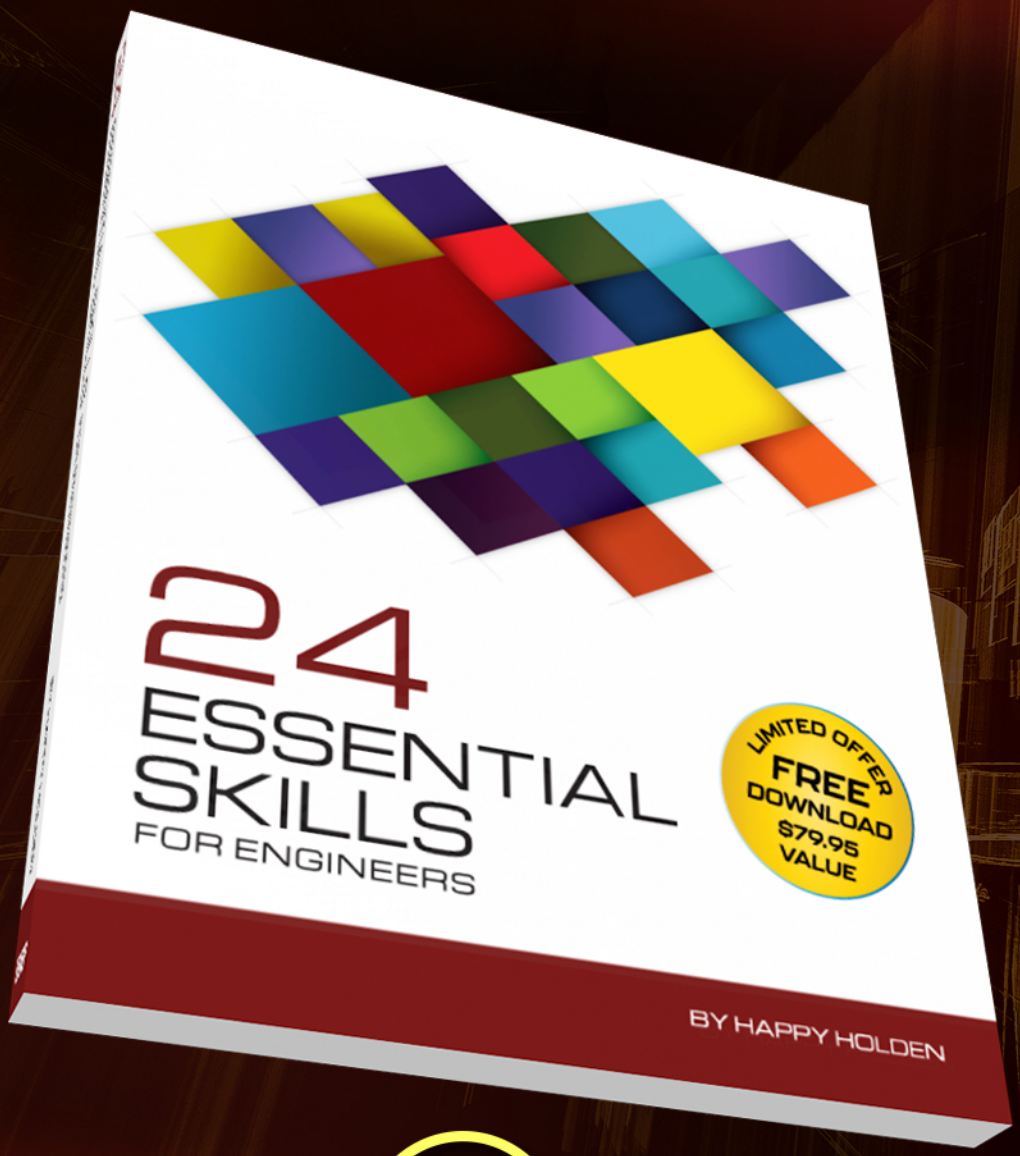
OCTOBER 2021

# PCB007 MAGAZINE

I-Connect007
GOOD FOR THE INDUSTRY

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

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



PCB007 MAGAZINE

# The CapEx Issue

What are the best CapEx strategies for PCB fabricators? Should you follow a formula, say, investing 15% of revenue each year in capital expenditures? Are your plans guided by your need to add capacity, or do you want to up your technology game so you can expand into new markets? Maybe you just want to replace outdated equipment that's costing you in wasted energy and labor man-hours?

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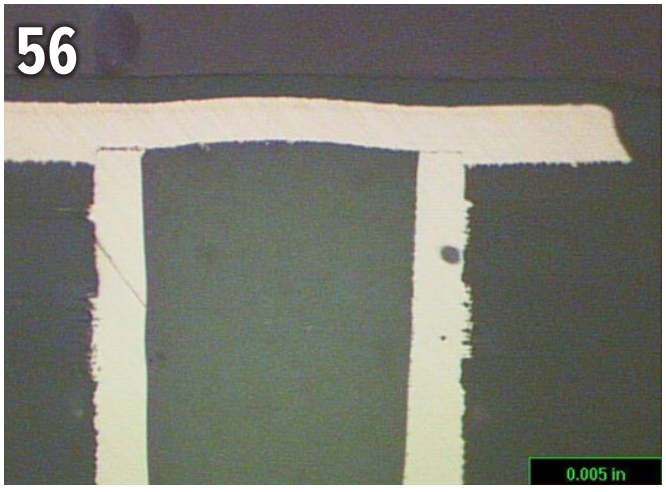


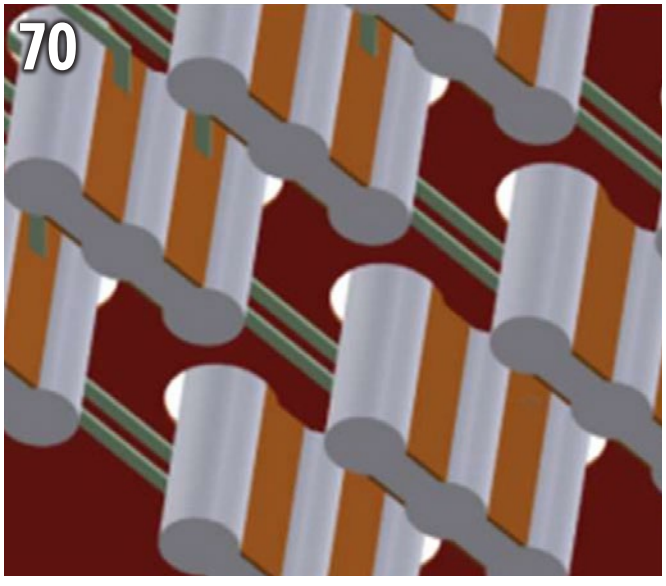



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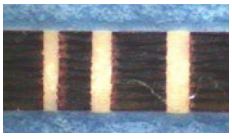




## HIGHLIGHTS

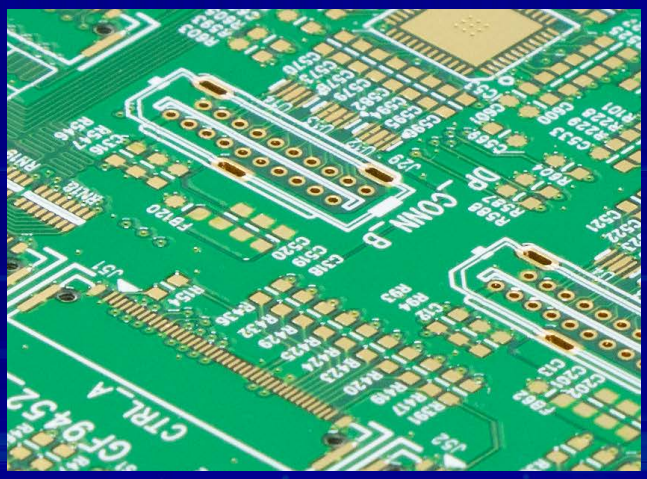


## DEPARTMENTS

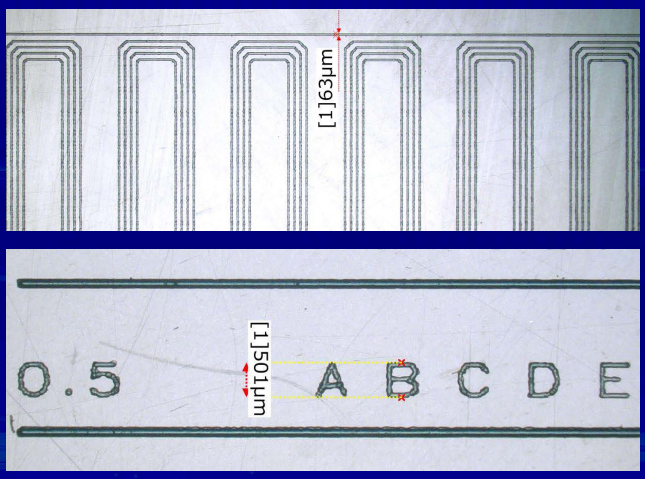



## SHORTS

# New 'Type F' CraftPix Inkjet Printers with 3.5pl print array

Improved solder mask openings

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# CapEx: Spending Money to Make Money

## The Shaughnessy Report

by Andy Shaughnessy, I-CONNECT007

We started out planning this issue with one central question in mind: What are the best CapEx strategies for PCB fabricators?

As the saying goes, "That depends..." Should you follow a formula, say, investing 15% of revenue each year in capital expenditures? Are your plans guided by your need to add capacity, or do you want to up your technology game so you can expand into new markets? Maybe you just want to replace outdated equipment that's costing you in wasted energy and labor man-hours?

As you'll see in this month's issue, the answer may be "all of the above." We found that there are a variety of CapEx strategies, and one size definitely does not fit all PCB fabricators.

Right off the bat, several fabricators refused to say one word on the record about their CapEx plans, even at a 30,000-foot level. They consider that information to be their IP, and there's no point in giving away state secrets.

And, while the term "CapEx" summons up images of new pieces of room-filling equipment, we found that CapEx planning now includes other expenses such as IT, consultants, and high-end cybersecurity, especially for companies in the defense and aerospace segments. For years, we've heard grumbling from fabricators about the cost of being NIST-800-certified, but that's the cost of doing Mil-Aero work.

One of the primary messages we heard repeatedly is that fabricators should not be afraid to spend money on equipment and processes that can save them money and labor in the long run. Fabricators are a notoriously conservative bunch of folks; with the margins they're dealing with, they really must be.

Many board shop owners would prefer to have a root canal over purchasing new equipment; they'd rather keep repairing the older equipment as it

breaks. We all know fabricators who have been using the same machines for decades. Some managers brag about building cutting-edge boards with equipment that they acquired during the Clinton administration. But eventually, it's going to be time to crack open the piggy bank.

You need to have a CapEx plan. So, we asked our expert contributors to discuss their CapEx strategies, as well as the market drivers and technical advances that are pushing today's fabrication capabilities to their limits.

We start off by speaking with Sunny Patel of Candor Industries. Sunny explains how they manage their CapEx spending, and the rationale for their recent equipment acquisitions. Next, in our interview with Joe Dickson of WUS, he examines capital expenditure strategies and offers insight about possible lower-cost alternatives. We also have a short conversation with Alex Stepinksi, who posits this question: Do you really need new equipment? He follows his own question with this answer: Maybe not.

MivaTek's Brendan Hogan discusses the company's new direct imaging technologies, and the challenges that are driving his customers to upgrade their equipment. Peter Bigelow of IMI explains why companies shouldn't be afraid to invest in processes that may save them time and money, and why ITAR-compliant manufacturers may wind up cracking open the piggy bank to fund IT and cybersecurity upgrades as well as new equipment. And we have a conversation with Thomas Walsh and Travis Houchin of Integrated Process Systems, who detail the industry trends they're seeing in capital expenditure, as well as the changes they have noticed in their customers' requirements. We also have columns from our regular contributors Mike Carano, and Steve Williams. Happy Holden now adds his voice to our pages, by picking up where Karl Dietz left off.

There's quite a bit happening in the industry now—much of it is positive, but some of it is quite challenging. (The supply chain problem doesn't seem to be going anywhere soon.) We'll be keeping an eye on the issues that matter to you. See you next month! **PCB007**

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

# Candor Demonstrates Growth and Investment Go Hand in Hand

**Feature Interview by the I-Connect007 Editorial Team**

Sunny Patel of Candor Industries discusses his company's significant growth during the past four months. He breaks down how they've managed their CapEx spending and the rationale behind their recent capital equipment purchases.

**Barry Matties:** Sunny, you have talked about substantial growth over a four-month period. How did you manage such growth? That's got to put a lot of stress on your systems.

**Sunny Patel:** Well, I don't really know how it happened, actually (laughs). It was lucky, I suppose, in the sense that everything worked out at the same time.

Usually, summers are slow, and with COVID, some of the automotive customers were facing some penalties with Asian board shops going into 20-week lead times and four-week shipping containers costing double or triple the price. Instead, they found that our pricing was working out to be a better option.

**Matties:** Automotive typically orders pretty large volumes. Are you geared to do large volume work there, or did you see an increase in batch size?

**Patel:** We're normally prototype or mid-volume, and the equipment we purchased helped us offset the volume a little bit with the similar amount of people that we have. We're up to 40 people; we were maybe at 30 or 35 full time before the pandemic.

**Matties:** When you add people, though, it's not proportional to the revenue, because I would think that you're getting more automation into the facility.

**Patel:** Yes, exactly. We purchased a direct imaging machine, an inkjet solder mask machine, an induction press, and a DIS inner layer pinless bonder. All those things helped offset manual

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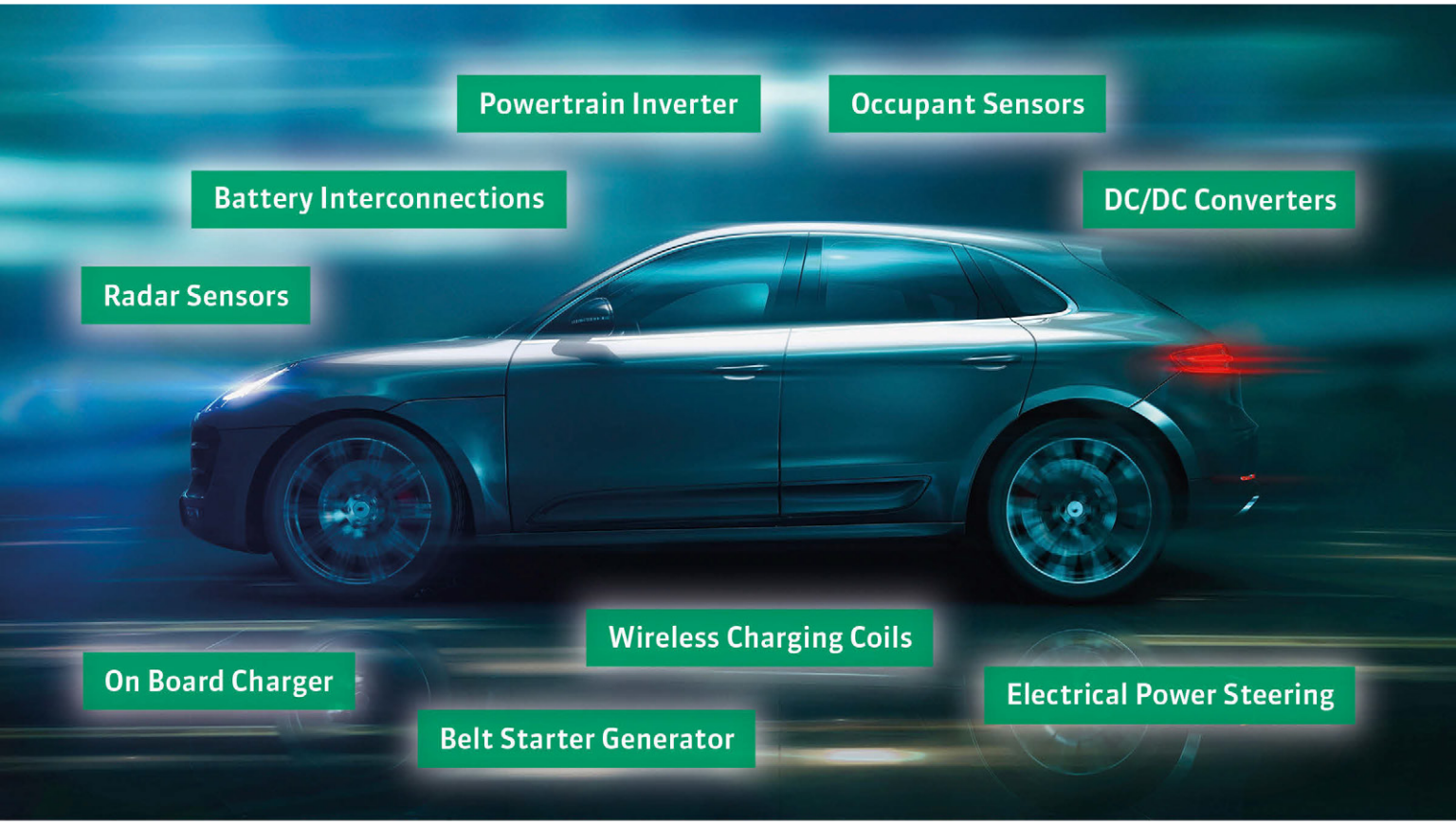


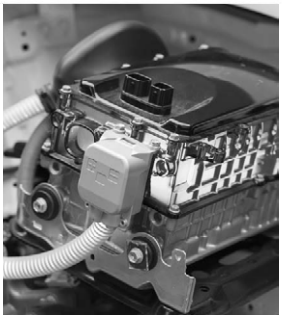


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Sunny Patel

work; it was a lot more automation and fewer steps to process.

**Nolan Johnson:** Were the equipment purchases in response to the sales or was Candor anticipating the sales?

**Patel:** In front of the sales. We noticed at the beginning of the pandemic that a lot of customers were looking at a local source more than they were beforehand. Our old customers would contact us and say, "Hey, we're back. We need some help." We helped them out as the pandemic went along. Then our regular sales came back, and these customers didn't leave. At that point, we realized that we needed to do something to get ahead of any additional sales that will come back after the pandemic. It was just a strategic move.

**Matties:** When you're looking at your capital expenditures, how do you prioritize? You mentioned a good list of nice equipment, but what's the rationale behind your thinking? Are you looking at bottlenecks or market opportunities or a combination? What's the motivation?

**Patel:** It was a combination. We're always trying to simplify our process. That's the main vision for our board shop—not necessarily through automation, but also in simplifying the whole process. For example, most people who were investing have a silkscreen inkjet machine nowadays. We were a little bit behind the curve there, but the whole idea is that you're eliminating the need to screen or print an image and whatnot. That was a priority. We can see that with the press side, we are limited then by the amount of presses we can do daily and the whole energy savings going into induction is also a bonus. At the same time, solder mask inkjet is something that's at the cusp of being ready, and we felt going into it now is a good step in the right direction. So, it's a combo.

**Matties:** When you say to simplify the process, I'm hearing you say to reduce the number of steps required. Is handling a consideration between human and machine to eliminate human contact as much as possible?

**Patel:** Oh, for sure. That's where the bonding machine comes into play for the inner layer bonding. We used to be a semiautomatic process, and now we're letting the machine take care of everything. As things get smaller and smaller, and the more you have humans handling that, the more chance of a failure. Of course, it's a key part of the expenditures.

**Johnson:** Sunny, would you have been able to accept all that work had you not had that equipment on the way?

**Patel:** No, definitely not.

**Matties:** So, being market-driven is part of it as well.

**Johnson:** Are you at full capacity now that you have new equipment? Do you still have room for more sales?

**Patel:** Things are moving more smoothly in the shop. We're comfortable. It's not like we're thinking, "Oh my gosh, we're going to fail at everything." It's a well-controlled production environment right now. And we wouldn't have seen that last year.

**Matties:** How much money or investment did you put in the front end of your factory, the planning side?

**Patel:** We actually made a big purchase on the software side as well. We use Ucamco's Integr8tor pre-CAM automation software, and we're putting it all together with Integr8tor and some scripting; there's a lot of heavy lifting done on the software automation side before we even get to our engineers. It's good that you brought it up, but we have a lot of software tweaks that were done to make life easier for engineers as well.

**Matties:** Now, when you're bringing in all this new technology, like front-end software and in the shop with equipment and workflow process. How do you address the learning curve or the training that you have to do?

**Patel:** It's all done on the managerial side first. We say, "If we're going to put in something, we need the top guys to know what's going on first, and then the trickle-down training from there." The great thing is that a lot of these on the software side or the equipment side; they have a good technical base to ongoing questions and things like that. It's easier to contact and get ahold of someone to help you out. The great thing is that a lot of this equipment is a lot easier to run nowadays because they've developed something like a human proof version, I suppose. So they're finding it a lot easier to run the machines or run the software, and that's the whole idea.

**Matties:** Are you seeing more of a connected factory feel at your facility now?

**Patel:** We haven't gotten to that point where we're at 4.0. We're a smaller shop, so it's harder to see the benefit of that side yet—maybe once we scale a little bit more. The good thing is that as managers we have a lot of eyes on the floor. Once it gets to the point where it's not manageable by us, that's when it starts becoming more important.

Once it gets to the point where it's not manageable by us, that's when it starts becoming more important.

**Matties:** As you talk about the new equipment being human proof, that's the first step to what we would deem a smart process. Eventually, you get enough of these smart processes inside your facility and suddenly you're a smart factory.

**Patel:** Exactly. It will happen before we realize it.

**Matties:** When you're looking at your own budget, do you set a CapEx budget, or is this an opportunity-based authorization of expense?

**Patel:** It was opportunity-based this time. We didn't have a budget going into this year. We wanted to pull the trigger as the opportunity to purchase the equipment arose. It was a bit of a risk on our side because we didn't necessarily have the budget at the beginning, and we grew into it as we went along.

**Johnson:** Now that this is paying off, how are you planning to reinvest some of this extra money for further growth?

**Patel:** We have two more pieces of equipment to buy by next year that we believe will put us in the upper echelon of North American board manufacturing. We're going to keep going as much as we can on the investment side. This seems like the perfect time to catch the wind.

**Matties:** With this new equipment, what metrics will you use to validate the investment? For example, you mentioned induction, that's an easy one; but how do you put that together?

**Patel:** For induction, we can measure the energy usage and the like, and we're always looking at the yield and the pass/fail percentage. It's all tracked with the software. We expect our new equipment will drive total cost savings of about $150,000 and improve our gross margins from 22.6% in FY2018 to 27% in 2021.

**Matties:** I would think that when you're simplifying processes, you're reducing cycle time. You probably see work coming through your facility faster and more efficiently, with higher yields, lower cost, less scrap. How do you establish metrics at the beginning when you're deciding to purchase that equipment?

**Patel:** We know what the process already is. But what is it going to do differently if we do purchase the equipment, and what materials savings are there? What's the energy difference? We did a whole calculation on energy savings for the induction press. It's significant.

**Matties:** And when you're looking at the equipment investment, do you have a threshold of improvement that it must meet before you would invest the dollars?

**Patel:** In this case, it seemed like a no-brainer based on what improvements they're going to bring. In the future, it will be more of a technological unlocking, I suppose, rather than a process of elimination.

**Johnson:** While it sounds like you get process improvement out of it, I'm hearing that the expanded capabilities portfolio helped you bring in more business. In other words, one can spend capital to save money and increase your margins, or to get more top line revenue.

**Patel:** Right. With the new equipment, we expect operational cost savings alone of $50,000—the value of about 3,000 labor hours redirected through more efficient processes. For example, with the bonding machine that we had, the process would take two people, and they're punching and bonding on two different pieces of equipment, and it was a 15- to 20-minute cycle. Now, it's down to five minutes, one person, and automated tolerance. The numbers are there, but it was just something we had to do to get to the next level.

With the new equipment, we expect operational cost savings alone of $50,000—the value of about 3,000 labor hours redirected through more efficient processes.

**Johnson:** I'm sure you're getting better quality out of that step too.

**Patel:** And the registration is just phenomenal, comparatively.

**Matties:** How involved is your sales and marketing team in your capital expenditure?

**Patel:** Sales always knows what technology customers are, whether we're missing out on opportunities because we're just not capable of

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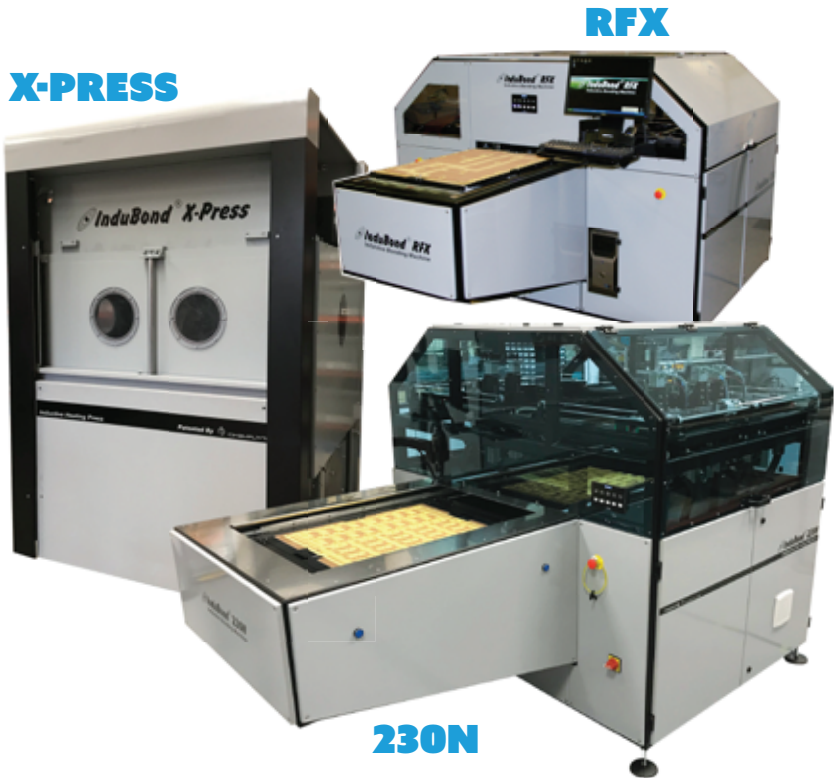


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building them. We talk to the sales guys to figure out something like, "Where are we missing our opportunities? Is it worth getting these sets of equipment to make sure that we're able to produce it, and not only able to produce it, but to price it the right way so that we actually can get the business?"

**Matties:** I think that's to Nolan's point; once you had that capability, how much new market space did that open for you?

**Patel:** Because we have been talking to our customers about what we're about to do and having those conversations with sales and just directly our customers, we know where the niche is and where we can grow our business. That conversation is key to understanding how to commit the dollars.

**Matties:** I think that's part of the justification for the metric when you're looking at this expense. You're saying we're spending X dollars, but it's going to open this whole new market segment for us that's worth a hundred million dollars globally or whatever the number happens to be.

**Patel:** For sure. It's part of the whole process.

**Johnson:** Sunny, did you finance these purchases? Or did you use cash out of the company?

**Patel:** A little bit of both. We took some of our own cash and leveraged that using the bank to take this the rest of the way to the purchase.

**Matties:** There are some good interest rates out there right now, I think.

**Patel:** Exactly. Banks want to invest. This is a perfect time to go for it.

**Johnson:** You got a good response from the bank about financing?

**Patel:** Yes. Especially with the opportunities that the equipment can bring. They were excited about it.

**Johnson:** Was your sales forecast a part of the conversation?

**Patel:** Yes, exactly.

**Andy Shaughnessy:** Do you find that the banks have a better understanding of our industry now? We've heard for years that they don't quite get us.

**Patel:** No. There was still a lot of hesitation, because from our side, we don't have long-term contracts. I think a lot of the board shops are still like that. Of course, the banks are a little bit apprehensive, but what they saw from us is that we're steadily growing year by year, adding new customers. They felt a little bit less risk involved there. I think that this coming year, they'll see they made the right decision, and they're more confident in giving us even more investment opportunity.

I think that this coming year, they'll see they made the right decision, and they're more confident in giving us even more investment opportunity.

**Matties:** Oftentimes when you're bringing in new processes and growing, that means some facility upgrades, maybe some remodeling. Are you having to do that, or is this kind of just a plug-and-play situation?

**Patel:** We had to be smart with our space. We didn't have much room to go with, but we

had to imagine at the point like, what can we really remove? How can we make this space a little bit more organized and use the e levated space to allow us to have a little bit more room to really fit all this equipment? The good thing is that some of this equipment removes two or three older pieces of equipment. We could get two pieces out and put two pieces in and it works out. It's definitely a balancing act. It took a lot more work from the maintenance side to really make sure it all works out.

**Matties:** With all this work coming back to North America, do you think it's here to stick? Or do you think this is a flash in the pan, so to speak?

**Patel:** It's hard to say if it will all stay, but to me, it seems that, at least partially, it's here to stay; maybe not fully, but some people will stick to North America.

**Matties:** They just find it easier to deal with this time zone, and its culture and language. Is that the case?

**Patel:** Exactly. I feel like what's going to happen is they're still going to buy maybe 95% offshore and then keep 5% to have that local source, just in case something happens like this again. If the pricing doesn't normalize next year, if it remains in this area, I don't think there's any incentive to move back. It all depends on how the market stabilizes.

**Shaughnessy:** You talked about how this was led by customers and sales, so it's not really a formula or a cutoff or anything where you realize, "Oh, now it's time." You are just constantly keeping track of it.

**Patel:** Exactly. Since 2018, we've been looking at these pieces of equipment and we had this window of opportunity where the pandemic had a positive aspect in that sense.

**Johnson:** This has paid off for you. Are you looking at maintaining the momentum?

**Patel:** For sure. That's the whole idea. We want to keep innovating, trying to bring our costs down, and attract new customers.

**Matties:** What areas were you looking at for your next investment?

**Patel:** We're looking at a green pico laser driller/router. That will save us a lot of headache and time for our blind via processing, cover flex stuff, and any fine routing that we have to do. The great thing about a green pico laser is it evaporates rather than burns. That would be an exciting piece.

**Matties:** Is flex one of the growth areas for you?

**Patel:** Yes. We're seeing a lot of flex coming our way, as well as some really tight routing, blind via technology, and etch resist printing. We're still researching to see if it's viable, but it seems like a game changer to us, and we'll see how it goes.

**Matties:** How much input did you get from your frontline operators, the people actually running the equipment, to find out what could be improved?

**Patel:** I'm always on the shop floor. I can see where they're having trouble, and then, daily, I try to always get their ideas and see what they're having trouble with. It's a constant conversation, even with the new equipment. The more you know what's happening inside, the better, I would say.

**Matties:** When you brought in your induction press, did you eliminate the old press, or did you just add this capacity?

**Patel:** Well, it's still there, but we just got the press a couple of weeks ago. I think we don't

need it, but we're going to keep it there until we're darn sure.

**Matties:** With the induction press, you can do heat up and cool down all under pressure in the same process. Is it your intent to do it that way? Will it yield better results?

**Patel:** Exactly. It seems like a game changer.

**Matties:** With that rapid heat up, it really does. With the press, you can make that material glow if you want it to.

**Patel:** Yes. We can do fusion bonding on there too.

**Matties:** Any final thoughts you have or advice for board shops on capital expenditures, whether it's planning, or any other insight that you want to share?

**Patel:** I would recommend that the more communication you have with everyone inside the plant, the better—the sales guys, the customers. Get the whole picture as much as you can. It just seems like a point in time where you shouldn't be afraid to take on a little bit more risk.

**Matties:** Great. Thanks for speaking with us today, Sunny. **PCB007**

# Additive Reality: Solder Mask Patterning at the Edge Between Drops and Bricks

**By Luca Gautero**

The digital form of inkjet printing technology operates on files containing a rasterized image; these bitmaps, in their simplest form, contain information about the presence (or absence) of drops. Additionally, the resolution brings in the drop's pitch. This represents a 2D view of a pattern. Such a pattern might, once printed, have a thickness, however, the rasterized image does not carry this information. For pure 3D printing, the solution is to assign a fixed height step to each printed layer. Elegant and simple: each drop approximates a brick of fixed length, width, and height. This works reasonably well when the approximated drop dimensions are far below the tolerance needed for the application.

For solder mask requirements, however, this is not the case. Features in PCB designs span several orders of magnitude with their length and width. The smallest feature is only one, two, or three times the size of a drop depending on the hardware choice (see my August column, "Printhead Selection or 'Shop 'Til You Drop'"). As a bridge between the bitmap definition and the final pattern, it is useful to define the outflow length of a drop ($L_{of}$). This length is the difference between the bitmap pattern length and the final length of the printed and cured feature.

Luca Gautero

Since the digitally defined bitmap provides control of the pattern, adding a reproducible $L_{of}$ extends the reproducibility all the way to the printed image. The proper place to implment this extension is between the vector format CAM definition of the pattern and the subsequent generation of the rasterized image. At this moment, geometrical features defined by coordinates become bitmaps. The $L_{of}$ length becomes the resizing length for features that need to be printed. Similar intervention on vector formats are already common to compensate under-etch or over-etch during wet processing for etching.

**To read this entire column, click here.**

**Luca Gautero** is product manager at SÜSS MicroTec (Netherlands) B.V.

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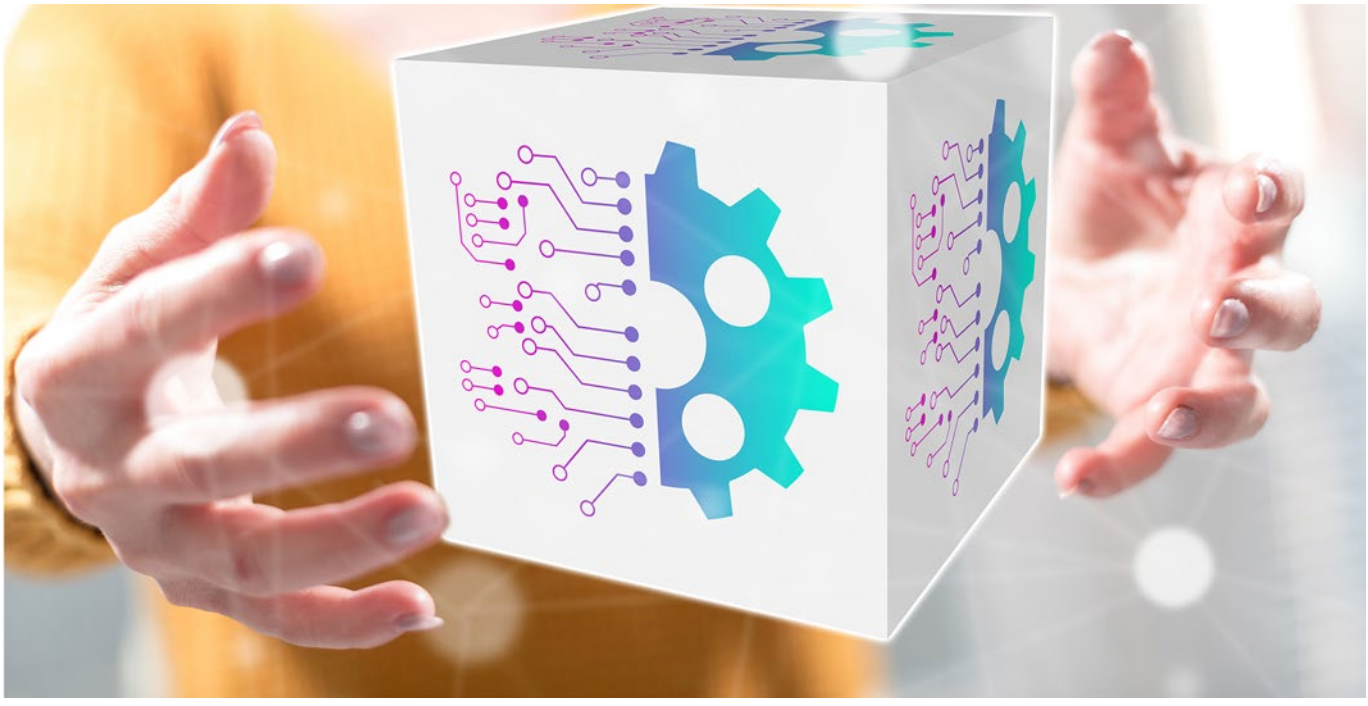

# The Truth About Capital Expenditures

**Feature Interview by the I-Connect007 Editorial Team**

In this interview with Joe Dickson of WUS, we examine capital expenditure strategies to remain competitive on the technology curve. Dickson discusses how PCBs are moving into 3D interposer technologies vs. the traditional 2D, CPU-centric, flat printed circuit boards. Joe also outlines the massive amount of capital equipment and capital expenditure that cutting-edge manufacturing requires, with some insight on lower-cost alternatives as well.

**Nolan Johnson:** Joe, you've been making the point recently that the volume disruptive technology is going to Asia. That's what we wanted to talk about: capital expenditure and where that's headed. Let's start by discussing why the disruptive technology is going to Asia. North America seems to be taking a pass in this arena, and yet, historically, it's been the U.S. that's embraced disruptive technologies. What gives?

**Joe Dickson:** I look at it not so much as the U.S., but I call it the West, because people whom I've worked with over the years, my peers and competitors, were either in the Netherlands or other areas, Canada, etc. The Western markets today have advanced technologies that they're working on, but they're typically focused on where their current revenue stream is, which is military application and high reliability capabilities. There's nothing wrong with that, because a lot of times in the past, those technologies leveraged into volume. But I see that separating more and more, and Happy is very familiar with this.

HDI took forever to integrate into either military or advanced structures like that because the volume manufacturing and process knowledge was all overseas. It wasn't that this technology was unknown; it was just so expensive for the infrastructure to build up for a small market. I mean, to justify high volume laser capability that could do dense motherboards at 10,000 a day, it's difficult for a small board shop in the West to justify that. They get

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smaller scale, less control of the machines, and their price point per via becomes more. That's challenging.

**Happy Holden:** The one thing that VeCS has going for it is that you can get HDI density without having a laser drill, which ought to be a big advantage to smaller North American shops when all they have to do is change their drill bit in their processes, rather than buy new machinery.

Joe Dickson

**Dickson:** Right. Two years ago, we were looking at doing it with conventional routers, conventional machines, just like Happy mentioned. Now we have very high-speed routers, approaching high drill machine capability, CCD alignment routing machines, and depth-control routing machines. Those have all been innovated in two years. No one in the West, from a board shop standpoint, really understands how that works. I see on LinkedIn all the time these celebrations that these via fill machines can do 3.0 millimeter thick with 0.2-millimeter vias and can via-fill them. We've been doing that for five years with the processes we have in Asia, but the equipment is high-volume, dual-step processes. High vacuum screen print, second fill, and automated squeegee, and we've been able to do it in a relatively high volume for years. It's because the machines are large and expensive, so it's difficult for a small-volume shop to rationalize that.

Lamination, drilling, everything is going to large highly automated equipment and it's getting more challenging for a small shop to justify those. I don't envy an engineering manager or somebody who is trying to do that anywhere. It's very tough. I talk to my friends that are still in the industry in the West, and they have to get very creative to find these capabilities. Happy, I'm sure you've seen that on the HDI side. It's very challenging.

I think the days of the 3D stacked system-on-chip, system-on-interposer, system-on-PCB have just begun. We are just barely getting into it. The idea that a PCB is a commodity is an antiquated concept that most customers are just starting to understand. And I think this shortage in the die market and the initial supply has allowed us to look at the ecosystem a little differently.

**Johnson:** Joe, you just said something very insightful: a printed circuit board is moving from being a commodity to being a specialized product as a part of the design.

**Dickson:** If you look at where we were 25 years ago, we had data coming into a chassis and it had to be managed into a single CPU. We created a carrier, a server, or a motherboard and this entire network went out to what's called a midplane or a backplane. We were all happy and thought, "Wow, this is the computer age. This is what it's going to be forever." As the signal speeds got faster, then we started running signals on optical cables and it got faster. But that single logic management was still there.

Now we're at another fork in the road where the main PCB is becoming more like the backplane again. The transference layers may not have much of the active capability directly on it, but it houses everything else, and you're stacking 3D chips, memory, and accelerator systems. Everything is becoming more closely tied together but also interdependent. That's where you have what you'll call a substrate interposer. Now you have a system-on-chip where you have multiple chips, CPU, GPU, memory, accelerators, whatever it is, and you're putting them closer and closer, stacking them, and manipulating the data. Yet, as soon as you get it to where it you've got that system

mature, there will be another new active component, one that's going to obsolete it.

You need to have what I call a transitional interposer. The old traditional motherboard that used to be super advanced is more than just a glorified wiring board that connects everything. You will have optical flyover, copper, flyover. You're going to have all kinds of things moving in and out. The PCB industry, at least what I see as our next great evolution, means we can't think of that like a normal PCB.

Happy started doing HDI microelectronics 30 years ago. Moore's law didn't always work at the PCB level because higher resolution didn't cause lower prices. But all of that is changing now because of 3D system-on-chip. Now you don't have an Intel or an AMD or somebody driving the whole industry. You have smaller drivers all over the place. Anyone with a design with ASIC can marry these together and create an IP that's unique. That's going to completely change the structure of the interconnects below it. That's where I see the big next jump.

To that end, near-billion-dollar factories are not that outlandish anymore because if you're talking about near 50-micron lines and spaces, you're basically building a traditional interposer with attributes that were chip or die level 10 years ago.

**Johnson:** Seems there are two opposing directions here. Talking about interposer applications, increased density is the driver and there needs to capital equipment investment. But at the same time, with a shift back to a more traditional function for the main printed circuit board—a motherboard backplane sort of operation—you're saying that it's getting simpler. The 3D element is more advanced, but the large PCB will continue with similar attributes. The 3D is a system-on-chip or system-on-PCB, right?

**Dickson:** Happy called it a silicon interposer; that's probably the best terminology I've heard. It's a sub 50-micron L/S interposer as opposed to an above 50-micron interposer. Some have three layers; some have four layers. I'm seeing PCB-like structures that are on flip chips with a silicon interposer that's built in there. Then there's another transitional interposer in the 0.5 to 0.9 mm pitch range that allows these systems to be mounted on the main PCB. The idea that you have just one die and then a single interposer just doesn't work, because the CPU is not the center of the universe anymore. There are multiple levels of data processing.

**Holden:** The signal integrity, like you said, is such a thing that you have a very fast CPU die, but when you put it on a relatively larger package and bring it out to any kind of BGA or pin grid array, you induce so many parasitics that if you want to eliminate the package, you put the memory right next to it, you put the IO right next to it. Now you've got what we call system-on-package, not system-on-chip.

Maybe what has happened is that when we had the daughterboard, the motherboard, and the back panel, that's going out the door through miniaturization. Now we have an organic printed circuit board, which is the cumulative back panel, and on it are all these system-on-packages that look like very fine pitch BGAs, but they're replacing the daugh-

tercards. You've got these multiple system-on-package daughtercards that you can surface mount and that's your whole system. It's not a big backplane with press fit connectors anymore. And it could be even, because of the signal integrity, a PTFE-like or ceramic-like printed circuit board that takes these fine pitch systems-on-packages that look like BGAs but, in fact, are entire systems inside.

**Johnson:** Joe, we've got all these Dagwood sandwiches of functionality getting stacked up on a plate, if you will. This seems to create an inflection point for the printed circuit board industry. Either you're moving into interposers, which are going to be an ongoing key part of what we do, or you're staying on, with the traditional flat board. To go into interposers, are you talking about a lot of capital equipment and a lot of capital expenditure?

**Dickson:** Yes. And most of the processes are not parallel. You can't produce the same types of products on the same processes.

**Holden:** But you can step halfway into it.

**Dickson:** Yes. And that's what has happened.

**Holden:** That's what ASAP and VeCS are. ASAP and VeCS would allow you to jump into the under-50 micron without buying a laser drill and just changing your drill bit in your drill or routers.

Interestingly, that's what the U.S. military is asking for. The military wants to move into chiplets and system-on-board micro-packages, but they've got to stay within the ITAR restrictions.

**Dickson:** When I'm talking to people who are very early in VeCS, I don't use the term VeCS anymore with them. I call it micro slot and blind micro slot technology. That's because it's used not only in PCBs, but in other applications. It's moving up the supply chain from PCB into the interposer into what I'll call the silicon substrate.

To be honest with you, I think 10 years from now, you'll see micro slots that are shields for the signals. You'll see them everywhere inside the silicon interposer, and you'll have intermixes of HDI, VeCS type structures, and micro slotting because the parasitics will be a bigger factor. You can create a two-signal structure and then the rest of the slot becomes a shield. It's almost a perfect two-thirds Faraday cage.

So now you've got two different manufacturing methodologies there if you're trying to do it. But VeCS can do both of those. It can do the high-density thick boards in a conventional process. If you're using VeCS, it's a relatively simple transition.

**Holden:** There are four or five other advanced technologies that we really don't have in North America—for example, a very inexpensive method of excising the bad boards and then putting in a new board in perfect alignment so that we ship only good images in the subpanels. The boards inside of that subpanel


had come from four or five different lots, but at least everything gets shipped. It doesn't get thrown away.

**Dickson:** Happy, you're dead on. The carriers for assembly and automation in high volume manufacturing are fundamentally different than for low volume. Your cost per square centimeter is critical. If you're able to utilize all that material set, your costs go down by a significant margin. To me, that's the fundamental difference between the West and other parts of the world is that people aren't putting in low-cost volume manufacturing. My experience building manufacturing plants outside the West is they are five times the size of the largest plant.

When I hear people talking about bringing technology back to the West, I don't think they fully rationalize where technology is going. You put a 300,000-square-foot facility in the United States, for example, in a low-cost region with lots of water. Even still, you're going to spend over a billion U.S. dollars. The high-volume laminate manufacturers will tell you that the quality goes up because they're able to reproduce very, very high-volume materials. And if you're dealing with high-volume, high-quality materials that are lower cost, you have a huge advantage. But that's just because that's where they put the manufacturing plants.

**Johnson:** Joe, I'm listening to all this and I'm thinking, there's no way we can keep up. There's too much. To use my capital expenditure well, I need to be planning not for what I'm going to be doing now, but what I plan to do with my facility after that.

**Dickson:** We've been talking a lot about layers above the PCB. Now, if you move down into the PCB, the technologies that are "mature" are, say, 0.2-millimeter drills with a finished hole size of 0.16 millimeters. I think most of the Western manufacturers can do that. That's moving up. They'll probably get thicker. There will probably be some power distribution in that so they're going to be able to do that. Those are more traditional manufacturing. VeCS could benefit them dramatically because they could lower the layer count and assist in that. If you move it into the HDI type of technology, you're building facilities that are really expensive, or you're doing small volume.

For the Western companies, innovation is in the medium size capabilities. It's in new customer applications just coming to market. The traditional network suppliers are coming up with their own ASICs. They're coming up with their own systems-on-chips. Those markets take a while to mature. There's an entire market right there for them that won't require a lot of equipment changes, but they're at the bottom of the food chain. To stay influential in the design curve, they have to be involved in predesign chip ecosystems way before a design is started. This is tough as many customers, even new to PCB customers, treat PCBs as a commodity. This isn't the case with interposers or systems-on-PCBs. They are created in parallel.

Moving these to 3D structures in low- to mid-volume is going to be a huge market. That's why we've moved our pre-engineering discussions to products that are one year out or more. This was unheard of, with small OEM exceptions, just five years ago. It matches the next-generation chips with PCB ecosystems.

**Johnson:** What leaps out of this conversation is that there's technology that you need to choose to invest in, to move forward... or choose not to. That's the decision point that a lot of printed circuit board fabricators are going to find themselves in. It's going to be either pick a path, invest, and develop a specialty, or just be a generalist.

**Dickson:** Yes. And to Happy's point, if you don't have a disruptive technology that is going to make something uniquely different for organic interconnects, you probably will not survive, because this next generation is marrying micro-technology that's been in a phone for years. If you don't have a market to drive that to and you can't supply a disruptive and cost-effective high technology alternative, you're just going to be one of many. And volume will always win out.

**Johnson:** Thank you for this, Joe. We really appreciate it.

**Dickson:** Happy to help. Thank you. **PCB007**

# Do You Really Need to Buy New Equipment?

**Feature Interview by the I-Connect007 Editorial Team**

When we began looking into CapEx strategies for PCB manufacturing, we ran into a few company owners who were proud of making their old fabrication equipment last for decades. We recently spoke about CapEx planning with Alex Stepinski, former VP of GreenSource Fabrication, who built a zero-wastewater PCB fabrication facility from the ground up.

As Alex explains, your old equipment might actually last for decades, and if you need new equipment, you might find what you're looking for in another industry.

**Barry Matties:** I've mentioned this in several interviews, but oftentimes I hear fabricators bragging that they're building boards on a 20-year-old piece of equipment, as if that's a win of some sort. What are your thoughts on that?

**Alex Stepinski:** Well, a 20-year-old piece of equipment is one thing, because you could be using a 20-year-old piece of equipment if it has decent controls. It's really about the control level of the equipment.

Alex Stepinski

When we talk about age, you could buy new equipment 20 years ago that will still be working today, and some of it works quite well. It's just a matter of the type of controls that you put on it. Really, the value is in the engineering work that was done on that tool: How much engineering work was done, how was the capability developed, how well-understood is the tool?

If you have a well-understood tool, it could be 50 years old; you just need to be able to adjust controls or not. As long as you understand them, maybe you could adjust other aspects to compensate. It's really about doing due diligence in process engineering.

**Matties:** If we're talking about adding sensors, you have to be able to incorporate them into that aged equipment. You had a thought, Happy?


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**Happy Holden:** Yes, I was really surprised that on our alkaline etching machines, the control system was from ADA Tech. When we delved into it and started making measurements closely, we found out that this thing was really imprecise, which got us to brainstorming about how could we build a better specific gravity controller. We actually came up with a $55 one we built ourselves that has +/- 0.001 SG units control.

**Stepinski:** There you go. Exactly right.

**Holden:** They have them in the chemical industry, but they're $5,000 to $10,000 each, while the one we devised was $55. The mechanical engineers kept saying it wouldn't work. We finally dug out the textbooks and showed them, "You don't remember Archimedes' principle, the center of displaced mass. If we submerge the specific gravity sensor, then the mass never changes." They were saying, "The way you guys got it arranged this thing won't work." But they had just forgotten that little minor part of Archimedes' principle.

**Stepinski:** Yes. Nowadays, they'll do a standpipe with a pressure transducer on the bottom, and that's becoming more popular in the market on newer machines.

**Holden:** We had one of those also. A lot of times, we were taking things out of other segments: automotive, chemical, any place we could find a sensor that could be adapted to printed circuits. And, of course, digitization of the automobile was great because then we got low-cost volume sensors that they used to measure gasoline flow. Rather than spending a lot of money on very precise metering pumps, we just bought precise flow-measuring devices, and not precise metering pumps.

**Stepinski:** Yes. I agree. I've gone to trade shows outside of our industry to learn a lot myself, because just staying in our industry trade shows restricts your vision a bit. Going outside and bringing in equipment from other industries was a big component of what I did at GreenSource.

**Matties:** Thank you so much, Alex.

**Stepinski:** It was nice speaking with you too.

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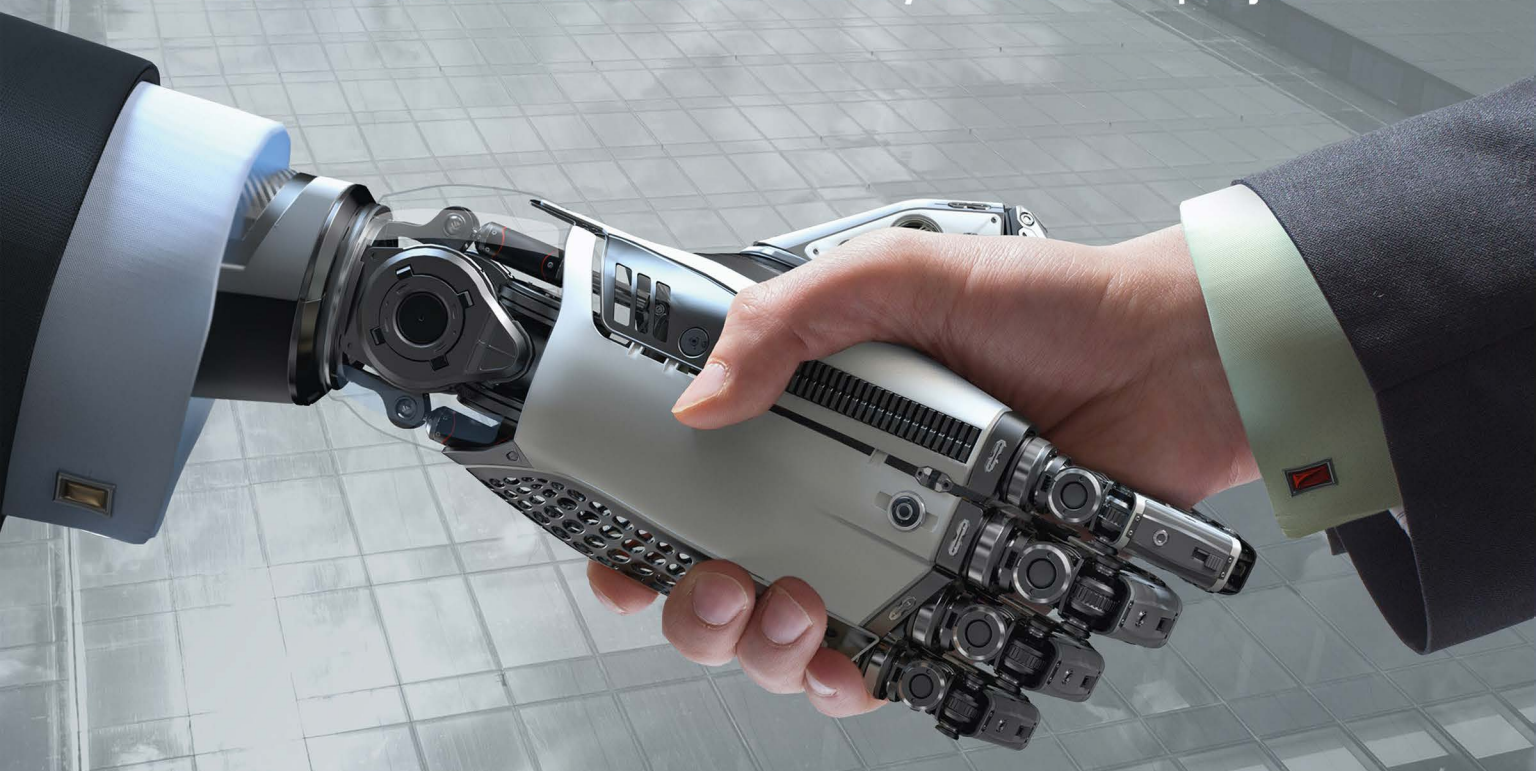

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# MilAero007 Highlights

## Volunteers Honored for Contributions to IPC and the Electronics Industry ▸

IPC presented Committee Leadership, Special Recognition and Distinguished Committee Service Awards on August 30 at IPC's SummerCom Standards Development Committee Meetings in Milwaukee, Wisconsin.

## ICT Autumn 2021 Webinar Review: High-voltage Testing and Advanced Antenna Materials ▸

This year's Institute of Circuit Technology autumn webinar presented papers by leading experts on high-voltage testing and advanced antenna materials. It was introduced and moderated by ICT Chair Emma Hudson.

## Defense Speak Interpreted: What Does Convergence Mean to Defense? ▸

How can a simple term like "convergence" be confusing, even at the Department of Defense and the U.S. Army? Webster's dictionary defines convergence as "1. The act of converging and especially moving toward union or uniformity," and "4. The merging of distinct technologies, industries, or devices into a unified whole."

## Summit Interconnect Partners with Lindsay Goldberg for Its Next Stage of Growth ▸

Summit Interconnect announced that affiliates of Lindsay Goldberg, a private investment firm, have completed a majority investment in the company in partnership with the company's president and CEO, Shane Whiteside, and other members of the management team.

## Kodiak Assembly Solutions Now ITAR Compliant ▸

Kodiak Assembly Solutions LLLP, a leading contract electronic manufacturer, announces that it has successfully completed its ITAR registration.

## Libra Industries' Dayton Facility Passes 3 Audits for Aero/Defense, Manufacturing, Medical Certifications ▸

Libra Industries, a privately held systems integration and electronics manufacturing services provider, is pleased to announce that its Dayton facility has passed surveillance audits for its AS9100D (aerospace-defense), ISO 9001:2015 (manufacturing) and ISO 13485:2016 (medical) certifications.

## BAE Systems Utilizes VJ Electronix's XQuik II ▸

VJ Electronix, Inc., the leader in rework technologies and global provider of advanced X-ray inspection and component counting systems, is pleased to announce that BAE Systems Inc. has been using the XQuik II to solve an industry-wide problem with the industry-standard Waffle Pack design.

## New Satellite Navigation Capabilities to Potentially Benefit Australia, New Zealand ▸

Thales Alenia Space, the joint venture between Thales (67%) and Leonardo (33%), announced that it has signed its first contract with the EU Agency for Space Programme (EUSPA), to provide new capabilities to Europe's EGNOS satellite navigation system.

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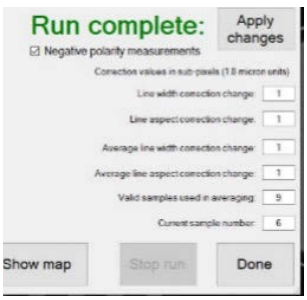


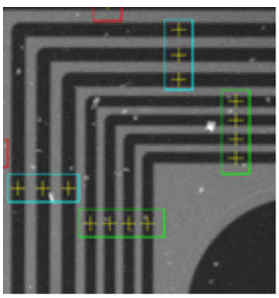

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# Direct Imaging and Beyond

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson speaks with Brendan Hogan of MivaTek about their new DART technology coupled with the release of a next-gen light engine, which is helping their customers cut costs and re-evaluate how they think of direct imaging.

**Nolan Johnson:** Brendan, welcome. We haven't talked in a few months. What's been happening at Miva?

**Brendan Hogan:** I believe we spoke at productronica, and a lot has happened since then in terms of the world but also our world here at Miva.

**Johnson:** In general terms, how has Miva weathered the last year?

**Hogan:** We weathered the storm pretty well. We've been busy. Much of our effort throughout the pandemic was on new technologies and projects. We had some well-timed high-tech projects that expanded our thinking on several fronts. We spent a lot of time and effort in R&D with some really exciting breakthrough developments.

We recently held a virtual conference called MivaCon, where we introduced our next-gen light engine technology and our new patented DART system to support Industry 4.0. These are game-changing technologies for our customers. We really believe that the key in our product going forward is how we look beyond direct imaging and make the whole factory run better. How can we improve other steps of the process? DART technology does that in dramatic fashion.

**Johnson:** And what do these new technologies bring to the customer? Tell me about DART.

**Hogan:** DART stands for digitally adaptable rasterization technology. Direct photolithography is the conversion of a CAM file and rasterizing it to a pixilated form so that the image can be produced on the substrate digitally. To

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date, conventional direct imaging systems make modest scaling or feature manipulations in an effort to "fit" the image to the panel.

The problem is that fabrication materials and processes are colluding to require more than "modest" adjustments to scale to meet requirements. Consider that we now have panel designs with multiple lamination cycles of exotic material builds, then panels are mechanically drilled with positional and registration error and/or laser drilled with completely different error levels. It makes for a very complex picture when the end user is looking for tight annular rings and ever smaller feature sizes.

Brendan Hogan

DART is designed to be a path to solve the most difficult manufacturing problems we face out in the future. Feature sizes will only get smaller, drilling denser, and materials will be more exotic; we know this is a certainty. At Miva, we have a solution path to handle the most difficult of these issues.

Existing Miva users can use DART today to transform the digital photolithography process into a factory floor-level tool to provide automatic compensations for variations in processes, such as develop, etch, or plating, to ensure that feature sizes and processes are performing at optimal levels.

In late 2022, Miva will be introducing its full vision for Industry 4.0 with its patented DART solution. That is, an integrated module to measure the as-built location of all designated panel features in-line with the next-gen direct imaging system, to allow DART's artificial intelligence kernel to adapt all panel features with greater precision, what we know today as "scaling." When coupled with Miva's post-develop/etch/plating feature size control, the Miva digital photolithography system turns the Industry 4.0 concept into reality with a real-time control center with feedback from all processes.

**Johnson:** Am I correct in hearing that DART is the start of a smart factory?

**Hogan:** DART is a smart factory. In the previous machine versions, we perform small parts of DART, but we were limited by computing power—the natural constraints of the technology we were using. By coupling our next-gen light engine and new processing power with the DART artificial intelligence kernel, we're able to take a wider array of data inputs into the equation when we do our digital adjustments for the feature size, position, and other factors.

Controlling feature size and scale accuracy in direct imaging is more than meeting your customer spec. Some applications don't require hyper-precision, but DART is also about opening the process window, and this is where some customers must really focus—the idea of opening a process window and controlling your factory in an automated way or under a reasonable paradigm. By opening the process window, the etch and strip process gets much better and can produce more with the same equipment set. If your features are more repeatable, you can develop finer features to a higher yield. If you can plate your features or come back and do a secondary plating operation with confidence that everything is going to be accurate, the investments that are made elsewhere in the factory are easier to justify, because the factory can handle increasingly higher technology.

It's a challenge for many of our customers to make this huge investment in direct imaging in general, whether it's ours or anybody else's. It's usually one of the most expensive pieces in the building. But our new DART technology, coupled with the next-gen engine, really should be having our customers re-evaluate how they think of direct imaging.

**Johnson:** How does you go about developing a technology like this?

**Hogan:** The company is growing quickly but is still relatively small. Collaboration and vision are required, we have major microelectronics partnerships and projects with companies and universities in Europe and the U.S. that have altered our thinking as to what our technology could be. Our work with the CHiPS consortium at the UCLA Nanotechnology Center is an example, where we use DART technology to alter the substrate positions of 1-micron pads to correct for error in the positions of semiconductor die before being attached. Some of the elements of the DART concept come from our work at UCLA, because of what we do in microelectronics. Functionally, UCLA is working to eliminate the package of the semiconductor altogether and mount the die directly to a silicon substrate. The key thing we found is that the mounting points on the die vary by a few microns. The question was: How can we manipulate the feature locations and the features so that each die (because we're talking about a micron variation) now matches to the substrate? The original thought process came three years ago when we faced this problem mounting embedded components for a micro-level customer in Europe.

**Johnson:** Obviously, it brings some greater sophistication to how your patterns get rasterized, and that's always an issue, but what does the light engine bring to this?

**Hogan:** The first step is that the light engine had to become DART compliant; everything in our system, the servers and all the hardware, must work in tandem to accomplish this complex task. But next-gen light engine takes advantage of the very high density DLPs, which are now imaging four million pixels at every flash. While it's a major throughput enhancement, the data channel has also been significantly enhanced to allow for real-time data transfer such that DART can now be responsive in real-time.

**Johnson:** That's easier maintenance, more throughput and a more robust system, lower cost to operate, more automation, and connection to the rest of my fab floor to automate more and have a wider process window. Those are a lot of benefits associated with swapping out and updating my equipment.

The next-gen light engine offers roughly twice the throughput for a modest increase in cost; this means a huge impact on cost per panel imaged.

**Hogan:** Certainly, the next-gen light engine offers roughly twice the throughput for a modest increase in cost; this means a huge impact on cost per panel imaged. Fewer light engines required means less complexity and higher reliability. But many of our existing customers don't need to swap out their equipment to become DART compliant. We've built an upgraded system now that extends the capabilities of the existing equipment to include DART. There are certain elements and some benefits of DART that the existing customer base won't be able to take advantage of, but at the end of the day they will have the capability, and that was all covered in our MivaCon virtual conference, which we opted to do when IPC APEX EXPO was canceled. New DART process control tools to make develop/etch/plating more consistent and feature control tools to improve feature uniformity are readily available to the currently installed machine base.

**Johnson:** Based on the experience you had with MivaCon, is it something you will continue?

**Hogan:** Yes, I think so. It wasn't to replace IPC APEX EXPO, but to educate our existing customers and begin building more content that allows us to get deeper into explaining our technology. We are in the process of evolving our website to include more regular webinars. A big element of our products is to reduce our technical support cost to the customer. If you're going to be the cornerstone of the shop, which direct imaging usually is, many of our customers don't have two or three direct imagers as a backup if one goes down.

We place a lot of emphasis on training the customer to conduct maintenance and calibrations to reduce support costs. Most direct imaging equipment has a reputation for very high cost of support, upward of 8% of original machine cost—every year. Miva systems are averaging a quarter of that.

**Johnson:** As you talk to your customers, what are the burning issues in imaging that are motivating them to be looking at new equipment? What are they trying to achieve?

**Hogan:** The biggest challenge the customer faces is about capital. Budgets are limited; where do they spend their capital? Do they spend to change or update processes? Do they spend it on yield enhancers? New technology? New capabilities? Customers need to prioritize their investment time horizon on what products or companies are leading technology and building systems that can adapt as requirements change. When we develop a product, we focus on how flexible it is and how long it can stay in the field. How long will it meet the future technologies? Miva still supports its original film plotters that are in the field over 20 years; we don't look at a seven-year horizon. If there is a way to adapt a machine for a new application, we seek it out.

When it comes to high-end capital equipment, customers get a little bit of "business vertigo," where the price of the equipment is so high that the customer needs to confirm that the product can and will adapt to future needs. They need a little bit more understanding of their own costs. What are the cost drivers in their own facility? So, when we do our own modeling, we try to include everything. We show the customer what they should be thinking about in terms of real savings, the costs of imaging.

DART extends our reach into some of the other processes that they already have and makes those processes better, more valuable, and extends their useful life. We've been able to demonstrate that it makes the existing development equipment operate better. That's a big game changer in terms of how either capital equipment or ROI should be considered.

**Johnson:** Can you give me an example of that?

**Hogan:** DART as delivered today comes with a series of optimization tools which allow you to adjust your develop/etch/plating to be more uniform, more repeatable. In one particular installation, we used a very large format machine with a 42-inch-by-60-inch imageable area—the size of a conference table. The challenge was to get all the features within 1-2 micron everywhere on that imaging area.

The DART Process Control module was used to optimize the develop and etch process. Using the machine vision technology integrated in the Miva system, we can present feature deviations in size on a topographical map to determine the sources of variation in develop/etch/plating. The testing and adjustment can occur at the operator level so it can be done periodically as a normal operation. Once dialed in, the process window is widening for these processes.

DART First Article serves as a precheck to confirm each process effortlessly and at the operator level. The tool uses the Miva machine

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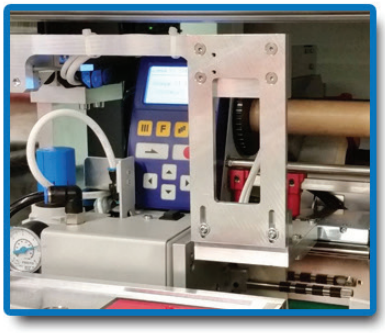

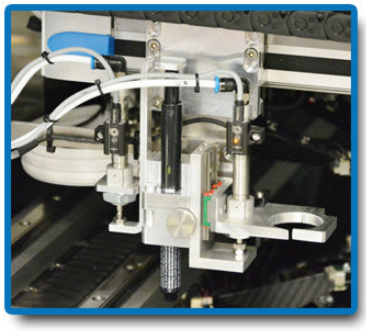

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vision system to make recommendations to digital feature size adjustments that encompass variations in the external processes, such that the features exit the etch process at optimized feature size.

**Johnson:** It sounds to me like, through the DART technology, you're able to compensate for the specific performance of the other equipment in the line—the etch equipment, for example. DART is adjusting the raster patterns to get a more precise result out of that specific piece of equipment.

**Hogan:** Yes, Industry 4.0. Conceptually, digital imaging in the first phase was to basically get rid of silver film and take some of the human error out of registration. DART starts to take some responsibility for the output from develop/etch/strip by building these feedback loops. Currently, the feedback loop is not live where every panel off the machine is being measured in an automatic way. We're developing that; it's in our technology roadmap.

The key thing is it's at the operator level. If an operator can do this and make these adjustments without calling a process engineer, stopping the line, and doing some development effort, that's important because it needs to be at a level where an average person can analyze the results. We put all the analytical recommendations on-screen.

**Johnson:** If you can adjust the imaging in DART for variations on your line throughout the day, then you can most definitely adjust the output for different lines in the same facility. Operators can make adjustments at the image to dynamically dial each board into the center of the process window—or at least closer to the center of the process window.

**Hogan:** That's right. Some of the development concepts go back a few years, when customers were doing some controlled impedance work and they needed a specific group of lines to be within a very tight tolerance or confirm their size. The issue of controlling feature size in the aggregate becomes compelling if you're trying the 2-mil line and space and your features are maybe within five to 10%; that means the space between the lines is closing up and your develop process is much more challenged. DART becomes a yield game changer in something like that. To a very large extent, tools like this will allow the user to get much more out of their existing equipment set.

**Johnson:** That does seem to be a theme for capital expenditures right now: taking a system-wide view of any equipment being purchased. How does your system add value, not just to that particular gate in your manufacturing process?

**Hogan:** The modern factory floor collects a ton of data. Industry 4.0 and DART are about putting the data to work to digitally adapt at the imaging level so that the result is deterministic. The government talks about expanding manufacturing; hopefully they will get the message and start to help our customers out with some tax benefits for acquiring capital equipment that lowers costs and expands technology. Capital equipment that isn't fully expensed in the first year reduces our ability to be cost competitive given our higher labor costs. There was some accelerated depreciation, which was good. I think it was a good down payment. But if the country is going to rebuild the manufacturing base, the government must think of it more broadly and allow the customers the tax deductibility and the expensing of equipment to be accelerated permanently. This aligns the objective of expanding manufacturing and technology with tax policy.

**Johnson:** Federal legislation passed in the U.S. recently to help encourage U.S. technology—military tech, in particular—to take care of our own military electronics needs, specifically. Of course, one would anticipate that's going

to trickle down into other markets as well. Because you have a strong presence in semiconductor manufacturing, Miva is well placed to see market drivers not only in the printed circuit board side of the business, but in the semiconductor side of the business. Compare and contrast, if you will, your view on support and subsidy going into semiconductor vs. printed circuit board.

**Hogan:** Well, we certainly see that in defense contractors, direct government operations, DARPA, and the various science foundations related to the government. Miva systems have been adopted by many of the most notable organizations that are defending the country in one form or another.

The government has a major role provided it's not steering the outcomes. ChiPS (UCLA) is working with new high-reliability interconnect methods by coupling PCB and semiconductor approaches in medical devices, flex materials, and highly integrated ICs. Their efforts and the efforts of many of our customers involve specific solutions for defense and security issues, but also then have major overlap into everyday or productivity solutions as well. This is where the governmental role can be vital because it echoes into every part of the economy.

**Johnson:** Brendan, this has been awesome. There is a lot here. Thank you for all of this.

**Hogan:** Thank you. Hopefully all of you are safe and we can see you at IPC APEX EXPO in a few months—in person. **PCB007**

**Brendan Hogan** is managing director of Mivatek Global. He has 35 years of electronic manufacturing experience. He has a BSEE and MBA from Rutgers University.

# Managing Capital Expenditures: Not Just Machines Anymore

**Feature Interview by Barry Matties**
I-CONNECT007

In this interview, Barry Matties spoke with Peter Bigelow, CEO of IMI Inc., about the trickiness of managing CapEx in a company with limited resources. They discuss the importance of planning things out in advance while still being flexible, why companies shouldn't be afraid to invest in processes that may save them time and money, and why firms with ITAR customers may wind up spending as much on IT and cybersecurity as on equipment.

**Barry Matties:** We have been looking at the process of CapEx, how people go about deciding what they're going to spend their funds on, and the motivation behind it. When you're looking at CapEx expenditures, what's your approach to ranking or prioritizing where you're going to invest your money?

**Peter Bigelow:** Well, that kind of explains it all. I may not be the typical owner because we're a small company and I wish I had more capital dollars. We spend about 8% of sales on capital, which is a large percentage, but in dollars it's not huge. I typically have something I must replace or something I want to buy new, and something which comes out of the blue. With this year as an example, we bought a new etcher and that was more of a replacement than an addition. We're also buying lab equipment, which is technologically advanced so, in my mind, it's not a replacement, but an addition. In past years, we've put in direct imaging (DI), which was an addition; we bought drill machines, which were a replacement; and you have that kind of a flow that goes on.

So, I look out a few years and say, "If I can average spending at so much per year, what are the major things that either appear will need to be replaced or appear to be newer technologies we should be embracing?" You work through a budget and then you move the pieces around based on the opportunity. A piece of equipment planned for two years out becomes available, so you move it up and push something else back out. You're doing a lot based on need. Then you have the things which you don't plan

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Peter Bigelow

on, such as when a chiller dies and it shouldn't have, but it does, and you have to replace it.

One of the big expenses we've had over the last few years is NIST-800, CMMC, and IPC-1791—just security, cybersecurity, and all that goes with it. For us, that meant spending a lot of money on consultants, which is not really capital, but then basically redoing our entire IT and physical plant security systems, which was a major capital upgrade. I could argue, did we really need it all to run the business? No. But to be in the markets we're in, we certainly did. So, we spent a lot of money on what was an unforeseen expense. If you'd talked to me five years ago and said, "You're going to spend a few hundred thousand dollars on IT and security stuff," I would have said, "Really? For our company? I don't think so." But we have. And because we've done that, we are now IPC-1791 certified. I think we were the fourth fabricator in the country to get that certification. We're in good shape for the CMMC, if and when that finally rolls out, to be at least level three. We're hoping for level four. But that was all unexpected.

When you're looking at capital in a company our size with limited resources, you have to plan it out and be flexible enough to move around priorities when things occur. If I were in an assembly business, which is quite different, that's dealing with an entire line. I'm guessing that you've got the same issue of needing to replace a line at some point with newer or better. But you're also probably looking at what mix of business am I quoting, and do I have enough capacity or capability for that particular mix? You're probably focusing more on the sales end of what you need vs. the operations of what you need. We all need more test measurement, verification, and validation equipment. Everyone needs that, no matter what industry you're in. If I were a larger fabricator, I'd be doing what I'm doing, but on steroids. It's a lot more money, and a lot more complex.

**Matties:** You've mentioned a couple of things. One, it's a replacement strategy and you have end-of-life equipment that you must replace. When you look at replacement, you're usually either looking at adding the latest technology or adding capacity. But on the IT side, it's what you had to do to stay in the marketplace, so it really was a strategic expenditure that you made there.

**Bigelow:** Correct.

**Matties:** But you indicated that it was a surprise. Why was it a surprise?

**Bigelow:** The surprise was that, once you start to work on one aspect, it mushrooms into everything. As soon as we started working on making our systems "secure" to communicate in and out of the company, as well as interact with our customers and suppliers, it started a

domino effect that impacted virtually every piece of equipment we had in the plant. We had to have the internet, which communicates outside, made secure; and intranet, which communicates inside the facility, be able to quarantine information that was on older systems allegedly vulnerable to cyber hacking. Now it must be Windows 10 software and not anything older than that. We have DOS still running in our building. We have some of our old Excellon machines that work great, but the software is ancient.

We needed to find a lot of workarounds to make sure that the data coming in and out of the building was secure and nobody could get it. Once it was in the building, we had new protocols and, in some cases, new methods for communicating with equipment that was offline and safeguards to make sure that the offline data did not end up in an online environment. All that requires additional servers, and not just hardware, but process and procedure changes. That was what surprised me, because I thought it was going to be rather simple—we update the computers, we update the server, done deal. Instead, we discovered it required buying expensive stuff, like switches, servers, and all kinds of equipment which you don't think about; you don't think about the expense and it can begin to add up.

To update some of our equipment, we had to have new methods for when suppliers come in with a laptop and they want to update the software; in a secure IT environment, they can't do that. Now they must go through a different protocol, which none of them like because it's a real nuisance; we understand that, but you must do it. Even with equipment you don't think about, like controllers for heating and air conditioning, suddenly they have to be secure. It was just kind of a surprise. We're a small company; we don't have an IT staff that can race around and do it all, so we had to change how we operate.

We had to find an IT company which had expertise in security and compliance. Previously, we had someone who would come in and fix stuff, and he was wonderful, but he had no interest in worrying about whether it's HIPAA-compliant, SEC-compliant, or cyber DoD-compliant; he didn't want to do that. We had to bring in a firm and get them up to speed on what we do. All that time and effort was a surprise, and as difficult as it was for us, I'm sure every company in the industry is going through something similar. I really feel that it's a scalable expense. Whatever I spent, you could probably just take the company's sales and use the multiplier against our cost and it's probably going to be that kind of a cost for them. There's no cheap way out. I don't think there's any economies of scale.

**The more facilities you have, the more lines you have, the more people you have, the more issues come up that need to be dealt with.**

The more facilities you have, the more lines you have, the more people you have, the more issues come up that need to be dealt with. Now you're paying for licenses for everyone's email accounts, so they are able to two-factor authenticate everything they do. It's been extremely interesting. As you may know, I've been frequently on the Executive Agent calls and various IPC committees on 219B, 1791, and so on. I keep telling them I'm the poster child of the small guy, so if I'm telling you I can't afford to do it, or I can't do it, that means that there are a lot of other companies, maybe outside our industry, that are going to be in the same awkward position of having to make "Sophie's choice." What do you do next?

In March of this year, IMI installed a UCE (Universal) Alkaline Etching Machine to offer their customers world-class etching and line/trace tolerances.

**Matties:** For some of those companies, they're just going to wind up closing their doors, I would think. How can you survive if you don't have that infrastructure and security in place?

**Bigelow:** That's very true. I think it will force some smaller companies to decide to milk it and retire rather than try to keep going. We have some things we outsource; I think everybody in the industry outsources a process which they rarely need to do that's not worth putting in. In one case, it's literally a machine shop run by a dad and his son. They've made it clear that they're not going to do ITAR because it's too difficult for them. They just don't care. Unfortunately, the stuff we had been sending to them was ITAR, so we had to find a new supplier. We've got that kind of disruption going on. A lot of the companies that the military subcontracts to are going to say, "I don't want to do that to become ITAR, CMMC, etc., compliant because you're too small a portion of my business to go through all of this."

I agree with that. But I also happen to think that a lot of the cybersecurity things which have come through on the DoD end of it, and including even IPC-7091, will be adopted by a lot of companies which are not military-centric. Anyone who's got intellectual property, in the medical world, or if you're in anything which is patent rich, I think they will need to have that kind of security system in place. They will have to belly up to the bar or have their suppliers do it to become certified or to comply. The bright side is that it may be required by more than just DoD-centric companies.

**Matties:** Now, shifting gears to paying for the CapEx. The cost of money is pretty cheap right now. Do you find this is a good time for finding capital and investing?

**Bigelow:** There's plenty of money available with leasing companies, banks, and so on. I'm a conservative guy. I don't want to leverage too hard because when there's a downturn, it can be devastating, so we're conservative on that. We try to spend a sizable portion of cash vs. borrowing and so on, but the money's available, for sure. I think that it bodes well for people spending capital. There are many who received PPP loans and they did not need to use the money for COVID purposes; that extra money can be used to reinvest. My neighbor is a restaurant equipment distributor. He said 2020 was a horrible year because everything was shut down. This year has boomed because everyone got the PPP money and they're redoing their restaurants to beef up their takeout, upgrade, and so on.

I have to believe other industries have had some of that opportunity to use PPP funds to spend on capital equipment as well. But there are indications interest rates will be going up. Between shortages, which are going to theoretically tick up the inflation level, and federal policy and government spending policies,

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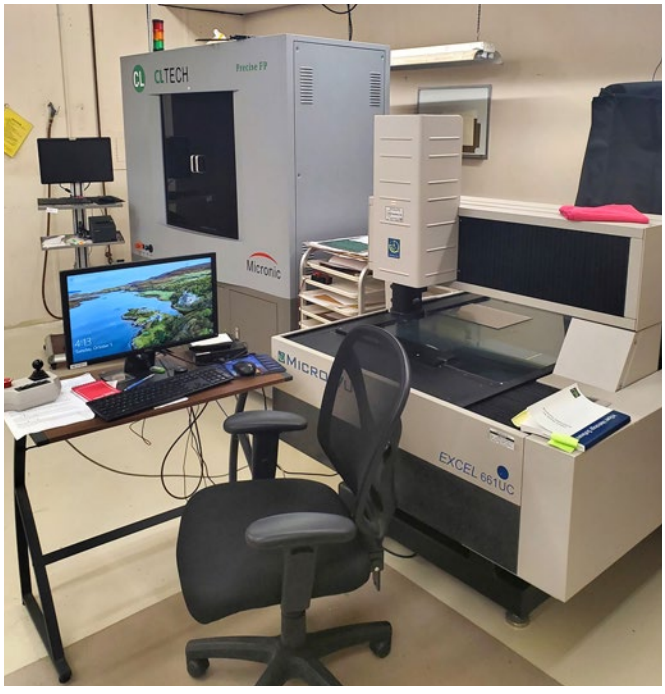


IMI's new purchase of a Micro-Vu Excel 661UC vision CMM has expanded their metrology capabilities in terms of accuracy, repeatability and speed.

interest rates will be going up. I think people are seeing that and thinking, "We've got a pretty good economy right now, so if I borrow more today, it will be a bit cheaper for me long-term than if I wait and do something further out." I think it's the publicly traded companies vs. privately held companies that have access to greater capital.

I have had this conversation with some who have done industry checks on circuit board fabricators; they are horrified because, of the approximately 200 companies left, 150 of them are not profitable. I said, "Well, they're probably all privately-held companies, so the number you need to look at is EBITDA, not profits, because you're spending the money on capital so you can take advantage of accelerated depreciation and not pay taxes. If you've got the EBITDA to do that, that's great, you're reinvesting." But publicly traded companies must beat to a different drummer so they may do things differently. A company like TTM, which has more access to capital than I would ever have, has a lot larger need for capital equipment, and is probably more strategic in how they spend it, may find that they have internal restrictions that I don't have on how much they can spend on CapEx. Yet while I don't have those restrictions, the one I have is just simply that I don't want to spend too much money because I don't want to go broke.

**Matties:** Exactly. When you're looking back to the CapEx expenditure for a specific period, are you looking at a year in advance? What sort of horizon are you looking at when you're planning your CapEx?

**Bigelow:** Every year—which is coming up, probably in an October timeframe—I will put together a capital plan as a five-year outlook. For next year, I have my needs and wants, and I put that list together. Then the next year, I will probably have fewer needs and a couple of wants. Some of the needs might be from my want list in the earlier year and I work my way out. I always plug in a number for miscellaneous manufacturing and miscellaneous facility. We own our facility, so we must be aware of those CapEx needs as well. Something may happen that requires we do something to the building vs. spending on the manufacturing equipment side.

When I do this, it usually results in a huge number. I know what I can spend so sometimes I will blow the budget in one year and then the next year I cut back a little bit on what I spend, but I'm rolling the budget, working it where I need to. There are some items which for several years we kept pushing out, and there are some things which have popped into a year which we hadn't planned on. But by trying to look at it that way, being flexible and having conversations, we know what's about to break, what has broken, what new things we should be looking at, and we factor that in. As we are a small operation, we can all talk about it easily.

**Matties:** So, the replacement would be straightforward. You see what's aging, what's wearing

out, and you know what you need to replace. What other priorities are you looking at? Is it a bottleneck in your shop? A cycle time reduction? Increased yield? How do you prioritize the importance there?

**Bigelow:** I think there's always a bottleneck. Once I had a consultant who said that what they found fascinating about circuit board fabricators was that there was always a bottleneck, and it was never the same; the bottleneck is like a bubble; it kind of moves through. But, case in point, a few years ago, it became apparent that we were doing a lot more first article inspections (FAIs) than we'd ever done before. It was a growing trend. We realized we had to beef up our inspection area and the physical layout, as well as the equipment. We spent some money on CMM equipment, additional scopes, different types of computer software, and so forth. It was more like we identified a potential bottleneck that was soon going to really be a problem. Then we looked at other areas. In the wet process area, there are a few things we have on the list of things we want to do. They would add capacity, yes, but will also add capability.

When we invested in the DI, that was an interesting issue. Our photoplotter was dying and that was going to be a couple hundred thousand dollars to replace. But we also knew that the strength of this company was we could plate anything; and we do so. We can press anything. We're very good at mixing materials and shrink factors, but the weak link was our old registration equipment. That was the case where the DI was going to be a lot more expensive but appeared to be the direction we needed to go. We bit the bullet, put in a direct imaging system, and it was a phenomenal game changer in efficiency and time reduction; obviously, the level of accuracy and quality would improve so registration is our strong suit now.

That one was strategic. We had to do something because of replacement but decided to leapfrog forward and get ourselves in a better position. I think there are probably a few other areas where we could do that as well; the technology is improving to a point where instead of doing what you did before, maybe go further. I look at our press; we have a fine press but looking forward I would really like something that could go maybe 80 or 90 degrees hotter so it could run some materials we can't run today. That's one where it's not high priority. It's on the B list, if you will. But when the time comes, it's going to probably be a radically different system than we have today because I want to be able to run materials we currently can't or that we have difficulty running at the current max of the system we have.

**Matties:** Have you considered an induction press?

**Bigelow:** We're thinking about where we need to understand how that works with PTFE materials and so on because that's the bulk of what we do. There's a lot of homework we have to do up front on what kind of press it is. Everyone's paradigm seems to be FR-4 and the variants of FR-4, yet we run very little of that. When we run it, it's often with another material so that's where we need to spend a little more time doing some homework on that. But we may go that direction. It's one of the technologies we're looking at.

**Matties:** By bringing in direct imaging, the DI system, you eliminated many process steps by doing that, so your cycle time certainly decreased in that regard. When you looked at that and you totaled the savings, did that inspire you to look for other technologies, for example, inkjet solder mask?

**Bigelow:** We never planned on savings. Everyone said we'd save some money and we always kind of figured, "Yeah, sure." It was a savings. I think that opened our eyes to the fact that there are places where you can make that kind of a change and get a lot of collateral benefit. We

IMI's recent capital expenditures include a laser depaneling machine.

do so much PTFE and we do very little solder mask. But we have been intrigued with some of the ink technologies that are out there. We've been intrigued with a lot of different things that look like they could be very beneficial. Do we have the volume for it? I don't know. But if we're going to make a change, should we just make the change and go from there? That's a battle I have: it may cost more, but if it has more capability, it should benefit us in other ways. Some of the people who are actually doing the process are more set on, "I don't want to change." You've got to balance all that around, too.

**Matties:** The old paradigms get in the way of some of the planning. People are stuck in the way that they do things, but when you look at DI as an example, sure, it was an expensive price tag. You chose to bite the bullet and the savings were greater than you expected. There are soft savings in there that you may not have even realized. For CapEx planning, we can't let the price tag scare us away from some of these technologies. I think that is the message.

**Bigelow:** Absolutely. You must keep your eyes open for all the technologies coming down the pike. And, even if on the surface it appears to be either overkill or something that's not going to quite fit into your situation, you should take a hard look at it because sometimes a technology may have a lot more capability than it's being advertised to have, or the salesperson may not understand your business and where it might best fit in. You have to look at all of that. That's the exciting part, by the way, of capital spending. Every accountant will sit there and moan and groan that no matter how much you think you're saving, you're not saving enough and it's costing too much money. But the exciting part is seeing what some of this equipment can do and how it can change how you operate. I tend to really like looking at equipment and seeing what it can do. I like going to shows and seeing everything. It's a little like when you go to a Home Depot. I know what all these things do but I'm not sure what I'd ever do with them. But you go to a trade show, and you see everything and say, "Yeah, I could use that. Maybe we should be considering something like this or that."

**Matties:** How involved is your sales and marketing team in your CapEx planning, generally?

**Bigelow:** Since I run sales and marketing, they're very involved. But to that point, we get requests from people on doing things which we can't do. I pay attention. If I'm getting enough inquiries, what will it take to do that? We do a lot of substrates here and we get inquiries all the time about aluminum, which

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we do not process. I keep thinking, why not? What's the gate for doing that? There are some waste treatment issues which enter the picture and need to be thought through. Everyone who visits IMI asks, "Why aren't you doing flex? You guys are perfect for flex. You've got all the material handling because you're running very thin materials." Well, we spent a long time looking into flex and we concluded that for us, the tooling was going to be such a radical departure and that it probably was not the place to invest in growth with the limited resources we had available. But you went through a real exercise of what we had in place, if we could put everything together, and if we have complimentary processes. But it's the areas that you don't understand that are going to kill you. As we spoke to more people, they said that the tooling can absolutely kill you if you don't really understand it and do it well.

When you're looking at CapEx, the other side is the facility itself.

**Matties:** I think that's part of experience and wisdom, to understand and to have the discipline to know when to say no, because you can find yourself in a lot of trouble and a deep hole if you don't.

**Bigelow:** In this industry, we both know a lot of people who, over the decades, have made some strategic errors that ended up costing their businesses. I don't really want to be the next one who does that. We're still here, and I want to continue to be.

**Matties:** What year did you start your business, Peter?

**Bigelow:** I got into the circuit board business in 1992, back at Beaver Brook Circuits [Connecticut]. I came here in 2002 and bought the place in 2006. IMI is 50 years old this year, so we are also one of the oldest companies on the fabrication side in North America.

**Matties:** I visited your facility some years back, and I recall it was in a very cool structure. It seemed like it was an old store.

**Bigelow:** It's a whole grocery store, and the cool structure is where you parked your car underneath it, the front thing. We removed that several years ago because it was falling apart. We moved here in 1985 and bought the building that had been a grocery store and converted it over to manufacturing.

**Matties:** When you're looking at CapEx, the other side is the facility itself. There's always going to be more requirements for investment, changing floor plans, and that sort of thing. How do you weigh that into your mix of CapEx spending?

**Bigelow:** It's part of the equation. I must tell you that I always hate having to replace HVAC systems because, while I know we need it, it's very boring. I also know those types of things are going to need replacement periodically. We had to replace our roof at one point; that was very expensive, and it also sucked some money out of the operating business, but you have to do it. We pay rent and we try to have the rent account cover as much of the building needs as possible, but when we redid the whole quality area a few years ago to facilitate the changes taking place, the operating company footed that bill.

We were restricted with some walls that we could not move but we found a way around it. It's part of what you do. The floors and things like that, at some point have to be redone and you just factor it into that miscellaneous budget for facilities. The budget number is usually

big because if you replace an air conditioning unit, we're talking $25,000 to $30,000. Even in a small company you have to plan on probably $40,000 or $50,000 for all that in a given year. Some years you get away with almost nothing and you can spend that money elsewhere, but other years it's going to be more expensive.

Some years you get away with almost nothing and you can spend that money elsewhere, but other years it's going to be more expensive.

**Matties:** That's the way it goes. What about workflow? How do you utilize that space and change your workflow?

**Bigelow:** The configuration of our building is such that in that particular case, we have a space which is bigger than we need, but there's not much flexibility. In wet processes, we've successfully moved stuff around based on desired changes, but we're limited because it all has to tie into the waste treatment system. There are a lot of places with limitations. We have talked from time to time about doing a shuffle in the building and swapping departments around—maybe in a couple years because it requires a lot of planning and staging to be successful. As an example, we've talked about moving inspection into the area with the photoplotter that's no longer used, and then taking the current inspection area and making it strictly for electrical test and other processes which are not exclusively part of final inspection. In doing so, we would be able to put a significant cleanroom in one of the areas which we'd like to have.

But that requires doing a shutdown when you can actually plan it. At the same time, we would redo the floors, which means you've got to bring somebody in for that. Those become big projects that may not cost a lot of money but are highly disruptive and require significant planning to pull off.

**Matties:** There's a big interruption in your daily process.

**Bigelow:** Yes, absolutely.

**Matties:** Good. Peter, is there anything else around CapEx that you feel we should share?

**Bigelow:** I think we've touched on pretty much all of it. Depending upon your size, the business you're in, if you're assembly, fabrication and so on, your challenges are going to be different. I think the thing which is essential is that you keep doing it. You can't say this year that you don't want to do something because the following year, it will cost you twice as much. Every business has replacements on a regular basis, and you just can't stop because it will cost you the same, but it will be much more difficult to fund it when you have to do all in one year vs. a little bit every year. You're kidding yourself if you think you can cut out capital spending. You need to do it with a discipline that gets you to a long-term goal, which should be success.

**Matties:** Whatever your motivation is, be it cycle time or yield or whatever, stick to your plan.

**Bigelow:** Correct.

**Matties:** Great speaking with you, Peter. Thank you for your time.

**Bigelow:** Thank you for the opportunity, Barry.

PCB007

# Supplier Highlights

## The Plating Forum: An Overview of Surface Finishes ▸

Surface finishes' research and development departments on the supplier side have been very busy coming up with new finishes to meet the everchanging demands of the electronics industry. Today, designers have wide variety of finishes to choose from.

## Nano Dimension Teams with Fraunhofer Institute to Develop Next-gen 3D Printing Systems ▸

Nano Dimension Ltd. announced a collaboration with the Fraunhofer Institute for Manufacturing Engineering and Automation IPA (Fraunhofer IPA).

## Matrix Announces Expanded Inventory for Flex Materials ▸

Matrix Electronics, a North American quick-turn supplier for raw materials to the printed circuit market, announced that they have completed an expansion of their inventory of flex circuit materials to support the growing flex and rigid-flex circuit business.

## Ucamco Releases Updates for UcamX and Integr8tor ▸

Ucamco is proud to release UcamX and Integr8tor v2021.04. Both are major updates for your software suite and for the PCB sector at large.

## IEC Partners atg and Eternal Technology Receive Award from TTM Technologies ▸

IEC is proud to congratulate two of their supply partners, atg Luther & Maelzer and Eternal Technology, for winning a Global Supplier Award this year from TTM Technologies.

## Insulectro Hires Supply/Demand Expert Montserrat Barcelo as Director of Supply Chain ▸

Insulectro, a distributor of materials for use in manufacture of printed circuit boards and printed electronics, has hired industry veteran Montserrat Barcelo as director of supply chain, replacing Jason Shuppert, who was recently promoted to vice president of operations.

## Testing Todd: Design for Manufacturing? Don't Forget Test! ▸

Design for manufacture (DFM) is a great discipline for creating designs that provide optimum performance while still maintaining affordability. However, what can be, and does get overlooked is the DFT (Design for Test) variable. As greater manufacturing demands are put to the manufacturer it also creates challenges to validate the electrical deliverables that may be required.

## Additive Reality: Solder Mask Patterning at the Edge Between Drops and Bricks ▸

The digital form of the inkjet printing technology goes through files containing a rasterized image; these bitmaps, in their simplest form, contain information about presence (or absence) of drops. Additionally, the resolution brings in the drops pitch.

## Nan Ya PCB Reports 30% YoY Revenue Growth for August ▸

Nan Ya Printed Circuit Board Corp. has posted unaudited sales of NT$4.7 billion ($170.36 million at $1=NT$27.73) in August 2021, down by 3.2% from the previous month, but up by 30% year-on-year.

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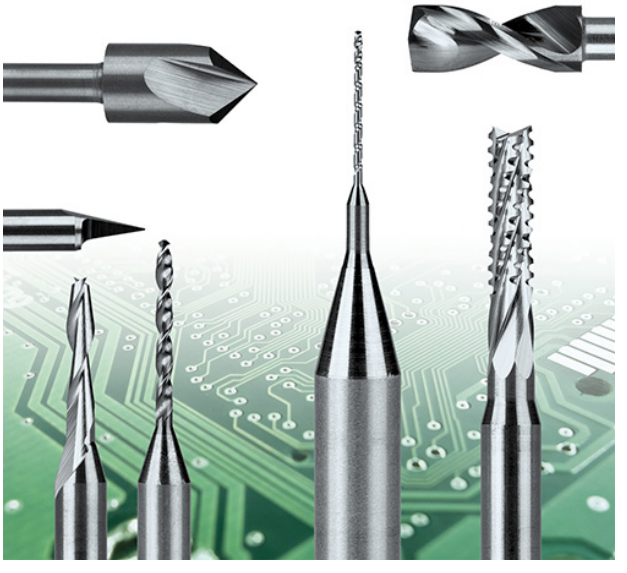

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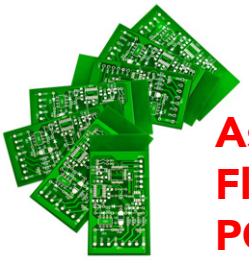

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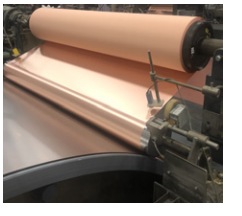

# Via Filling—Continued

## Trouble in Your Tank

by Michael Carano, RBP CHEMICAL TECHNOLOGY

## Introduction

In a previous column, I presented several options with which to accomplish blind and through-hole via filling. In this edition of Trouble in Your Tank, filling blind vias and through-holes with polymeric pastes will be presented.

## Via Fill Paste

Often the term "plugging paste" is used to describe the method and material of completely filling blind vias and through-holes. In general, paste filling material selection is at the request of the end user and is indicated for several reasons. It has been my experience that major OEMs are driving the industry to migrate to the high Tg/low CTE plugging paste formulations for high density applications. In addition, these formulations are of a non-conductive nature that provide a high quality plugged via, and are also cost effective (Figure 1). Limitations abound depending on PWB thickness, via diameter, and paste properties.

### *Properties of Via Fill Materials*

What attributes are needed for a high performance via fill material? There are specific requirements for the plugging paste material. These are:

- Good adhesion between copper and paste, even under temperature influences
- Good adhesion of copper, dielectrics, or photoresist
- Solvent-free, one-pack system
- No air inclusions in the paste
- Tg > 140°C
- CTE < 40 ppm (below Tg)
- No shrinkage during curing
- Easily planarized

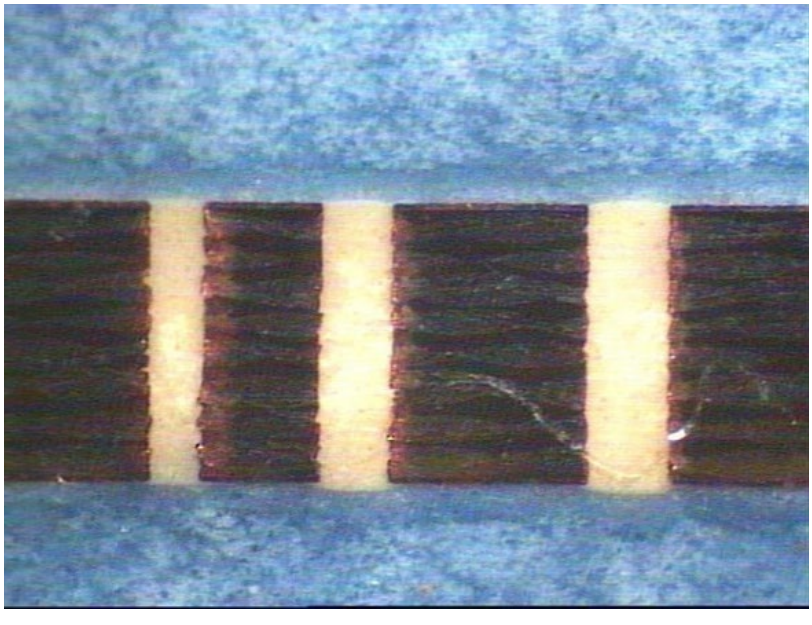

Figure 1: Example of a paste-filled through-hole.

Additionally, the plugging paste material must maintain a reasonable shelf life at room temperature. Keep in mind that these materials are thermally reactive.

It is highly recommended that the fabricator uses a 100% solids content of the paste material with the thermally cross-linkable epoxy resin and specially designed ceramic fillers. The ceramic filling material restricts Z-axis expansion when the filled vias are subjected to a thermal load. Interestingly, the coefficient of thermal expansion must remain in the 40-60 ppm range to ensure that via cracks do not occur in the filled via. In addi-

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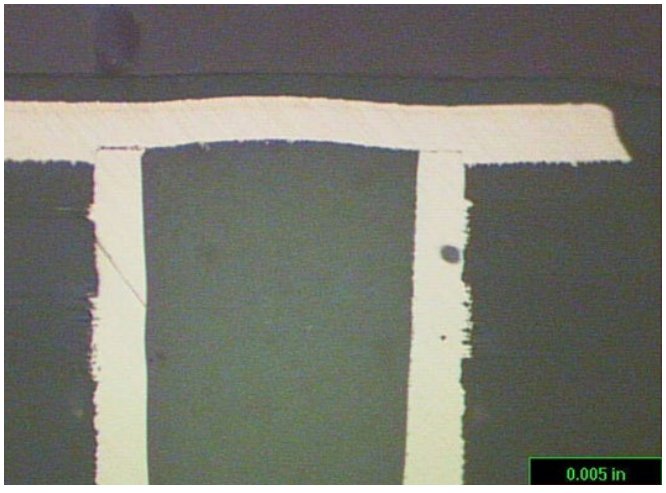


Figure 2: Plated copper separating from filled via due to excessive Z-axis expansion.

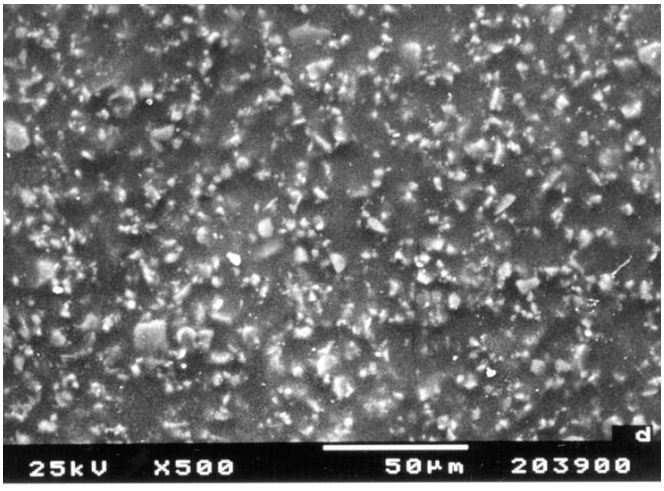


Figure 3: Top view of filled via with plugging paste. Ceramic particles embedded in the matrix are clearly visible.

tion, it is critical that Z-axis expansion be minimized to prevent the plated cap from lifting (Figure 2).

As noted previously, a properly formulated plugging paste for via fill must maintain a low CTE at and above 140$^0$C. The ceramic particles that are formulated in the resin system function to restrain Z-axis expansion under thermal loading.

The ceramic fillers can be seen in Figure 3 under high magnification of the fully cured polymeric paste.

There is no disputing the fact that the vias must be filled void-free and maintain integrity throughout various thermal excursions. Z-axis expansion notwithstanding, the second critical thermal characteristic is the glass transition temperature of the cured paste material. Typically, a Tg of 140$^0$C is ideal. However, the Tg can be increased by prolonging the final curing time and increasing curing temperature from 140$^0$C to approximately 175-180$^0$C. It is desired to have the highest possible Tg without impacting the flow and metallization properties[1].

With increased densification leading to higher I/Os, smaller components, higher assembly temperatures, and smaller vias, the CTE gains increased importance. Thus, the CTE values of the paste must be minimized to relieve stress that will cause the plug to over expand, causing the over-metallized copper deposit to lift[2]. It is critical that to attain long term stability within the filled via under load conditions, load amplitudes must be minimized as much as possible. This means that the CTE must be as low as possible over the temperature ranges[2].

Regardless of the method of via filling chosen, this is a process that is here to stay. Via filling technology is a critical aspect of HDI printed circuit board fabrication and the never-ending quest for miniaturization. **PCB007**

**References**

1. Karsten Andra, "Hole Plugging Technology for Multilayers and HDI Packages," EPC PCB Convention, 1999.

2. Internal communication with Lackwerke Peters.

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

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# Made in the USA

**Feature Interview by Barry Matties**
I-CONNECT007

Barry Matties interviewed Thomas Walsh and Travis Houchin of Integrated Process Systems regarding industry trends they're seeing in capital expenditure and the changes they have noticed in their customers' requirements.

**Barry Matties:** You have added some new people in the last year or so. How many people are now at IPS?

**Thomas Walsh:** We have over 60 now. The company wanted to expand the sales, service, and engineering teams—we added a few engineers, inside service, parts, and our plan is still to add more field guys. IPS has enough equipment in the field now which demands that we have traveling service employees. That is a focus right now.

**Matties:** You're coming in as the national sales director of technical sales. What's your background?

**Walsh:** I started in PCBs at Hewlett-Packard in Loveland, Colorado in 1993. I was an engineering manager at Unicircuit, then I was in international technical service for Uyemura for several years before going into semiconductor manufacturing and metal finishing.

**Matties:** You've gained a lot of experience about the processes employed. How is that translating into the work that you're doing now?

**Walsh:** When I was inside a shop as an engineer, I worked with our equipment suppliers very closely to help design our line so that it fit our manufacturing needs. Being in the field and working in multiple industries helped me understand that there are many different ways

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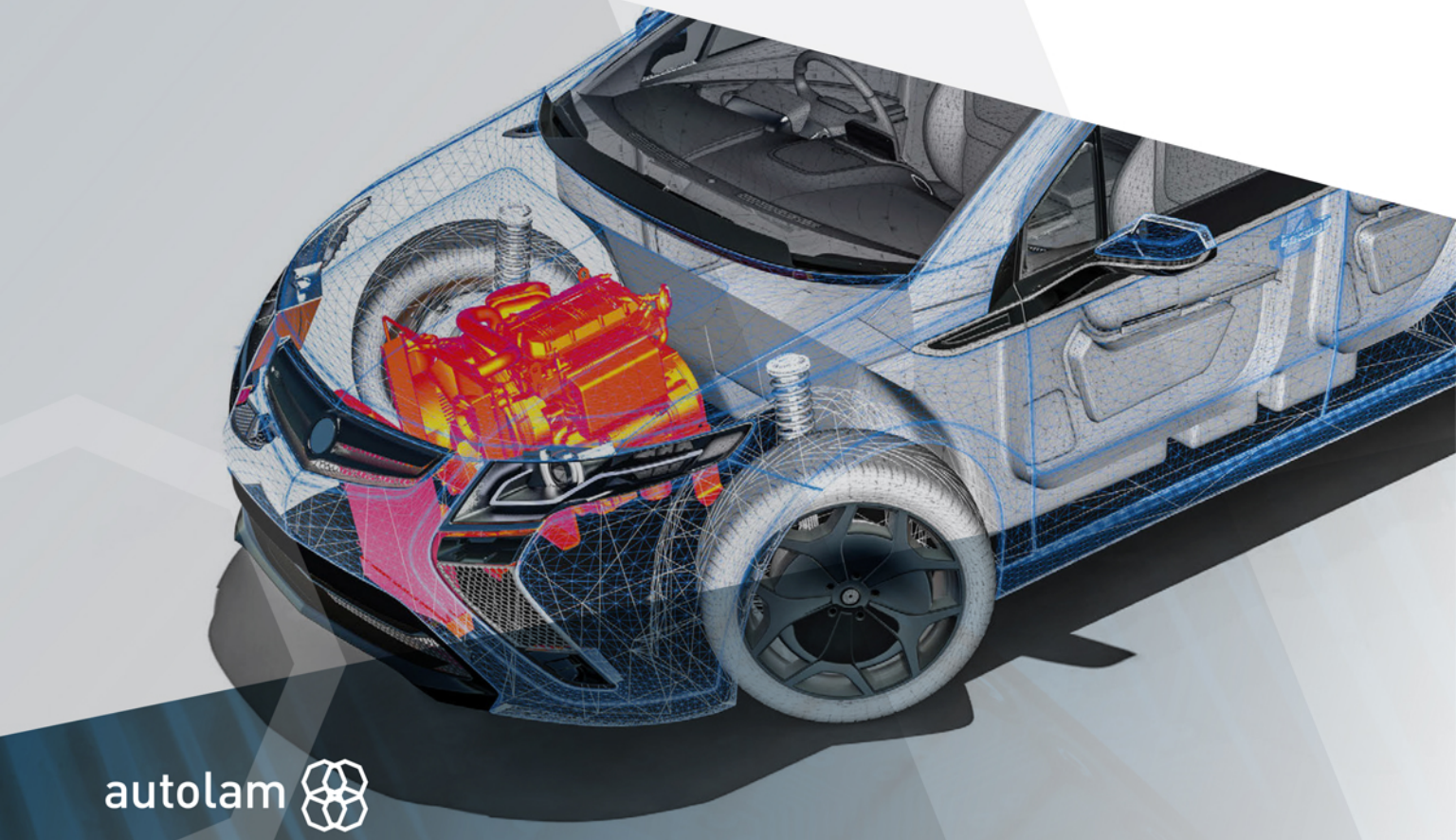

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to tackle similar issues. I think it's a great fit, for both me and IPS.

**Matties:** In terms of the equipment, what trends are you seeing in customer requirements? What's different between now and then?


Thomas Walsh

**Walsh:** For horizonal processing equipment, panels are getting thinner, and they've been getting thinner for decades. Additionally, copper via fill was starting to really pick up in the mid-2000s, and now you're almost required to have it. If you want to do any kind of military or aerospace, you are expected to have copper via fill. We're seeing more of that, as well as manual lines, manual tanks.

**Matties:** Do you find it surprising that there are so many manual tanks?

**Walsh:** Every chemical supplier has a different requirement for what they want, and they are innovative in how they do it. We work with them all. Everybody has a similar feel, but they're all a little unique. Manual tanks are just so versatile, and so expandable. You can start with one and, as your equipment needs grow, you can add two, three, or four more. It's not just manual tanks; we are fabricating a few of our automatic plating lines to incorporate that same technology as well.

**Matties:** What trends are you seeing in terms of what's being purchased?

**Walsh:** There are a lot of automatic plating lines being purchased, but most of our customers are looking for U.S. service and support.

**Travis Houchin:** I think we're getting a pretty good mix. I can tell there's a lot of cleaning and bonding going on. We're seeing a high need for that.

**Walsh:** We are also getting a lot of alternative oxide lines.

**Houchin:** It seems like most of the alternative oxide lines are because the lines have been so old and outdated that now it's finally time to either increase capacity or just get something newer in there. They are buying IPS due to our thin core transport capabilities.

**Walsh:** IPS still has several lines in the field that are 20 to 25 years old. At some point, you need to pull the trigger to get a new line.

**Matties:** I find it quite surprising in this industry that many are building boards on decades-old equipment. Is it because of lack of investment or lack of need?

**Walsh:** It's both. Some companies have tightened the belt over the years. That money has been flowing a little better now, however the materials are requiring new equipment. It says a lot about a printed circuit board shop that can keep a piece of equipment running for 20–25 years. That's impressive.

**Matties:** It is impressive. But it's also concerning because we are not staying up to date. When a fabricator is looking at their CapEx plan, are they falling short or are they making compromises where they shouldn't be?

**Walsh:** Many shops have bandaged equipment together over the years just to keep things running. Some shops are still using 5-mil or 10-mil frames and leaders to get material through a horizontal line—but with a modern horizontal transportation system you can run a piece of 2 mil all day without a leader.

**Matties:** It seems to me that fabricators may be missing market opportunity because they're handicapped with older equipment.

**Walsh:** That's absolutely true. An ultra-thin core transportation system can save you so much loss from handling damage, jamming, and time spent leadering.

Travis Houchin

**Matties:** How can you tell that story to a fabricator when you're in your sales mode?

**Walsh:** The number one growth industry in the circuit board market is military, space flight, and defense.

**Matties:** Especially in the U.S.

**Walsh:** Right. Those products are very hard to build on any kind of older technology. If you're used to dealing with 20-year-old technology then the new spray systems, flood modules, transportation systems—they're completely different. We innovate our systems yearly, not by the decade. There's not a leading aerospace or defense company out there that's running product on a 20-year-old piece of equipment. There isn't a single one.

**Matties:** That's where you see market growth, right?

**Walsh:** That is the growth, yes.

**Matties:** If you're going to be a board fabricator today, you really need to be thinking about your cutbacks in all areas, but is it driven primarily around material handling or are there other considerations?

**Walsh:** To be successful today you cannot afford to lose time or create scrap. Sure, material handling is a big part, but it's also equipment development and how your spray system or flood chamber is designed, and how everything interacts. How much data can you automatically collect from your equipment? These are all key to the whole system in modern day PCB manufacturing.

**Matties:** When people are upgrading, are they looking at adding AI—some sort of 4.0 intelligence—into this? Is that a priority for them?

**Walsh:** When you're dealing with sophisticated customers, the board shops need to have a proven piece of equipment, but they also need to have the data logging and everything that goes along with it. It's not very often that we sell a piece of equipment anymore that doesn't require data logging. If something goes wrong, the circuit board's end-customer wants to be able to track the cause all the way back to manufacturing. What happened during processing?

**Matties:** You guys were at Alex Stepinski's first shop, the Whelen factory. That was a fully automated system, so you have a lot of experience with the role of automation and software development. Are other customers looking for that level of sophistication?

**Walsh:** It's surprising, but we're not seeing a lot of fully automated factories in the circuit board industry. Now, we are seeing more material handling, loading/unloading, accumulators, those types of things.

**Matties:** That's more of the mechanization of a factory, rather than an automated AI approach.

**Walsh:** You're absolutely right.

**Matties:** It seems like the board fabricators are going to be taking more of a smart process approach rather than a smart factory approach. They may come in and isolate an island, if you will, and automate that with some AI.

**Walsh:** Right. The thing is it's still a very high-mix market, so your defense guys aren't going to build 100,000 boards of one design. They're going to build 50 of one design but they're going to build 20 different versions of those 50 offs. Some of that leads to the thought, "You can handle the material, but you can't automate everything," because some things are a little more complicated.

**Matties:** Didn't Whelen prove that you can?

**Houchin:** With Whelen, one of the biggest factors was that we started out with an open building and an open project where everything was coming in new. We could plan for that and incorporate a lot of that automation. Most of these factories aren't starting with an open building, they have an existing building with existing equipment, and to do that type of automation they would have to replace everything and with a good layout plan to get to that level of automation, whereas they're probably going to piecemeal parts and see what they can fit into their existing line.

**Matties:** That's a very good point. Some might say that it's better to shut it down and build it new than to try to come in and piecemeal it. Especially if you can bring in the latest technology and attract market that way.

**Walsh:** Very true.

**Matties:** It's still a big investment.

**Walsh:** It's a huge investment.

**Matties:** Maybe $50 million or more, right?

**Walsh:** Right.

**Matties:** Is IPS playing on the environmental recycling side at all?

**Walsh:** We do a lot of water recycling and zero discharge. IPS has been working those kind of projects for years, especially for our California customers. That's becoming more and more popular. We have done several waste treatment projects and recycling systems. This is probably the perfect time to announce that Trionetics and IPS have recently become strategic partners and we feel the fit is perfect for the industry. Both companies have superior support and workmanship and are designed, engineered, fabricated, and supported straight from our U.S. factories.

**Matties:** Is there a growing demand for waste treatment?

**Walsh:** There is. Especially when you hear of a place starting up with a new line or a new process. As little discharge as possible and to recycle as much as possible. We're definitely seeing it more and Trionetics is the expert in the field. It's such a great addition to our offerings, we couldn't be happier.

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**Matties:** In terms of the equipment that you're selling, are people coming in and looking to customize each piece or are they looking for off-the-shelf?

**Walsh:** At IPS, we really don't do off-the-shelf. Everybody has a slightly different footprint they need to fit in, or they have a different requirement, so we design and engineer every piece in-house, then custom-build it to that customer.

**Matties:** When it comes to the equipment reliability and maintenance, what requirements are customers looking at there?

**Walsh:** We offer a one-year warranty on anything we build, but what we're seeing is that customers are asking for quarterly factory maintenance from us. This means we send people out to their factory once a quarter to tune everything up. We're seeing a lot more of those kinds of service agreements, and that's one of the reasons we're expanding our service team.

**Matties:** You mentioned you had a lot of installations. Besides horizontal, you also offer vertical equipment from your VCM line. Is that still something that people are interested in?

**Walsh:** Yes. If you have a small space, and you need to shoehorn a process in, there's no better way. With a VCM, there is no puddling during processing because the panel is vertical; many customers prefer it. I ran them for years when I was inside a board shop, and they ran great. If you want great performance or have a small space and want almost no maintenance, that's the way to go.

**Matties:** Is it really just space require-ments or is there a performance ben-efit to VCM?

**Walsh:** Every customer feels differently about it, but many of our customers like that there's no puddling. Performance wise, they are simple to run and keep maintained.

**Matties:** What's the typical order process for a customer? How does that work here?

**Walsh:** They'll contact us, and we'll get to basic requirements of what they're looking for, size of equipment they want to fit into the area available, and we will create a quote. If it's close to something that's already been manufactured, we can send them a drawing or manipulate a drawing quickly. That will give them a sense for what it looks like, and that's how the process starts. Once the order is placed, it goes right into engineering review and the sales guy and the customer and our engineering work through all the details and all the pieces, and then it's off and running in engineering. It's designed from the ground up in SolidWorks.

**Matties:** What's your lead time right now?

**Walsh:** If it's something simple, 18 to 20 weeks. If it's something more complicated, 24 to 28 weeks. We're very busy right now. Our very complicated stuff is extremely complicated, and we do everything in-house, so you really are looking at 24 weeks.

**Matties:** I guess that's a good indication of market conditions right now, right?

**Walsh:** It is. If we hadn't expanded our building and expanded the team I don't even know where we would be right now.

**Matties:** You've expanded the facility by 17,000 square feet?

**Walsh:** Something like that, yes.

**Matties:** Are you going to outgrow that soon?

**Walsh:** It's full right now. We shipped a couple of pieces of equipment last week, a couple more this week, and we're getting ready to ship more next week. We have process lines that are already cut out with our CNC and just staged and ready to get tacked, welded, and then moved into assembly. We have several pieces that are ready to go in assembly. We have several pieces lined up at every stage, getting ready to load to the next chamber.

**Matties:** Are you seeing pent-up demand from the fabricators?

**Walsh:** I don't know if it's pent up, but it's a steady increase. Luckily, Mike had the idea to continue to buy raw materials ahead of time. The price of plastic has gone up dramatically, but you'll see we have a lot of pallets of plastic in storage.

**Matties:** I saw that on the last visit. I was quite impressed with the vision to do that.

**Walsh:** We don't feel like the price is going to come down anytime soon. We're trying to hedge our bets a bit and adding more inventory of raw materials.

**Matties:** Do you have ongoing COVID-related issues?

**Walsh:** COVID effects are still here but things have become more normal. Our sales staff is starting to hit the road more now. Customers are starting to invite us in, instead of telling us to stay away. I can't wait for the next IPC APEX EXPO because I really missed it this year. I really miss the industry coming together. It's great to see all our friends in the industry and to see how they're doing.

**Houchin:** As we mentioned, we've got tons of orders. We're busy; we're pumping out machinery. I'm grateful that our industry is starting to realize the importance of having North American service and support since COVID.

**Matties:** Are any fabricators interested in coming here to visit your facility?

**Walsh:** Yes, they are. We still do customer visits all the time. We have several customers that fly in to buy off on their equipment. That has never stopped.

**Matties:** It's always great to see American manufacturing. Do you see a shift in supply chain from COVID? Do you see more people looking for Made in America?

**Walsh:** Very much so. It's not just the equipment itself, it's the spare parts availability, factory support, and our field service teams. Maybe you can get a piece of equipment from overseas


and maybe they store a few parts in the United States, but to get true factory support is impossible. That's why we're expanding our field team so much, we have such a demand for it.

**Matties:** Your existence is so dependent on the chemical suppliers as well.

**Walsh:** It is.

**Matties:** How is that relationship with all the chemical suppliers?

**Walsh:** We don't play favorites. We work with them all, and I would say we have a great relationship with all of them. They turn us onto customers all the time, and we work with their design team. When they create something new, they come to us to ask us to design a piece of equipment for that process.

**Matties:** It's very collaborative.

**Walsh:** Yes. Mike has been building those relationships for over 25 years and they are rock solid.

**Matties:** Do you see any trends in new processes coming out, or are the existing processes being refined?

**Walsh:** I would say more refinement than innovation. I know I keep pounding the point, but it's the copper via fill. We're seeing more and more unique requirements from suppliers on equipment that they like to see.

**Matties:** Now, with all that mSAP and all that additive manufacturing, how is that playing into your business?

**Walsh:** Mike has a couple of R&D projects that he's trying to formulate for a true contact-free processing, and he's wanting to build a couple of prototypes; that's going to be a big deal. His goal is to have something for the next IPC APEX EXPO.

**Matties:** I certainly appreciate your time today.

**Walsh:** Thank you. PCB007

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

# Vertical Conductive Structures (VeCS)

## Happy's Tech Talk

by Happy Holden, I-CONNECT007

*In remembrance of our late technical editor, Dr. Karl Dietz, Happy Holden has volunteered to resurrect Karl's popular Tech Talk column. Karl authored this technical column from August of 1995 to August of 2016 compiling 225 columns over those 21 years. Happy will endeavor to catch our readers up on the latest technologies developed around the world and close the five-year gap since Karl stopped writing his column.*

The industry has not introduced many new structures in the last 60 years. Multilayers have continued to evolve with thinner materials and smaller traces and spaces as well as drilled vias. It's been nearly 40 years since Hewlett-Packard put its first laser-drilled microvia boards into production for its innovative Finstrate process[1].

Now we have a new structure, vertical conductive structures (VeCS), developed by Joan Tourné of NextGIn Technology BV of the Netherlands. This technology is a breakthrough because now any advanced board shop can produce HDI level high density interconnects without any new capital equipment—and at a lower cost with higher electrical performance. I first became aware of the technology from an interview in the February 2017 issue of *The PCB Magazine*[2]. As seen in Figure 1, the key technology is the replacement of small or blind vias with a routed trench (slot), that is much easier to metallize and plate.

VeCS is a true 3D concept for interconnection by creating a routing channel (slot) in the printed circuit that can then be metallized and plated easier than high-aspect ratio vias while allowing a connection to the inner layers. The channels are easier to plate and can be created by existing PCB fabrication equipment. This allows HDI densities to be achieved without

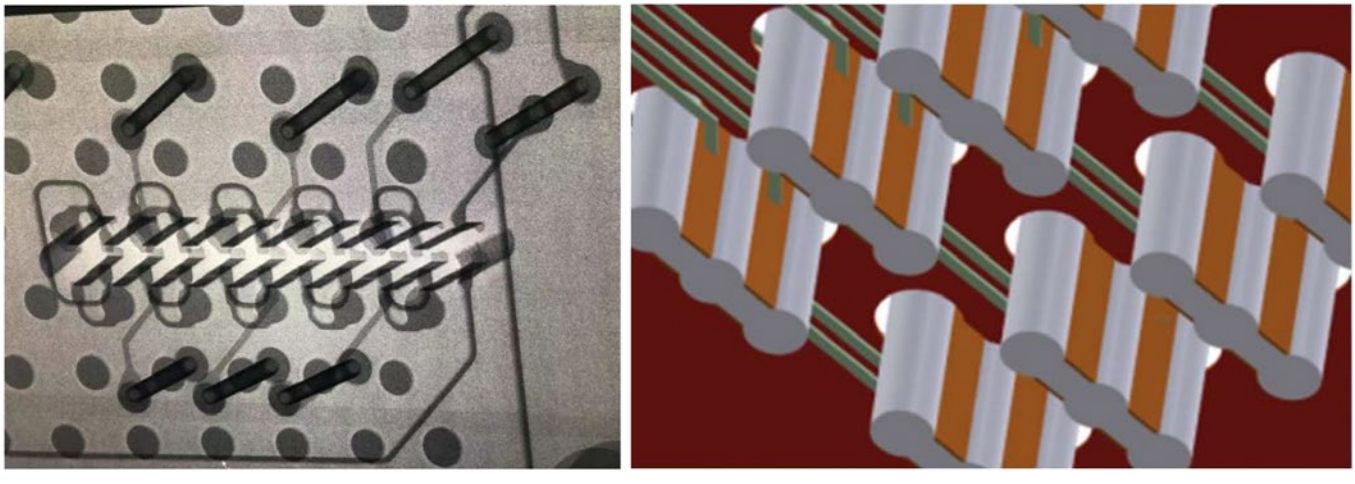

Figure 1: VeCS slot under magnification (left), bottom view of VeCS slot (right). (Source: NextGIn)

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significant added costs along with easier fabrication processes and higher electrical performance and reliability. The process and applications already developed by NextGIn Technologies are: VeCS -1, -2, and -HDI[2,3]. The three main combinations of their interconnect slot technology are defined as:

- **VeCS-1:** Where the channel (slot) goes through the substrate
- **VeCS-2:** Here, the slot is formed as blind or in a hybrid-blind and through-slot combination
- **VeCS-HDI**: Laser-drilled microvias are used for fine-pitch utility on ultra-fine-pitch components

Figure 2 highlights these three structures.

With channels (slots) formed from both sides, the 3D vertical traces provide greatly increased density without sequential laminations. Replacing larger through-hole vias with slots provides better power integrity for new power-hungry chips while lowering inductance and capacitance for improved signal integrity.

## The Channel or Slot

The all-important step of metallizing and plating the typical 0.3 mm blind slot is shown in Figure 3. for various depths and lengths (from depths of 0.47 mm to 1.23 mm and lengths of 0.6 mm to 1.8 mm). Some of the smaller aspect ratios have insufficient chemical exchange but

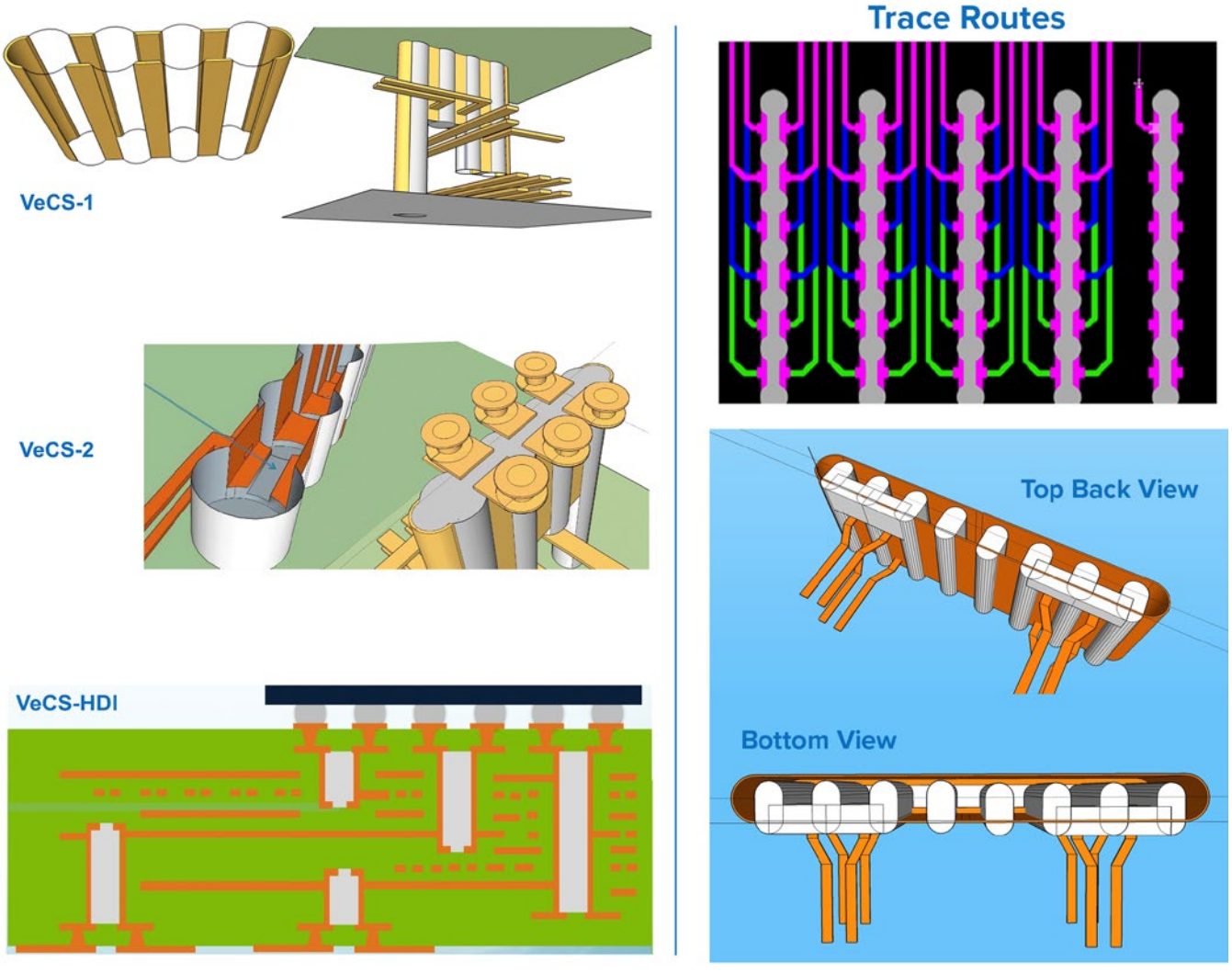


Figure 2: (Left) three different structures, based on the original concept of a slot or trench, make up VeCS; (right) trace routes showing various layers, and 3D views of the construction. (Source: NextGIn)

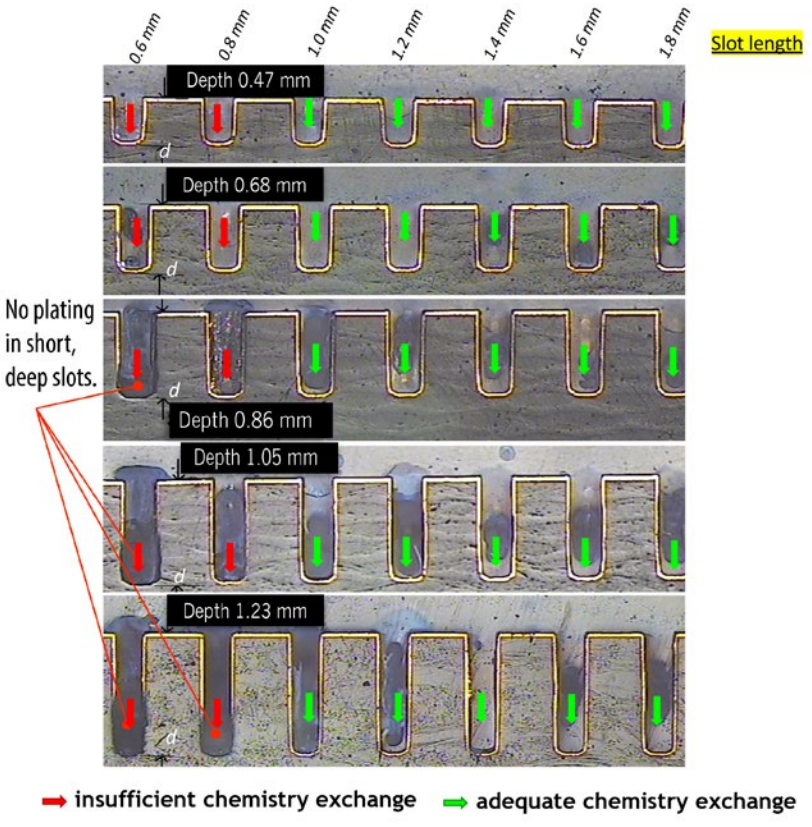


Figure 3: Creating and plating the blind channel (slot) is the key feature of VeCS-2 but is within the capability of any high-performance PCB fabricator[3]. (Source: NextGIn)

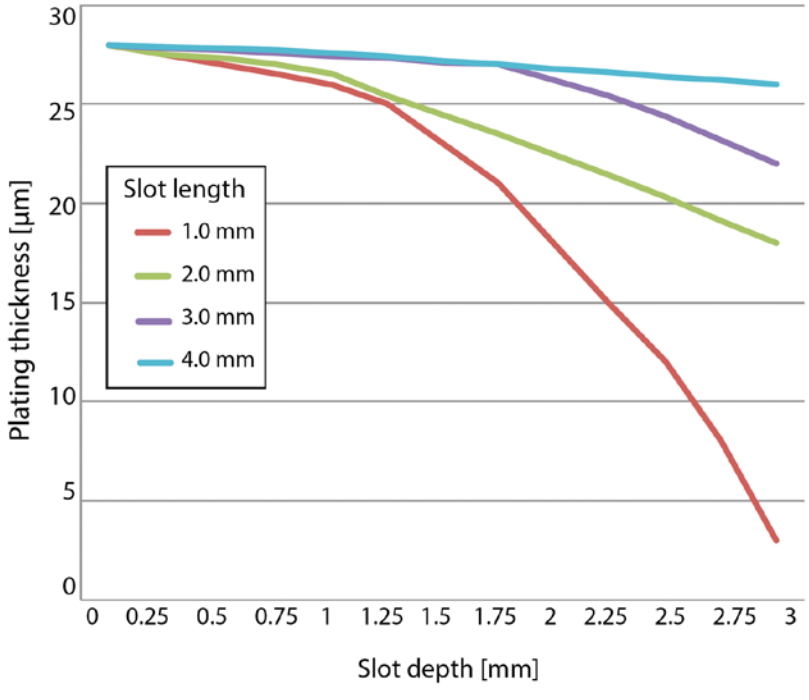


Figure 4: Plating thickness as a function of slot depth and length[3]. (Source: NextGIn)

the majority have excellent chemical exchange for normal plating baths. The new alternative drill/router bits have successfully created channels of 0.1 mm with straight walls and no burring. Figure 3 shows various blind channel depths plated with conventional plating equipment.

Figure 4 shows plating results with respect to the slot length and slot depth. Note that for these tests, NextGIn used plating processes at standard parameters and chemistry types. The method of plating was electroless copper followed by a panel plate to the required copper thickness in the slot targeting a thickness of 25 µm.

## Fabrication Process

Figure 5 presents the views of the VeCS fab process, starting with a conventional through-hole multilayer. The process has eight steps:

1. Create slot
2. Plate slot
3. Alignment in BGA pin field
4. Resin fill PR slot and PR stencil
5. Drill CR slots
6. If vertical traces are going to be used, drill BR slots
7. BR/CR stencil
8. Resin fill BR/CR slot

In Step 1, after drilled vias are completed, the primary cross-rout (CR) slots are put in. Here, a special drill/router bit uniquely suited for this operation is used. Much work and experimentation were conducted to perfect an ideal drill/router bit for this task. Then in Step 2, metallization and copper plating are performed. In Steps 3 and 4 the resin is now used to fill the CR

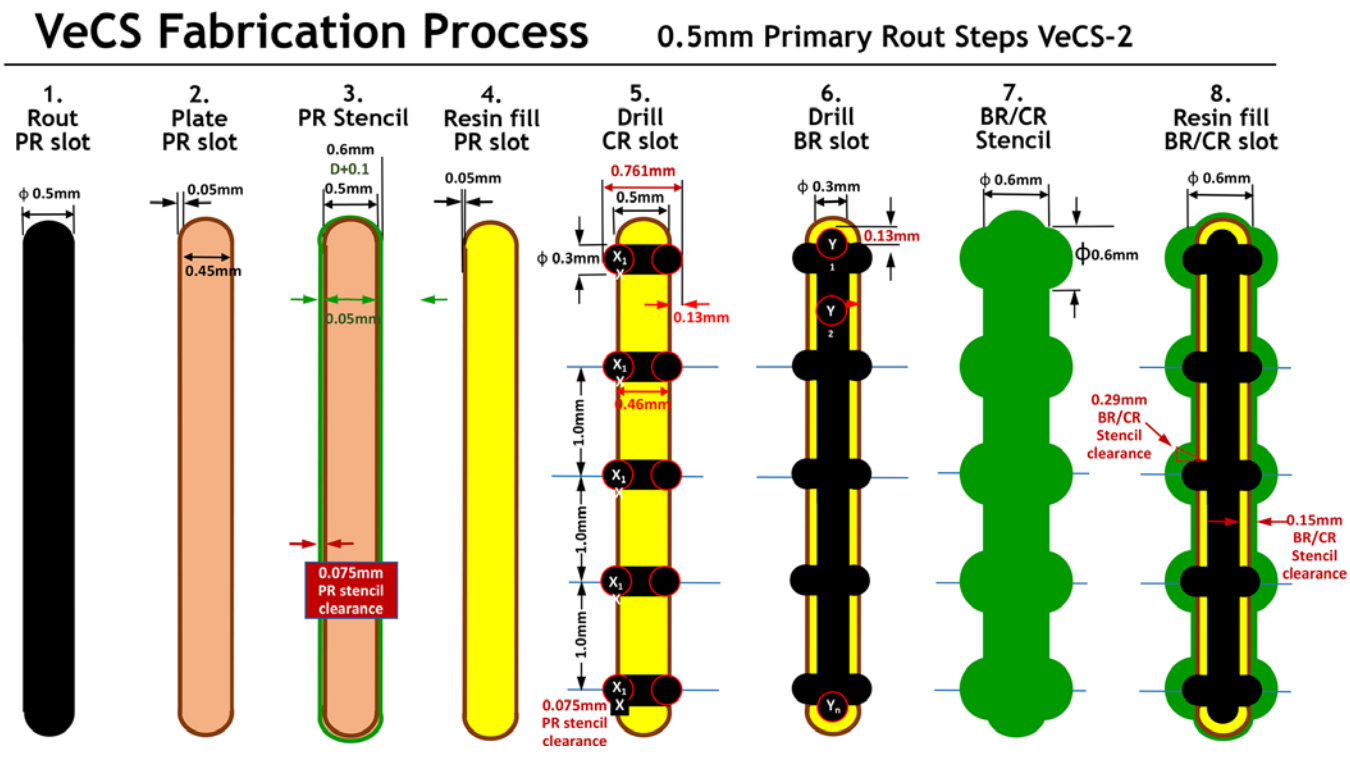


Figure 5: The VeCS fabrication eight-step process[8]. (Source: NextGIn)

slots. After curing, next is the important Step 5 where cross-routes create the vertical interconnects. If vertical traces are going to be used, Step 6, drill/rout out the back-rout (BR) slots. Then selected vias and slots are resin-filled and cured. In Steps 7 and 8, for pattern plating, the normal process resumes of imaging, plating, stripping and final etching. In the final panel, the board would be solder masked, with any final finishes and fabrication.

## Design Rules

To illustrate various routing densities, we like to illustrate 0.7 mm pitch because VeCS has a 600% increase over through-hole while HDI has only a 200% improvement.

The cross-rout or CR step is also completed. Clearly you can see the glass dielectric removed between the VeCS circuits. This eliminates glass influence for issues like CAF[4].

**VeCS-2 design details:** The middle part (conductive material) is removed to create two different potentials to the left and right of the slot. Not every position in the slot needs to be processed in this way as it depends on the design.

This design method for VeCS is another example of creative concepts. The VeCS-1 with back rout or VeCS-2 differential signals are routed and surrounded by a "racetrack" type ground reference. This nearly creates a complete Faraday Cage for the connections. The SI performance is beneficial for speeds above 10Ghz.

Details of the 0.5 mm pitch VeCS breakout using standard VeCS design rules are in referenced in Table 1. Routing will depend on cross-rout slot dimensions. But remember: HDI can only go one or two layers down, while VeCS can go three times deeper.

A complete set of design guidelines for VeCS-1 and VeCS-2 (Table 1) are broken down into standard, advanced, and in R&D. Additional design illustrations and advice, including tool setups are in the August 2019 issue of *PCB007 Magazine*[5].


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**Table 1: VeCS Design Rules.**

| VeCS-1 | Standard | Advanced | R&D |
|---|---|---|---|
| *A* = Primary slot width | 0.50 mm | 0.40 mm | 0.30 mm |
| *B* = Primary slot length, minimum | 1.6 mm | 1.6 mm | 1.6 mm |
| *D* = Cross slot width | 0.30 mm | 0.30 mm | 0.25 mm |
| *E* = Cross slot length, minimum | A + 0.20 mm | A + 0.15 mm | A + 0.15 mm |
| *I* = Vertical (VeCS) trace thickness, minimum | 0.020 ~ 0.025 mm | 0.020 ~ 0.025 mm | 0.020 ~ 0.025 mm |
| *W* = Vertical (VeCS) trace width, minimum | 0.30 - 0.40 mm | 0.25 - 0.30 mm | 0.25 mm |
| **VeCS-2** | **Standard** | **Advanced** | **R&D** |
| *A* = Primary slot width | 0.50 mm | 0.40 mm | 0.40 mm |
| *B* = Primary slot length, minimum | 1.6 mm | 1.6 mm | 1.6 mm |
| *C* = Primary slot nominal depth (C) below critical signal layer | 0.125 mm | 0.10 mm | 0.10 mm |
| *D* = Cross slot width | 0.30 mm | 0.25 mm | 0.25 mm |
| *E* = Cross slot length, minimum | A + 0.30 mm | A + 0.20 mm | A + 0.20 mm |
| *F* = Cross slot nominal depth below primary slot depth | 0.125 mm | 0.10 mm | 0.10 mm |
| *G* = Bottom slot width | 0.30 mm | 0.25 mm | 0.25 mm |
| *F* = Bottom slot nominal depth below primary slot depth | 0.125 mm | 0.10 mm | 0.10 mm |
| *I* = Vertical (VeCS) trace thickness, minimum | 0.020 ~ 0.025 mm | 0.020 ~ 0.025 mm | 0.020 ~ 0.025 mm |
| *J* = Nominal isolation (keep-out) depth below bottom slot | 0.25 mm | 0.20 mm | 0.20 mm |
| *W* = Vertical (VeCS) trace width, minimum | 0.30 - 0.40 mm | 0.25 - 0.30 mm | 0.20 mm |

Design examples for Siemens Digital Industries Software, Cadence, Zuken and Altium

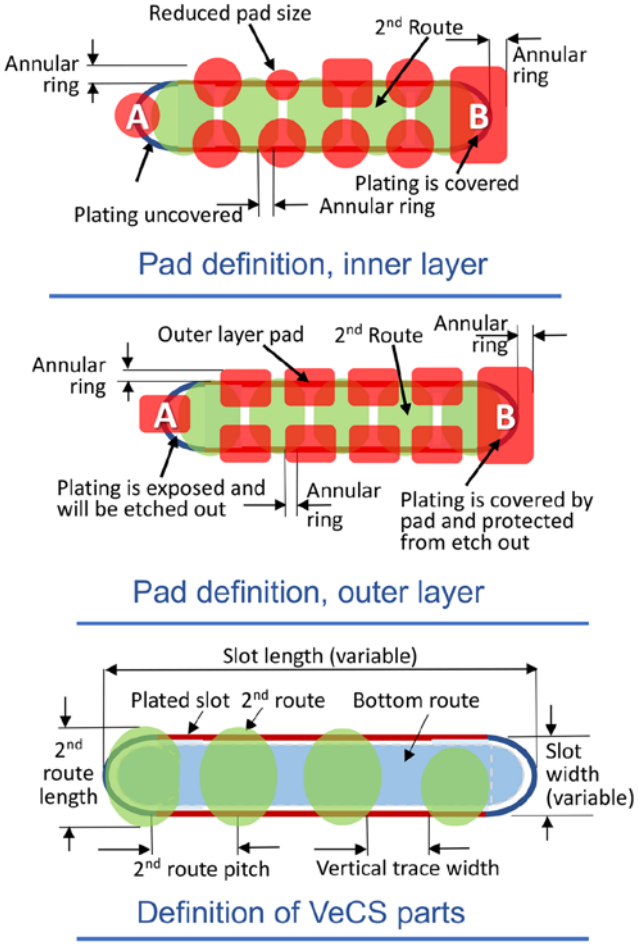


Figure 6: Recommendations for VeCS design rules from Table 1. (Source: NextGIn)

Videos that show the routing of VeCS structures on various EDA tools like Siemens/Mentor, Cadence, Zuken, and Altium are available by contacting NextGIn Technologies.

## Electrical Performance

Electrical performance is another area (besides CapEx and costs) where VeCS outperforms plated through-hole and HDI. The vertical trace does not have the capacitance and inductance of a via. For extremely high-speed logic, the ability to create shielded differential pairs with minimum distortion is unique. As seen in Figure 7, experimentation was conducted to tune vertical traces in the slot such that there is almost no reflection/dispersion. BestPCB compared simulated vs. actual product measurements. Additional figures show the simulated tuning of a TDR response on VeCS-2 where we can vary it from a capacitance to an inductance response or make it as "flat" as possible on the NextGIn website.

Modeling with Simbeor has determined the best performing layer transition. Can we use VeCS to make layer transitions and re-introduce Manhattan routing? First results look interesting. Manhattan/VeCS routing is an

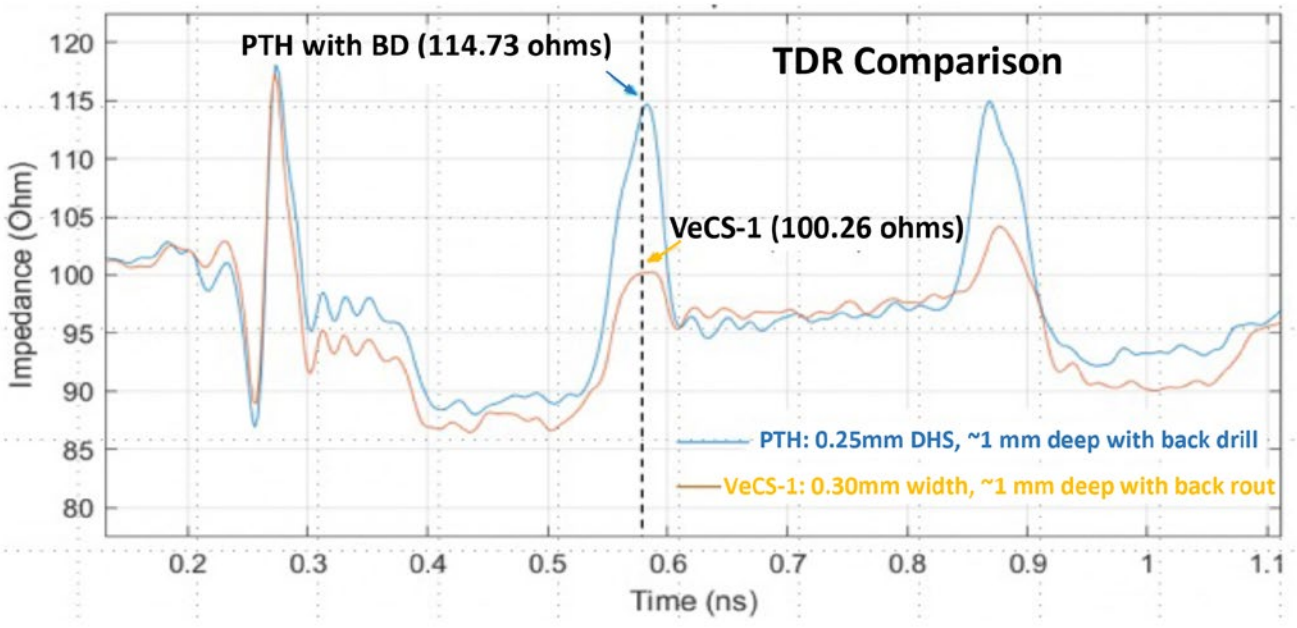


Figure 7a: A TDR comparison of a high-speed signal propagation (impedance) through vertical connections of a back-drilled PTH vs. a back-drilled VeCS-1 vertical trace seen in Figure 7b. (Source: BestPCB)

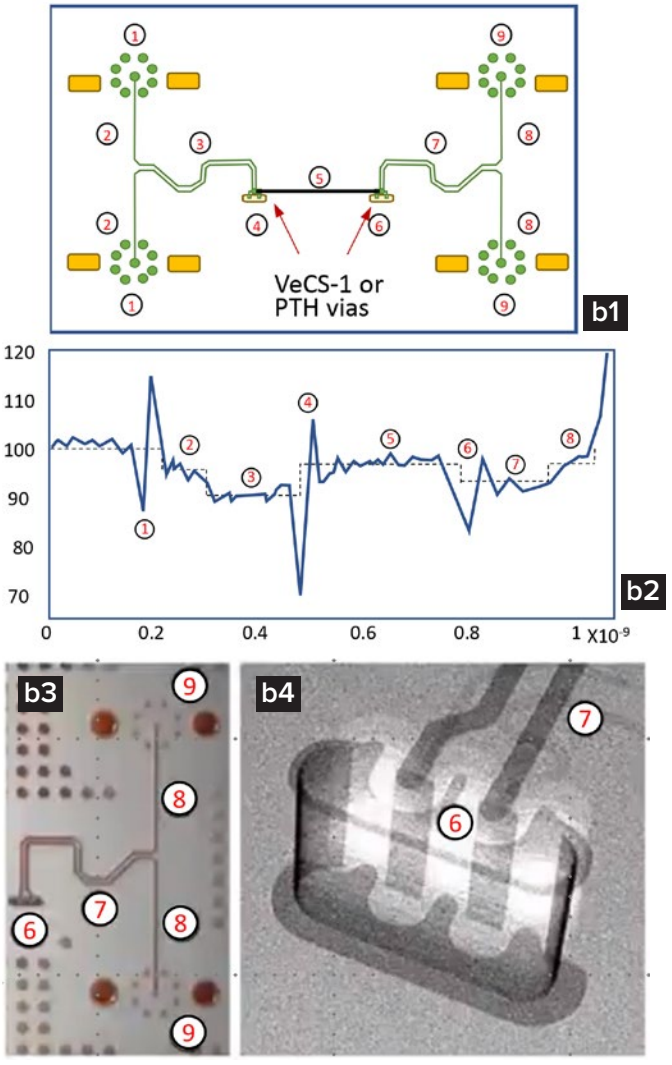


Figure 7b: Four figures of a high-speed signal propagation (impedance) through the back-drilled VeCS-1 connections;

7b1: Top view of test board schematic;

7b2: TDR measurements along test traces;

7b3: Top photo of test board;

7b4: X-ray image of the shielded VeCS-1 vertical connection to inner layers.

1 & 9: Molex 72351-1851 and launch via;

2 & 8: A short single-end routing on L1;

3 & 7: Differential routing on L1;

4 & 6: Test via (VeCS-1 or PTH);

5: Differential routing on inner layer.

(Source: BestPCB and WUS Printed Circuit Co.)

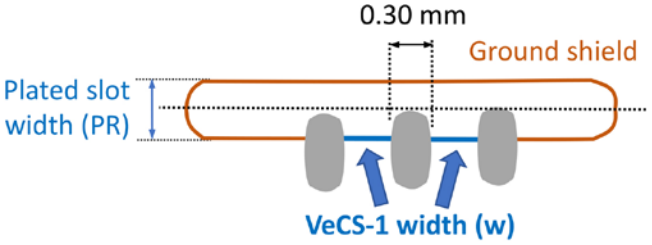


Figure 7c: A top view of the VeCS-1 vertical connections with plated ground shield as seen in Figure 7b4. (Source: NextGIn and WUS)

alternative for expensive point-to-point routing for dense boards. VeCS electrical performance is discussed in an October 2019 *PCB007 Magazine* article[6]. (It contains an eye diagram showing simulated layer transition in VeCS at 30 GB/s.)

Reducing reflections in transmission lines is one of the areas of focus with VeCS. Tuning the impedance of the vertical trace using, for example, a shielded VeCS slot enables the designer to match the vertical and horizontal impedances of the transmission line.

## Reliability

A VeCS laminate reliability review reported that on testing 370HR, it passed six cycles of 260°C reflow including CAF tests. IST VeCS coupons passed 250 cycles and 19 reflow cycles to 217°C. TCT performance on IST passed 100 cycles and TCT performance on CAF coupons passed 100 cycles (Figure 8a).

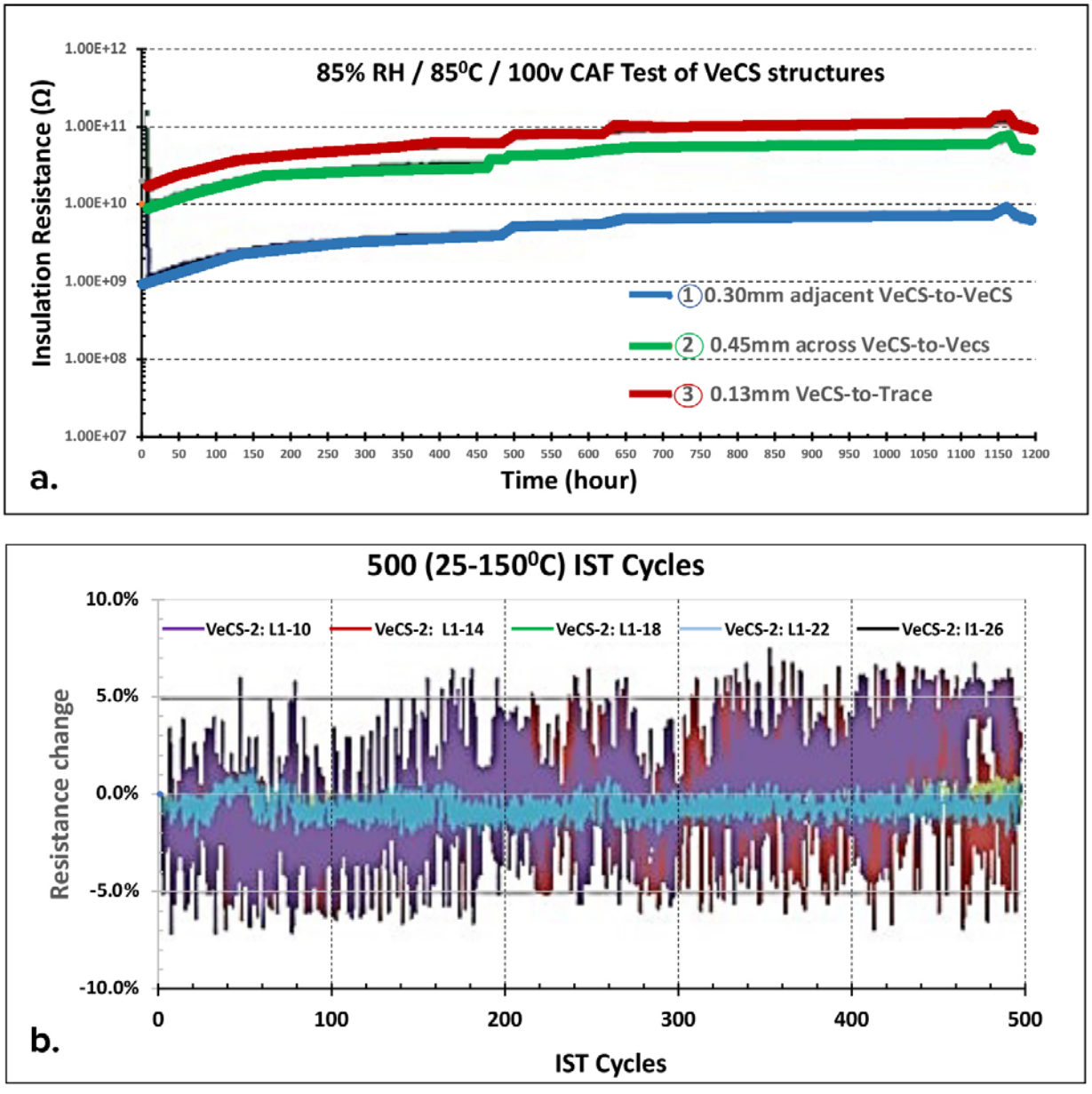


Figure 8: a) CAF test of three VeCS structures for 1090 hours at 85% RH, 850C at 100 volts; b) resistance change of five VeCS-2 slot structures for 500 cycles of 25 to 150°C. (Source: WUS Printed Circuit Co.)

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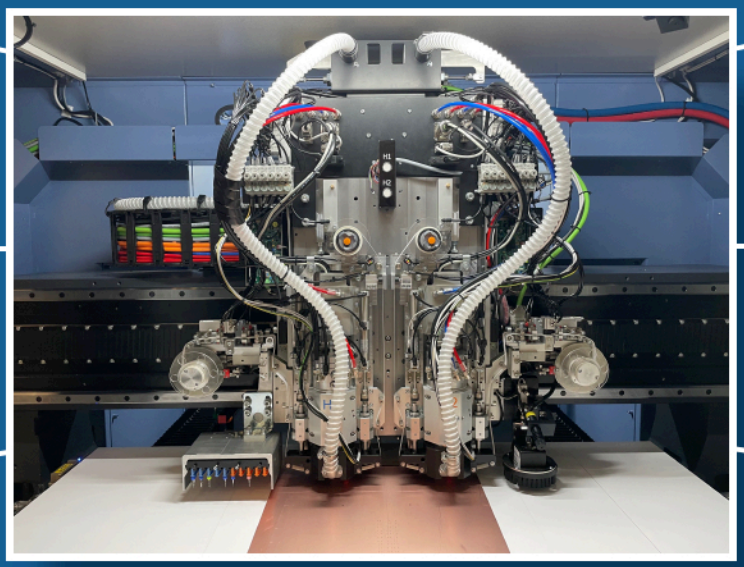

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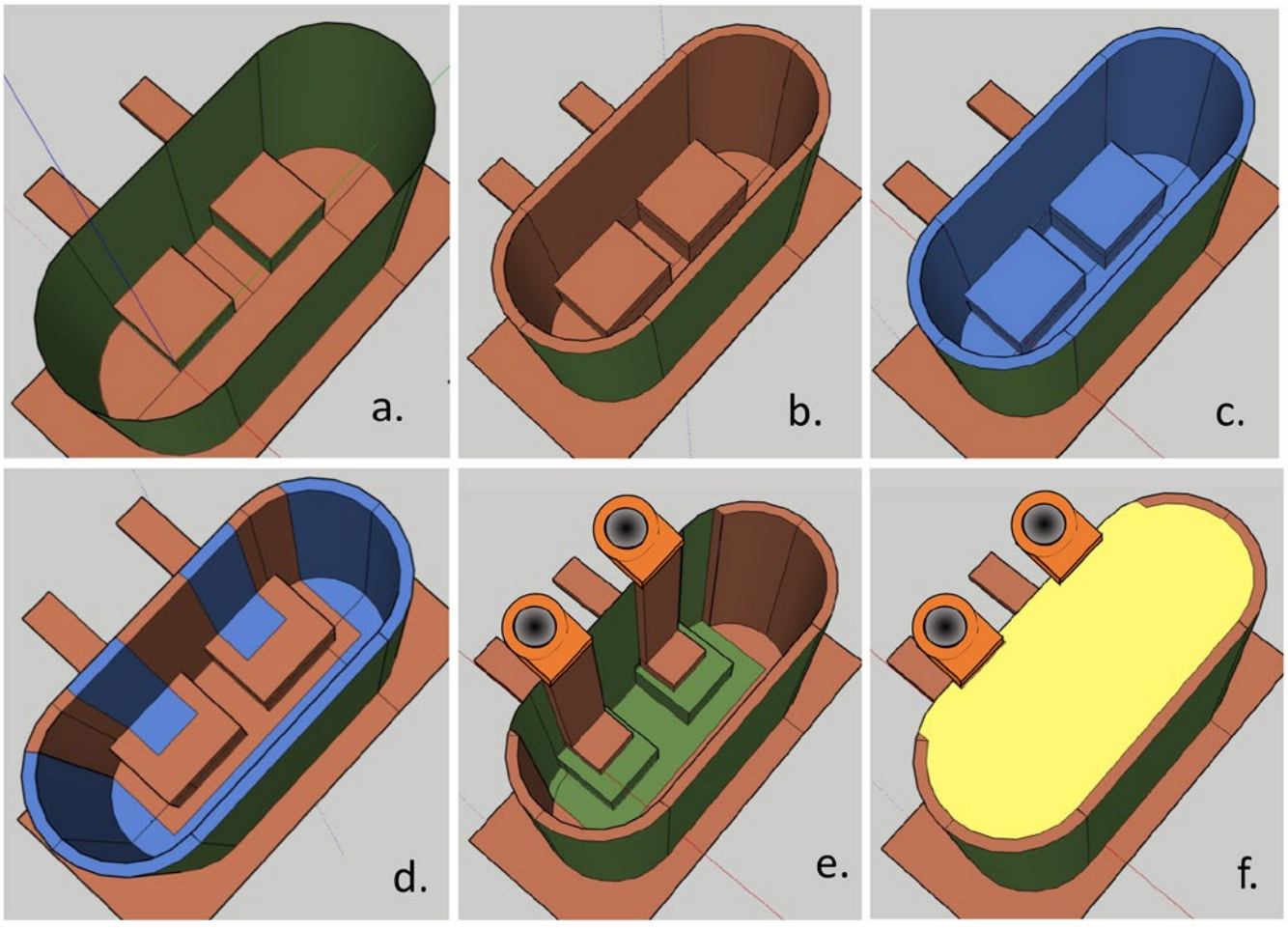



Figure 9: The micro-VeCS process as follows: a) laser cutting the cavity; b) plating the cavity; c) apply positive electrodeposited resist; d) direct expose the resist; e) etch and strip; f) fill VeCS slot.

Extensive IST testing has revealed that VeCS coupons achieved 10 to 30 cycles while conventional PTH had a range of seven to 10 cycles (Figure 8b). Additional data is available from NextGln.

## Future Enhancements

The current focus is on the use of HDI microvias to enable VeCS applications for fine pitches down to 0.15 mm. The micro-VeCS process is shown in Figure 9 for inner layers.

VeCS/HDI will scale down the feature sizes for VeCS to enable it to run smaller devices pitches–device pitches down to 0.15mm are possible, as seen in Figure 10.

The benefits of VeCS/HDI are:

- No materials limitations. Use flat weave materials to support the laser processing
- Compete with HDI constructions and take advantage of reduced lamination cycles reducing lead time and complexity
- Single lamination process versus 5 or more laminations
- Reduce cost by 40-60%
- Higher yields

Additional information is available at PCB007, EIPC Winter Conference, LinkedIn[7,8,9] and by contacting NextGIn Technologies. **PCB007**

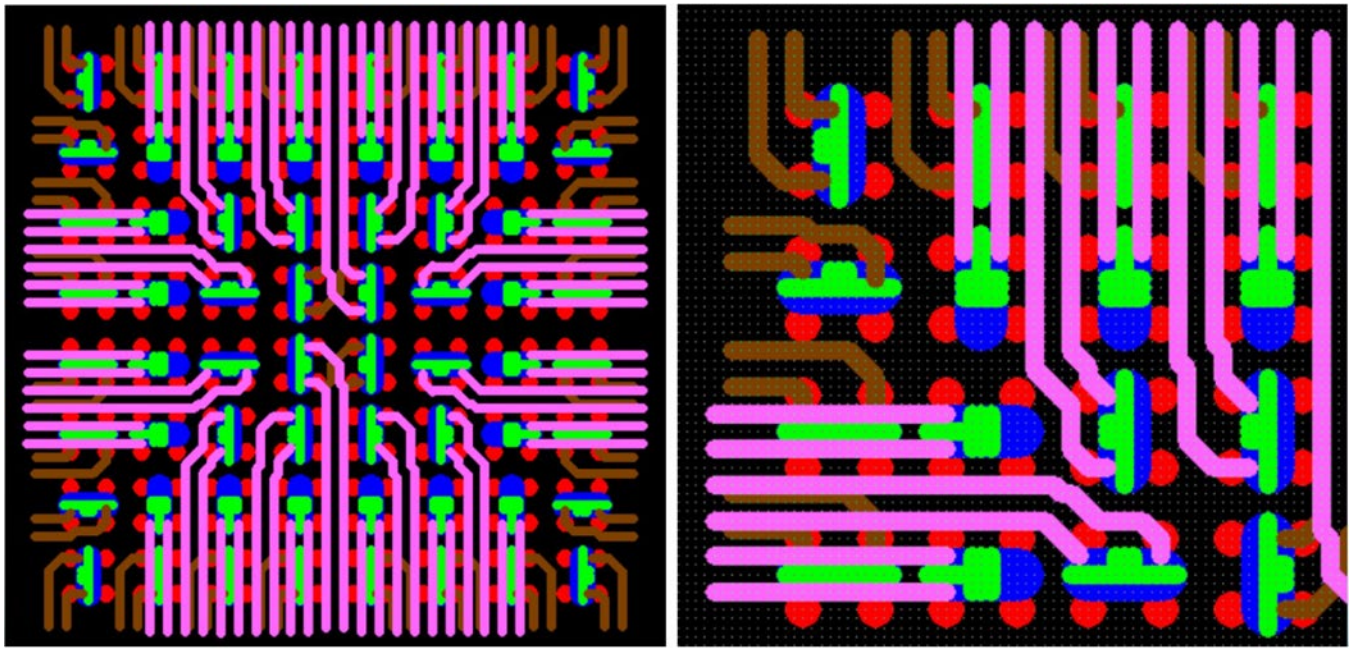


Figure 10: Routing of a very-fine pitch BGA using HDI, and VeCS-2 buried slots with close-up of quarter-pattern. (Source: NextGIn Technologies)


**References**

1. "Finstrate: A New Concept in IC Substrates," Steve Leishman, IPC Seminar on Competitive Electronics Packaging, October 1983, Washington, D.C.
2. "Vertical Conductive Structures—a New Dimension in High-Density Printed Circuit Interconnect," Pete Starkey, *The PCB Magazine,* February 2017, pp. 16-20.
3. "Vertical Conductive Structures, Part 1: Rethinking Sequential Lamination," Joan Tourné, *PCB007 Magazine,* April 2019, pp. 88-93.
4. "Vertical Conductive Structures, Part 2: VeCS and Micro-machining," Joan Tourné, *PCB007 Magazine,* June 2019, pp. 72-78.
5. "Vertical Conductive Structures, Part 3: Design Tool Techniques," Joan Tourné, *PCB007 Magazine,* August 2019, pp. 90–99.
6. "Vertical Conductive Structures, Part 4: Tuning Your Signal Performance," Joan Tourné, *PCB007 Magazine,* October 2019, pp. 68–76.
7. Vertical Conductive Structures, Joan Tourné, EIPC Winter Conference 2020 presentation.
8. "The Impact and Benefits of VeCS Technology," an interview with Joan Tourné and Joe Dickson, *PCB007 Magazine,* November 2020, pp. 30-43.
9. VeCS-New High-Density Interconnects, Joe Dickson, Linkedin, November 2020.



**Happy Holden** is an I-Connect007 technical editor, and the author of *24 Essential Skills for Engineers.* To read past columns, or contact Holden, click here.

# Electronics Industry News and Market Highlights


## PAC INNOVATION RADAR Names Siemens 'Best in Class' in Open Digital Platforms ▸

Siemens Digital Industries Software announced that it has been named "Best in Class" in PAC INNOVATION RADAR's vendor analysis report, the Open Digital Platforms for Cloud-centric Industrial IoT in Europe, 2021.

## Thales Receives Contract from Network Rail for FOAS ▸

Network Rail has awarded a contract to a consortium led by Thales Ground Transportation Systems Ltd to develop and trial Fibre Optic Acoustic Sensing (FOAS) technology that will support improvements in safety and performance on the railway.

## EU Steps Up 'Semiconductor Sovereignty' Plans ▸

The European Commission plans to introduce a "European Chips Act" to provide a European vision and strategy to boost cutting-edge semiconductor manufacturing capacity in the region.

## Ansys, Rockwell Automation Optimize Industrial Operations with Expanded Digital Twin Connectivity ▸

Ansys and Rockwell Automation are expanding digital twin connectivity to industrial control systems, enabling users to optimize the design, deployment, and performance of industrial operations.

## Electrolube Takes EV Thermal Conductivity to Another Level ▸

Electrolube, a global leader in protective electro-chemical solutions, will make a welcome return into the realm of live exhibitions with ESI Automotive and MacDermid Alpha Electronic Solutions.

## BT, Oracle to Accelerate Delivery of New 5G Services in the UK ▸

BT Group—UK-based mobile and broadband provider—has selected Oracle Communications Cloud Native Converged Policy Management to optimize its network resources and bring new 5G offerings to market faster.

## Tower Semiconductor Announces Breakthrough LiDAR Technology ▸

Tower Semiconductor, the leading foundry for high-value analog semiconductor solutions, announced a breakthrough development of LiDAR IC technology designed for advanced driver-assistance systems (ADAS) and ultimately self-driving cars.

## European Enterprises Look for IoT Providers with Broad Geographic Capabilities ▸

Enterprises in Europe are looking for service providers able to cover multiple geographies to help them roll out and manage their IoT networks, according to a new report published by Information Services Group, a global technology research and advisory firm.

## Seoul Semiconductor to Launch WICOP TE for Headlamps ▸

Seoul Semiconductor Co., Ltd., a leading global innovator of LED products and technology, announced that it launched WICOP TE (Top Electrode) designed to improve the thermal efficiency of headlamps for vehicles.

# With Functional Paste, Electronics Evolve!

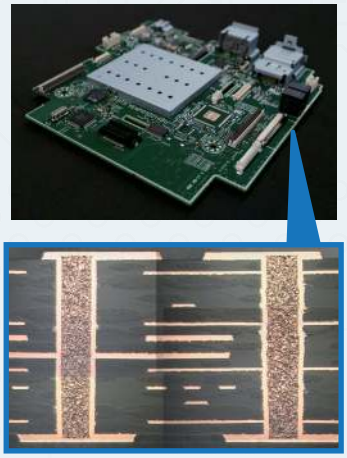
## Main Lineups

### Via Filling Paste - Metal Contacting Type
### AE2217, AE3030, AE1125DS

**For Automotive PCB & Electronic Device PCB**

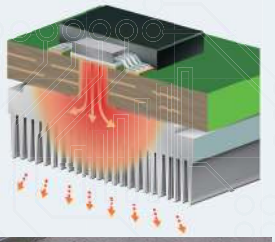
**CAR**

**Through-hole Fill Paste for High Performance Applications**

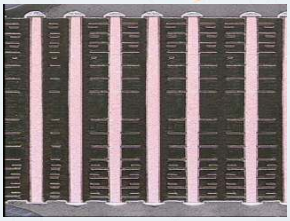


**Device**

**Solution for Thermal Management of PCB**

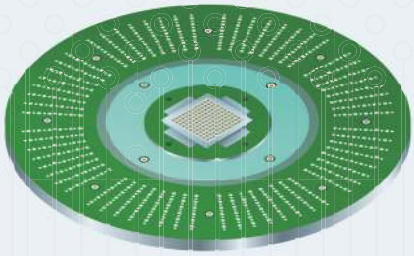


**IC Tester**

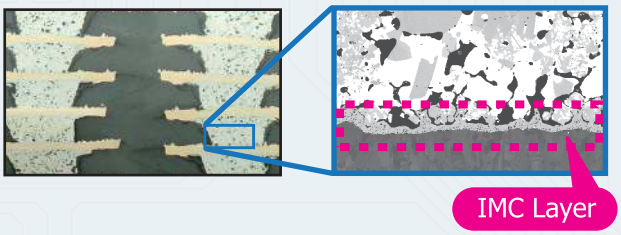


### Metalizing Paste - TLPS Type
### MP Series

**Board-to-Board and Inner Layer Interconnect Materials**

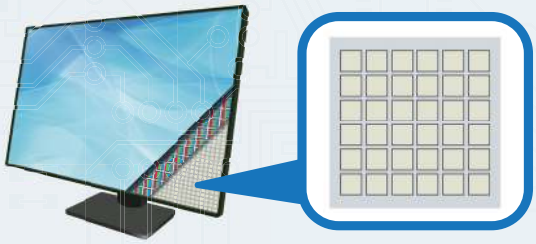


**MP Series forming IMC layer**

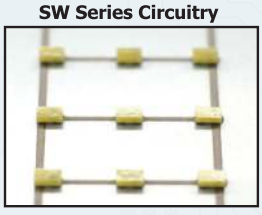



### Circuitry Paste
### SW Series

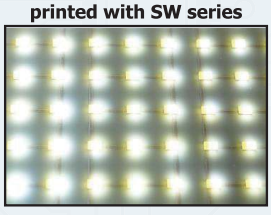
**For Circuitry of LED Backlight Display**



**LED lights connected by SW Series Circuitry**



**LED powered by circuits printed with SW series**



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# Leadership 101—
# The Law of Empowerment

**The Right Approach**

by **Steve Williams,** THE RIGHT APPROACH CONSULTING

## Introduction

*Good leadership always makes a difference; unfortunately, so does bad leadership.* This leadership truth continues as we will be talking about the 12th of the 21 Irrefutable Laws of Leadership.

## The Law of Empowerment

John Maxwell's Law of Empowerment says that *only secure leaders give power to others.* But what does it mean to be secure? Using the analogy of personal finance, let's look at what's missing from the lives of insecure leaders and illustrate why security matters. I believe we are all familiar with the terms pauper, debtor, and hoarder, and in this context none of them have any capacity to give to others (financially). Here's why:

- Paupers have no source of income aside from the financial assistance they receive from someone else. Penniless and dependent, they're clearly unable to help others financially.

*Leaders without purpose are like paupers.* They have no passion, low energy, and little drive to grow in influence. Usually, their only source of power is the position they have been given by somebody else. In terms of personal authority, they're impoverished.

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# Serious About Speed

For over 30 years Prototron Circuits has led the pack when it comes to providing quality circuit boards FAST.

Be it Class 3, AS9100, ITAR or MIL-PRF-31032, Prototron has the speed you need.

**Prototron Circuits**

*America's* **Board Source**

- Debtors may have nice salaries, but their expenses exceed their income. They've maxed out credit cards and taken out hefty loans. Consequently, they're stuck paying exorbitant interest rates on the amounts they have borrowed. In an upside-down financial situation, they're in no position to give generously to others.

  *Leaders without authenticity are like debtors.* Someone deeply in debt may appear wealthy, even though they're secretly on the verge of bankruptcy. They may have the tools to succeed but lack the moral veracity.

- Hoarders are sitting on a pile of wealth, but they think only of protecting it rather than of sharing it with others. They have the plentiful resources but are unwilling to part with them.

  *Leaders without humility resemble hoarders.* Having put their talents to work, they enjoy a significant amount of power. However, they're worried about others taking it from them or gaining more of it than they have. So, instead of using their influence to empower others, they keep it for their own benefit.

## Insecure Leaders Don't Delegate

I would bet a boatload of beer that most of us have either worked for, or worked with, an insecure manager. These individuals are threatened by those who work for them and in a constant mode of protecting their knowledge and experience. In my last column: *Leadership 101—The Law of the Inner Circle,* I stated that I always try to hire people smarter than me (not all that hard). An insecure manager would never do this for one or more of the following reasons:

1. **Fear of loss.** Some leaders worry that if they empower their followers, their followers will surpass or replace them. If the people you lead are always successful, people will realize that they are successful because of how you developed them.
2. **Fear of change.** By nature, people resist change. As a leader, you must consciously fight against this fear. Change improves organizations. You must be willing not only to change, but to spearhead the change.
3. **Fear of unworthiness.** If you're self-conscious, you may think you personally don't have any power, and if you don't have power yourself, then you can't share it with others. Good leaders believe that a single person can make a change, whether that person is themselves or their followers.

## Application Examples of the Law

### *Failed Application: Ford Motor Company*

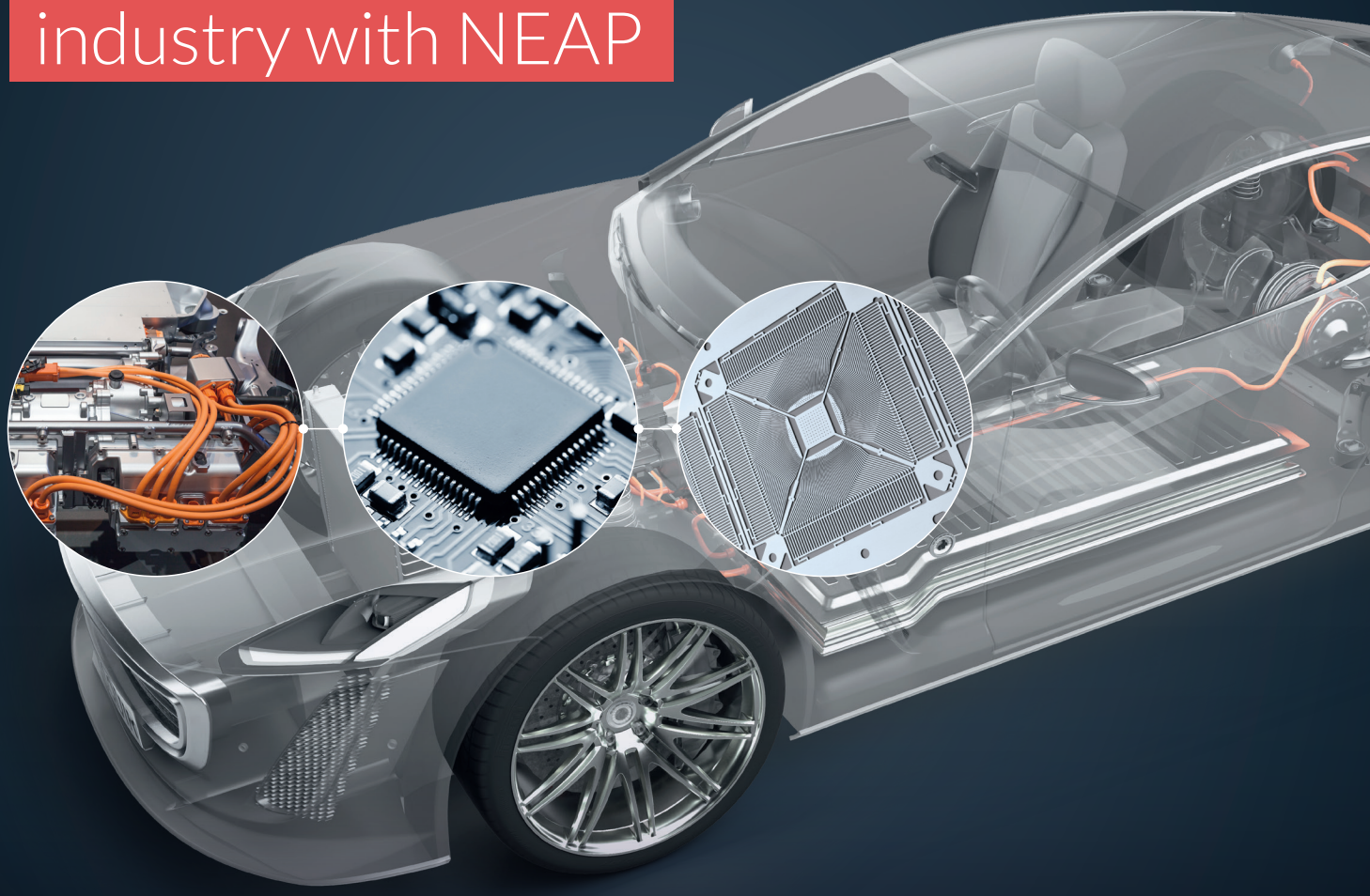
Henry Ford was no doubt an innovator that revolutionized the automotive industry with his assembly line. However, he was also a controlling micromanager that stifled creativity and dissenting ideas. Ford was so enamored with his Model T automobile that he refused to change it or develop other models. In fact, when one of his chief designers presented him with a prototype of a new and improved Model T, he destroyed the car with his bare hands. How did this impact his business? In 1914 Ford owned 50% of the automotive market and by 1931 this dominance had been cut in half. To pour salt in his wounds, many of his most talented people left to go to his competition. Henry Ford was an insecure leader.

### *Successful Application: Abraham Lincoln*

Most presidents select their cabinet members from their allies, or at least from people that share their positions and policies. Abraham Lincoln chose people who disagreed with him, his political rivals, and his antagonists—people who were potentially as strong or stron-

ATOTECH

# Conquer even the toughest requirements of the automotive industry with NEAP



**NEAP** is our new non-roughening adhesion promoter on silver surfaces of lead frames with alone-in-its-class performance. It helps you to dramatically increase performance and reliability under humidity and heat exposure of lead frame packages. Implementation is quick and hassle-free, and thanks to chemistry savings and drag-out reduction, you can lower expenses from the very start. Enjoy more ease of use and performance with this environmentally friendly solution. It's got all you need to reach your automotive OEM qualifications and more. A significantly higher thermal stability also helps you meet even the toughest requirements set by the automotive industry, even beyond MSL1.

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ger than him. He was confident enough in his own leadership that he had no problem giving power to other leaders.

Lincoln empowered others throughout his presidency. He didn't micromanage or look over the shoulders of his generals. When Lincoln gave Gen. George G. Meade command of the Potomac army, Lincoln told him that it was a very important command, that he believed Meade could handle it, and that Meade had full control of the army—Lincoln wouldn't interfere. While Meade wasn't perfect, he did a great job with his first major assignment—Gettysburg. Abraham Lincoln was definitely a very secure leader, and arguably one of the greatest presidents of all time.

### *How Do You Become a Secure Leader?*

Three simple steps:

1. Hire good people (smarter than you).
2. Groom them to be your successor.
3. Get out of their way.

Follow these guidelines and The Law of Empowerment, and you will truly be surprised at the results. Don't be afraid to delegate and share every bit of knowledge and experience you have with your team, and you will quickly reap the benefits. **PCB007**

*"The best executive is the one who has sense enough to pick good men and to do what he wants done, and the self-restraint enough to keep from meddling with them while they do it."*

—Theodore Roosevelt

**Steve Williams** is president of The Right Approach Consulting. He is also an independent certified coach, trainer, and speaker with the John Maxwell team. To read past columns or contact Williams, click here.

# Why Choose Fein-Line?

## Because there is a fine line between winning and the alternative.

**Fein-Line Associates** is a consulting group serving the global interconnect and EMS industries, as well as those needing contact with and/or information regarding the manufacture and assembly of PCBs. Dan (Baer) Feinberg is a 50+ year veteran of the printed circuit and electronic materials industries. Dan is a member of the IPC Hall of Fame; has authored over 150 columns, articles, interviews, and features that have appeared in a variety of magazines; and has spoken at numerous industry events. As a technical editor for I-Connect007, Dan covers major events, trade shows, and technology introductions and trends.

Fein-Line Associates specializes in:

- Management consulting
- Technology transfer
- New product market entry
- Merger and acquisition due diligence
- Market information and market research
- Expert witness assistance and seminars regarding all aspects of printed circuits
- Electronic assembly manufacturing and marketing

**Fein-Line Associates**
P.O. Box 73355
San Clemente, CA 92673

Telephone: (949) 498-7866
Email: baer@feinline.com

Dan (Baer) Feinberg

Fein-Line ASSOCIATES

**www.feinline.com**

# TOP TEN EDITOR'S PICKS

## Flex DFM: When All Things Must Be Considered

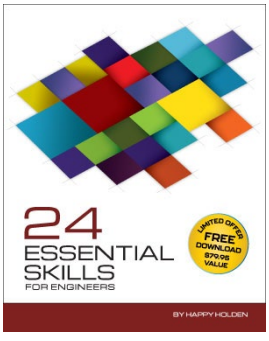
One of the best ways to avoid flex failures is by communicating with your flex fabricator early and often. Here are a couple key reasons why involving your flex and rigid-flex supplier early in the design of your product will help you save time and money—and produce a more reliable flex circuit.

## From DesignCon: Victory Giant Pushing the Technology Envelope

George Dudnikov

Victory Giant's Executive Vice President and CTO George Dudnikov let me in on the growth happening within his company, which includes a much larger Industry 4.0 facility and the capability to do pulse plating up to a 25:1 aspect ratio.

## 24 Essential Skills for Engineers: The Story Behind the Book




In this interview with I-Connect007's own Happy Holden about his newest book, 24 Essential Skills for Engineers, which he wrote over the span of his career, he highlights some particular moments from his time working at HP and as CTO of Foxconn which inspired many of the book's chapters. Happy explains why he covered engineering skills as well as "soft skills" such as problem-solving and communication—skills which are keys to succeeding as an engineer.

## It's Only Common Sense: Get Off Death Row, Part 3—Finding, Hiring, and Keeping Good People

Dan Beaulieu

In the early 1970s, I was a program coordinator for Maine Electronics, a division of Rockwell International. As I got to know more about the job, the product, and the company, I fell in love with the work. Rockwell was building important products, from the Minuteman missile to the F-111 fighter, the Viking; later, we were a prime for the Space Shuttle.

## South Coast Circuits' Amanda Burgesser Invited to Join Chief's Private Network

Amanda Burgesser

Chief's distinguished membership works to broaden female representation in senior positions within the business community.

## Taiflex Reports 19% Revenue Growth in Jan-Aug 2021

Taiflex Scientific Co. Ltd, a Taiwan-based manufacturer of flexible printed circuit materials such as flexible copper clad laminates (CCLs) and coverlays, has announced consolidated revenue of NT$876 million ($31.67 million at $1:NT$27.66) in August 2021, up by 1.8% year-on-year, but down by 7.5% from the previous month.

## Compeq Posts 8.5% MoM Revenue Growth in August

Taiwan-based Compeq Manufacturing Co. Ltd has posted unaudited sales of NT$5.8 billion ($210 million at $1:NT$27.67) for August, up by 2.86% year-on-year, and up by 8.5% from the previous month.

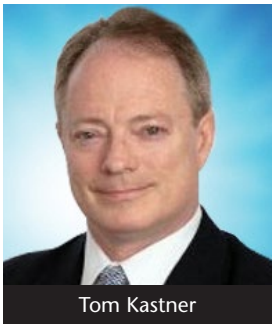
## Flexium Reports 24% YoY Revenue Growth for Jan-Aug 2021


Taiwan-based flexible printed circuit (FPC) manufacturer Flexium Interconnect Inc. has posted sales of NT$3.065 billion ($110.78 million at $1:NT$27.67) in August, up by 20.4% year-on-year, and by 10% from the previous month.

## IPC Unveils Golden Gnomes Awards at IPC SummerCom 2021


A new awards ceremony, the Golden Gnome Awards, was launched at IPC SummerCom 2021. The Golden Gnomes, inspired by IPC's fictional TechNet gnomes Clumpy and Kloumpios, will occur annually at IPC SummerCom.

## Punching Out! Tips From Recent Sellers and Buyers



Tom Kastner

M&A activity is at a very high level in the PCB and EMS sectors, as well as in most sectors of the economy. We recently talked with a wide variety of buyers and sellers and scribbled down some of their insights (names not given due to confidentiality).

# Career Opportunities

# Is your team growing?

## Find industry-experienced candidates at I-Connect007.

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

In addition, your ad will:

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

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

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# Career Opportunities


## Sales Manager

### New Business Development (m/w/d) – Sales Territory: Germany

CML Group is a global leader in the Printed Circuit Board industry, specialized in PCB manufacturing and sustainable PCB supply solutions. Our products are made to the highest quality and reliability standards, including automotive requirements.

For the expansion of our target markets, we need you to generate new business, drive new projects from RFQ stage and manage the customer relationship.

**Your responsibilities:**

- Develop new customers and build long-term customer relationships
- Understand the customer requirements and acquire new contract enquiries from all market sectors
- Proactive market and customer research
- Identify new potential electronic industry sectors
- Result-oriented sales management including support and consulting on new projects
- Independent management and organization of your accounts
- Price and contract negotiations with customers and contractual partners

**Your profile:**

- Several years of professional experience in sales and key account management
- Knowledge of printed circuit board production/ industry would be an advantage
- Fluent in Business English and willingness to travel internationally
- Flexible and an open-minded mentality
- Strong communication skills, team player
- Self-motivated, well-organized, professional
- Your home base is in Germany

Interested? Looking forward to your application!
Please send your application to hr@cmit.support.
For more information visit
www.cml-globalsolutions.com

apply now


## Field Application Engineer

Perfect Point Precision Carbide Tools, a leading supplier of circuit board cutting tools, is looking to add to our technical staff to enhance our customer support team at our Santa Ana repointing facility.

We offer competitive skills-based remuneration and additional performance-based compensation.

As field application engineer, you will be responsible for resolving technical issues and providing engineered solutions to our client base, as well as support sales of carbide cutting tools and repoint services.

**Desired traits:**

- A strategic thinker with strong management, analytical, and planning abilities
- Exceptional written and communication skills
- Self-motivated team player able to work collaboratively with our technical and sales teams

Send your resume to
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for consideration.

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# Career Opportunities

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INTERNATIONAL GROUP
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## Customer Service Representative, UK

We are looking to expand our UK Customer Service/ Internal Sales team. As Customer Service Representative you will provide great sales and customer service support and respond to the needs of clients from industries including Aerospace, Defence, Automotive and Pharmaceutical. Duties include:

- Maintain & develop relationships with new and existing customers
- Make rapid, accurate cost calculations and provide quotations
- Accurately input customer orders through bespoke MRP System
- Liaise with colleagues at Chinese HQ and other Overseas Business Units to manage domestic and international requirements
- Assist sales team with reporting, sales analysis and other items at their request

### Skills and abilities required for the role:

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

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

### What's on Offer:

- Excellent salary & benefits commensurate with experience

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

Please forward your resume to HR@ventec-europe.com

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# Career Opportunities

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

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

## Laminator Technician

### Nature of Duties/Responsibilities

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

### Education/Experience

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

## Wet Process/Plating Technician

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

### Purpose

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

### Nature of Duties/Responsibilities

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

### Education and Experience

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

## Production Scheduler

### Main Responsibilities

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

### Education and Experience

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

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# Career Opportunities


Fuji America Corporation is a rapidly growing electronics assembly equipment distributor. We support the factories of the future and smart factories globally. We offer an exciting and challenging career for a software support engineer and an applications engineer who want to join our growing company.

## Software Support Engineer

As a software support engineer for Fuji America Corporation, you will be a customer-facing technical advisor with the opportunity to solve technically complex problems for our proprietary software. As a trusted advisor to our customers, you will have influence over a broad range of solutions that create business value. As a valued member on our team, the software support engineer will use advanced troubleshooting methods and tools to solve technically complex problems. These highly complex, escalated problems require broad and in-depth product knowledge, as well as exceptional troubleshooting skills.

- Field installation of proprietary software/ automation equipment throughout North America
- Field troubleshoot, repair, training, and process support of proprietary software
- Provide remote and on-site technical support
- Troubleshoot Windows 10/Windows server installing, configuration, and support
- Networking experience—setting up and supporting networks.
- Exposure and/or experience with Oracle or Microsoft SQL server databases
- Strong verbal communication skills with both customer and other technical depts.
- Flexibility to travel and perform job assignments on short notice
- Strong aptitude with current computing applications and networking processes

### Experience

- Bachelor of Science in computer science or related field preferred

## Applications Engineer

As an applications engineer, you will be responsible for doing cycle time and studies in preparation to make recommendations of Fuji products for customers' applications. Support implementation of activities within the technical center such as customer visits, demonstrations, evaluations, testing, inspection of Fuji products, including peripheral equipment from other vendors.

- Assist sales representatives in technical aspects relating to machine and software functions and utilization.
- Assist sales representatives and customers with providing CTA (Cycle Time Analysis) to them for recommending Fuji products to customers' specific applications. This includes the sFAB machine as well as all other SMT machines.
- Schedule and perform product demonstrations on all available types of equipment and software to potential and existing customers.
- Test and evaluate existing as well as new technologies on equipment and software performance and reliability.
- Assist in the coordination of any new FAC projects by utilizing your full potential.
- Responsible for the setup of the equipment and its demonstration for various trade shows.
- Assist FAC staff in any technical issues which may require attention.
- Assist in the coordination of design and manufacture of customs tooling for placement equipment.
- Perform inventory checks every six months according to the schedule and manner regulated by the company, if applicable.

### Experience

- Minimum five years programming/computer experience
- Bachelor's degree preferred

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# Career Opportunities


## PCB Field Engineer– North America Operations

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

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

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

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

**RESPONSIBILITIES INCLUDE**

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

**REQUIREMENTS**

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

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

**SALARY**

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

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Prototron Circuits

## Sales Representatives

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

Reasons you should work with Prototron:

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

Interested? Let's have a talk.
Call Dan Beaulieu at
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# Career Opportunities

## The Test Connection, Inc.

### Rewarding Careers

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

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

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

### Associate Electronics Technician/ Engineer (ATE-MD)

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

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

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### Test Engineer (TE-MD)

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

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

apply now

### Sr. Test Engineer (STE-MD)

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

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

We proudly serve customers nationwide and around the world.

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

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# Career Opportunities

EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

## Maintenance Technician

Inspects work-related conditions to determine compliance with prescribed operating and safety standards. Operates power-driven machinery and uses equipment and tools commonly used to maintain facilities and equipment. Replace filters, belts, and additional parts for repairs and preventive maintenance. Moves objects weighing up to 150 lbs. using a hand truck or pulley. Cleans work area and equipment. Works with cleaning fluids, agents, chemicals, and paints using protective gear. Works at elevations greater than ten feet, climbing ladders, while repairing or maintaining building structures and equipment. Assists skilled maintenance technicians/workers in more complex tasks and possible after-hours emergency repairs. Must meet scheduling and attendance requirements.

apply now

## Plating Operator

Plating operator for printed circuit boards. No experience necessary, will train. Must be able to work with chemicals, lift up to 50 pounds, and have good math skills. Minimum high school/GED or equivalent. All shifts (1st, 2nd, 3rd), 8 hours per day minimum, Monday thru Friday. Saturday and Sunday work is common allowing for steady overtime pay.

apply now

EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

## Water Treatment Operator

Responsible for operating waste treatment plant, our operation that converts wastewater in drains and sewers into a form that's metal free to release into the environment.

Control equipment and monitor processes that remove metals from wastewater. Run tests to make sure that the processes are working correctly. Keep records of water quality and pH. Operate and maintain the pumps and motors that move water and wastewater through filtration systems. Read meters and gauges to make sure plant equipment is working properly. Take samples and run tests to determine the quality of the water being produced. Adjust the amount of chemicals being added to the water and keep records that document compliance.

apply now

## Drilling Operator

Drilling operator for printed circuit boards. Minimum 2 years of experience. Minimum high school/GED or equivalent.

All Shifts (1st, 2nd, 3rd), 8 hours per day minimum, Monday thru Friday. Saturday and Sunday work is common allowing for overtime pay.

apply now

# Career Opportunities

MivaTek Global

## Product Manager

MivaTek Global is preparing for a major market and product offering expansion. Miva's new NG3 and DART technologies have been released to expand the capabilities of Miva's industry-leading LED DMD direct write systems in PCB and Microelectronics. MivaTek Global is looking for a technology leader that can be involved guiding this major development.

The product manager role will serve as liaison between the external market and the internal design team. Leadership level involvement in the direction of new and existing products will require a diverse skill set. Key role functions include:

- **Sales Support:** Recommend customer solutions through adaptions to Miva products
- **Design:** Be the voice of the customer for new product development
- **Quality:** Verify and standardize product performance testing and implementation
- **Training:** Conduct virtual and on-site training
- **Travel:** Product testing at customer and factory locations

Use your 8 plus years of experience in either the PCB or Microelectronic industry to make a difference with the leader in LED DMD direct imaging technology. Direct imaging, CAM, AOI, or drilling experience is a plus but not required.

For consideration, send your resume to N.Hogan@MivaTek.Global. For more information on the company see www.MivaTek.Global or www.Mivatec.com.

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MivaTek Global

## Field Service Technician

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

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

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

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

### More About Us

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

apply now

# Career Opportunities

ARLON ELECTRONIC MATERIALS

Arlon EMD, located in Rancho Cucamonga, California, is currently interviewing candidates for open positions in:

- **Engineering**
- **Quality**
- **Various Manufacturing**

All interested candidates should contact Arlon's HR department at 909-987-9533 or email resumes to careers.ranch@arlonemd.com.

Arlon is a major manufacturer of specialty high-performance laminate and prepreg materials for use in a wide variety of printed circuit board applications. Arlon specializes in thermoset resin technology, including polyimide, high Tg multifunctional epoxy, and low loss thermoset laminate and prepreg systems. These resin systems are available on a variety of substrates, including woven glass and non-woven aramid. Typical applications for these materials include advanced commercial and military electronics such as avionics, semiconductor testing, heat sink bonding, High Density Interconnect (HDI) and microvia PCBs (i.e. in mobile communication products).

Our facility employs state of the art production equipment engineered to provide cost-effective and flexible manufacturing capacity allowing us to respond quickly to customer requirements while meeting the most stringent quality and tolerance demands. Our manufacturing site is ISO 9001: 2015 registered, and through rigorous quality control practices and commitment to continual improvement, we are dedicated to meeting and exceeding our customers' requirements.

For additional information please visit our website at www.arlonemd.com

apply now

KOH YOUNG TECHNOLOGY

## Logistics Assistant

Koh Young America is looking for a Logistics Assistant to assist and oversee our supply chain operations. Working alongside a Logistics Specialist, you will coordinate processes to ensure smooth operations using a variety of channels to maximize efficiency. You must be an excellent communicator and negotiator well-versed in supply chain management principles and practices. Also, you should be meticulous with a focus on customer satisfaction. These attributes are ideally complemented by a Bachelor's in Supply Chain Management or equivalent professional experience in the manufacturing industry.

This position is in our Duluth, Georgia, headquarters, where we serve our customers within North and South America. We offer health, dental, vision, and life Insurance with no employee premiums, including dependent coverage. Additionally, we provide a 401K retirement plan with company matching, plus a generous PTO policy with paid holidays.

Koh Young Technology, founded in 2002 in Seoul, South Korea, is the world leader in 3D measurement and inspection technology used in the production of microelectronics assemblies. Using patented 3D technology, Koh Young provides best-in-class products in Solder Paste Inspection (SPI) and Automated Optical Inspection (AOI) for electronics manufacturers worldwide.

apply now

# Career Opportunities

Manncorp™

## SMT Operator
### Hatboro, PA

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

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

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

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

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

apply now

Manncorp™

## SMT Field Technician
### Hatboro, PA

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

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

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

**We Offer:**
- Health and dental insurance
- Retirement fund matching
- Continuing training as the industry develops

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# Career Opportunities

SIEMENS

## Siemens EDA
## Sr. Applications Engineer

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

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

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

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

apply now

U.S. CIRCUIT

## Plating Supervisor

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

Competitive benefits package. Pay will be commensurate with experience.

Mail to:
mfariba@uscircuit.com

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# Career Opportunities

BLACKFOX
Premier Training & Certification

## IPC Instructor

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

***Independent contractor, possible full-time employment***

**Job Description**

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

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

**Qualifications**

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

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

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

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

apply now

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

## CAD/CAM Engineer

**Summary of Functions**

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

**Essential Duties and Responsibilities**

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

**Organizational Relationship**

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

**Qualifications**

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

**Physical Demands**

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

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# Career Opportunities

## Now Hiring

### Director of Process Engineering

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a director of process engineering.

**Job Summary:**

The director of process engineering leads all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering processes within the plant.

**Duties and Responsibilities:**

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Provides guidance to process engineers in the development of process control plans and the application of advanced quality tools.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating them into the manufacturing operations.
- Strong communication skills to establish priorities, work schedules, allocate resources, complete required information to customers, support quality system, enforce company policies and procedures, and utilize resources to provide the greatest efficiency to meet production objectives.

**Education and Experience:**

- Master's degree in chemical engineering or engineering is preferred.
- 10+ years process engineering experience in an electronics manufacturing environment, including 5 years in the PCB or similar manufacturing environment.
- 7+ years of process engineering management experience, including 5 years of experience with direct responsibility for meeting production throughput and quality goals.

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## Now Hiring

### Process Engineering Manager

A successful and growing printed circuit board manufacturer in Orange County, CA, has an opening for a process engineering manager.

**Job Summary:**

The process engineering manager coordinates all engineering activities to produce quality products and meet cost objectives. Responsible for the overall management, direction, and coordination of the engineering team and leading this team to meet product requirements in support of the production plan.

**Duties and Responsibilities:**

- Ensures that process engineering meets the business needs of the company as they relate to capabilities, processes, technologies, and capacity.
- Stays current with related manufacturing trends. Develops and enforces a culture of strong engineering discipline, including robust process definition, testing prior to production implementation, change management processes, clear manufacturing instructions, statistical process monitoring and control, proactive error proofing, etc.
- Ensures metrics are in place to monitor performance against the goals and takes appropriate corrective actions as required. Ensures that structured problem-solving techniques are used and that adequate validation is performed for any issues being address or changes being made. Develops and validates new processes prior to incorporating into the manufacturing operations

**Education and Experience:**

- Bachelor's degree in chemical engineering or engineering is preferred.
- 7+ years process engineering experience in an electronics manufacturing environment, including 3 years in the PCB or similar manufacturing environment.
- 5+ years of process engineering management experience, including 3 years of experience with direct responsibility for meeting production throughput and quality goals.

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# Career Opportunities

INSULECTRO

## Are You Our Next Superstar?!

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

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

View our opportunities at Insulectro Careers (jobvite.com)

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eptac

TRAIN. WORK SMARTER. SUCCEED.

## Become a Certified IPC Master Instructor

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

### Qualifications and skills

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

### Benefits

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

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# Career Opportunities


## 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.

apply now


## Pre-CAM Engineer

Illinois-based PCB fabricator Eagle Electronics is seeking a pre-CAM engineer specific to the printed circuit board manufacturing industry. The pre-CAM Engineer will facilitate creation of the job shop travelers used in the manufacturing process. Candidate will have a minimum of two years of pre-CAM experience and have a minimum education level of an associate degree. This is a first-shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to HR@eagle-elec.com indicating 'Pre-CAM Engineer' in the subject line.

apply now

## Process Engineer

We are also seeking a process engineer with experience specific to the printed circuit board manufacturing industry. The process engineer will be assigned to specific processes within the manufacturing plant and be given ownership of those processes. The expectation is to make improvements, track and quantify process data, and add new capabilities where applicable. The right candidate will have a minimum of two years of process engineering experience, and a minimum education of bachelor's degree in an engineering field (chemical engineering preferred but not required). This is a first shift position at our Schaumburg, Illinois, facility. This is not a remote or offsite position.

If interested, please submit your resume to HR@eagle-elec.com indicating 'Process Engineer' in the subject line.

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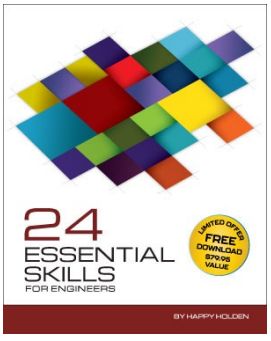
## New from Happy Holden:

## *24 Essential Skills for Engineers*



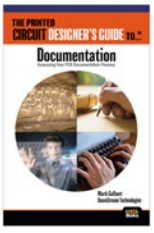

This book is a blueprint of the strategies that Happy has used for decades to overcome engineering challenges. Each chapter is devoted to a skill that engineers do not typically learn in college, such as problem solving, design of experiments, product and process life cycles, Lean manufacturing, and predictive engineering. You won't find all this information in one publication anywhere else. Happy has done all the hard work for you. All you have to do is read this book and take notes. **Get your copy now!**

## I-007eBooks The Printed Circuit Designer's Guide to...


### Thermal Management: A Fabricator's Perspective

*by Anaya Vardya, American Standard Circuits*

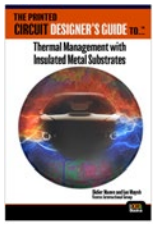
Beat the heat in your designs through thermal management design processes. This book serves as a desk reference on the most current techniques and methods from a PCB fabricator's perspective.




### 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.




### 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. This micro eBook provides information needed to understand the unique challenges of RF PCBs.


### Flex and Rigid-Flex Fundamentals

*by Anaya Vardya and David Lackey, American Standard Circuits*

Flexible circuits are rapidly becoming a preferred interconnection technology for electronic products. By their intrinsic nature, FPCBs require a good deal more understanding and planning than their rigid PCB counterparts to be assured of first-pass success.

**Our library is open 24/7/365. Visit us at: I-007eBooks.com**

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# ADVERTISER INDEX

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