks in real-time. I agree that this is a very powerful approach to manufacturing, which does not require massive amounts of systems integration within a factory. Rather, it's a subset of machines that work together to continually tune a process while it's running. This becomes increasingly feasible the closer the steps are together in time and space. We look forward to gaining access to these types of advanced technologies that are indeed in our capital investment roadmap.

Nolan Johnson: Earlier in the conversation, you mentioned that, as you moved the engineers to the floor to respond to the need for production and the call for ventilators, your scrap rate went down.

Automated panel handling on the production floor at Calumet.

LaBeau: With our state and building in lockdown, no visitors coming or going, and nowhere for our employees to be other than work or at home, we had few distractions and a tremendous amount of focus. We had our office staff and engineers on the floor, working side by side with operators. Our engineers learn by spending time working as operators. People that normally are running a line also shared and gained insights. All kinds of unanticipated opportunities are coming out of COVID-19 as our entire workforce worked together, allowing us to look at things from new perspectives.

Johnson: It's a common suggestion that engineers should be on the manufacturing floor more often than they are, which your experience demonstrates.

Brassard: The sad part is everybody in manufacturing knows this. Anybody you talk to in a PCB shop is going to tell you your engineers need to be on the floor. They should have desks on the floor, not in offices some distance off. They need to be out in the thick of it, but knowing it and implementing it are two completely different things.

One thing about overwhelming demand is there is little uncertainty; the work is there. You don't have to figure out whether or not you can afford the next employee, pay the overtime, or do an incentive. You just have to schedule the work, balance your WIP, resolve your bottlenecks, move people where they are needed quickly, and get producing. Witnessing our workforce ramp up output was amazing and humbling. It's reminiscent of the year 2000 when domestic PCB shops were a booming business.

Matties: There were no interruptions when you bring a laser focus to a task the way you did. We hear that there's not a lot of profit in PCB manufacturing; however, our thought is that the profits are just lost in the waste. What percentage increase would you see by focusing on removing the waste and increasing your yields and productivity?

LaBeau: We may keep an additional 8–10% by eliminating manufacturing waste; this would be true of any PCB manufacturer. But in world-class manufacturing, the concept of waste is a much larger topic than solely over-production and material waste, but that's another conversation.

Brassard: We learned something from our company's performance under the unique set of circumstances caused by COVID-19. What's clear is there is a tipping point with the volume of demand when fixed costs become leveraged, and work becomes more profitable. When a PCB shop—and perhaps any manufacturing business—has a sufficient certainty and volume of work to run their factory wide open, they will likely be thriving and growing. Does this mean a resurgence of work in the United States would breathe new life into previously struggling PCB shops? I suppose yes, provided the PCB shop has the equipment and know-how to participate in the technologies that are increasing in demand, which is often not the case, again according to the DoC study.

LaBeau: What's also interesting is the impact on profits of increasing volume vs. reducing waste. Experience has shown that increasing volume can have an order of magnitude increase in financial performance as compared to eliminating all waste. Obviously, manufacturers want to increase volume to leverage their fixed costs while simultaneously reducing waste, improving profitability.

Matties: It's the combination of both because once you remove waste, it allows you to bring more work through.

Brassard: Well-stated. Lower waste allows us to increase capacity, and increased throughput also tends to cause a reduction in waste. This is an interesting feedback loop. Studying the principals of world-class manufacturing helps us to understand why this happens.

Matties: Exactly. It's not one of the activities. The scrap rate went down because you

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had process improvement, which increased throughput. And when you bring engineering in, you start looking at capability, which gives you a stronger place in the market and allows you to sell your boards for a higher dollar. It's all connected. The core message is there's still profit in PCB manufacturing if you do it properly.

Brassard: We completely agree, but that's in part because PCB demand has been slowly increasing in North America. We think that if there was ever a time for people to make an argument that we need to build PCBs in the United States, it's now, with OEMs experiencing increasing risks manufacturing offshore. Apparently, there is some degree of movement away from globalization to regionalization, where American and European OEMs are feeling increased risk with being too reliant on offshore supply chains. We don't necessarily have to do away with offshore supply chains, but the domestic PCB manufacturing industry must become more competitive regionally and globally. We need to figure out the economics of a resilient and capable domestic electronics manufacturing industrial base. We have seen that increased certainty comes from strong demand, which triggers investment in people and equipment, which increases participation in the market, and steady growth ensues. For Calumet, COVID-19 provided a tipping point of demand that supercharged our manufacturing engine while simultaneously allowing an unprecedented level of solidarity and focus for our workforce.

Matties: Do you think we may start to see some new facilities and perhaps even some captive facilities being created in the U.S.?

LaBeau: That's an interesting question. We're wondering about that also. Will the HP model come back? Will we see more OEMs having captive facilities? We cannot know with any certainty, but there is a shortage of expertise to go around in the United States—again, according to the DoC survey. It may prove problematic for OEMs to spin up their own shops. Incidentally, Calumet has been a large proponent of strengthening the electronics industry workforce, representing IPC at several White House workforce events, among an array of other activities.

Matties: You're keying in on probably the biggest issue we have, and that's today's huge skilled labor shortage.

Brassard: And we have some competitive advantages when it comes to hiring young engineers, such as having Michigan Tech 12 miles down the road. However, experience plays the most important role in the science, engineering, and art of manufacturing circuit boards. There are some amazing experts within the domestic industry, and we are very privileged to work with them, but they are also spread thin across the entire industry. I'm not sure the domestic supply chain could source sufficient expertise to stand up even a handful of shops simultaneously in a relatively short amount of time.

Matties: The estimate is about a six-year process to bring a board shop online to being solid.

Brassard: Here's what I've observed. You have domestic shops that are very high technology at almost no volume. Then, you have shops that are running conventional technologies and producing at medium to high volume. What you don't see in the United States, as evidenced by the testimony of numerous DoD prime OEMs, are high-technology shops that are also high-, medium-, or even low-volume. This is complicated further if we also start talking about lead-times and prices. This is the crux of the OEM problem. They are moving into a space where they require advanced designs manufactured at some volume within the United States with tolerable lead-times and prices. Again, according to their own frustrated testimony, it's a rare or almost non-existent entity within the United States. What's more frustrating for OEMs is PCB manufacturers are no-bidding advanced designs, seeing no reason to engage in high-risk work that would only serve to clog their profitable manufacturing arteries, which are

Calumet Electronics representatives with Ivanka Trump at a workforce event at the White House.

doing quite nicely with revenues from more conventional technologies.

Johnson: Is it fair to conclude that your new equipment is targeting capability more than capacity?

LaBeau: Not at all. Manufacturing conventional designs for our customers is fundamental to our mission, and having ample production capacity is the cornerstone of our operation. It's also true that we are driving our capabilities with focus and purpose with end goals in mind, but manufacturing very complex designs as one-offs does not solve the problems faced by the DoD and aerospace OEMs. Capacity will always be as important as capability. Fortunately, investments in new capital equipment bring capability and capacity improvements hand in hand.

Brassard: The bottom line is Calumet is striving to offer our customers the most advanced engineering and manufacturing capabilities, not just for one-off prototypes, but as standard scalable and sustainable production. We have a track record of successfully taking science projects from the R&D benchtop to standard production. Now, we are pushing hard against our own limitations and learning it is possible for United States PCB manufacturers to regain state-of-the-art capabilities. If we can do it here in Upper Michigan, other domestic PCB manufacturers should be able to do similarly. We simply want to be the best and most reliable PCB manufacturer in the United States, enabling our customers to accomplish their missions.

Matties: Thank you both very much for your time and insights.

Brassard: Thank you.

LaBeau: Thanks. **PCB007**

I-Connect007 Survey on Leadership: More Important Now Than Ever

Feature by Michelle Te
I-CONNECT007

Until Lee Iacocca emerged on the scene as CEO of Chrysler, the general image of the American CEO had been of a buttoned-down organization man who was essentially bland and characterless. Iacocca spent his company's profits on a lavish office, conducted regular interviews with national talk shows, and sold seven million copies of his autobiography [1].

Iacocca's strategy was to enhance the company's image by enhancing his own. Yet, he seemed more intent on boosting his own greatness than advancing the needs of his company. And while Lee Iacocca's flashy image approach worked for a while, it failed to sustain the company's profitability [1].

In the book *Success Mindsets* [1], author Ryan Gottfredson explained it this way: "From the outside, it was clear that he spent too much company time and resources on things that would enhance his public image—all in an effort to increase Chrysler's stock—and not enough time on what would make the company profitable in the long run…When Japanese automakers started taking over the American market, rather than seeking to improve Chrysler's cars, Iacocca worked with the Reagan administration to impose tariffs and quotas that would stop Japanese manufacturers."

Quoting Jim Collins' *Good to Great* [2], Gottfredson also concluded, "While Iacocca was personally on the rise, his company was not. In the second half of his tenure, Chrysler's stock fell 31% behind the general market." It's

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clear from this example that a leader's industry knowledge, leadership skills, and even charisma can make a critical difference in the growth of a company.

Intrigued by this idea, the I-Connect007 research team recently conducted a survey on leadership, covering everything from leadership qualities to stories and lessons learned from inspirational leaders. Read what respondents from the industry had to share on the topic of leadership.

Leadership Roles

According to the survey results, the primary roles of a leader are not to amass bigger offices and best-selling books. Rather, the results demonstrated that the most important qualities are team leadership, providing inspiration/motivation, setting goals, having a vision, and communicating well with others.

In response to the I-Connect007 survey question, "What would you consider to be the primary role of a leader," many shared how a leader's role is to:

- Lead by example
- Provide clear guidance for the team
- Mentor others
- Support subordinates
- Provide a vision and then enable a team to accomplish that vision

Leadership Qualities

The next survey question was, "What are the qualities of a good leader?" Nearly half of those who responded were clear: A good leader builds a strong team through support and mentorship. Other responses were as important: Effective leaders listen to understand, show integrity, provide inspiration, stay open-minded, push others to excel through personal example, are respectful, know the strengths and weaknesses of team members, are resourceful, demonstrate compassion, and stay up-to-date in their field.

As a manager, it can be tough to have all qualities in abundance. In an interview with the I-Connect007 editorial team regarding IPC's Certified Electronics Program Manager Course, IPC's director of education development Carlos Plaza said not to worry and explained how being adaptable is most effective:

> *"One of the mistakes that we often make in business is assuming people either have these things, or they don't—the "born leader" example. I'm not sure that it really exists. Sometimes, you have people with the right aptitudes for a particular problem, and in the old days, those problems were pretty static and repetitious because technology and systems moved so slowly. But today, because they move so quickly, you need to have someone who's able to apply those aptitudes—be creative, have complex problem-solving skills, and emotional intelligence—constantly to different situations. That all starts with listening and being able to accurately take in the world around you without letting your ego get in the way. Checking your ego is one of the top things a leader needs as well."*

In the same interview with Plaza, instructor Susan Mucha stated, "The bottom line is there's not one thing that makes a great leader, but a combination of really being able to know when it's time to lead and manage and being able to inspire a team rather than have to order them to do it."

Leadership Challenges

With these strong qualities in mind, I-Connect007 asked, "In today's business environment, what are the greatest challenges facing leaders?" While many of the responses were what might be expected, the top response outpaced all others: finding and keeping talent. Clearly, finding and maintaining qualified employees in the diverse electronics field is high on the list of concerns among survey respondents.

As one respondent stated, "There is a challenge in being both a technical expert as well as a personnel expert," while others noted that some leaders seem to lack empathy, overwork their employees, and have too many distractions. Readers were concerned that leaders are challenged to adapt to the pace of change in the workplace and hit "moving targets," are restrained by shrinking budgets, and have blurred vision for the company. One respondent noted the difficulty of trying to grow your business when there are so many factors that are completely out of your control.

Leadership Stories

I-Connect007 further challenged respondents to explain their answers further and share stories about inspiring leaders they had encountered in their careers. Here are a few answers:

- I admire Elon Musk. He establishes a bold vision and challenges his team and partners to get his companies there. He doesn't take "impossible' for an answer." And he is able to manage through his personality quirks.
- I admire one of my co-workers. Scott is a long-term employee at the company where I work. He is an accomplished mechanical engineer who also serves as a manager. He understands the current technical details of several active design projects, coordinates department status meetings and outside testing, tracks action items, and manages good relations with our clients, just to name a few of his many functions. On top of that, he is always willing to take a few minutes to answer technical questions, mentor newbies in the department, or even just take care of something that needs to be done. Even though he is very busy, he maintains a good attitude in the face of adversity and stands up for what is right. He's also someone who can be trusted with confidential information and is supportive when you need help. Basically, he leads by example.
- I admire my grandmother. She was born on a dirt floor in a small Midwestern farming community. She eventually built and ran the local hospital. One day, when

I was five, I went to see her. I found her out front, planting flowers with a maintenance person. I said, "Grandma, why are you planting flowers? I thought you were the boss." She laughed at me and said, "I'm helping plant flowers because I am the boss." It's a lesson I'll never forget. We lead by example.

- I admire a manager to whom I used to report. During my time working for Mark, I learned many things regarding leadership, such as problem solving as a team, working as a team, and developing the best ideas as a team. Mark is very well-read on these subjects and helped our design team work together to solve quite a few challenges. Though I think Mark knew the possible sources of our stumbling blocks, he did not tell us what to do to solve them. He met with our group to help us learn communication and analysis skills to identify and solve them with a team approach. He even went as far as purchasing all of us copies of *The 4 Disciplines of Execution* [3] and helped us choose a "wildly important goal" to reduce PCB design errors making it to our in-house assembly operation. He demonstrated very helpful leadership that I am still inspired to emulate six years later. Thanks, Mark!

Leadership Lessons

The final leadership question posed was, "What is the most important leadership lesson you have learned?" This comment summed it up well: "You are measured by the way you treat other people." Many of the other answers indicated that respondents learned the importance of listening well before speaking, being honest, accepting your mistakes and learning from them, and getting things done as a team.

Conclusion

Today's leaders have a lot to consider, including numerous business and market challenges. However, based on readers' responses, there seems to be agreement on a variety of leadership roles and qualities. There are also great, and not-so-great, examples of leadership, as well as inspiring stories about leaders from bold visionaries like Elon Musk to coworkers, managers, and grandmas. Leadership is truly more important now than ever. **PCB007**

Editor's note: Survey responses have been edited slightly for clarity.

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Michelle Te is an associate editor for I-Connect007.

Rogers' Laminates: Paving the way for tomorrow's Autonomous Vehicles

Autonomous "self-driving" vehicles are heading our way guided by a variety of sensors, such as short and long range radar, LIDAR, ultrasound and camera. Vehicles will be connected by vehicle-to-everything (V2X) technology. The electronic systems in autonomous vehicles will have high-performance RF antennas. Both radar and RF communication antennas will depend on performance possible with circuit materials from Rogers Corporation.

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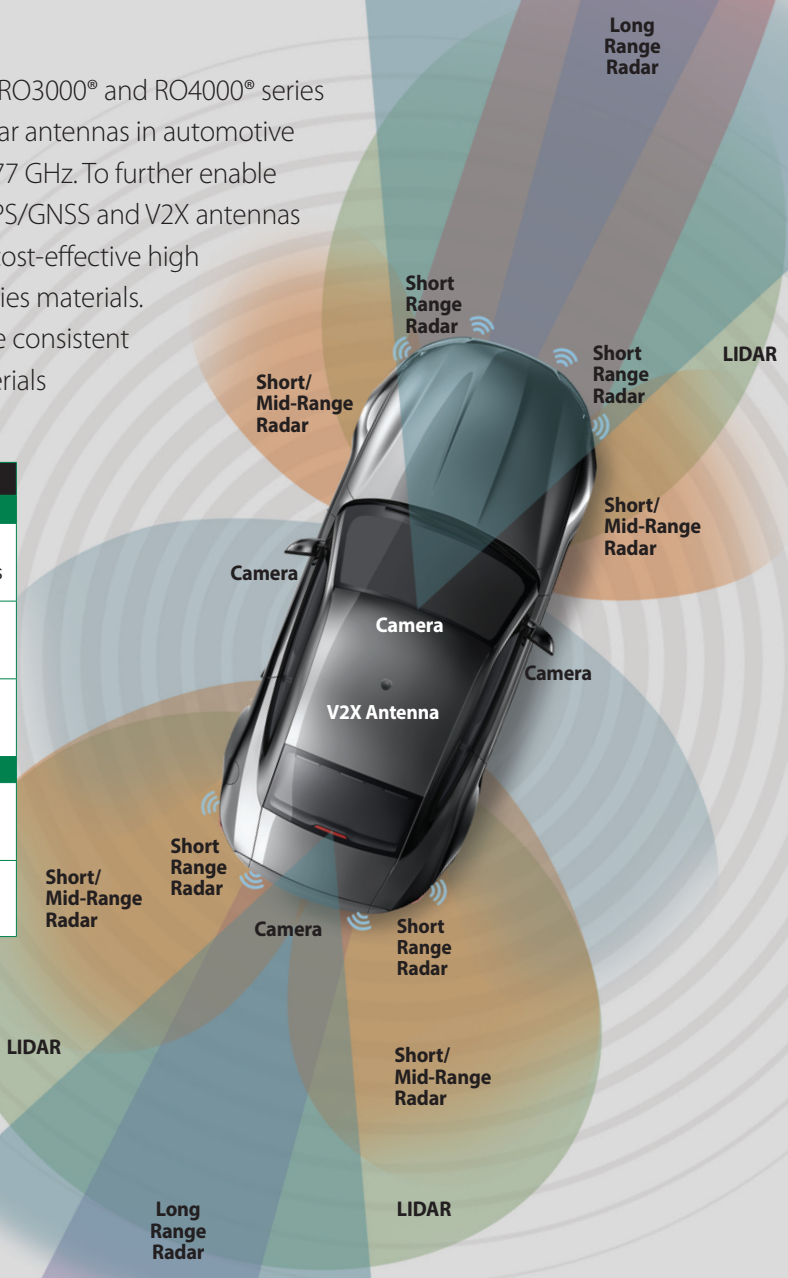

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3 Tools That Should Be in Your Leadership Toolbox

One World, One Industry

Feature Column by Dr. John Mitchell, IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

There can be a lot of weight given to the abilities of the leader of an organization. Perhaps you have heard someone describe a business leader or sports coach by saying, "They took them to great heights!" Maybe it is the skeptic in me, but I wonder just how much was attributable to leadership prowess and how much was due to other factors. Here, I will share three important tools that should be in your leadership toolbox.

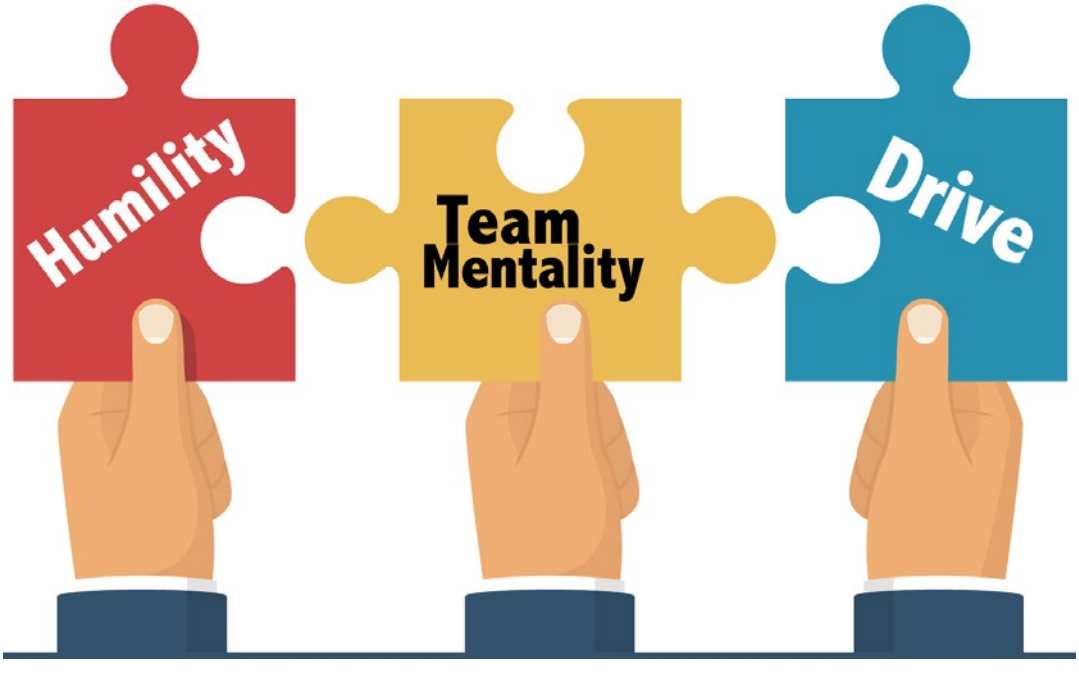
Beware of 'Rising Tide Syndrome'

Early in my tenure at IPC, I was at a dinner meeting with an association executive director who was also closely tied to the electronics industry. Over the course of dinner, he proceeded to share with great pride how he had grown his association ("single-handedly" was implied) over the previous four years. This was 2013. He had taken over company leadership at the end of the great recession and—surprise, surprise—experienced growth every year thereafter. What was left unsaid was that practically every other company experienced growth over that period. A rising tide lifts all ships.

Now, this particular executive may have done some amazing things to be successful, but the message here is that we should not assume that as leaders we are solely responsible for the successes we are seeing. There are quite often too many variables in play to claim all the credit with any high degree of confidence. Leaders need to recognize that there are things we can control and things we cannot. A healthy dose of humility should be a well-used tool in the leader's toolbox.

A Team Mentality

Whenever I am asked what it takes to be successful, the first thing that comes to mind



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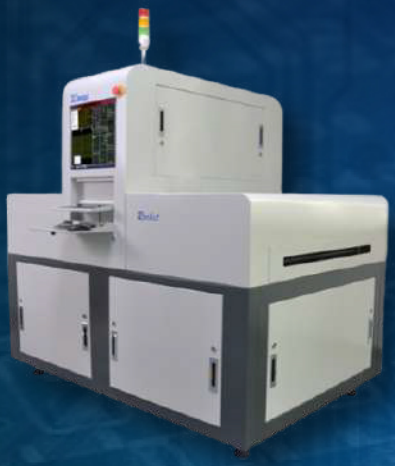

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is my team. Surround yourself with people who are better and different than you are. This takes many forms—diversity, intelligence, expertise in different areas, etc. I like to use the example of the Chicago Bulls in the 1990s. They had the leadership of coach Phil Jackson. They also had Michael Jordan—who seemed to know how to play the game—and Scottie Pippen as the second option, who was nearly as reliable. Additionally, the team had Dennis Rodman, who played a very specific role—rebound and disrupt. John Paxson and Steve Kerr were the outside threats in their various areas. That team's dominance during that decade was undeniable.

When you have a high-functioning, focused team—one where each player knows their primary role, performs it well and has a broad skill set to contribute in other areas—it is amazing what can be accomplished! So, add a team of strong, talented players to support each other to your leadership toolbox.

Consider the Drive

This is the final trait I would like you to consider, and one area in which I believe a leader is well-suited to make a direct impact. Drive consists of these elements: unrelenting push for an objective and a sense of urgency to make a change. But be sure to exercise caution here; driving full force down the path that leads off a cliff is leadership, but it is not good leadership. Use your team to consistently make course corrections as required by changing conditions. Assuming you have confidence about the path forward, and a certain level of bullheadedness to make change happen, drive is another tool that should be used to smash through barriers keeping your group from success.

Humility, team, drive—there are likely many other equally worthy attributes we would want in our leadership toolbox, but these three are pretty important to me. **PCB007**

Dr. John Mitchell is president and CEO of IPC. To read past columns or contact him, click here.

IPC's Program Manager Training Certification Course Goes Digital

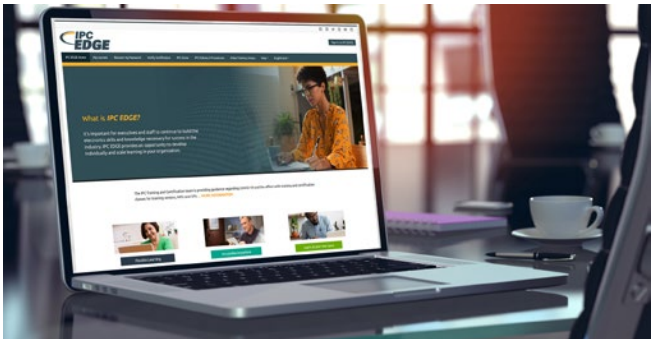
by the I-Connect007 Editorial Team

In the August 2020 issue of *SMT007 Magazine,* we published an interview with Susan Mucha, president of Powell-Mucha Consulting, and Carlos Plaza, IPC's director of education development. Mucha and Plaza discuss what it means to be a successful leader under the umbrella of discussing IPC's Certified Electronics Program Manager (CEPM) Training and Certification Program, which was converted to an entirely online platform in 2017.

Read the full article, and learn about this program by clicking here.

Susan Mucha

Carlos Plaza



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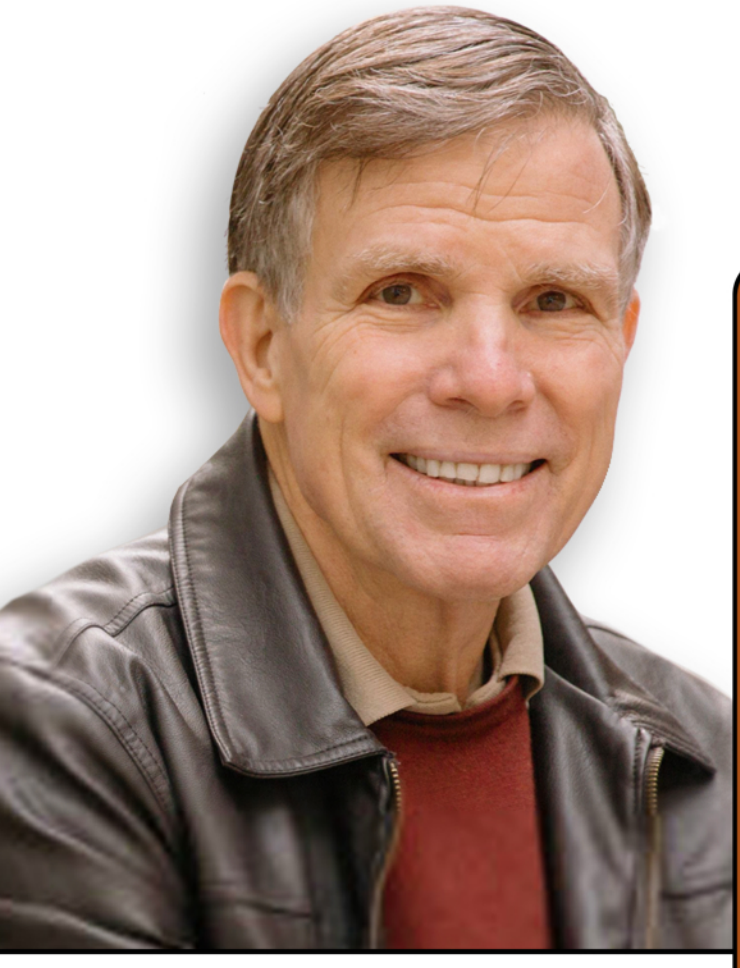

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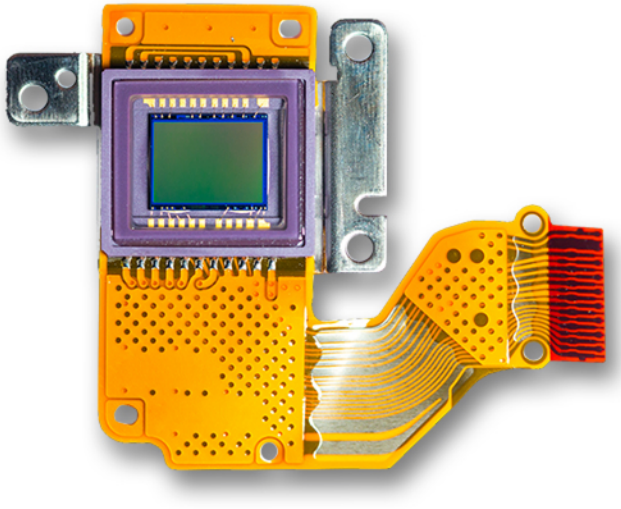

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Blue Box: Leading a Cleaning Revolution

Jim Metropoulos

Feature Interview by the I-Connect007 Editorial Team

Jim Metropoulos, CEO and founder of Blue Box, talks about the innovative foam solution he developed to clean the coils of HVAC systems in large facilities, ranging from casinos and manufacturing plants to some of the top hospitals in the country.

Nolan Johnson: Jim, tell us about yourself, as well as Blue Box and what you're doing.

Jim Metropoulos: Absolutely. The patented Blue Box enzyme treatment is an innovation I developed about five years ago. During this global pandemic, Blue Box has developed an additional treatment that kills airborne pathogens, such as the coronavirus, trapped in a building's HVAC system.

When I founded Blue Box, I like to say it was "accidental innovation" because I did not set out in the world to solve the great coil problem that no one else knew about. Blue Box was originally started to do chemical cleaning in refineries. The treatment system itself was very compact—the size of a suitcase back then—but I could fill a three-story house with foam. I would mix in hydrochloric acid or sodium hydroxide, and it was a way to do chemical cleaning in big industrial systems.

I was looking for a way to clean big industrial systems to improve heat transfer efficiency and energy consumption. If you can improve efficiency, the HVAC system will consume a lot less energy. It was a new model for carbon reduction.

Then, I started to clean big industrial systems using enzymes because, in industrial equipment, you form what's called biofouling in systems. Biofouling is when bacteria and fungus start growing, forming biofilms–a slime that starts forming on equipment. The problem is that biofilms are chemically resistant, so I pioneered a way to use enzymes that would digest it out. The virtue is there are no chemicals involved; it's pH-neutral and safe to handle.

About five years ago, I toured a big auto plant with an engineer, looking at other systems, and we walked past an air handler. In auto plants, they use air handlers for controlling the air and humidity in paint-proofing operations, but they also have air handlers throughout the plant for air conditioning. I wasn't thinking about HVAC, but he asked, "Can you adapt your process to clean the coils in my air handlers?" My reply was, "Sure, how hard could that be?"

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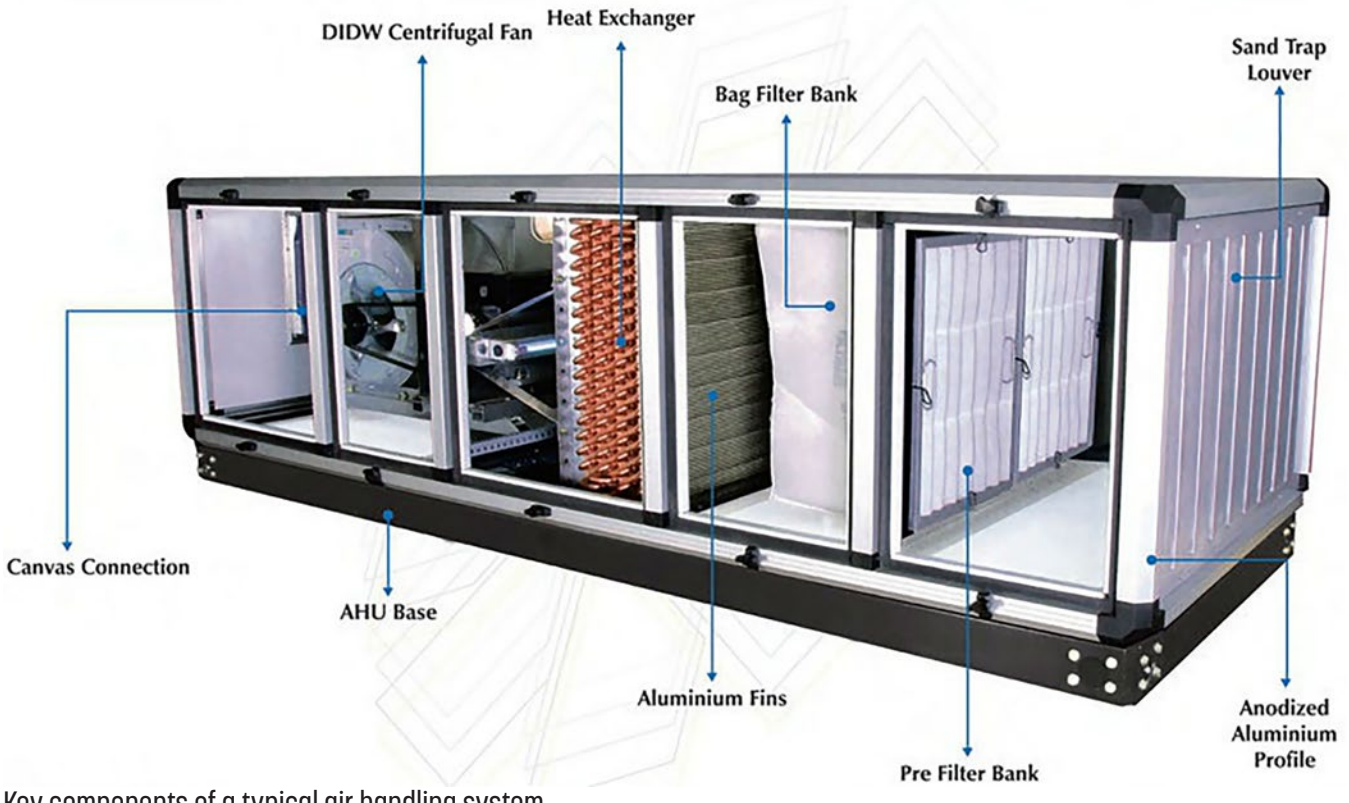
Virtually every modern building in the world is outfitted with an HVAC system, running at some level of inefficiency and unhealthiness, simply because there's never been a way to clean the heat transfer coils within that HVAC system. All the air must pass through the coils in order to be heated or cooled. Then, it's piped into a building.

Coils can be very big in these HVAC systems. They could be 20 feet high, 30 feet across, and three feet deep, and they're very dense. They're designed so only air molecules get through, but they also load up with dirt and grime—specifically bacteria or fungus. You have a lot of condensation inside the coils, and wherever there's condensation, you get biological growth. If you ever walk in a building and it smells funky, you're smelling dirty coils in that building. Those coils are disgusting.

Everything airborne in a building will end up in the coils. They bring in outside air, but these systems also recirculate the air. Probably 90% of the air in an office environment is recirculated because once that air is cooled–or heated, depending on whether it's summer or winter–it's much more efficient to recirculate that cooled or heated air instead of constantly bringing in outside air and dropping down the temperature. Everything in the building ends up in those coils.

During the current pandemic, we realized that we needed additional disinfection to target airborne pathogens, including the coronavirus. We developed a modified enzyme treatment that includes a second-stage disinfection process. During this treatment, we inject a thick foam of chlorine dioxide into the coils. Chlorine dioxide is a well-established and powerful disinfectant proven to kill bacteria, fungi, and viruses, and is on the EPA list of approved responses to COVID-19. That treatment is now part of our standard protocol for cleaning all coils.

The problem has always been that the coils are very dense and deep. To clean them, the current technique is to take a pressure washer and blast some water on it, but it only goes a couple of inches into the coil because of their density. It won't go further than that into the coil, and 95% of the internal surface area is completely untouched; it has always been that way.



Key components of a typical air handling system.

When all this stuff starts building up deep inside these coils, it restricts airflow as well as heat transfer. The system increases energy consumption and works much harder to get the original performance. To get through any depth of coil, we inject a chemical-free enzyme into the coils, and the enzymes start digesting all the bio—the bacteria, fungus, and all that stuff inside. The Blue Box patented process is this: you keep the air handler on while you inject the enzymes in as a foam face, which acts like shaving cream. The airflow just draws it in, almost sucking it through the coils.

The single biggest pain point for any building's operations is always the coils. It's the chokepoint of the entire building. Up to 70% of all the energy consumed in a high-rise building goes to the HVAC system. Up to half that energy, sometimes even more, can be wasted simply because the coils are fouled up.

By solving this problem–and it's such a simple solution–you can now have a fundamental effect on energy consumption, but you can also start looking at indoor air quality. As you know, indoor air quality is very significant with COVID-19 because we now know it's traveling through the HVAC system, and there's a big concern that it's ending up inside these coils. We've been brought into many major hospitals around the United States to remove all the biofilm and disinfect the coils in the hospitals. Some examples are Memorial Sloan Kettering in New York City, which is the largest and oldest cancer hospital in the United States, if not the world; University of Texas MD Anderson Cancer Center in Houston, Texas, which is probably the number two cancer hospital in the United States; Houston Methodist Hospital, which is a massive medical facility; Baylor Scott & White in Dallas, Texas; UCLA Medical Center; and University of Miami Medical Center.

When you go into a hospital's air handlers, you can see stuff oozing out of the coils; it's that bad. That's because a hospital is a microbial-rich environment, and the coils load up so much more than a commercial building. Commercial buildings are filled with biofilm, but the level is just more extreme in hospitals. Before Blue Box, there wasn't much a hospital could do. Now, they're able to get through their coiling, and we deliver perfect surface area coverage throughout that coil.

Biofilm buildup on HVAC coils can harbor and spread bacteria and viruses throughout the building.

I've modified the formulation to add in a really powerful disinfectant called chlorine dioxide. I first use the enzymes to remove all the biofilm because it will act as a protective nest for bacteria, fungi, and even viruses. That's a big concern with the coronavirus because it can land on a surface and live exposed for a few hours or even a couple of days. But if it lands in biofilm and is protected, there's a pretty good chance it could live and fester in the coils for an extended period of time. Bacteria in these large buildings will jump from air handler to air handler because it just gets in the air stream and then migrates throughout a building.

We've been commercializing Blue Box for the last four years. We do 50% of the Las Vegas Strip. Some of our hotel clients include the MGM Resorts, the Bellagio, Mandalay Bay, and

Global HVAC systems total about $4 trillion globally.

Luxor. I asked the people at Bellagio, "How much money am I saving you with this process?" They said, "Don't worry about it. Just keep on coming back." But I would estimate they're probably saving easily $1–2 million a year just on their energy bill. I don't know the exact numbers, but I would guess they spend around $20 million a year on energy usage, with 70% of that probably going through the HVAC system. I know that it can improve the efficiency of their air handlers by 50–60%; the savings are very substantial.

We also know for a fact that we can have a fundamental effect on a building's energy consumption and indoor air quality. No one really thinks about it, but the processing of air is very fundamental. It defines the modern world. Dallas, Phoenix, and Las Vegas would not exist the way they do without air conditioning; the same is true with Singapore, Hong Kong, etc.

HVAC is a major driver of energy consumption in the world. It's also a major driver of carbon emissions, and there's a pretty good chance it's a major driver of poor human health because the average American spends 90% of their time every day within a climate-controlled environment. Every one of those systems is running at some level of poor indoor quality.

Dan Feinberg: Is this something that could be used in a home air conditioning unit? This could have a huge market.

Metropoulos: Let's chat about the market. HVAC systems are valued at somewhere around $4 trillion around the world, with $130 billion worth of HVAC system materials purchased every year. The majority of those purchases are to replace the coils from the existing systems. In any high-rise or building, it's only a matter of time until they have to replace those coils; it's pretty common for them to be replaced every 10–15 years. Replacing one coil in a big system could cost $100,000–$200,000, and a big building could have 50–70 air handlers, so it's not cheap.

Johnson: That is a lot of money to consider spending on a consumable.

Metropoulos: Exactly. I'll give you an example. General Motors invited me last year to their Fairfax assembly plant in Kansas City, Missouri, where they have a giant system with a 75,000-CFM (cubic feet per minute) air handler. The coil on this system was 18 feet high, 22 feet across, and three feet deep—a monster—and the plant has 150 of those systems on its roof. Even with employing a crazy amount of filtration to prevent fouling, it was still loaded up with severe hydrocarbon fouling from the manufacturing because of the welding they do there.

In just a few years, this system was about 96% plugged, and every one of GM's industrial engineers looked at the system and said, "This thing's ruined. There's nothing you can do about it." They tried everything—pressure washing, chemicals, steam, etc.—and they couldn't move the needle.

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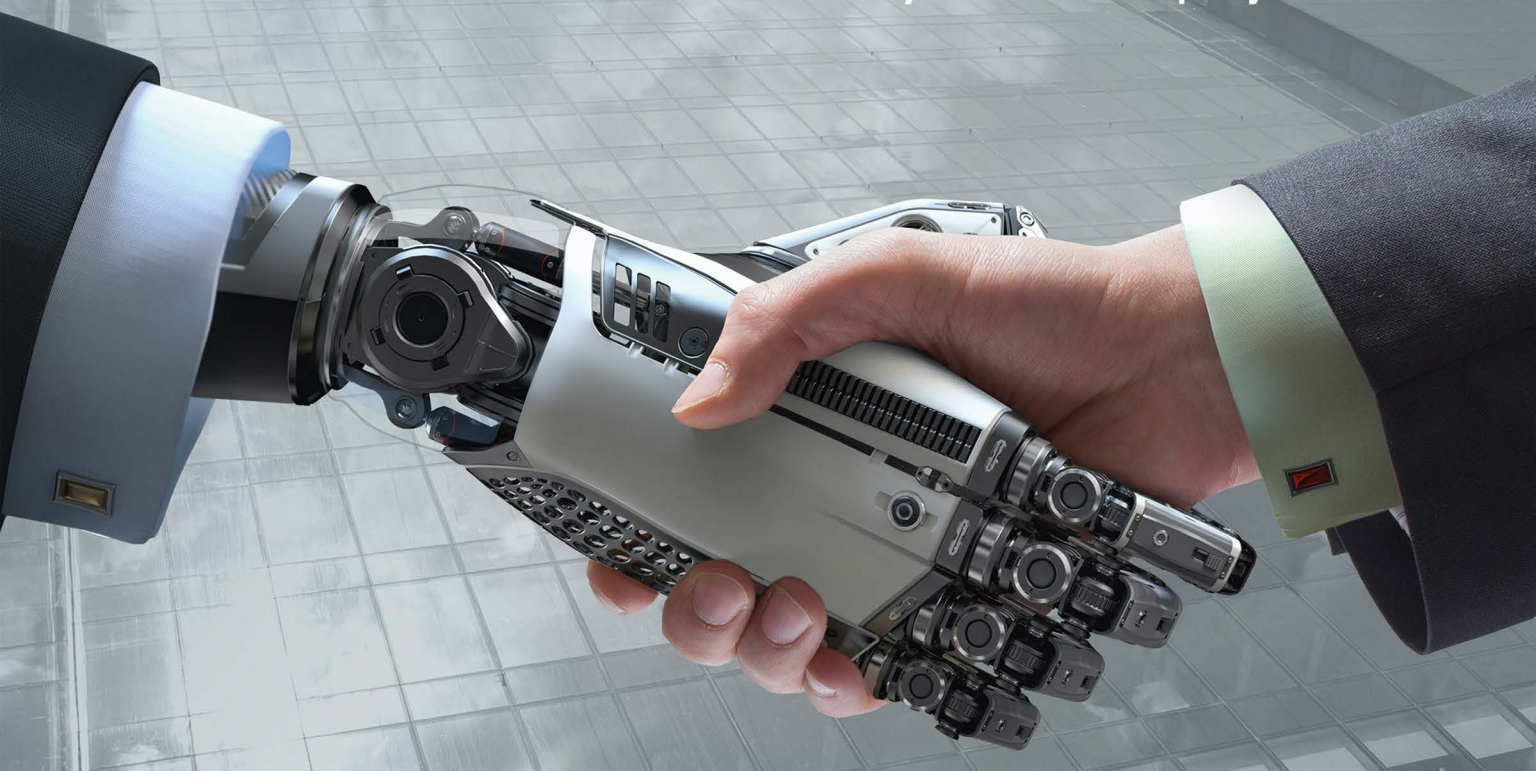

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pact. It only weighs 35 pounds, and you can bring it on the plane as a carry-on. I showed up to this big meeting with General Motors with my little Blue Box treatment case, and they said, "I thought you were doing a demo today." I said, "I am." "Great," they responded. "Where's your gear?" I replied, "Everything I need is in this box right here." Their reaction was, "There are 75,000 CFMs in there? No way."

In four hours, I had restored their system like it was brand new, which blew them away. I saved them $200,000 right away because they wouldn't have to replace their system, and they calculated it would save them another $50,000 in energy costs for that specific unit over the next year because the system was no longer running under pressure.

Often, the most important part of manufacturing in electronics and other very highly-specialized types of environments is air. They need clean-room level environments, with precise control of the humidity, particulates, and more. HVAC systems are of utmost importance. For Infineon, a semiconductor company, our product greatly improves on the delivery of a cleanroom type of environment because they often use tremendous amounts of HEPA filters to remove the particulates. These filters are downstream of the coils to capture the biological particles streaming out of the coils. Now, by solving the coil issue, you have higher quality control in your downstream, and it takes a load off of the HEPAs, so you have better control.

Johnson: The coils, in many cases, act as filters, and then you have to worry about cleaning the coils.

Metropoulos: Yes. The world also consumes $50 billion in filters every year. The whole filter industry evolved because there's never been a way to clean these coils. Filtration can be very complex. You get into what are called MERV 8 filters up to MERV 9, 10, 11, 12, etc., and it goes all the way up to HEPA-grade filters. The higher the number, the more restrictive that filter is, so it captures smaller and smaller particles; there's a whole science behind it. The higher the MERV rating, the more extreme the airflow restriction. The more airflow restriction, the more energy-intensive that filter is on the HVAC system.

In a building, up to 30% of all the energy consumed in the HVAC system is consumed by the filters because of airflow. The role of the filter is to protect the coils, but no matter what, these coils will still get fouled up, and no one in the industry has ever thought about it this way. The coil is a wet filter because there's always condensation. It's very effective at capturing all the particles, but it would plug up. Once that happened, you had to cut out that coil and put in a new one, which is a very expensive proposition. Blue Box completely changes that, and we guarantee that coil will never plug up on you. This means you can dramatically, almost radically, change how you handle the filters upstream. It has a huge impact on the energy efficiency of that system.

At General Motors, all plants follow the same filter protocol: three stages of filters and three walls to help capture the particles, all to protect that coil. But one thing I'm out to prove with General Motors is that we can reduce filter usage by 80% by eliminating stages two and three of the filter program. We replace that remaining filter every three months, and when we do, we foam out the coil. You clean the coil more frequently with the first filter capturing most of the particles, and all of a sudden, GM saves $2 million in energy costs across the entire plant.

I just bought a filter company in January that specializes in filtration. I wanted to gain expertise in filters and how to replace industrial filters. My objective is to completely change how you do filtration: fewer filters and more coil cleaning. If you look at it from an engineering perspective and cleaning more frequently, this is a radical change. Every engineer I've talked to gets it. When they first hear about it, their reaction is, "It's too good to be true." But once they hear the explanation and see it, they completely understand. It makes total sense. It's just that their whole training has been that the mechanical people like to replace coils and the

filter people like to sell filters. There's really never been anybody who wanted to solve the problem.

Johnson: What's it like to clean out a coil?

Metropoulos: A cardinal rule with equipment is you never work on a piece of equipment while it's on. You do lock-out, tag-out. When I first saw this system, I followed that protocol and shut it down. I knew there was going to be biofilm in there based on my other experiences, so I asked myself, "How do you get to this coil?" The answer is that you don't. No one does. Then, I started thinking, "Why have it turned off?"

Lock-out, tag-out is to protect you from moving parts in hot equipment as well as voltage. When you work in the air handler, you're protected because the coil acts as a protective wall. You can't get sucked through a coil; it's just moving air through. It's not high pressure or anything like that, so it's very safe. They use lock-out, tag-out because if you're on the other side, pressure washing the backside, it makes sense. I talked to the engineers about it. They said there was no way to leave the equipment. After an hour debating with them, they said, "Go ahead, do it, but don't tell anybody." I proved the efficiency of leaving it on by 40% on just the first time. It was key to solving the problem.

Feinberg: This is captivating and very cool. As you were explaining all this, I imagined the coil was a sinus, and you're basically clearing out the congestion in the sinus.

Metropoulos: That's a very good analogy. Think about it this way: the coils are the lungs of a building, and the air in that building goes through those coils in the HVAC system. That building right now has asthma.

Johnson: You were talking earlier about how fine you could go with your filters, and that requires a bigger motor to push the air harder through those filters, of course. Are there filters that get down to the viral level?

The view from inside an HVAC air handler.

Metropoulos: The biofilter makes a Petri dish. In hospitals, there are two different sides: the patient side with the doctors and nurses, and the mechanical side with the engineers. Those two groups don't talk to each other. The engineers are responsible for making sure the facility is open 24/7 and never shuts down. Doctors and nurses have no idea where the air is coming from. Look into a surgery center, like an operating room, and they're scrubbing themselves head to toe. They're disinfecting the walls, floors, equipment, etc., and yet what about the air coming into the room? You can trace it back to the air handlers, and you would throw up if you saw that air handler. It's that dramatic.

Feinberg: Where do you make these?

Metropoulos: We make them ourselves in the U.S., and I'm making a point of that. I don't have to worry about any supply chain issues. It's funny because COVID-19 changes everybody's thought process on whether you really

want all your stuff outsourced; crises do happen. Right now, they're being made in Los Angeles, but I just moved the entire company to Dallas, and we're growing like weeds.

We make all our systems, and at this stage in our growth, we also do the service. The idea is to develop the program so that a building is charged a subscription fee, and we guarantee to keep its Delta P, or change in pressure, at a certain level.

We also want to monitor these systems remotely and electronically. This is where the electronics aspect really comes into play. Look at the Las Vegas Strip: there's no downtime allowed, so we sensor up all the MGM properties and remotely monitor and deploy a technician to clean specific systems when their Delta P is going up. We keep the system at a design peak thermal efficiency. We drive that through data and analytics and optimize filters.

Feinberg: Is Blue Box a public company yet?

Metropoulos: No. We're still private, but we're growing fast. I started commercializing this in 2016 in Southern California, and now we have operations in Southern California, Las Vegas, Dallas, Houston, San Antonio, Oklahoma City, and Denver. We're everywhere from here to New York City. In New York City, we just disinfected a two-million-square-foot building—the offices that house the attorney general. This week, we're disinfecting the Dallas police station, and we're not charging them; we're doing it as part of our civic duty because the police officers and fire stations are on the front lines.

Whenever my people have downtime, I send them to a police station or fire department and have them start treating their systems to help out where we can. We do the same thing with nursing homes. If we hear about a bad situation, we offer to disinfect things either at cost or no charge. We just finished up the NRG Stadium in Houston because they're converting it into a COVID-19 emergency hospital. It will be interesting to see how the COVID-19 really changes people's perception now of indoor air.

Feinberg: Absolutely. We can tell you're excited about it, and you should be. What's your website?

Metropoulos: BlueBoxAir.com. If you have any questions or follow up, feel free to reach out to me.

Johnson: How many employees do you have?

Metropoulos: We have 60 right now, but there's a pretty good chance it will be anywhere from 120–200 by this time next year.

Johnson: Jim, thanks for the time.

Metropoulos: Thank you. I really appreciate it. Take care. **PCB007**

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Navigating the Challenges of the New Normal

Feature by Kevin Jobsky
ICM CONTROLS

Stroll out onto the manufacturing floor at ICM Controls, and it appears to be business as usual. The bustling activity of employees and the sounds of their voices reaching out over the constant hum of the board shop and assembly equipment is a clear indicator that production is in full swing at the facility in North Syracuse, New York.

Take a closer look, however, and you'll realize the many subtle changes implemented throughout the factory from just a few short months ago that serve as a constant reminder of how the COVID-19 pandemic has changed the workplace and how business is done—possibly forever.

Workers now don masks, and an attempt has clearly been made to space people out to meet social distancing guidelines—not an easy task in a manufacturing facility designed for worker efficiency. Separation barriers have been installed between work areas to limit exposure to each other. Sanitizing stations and floor stickers adorn the hallways, with notices on the walls that remind us all to avoid touching our face area and to stay six feet apart. Even before employees leave home for work, they are asked to check their temperatures and to not come in if they show signs of a fever.

Welcome to the new normal.

Fortunately for ICM Controls, a captive shop turned contract manufacturer at the onset of the pandemic, the company was declared to be essential and allowed to remain operational early on by New York State—albeit with restrictions on the number of employees that could physically be in the building at any one time. Being able to keep our doors open afforded us the luxury to prepare ourselves and our facility in real-time, giving us a head start over others that had to wait to reopen their doors.

Even so, a multitude of challenges still lays ahead—more far-reaching than sourcing hand sanitizers and masks—that ICM Controls must successfully navigate if it hopes to come out on the other side of this pandemic with only a handful of minor battle scars. Undoubtedly, there are many companies—large and small—that will not be so fortunate.

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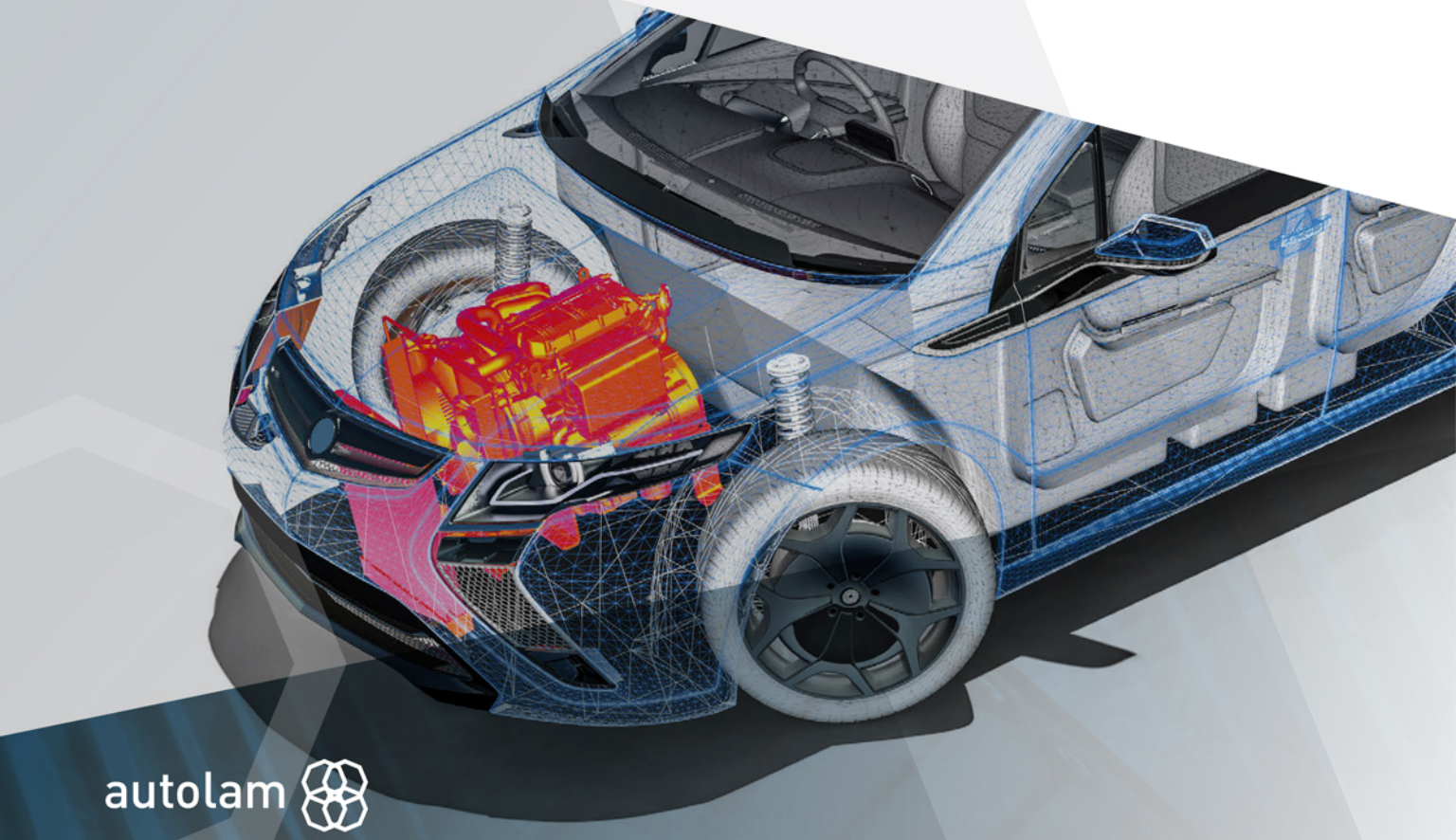

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Masked worker filing away a large stack of recently manufactured bare boards for a large OEM customer, prior to the boards moving on to assembly. It is just one of several shelving areas throughout the board shop/auto assembly area.

As government leaders ease restrictions, a mountain of uncertainty looms that local businesses must contend with if they hope to survive, let alone prosper. Everyone wants a speedy recovery and, based on the recent jobs report, companies are betting on it. But those who believe that companies can simply "flip a switch" to turn the economy back on and "everything will revert back to business as usual" are being naïve.

Over the next few months, companies of all sizes will routinely be required to make pivotal decisions concerning a web of complex personnel, operational, and supply chain challenges that will have a significant impact on not just their operations, but also those of their customers and their customers. Companies with multiple locations, or those that do business in multiple states and multiple countries, will be tested even more. These decisions collectively will largely determine just how fast the U.S. economy is able to bounce back.

States and countries around the world are opening on their own timetables and with their own guidelines and restrictions. This discontinuity can wreak havoc on buying and forecasting decisions. A company's customer base may be fully operational in one state, but restricted to 50% capacity in another, and their customer base may be experiencing the same. Worse yet, some customers may have been forced to shut their doors forever—a non-human statistical casualty of COVID-19.

These uncertainties, if prolonged, can lead to an operational paralysis and alter a factory's production schedule and how fast it elects to bring back its employees. Conversely, a diverse company that supports several manufacturing disciplines from PCB/A to turn-key and branded product solutions may sense a surge in demand and decide to "go all-in" and invite its entire workforce back as soon as it was allowed.

In doing so, however, HR teams had to overcome multiple challenges. With local schools and some area daycare centers still closed, it made it difficult—even impossible—for some parents of young children to come back, even when they wanted to. Some were brought back on adjusted shift schedules. There were others that simply refused to come back out of concern for their health and well-being and/or because they are making more on unemployment (at least through July).

Recruiting new employees presented its own set of challenges as well. We prefer to recruit directly versus using an agency and typically conduct in-person first interviews. The natural alternative would be to move to virtual interviews, but not all candidates have the necessary computer skills or equipment to participate in a virtual interview.

HR and operations are not the only departments that have had to deal with the fallout of the lockdown. Many sales and marketing initiatives have been left in limbo or have been adjusted to comply with various travel and visitor restrictions that, again, differ from state to state and customer to customer. Improv-

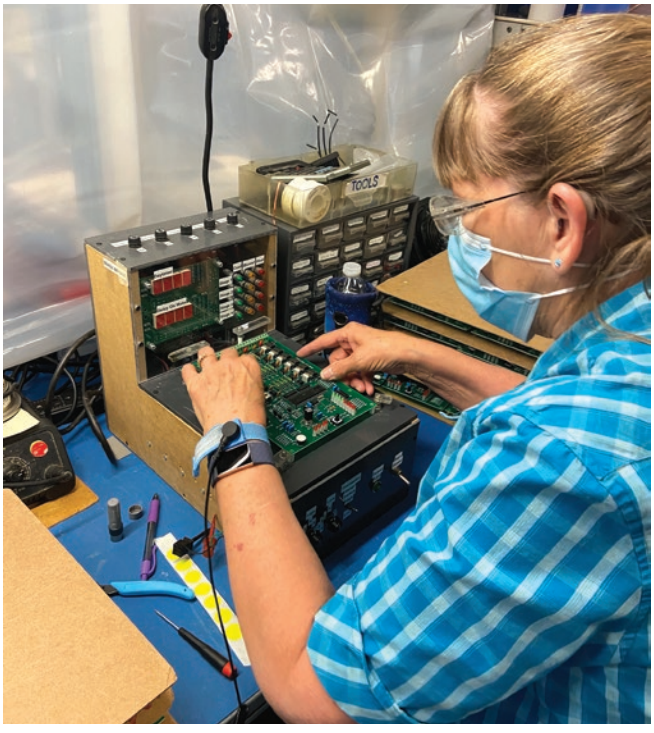
ing guidelines and restrictions remains fluid, keeping would-be business travelers in a state of flux. This, in turn, makes budgeting decisions that much more difficult. How long does a company wait before it decides to redirect monies to a certainty?

As noted previously, we made a conscious decision earlier this year to enter the world of contract manufacturing. The decision had little to do with—but was definitely sped up by—the onset of the pandemic, as the company advertised its services to other manufacturers in need. Among some of the sales and marketing strategies planned to promote its new initiative, our company registered to attend/exhibit at several trade shows. As the pandemic widened, these trade shows were either canceled or postponed and have remained that way today.

In the early days of the pandemic, it was the Biogen Leadership Conference held at the Boston Marriott Long Warf Hotel that led to 77 of the first 95 reported COVID-19 cases in Massachusetts. There were a sparse 175 registered attendees at the event. Some of the shows we planned to attend draw 60,000+ attendees annually.

Additionally, we're getting ready to launch several new branded products later this summer and early fall. In keeping to schedule, ICM Controls has had to resort to less effective video conferencing and virtual training strategies to educate its sales force on the new product offerings. Sales and marketing have essentially had to rethink and retool its product roll-out strategies overnight.

Of even greater concern are the lingering questions over the health of the supply chain. Will OEMs that pushed out orders at the height of the pandemic suddenly request to expedite those orders upon their reopening? For us, in some cases, it has been yes, but not in other cases. This can result in scheduling nightmares to ensure timely deliveries of components, as well as getting machine time on the production floor. Do companies override their ERP models to purchase excess material to build up inventory at the risk of the country falling into a prolonged economic slump?



Worker tests a control board on the final assembly line. You'll notice the plastic sheet that divides/protects/shelters her workspace from the person who sits across from her. ICM Controls now has plastic dividers like this throughout the final assembly area.

Pulling the trigger too fast could put too many unwanted products on the shelf. Wait too long to order parts, and you might run into a component shortage from everyone else trying to buy at once, resulting in exceptionally long lead times that might force your customers to turn elsewhere for products.

Throughout the lockdown, we worked closely with our key suppliers and OEM customers on forecasting and scheduling. In many cases, OEMs struggled and could only guestimate demand and how quickly their production lines would ramp back up to full capacity. Everyone remains optimistic as they try to gain visibility several extra steps down the supply chain, but no one is certain.

Compounding the issue is whether there will be a change in consumer confidence when states fully reopen. Prior to the lockdown, consumer confidence was strong. Unemployment was low. Families were spending money freely and buying new to replace the old. Consumer confidence plummeted in April but appeared

to steady itself in May. Today, many key economic indicators remain strong, bolstered by the May jobs report, but is this a "head fake" devoid of realism?

We are of the mindset of "going bold" because there might not be a tomorrow. This strategy recently paid off on multiple occasions, as the company was able to secure new business when competitors were unable to deliver products due to supply chain issues stemming from the pandemic. In another instance, a major OEM brought ICM Controls into their fold to comply with a strategic shift in their supply chain philosophy that now mandates all purchased components to be multi-sourced, with at least one source being domestic. Other OEMs are considering following suit.

The reopening of the country is going to be a long process that will consist of many stages and subplots. It is estimated that 70–80% of the nation's small businesses and services are already operational to some degree. Even so, many companies—especially manufacturers—will be required to completely rethink their short- and long-term business plans. We are only at the beginning of stage one of reopening, which addresses immediate concerns in order to help shore up the bottom line.

Stage two won't be for another 6–12 months when companies begin to take a long, hard look at where and how they purchase goods and adjust their policies in order to mitigate risk to their supply chain. We went through this exercise a year or two before amidst the trade war with China, as we did not want to be overexposed to any one region. We started working with major OEMs to qualify critical components from a variety of sources all over the world. This forward-thinking has the company operating today from a position of strength.

Further out, stage three will be largely based on the decisions made in stage two and be tied to a company's 3–5 year business plan, but could very well shape the way manufacturing looks in the future. This decision will be especially critical for larger companies that not only outsource work to China but have also invested monies and resources in facilities in China to capitalize on cheaper labor rates.

The accelerating political discord between the United States and China may wind up playing a major role in this decision-making process. Both countries have been at odds over the past two years due to the trade war, Hong Kong, and now the pandemic. Businesses with exposure to China must already contend with supply chain disruptions due to the Chinese New Year, but planning around a single annual annoyance is far easier than dealing with a constant array of unexpected policy shifts and shutdowns. At some point, companies must ask themselves if it is worth it.

As we move forward, economic success will depend on how companies are able to maintain compliance and respond to ever-changing guidelines and executive orders from each state and each country. Smaller or vertically integrated companies can adopt internal policies that tend to be more fluid because they can pivot more easily and react faster to change.

Large conglomerates, on the other hand, must prepare themselves with multiple action plans to handle almost any scenario in order to enact policy change over their entire enterprise in a timely manner, which is not an easy task. Then again, nothing in the post-COVID-19 business world is.

The one certainty, however, is that domestic contract manufacturers will be ready to help with their transition should these companies decide to bring the work back home. **PCB007**

Kevin Jobsky is senior marketing manager at ICM Controls.

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

MilAero007 Highlights

Defense Speak Interpreted: DMEA ▶

A June 17 article announced a supply chain award of $10.7 billion to eight defense companies for semiconductors. Dennis Fritz explains how the Defense Microelectronics Agency (DMEA) administers this contract and keeps the technology secure.

Understanding MIL-PRF-31032, Part 1 ▶

Over the course of this series, Anaya Vardya will discuss topics such as MIL-PRF-31032 requirements, the quality plan, responsibilities of the Technical Review Board (TRB), and the testing and reporting requirements for the certified shop into the DLA.

This Month in *Design007 Magazine:* When Working Remotely, Cybersecurity Is a Necessity ▶

When we started planning this issue on working remotely, we knew we'd have to speak with Stephen V. Chavez, chairman of the Printed Circuit Engineering Association (PCEA). We recently asked Steph to discuss some of the security measures that his company employs and what his experience has been like since he began working out of his Arizona home office full-time several months ago.

Lockheed Martin Chooses Austin American Technology for Cleaning Needs ▶

Austin American Technology announced its newest machine sale to Lockheed Martin, which purchased an X30-A Vertical Format Batch Cleaning System.

NEOTech Partners With Numerica Corporation for the Air Defense Market ▶

NEOTech, a provider of manufacturing technology and supply chain solutions for brand-name OEMs in the industrial, medical and mil/aero markets, announced a new partnership with Numerica Corporation, a company that continues building on two decades of experience developing and deploying sophisticated algorithms and software for some of the nation's most critical Air and Missile Defense programs.

Electronics Manufacturing Industry Applauds Congressional Actions ▶

IPC, the global electronics manufacturing association, applauds leaders in the U.S. Senate and House for approving IPC-backed measures that will bolster the resiliency and security of the U.S. defense electronics industrial base.

BIRD: Israel-U.S. Binational Industrial R&D Foundation to Invest $8 million in 10 New Projects ▶

During its meeting on June 23, 2020, held via video conference, the Board of Governors of the Israel-U.S. Binational Industrial Research and Development (BIRD) Foundation approved $8 million in funding for ten new projects between U.S. and Israeli companies. In addition to the grants from BIRD, the projects will access private sector funding, boosting the total value of all projects to approximately $20 million.

Indium Corporation to Feature AuSn Precision Preforms at Space Tech Expo ▶

Indium Corporation will feature its precision AuSn preforms for high-reliability aerospace applications during the Space Tech Expo Connect virtual exhibition from August 10–13.

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Leadership Styles for Success

The PCB Norsemen
Feature Column by Didrik Bech, ELMATICA

Leadership is the foundation of a successful business, but how do you define it? Leadership has various definitions, depending on where you are in the world. The range of leadership attributes varies from "a practical skill encompassing the ability of an individual or organization to lead or guide other individuals, teams, or entire organizations" to "a process of social influence in which a person can enlist the aid and support of others in the accomplishment of a common task" [1].

Leadership Styles

What styles of leadership are there, and what type do you use? Leadership styles are often attributed to a situation or circumstance a company is encompassed in. Here are five key leadership styles [2]:

1. **Autocratic:** All decision-making powers are centralized in the leader.
2. **Democratic:** The leader shares the decision-making abilities with group members.
3. **Laissez-faire:** Decision-making passed on to subordinates with the right and power to make decisions to establish goals and work out the problems or hurdles.
4. **Task-oriented:** Are generally more concerned with producing a step-by-step solution for a given problem or goal, strictly making sure these deadlines are met, and results and target outcomes are reached.
5. **Parental:** The structure of the team is organized hierarchically, where the leader is viewed above the followers.

The Art and Science of Leadership

The definition of leadership and leadership styles depends on where and when you were raised, your education, and the financial, technological, and cultural situation where one is executing leadership. To draw a parallel between leadership and creating and maintaining a successful business, both have an element of art and science to them.

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In relation to leadership and business success, I would like to share some of my thoughts and experience. I am not claiming it is the right or correct recipe for all circumstances. However, I believe my leadership style has been successful in relation to creating emotional and economic value for my colleagues and shareholders—the ultimate judgment of this shall be bestowed on my colleagues and shareholders.

Psychological Capital: The Key to Break It or Make It

Elmatica recently participated in a master thesis concerning change management and how leadership can minimize the negative effects of organizational change and still motivate the employees. The key is psychological capital. Recent research shows that the link between psychological capital and authentic leadership is more important than ever in change situations, both for a company as a whole and the individual.

Personal Leadership

When I had the privilege of joining Elmatica in 2011, I was to become the third CEO in the past 40 years. One key aspect at that time was to modernize, digitalize, and further internationalize the company. This constitutes a change, and change is not always welcomed, even though everybody considers it crucial.

The leadership style I believe in would be called personal leadership, which is described as a combination of democratic and task-oriented leadership. It emphasizes creating psychological capital [3], challenging and supporting people to live more productive and meaningful lives, and helping them realize their potential.

Personal leadership can be defined as developing strategies and goals based on current and future internal capabilities, implementing organizational escalation levels, clear mandates and responsibilities, transparency, and mutual respect. This type of leadership equips and develops the organization with the correct capabilities and dramatically increases its chances of becoming a successful business.

Today's Leaders

Many of the challenges of today's leaders are not the same as during 1970. The hierarchical "command and control" structures of the past are practically gone in many countries and companies. Just telling someone to do something without a purpose is not optimal in a complex business structure. Whilst leaders of the past would lead by the power of their position, leaders of today should lead by inspiration, influence, and cooperation.

With new technology, social media, and constant and immediate access to information, a leader should no longer stay put in their corner office. Changes happen faster than before, and every leader needs to be in the field with their colleagues, fighting the same battles and leading the way by doing, not just saying. They should nurture psychological capital and further develop it.

Are You a Boss or a Leader?

For me, leadership starts with how you refer to it. The naming of the role is not a random choice. I do not want to be perceived as just "the boss;" instead, I want to be perceived as the leader. I wish to inspire others to be leaders, which starts with addressing the people I represent as colleagues.

Being a leader in any position is to take control and develop one's responsibilities on both a business and a personal level. Understanding what you like and what you want in the context of the organization's requirements will allow you to transform your initiative into creative energy, which creates value for you and your company. Those who do not seek to explore their potential and push the boundaries of their existence will not have the pleasure and honor of understanding what they deserve and have to give.

The True Joy of Being a Leader

While many seem to believe that leadership is about deciding and delegating, for me it is about enabling colleagues with trust, support, and responsibility. It means supporting their personal development and the compa-

ny. The goal is to promote personal initiative and a culture of allowing mistakes to happen, as long as there was a strategy for the decision that led to failure. We learn much more from our failures than our successes, and nothing should be more gratifying to a leader than seeing one's colleagues and friends develop and improve. This is one of the true joys of being a leader.

One Thing That Money Can't Buy

If loyalty is something you consider as a key attribute for developing your company, then implementing a personal leadership style is one clear way to go, as loyalty is not something money can buy. However, with every leadership style, there are also potential negative effects one must be aware of and know how to address. In an organization based on trust, mandates, and friendship, one can experience that a colleague can fail to understand the boundaries of one's position and "take rights" one does not have.

Thus, it is crucial that the company has developed and implemented a quality management system to address these boundaries. This will make it clear when one must seek permission. If this is not addressed properly, some people can misunderstand the trust they have been given and can, with the best intentions, wrongfully take matters into their own hands.

What to Look for in a Leader

Creating and maintaining a successful business is impossible in the long run without proper leadership. It is challenging to find, attract, and retain leaders who seemingly create success after success, while protecting and safeguarding the individual colleague and shareholders.

My advice when searching for your new leader is to take your time to get to know them and let them get to know the company. Look beyond the academic background of the individual to understand who they are, what makes them "tick," and their emotional realm, as emotions govern reason and not the other way around [4].

As a rule of thumb, you should, at minimum, spend 70% of your time in any interview learning about the candidate's upbringing, morals, life philosophy, and other highly emotional thoughts and considerations. Creating trust and loyalty begins at the first encounter, and emotional capital will be the premise for this exchange.

Expressing Emotions

Some literature and leaders claim that you should not express emotions as a leader. I know we are all different individuals—some more emotional than others—but please tell me what is more natural than expressing how you feel. The key is to address each individual at the emotional level where they are currently residing and respect their boundaries. By doing so, a great leader can access one's personal emotional capital to establish contact, as well as motivate and understand individuals within a wide range of emotional levels.

Conclusion

Being a leader, or the representative of many colleagues, implies that the leader will have to address numerous aspects of leadership and business. If you have a personal leadership style, you will have the benefit of addressing these challenges in a democratic and task-oriented style, where people will be creative, trustworthy, and loyal, with the same strategy and goal as the leader.

Finally, ask yourself, "What kind of leader am I? What kind of organization do I work in, and how is the leader of that organization doing?" **PCB007**

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Didrik Bech is the CEO of Elmatica. To read past columns or contact The PCB Norsemen, click here.

Palladium Plating Increases Robustness, Lowers Cost

Article by Britta Schafsteller, Gustavo Ramos, Dirk Tews, and Dimitri Voloshyn
ATOTECH DEUTSCHLAND GMBH

Abstract

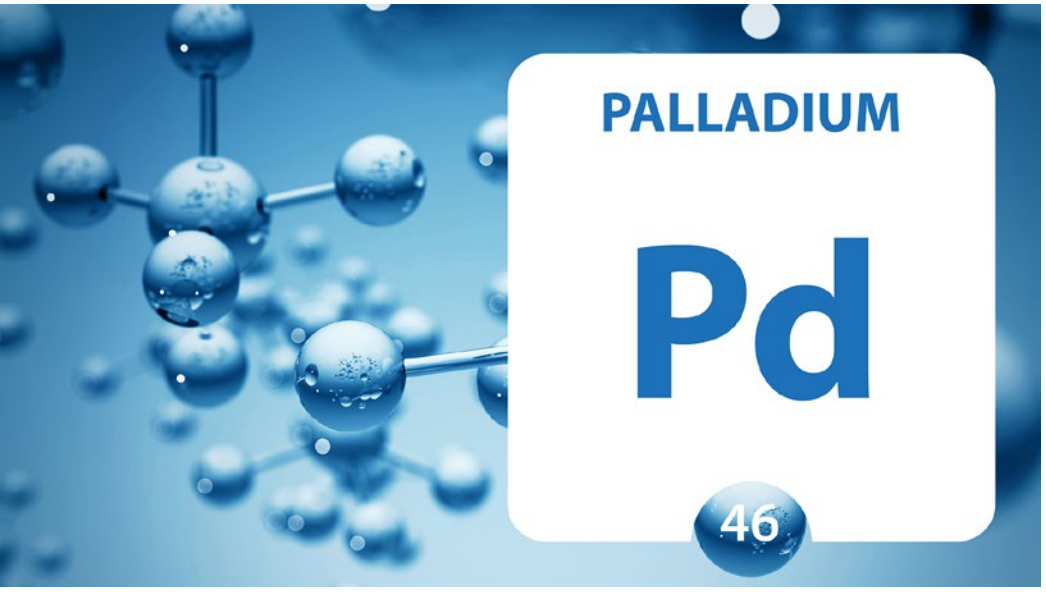
Due to its multiple soldering and bonding capabilities, electroless nickel/electroless palladium/immersion gold (ENEPIG) is a highly reliable finish with a broad application field. This article introduces a new electroless plating bath to deposit pure palladium layers, which allows you to operate the process with lower palladium content and higher process robustness. The performance of the deposits is tested in various ways and compared to market proven production solutions.

Introduction

ENEPIG is an accepted and well-established finish for high-performance and high-reliability applications in a growing market. The nickel layer provides a reliable diffusion barrier and, at the same time, is a solderable and bondable surface finish allowing a variety of applications. Yet there are some reasons slowing down the growth of the ENEPIG use in the market, in particular over the past 1.5 years.

Due to the recently increasing Pd price, the process cost became of major interest, and cost reduction is one of the main targets in the application of the ENEPIG process. At the same time, the electrolytes for electroless palladium plating are well known to be sensitive to wrong handling and contaminations from outside. In this article, a new Pd plating solution will be presented that can be operated with a low Pd content while at the same time assuring high process robustness.

This article focuses on the comparison of the new Pd electrolyte Pd-Core® with a conventional Pd plating solution. The new formulation allows a process operation with a Pd content of only 0.5 g/l, and with that, to reduce the full process costs by about 50%. At the same time, the bath can achieve a far extended bath life compared to conventional processes in the market without forming any precipitation or plate-out.



Plating

One of the key properties of the new Pd-Core® process is the low palladium content at which it is operated. Even though the target concentration of palladium in the solution is 0.5 g/l, the bath de-

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Prepreg **R-5680(GN), R-5680(GE)**

(GN):Low Dk Glass cloth type (GE):Normal Glass cloth type

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- Multi-site production in Japan/China

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R-5785(GE)	3.6	0.003 @ 12GHz

Applications

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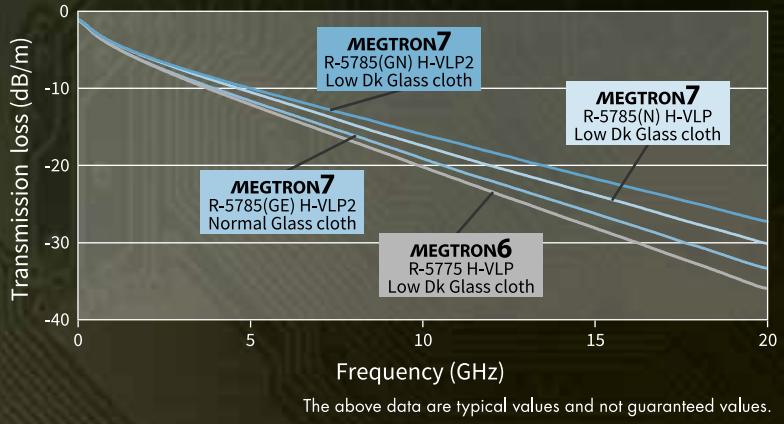
Transmission Loss

- Construction

Trace thickness(t)	18μm
Dielectric thickness(h)	300μm
Copper thickness	18μm
Inner treatment	No-surface treatment
Core	0.15mm (#1078 x 2ply)
Prepreg	0.15mm (#1078 x 2ply)
Line length	1000mm
Impedance	50Ω



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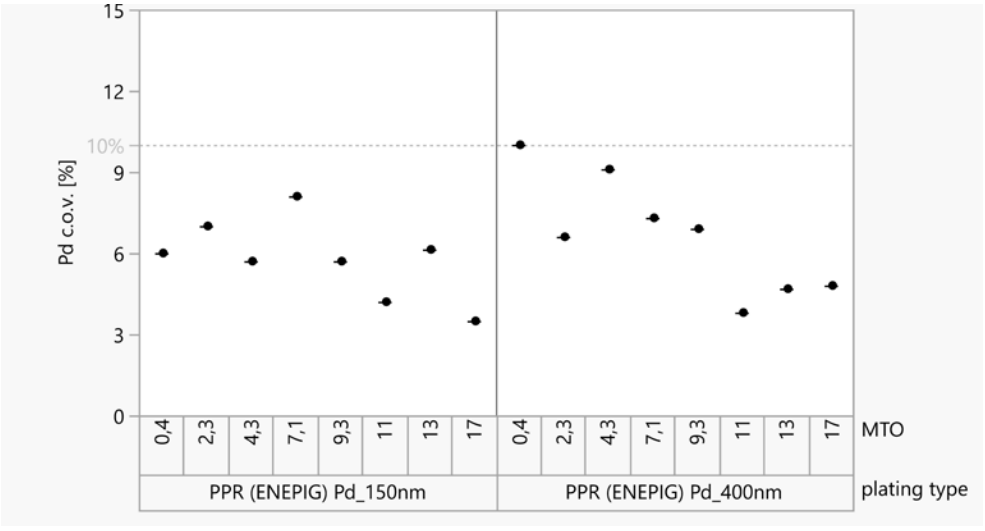

Figure 1: Thickness distribution of Pd deposit on different pad sizes over the full bath life.

posits with constant performance over its full lifetime, and can deposit a layer with a thickness distribution of 5–10% CoV measured on 10 pads with different pad sizes varying from 0.25–49 mm². This thickness distribution is independent of the overall palladium thickness and can be achieved for 150 nm target thickness as well as for 400 nm (Figure 1).

Operating at mild conditions of 55°C and a pH of 5.8, the process works for 10 MTO and more with stable and constant performance without any indication for plate-out or precipitation. A Pd layer thickness of 150 nm can be achieved in a plating time of approximately eight minutes. The palladium layer that is deposited is of fine crystalline structure comparable to other pure Pd deposits that are present in the market (Figure 2).

Soldering and Bonding Performance

In the following section, the solder wetting, solder joint reliability, and wire bonding performance of an ENEPIG finish with the new Pd-Core® layer are studied and compared with the performance of an ENEPIG finish with a conventional pure Pd process. In selective wave soldering tests applying a SAC 305 solder according to IPC J-STD 003, all through-holes were fully wetted with solder in as received as well as in aged conditions. Figure 3 shows the exemplary result for through-holes with a diameter of 0.8 mm in as received after 2x reflow and humid aging for 8h at 72°C with 85% relative humidity.

To study the solder joint reliability of the ENEPIG finish, high-speed shear tests have been performed with both the Pd-Core® and

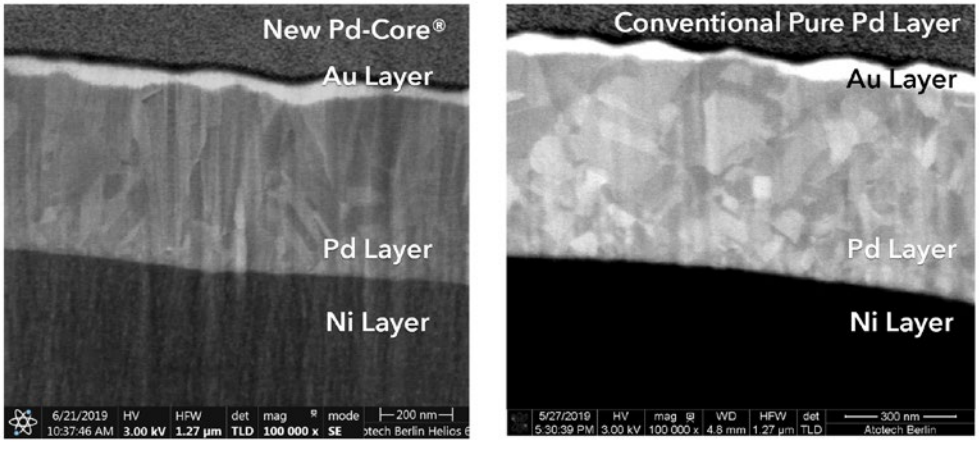

Figure 2: FIB cut of the crystal structure in the Pd deposit.

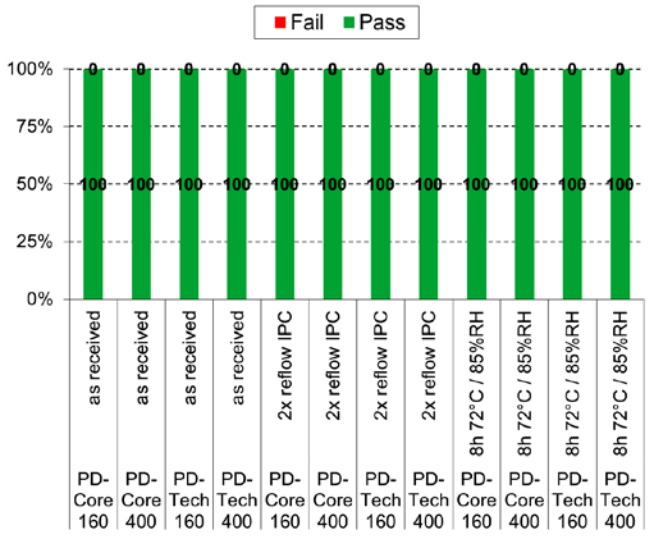

Figure 3: Selective wave soldering results on 0.8-mm PTH with Pd-Core® and Pd-Tech® PC palladium layers with 160 nm and 400 nm Pd layer thickness at different aging conditions.

the Pd-Tech® PC Pd layers. The test was repeated over the full lifetime of the bath and with layer thicknesses of 160 nm and 400 nm of palladium. Nickel and gold layer thicknesses were kept the same for all conditions. Thirty solder balls of a SAC 305 solder with a ball diameter of 450 µm were applied on 380 µm SR-openings and sheared per test condition with a shear speed of 1.2 m/s and a shear height of 20 µm. Shear energy and fracture modes were observed to be comparable for both processes having a constant performance over the full lifetime of the bath. No significant difference could be observed between the new Pd-Core® finish and the mass production proven Pd-Tech® PC palladium (Figure 4).

Also, looking into the formation of the intermetallic component of both finishes, the appearance is comparable, and no difference can be identified (Figure 5).

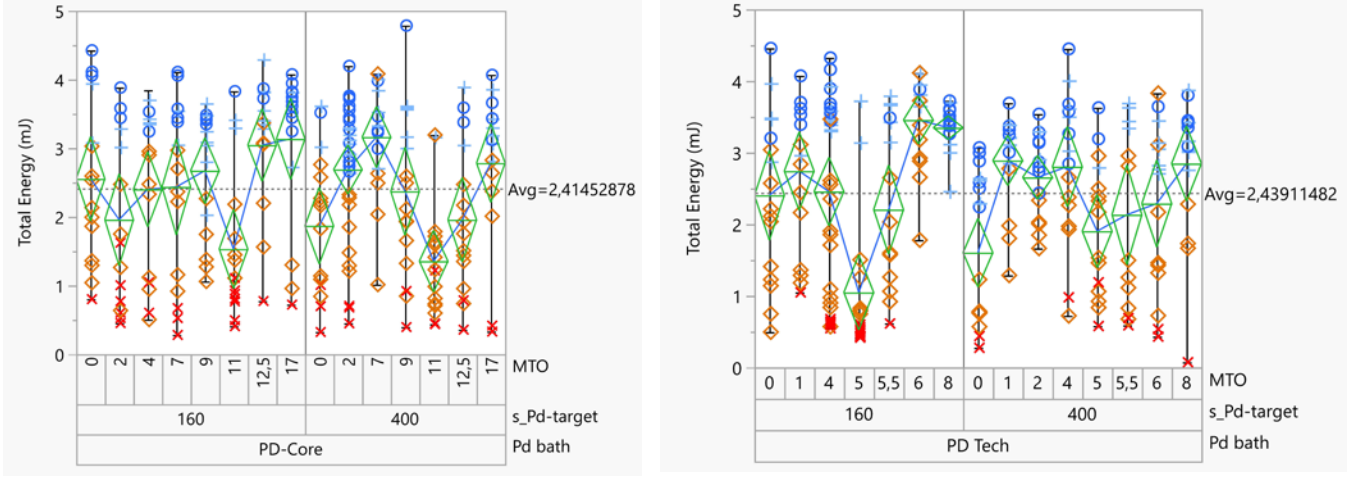

Figure 4: Total energy values for high-speed shear testing of ENEPIG layers with Pd-Core® and Pd-Tech® PC palladium.

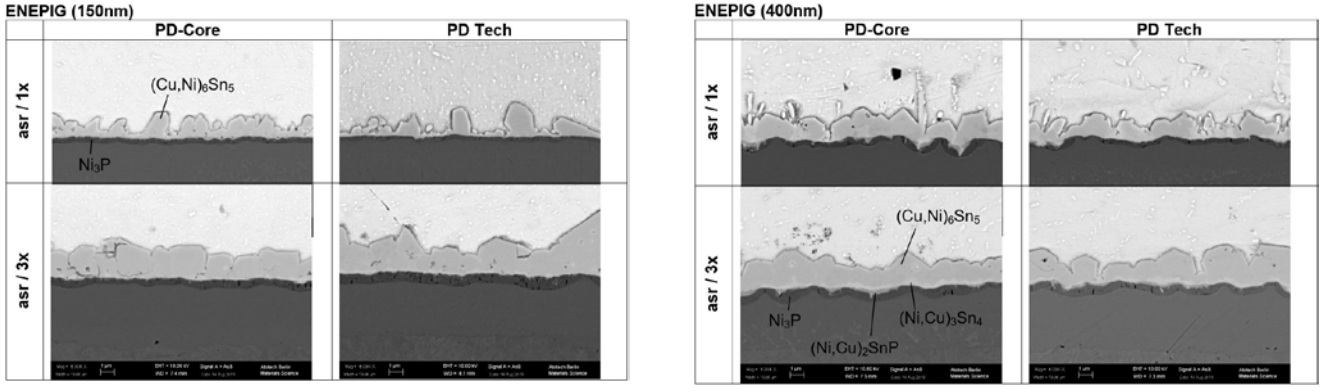

Figure 5: Cross-section of the IMC formed after 1x and 3x reflow with ENEPIG finishes with 150 and 400 nm of palladium.

The volume, as well as the shape of the IMC that is formed after the reflow aging, is comparable for both processes and results in the formation of a very homogeneous and dense IMC with even grain size and without any defects or voids.

As one of the main purposes of the ENEPIG finish is to enable a gold wire bondability with lower gold thickness, the wire bonding performance has been compared to the conventional pure Pd deposit. Again, the layer thicknesses were comparable, and the performance was checked throughout the entire Pd bath life. The bonding was performed using a 23 µm gold wire with a break load of 9.9 g, and the pull strength was measured in as-received condition, as well as after aging for four hours at 150°C. The mean pull values that were measured were comparable for both processes and consistent throughout the bath life (Figure 6).

Only fracture modes of 2, 3, and 4 were observed; no indication for lift-offs or peeling could be detected. The tests were performed over a Pd bath life of Pd-Core® of 16 MTO @ 0.5 g/l Pd, which equals eight MTO of the conventional pure Pd bath with a Pd content of 1 g/l. Therefore, it can be concluded that the performance of both processes is fully comparable and that the Pd-Core® offers the same reliability as the mass production proven conventional pure Pd deposit.

Process Robustness

Earlier studies showed that the Pd plating process could be quite sensitive to any process contamination or poor rinsing [1–2]. The rinse quality of the rinse step between the nickel and the palladium plating can have a significant impact on the initial seeding of the palladium layer, which can influence the deposition rate as well as the initial crystal structure and layer growth of the deposit. To check the sensitivity of the palladium plating towards the rinse quality, an additional test was performed where the rinse between nickel and palladium was contaminated on purpose. The rinse water was doped with nickel bath solution up to a conductivity of 500 µS. The test panels were pushed through the whole process until the Pd step and rinsed and dried right after the palladium plating. The palladium deposit was investigated by means of surface SEM on eight different areas on the test coupons. Pores in the Pd layer top view were counted, and the

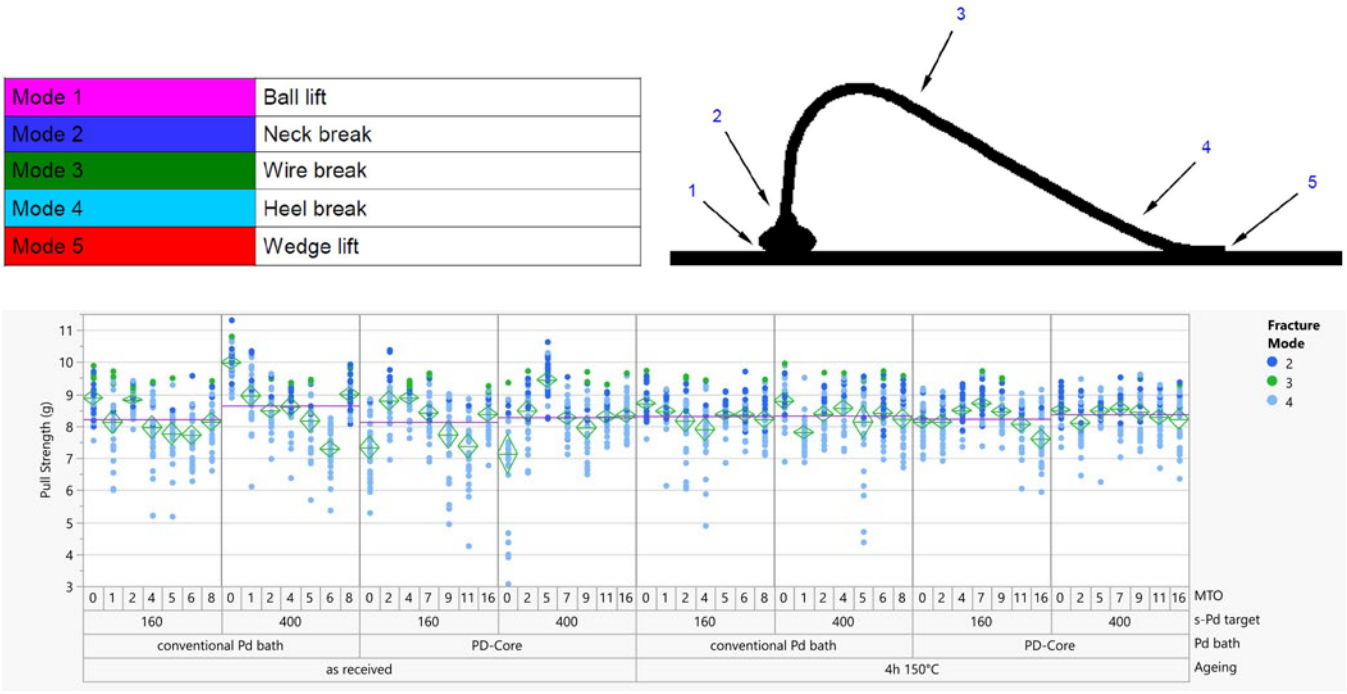

Figure 6: Pull strengths and fracture modes for gold wire bonding of ENEPIG.

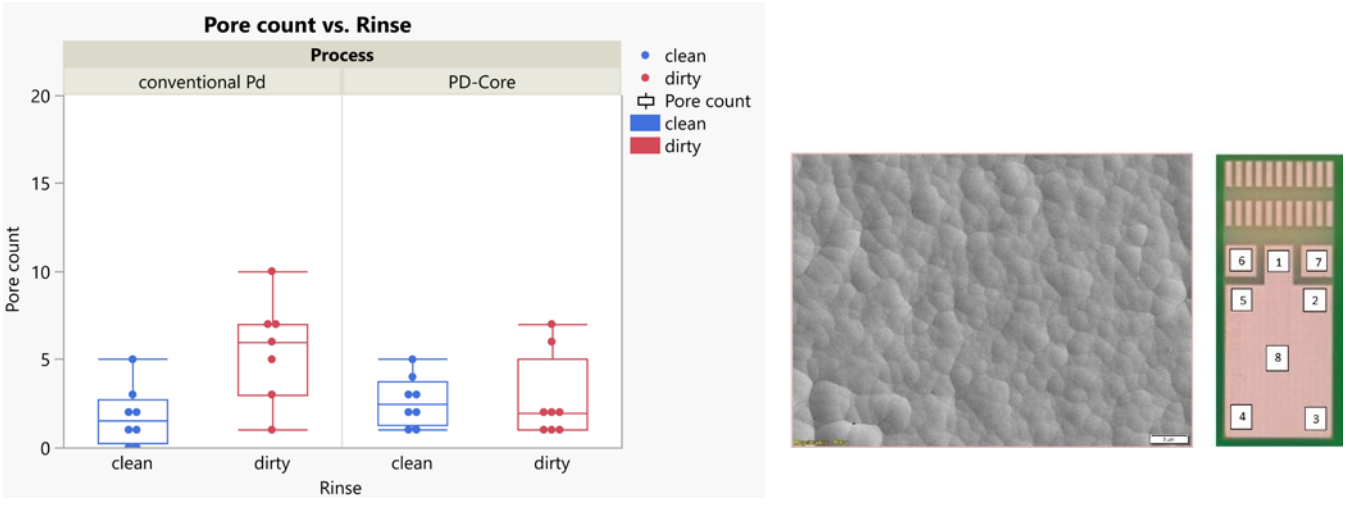

Figure 7: Process sensitivity toward rinse cleanliness.

different conditions were compared. The formation of pores, in this case, acts as an indicator of a disturbed initial palladium growth and potential defects in the layer formation (Figure 7).

The result clearly indicates that the Pd-Core® offers a significantly improved bath sensitivity toward potential contaminations in the process. Even with a contaminated rinse, no effect on the formation of pores in the palladium layer can be seen. In comparison to the conventional process, the Pd-Core® appears more robust and can help to ease the handling of the whole ENEPIG process.

Summary and Conclusion

This article presented a new plating bath for electroless plating of pure palladium layers. The soldering and bonding tests that were conducted showed that the layer performance is at least as good as the performance of the mass production process, which is available in the market. Besides the high reliability of the surface finish, the new process offers significant cost savings due to its reduced precious metal content and long lifetime. Further advantages are the increased process robustness and reduced sensitivity to contaminations in the process. These ease process handling and help to reduce maintenance efforts. **PCB007**

Note: This article was originally titled "Pure Palladium Plating for ENEPIG: Improved Process Robustness for Lower Cost."

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Dirk Tews, EL R&D manager for selective finishing at Atotech in Berlin, Germany.

Dimitri Voloshyn, development engineer for selective finishing at Atotech in Berlin, Germany.

Electronics Industry News and Market Highlights

China Everbright Limited, Terminus Technologies Launch A 10-Billion AI Economy Fund ▶

China Everbright Limited and Terminus Technologies announced the joint launch of "CEL AI Economy Fund," aiming to raise RMB 10 billion and operate in both Renminbi and USD.

Lion Semiconductor Collaborates With Renesas to Develop Advanced 50W Wireless Power ▶

Lion Semiconductor Inc. announced it is working with Renesas Electronics Corporation, a supplier of advanced semiconductor solutions, to develop ultra-high-speed wireless charging solutions with up to 50W for use in flagship smartphones and other mobile devices.

BIRD: Israel-U.S. Binational Industrial R&D Foundation to Invest $8 Million in 10 New Projects ▶

During its meeting on June 23, 2020, held via video conference, the Board of Governors of the Israel-U.S. Binational Industrial Research and Development (BIRD) Foundation approved $8 million in funding for ten new projects between U.S. and Israeli companies. In addition to the grants from BIRD, the projects will access private sector funding, boosting the total value of all projects to approximately $20 million.

Bosch Launches Longevity Program for Industrial, IoT Applications ▶

Bosch Sensortec is launching a longevity program and expanding its product portfolio to meet the specific needs of industrial applications. By ensuring products will be available for 10 years, this new program will give customers peace of mind, as well as access to high-performance, robust sensors, and increased purchasing flexibility due to smaller reel sizes.

New MIT Research Suggests Widespread Autonomous Driving at Least a Decade Away ▶

The MIT Task Force on the Work of the Future released a new research brief examining the future of autonomous vehicles. The brief is part of a series of subject-specific research projects by MIT faculty that will help frame national discussion and policies about work, technology, and how we can create greater shared prosperity in the country.

ADLINK Launches All-in-One AI-Enabled Smart Camera ▶

ADLINK Technology Inc., a global leader in edge computing, launched the new NEON-2000-JT2 AI-enabled smart camera series to make machine vision deployment for AI-based factory automation easier.

NVIDIA Names John Dabiri to Board of Directors ▶

NVIDIA announced that it named to its board of directors John Dabiri, the Centennial Professor of aeronautics and mechanical engineering at the California Institute of Technology, where he previously served as dean of students and chair of the faculty board.

Samsung Leads Semiconductor Paradigm Shift With New Material Discovery ▶

Researchers at the Samsung Advanced Institute of Technology (SAIT) unveiled the discovery of a new material, called amorphous boron nitride (a-BN), in collaboration with Ulsan National Institute of Science and Technology (UNIST) and the University of Cambridge. Published in the journal Nature, the study has the potential to accelerate the advent of the next generation of semiconductors.

Leadership Lessons I Learned From Sonny Barger

The Right Approach

Feature Column by Steve Williams, THE RIGHT APPROACH CONSULTING

Introduction

Countless books have been written about the great leaders throughout history who have served as role models for generations of business executives. But what about the lessons that can be learned from the names you won't typically find in the business section of your local bookstore? Much can be learned from them, too. In this column, I discuss leadership lessons I learned from Sonny Barger (Figure 1).

Background

For over 50 years, Ralph Hubert "Sonny" Barger presided over one of the most violent and successful operations in organized crime history: the Hells Angels Motorcycle Club (HAMC). Born on October 8, 1938, Barger's mother left him with his alcoholic father and older sister when he was just four months old. His violent tendencies surfaced early with several school suspensions for assaulting teachers and fighting with his classmates. In 1955, he enlisted in the army at age 16 and was discharged 14 months later when it was discovered that he had forged his birth certificate to be able to join.

After returning from the Army, Barger rode with some small local motorcycle clubs but quickly left, disappointed in the lack of "brotherhood" and courage in the membership—two attributes that would become guiding principles of the Hells Angels. He began riding with some friends who shared his vision, and one of the bikers, Boots Don Reeves, wore a patch he had found in Sacramento of a small skull wearing an aviator cap with a set of wings. Boots suggested they name their new club the Hells Angels after the patch. They went to a local trophy shop and had a set of patches made in April of 1957, not knowing that their actions that day would be the origin of one of the most notorious motorcycle clubs in history, and one that is still going strong today.

At the time, there were numerous independent Hells Angels motorcycle clubs throughout California, often not even knowing about each

Figure 1: Sonny Barger.

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other. Barger founded the Oakland Chapter of the HAMC in 1958 as president and quickly moved up the ranks to become the national president. Sonny Barger is widely credited with organizing the disparate groups under one "mothership," and for the tremendous international growth under his leadership. Barger also engineered the movement of the HAMC from crimes against public order to organized crime for profit.

Barger organized the HAMC like a traditional business with an organizational structure, including chapter and national positions of president, vice president, treasurer, intelligence officer, and sergeant in arms (security). Members pay fees, hold fundraisers, and also make money legitimately. They trademarked their images and make a significant amount of money selling trademarked merchandise like T-shirts and other branded gear. The Hells Angels are big business, and while exact numbers are difficult to attain for obvious reasons, it is thought that worldwide revenue is in the billions of dollars.

Today, the HAMC has over 2,500 members in over 200 charters across 29 countries and six continents. The Hells Angels' brand is so strong that they have actually become a business, formally incorporated in both the U.S. and Canada. Local, federal, and international law enforcement agencies allege that the Hells Angels are in the business of a range of illicit activity, including drug distribution, trafficking of firearms and stolen goods, prostitution, arson, robbery and other violence, extortion, and money laundering. In 2011, the State Department and the Department of Homeland Security added The Hells Angels to a list of criminal organizations that includes the Mafia, the Chinese Triads, and the Japanese syndicate Yakuza.

At the age of 77, Sonny Barger remains an active member of the Hells Angels in the Cave Creek Arizona Chapter since moving there from Oakland in 1998. In the interest of full disclosure, the Hells Angels claim they are just a group "of motorcycle enthusiasts who have joined to ride motorcycles together, organize social events, fundraisers, parties, and motorcycle rallies."

Lesson #1: Great Leaders Know They Don't Have All the Answers

"Leaders accept dissent. The tyrant goes it alone." –Sonny Barger

Modern Business Application

In any business organization, a leadership mistake may result in a financial loss, product failure, or employee defection. In Sonny Barger's world, a leadership mistake may result in people dying. These kinds of stakes certainly come with their own set of elevated pressures and challenges, and business can take a lesson from Barger's masterful leadership under extreme conditions.

Many leaders surround themselves with extremely bright and loyal followers who either are uncomfortable with disagreement or have chosen sycophancy from a political standpoint. Truly great leaders have the courage and confidence to surround themselves with the most honest people. Autocrats are always right be-

cause they insist they are. They rarely listen to anyone other than themselves anyway. Leaders listen and act accordingly.

We are taught that conflict is bad and should be avoided, and most certainly conflict can be destructive and create dysfunction in an organization. However, an environment that encourages new ideas, viewpoints and constructive criticism can turn conflict into a very powerful decision-making tool. This is not to say that a leader will always, or even occasionally, heed the advice of trusted advisors, but a great leader will welcome this discussion as a means to making the best possible decision for the organization. What frequently happens is that in the course of a healthy discussion with constructive dissent, differing perspectives will organically generate thoughts and ideas that would not have occurred to anyone on their own.

Leadership Nuggets

- Create an environment that encourages constructive dissent
- Don't be afraid to shake up the status quo
- 1 + 1 = 3
- Don't confuse honest dissent with disloyalty or subversion
- Diversity of opinion makes us smarter; groupthink makes us dumber
- Harmony is overrated
- Express disagreement respectfully, always
- Exercise an open mind; use the Socratic method to encourage critical thinking
- Ask for advice when you need it, and listen when it is offered
- Accept genuine dissent and criticism as it's intended and learn from it
- Remember that disagreement does not equal disloyalty
- Listen first, talk second
- Sometimes, the best decisions are made by coloring outside the lines
- Part of a leader's job is to play the role of devil's advocate
- Conflict is an unavoidable part of human nature; great leaders manage conflict to drive positive organizational improvement

Lesson #2: Create an Environment of Empowerment

"We learn from our mistakes—pure and simple. Most of us can only improve after we know what it feels like to have screwed up. You have to give your people the freedom to screw up." – Sonny Barger

Modern Business Application

This may seem like an odd statement coming from the leader of a band of ruthless criminals, but Sonny understood that ruling with an iron fist and instilling the fear of failure just wouldn't work. Whether you are leading a group of tough and violent bikers or a team of factory workers, to be productive and creative, people need the freedom to make their own decisions, even when they are wrong. Expecting people to come up with the only solution acceptable to the leader is not empowerment; it is called politics, which is counterproductive.

Leadership Nuggets

- Training and resources build the foundation for an empowered environment
- Don't micromanage; encourage empowerment but require accountability
- Clearly define roles and boundaries to avoid inefficiency through redundancy
- Challenge your employees, align on objectives, and then get out of their way

- Give credit where credit is due; taking credit for others' accomplishments will destroy an empowering environment
- Focus on results, not just actions; people must be made to feel like owners and entrepreneurs of their process, project, etc.
- Don't just celebrate success; also celebrate the employees who failed but took a calculated risk
- Delegation is not empowerment unless accompanied by the authority, resources, and support required to be successful
- Providing continual feedback, both positive and constructive, is a key building block for improvement and future success
- Remove barriers that limit employees to act in an empowered way
- Transparency builds trust; share pertinent information early and often
- Develop an empowering leadership style that nurtures, coaches, mentors, encourages and supports, even (especially) in difficult situations
- Training + trust = empowerment
- Demonstrate the calculated risk-taking behavior you want your teams to emulate
- Communicate the vision, goals, and objectives so that everyone involved is on the same page

In Closing

Being a Harley enthusiast for over a dozen years, I have been fascinated with the outlaw biker culture, in general, and Sonny Barger, in particular. During my research into the man and his exploits, it became clear to me that the leadership skills Sonny Barger has honed over the past half-century managing the international Hells Angels organization can be just as effective in today's business environment. **PCB007**

Steve Williams is the president of The Right Approach Consulting. To read past columns or contact Williams, click here.

Leaning on Leadership

by the I-Connect007 Editorial Team

It goes without saying that in times of crisis or great uncertainty, we often look to those in leadership positions to guide us and give us direction.

In the June 2020 issue of *SMT007 Magazine*, we published an interview with Tom Forsythe, executive vice president of KYZEN. In this conversation with Barry Matties and Nolan Johnson, Forsythe shares his insight on leadership and what he believes makes a good leader.

Read the entire interview here.

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New Laser Method for PCB Depaneling Increases Process Utilization

Article by Frank Gäbler
COHERENT INC.

Technological changes in the materials, thickness, and composition of PCBs are motivating a move away from traditional mechanical cutting and depaneling methods toward laser-based processes. But not all lasers for PCB depaneling are created equal. There are significant differences among various lasers in cut characteristics and quality, specifically in terms of the heat-affected zone (HAZ).

This, in turn, affects process utilization since it determines how closely circuits can be placed on a PCB, and can also impact circuit functionality and downstream processes like waterproofing or EMI shielding. This document presents a new nanosecond laser and associated cutting process developed at Coherent Inc. that enables laser depaneling with substantially reduced HAZ compared to other currently available products.

Why Laser Cutting?

The market increasingly demands physically smaller and thinner PCBs, which offer greater functionality and improved energy efficiency. Manufacturers must deliver all this in a highly competitive cost environment. In terms of construction, this has meant greater use of thinner traditional boards, wide-scale implementation of flex circuitry, thicker conductive layers, and increased utilization of low-k dielectrics (the latter especially for 5G technology). One way to manage cost is through improved process utilization. Specifically, this means placing boards closer together on a panel to increase yield.

In terms of cutting and depaneling, all this necessitates increasingly narrow kerf widths and higher dimensional accuracy for the cutting process. The closer physical proximity of the cut to the functional areas of the PCB also means that the cutting process must not affect the surrounding material or circuitry, whether due to mechanical stress or heat. Another requirement is minimal production of debris, which might require a subsequent cleaning step.

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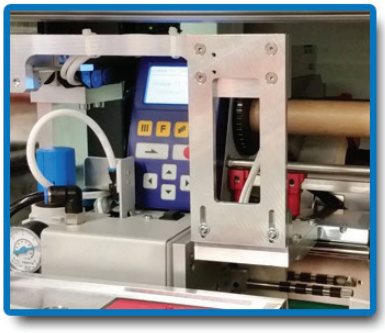

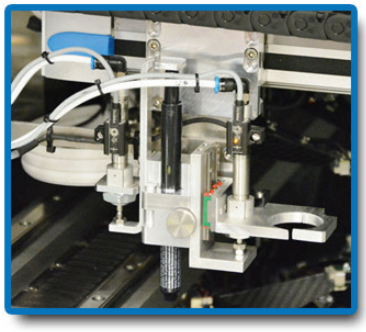

Highlights:

- Small footprint (6 square meters)
- Dual shuttle pick & place automation
- High accuracy combined with high test speed
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All these constraints make traditional mechanical PCB depaneling methods—including routers, saws, die-cutting, punching, scoring, and pizza-cutting, etc.—less practical and less cost-effective. This impels a move toward laser cutting, which offers substantial benefits in virtually every one of the areas previously mentioned, although usually at the expense of reduced cutting speed.

Why UV Laser Cutting?

Laser depaneling has, of course, been in use for some time. But it's important to understand and differentiate the various technologies referred to by this terminology. The original implementations used CO_2 lasers that emit in the far infrared. This technology cuts by heating the bulk material, which results in a significant charring and heat-affected zone (HAZ). Also, compared with shorter, ultraviolet (UV) wavelengths, this long wavelength cannot be focused to a small spot size, meaning it produces a larger kerf width.

More than a decade ago, the diode-pumped solid-state (DPSS), nanosecond pulse width, frequency-tripled laser emerged as a viable source for PCB depaneling. It offers ultraviolet (355 nm) output with sufficient pulse energy to enable material removal through a relatively "cold" ablation process—that is, one with a much smaller (but still noticeable) HAZ than the CO_2 laser, and also substantially less production of debris and recast material. The pulse energy and repetition rate of commercially available sources enable cutting at economically viable feed rates, although not as fast as the CO_2 laser. The primary benefits of UV technology are summarized in Table 1.

Advantage	Explanation
Mechanical Precision	Cutting is performed with very high dimensional accuracy and precision, along with a narrow kerf width. This enhances the ability to cut near active features on the PCB.
Stress-Free	The cutting process itself is vibration and friction-free and doesn't produce mechanical deformation or delamination of the PCB or introduce residual stress. This avoids the introduction of subsequent failure mechanisms through the cutting process.
Low HAZ	The inherently "cold" nature of the UV laser ablation process prevents bulk changes to the substrate and avoids the melting of circuit traces which might lead to a short circuit. The minimal debris creation of the process eliminates the need for follow up cleaning steps and again minimizes the possibility of subsequent circuit failure. It even permits depaneling of assembled boards.
Operational Flexibility	The laser beam is an inertia-free tool that moves under computer control, and whose power can be rapidly varied. This delivers several advantages. First, virtually any shape can be cut, freeing PCB designers from the form factor limitations imposed by traditional cutting methods. Next, cutting patterns can be varied through software control, enabling rapid changeovers in production, and also making short-run manufacturing cost-effective. Finally, varying laser power enables a single tool to perform many other operations besides just cutting. These can include marking/engraving and metal ablation.
Material Independent	Ultraviolet light is strongly absorbed by nearly all PCB materials. This makes the process compatible with virtually every PCB construction, including traditional copper-clad flex laminate, flex materials (even those incorporating thicker conductive layers), and various low-κ dielectrics.

Table 1: Primary benefits of UV technology.

Advances in UV Laser Depaneling

While laser depaneling clearly delivers numerous benefits, PCB manufacturers are already pushing this technology to the limits to meet ever more stringent size, materials, and cost challenges. In particular, achieving further reductions in HAZ and debris formation, and improving the cut quality obtained with nanosecond pulse width UV DPSS lasers, is an active area of development.

To aid in this effort, applications research at Coherent Inc. has explored the outcomes and process space of using a nanosecond pulse width, high-pulse energy, UV DPSS laser (AVIA LX) for cutting a variety of PCB materials and material combinations. Based on this work, the Coherent team developed a new PCB cutting method that has already proven to deliver a reduced HAZ, a higher-quality cut edge, reduced kerf width, and increased production throughput.

One key element of this technique is a proprietary method for controlling the timing and spatial positioning of laser pulses delivered to the work surface in such a manner that heat buildup is avoided. Because thermal damage is absent in this approach, it's possible to utilize a laser with substantially higher pulse energy when cutting thicker materials (1 mm and above).

The advantage of a higher pulse energy is that it eliminates the need to employ the traditional scheme used for cutting thicker materials. Specifically, this involves making a series of laterally displaced scribes to produce a "v-groove." The "v-groove" geometry is necessary to avoid clipping the beam as it penetrates further into the material when making a high aspect ratio cut. This would reduce its power and thus limit ablation efficiency. But the AVIA LX, coupled with this novel pulse timing approach, can utilize pulse energies as high as ~400 µJ to repeatedly scribe along the same line (no lateral displacement, or "v-groove"). The result is faster cutting and significantly reduced kerf width.

Higher pulse energy also increases the laser focus tolerance at the work surface. Specifically, when using a lower-pulse energy laser, it is necessary to shift the focus of the beam as the material is penetrated so that the minimum focused spot size is always maintained precisely at the depth at which cutting is occurring. This is necessary to achieve sufficient laser fluence to get above the material ablation threshold. However, doing this in practice requires either physically shifting the PCB up, which slows the process, or employing a three-axis scanner (one which has a focusing capability), which increases equipment cost and complexity.

The higher pulse energy of the AVIA LX makes it possible to simply focus the laser at a point mid-way through the PCB and perform cutting. This is because there is sufficient laser

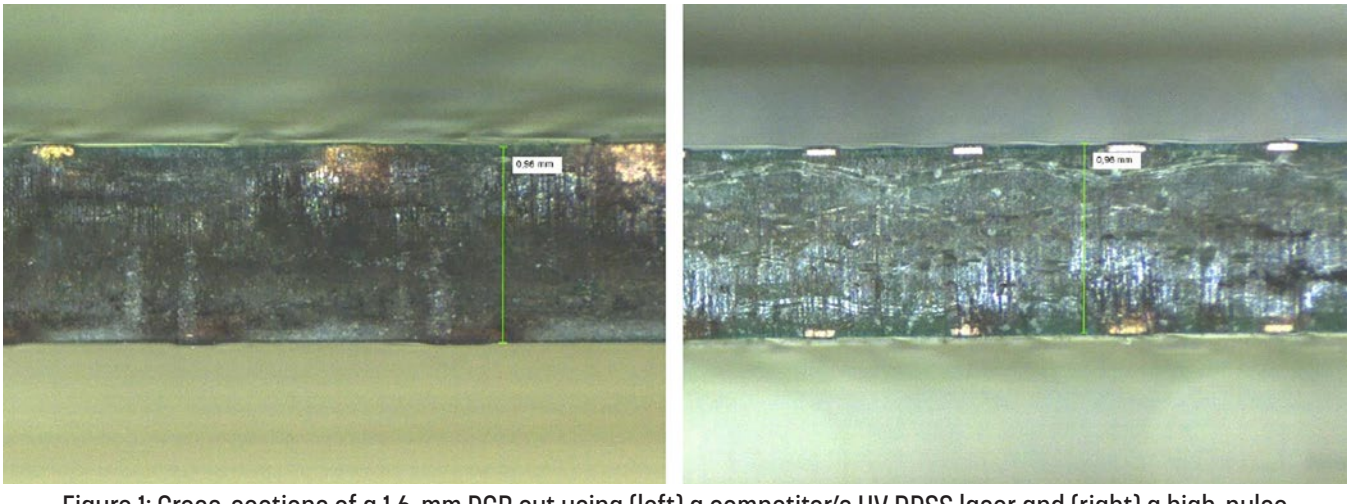

Figure 1: Cross-sections of a 1.6-mm PCB cut using (left) a competitor's UV DPSS laser and (right) a high-pulse energy UV DPSS laser (AVIA LX) employing the Coherent technology. The latter delivers a better quality edge, and much cleaner cuts of the copper traces.

fluence for ablation even well out of perfect focus for the laser. The benefits are faster cutting and reduced system complexity.

An example of the improvements achieved are shown in Figure 1, which compares cuts in a 1.6-mm PCB with copper traces, made using the type of UV DPSS laser currently commercially available for this application versus the same material processed using this new approach. The board processed with this technique shows a cleaner cut edge and substantial improvement in the cut edges of the copper traces.

Figure 2 demonstrates the reduction in kerf width achieved utilizing this method.

Figure 3 shows how it enables cutting of multilayer PCBs (with glass fiber layers) with minimal debris, narrow trench width, and substantially reduced HAZ.

In the past, laser cutting of polyimide and EMI shield foil produced some delamination at the cut line due to the wide HAZ. In this case, it's necessary to use lower pulse energy to avoid damaging the material. But the same pulsing approach is utilized to eliminate heat buildup and delivers the same benefits of reduced HAZ

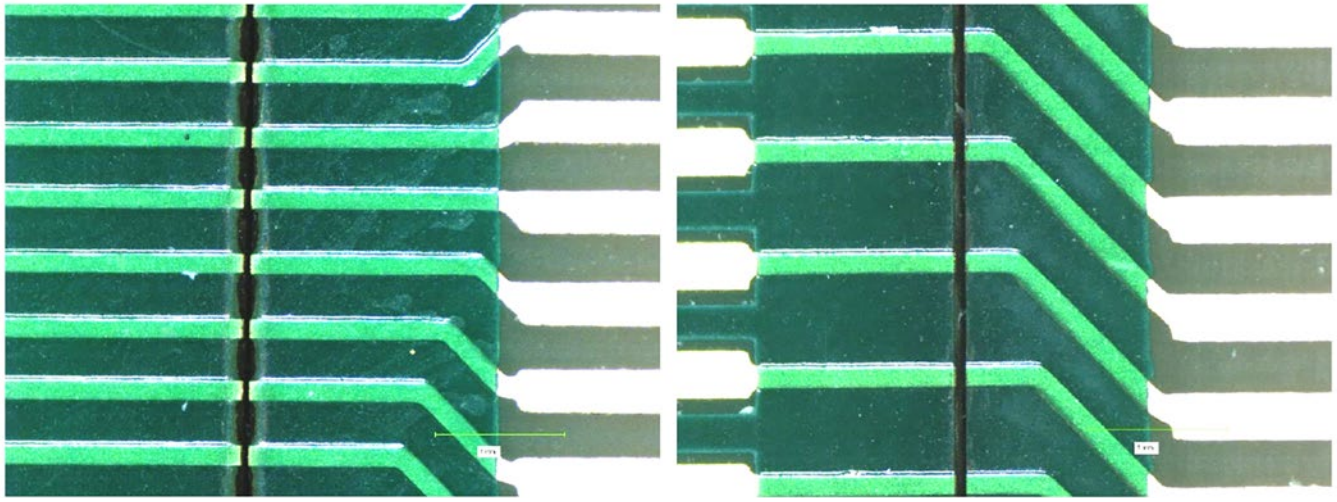

Figure 2: Top views of a 0.95-mm PCB cut using (left) a competitor's UV DPSS laser and (right) a high-pulse energy UV DPSS laser (AVIA LX), which yields a narrower and more consistent kerf.

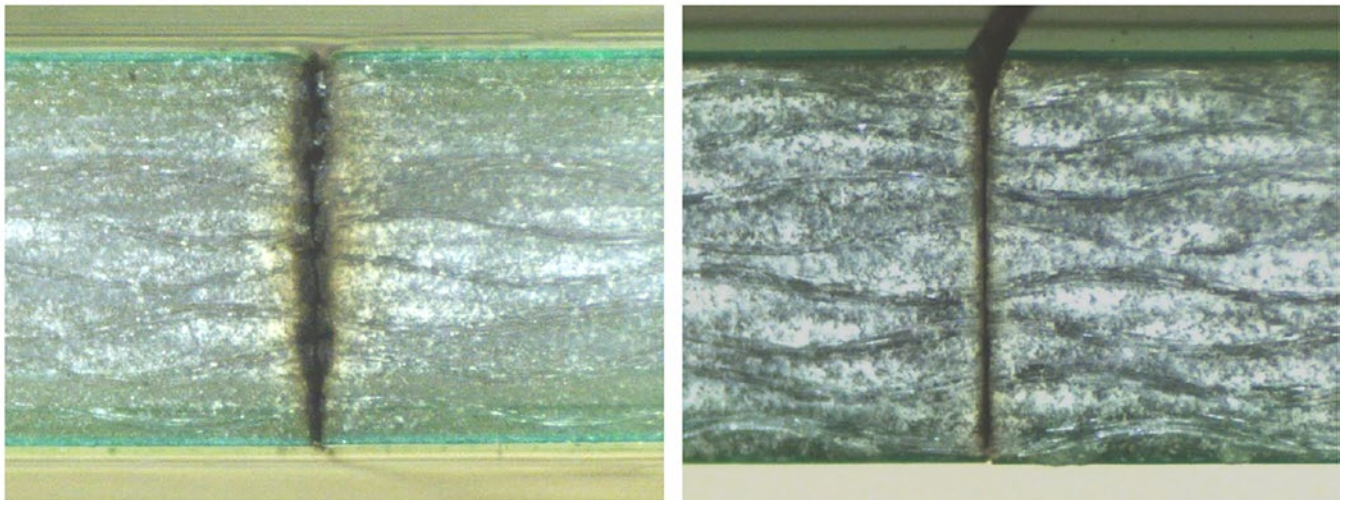

Figure 3: Cross-sections of a 1.6-mm, multilayer PCB (with glass fiber layers) cut using a (left) a competitor's UV DPSS laser and (right) a high-pulse energy UV DPSS laser (AVIA LX) the new Coherent method. This delivers a more narrow trench channel and smaller HAZ.

Plating Simulation Raises Yield and Profitability

What if the PCB pre-production engineer could upfront identify problem areas for the pattern plating, and apply auto-intelligent copper balancing as part of the CAM process to provide a right-first-time panel layout for production?

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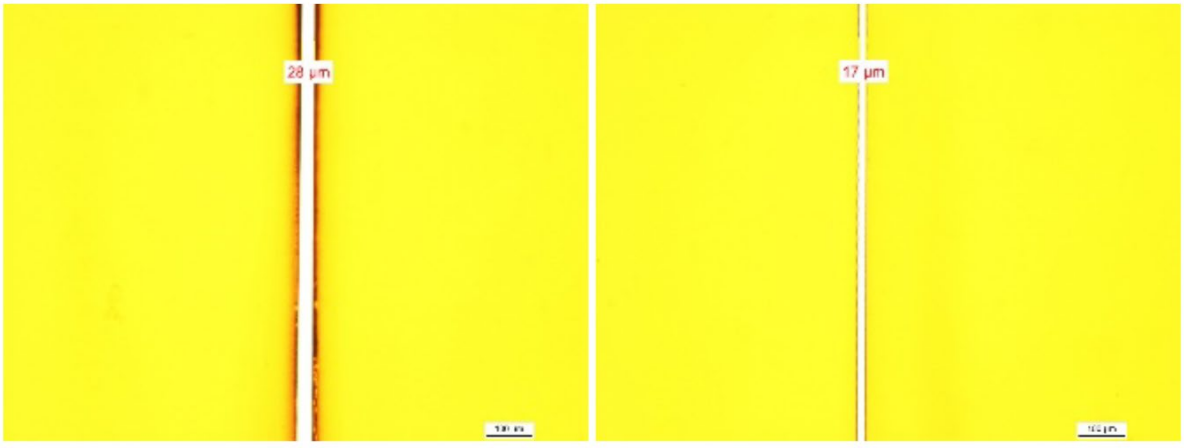


Figure 4: Top view of a 100-µm polyimide foil shows a cutting result achieved with a competitor's UV DPSS laser on the left, having a wide cut kerf and a sizeable HAZ. The cutting result on the right was achieved with the Avia LX UV DPSS laser. This delivers a narrower trench channel and smaller HAZ.

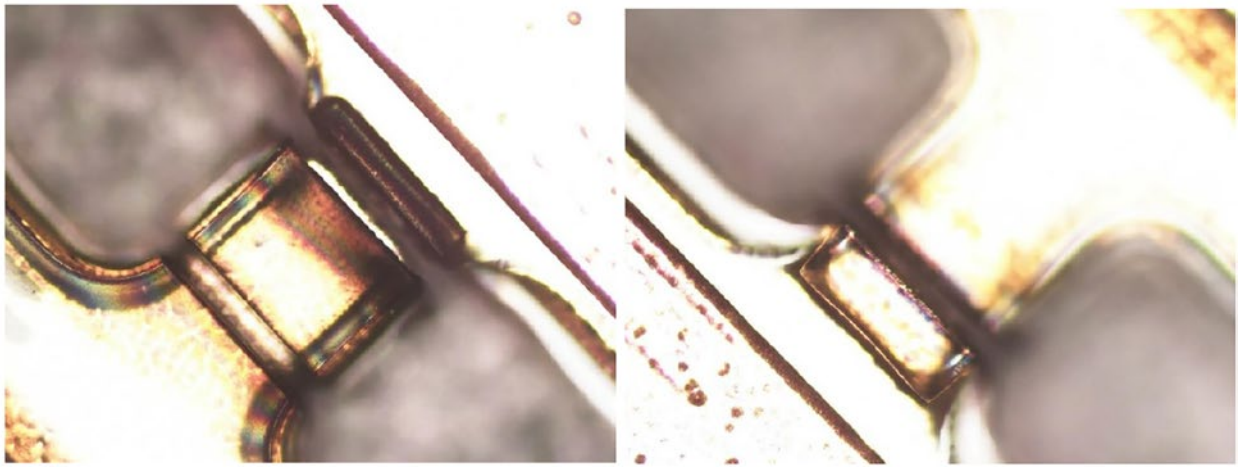


Figure 5: Top view of 0.13-mm FPCB cut using a (left) a competitor's UV DPSS laser and (right) a high-pulse energy UV DPSS laser (AVIA LX). This produced a much smaller HAZ and achieved this at a higher cutting speed (13 mm/s compared to 11mm/s).

and kerf width. This reduces production costs by enabling downstream production processes to achieve higher yields (Figure 4).

Finally, the reduced HAZ and increased throughput possible with the Coherent pulsing method, but with lower pulse energy when processing a flex PCB, are illustrated in Figure 5.

Practical, High-Pulse Energy DPSS UV Lasers

For traditional, thick PCB materials, implementing the Coherent pulse control method in practice requires a UV DPSS laser source having higher pulse energy than previously commercially available. To meet this need, Coherent developed the AVIA LX, a 20 W (at 355 nm), solid-state, nanosecond pulse width laser, which can produce a pulse energy of up to 500 µJ.

This laser was specifically designed to enable high throughput, high-quality PCB depaneling. It combines several technological advances in design and manufacturing to deliver this high energy output along with an unmatched combination of high reliability, superior performance, and low cost of ownership.

In particular, this product leverages the extensive experience at Coherent in producing reliable, long-lifetime lasers with UV output.

The non-linear (frequency tripling) crystals used in it are produced within Coherent, pro-

viding direct control over the quality and optical characteristics of this critical component, and enabling us to achieve longer lifetime, improved performance and reduced cost of ownership. Lifetime is further maximized by the use of a built-in crystal shifter which contains a map of the actual crystal in the laser, and the location of 20 pre-qualified third-harmonic generation spots (with over 1000 hours lifetime per spot) within it.

Contamination of the optics is a key limiting factor in the lifetime of UV lasers. AVIA LX lasers are manufactured in a cleanroom, and the internal optics that are directly exposed to UV light are contained within a PureUV-sealed compartment to prevent contamination in actual use. This maximizes lifetime and service intervals.

Furthermore, this laser is based on an extremely robust industrial design, which has been validated by HASS and HALT (high accelerated life testing). In HALT prototypes are iteratively tested to destruction, re-designed, and retested to eliminate any inherent weaknesses. Highly accelerated stress screening (HASS) then stresses actual production units beyond their specified operating environment. This protocol screens out any deficiencies in manufacturing and packaging. The result is unmatched product reliability and lifetime.

AVIA LX is also designed with ease-of-integration and ease-of-use in mind. For instance, integration is simplified using built-in control electronics and an integrated beam expander. The use of water cooling maximizes lifetime and pulse-to-pulse stability, even when operating at high power.

Conclusion

The Coherent AVIA LX laser, together with novel pulse control technology, has demonstrated superior results for PCB depaneling as compared to traditional mechanical processes, and even previously available nanosecond pulse width UV DPSS laser sources. It should prove a useful source for a variety of the fabrication processes required for next-generation microelectronic devices, including cutting of traditional PCBs and flex circuitry, SP cutting and trenching, and EMI shielding cutting. **PCB007**

Frank Gäbler is director of product marketing at the DPSS Business Unit of Coherent in Luebeck, Germany. He holds a Dipl.-Ing. manufacturing technology degree from FhG, Institute of Lasertechnik, RWTH in Aachen, Germany, and has over 25 years of experience in industrial applications of laser technology. He can be reached at frankgaebler@coherent.com.

Don't Be a Boss: Be a Leader

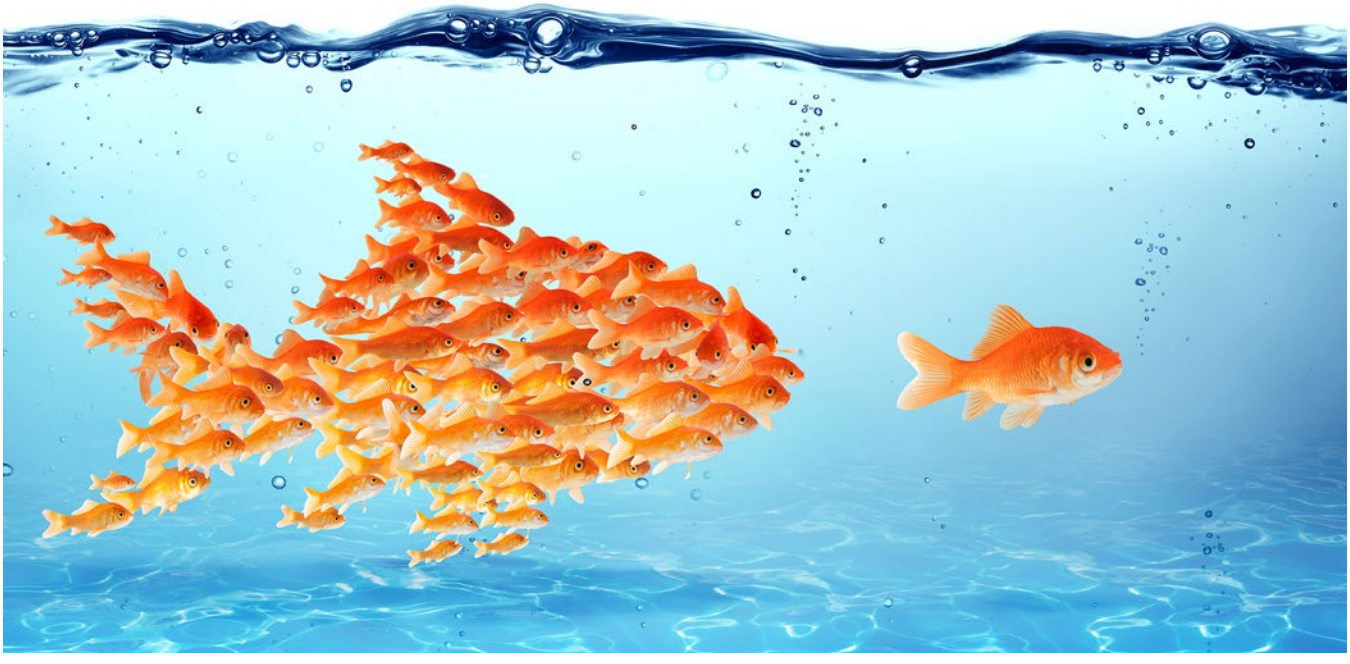
Testing Todd
Feature Column by Todd Kolmodin, GARDIEN SERVICES USA

Leader, boss, follower, collaborator, teammate: these are terms we have heard often during our lifetime. The term leadership is used in many different ways. We hear it in marketing all the time as companies use phrases such as, "We are the leader in XYZ," or, "We are leading the way." But this shouldn't be confused as leadership or as actually being better. In reality, these terms break down to, "We are first," or, "We are ahead of the others." It doesn't necessarily mean that they are better. Think about that the next time you hear it, and how it is being used.

Leadership—or being a leader—is one of the most difficult qualities we can master. Many cannot, or would rather not, and there is nothing wrong with that. In fact, many of us do very well as followers, collaborators, and teammates. It makes sense; if everyone was a leader, nothing would get done. Think about it.

However, we have all seen the misconceptions. For example, just because someone is a "boss," it doesn't make them a "leader." Yes, they give you tasks, and they answer to the next tier of management. You routinely perform your daily tasks and may not even see this generic "boss" regularly. This could go on for years. But if something goes wrong, we know what goes downhill. The generic "boss" is all over you and your co-workers for what you messed up. In many situations, this generic "boss" is not well-liked.

Now, a leader is a very different person. They are very easy to identify and we see them all the time because they stand out. Why is that? Because a leader takes the time to know their team, looks for the individual strengths and weaknesses of the team, and develops strategies or plans to better the team. The truth is, we seek out leaders be-



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cause they interact with their team, nurture the strengths of each individual, and—based on abilities—adjust the team for the greater benefit of the whole.

When a true leader is involved, you will usually see smoother-running operations, lower absenteeism, and a higher sense of morale. Leaders strive to develop the skills of their teams, consider each individual's skill sets, and encourage those skills to grow. Many times, a leader will teach and train their team to levels matching their own. They are not worried about job mortality—rather they consider the overall goal of the team and their success. With strength and depth, the team survives regardless of the loss of an individual or two. The team can adjust and still succeed. A minor imbalance does not put the team in turmoil. That is a leader.

If you work for a leader, you will notice other distinguishing qualities. For example, if something goes wrong—and they do, at times—your leader will be the first line of defense from "upstairs." Unlike the generic "boss," your leader will represent you as part of the team. They will keep your issues private, seek to coach you through the problem and resolve to solve the issue together. If the problem was systemic in the department, the leader reviews the causes and seeks to correct it. Another major attribute in strong leadership is a lack of ego; rather, recognition is the reward from others for good leaders and those who embrace this discipline.

Be safe, wear your mask, and be good humans. **PCB007**

Todd Kolmodin is VP of quality for Gardien Services USA and an expert in electrical test and reliability issues. To read past columns or contact Kolmodin, click here.

Adhesive Film Turns Smartwatch Into Biochemical Health Monitoring System

UCLA engineers have designed a thin adhesive film that could upgrade a consumer smartwatch into a powerful health-monitoring system. The system looks for chemical indicators found in sweat to give a real-time snapshot of what's happening inside the body. A study detailing the technology was published in the journal *Science Advances*.

Smartwatches can already help keep track of how far you've walked, how much you've slept, and your heart rate. Newer models even promise to monitor blood pressure. Working with a tethered smartphone or other devices, someone can use a smartwatch to keep track of those health indicators over a long period of time.

What these watches can't do, yet, is monitor your body chemistry. For that, they need to track biomarker molecules found in body fluids that are highly specific indicators of our health, such as glucose and lactate, which tell how well your body's metabolism is working.

Researchers engineered a disposable, double-sided film that attaches to the underside of a smartwatch. The film can detect metabolites and certain nutrients that are present in body sweat in very tiny amounts. They also built a custom smartwatch and an app to record data.

"The inspiration for this work came from recognizing that we already have more than 100 million smartwatches and other wearable tech sold worldwide that have powerful data-collection, computation, and transmission capabilities," said study leader Sam Emaminejad, an assistant professor of electrical and computer engineering at UCLA.

(Source: UCLA)

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Supplier Highlights

Nano Dimension Appoints LM Instruments to Market PCB/Hi-PEDs 3D Printers ▸

Nano Dimension Ltd., an additively manufactured electronics (AME)/printed electronics (PE) provider, signed an agreement with LM Instruments, which will represent Nano Dimension in the Mid-Atlantic States by marketing its 3D fabrication machines for high-performance electronic devices (Hi-PEDs).

Taiyo America Announces New Technical Sales Engineer ▸

Taiyo America, Inc. is pleased to announce Kate Han as technical sales engineer for the Western Region of the United States, effective July 1, 2020.

Insulectro to Distribute Kemmer Praezision Drill and Routing Products in North America ▸

Insulectro, distributor of materials for use in the PCB and printed electronics industries, announced it would distribute Kemmer Praezision GmbH drills, endmills, and routers to augment its drill room offerings.

MacDermid Alpha Releases Systek UVF 100: 2 in 1 RDL Simultaneous Copper Via Filling and Fine-Line Plating for IC Substrate Manufacturing ▸

MacDermid Alpha Electronics Solutions, a global leader in specialty materials for electronics, announced the release of Systek UVF 100, the newest release in the Systek family of IC substrate manufacturing solutions.

Arlon EMD Launches New Website ▸

Arlon EMD, a specialty electronics material manufacturer, based out of Rancho Cucamonga, California, announced the launch of its new website.

Avishtech Announces Gauss Stack and Gauss 2D PCB Modeling Software ▸

Avishtech Inc., a simulation-based design software provider headquartered in San Jose, California, announced the introduction of its Gauss suite of software for the design and simulation of PCB stackups and transmission lines used in PCBs and semiconductors.

Rogers Corporation's Advanced Connectivity Solutions Business Adds North America Distribution Channel ▸

Rogers Corporation's Advanced Connectivity Solutions (ACS) business announced the introduction of a new distribution channel in North America with the addition of Bonding Source, a Krayden Company, to their sales and service team effective July 6, 2020. ACS provides global customers with high-performance and high-reliability RF material solutions.

SCHMID Group Will Relocate Its Main Chinese Plant ▸

The SCHMID Chinese main factory will move out of the free trade zone in Zhuhai to a newly constructed factory in Zhongshan, about 40 kilometers away. The move will take place over a period of 2–3 months to avoid any disruption to production.

Nano Dimension's President and CEO Invests in the Company ▸

Nano Dimension Ltd., an additively manufactured electronics (AME)/printed electronics (PE) provider, announced that Yoav Stern, who joined the company as president and chief executive officer in January 2020, is purchasing from the Company a Series A warrant to buy up to 6,880,402 of the Company's ADSs for an aggregate exercise price of $5,160,302.

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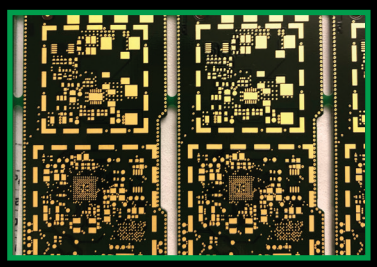

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- IJR-4000 LW100
  - Rigid White Legend Ink Cured by LED
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Creating Energy in Leadership:
IPC Opportunities for Emerging Engineers

Article by Teresa Rowe
IPC—ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

Let's face it. We are all getting older, and as we age, so does our industry. With the advent of electronics, the adage "it's a small world" came to mean something more, and with that change came the realization that time doesn't stand still. We must plan for the future now. What happens when our technical experts open the next chapter of their lives? Will we, as Stevie Nicks asks in "Landslide," "Be able to sail through the changin' ocean tides?"

To stem the approaching gap created by the loss of subject matter experts to vital industry programs, IPC introduced its Emerging Engineer Program in 2016. In this program, IPC pairs someone in the first five years of his or her career in the electronics industry with a mentor from industry experienced in IPC programs and activities. Over the course of three years, the emerging engineers are given access to IPC professional development courses, technical presentations, standards development activities, industry equipment and service providers, and, most notably, the subject-matter experts that make our industry what it is today.

In their first year of the program, the emerging engineers are required to participate in a series of events centered around IPC APEX EXPO, IPC's award-winning industry conference and exhibition. Since this is the largest IPC annual event and the place where the industry comes together, the emerging engineers are tasked with developing their professional knowledge by attending educational courses and presentations, participating in standards development task groups, and meeting exhibitors representing the latest innovations the industry offers. They also have the opportunity to meet the brightest and best in the industry through networking events.

Second- and third-year emerging engineers are presented with more challenging activities, including taking on action items during standards development meetings, leading standards development meetings, and working on special projects. One such special project is the collection of tribal knowledge where emerging engineers document the information the experts live and breathe as part of the fabric of their lives.

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As we approach 2021 and the program's fifth anniversary, we must reflect on how IPC's Emerging Engineer Program mission is going and what's next. Today, more than 50% of the emerging engineers who started the program before 2020 are in standards development task group leadership roles, and some have moved into managerial positions in their organizations, are encouraging others to participate in the Emerging Engineers Program as mentors, and remain strong program advocates. They often request additional mentees, as they recognize the importance of the mission.

In 2020, the first-year class size grew by 450%, and some of these emerging engineers are already moving into leadership roles. The phenomenal growth of the program is a testament to our industry's recognition of the need for long-term planning and its willingness to invest in the future. Many of these new emerging engineers are process and design engineers hungry to soak up what the industry has to offer. The college and university student participants also bring the same enthusiasm with them, and collectively, there is a buzz when they walk into any event or activity. This is the future.

Christina Trussell, Blue Origin, joined the Emerging Engineer Program in 2020, and she hasn't looked back. While attending standards development meetings at IPC APEX EXPO 2020, she quickly started contributing to the development of IPC's cable and harness standards. Through her work ethic and commitment to the projects assigned, she is now a vice-chair for the task group responsible for the maintenance of a space addendum. This positions her to gain more leadership experience as she continues her professional journey.

Since its inception, IPC recognized that the Emerging Engineers Program must give college and university students an opportunity to participate. Many of us remember how taking on such an extracurricular activity gave us the edge on job applications and made us a shining star in our first jobs—but it can also be a burden. Attending IPC APEX EXPO means time away from class, and southern California isn't necessarily a short commute from home for many of our student participants. IPC addresses these concerns by providing students with the funding to make the trip to IPC APEX EXPO and support to approach their academic advisors.

Arvind Srinivasan Karthikeyan, Ph.D. student and graduate research assistant at Auburn University, joined the program earlier this year as an emerging engineer. Arvind's enthusiasm for the program was evident when he stated, "I'm elated at being offered this great opportunity." He further noted that being selected to the Emerging Engineers Program is "icing on the cake" at this time in his career. He found not only a place to strive to excel but also a place to learn from others. Alongside his mentor Dr. Milea Kammer, a Honeywell Aerospace and an Emerging Engineer Program graduate from an earlier class, they developed a schedule for him that allowed him to pursue his interests while stretching to new heights.

Some of the program's previous student participants are now working in the industry and often speak of the value of the program to their careers. Tayler Swanson, Digital Instruments Inc., was a student at Rochester Institute of Technology when he joined the Emerging Engineer Program in 2017. Tayler is a strong advocate for the program and is always willing to speak to students to encourage them to participate. Through his advocacy, he is inspiring others to join our industry, and meet the opportunities and the challenges the industry has to offer in a face-to-face, collaborative forum.

To build on this success, IPC is taking the program to the next level for students. The IPC Education Foundation (IPCEF) is launching a call to action for all IPC student members and will offer an opportunity for five students

Paige Fiet

to participate in the program with funding awarded through the IPCEF. Students will apply for the program through the IPCEF website and be asked to provide their resume as part of the application process.

Those selected will become part of IPC's Emerging Engineer Program with full benefits. Included in the emerging engineers selected from IPCEF student members in 2021 will be Paige Fiet, senior at Michigan Technological University and the IPC's Board of Directors student member liaison. Earlier this year, IPC announced Paige was elected by her peers involved in IPC Student Chapters to serve a one-year term in this role. She will bring a fresh and contemporary voice that will provide invaluable insight into IPC's education initiative.

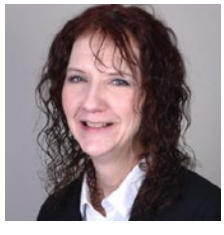
The next step in Paige's journey as an emerging engineer will bring her in contact with her mentor in advance of IPC APEX EXPO, where she will have an opportunity to select and schedule her activities to maximize her experience. Mentors come from many different backgrounds and experiences, from management to engineering, and emerging engineers are finding that these vast differences help them to see the industry in a different and exciting light. Knowing that Paige is interested in engineering and corporate management provides the keys to a successful mentor match and one that IPC does not take lightly. The four IPC student members who join her in the program in 2021 will experience the same level of commitment from IPC staff.

As we plan for the upcoming year and beyond, IPC is working on new things for the program. Each emerging engineer is required to provide an annual report on their experience as a participant, and IPC uses their feedback to improve the program. For example, in addition to introducing the tribal knowledge project, we have added several networking opportunities where program participants can meet fellow emerging engineers. We also created a space on IPC Works, IPC's online standards development platform, for them to collaborate and share. It is important to remember the people the emerging engineers meet, and the professional network they build will serve them throughout their entire career.

Without a doubt, IPC's Emerging Engineer Program is growing by leaps and bounds, and there are new surprises and twists right around the corner. One only has to mention the program to a returning emerging engineer and there is an excitement to get started. They look forward to it from year to year, and even when they complete the requirements, they are ready to take on new challenges. The success of any program is often found in the program's bedrock and in the community around it. IPC's Emerging Engineer Program provides the platform for tomorrow's industry leaders to gain confidence and knowledge to grow both personally and professionally.

Even as it evolves, IPC's Emerging Engineer Program remains true to its roots. From the summer of 2015 when it was a concept and a few words on an Excel spreadsheet of ideas to today, where IPC is looking at opportunities to bring the program to local markets in Europe and Asia, it has blossomed into a truly inspiring program for IPC to invest in the future of our industry. In these strange times, where we are redefining "normal," we need to embrace the future so that we can sail through the changes facing our industry and not let a landslide bring it down.

If you are interested in learning more about IPC's Emerging Engineer program and applying, please visit ipc.org/emerging-engineer. Students are encouraged to visit ipcef.org as well. The deadline for applications to start the program in 2021 is November 20, 2020. **PCB007**



Teresa Rowe is senior director, assembly and standards technology, at IPC.

A Process Engineer's Guide to Electroless Copper

Trouble in Your Tank

by Michael Carano, RBP CHEMICAL TECHNOLOGY

Introduction

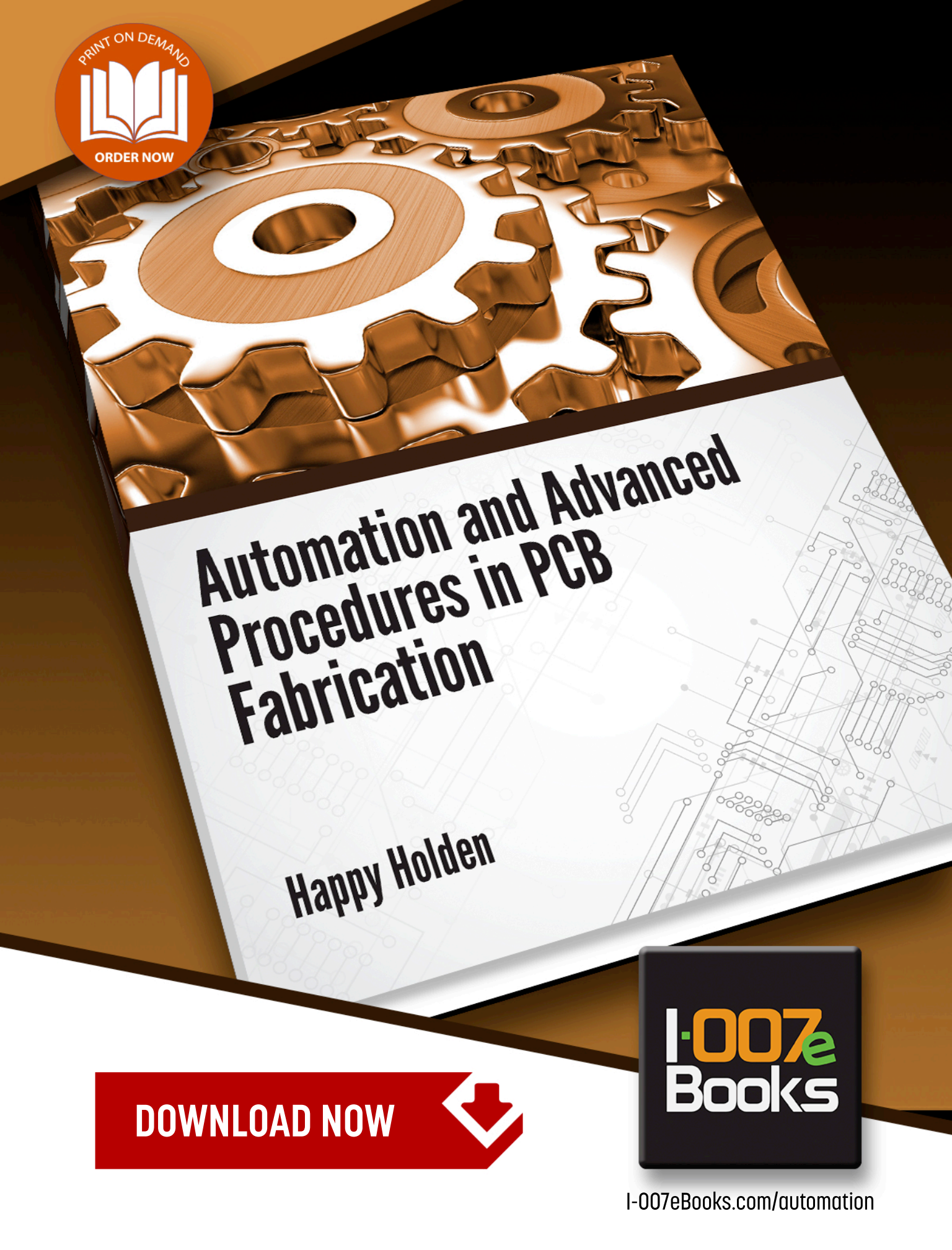
The electroless copper metalization process (also known as plated through-hole or PTH) is a system of multiple process steps with the expressed goal of producing a continuous, void-free, and tightly adherent deposit through the vias and surface of the circuit board. While these various steps in the process all play a role in the successful operation of the process, the subject of this column is on the electroless copper plating solution itself. The discussion will focus on a copper formulation based on copper chloride, EDTA, formaldehyde, and sodium hydroxide.

The Autocatalytic Copper Process

Electroless copper plating solutions by their very nature are thermodynamically unstable. There are several side reactions that take place in the course of the everyday operation of the electroless copper plating solution. The stability of the plating solution requires diligence on the part of the process engineer. For copper ions to be reduced to copper metal, the inherent instability of the electroless copper solution is expected. However, the stability of the solution must be controlled to prevent deleterious defects, including interconnect defect (ICD), excessive plating thickness, and excessive stress of the copper deposit. Deposit stress alone can lead to copper blistering from the hole wall and separating from the internal layer copper interface.

A few key aspects of stability include the following:

- Stability will decrease as specific gravity increases.
- Stability will decrease as the temperature increases.
- Although stability is improved by running at a lower temperature, the rate is sacrificed to the point where a medium deposit bath is unattainable.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- Low loading with intermittent use (< 3 sq. ft./gal/shift) will lower the amount of active stabilizer in the bath and decrease stability. When this occurs, excessive copper loss is expected.
- The specific gravity of the electroless copper plating solution should be monitored each shift. As specific gravity increases, copper loss or plate-out increases (Figure 1). Note: Consult the supplier of the particular electroless copper process in use. There may be differences in specific gravity recommendations.
- The process tank containing the electroless copper solution should be etched out every few weeks, depending on operation and maintenance. Copper deposits that form on the tank walls and heaters due to normal plate-out must be removed as part of process maintenance. It is good practice to have two electroless copper plating tanks in the PTH line. As one goes offline for maintenance, the second one is ready to go.
- Sporadic short-term fluctuations in temperature have no adverse effect on stability.

Electroless Copper Solution Life

As much as we would like them to, plating solutions do not last forever. There are numerous factors that negatively impact the useful life of a plating solution. The electroless copper solution is no exception.

Figure 1: Example of copper plate-out.

Factors affecting electroless copper solution life may include:

- Tank condition (is there copper plate-out on the tank walls?)
- Bail-out schedule
- Filtration (are the copper particles being effectively removed)
- The amount of time spent operating bath out of chemistry and temperature specifications
- Extended idle periods at temperature and concentration
- Improper bath turnover from low loading
- Poor rinsing/drag-in of catalyst and accelerator
- The buildup of formate and other by-products

The bath ages with the buildup of formate, carbonate, and chloride as by-products. These by-products are measured with specific gravity but are not individually differentiated. Chloride increases linearly with the consumption of cupric chloride (if a copper sulfate electroless process is in use, by-product build up rates will be different). Carbonate is another by-product and is formed as carbon dioxide in the air reacts with sodium hydroxide in the bath. Assuming air flow is constant, carbonate will also build linearly. Formate also tends to grow linearly at low levels through several reactions:

1. $2HCHO + OH^- \rightarrow CH_3OH + HCOO^-$ (Cannizzaro reaction)
2. $2Cu(II)\ (chel) + HCHO + 5OH^- \rightarrow Cu_2O + HCOO^- + 3H_2O + 2\ (chel)$
3. $2HCHO + OH^- \rightarrow HCOO^- + H_2$

Excessive formate is known to promote the creation of additional formate through the breakdown of formaldehyde resulting in the generation of copper(I) oxide (reaction 2), which will, in turn, create copper dust through the following reaction:

4. $Cu_2O + H_2O + (chel) \rightarrow Cu^o\ (dust) + Cu(II)\ (chel) + 2OH^-$

Therefore, as conventional electroless copper solutions age with increased metal turnovers, and normal plating solution age, there is a higher formate buildup. Therefore, there

will be increased instability in the copper plating solution due to the accelerated formaldehyde breakdown rate. When this occurs, the go-to tactic is to bail out a portion of the working plating solution and replace that with fresh electroless copper components. This reduces the specific gravity to a lower level. Also, keep in mind that the formation of carbonate and formate is not linear. And the buildup is not easily predicted.

Again, unlike electrolytic plating solutions, electroless copper is thermally unstable. While suppliers have worked diligently to ensure reasonable stability of the copper process, by-product buildup, catalyst drag-in, and other factors will create conditions ripe for plate-out and copper loss. Drain the boards before entry into the electroless copper solution. Water from rinses may contain both organic and inorganic contaminants. Follow recommended times of immersion in all proprietary pre-plate solutions and rinse thoroughly after each step. Palladium drag-in to electroless copper may cause instantaneous solution decomposition.

Always strive to use best practices when it comes to rinsing, filtration, and monitoring of any contaminants. **PCB007**

Michael Carano is VP of technology and business development for RBP Chemical Technology. To read past columns or contact Carano, click here.

A Ticketmaster for Science Seminars

One of the perks of an academic's pre-pandemic life was the chance, at least once a week, to sit in on cutting-edge research presented by invited experts from around the world.

The COVID-19 pandemic has put a pause on seminars hosted physically on university campuses. But in mid-March, a small team of MIT mathematicians began to notice that institutions around the world were finding ways to continue hosting seminars online. To virtually attend these talks, however, required hearing about them through word of mouth or digging through the webpages of individual departments or organizers.

Enter researchseminars.org, a website the MIT team formally launched this week, that serves as a sort of crowdsourced Ticketmaster for science talks. Instead of featuring upcoming shows and concerts, the new site lists more than 1,000 free, upcoming seminars hosted online by more than 115 institutions around the world.

"We've had a lot of feedback from users, who say, 'Thank you so much for building this. I feel like part of a community again,'" says Drew Sutherland, principal research scientist in MIT's Department of Mathematics.

The site is designed so that any verified organizer can add their own seminar listing. In this way, the team hopes the site can serve as a centralized, crowdsourced portal to the latest scientific advances being presented anywhere in the world. Users can filter seminars by topic, then click on a listing for details on how to virtually attend. After entering a password–or in more discerning cases, solving a math puzzle–they can sit in on live talks they might have been unable to attend in person.

(Source: MIT News)

Editor Picks from PCB007

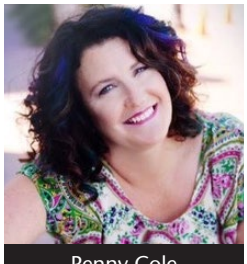
1 Standard of Excellence: Being a Valuable Customer ▶

We always talk about being a valuable vendor, but what about being a valuable customer? Anaya Vardya shares five guidelines for making sure that you are always your suppliers' most valued customer.


Anaya Vardya

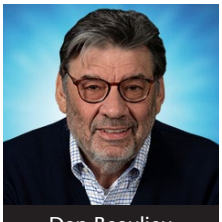
2 Selling in a Post-COVID Environment, Part 1 ▶

Nolan Johnson spoke with Penny Cole of Lotus Foods about how COVID-19 has affected her industry's distribution channels and supply chain, as well as how she's adapted to the shifting dynamic as a salesperson.


Penny Cole

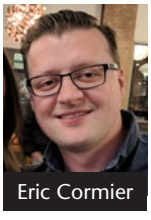
3 Find the Perfect Employee With D.B. Management Group ▶

If you're searching for the right person for an open job in the PCB industry, look no further than D.B. Management Group's recruiting page in each of the I-Connect007 magazines.


Dan Beaulieu

4 Cyberattack! Think It Couldn't Happen To You? Think Again! ▶

Eric Cormier and Dave Ryder of Prototron address the ransomware attack that locked them out of their system last December, bringing business to a screeching halt and forcing them into the arduous process of a full rebuild. With things finally starting to normalize, Eric and Dave now offer precautionary advice they've accumulated over the past six months.


Eric Cormier

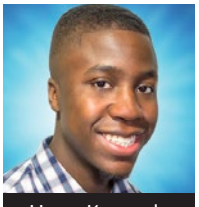

Dave Ryder

5 Punching Out! Acquiring a Distressed Company ▶


Tom Kastner

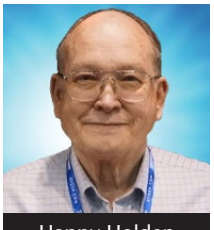
Everyone loves a bargain. Just like buying an old car or a fixer-upper house, you can get a great deal, or sometimes you get what you pay for. Tom Kastner shares some thoughts on acquiring a distressed or underperforming business.

6 Fresh PCB Nuggets: Pros and Cons of the 6 Most Common Surface Finishes ▶


Harry Kennedy

A surface finish can be defined as a coating, either metallic or organic in nature, that is applied to a PCB to ensure the solderability of the metal underneath. There are only two different types of surface finishes for PCBs: organic and metal. Harry Kennedy describes the pros and cons of the six most common finishes on the market.

7 Just Ask Happy: Ranking the Top Countries by Fab Technology and Production ▶


Happy Holden

We asked for you to send in your questions for Happy Holden, and you took us up on it! This time, one of our readers asked Happy to rank the top countries that provide PCB fabrication services. Check out the global fab trends now and in 10 years.

8 One World, One Industry: A Lasting COVID-19 Lesson—Resilient Regional Manufacturing Networks ▶

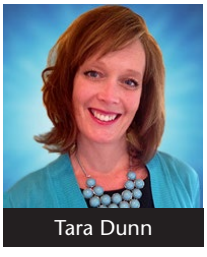

Dr. John Mitchell

Sophisticated global supply chains are generally efficient in meeting societal demands, but the COVID-19 pandemic illustrates that—in times of crisis—these supply chains can break down. IPC's Dr. John Mitchell emphasizes the need for resilient regional manufacturing networks across North America.

9 AT&S Starts Partnership With Design Company IMST GmbH ▶

With the aim of jointly developing high-frequency technology solutions, AT&S has concluded a strategic cooperation agreement with IMST GmbH in Kamp-Lintfort, Germany. IMST is a design and development center for radar, radio modules, communication systems, chip design, antennas, and regulatory certification and has its own accredited test center.

10 Flex Talk: Additive and Subtractive—When Opposites Attract ▶


Tara Dunn

Market dynamics in the electronics industry are quickly changing. Some solutions add considerable cost to the PCB and often introduce reliability and yield concerns. Columnist Tara Dunn explains an alternative that has been installed in three U.S.-based PCB fabrication facilities: the A-SAP™ process, which is Averatek's semi-additive process.

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

In addition, your ad will be featured in at least one of our newsletters, and your posting will appear on our **jobConnect007.com** board, which is also promoted in every newsletter.

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Skills and abilities required for the role:

- Proven B2B customer support experience or experience as a client service representative
- Strong skill set in Excel, Word, and Outlook for effective communication
- Strong phone contact handling skills and active listening
- Customer orientation and ability to adapt/respond to different types of characters
- Excellent communication and presentation skills
- Ability to multi-task, prioritize, and manage time effectively
- High-school degree

What's on Offer:

- Excellent salary & benefits commensurate with experience

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

Please forward your resume to jpattie@ventec-usa.com and mention **"Customer Service Representative—Chicago"** in the subject line.

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MivaTek Global

MivaTek Global: We Are Growing!

MivaTek Global is adding sales, technical support and application engineers.

Join a team that brings new imaging technologies to circuit fabrication and microelectronics. Applicants should have direct experience in direct imaging applications, complex machine repair and/or customer support for the printed circuit board or microelectronic markets.

Positions typically require regional and/or air travel. Full time and/or contractor positions are available.

Contact **HR@MivaTek.Global** for additional information.

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Career Opportunities

ROYAL FLEX CIRCUITS

Director of Business Development

Royal Flex Circuits is looking for an experienced Director of Business Development to increase company revenue by identifying and nurturing profitable business opportunities and developing long-term sales strategies. The successful candidate will have experience contacting potential clients, establishing lasting relationships, and converting leads to sales.

Responsibilities include but not limited to:

- Consistently meet or exceed monthly sales objectives with profitable sales revenues for a specific territory
- Develop new customers and maintain business relationships through active and personal communications
- Work with internal departments to efficiently handle customer data and order needs
- Provide ongoing account management by holding regular discussions with customers
- Understand the customer's general business needs, and be able to effectively communicate Royal Circuits' unique approach to provide quick-turn PCB fabrication
- Develop and maintain technical knowledge of the various aspects of circuit board fabrication

PCB sales experience strongly preferred.

The successful candidate will demonstrate excellent communication and leadership skills as well as strong business acumen.

Please send resumes to
victor@royalcircuits.com

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SOMACIS

Chief Technology Officer

SOMACIS Inc. is a well-established (over 45 years in business), advanced technology, high-reliability PCB manufacturer, located in Poway, California.

The CTO will be our first technology go-to expert and play an integral role in setting the company's strategic direction, development and future growth.

CTO will:

- Be responsible for the implementation, maintenance, and improvement of all processes and procedures
- Review current and future technologies and make recommendations as to the most suitable direction for the future technical development of the company
- Ensure company is in compliance with legislative and regulatory requirements
- Supply technical support in all areas throughout the company in accordance with instructions of the operations director
- Collaborate with both quality and production departments to ensure the quality of the product
- Plan and manage the evaluation, introduction and acceptance trials of new equipment and processes
- CTO will manage the operational and fiscal activities of PCB engineering processes, procedures, technology, and the Somacis Process Engineering Team

Required skills:

- B.S. degree in chemical, electronic, mechanical or manufacturing engineering technology or 10 years of progressively responsible experience as an engineer in the PCB industry
- Minimum ten years' engineering experience in related manufacturing industry
- Ten years' progressively complex technical experience in PCB manufacturing processes involving the latest state-of-the-art applications and techniques

Excellent benefits and relocation reimbursement.
Salary negotiable and dependent on experience.

Send resume to:
Cindy Brown, cindyb@us.somacis.com

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Career Opportunities

LENTHOR ENGINEERING
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Sales Account Manager

Sales Account Management at Lenthor Engineering is a direct sales position responsible for creating and growing a base of customers that purchase flexible and rigid flexible printed circuits. The account manager is in charge of finding customers, qualifying the customer to Lenthor Engineering and promoting Lenthor Engineering's capabilities to the customer. Leads are sometimes referred to the account manager from marketing resources including trade shows, advertising, industry referrals and website hits. Experience with military printed circuit boards (PCBs) is a definite plus.

Responsibilities

- Marketing research to identify target customers
- Identifying the person(s) responsible for purchasing flexible circuits
- Exploring the customer's needs that fit our capabilities in terms of:
  - Market and product
  - Circuit types used
  - Competitive influences
  - Philosophies and finance
  - Quoting and closing orders
  - Providing ongoing service to the customer
  - Develop long-term customer strategies to increase business

Qualifications

- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is a leader in flex and rigid-flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: hr@lenthor.com

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LENTHOR ENGINEERING
MAKING THINGS FLEXIBLE IN A RIGID WORLD®

Senior Process Engineer

Job Description

Responsible for developing and optimizing Lenthor's manufacturing processes from start up to implementation, reducing cost, improving sustainability and continuous improvement.

Position Duties

- Senior process engineer's role is to monitor process performance through tracking and enhance through continuous improvement initiatives. Process engineer implements continuous improvement programs to drive up yields.
- Participate in the evaluation of processes, new equipment, facility improvements and procedures.
- Improve process capability, yields, costs and production volume while maintaining safety and improving quality standards.
- Work with customers in developing cost-effective production processes.
- Engage suppliers in quality improvements and process control issues as required.
- Generate process control plan for manufacturing processes, and identify opportunities for capability or process improvement.
- Participate in FMEA activities as required.
- Create detailed plans for IQ, OQ, PQ and maintain validated status as required.
- Participate in existing change control mechanisms such as ECOs and PCRs.
- Perform defect reduction analysis and activities.

Qualifications

- BS degree in engineering
- 5-10 years of proven work experience
- Excellent technical skills

Salary negotiable and dependent on experience. Full range of benefits.

Lenthor Engineering, Inc. is the leader in Flex and Rigid-Flex PWB design, fabrication and assembly with over 30 years of experience meeting and exceeding our customers' expectations.

Contact Oscar Akbar at: hr@lenthor.com

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Career Opportunities

Quality Engineer

SUMMARY

Quality engineer with supervisory responsibilities, reporting to operations manager at Indium Corporation, European Operations. Candidate should be based within one-hour travel distance of Milton Keynes, U.K. M-F, 40 hours per week. Open until filled.

RESPONSIBILITIES

- Preventive/predictive maintenance, servicing, calibrations of equipment and facility in the work area
- Overseeing document control
- Approval of departmentally controlled docs
- SOP updates
- Full involvement in external audits, supported by the rest of the supervisor team and operations manager
- Internal and supplier auditing
- Product audits
- Sign off on TEOs and MRBs
- Reporting KPI performance to operations manager
- PPAP
- FMEA, control plan
- Customer complaints, RMAs investigation and reporting
- Project lead
- MSA design and implementation
- Maintenance of approved supplier list (ASL) and approved parts list (APL)
- Supplier risk assessments
- CAPAs, including SCARs
- Product qualifications
- Maintenance of equipment list
- Control of non-conforming product
- Sign off on change management (minor)

REQUIREMENTS

- IT literate
- Excellent written and verbal communication skills
- Strong interpersonal skills
- Numerate
- Six Sigma green belt
- Core Tools trained and certificate held
- Experienced auditor to IATF standard
- VDA trained auditor
- Several years' experience in a quality department within the automotive industry, including experience of IATF16949
- A recognised degree-level qualification in science
- Member of a certified industry organisation (CQI) or equivalent

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Image Department Operator

Alpha Circuit Corporation is a manufacturer of printed circuit boards located in Elmhurst, IL. We are currently seeking an operator in our Image department.

- All safety gear will be provided
- No experience required but a plus
- Full paid training provided
- Benefits: Health Insurance, 401(k), paid time off

Responsibilities:

- Expose dry film and liquid photo imageable ink
- Develop exposed photo imageable ink
- Develop exposed dry film
- Laminate dry film resist on inner layer and outer layer printed circuit panels
- Learn, understand, apply, and accept responsibility for in-process quality standards
- Be able to lift up to 15 lbs. shoulder high

If you are interested in this position, please contact Nita Buccino.
Email: nvb@alphacircuit.com,
cell: +1-847-489-2341.

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Career Opportunities

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NORTH AMERICA, INC.

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Burkle North America seeks a full-time service engineer in the Northeastern U.S. This position will provide expert-level service on multiple laser drilling and direct imaging product lines. Install, commission, and maintain Schmoll products at multiple customer sites across the Northeast. The candidate will perform modifications and retrofits as needed. Maintain complete and detailed knowledge of Schmoll products and applications and handle a wide variety of problems, issues, and inquiries to provide the highest level of customer satisfaction. Assist customers with the potential optimization of their machine functions and work with clients on application improvements.

Qualifications

Required: Bachelor's degree from a technical college/university in an associated field. Three years directly related experience, or equivalent combination of education and experience. Must possess a valid driver's license and have a clean driving record.

Preferred: Experience in control systems and electronic troubleshooting, as well as in general electrical and mechanical service tasks. Experience and knowledge in the PCB manufacturing process, with a focus on laser drilling and/or direct imaging.

Send resume to hr@burkleamerica.com.

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WHELEN®
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Process Engineering Director

Whelen Engineering Co., Inc. seeks full-time process engineering director in Concord, NH, to develop, plan and execute GreenSource Fabrication, LLC Div.'s process technology business strategy; manage process engineering activities, staff and compliance; improve process design, cost, quality and resource utilization; interact w/ customers and incorporate feedback; develop financial capital and labor projections; travel internationally for conferences, supplier and customer visits (15-25% worktime); write white papers, IP applications and give talks re. Division's products/processes.

Min. req.: U.S. Bachelor's or foreign equivalency in environmental science or engineering; min. 10 yrs. work exp. in: PCB fabrication process engineering; comprehensive and current experience in PCB fabrication/substrate markets w/ SAP tech; developing chemical and mechanical processes, chemistries and equipment for PCB manufacturing demonstrated by international experience implementing complex processes; ability to direct and troubleshoot PCB manufacturing problems; min. 5 years exp. leading, managing and training process engineering teams, developing and executing process technology business strategies and plans in worldwide PCB markets, including Japan, Taiwan, China, Europe; min. 3 years exp. giving talks, writing and presenting white papers; ability to travel internationally (15-25% worktime).

Send CVs to: Corinne Tuthill,
ctuthill@greensourcefab.com
or GreenSource Fabrication, LLC,
99 Ceda Road, Charlestown, NH 03603.

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Career Opportunities

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

Qualifications and skills

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

Benefits

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

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APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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Career Opportunities

TAIYO AMERICA

Development Chemist
Carson City, NV

Develop new products and modify existing products as identified by the sales staff and company management. Conduct laboratory evaluations and tests of the industry's products and processes. Prepare detailed written reports regarding chemical characteristics. The development chemist will also have supervisory responsibility for R&D technicians.

Essential Duties:

- Prepare design of experiments (DOE) to aid in the development of new products related to the solar energy industry, printed electronics, inkjet technologies, specialty coatings and additives, and nanotechnologies and applications
- Compile feasibility studies for bringing new products and emerging technologies through manufacturing to the marketplace
- Provide product and manufacturing support
- Provide product quality control and support
- Must comply with all OSHA and company workplace safety requirements at all times
- Participate in multifunctional teams

Required Education/Experience:

- Minimum 4-year college degree in engineering or chemistry
- Preferred: 5-10 years of work experience in designing 3D and inkjet materials, radiation cured chemical technologies, and polymer science
- Knowledge of advanced materials and emerging technologies, including nanotechnologies

Working Conditions:

- Chemical laboratory environment
- Occasional weekend or overtime work
- Travel may be required

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Manncorp™

SMT Field Technician
Huntingdon Valley, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

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

We Offer:

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

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Career Opportunities

U.S. CIRCUIT

Sales Representatives (Specific Territories)

Escondido-based printed circuit fabricator U.S. Circuit is looking to hire sales representatives in the following territories:

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

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BLACKFOX
Premier Training & Certification

IPC Master Instructor

This position is responsible for IPC and skill-based instruction and certification at the training center as well as training events as assigned by company's sales/operations VP. This position may be part-time, full-time, and/or an independent contractor, depending upon the demand and the individual's situation. Must have the ability to work with little or no supervision and make appropriate and professional decisions. Candidate must have the ability to collaborate with the client managers to continually enhance the training program. Position is responsible for validating the program value and its overall success. Candidate will be trained/certified and recognized by IPC as a Master Instructor. Position requires the input and management of the training records. Will require some travel to client's facilities and other training centers.

For more information, click below.

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Professionals Seeking Employment

db MANAGEMENT GROUP
Strategic Business Growth Consultants

D.B. Management Group L.L.C. is currently working with many professionals who are seeking new positions. If any of these qualified professionals sounds like someone you would like to learn more about, contact **Dan Beaulieu** at **207-649-0879** or **danbbeaulieu@aol.com.** If you are a qualified professional looking for a new opportunity, contact Dan as well. Fees are 10% of candidates' first year's annual compensation. There is no fee for candidates.

Click here to learn more ▶

President, Company Leader, Business Builder
This professional has done it all. Built new businesses and turned around hurting businesses and made them successful. A proven record of success. This candidate is a game-changer for any company. He is seeking a full-time leadership position in a PCB or PCBA company.

General Manager PCB and PCBA
Senior manager with experience in operations and sales. He has overseen a number of successful operations in Canada. Very strong candidate and has experience in all aspects of PCB operations. He is looking for a new full-time position in Canada.

Regional Sales Manager/Business Development
Strong relationship management skills. Sales experience focused on defense-aerospace, medical, high-tech PCB sales. Specializes in technical sales. Also has experience in quality, engineering, and manufacturing of PCBs. He is looking for a fulltime position in the Southeastern U.S.

Field Application Engineer (FAE)
Has worked as a respected FAE in the U.S. for global companies. Specializes in working alongside sales teams. Large experience base within the interconnect industry. He is looking for a full-time position.

Business Development Manager
Understands all aspects of interconnect technical sales from PCB design and fabrication to assembly and all technologies from HDI microvias to flex and rigid-flex. Has also sold high-tech laminates and equipment. Proven record of sales success. He is looking for a full-time position.

CEO/President
Specializes in running multi-million dollar companies offering engineering, design, and manufacturing services. Proven leader. Supply chain manager. Expert at developing and implementing company strategy. Looking to lead a company into the future. He is looking for a full-time position.

PCB General Manager
Forty years of experience serving in all capacities, from GM to engineering manager to quality manager. Worked with both domestic and global companies. Available for turn-around or special engineering projects. He is looking for long-term project work.

Process Engineering Specialist
Strong history of new product introduction (NPI) manufacturing engineering experience: PCB/PCBA. Held numerous senior engineering management positions. Leads the industry in DFM/DFA and DFX (test) disciplines. He is looking for either a full-time position or project work.

VP Sales Global Printed Circuits
Worked with a very large, global company for a number of years. Built and managed international sales teams. Created sales strategies and communicated them to the team. One of the best sales leaders in our industry. He is looking for a full-time position.

Plant Manager
This professional has years of experience running PCBA companies. Led his companies with creative and innovative leaderships skills. Is a collaborative, hands-on leader. He is looking for a full-time position.

National Sales Manager
Seasoned professional has spent the past 20 years building and growing American sales teams for both global and domestic companies. Specializes in building and managing rep networks. He is looking for a full-time position.

Global Engineering Manager/Quality Manager
Has experience working with large, global PCB companies managing both engineering and quality staff. Very experienced in chemical controls. She is interested in working on a project-by-project basis.

CAM Operators and Front-end Engineers
These candidates want to work remotely from their home offices and are willing to do full-time or part-time projects.

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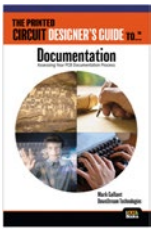
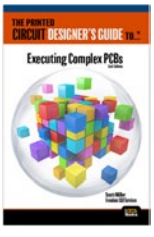
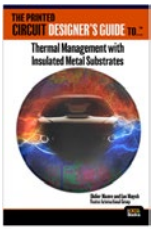


Documentation, by Mark Gallant, Downstream Technologies
When the PCB layout is finished, the designer is still not quite done. The designer's intent must still be communicated to the fabricator through accurate PCB documentation.



Executing Complex PCBs, by Scott Miller, Freedom CAD Services
Designing a complex circuit board today can be a daunting task. Never before have PCB designers on the cutting edge faced more formidable challenges, both electrical and mechanical.

Producing the Perfect Data Package, by Mark Thompson, Prototron Circuits
For PCB designers, producing a comprehensive data package is crucial. If even one important file is missing or output incorrectly, it can cause major delays and potentially ruin the experience for every stakeholder.



Thermal Management with Insulated Metal Substrates, by Didier Mauve and Ian Mayoh, Ventec International Group
Considering thermal issues in the earliest stages of the design process is critical. This book highlights the need to dissipate heat from electronic devices.

Fundamentals of RF/Microwave PCBs, by John Bushie and Anaya Vardya, American Standard Circuits
Today's designers are challenged more than ever with the task of finding the optimal balance between cost and performance when designing radio frequency/microwave PCBs.

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