

I-Connect007
GOOD FOR THE INDUSTRY

AUGUST 2023

PCB007

MAGAZINE



Developing High-flying Strategies

Your guides to success.

Want to up your game in about 30 minutes? Written by industry experts, all our books contain knowledge that you can apply immediately to make you (and your company) more successful.

“I-007ebooks are like water in the desert
...it’s up to you to drink it in order to survive!”

Stephen V. Chavez
Senior Product Marketing Manager
Siemens



BOOKMARK OUR LIBRARY



A Distinct Evolution from DFM



Look Inside

**“In an industry racing against time,
MDD is the key to staying ahead.”**

Ammar Abusham
DFM Integration Engineer (AR EE Team)
Meta Reality Labs

PCB007

M A G A Z I N E

Developing a Strategy

Today's PCB fabricators face a variety of market and supply chain obstacles in addition to competitors down the street and overseas. A solid strategy is a critical part of success. This month, we asked some of the top industry leaders and business strategy "gurus" to share their thoughts on developing strategies.

EXCLUSIVE COVERAGE ▼



New Schweitzer Engineering Laboratories (SEL) facility has the greenfield PCB manufacturing advantage.

10 **Discussing SEL's Strategy**
with David Whitehead



18 **A Look Inside SEL's New PCB Factory**
with John Hendrickson and Mike Brask



34 **Going Green**
with John Hendrickson

36 **Innovations in Final Finishing**
with Mike Brask



40 **FEATURE INTERVIEWS**
TTM CEO Tom Edman on the Process of Strategy



50 **Jet Appeal**
with Carsten Sundin, John Smoker, Aaron Park, and Austin Alley



70 **What's Your Process for Developing a Strategy?**
with Tim Rodgers



88 **Developing a Fabrication Business Strategy**
with Chris Chapman



84 **FEATURE ARTICLE**
10 Steps to Outstanding
by Dan Beaulieu



46 **FEATURE COLUMN**
Developing Your Team to Become Great Implementors
by John Mitchell



WORLD-CLASS SUPPLIERS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, salutes our premier suppliers.

CALL 949.587.3200 FOR MORE INFORMATION



Because Reliability Matters

THE NEW IS550H

FEATURES

HIGH OPERATING TEMPERATURE
 Continuous Operating Temperature up to 175°C

HALOGEN FREE

CAF RESISTANCE
 ≥1000hrs @ 1500V

HIGH THERMAL RELIABILITY
 Pass -40°C to +175°C, 2000 cycles

MARKETS

AUTOMOTIVE & TRANSPORTATION

AEROSPACE & DEFENSE



The Material for e-mobility that is suitable to use for those applications requiring high voltage, high power and high thermal stability.

✉ info@isola-group.com

☎ 800-537-7656

🌐 isola-group.com

isola®

EMD ELECTRONICS

Ormet® Sintering Paste: Fewer Multiple Lamination Cycles

Ormet® Transient Liquid Phase Sintering (TLPS) via fill pastes enable anywhere and any-layer vias in high-performance complex printed circuit boards without any need for copper plating. TLPS-filled z-axis interconnect layers can be fabricated in parallel with individual x-y trace layers, or PCB sub-constructions of multiple layers with installed PTH and laminated in a single cycle.



PCB007

M A G A Z I N E



COLUMNS

8 **Developing a Strategy**
by Andy Shaughnessy



64 **Smoothing the Rocky Road of Onboarding**
by Hannah Nelson



78 **India's Rise in the Global Electronics Ecosystem**
by Preeya Kuray



98 **Member Profile: Melanie Bera Anderson**
by PCBAA



SHORTS

- 9** Quantum Technology for Your Smartphone
- 48** New Type of Quantum Bit in Semiconductor Nanostructures
- 63** Infographic: The Heights of Flight
- 76** Protons Set to Power Next-gen Memory Devices
- 100** AI-based Technique for Predicting Crystal Orientation

DEPARTMENTS

- 105** Career Opportunities
- 114** Educational Resources
- 115** Advertiser Index & Masthead



HIGHLIGHTS

- 96** MilAero007
- 102** Top Ten from PCB007



TAKING IT TO THE EXTREME

HIGH HEAT

BY TAIYO



We created our new liquid photoimageable extreme solder mask, PSR-4000 HH01XR, to withstand temperatures of up to 200°C for up to 2000 hours. Designed specifically for DI equipment, it is the premier choice solder mask for ground and air vehicles as well as heavy industrial machinery. PSR-4000 HH01XR is user friendly with wide processing latitudes, low odor, fast developing, and good resistance to alternate metal finishes while maintaining dams of 3 mils or less.

- Screen Print & Spray Application
- RoHS Compliant
- Meets Aerospace Outgassing Requirements
- Resistance to extreme temperature of 200°C for 2000 hours
- Fine Dam Resolution
- Halogen-Free

Contact your local sales representative today!

Visit www.taiyo-america.com for more information.



Follow us on social media



Developing a Strategy

The Shaughnessy Report

by Andy Shaughnessy, I-CONNECT007

If you're around my age, you probably spent much of the 1970s playing board games such as Monopoly, Life and Scrabble. But I really enjoyed playing Stratego, which required that you plan a strategy to defeat the other players.

PCB fabricators of today are in the same boat now, but it's no game. They face a variety of market and supply chain obstacles in addition to competitors down the street and overseas. With profit margins tight enough

to squeak, fabricators need a solid business strategy.

But how does a leader plan a strategy? In a field of competitors offering basically the same services, how can your company differentiate itself? Will you be a cost leader, or focus on serving a niche market such as medical or defense? As we learn in this issue, one question that successful leaders need to ask themselves is, "What do I not want my company to be?"



This month, we asked some of the top leaders in the industry, and some of the top business strategy “gurus” in the world, to share their thoughts on developing strategies, particularly for North American fabricators.

We start with an in-depth look at SEL’s new captive facility in Idaho, featuring interviews with CEO David Whitehead, Engineering Director John Hendrickson, and Mike Brask, president of IPS which provided an ENIG line for the new facility. We have an interview with TTM CEO Tom Edman, who shares some of the strategy development ideas that have made his company one of the biggest fabricators in North America. IPC’s John Mitchell discusses one critical component of your strategy: developing the right team. We have an interview with Carsten Sundin, president and CEO of Stratos Aircraft, and his engineers, who break down their long-term strategy for bringing a new jet to market.

Next, we have an interview with Dr. Tim Rodgers of the University of Colorado, who lays out each step of a manufacturer’s development strategy, including identifying what exactly constitutes a good strategy. Columnist Dan Beaulieu loves to make lists, and this month he points out 10 steps to making your manufacturing operation outstanding. And Christopher Chapman, publisher of *The Digestible Deming* newsletter, discusses what today’s fabricators can learn from the work of W. Edwards Deming.

It’s hard to believe that summer is almost over. Before you know it, we’ll be in trade show season again. 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](#).

Quantum Technology for Your Smartphone



University of Copenhagen researchers have invented a “quantum drum” that can measure pressure, a gas leak, heat, magnetism and a host of other things with extreme precision. It can even scan the shape of a single virus. With two innovative solutions, researchers at the Niels Bohr Institute have found a way to get quantum technology into our pockets.

The heart of the apparatus could be called a “quantum drum.” It is a thin membrane that vibrates like a drum skin, but with so small an amplitude that the laws of quantum physics are needed to describe what’s happening. This means the drum can be used as an ultra-precise measuring device—a quantum supersensor.

“The sensor is so sensitive that, in principle, we could measure whether a single person is hopping from one leg to the other in Paris. We would be able to capture it here, in our Copenhagen basement, from thousands of kilometers away,” laughs Professor Albert Schliesser from the Niels Bohr Institute, who heads the team behind the quantum sensor.

Thought experiments aside, the sensor is very real and has many possible uses. By reading changes in the vibrations with which the quantum drum moves, researchers can measure a wide variety of influences with extreme precision.

“For example, a change in temperature or the presence of a gas will directly affect the way the drum vibrates, and it’s the same when we place a virus on the drum. A laser allows us to read the result accurately. But this is just the beginning,” explains Schliesser.

(Source: University of Copenhagen)



Discussing SEL's Strategy

Feature Interview by the I-Connect007 Editorial Team

The Schweitzer Engineering Laboratories (SEL) leadership team made some far-reaching decisions in the past decade: They opted to build their own captive PCB fabrication facility in Moscow, Idaho, and they decided to utilize zero-discharge processes. Now the facility is up and running and the state and local officials are firmly on SEL's side, thanks in large part to the green processing, not to mention the employment opportunities.

We recently interviewed David Whitehead, CEO of SEL, and asked him to discuss his pro-

cess for developing a business strategy. He explains how a company's core values inform its strategy, the need to understand your customers' needs, and why building your own PCBs makes sense in these times of supply chain disruptions.

Barry Matties: Why don't we start with your core values, and how those really are the foundation to strategy?

In the early days of the company, Ed Schweitzer wrote down our principles of oper-

ation, about eight pages front and back, and really described the way we want to operate the business. There were about 25–30 employees at that time. Now we have 6,300 employees all over the world, and we maintain that original culture and strategy across the company.

The very first part of those principles of operation are our nine values. The first two, quality and customer focus, really set the tone for how we do business. Every product and service we develop will be high quality. Our strategy around customers begins with how we will provide what we call PQFIDS—price, quality, features, innovation, delivery, and service.

That equates to the value that we'll provide to our customers. It must be all six of these criteria, which is really valuable to our employee owners, and our customers.

Matties: *SEL is a company that has really embraced vertical integration. At your PCB factory, just by having a shop and the designers and the collaboration opportunities here,*

I imagine that you're finding benefits that you didn't expect to see on a typical ROI sheet.

Yes, we are. It's an education in and of itself. You know, I'm one of these types of engineers: I really don't understand something until I do it wrong about three or four times.

When you build something yourself, you have to understand how it works. When you get to a level of expertise with something, you're able to modify whatever you're doing to meet the needs of your customers. It's probably better, cheaper, and faster than what we're getting from our existing suppliers—not that our existing suppliers were bad by any means.

We can do things a lot faster here. I started

my career as an electronics designer here at SEL, designing circuit boards to go inside our products. We'd send the Gerbers off to a manufacturer, and about two weeks later, I'd get the PCB back. Now when our engineers are done with a design, they can send it to our factory that's seven miles away, and probably have the board back in a couple of days and start testing.

Matties: *Now, when you're developing strategy, what are key considerations?*

Well, it has to fit within our mission statement. We build products and solutions for the electric power industry, so we're probably not going to build electric cars today. But it does give us enough pathway to come up with new, innovative stuff. While our core devices measure current and voltage on a power system, we also manufacture a line of ethernet switches. You might ask, "How does an ethernet switch fit into making electric power safer and more reliable?" Well, we use these switches to connect our devices and control power systems,



David Whitehead, CEO of SEL.

so that communication device becomes really critical. I'm not going to build a switch that competes with Cisco; rather, I'm going to tailor my solution to fit the needs of our particular industries.

Matties: *But when you're describing that, you're focused in on a core set of strategies. How do you look to build a strategy for the future?*

That is the fun part! It's my job to figure out and anticipate the challenges our customers will have tomorrow, whether it's integrating a new renewable source of energy, or figuring out how all these devices will communicate.

Matties: *But when you're describing that, you're focused in on a core set of strategies. How do you look to build a strategy for the future?*

That is the fun part! It's my job to figure out and anticipate the challenges our customers will have tomorrow, whether it's integrating a new renewable source of energy, or figuring out how all these devices will communicate.

How will we manage a wide-area power system five or 10 years down the road? Then we have to align our sales force and manufacturing capabilities to address the needs that we're anticipating. Like anybody, sometimes we get it right, and sometimes we get it wrong. We take the risk for the reward of making a little bit of profit.

Matties: *We keep hearing all the discussion about EVs and how fossil fuel will be a thing of the past. How does that news play into your longer-term strategy?*

The great part about our particular part of the industry is that we aren't necessarily concerned with how the electricity gets generated, or where it ends up being consumed. Our job is to manage how it flows through transmission networks and distribution networks. Whether it's coming from a solar plant, a nuclear plant, or a gas turbine, that's all great. What's being called the "electrification of everything" is really good for our business, because we know how to manage electric power and there will always be an increasing need for the control, monitoring, and optimization of power systems.

Matties: *Is this what helped drive the idea of bringing in more capacity to build your own circuits? When you look to expansion, what sort of window are you considering?*

Everybody has different levels or horizons of strategies. At SEL, we utilize a five-year rolling strategy. We plan and document where we want the company to be in this industry, and what technologies we'll advance based on what we see the market doing. Opportunities for vertical integration are always part of the discussions as we plan and set new strategies.

The PCBs that go into our products probably have the most intellectual property of anything we design right now. They really hold all our intellectual property together, when combining our software and the hardware and everything else that goes into our blue boxes. It's a big risk to send that out to somebody else, and there's nothing better than having our own PCB factory in our backyard to make sure that we can continue to ship products to our customers.

We've all experienced supply chain challenges in the past few years. People were trying to onshore as much as they could, and they



SEL has incorporated their own products into their infrastructure.

M A D E I N T H E U . S . A .



For more than 25 years, IPS has been your solution for the most state-of-the-art process equipment. All our systems are designed, tested and manufactured right here in America ...and we wouldn't have it any other way!



U.S. Coast to Coast • Parts and Service Fast
ips-vcm.com • sales@ips-vcm.com • 435-586-1188



SEL's zero liquid discharge process area.

We just started looking at how many circuit boards we consume, and the prices we were paying. This is such a key component in our products. Why not do it ourselves, do it cheaper, and in some cases, do it better? It's just a win for us and a win for our customers.

Matties: Now, you're a zero-discharge facility as well. What role did that play in the decision?

Our community, Moscow, is only seven miles away from our global headquarters, and we have many employees who live near the PCB factory, so it just makes sense to be a good steward of the environment. It wasn't because of any EPA regulations or what have you. It's just part of our company values. We want to be a good neighbor. We don't want to be discharging anything that might harm our employees or communities. We built what we believe is the greenest PCB factory in America, if not in the world right now.

Matties: That is quite impressive. Now, when you're thinking about strategy, how important was the idea of being an ESOP (employee stock ownership plan) company? In your strategy development, how does this carry you forward?

were consuming the rest of the capacity within the United States. If our circuit board factory had been online a year earlier, we could have avoided a lot of headaches and scrambling, plus a lot of expediting fees. So, being able to control the costs, quality, and lead times makes this a win for us. Our CFO did some calculations on the return on this \$100 million investment, and how long it will take to see payback. We're estimating it to be a couple years.

Matties: That's an incredible ROI. Engineering Director John Hendrickson estimated about three to four years. I'm probably a little more optimistic than John is (laughs).

Matties: What was the final tipping point to decide that you were building a factory?



John Hendrickson, Engineering Director, SEL.



Being employee owned has a lot to do with all of our decisions. I feel a tremendous responsibility as the CEO to make sure that we're taking care of our 6,300 employees and their families every day. So, when making the decision to spend \$100 million, I understand that it's certainly a lot of money for us. We didn't ask the government for any subsidies—not federal, state, or local. To do this, we reinvested our profit back into the printed circuit board factory, and our expectation is that, because we're making these sound decisions for our employee owners, we will see long-term benefits. One of the benefits of an ESOP is that we report to the employee owners, not external shareholders who are most interested in short-term gains. It really gives everybody a sense of ownership.

One of the best ways that we share our strategy with our employee owners is by hosting a

company-wide catered business lunch every Friday. We get everybody together and review how the business is doing. We've talked about the printed circuit board factory, its cost, and the challenges throughout the project. We talk about sales, if there's a problem with a customer or product, and we bring all this stuff forward. We're very transparent and open with the employees about how the company is doing and that has been our strategy since day one. I don't think we'll ever get rid of it.

Matties: What advice would you give to other businesses that are developing a strategy?

Make sure that everybody in the organization is aligned on what your mission is. What's your vision? Make sure everybody has bought into it, and then you can start picking out particular activities that you want to do. My advice is to do something innovative



and different that will really change whatever industry you're in.

Andy Shaughnessy: *David, where do you think leaders tend to go wrong when developing a strategy?*

Usually it's because your strategy gets disconnected from the customer and the customer's needs. That's always one of those challenges. Those things will happen every once in a while, but that's how strategies go wrong; you're not listening to the right people, or you're not connected enough with your end-user.

Shaughnessy: *We also hear about company managers following bad advice from consultants.*

Exactly. I would say that if you're hiring a consultant to tell you how to run your business, that's a big red flag and you need to step back and understand your business a lot better.

Matties: *Do you have any final thoughts that you'd like to share with the industry?*

I would encourage everybody to consider the idea of vertical integration and doing things yourself. Now, sometimes you just don't have enough scale to be able to build your own PCB manufacturing facility, but you can take baby steps to start designing your own circuit boards. Make sure you really understand the technology. Visit printed circuit board factories to understand the layup and the whole process—drilling, plating, and all those things.

My career advice for young folks is to become an expert at your job, understand your customers' needs in great detail and, finally, never say no to an opportunity. Taking on new challenges will grow your career.

Matties: *Very good. Thank you so much. Thank you. PCB007*



SMART PROCESS DESIGN



PRODUCTS & SERVICES FOR PCB FABRICATION:



- Turnkey wastewater and chemical recycling systems for fabs
- Smart factory design, investment/financial planning, project management services
- PCB fab design, DFM, NPI, yield improvement consulting
- Product industrialization, scale-up, cost/cycle time reduction, PCB supply chain sustainability planning for OEMs & fabs
- Process audits and system optimization modeling of integration of process, product, and human factors
- DIY process engineering consulting for SMEs

www.smartpcbfab.com



info@smartpcbfab.com

An ITAR-Compliant Public Benefit Corporation (B-Corp) founded by Alex Stepinski, patented inventor of Zero Liquid Discharge for the PCB industry, pioneer of Industry 4.0 reshoring, and first recipient of the I-Connect007 Good for the Industry award



A Look Inside SEL's New PCB Factory

Feature Interview by Barry Matties

I-CONNECT007

After years of planning, Schweitzer Engineering Laboratories is now manufacturing printed circuit boards in its new \$100 million captive facility in Moscow, Idaho. I recently toured the facility with Engineering Director John Hendrickson, who managed the design and setup of the greenfield site, along with Mike Brask, president of Integrated

Process Systems (IPS), a key supplier for the new Moscow facility.

The facility showcases the latest technology in PCB fabrication, along with a zero liquid discharge water treatment system. The site is surrounded by wheat fields—not a location where you would traditionally expect to find a PCB manufacturing facility. How-

ever, with their environmentally friendly factory, the city officials have welcomed SEL, and the facility has already been honored with the Idaho Association of Commerce & Industry Environmental Excellence Award.

The manufacturing area is set up on an open floorplan with only a couple of processes—drill and route—in closed rooms. As you would expect, data automation is in full use here. Each panel starts off with a serial number read by scanning equipment that connects with the MES to identify the job and program, and then loads that program onto the machine. SEL’s in-house software team builds and maintains these systems. They also employ automation/integration software engineers as well.

Now, the goal of automation here was not to reduce headcount?

John Hendrickson: Correct. That’s not why we focused on automation; we automated first to drive quality. The number one defect at board



Laser etched barcoder for material traceability.

shops is typically handling damage. So, how do you reduce that? You put in equipment, like we have from GreenSource and others, to help eliminate handling. Quite frankly, now our operators aren’t just feeding panels on a line. They’re managing an entire line, and they’re learning more about how those lines work and



From left: GreenSource Engineering (GSE) double loader, photoresist strip line, GSE unloader.



Schmolli's Modul drills in a Cube line shown with optional automation.

how to maintain them. They have a lot more ownership of that, even more than our maintenance team on a day-to-day basis.

All our lines are integrated. One of the cool things we're doing here is using SEL equipment to collect real-time process data. We have a product called RTAC (Real-Time Automation Controller) that communicates with PLCs, and we use that to get information using a range of industrial communication protocols. Using our software-defined network, we control all network traffic between MES, RTAC, and equipment. This increases the security between our systems and our equipment in case there's ever a security vulnerability with piece of equipment.

What sort of volume are you producing?

Hendrickson: While we have relatively high volume, we also have a lot of part numbers.

I believe that 20% of our part numbers are 80–90% of our volume, which means 80% of our part numbers are lower volume. This requires us to have flexibility to change over and run the lower-volume jobs. For example, the drill room features a number of Schmolli single-spindle drill machines, which load and unload through automation.

What sort of tolerances and line spacing are you trying to achieve?

Hendrickson: The traces and spaces we're targeting right now are about 2.5 mil traces and 3 mil spaces, especially for outer layers. We're also using pinless lamination to help get tighter registration there. We also have an Impex Pro X3 machine that will scan a panel with 150,000 holes in 20 seconds. It provides us the SPC data for diameter and location. It's been an instrumental tool in qualifying

Focused on Support

We provide first-class service and support—with a smile.

AUTOMATION SOLUTIONS FOR INTELLIGENT AND FLEXIBLE PRODUCTION



schmoll  **maschinen**
...one step ahead.

SERVICE: +1 (717) 420-8088
schmoll-support@burkleamerica.com

BURKLE
NORTH AMERICA, INC.

+1 (336) 660-2701
burkleamerica.com

drill. We've seen tighter registration and tolerance in our drill process because of a data driven process.

Are you doing continuous flow manufacturing?

Hendrickson: Our goal is to be as close to continuous flow as possible. We have small queues at the beginning and end of our lines. It's a balancing act to ensure a process does not run out of work.

As I entered the manufacturing area, the first piece of equipment I saw was a nearly 300-foot long Atotech horizontal plating line. The line will produce about around 100 panels per hour when it's fully up and running.

Hendrickson: We have four electroplaters with the first plater acting as a flash plate. Between platers two and three we installed automation to rotate the panel 180 degrees. The purpose of rotating the panel is to balance the copper across the panel.

Is that recommended by the supplier, or is it something that you decided to do, based on experience?

Hendrickson: That's something we decided to do. Another thing we're doing that isn't really done in North America too much is panel plating. We're not pattern plating. We're not applying dry film, putting on a reverse image, plating, tinning and then strip, etch, strip. Everything goes through develop, etch, strip, whether it's



Atotech's 300-foot long horizontal plating line at SEL's Idaho facility.

Focused on Solutions

We are setting new standards for PCB manufacturing.

Schmoll Maschinen MDI digital imaging machines provide a high-volume and stable processing solution for manufacturers looking for performance at the highest level. For unbeatable exposure times, look no further.



schmoll  **optronics**

Schmoll MDI Micromirror-Digital-Imaging
Tandem Table Machine

- + Direct imaging of inner layers, outer layers and solder mask
- + High resolution with L/S down to 0.5 mil
- + Tandem table concept (2x 24" x 36") and big panel capability (1x 54" x 36")

For more information call us:
+1 (336) 660-2701

BURKLE
NORTH AMERICA, INC.

burkleamerica.com



Chemcut CC8000 inner layer develop-etch-strip (DES) system using cupric chloride etchant. The two large portions of the line shown are the etching chambers.

an outer layer or an inner layer. This simplifies the factory by removing unique processes and providing redundancy as we will have two Chemcut DES lines. Panel plating also gives us a little bit more repeatability on copper thickness across the surface of the panel, where you only have the density of holes driving copper thickness variation.

On our Chemcut etching line, we've added a Sigma Mecer etch recirculation and reclamation system. The copper is removed from the etchant, plated on big copper sheets, and then sent out for recycling. The long-term goal is plate out in a form that we can reuse in our platers. Before dry film, we are cleaning the copper surface, microetching for adhesion, going through an electrostatic cleaner, and then we do a preheat. Not a lot of people do that, but we're getting the panel up to temperature. In the film laminator, we have heated rollers; we are helping promote adhesion as much as possible.

Is that a measurable improvement that you can come back and quantify?

Most shops don't do that.

Hendrickson: Not yet. We're starting with our lower-complexity boards; I expect the extra cleaning and heating of the panels to pay off when we produce our boards with finer features. After dry film, we put it in a buffer to get the panel back down to room temp before imaging.

We have a Schmolz MDI imager, which has a tandem table with two robots; a scanner on the line will scan the barcode and automatically load the program. The panel is loaded in the first drawer to image the top side, and then the robot flips it to the second drawer and images the backside. Panels are then put in a buffer to let the dry film settle for five minutes before moving on to develop.

In your lamination area, you went all in with induction presses. What was your thinking behind that?



Mecer's acidic etchant copper recycling system—capacity 180,000 lbs. copper per year—helps make SEL's Moscow factory a zero liquid discharge facility.



Right to left: GSE double loader, followed by Chemcut preclean line, electrostatic cleaner and preheat oven, cut-sheet laminator, GSE UV-protected lift-up gate, GSE FIFO/FILO-capable buffer with cooling, and partial view of Mylar peeler.



InduBond lamination press profile data.

Hendrickson: Well, they're definitely nice, clean machines. The energy savings alone is crazy. There are no thermal management challenges in the building like we would see with a hot oil press; we don't have to worry about any of that with the induction press technology. When the machine is running, you can

put your hand on it and it's not even hot, because all the energy is going to the panels in the book. Each plate is stainless steel and conductive, so you get even heating throughout, as opposed to a hot oil press, where you have to get the heat from the outside in. Also, heat-up time is rapid compared to an oil process. Each book has thermocouples that provide immediate response to the system, which automatically adjusts the energy to put drive the induction coils to keep the profile within spec. Eventually, we'll build this out to 10 two-opening presses.

For solder mask, you're doing nothing but inkjet printers. Was speed an issue here?

Hendrickson: Yes, we went with Notion Systems. This technology is newer, and speed is definitely a concern. But if you start to look at how long it takes for an imager to image solder mask, like laser or LED, these printers are getting pretty close to on par with that.



Notion Systems' n.jet technology saves multiple process steps, large investments in valuable space, energy, and labor. This completely digital process also uses UV-curable inks instead of solvent-based inks, which has far reaching effects on the environment.

Innovation

+ Precision

+ Reliability



In-house lab available for customer testing

Wet processing equipment for all of your circuit board manufacturing needs, such as:

- Cleaning
- Developing
- Etching
- Stripping
- Conveyorized Plating

To learn more about our lab, contact Chemcut at sales@chemcut.net

 **CHEMCUT**
BOUNDLESS INNOVATION | UNBEATABLE PRECISION

**APEX
EXPO**
IPC 2024
Booth 4437



Mike Brask, IPS president (left), and John Hendrickson, SEL engineering director (right), in front of the automated IPS ENIG Line.

It's quite a statement going exclusively with this technology.

Hendrickson: Yes, it was a leap. We did our research, but it was one of our bigger risks on the project. Most of the other processes are pretty tried and true, but this is newer on the market. This is one area where I didn't want to be saying in two years, "Man, I should have gone with inkjet printers."

The balance was the cost of a line like this versus the cost of a traditional line and, ultimately, the throughput these lines could give you versus a traditional line. All said and done, four printer lines fit in the area of one traditional line. Footprint space would have been four times that amount in a traditional process. In final finish, we are still using tin-lead HASL because we have some older products that are

exempt from some of the RoHS regulations in Europe. We also have a large IPS ENIG line, with baskets that hold 40 panels apiece. Mike, tell us about the IPS line.

Mike Brask: Sure. This is basically a big ENIG line. When you get into the line details, you have the whole chemical management scheme. There are a lot of baths to make up and chemicals to maintain, along with analyses. When you compare this to a typical plating line, you find the blue chemical drums everywhere, with employees transferring chemicals using handheld drum pumps. Here, every tank has continuous level control on it, baths are made up to specific concentrations, and everything's automatically dosed.



REDUCED
PRODUCTION
STEPS



REDUCED
MATERIAL
WASTE



REDUCED
ENERGY
CONSUMPTION



PRINT YOUR SOLDERMASK FULLY DIGITAL

CONTACT US

Notion Systems GmbH
Carl-Benz-Straße 22a
68723 Schwetzingen
G E R M A N Y

+49 6202 57877-0
+49 6202 57877-99
sales@notion-systems.com
www.notion-systems.com





IPS ENIG line process control and data capture panel.

The basket counter keeps track of how much product and square footage goes through the line. There's a robot system to move the work into, through it, and then out of the line. To start, it puts the serial-numbered boards in the basket to load the program. As that basket goes through the process, we fully record everything that each basket encounters. IPS worked with SEL to design a system to transfer that data.

When you look at controlling odor and fumes in this kind of environment, with SEL's open floor plan, the line benefits from a full enclosure system. It has an inner environment that's under negative pressure, so you don't have odor on the other side of the building. And it's a lot cheaper to design and add the enclosure than it is to build an isolated room around it.

Hendrickson: To maintain air quality in the shop, we have a main duct that's five feet in diameter that goes into our fume scrubber; it's a big work-horse pulling exhaust off all our wet lines. Our HVAC is replenishing that air. Also, for all of the chemical management, almost everything is dosed from day tanks across the factory.

It certainly smells fresh and clean in here.
Now, what about expansion?

Hendrickson: We reserved space for a second plating line in the future. Plating is usually your limiting factor and as our product complexity continues to increase, we will get less output because we will have to slow down the line to make sure we get good copper thickness in high-density areas. Maybe with the technology



Internal view of IPS automated ENIG line.



ATG flying probe electrical testers.

we're doing at that point, we'll have to put a vertical line in versus all horizontal, but we left ourselves options, just in case.

How did you approach electrical test?

Hendrickson: For electrical test, we went with flying probe and did not bring in any bed of nails. With the throughput of the new flying probe, it is very comparable to some of the bed of nails, and we do not have to build and manage fixtures. It simplifies this whole department.

What was the greatest challenge for you in setting up this facility?

Hendrickson: I think bringing the factory up will be the easy part. Our property team served as the general contractor on this project. We were designing and constructing the building concurrently with the factory processes: If we had gone more linear, we would still be building the facility right now. We built our first board a couple of days ahead of schedule and have beat every other milestone so far on the project. With the technology, there were challenges all over the place, but working with all

our suppliers and our internal partners helped us through it. Currently we're ramping up production volume, installing new equipment for capacity and capabilities, and making sure we have a quality product. I think over the next six to 12 months, the most challenging part for us will be bringing everything up to speed with the quality we expect.

Brask: Well, you also have a unique situation where you're choosing specific processes for your product. You don't have to have a full wet process room or the capabilities to be a job shop; you can pick and choose what you're going to do for your products and then automate those key points. You're able to skip a lot of steps.

Hendrickson: Mike has a good point. My background is coming from R&D, and we spent the last 20 years simplifying our designs, and we now have one material set. We worked with our suppliers to consolidate that. Within that material set, we have standardized stackups with one resin system. To Mike's point about streamlining the process and factory design,



AOI inspection process.



how we've simplified our designs, overall, has really helped us.

When you're choosing a supplier in a critical aspect, what are you really looking for?

Hendrickson: Our priority is to find suppliers as close to home as possible. We look to understand if their business philosophies align with ours, and do they have the right equipment to meet our needs? If we find the right partner, maybe their equipment sets don't meet our needs today, but that's where we want to build those deep relationships and work together to develop things to meet goals for both of us.

When you look at the labor market, what attracts somebody to modern PCB manufacturing, compared to what I would call a "jet appeal" or "tech appeal" company?

Hendrickson: There are still a lot of folks who don't necessarily want to get an engineering degree; they want to get into a tech field or work with their hands. I think we have factories in areas where there are a lot of folks who want to have this type of job. What sets us

apart from other manufacturing facilities are the work environment and how we treat our employees. We are a 100% employee-owned company.

You invested about \$100 million to set up this facility. What's the ROI expectation?

Hendrickson: It's two to three years.

In addition to the dollars, are you factoring in the innovation that comes out of this? That's a soft return that could accelerate. Do you think more companies will start keeping in mind that zero waste is a big factor?

Hendrickson: I definitely think they will.

With all the supply chain challenges in reshoring or near-shoring, it seems like \$100 million is not a bad investment if you have capital available.

Hendrickson: It's not. We were able to think differently, challenging how things are being done today. Greenfield for us was the advantage. If we were trying to retrofit an existing facility, we would not have been able to do a lot of the things that we've done here.

Looking at older brownfield sites, does it may make sense for them to expand by setting up a greenfield site? Even though the upfront cost may be greater, they could



Centralized dosing stations.

be dollars ahead in the long run. It seems like there's an investment community that's willing to invest, especially in a zero-discharge facility. What are your feelings about that?

Hendrickson: Oh, definitely. I think this is what future board factories should look like.

The process flow can be streamlined, reducing cycle time, the employees' work environment is clean and bright, and the impact to the local community, in terms of resources being consumed, are great advantages in the greenfield development.

Very good. Thank you for everything. This has been great.

Hendrickson: Thank you for visiting our facility, Barry. We appreciate it. PCB007



Schweitzer Engineering Laboratories' 162K-square-foot, \$100M manufacturing facility in Moscow, Idaho.

Going Green

Q&A with John Hendrickson

SEL is going green at its new 162,000-square-foot, environmentally friendly PCB manufacturing facility in Moscow, Idaho. As John Hendrickson explains, being a zero liquid discharge (ZLD) facility—a trend you are likely to hear more of in our industry—is not just a smart business decision, it's driven by SEL's core values.

Barry Matties: *As far as waste treatment goes, this is a zero liquid discharge (ZLD) facility, correct?*

John Hendrickson: Yes, it's zero discharge. We have zero drains in our manufacturing floor and zero drains in our water recycling room. The only drains we have are in our bathrooms and sinks; even the sinks in our lab are all pumped to our water recycling. There's no opportunity for somebody to dump something down the wrong sink.

We designed the factory with a chemical-resistant membrane underneath the facility. We designed the floor so that it slopes a little bit to the center. If we ever had a major spill on this floor, it would all go to the center of the floor and it would all be contained within

the building. In the water recycling room, we dropped the floor six inches.

The way this system works is that we have two primary inputs in the system for our rinse waters, which we manage separately from our concentrate side. On the concentrate side, we take the material and drop the metals out and then change the pH. Then we take that through our filter press. So that's where our metals are, and that goes out for recycling.

Everything else will move over to what we call a pH batch tank. We adjust that to a pH of 7 and then we run that through our evaporators. After the concentrate goes to the evaporators, then we take it to a dryer, and we're still putting it under pressure and heat evaporating and then it goes back to the rinse inside. On the rinse side, we'll take it through ozone, then we'll destruct the ozone with UV. We run that through a GAC (granular activated carbon) column, through ion exchange columns, and then eventually run it through reverse osmosis. That's how we generate our DI water.

Matties: *Is this kind of thinking why the city got behind this factory?*

Hendrickson: Yes. The fume scrubber and everything else definitely helped us with our EPA requirements. Visiting officials have all been very impressed by how clean the factory is and how we've managed some of these things. In fact, some of the things that we're doing with this equipment have never seen an application in the state before.

Matties: *Thank you, John.* PCB007





GREEN PROCESSES HELP THE FULLY AUTOMATED MECER SYSTEM TO REDUCE COSTS AND IMPROVE QUALITY



Regenerated etchant

HCl is reduced by 95% while alkaline etchant (replenisher) is completely eliminated



Recycled copper

Through recycling, the MECER system achieves 99.995% copper purity



Recycled rinse water

Water reuse during the etching process uses less water and reduces treatment costs



Parameter controls

Full control of pH, chloride and copper content improves quality and reduces waste



*International
Electronic
Components*



Innovations in Final Finishing

Feature Interview by Barry Matties

I-CONNECT007

In this interview, IPS President Mike Brask shares some insights about the company's latest automated ENIG line installed at SEL's new \$100 million PCB facility in Moscow, Idaho. As Mike explains, this line features quite a few innovations not usually seen in North America.

Mike, let's start with some details about the features of this fully enclosed ENIG line.

Just how long is this line?

Overall, this line is 81 feet long. Typically, ENIG lines haven't been this big in North America. One of the things we also had to do on this line was to elevate it two feet to facilitate the above-ground drain system SEL installed.

Everything has gravity feeds into their pump stations to move solutions to their zero-discharge waste treatment area.

One other feature to note is that each tank has a continuous level-control system to automate the dosing of chemicals, which allows them to dial in their concentrations of water and chemistry. They're totalizing water flow usages, productivity on all the rinses, and maintaining checks and balances on all the key tanks so that this line can run without constant operator intervention.

We have installed individual double-jacketed nickel tanks that allow for smaller batches of boards to work. With any of these hot pro-



cesses, the trick is to cool that tank quickly. These have jacket coolers on them that are plate heat exchangers and will refrigerate that jacket down out of that active plating zone within an hour. We also have our latest 45-degree oscillation features here, along with bump vibration.

How are you offering ongoing support to your customers?

All of our lines are networked into our facility. So, if customers have questions or need troubleshooting support, we employ two full-time programmers who do remote training to solve problems, or whatever is needed. That remote work gives us instant access to all our lines in the field.

Along with the support, the whole data management of that board going through a wet process is a big move for IPS to be compliant with Industry 4.0. It's not just what's happening to the board on the front end, it's the whole turnkey chemical management side of things. For example, this line has a complete turnkey nickel dosing. There are individual Palm controllers on every single tank and all that data is logged into the computer, so you know all your metal turns over the life of the bath. All the data from our lines at SEL are compatible and seamlessly integrated into their MES.

Also, we know one of the nasty processes is stripping nickel and the NOX gas and the safety hazard with all that. So, we automated it for them. There is a nitric holding tank that will

automatically transfer the nitric, do the rinsing process, and transfer the nitric back. You don't need a guy with a drum and hoses. We are doing that now for other customers—we're automating that chemical handling of the stripping process.

So, when someone is looking into acquiring a final finish line these days, what should they consider?

I would do my homework and look at all the upcoming final finishes. Nickel and gold are the conventional ones, but you also have ENEPIG, EPIG, and all these other autocatalytic golds and things coming in. It's critical to define the capacity and what you want to do with the line early on, because it's hard to modify after the fact.

Congratulations to you and your team on IPS's success.

Thanks. It really is because of that persistence, waking up every morning, and knowing what you

want to do as a business. That's one of the key things about being fabricators and tool builders. When I get my people out in the field, and they get to see the end-game of the product they're making, they're not just welding a piece of a frame together; they're building a system. In addition, this helps our team stay in tune and evolve with the newest manufacturing processes in the industry.

Well said. Thank you.

Thank you, Barry. PCB007



Mike Brask, IPS president.

ALL EPISODES
AVAILABLE



sustainability podcast



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



LISTEN NOW

TTM CEO Tom Edman on the Process of Strategy



Feature Interview by the
I-Connect007 Editorial Team

For this issue on strategy development, we sought input from Tom Edman, CEO of TTM Technologies. He's been at the helm for almost 10 years and has overseen quite a few major changes in that time.

In this interview, we asked Tom to discuss what goes into planning a successful strategy, how to narrow down the perfect strategy for your company, and why the boss shouldn't bear the entire responsibility for this strategy. It needs to be a team effort.

Barry Matties: *Let's start with how you define strategy. What does that mean to you?*

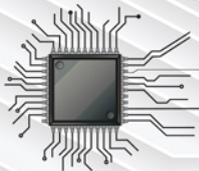
Strategy is about charting the corporation's direction for the long term. When I'm planning a strategy, I'm really outlining the criti-

cal components that will drive the company forward. For me, that's what you're looking at with a corporate strategy.

Matties: *What are some of the key considerations that go into developing a strategy?*

This is very timely, because we just started our process in July. First, we define the major trends that we're seeing globally that would have an impact on the company. Those trends can be anything, such as macroeconomic, climate, geopolitics, personnel challenges, and technology trends. So, we always start there, and I think that provides the right background.

One of the board members I worked with in the past always said that when you're developing a strategy you should start with no more



MivaTek

Global

2400NG - Dual Tray DI

High Throughput ● Automation Ready



Ready for your future



Sub 25-micron features with traditional PCB processing

Compliant with Miva's technology advances

Features

- NextGen Light Engine Feature Sizes: 6, 15, 30 Micron
- Quad-wave LED DLP: 360, 375, 390, and 405nm
- Worldwide DART™ DLP Patents Issued & Pending
- Panel Sizes: 24" x 30" (up to 42" x 60")
- Low Operating Costs, Flexible US Based Tech Support
- Automation compatible with third party sources
- Over 60 Machines in North America

Applications

- PCB: IL, OL, SM, Legend
- Micro-electronics: Features Down to 1 micron
- Chemical Milling
- Electroforming
- Glass Tooling

than three major trends that impact the company. We try to do the same because it helps one to really crystallize the major impacts that you have to look at as a company vs. getting caught up in some of the less critical areas. We always try to define three impacts, but sometimes we end up with four. At least that's where we start.

How do we address the major trends in our rolling three-year strategic plan? Every year, we come back to ground zero, take a fresh look at trends, and plan three major strategies that we will focus on in the three-year period. We define the tactics and we get a little bit looser there. We try to keep it to three, but we generally end up with five or six tactics, tying directly to the strategies.

Matties: *So, when people are developing strategy, especially in this industry, circuit boards are often referred to as a commodity item. How do you bring unique value into strategy?*

It's all about differentiation and focusing on areas where you have differentiation. That can be several areas. But if we have a technology that we've been working on, that that gives us an edge, that's one area of differentiation. We believe that our field application engineering capability and support of the customers in development work are critical areas of differentiation. We also have a footprint strategy that ties directly to our strategy.

It's critical that we offer differentiation in those three areas: technology depth (and the advantages we have), what we provide in terms of differentiation, and customer support that's technical in nature. As you pointed out, Barry,

if anybody says "commodity" to me, I'll say, "Fine. You take that business and treat it as a commodity. It's all yours."

Matties: *Yet, for so many people, it's a race to the bottom when you're in that mind space.*

Well said. We will take some projects to volume in China. But when we get those programs toward the end of life, we start to see Chinese competitors come in. That's a choice that customers are going to make. If they really feel that they want to take a cut, they can pursue commoditization of a particular program. It's just our choice as to whether we participate or not.

Matties: *I think that goes to another point of strategy: It's just as important to know what to say no to as what to say yes to.*

Absolutely. The real magic in strategy is what happens during the process; it's the sausage making that really is exciting about strategy as the teams work through their ideas. The next step is making sure that the strategy is communicated to the organization in how it ties to our vision and mission, along with the strategic elements that we are going after, and how it can impact them. But upfront involvement of management is critical, and then communication on the back side.

Matties: *That's exactly where I was headed—how important is it to communicate with your suppliers and customer base as well?*

When we do corporate presentations, we include our vision, mission, and strategic elements—the three major strategic elements that we're focused on. We also share our values in every presentation that we make to customers. It's the values that I spend a lot of time on with



“When you're developing a strategy you should start with no more than three major trends that impact the company.”

Excellon

*Manufacturers of precision Micro-Machining
Solutions for over 50 Years*



COBRA II Hybrid Laser

*UV and CO2 lasers
Blind via, flex cutting, cavities*



HS-4L

*Low-cost, 4-station precision drilling
or routing system with large panel option*



HS-1L DS

*Single-station, dual spindle high-speed
drilling/routing with Intelli-Drill Vision*



136L

*High-Speed, precise accuracy
drilling/routing with Intelli-Drill Vision*



154L

*Large panel size precision drilling/routing
Single station with vision options*



HS-2L

*High-speed, 2-station drill or router
w/populated board routing option*

**Move into the future with the latest innovations
in Fabrication Technology from the Industry Leader!**

our employees. Those haven't changed much at all over time.

Nolan Johnson: *You're describing a very much consensus-driven sort of process, with input that's not just from the top level. How open is this process to the employees at large?*

In our quarterly communication meetings, we chart the beginning and the end of the process. Part of our September session is trying to get people to really stretch in their thinking and throw out ideas and have a discussion vs. just presentations. After we've done the three-year strategy, we then focus on the first year of the strategy, and that becomes our budget. It's a whole exercise that stretches into early December that gets us from strategy to budget. In January, we roll the combined strategy and budget out to the broader organization.

I'll meet with all the management teams in our plants and review the broad outlines of the strategy for the year and what has changed. That's how it works in terms of the broader population. I can't say that we have the magic formula for making this whole thing work, but every year we try to get better at it.

Matties: *Audiences appreciate a limited number of slides.*

It took us a few years to figure that out.

Johnson: *Tom, what do you currently see as some of the major market drivers that would affect strategy for anybody in printed circuit board fabrication right now?*

I'll give you three. First is the macroeconomic climate, which is clearly having a huge impact

on our industry. We have a combination of slow growth and elevated capacity. That's a critical one. The second is the geopolitical environment, in particular the geopolitical environment between China and the United States. Overall, you can just call it global regionalization, which is driving supply chain resiliency, or China Plus One strategy, depending on which customer you talk to and where they are in the world. The third one is technology drivers. Now everybody's into AI, but I would say it's AI and 5G primarily driving huge shifts that we see in semiconductor and technology requirements, and that's impacting our business. Those are the three big ones.



Andy Shaughnessy: *Tom, what are some of the mistakes that you see leaders making when they're planning strategy?*

I think it's a huge mistake if a leader believes that they personally are responsible for driving the company's strategy. An organization is only made better by the input of the smart people that you bring together in a room. I think companies also make a mistake when they believe their strategy is sacred, and they can't communicate elements of the strategy in broader teams. That's the fun part, because it's just such an opportunity to get everybody on board with the company. People really enjoy stepping out of the day to day and actually thinking about something bigger.

Matties: *Tom, we certainly appreciate your time and insights today. Thank you very much.*

Thank you, Barry. PCB007

HIGH RELIABILITY FORUM

October 17–19, 2023

Hilton Baltimore BWI Airport
Linthicum (Baltimore), MD

**SAVE
THE
DATE**

**IPC's
High Reliability
Forum is back
in-person for
the first time
since 2019!**

IPC's High Reliability Forum Technical Conference focuses on **Class 3 electronics for mil-aero, automotive, and long-life applications** that are subjected to harsh use environments. Subject matter experts will facilitate true problem solving and cooperation to share best practices across applications focused on exceptional reliability requirements.

For more information visit: ipc.org/event/high-reliability-forum

Developing Your Team to Become **Great** Implementors

One World, One Industry

Feature Column by Dr. John W. Mitchell, IPC PRESIDENT AND CEO

Strategy is all about choices, and most often choosing what not to do. Too many organizations strive to do too much and because of that end up doing very little as well as they might have. We see this principle highlighted in many of the structural changes happening in major organizations. Very large companies are often splitting their organizations into separate divisions to allow focus or even spinning off portions of their business; again, focus is often the motivator.

Last November, General Electric (GE) split into three public companies, focusing to simplify its business while reducing debt. One

company focuses on aviation, another on health care, and the third on energy. GE's strategic rationale was clear: three well-capitalized, industry-leading public companies, each with deeper operational focus and accountability, greater strategic flexibility, and tailored capital allocation decisions. The conglomerate model no longer works well in a marketplace in which only the quick and agile survive.

In another such move, Continental AG recently spun off a portion of its business to create Vitesco Technologies, enabling Vitesco to focus entirely on the shift toward electric mobility.



Revolutionizing PCB Manufacturing Processes with Innovative, Automated and Quality Equipment & Advanced Materials

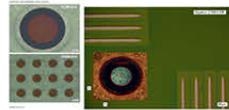
MACHVISION

Automated Final Inspection and AOI



BGA Missing Legend Soldermask breakage Pinhole Defect Under SM Soldermask Peeling

PrintProcess



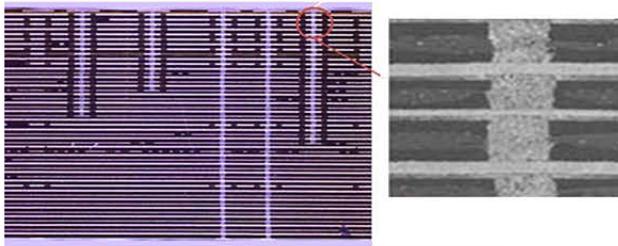
APOLLON A11
 Direct Imaging
 for Soldermask



RIVOLINO-5
 RivetBonding
 Equipment

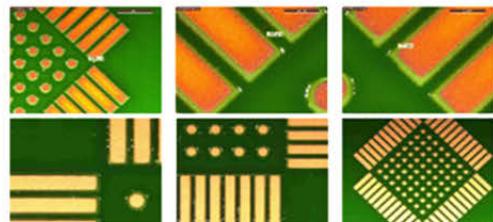
TATSUTA

Sintering
 & Conductive Pastes



AGFA

InkJettable Soldermask, Etch Resist
 & Plating Resist



Let me make a little bit more controversial statement: Your business strategy matters very little. You need one to provide focus, but what you list in your strategy is not really that secretive; letting it be public is not a matter of great concern. The real advantage of a company is not its strategy, but that company's ability to implement that strategy. Implementation is everything. This is the hard reality, the daily exercise and regular sleep of the corporate world. Without great implementation, your strategy is irrelevant. Where we need to be focused is on creating and developing our teams to become great implementors.

Think of your business strategy as a navigation system, with its implementation strategy essential to your company's success. The following aspects help connect the dots to ensure the execution makes it to its destination smoothly.

- Establish the right work environment and corporate culture that supports and embraces strategy implementation. By motivating employees and rewarding success, you'll improve the effectiveness of your strategy.

- Employ a team of highly skilled and experienced professionals to tackle individual supporting projects.
- Improve internal communication to ensure all team members have the support and knowledge they need.
- Develop procedures or policies which help teams better achieve their goals.
- Create a healthy budget and allocate the resources needed to implement the strategy.

We can talk all day long about how exciting and forward-thinking our strategies are, but how can we be successful if we cannot put those strategies into practice? While the new ideas and creativity of our workplace inspire us to think of success as limitless, without the hard work of putting those ideas into practice, we are just spinning our wheels. **PCB007**



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

New Type of Quantum Bit in Semiconductor Nanostructures

Researchers have created a quantum superposition state in a semiconductor nanostructure that might serve as a basis for quantum computing. The team headed by Feng Liu from Zhejiang University in Hangzhou, reported their findings in the journal *Nature Nanotechnology*, published online on 24 July 2023.

The team made use of the so-called radiative Auger transition. In this process, an electron recombines with a hole, releasing its energy partly in the form of a single photon and partly by transferring the energy to another electron.

In the current project, the researchers showed that the radiative Auger process can be coher-

ently driven: they used two different laser beams with intensities in a specific ratio to each other. With the first laser, they excited an electron-hole pair in the quantum dot to create a quasiparticle consisting of two holes and an electron. With a second laser, they triggered the radiative Auger process to elevate one hole to a series of higher energy states.

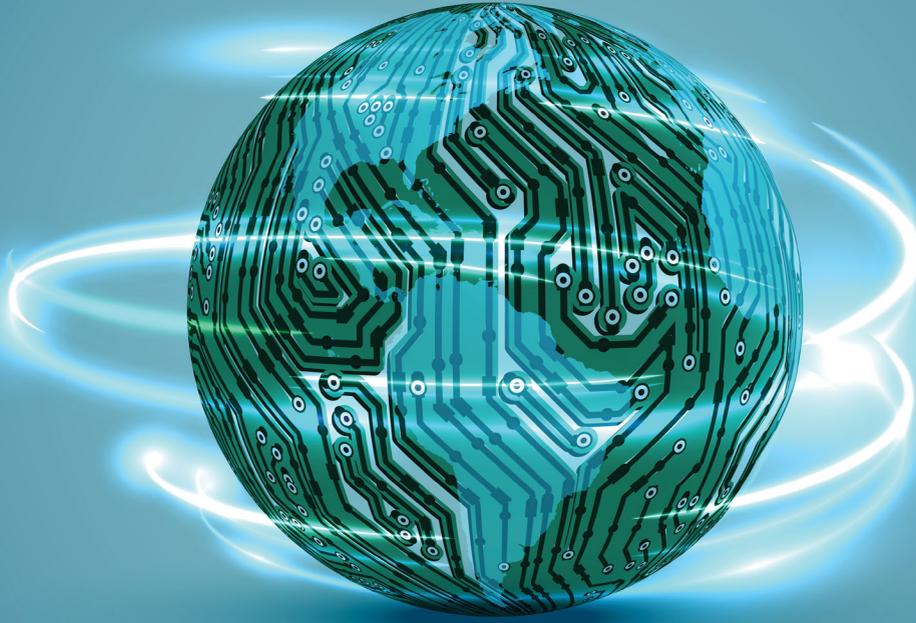
In the process, the researchers increased the ensemble homogeneity of the quantum dots and ensured the high purity of the structures produced. These measures facilitated the performance of the experiments by the Chinese partners working with Jun-Yong Yan and Feng Liu.

(Source: Ruhr-Universität Bochum)





Changing the World One Connection at a Time



By consolidating your spend into our own sourcing program, we can leverage our total volumes to get you the best pricing. Our staff can open the doors to Asia-based factory solutions not previously available to your purchasing team.



**World-class
PCB partners**



**Top tier
quality systems**



**Ambitious information
systems plan**

[LEARN MORE](#)

Linkage
Technologies

 info@linkage-tech.com
 linkage-tech.com



JET APPEAL

Feature Interview by Barry Matties

I-CONNECT007

In 2007, Stratos Aircraft set out to design and manufacture an exciting, high-flying new product, which they estimate is still at least five years away from going to market. With a hefty capital investment, they are now working on their second prototype: a six-passenger, single jet engine plane that cruises at 41,000 feet, with a range of around 1,500 nautical miles,

and a comfortable cabin pressurized to an altitude of 7,600 feet.

I recently went to the Stratos manufacturing facility in Redmond, Oregon, to meet President and CEO Carsten Sundin and his team where I learned more about what it takes to design, build, and bring a new aircraft to market.

Carsten, let's start with a little bit about your company.

Carsten Sundin: We started back in 2007 with a goal to design and produce an aircraft with significantly better performance than anything else out there in the high-performance, personal aircraft category. We set out to see what it would take to design an aircraft that would comfortably seat four people and travel as far as 1,500 nautical miles with reserves, cruise at 400 knots and, therefore, be a significant step up from anything else

available at the time. When we started our initial design studies, we didn't really have any set ideas about what that aircraft would look like. We considered all the various configurations and powerplant options. The further we got into it, the more we realized a single-engine jet would keep it less expensive. Single-engine turbine aircraft today are incredibly reliable; you simply don't need a second engine for safety reasons. These engines, as long as they get fuel, just don't quit. A single engine makes it a lot easier for the owner-operator. This aircraft is very simple to fly compared to even the basic piston-powered aircraft.

Long story short, our design studies led us to the Stratos 716X. It's an aircraft that's powered by a single Pratt and Whitney JT15D-5 engine. It has about 3,000 pounds of thrust and it propels the aircraft at about 380 knots. The production engine will take us to the goal of 400 knots. At 41,000 feet, this aircraft has a very comfortable cabin altitude of 7,600 feet, which is comparable to the Boeing 787. The trend is for lower cabin altitudes, so you arrive a lot more refreshed and not so fatigued from a long flight. So far, we've flown two aircraft now—



Carsten Sundin, president and CEO (left), and Chief Test Pilot Peter Stiles.

the Stratos 714 and the 716—and they're proving to meet all the performance goals that we set out to make.

What led you to want to start an aircraft company? It's not something people wake up one day and just say, "You know what? Today, I'm going to go build an airplane."

Sundin: Well, aircraft is all I've ever done. Straight out of college, I worked for Lancair. For 10 years, I was part of several exciting aircraft programs there including the Lancair 360, the ES, the Lancair IV, and the Lancair Legacy. I had very good exposure the first 10 years of my career, then I went on to manage the engineering of the Epic LT program, a six-seat turboprop aircraft company. I consulted for a few years after that. Then I wanted to get involved with aircraft design and manufacturing again. So, I pitched a few different ideas to potential investors and this one literally took off.

Nice. So, where are you in the cycle to go to market?

Sundin: Aircraft design and manufacturing is a very long road; it took us almost nine years



to get the first aircraft, the 714, flying. After the 714, we decided to stretch it to turn it into a true six-seat aircraft. That process took another three years, and as part of that process, we went through a weight reduction program. Not only did we increase the cabin volume by about 40%; we also reduced 400 pounds of weight. Weight is everything in aircraft design. That's like two people!

You must go through a lot of regulatory hurdles. Talk a little bit about that challenge.

Sundin: They say that by the time the aircraft is certified, the weight of the paperwork equals the weight of the aircraft. I think that's probably true. We still have a long way to go. Basically, what we've done today is designed and tested—both structurally and in flight—these two aircraft. We have hundreds of flying hours on them and thousands of hours in development, manufacturing, and testing. We still have a long way to go with certification. Even companies like Honda, with very deep pockets beginning to end, took about 20 years to certify the aircraft.

Wow. That's quite a commitment for one product to come to market. Is this a niche market that you're filling or are there already players in this space?

Sundin: Well, it's niche in the sense that we're targeting the owner-operator, but it's still a pretty large market.

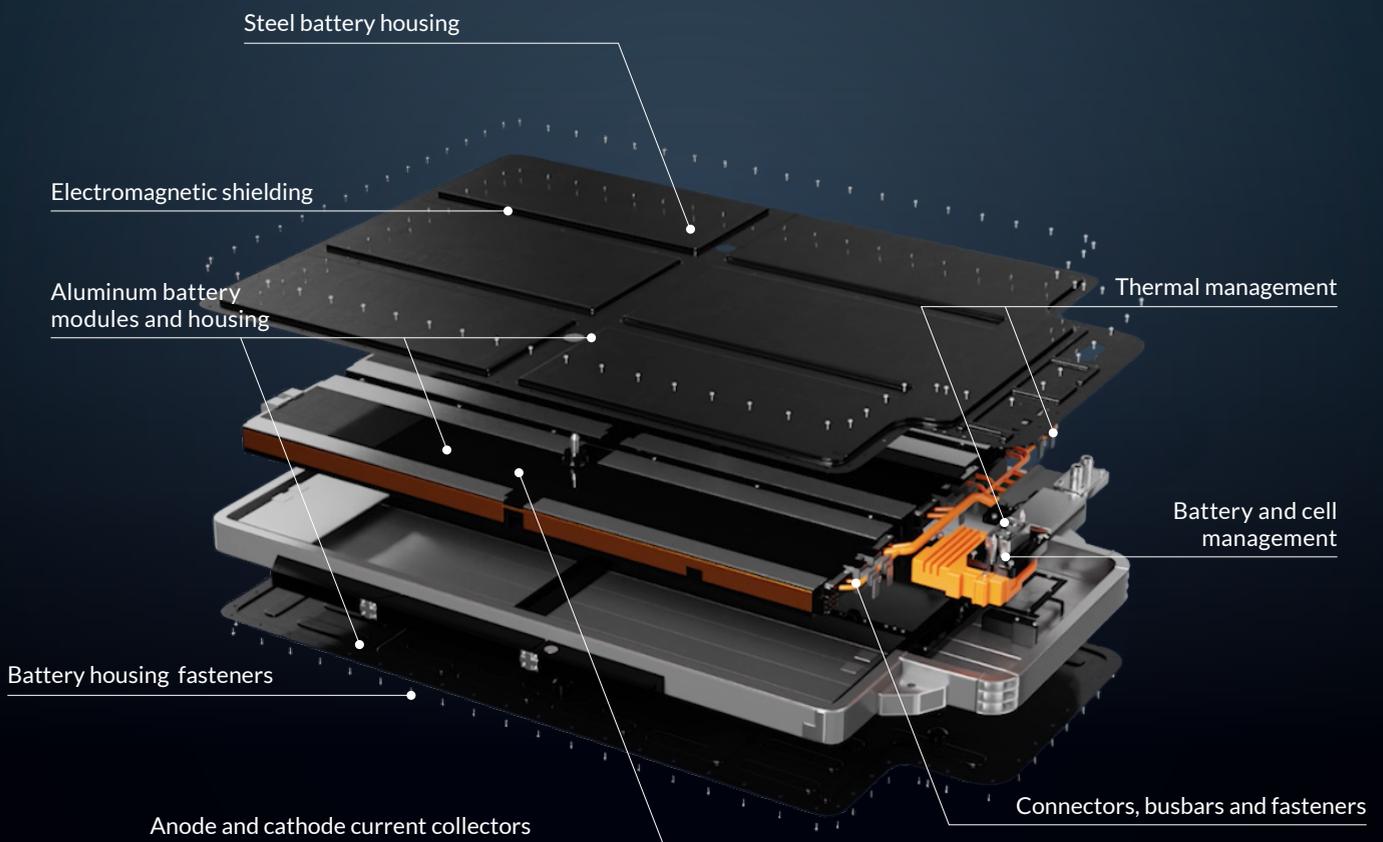
Do you see electric aircraft coming into play and into your design, as well?

Sundin: In time, but the battery technology is just not there yet for a high-performance aircraft. I think we're decades out still.

Are you designing any of your own electronics?

Sundin: Electronics is a fairly small part of this aircraft design, and any time there's a proven vendor part out there that works, we gravitate toward it. But in general, in aircraft manufacturing, there's just not that much off-the-shelf available. For example, I was hoping to find off-the-shelf landing gear, but that just didn't work out. We ended up designing and manufacturing our own landing gear. We don't make the

Leading surface-finishing solutions for BEV, HEV and PHEV batteries



Engineered for maximum performance, our cutting-edge surface modification and finishing technologies for EV batteries ensure optimal circuitry, corrosion protection, wear resistance, and adhesion promotion enabling superior connectivity, longer lifetimes, and outstanding reliability.

For more information on our company or products, just scan the QR-code.



raw materials, but we produce the tooling, we manufacture it, and we assemble everything. So, while we don't produce raw materials, windows, the engine, or the avionics, everything else is made right here in-house.

That's great. It's nice to know that there are still things being made in America.

Sundin: In aircraft manufacturing, I think it's still the only way to go.

What is the biggest challenge now, outside of the regulatory process, that you must go through?

Sundin: It really does come down to the regulatory process. We strategize to test everything before we start that process. We've cleared a lot of hurdles, and I would say we have "de-risked" this program as much as possible. It really comes down to this mountain of paperwork that we've got to go through.

If someone's looking at starting a manufacturing company, what advice would you offer?

Sundin: Don't get into aircraft manufacturing. That is, of course, a joke. If you were going into aircraft manufacturing, most importantly, use proven technology and methods. Producing aircraft is very, very difficult. And if you have ambitions of producing your own avionics or your own engine, you're destined to fail.

Use proven technology and proven designs. Basically, go look at everything that's out there. In each category, pick from the best proven designs and turn those proven designs into your aircraft design.

One of the struggles in business today, as I'm sure you're aware, is the labor market—finding and bringing in good talent. What are you doing in that regard?

Sundin: We did something that worked out very well for us. When we started this project we used a lot of experienced engineers, and not too long after that, we hired junior engineers and trained them. Aaron Park is a good example. He's right out of college and he will work with the experienced engineers. For the most part we have a few senior engineers who oversee things, and we have quite a few younger engineers who are proving to be exceptional.

That's a good strategy. However, your industry has what I might call "jet-appeal," compared to circuit board manufacturing. So, I think young engineers are probably more drawn to an environment like this.

Sundin: I think that helps, certainly. It has also helped us to have a lot of cool manufacturing technology. When you walk through the facility, you'll see a lot of advanced manufacturing here, and I think that attracts talent.





PERFECT POINT[®]
PRECISION CARBIDE TOOLS

Drilling Solutions for your PCB Fabrication

We offer a complete line of **Drills, Routers, Endmills and Specialty Tools**. We have the most experienced technical support team in the industry, and a world-class **Repointing Service** in US and Canada.



www.perfectpoint.us

One of the trends we're seeing is Industry 4.0 and a move to digital twin. How much of the simulation of aircraft parts are you doing digitally?

Sundin: We design the aircraft entirely on the computer. That means we designed the parts, the assemblies—all the way up to the completed product. Along the way, we test things virtually by simulation. We have virtual wind tunnels, which is CFD or computational fluid dynamics. We have virtual structures testing, which is FEA or finite element analysis. We'll do some coupon testing along the way to verify, then we do full-scale testing and, ultimately, full-scale flight testing. So basically, we design and optimize on the computer, and then we real-life test.

You're out flying your own aircraft.

Are you satisfied with the performance?

Sundin: It's meeting the performance targets, which were ambitious, so we're very happy about that. The most satisfying were the days when we achieved our major milestones. As an example, one milestone we'd looked toward for years and years was reaching 41,000 feet.

We did that in May 2022. Other milestones are first flights. But when we reach the ultimate milestones, like high altitude or high speed, those are big days for us. There's really nothing out there like the Stratos 716. There are other single- and turbofan-powered aircraft, but the performance of our aircraft is very similar to the light twin-engine business jets. I would say there's no simpler high-performance aircraft that's ideally suited for the owner-operator.

Well, I certainly appreciate your time.

Congratulations.

Sundin: Thank you.

After sitting down with Carsten Sundin, I met up with three young engineers at Stratos—Aaron Park, Austin Alley, and John Smoker—to learn more about their journeys from education to where they are now at Stratos.

Aaron Park recently graduated from Boise State University with a degree in mechanical engineering and is now the newest full-time design engineer at Stratos. Prior to that,



Left to right: John Smoker, Austin Alley, and Aaron Park.

he interned at Stratos for two years on and off during the summer with a little bit of remote work during the school years. Aaron said he has always loved aviation and decided to focus on mechanical engineering, especially when he started his internship at Stratos.

Austin Alley joined Stratos about six years ago and is now an engineering supervisor and CAD manager. While having an applied physics degree and mechanical engineering minor from the University of Idaho, he said he learned core principles of engineering from growing up on a farm. “That’s where I learned my mechanical engineering, fixing the tractors,” he says. “I learned from the start how to turn a wrench and from that, how design could be improved. For example, whoever designed our tractor made it so that I need to take four things off to get to a fuel filter or whatever. I was cognizant then that the people hated poor engineering. So, I definitely wanted to change that.”

John Smoker joined Stratos about five years ago. He has a general engineering degree with an emphasis in mechanical engineering. “The degree program was such that the fundamentals and theory were really emphasized. So, we didn’t get into much practical stuff; a little bit of SolidWorks, a little bit of Fault Tree Analysis. But it was really a base of mathematics, physics, some programming, and a good amount of electronics as well.”

The common thread I found talking to these young engineers is their desire to collaborate with the team and serve their internal customers, and they don’t take this lightly.

Aaron, you’re in an industry where failure can cause fatalities. How does that inform the way you approach your job, or the way you see the work that you’re doing?

Aaron Park: The added weight and responsibility is definitely in my mind as I’m creating drawings or designing parts. There are a lot of standards and specifications that we need to keep in mind. And, of course, all the aerospace standards are not something I learned in



CNC operator and machinist Rod McMahon.

school. I ask a lot of questions to try to merge the skills I learned there with what is required here to make sure that what I do is safe for the aircraft and the people in it.

I also realize there can be a disconnect between manufacturers and engineers in industry; the engineers don’t always know what’s going on in manufacturing. I try to learn how, for example, our welder likes to see welding callouts on drawings, or how the CNC operators will interpret the drawing and how we can best have that symbiotic relationship. A better connection reduces the chance of error.

We see this disconnect across a lot of industries. We hear fabricators complain that many designers just throw the designs over the wall and want the fabricator to figure it out. This is where your approach of learning who your customers are and what their needs are makes a lot of sense. In fact, another common theme we hear is to have designers learn the manufacturing process.

Park: While I was at Boise State, they updated the mechanical engineering curriculum with help from the local manufacturing industry. Micron and a host of smaller companies located in Boise were asked what skills, both technical and soft, graduates were lacking or that they needed to know. Being able to work with manufacturers and getting to know the equipment with hands-on experience was a big part of

their feedback. I'm grateful that I got to have classes where I was out in the shop working on mills, lathes, and learning how they work. Now that I'm working here at Stratos, I understand better what the manufacturers are doing, and I can ask them better questions, too.

Tell me about the soft skills you've found to be most valuable.

Park: A big part of what my college instructors wanted to convey that I now find really valuable is being able to communicate with whoever is going to be manufacturing your product and even explore scenarios where you were in the manufacturer's shoes. We had a long design class where we did our own design that we passed off to another student to build. But then we also received a design from someone else, built it ourselves, and iterated back and forth. The emphasis was on being able to effectively communicate with an employer or a coworker, or even another company that's manufacturing a product for you.

Further to that, I now ask a lot of questions at Stratos. Being able to articulate information and avoid any sort of miscommunication or misunderstanding has been a very important lesson for me.

So, Austin, you're reinforcing Aaron's point of communication and collaboration.

Austin Alley: Yes, figure out who your customer is. In the end, our customer is whoever is going to buy the airplane. As an engineer, my customer is the person who will make the parts I design and draw, and the person turning the wrenches. I'm out talking to the machinist, for example, asking how they need me to make a design for manufacturing. "Oh, you need that radius changed?" A lot of engineers don't even ask what the radius needs to be. But if you ask, it's like, "Well, if you change this by ten thousandths, I can use this other drill bit and I can cut this twice as fast." Little details like this are sometimes missed, whereas when you really talk to the person building it, you'll learn their

needs and it'll save them a lot of time in manufacturing.

John, I understand you're five years into your career, and you've made some advancements here. This sounds like a fast path for you.

What's your title now, and what do you do?

John Smoker: I'm our lead flight test engineer. I also do systems design work. Most of what I do currently is mid-level program management, coordinating with contractors and suppliers, working on timelines, and then working with the actual data coming off the aircraft. I learn from our chief test pilots and from the pilot contractors that we work with. Oftentimes, because we're working in such a fast-paced environment, we're jumping between programs. We've developed a software system here at flightline to manage configuration and control the aircraft; that's a huge thing. To manage weight and balance briefs debriefs, just making it so that you get the most information out of a very information-rich environment and coordinating it and calling it in such a way that two months down the road, we're in a completely different program. What do you know, what did we learn?

What was your first role here?

Smoker: I started as a low-level draftsman and spent a lot of time just talking to the machinists and fabricators, picking their minds, asking what they want to see on drawings, what does it take to actually build the part, do this thing, or make this system. I spent a lot of time learning the grammar of how to make stuff. I would say that would probably be one of the better investments that I've made in my career.

You're echoing what both Austin and Aaron had said, the importance of communication between your internal customers, who you're handing your work off to.

Smoker: Absolutely, because they [internal customers] are the ones who matter. It's not about just throwing a stack of drawings on their desk



and saying, “Okay, bye, see you!” The process is from initial design concept to final prototype phase one, prototype phase two to final concept, and your fingers need to be in that process the whole time. That’s the most fulfilling and rewarding way, I think, to tackle a project.

Excellent. What’s been the most exciting here for you?

Smoker: It’s funny, because when you’re around a project like this you get attenuated to the excitement and that’s an unfortunate part of being involved with the kind of resources we have, the kind of people we have. You get spoiled fast and you forget how amazing your life is. You just walk through the facility and have to pinch yourself.

Stratos has invested a lot of money into talented people and equipment.

Smoker: Absolutely. I’m passionate about our aircraft. I’ve loved aviation for as far as back as I can remember. So, when engineering was a discipline, I chose it and thought, well, if I can do anything with airplanes, that would be amazing. Amazingly, I’ve ended up here and

I’m very grateful for it. It’s a real privilege when you don’t mind the drive into work every day. There’s a culture of internal customer service, collaboration, and education at Stratos.

At Stratos, they’ve welcomed you to learn about all the other areas beyond your core function; that’s a great sort of company to be working for.

Park: Absolutely. I feel like I have learned just as much, if not more, working on the job as doing schoolwork. It’s being able to work alongside more senior engineers and talking with other departments for manufacturing metal parts, composites, learning about how things go on the flightline; it’s all very valuable information and I love getting to learn about all of it.

And you get paired up to be mentored by other engineers; I believe one of yours is Austin. So, Austin, you have been on a similar path as Aaron, and my understanding is that you’re carrying a lot of responsibility within the organization as a leader.

Alley: Yes. So, I worked hard and did a lot of the things Aaron is talking about, and I steadily worked my way up, nearing the top on that.



Tell us about being a mentor. How important is that, and what approach do you take with a new employee?

Alley: For the most part, we start off slow. It's like, let's see if this person can make this drawing and then, all right, they can do that. You see they asked questions, they are now a little better, a little smarter, so then you give them a little bigger project and you just slowly work your way up. Aaron is doing a great job asking a lot of little questions. Sometimes you can tell he's nervous to ask the question, but that's totally fine. I was the same way. When I first started, I knew almost nothing about airplanes. So, it's just every day asking the people above you, "Hey, how does this work?" Being open when I don't understand how something works. At times, I might think, "This is a stupid question." I'm still going to ask it because I want to know why it works like this or how it functions.

As a mentor you share and teach the culture of the company. It sounds like this is what I might describe as a nurturing company; the leaders encourage education, questions, mentoring, and collaboration.

Alley: Yes. We almost always hire new engineers, and a lot of positions here are filled by

people new to the industry as well. In a lot of ways, it seems like you're almost better off with that because you can kind of mold somebody into what you need. They don't come in with a preconceived notion of how this thing works. And if you think this other way, you're not having to butt heads with someone who's got 30 years of experience. (Granted, that person with experience knows there's a reason they are thinking that way as well.)

I met CNC operator and machinist Rod McMahon and machine operator Ed Kissler in the tool and the machining department, who remind us that there is no substitute for experience. These guys are true craftsmen, and they've been at their crafts for years; they're experts. There's a shortage in the labor force today for that kind of skillset. For you to come in and be exposed to these craftsmen and have that kind of experience to learn from must be invaluable for you.

Alley: Yes, totally. When we make a drawing for the first time of some complex machine part, we go out and talk to them and they almost always have some suggestion to make it easier to build. Working together makes a huge difference for the whole team and it makes their jobs easier.

INSULECTRO



WORLD-CLASS SUPPLIERS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, salutes our premier suppliers.

CALL 949.587.3200 FOR MORE INFORMATION



Denkai America



Denkai America is a leader in the manufacture of high-quality electrodeposited copper foils for printed circuit board (PCB), industrial, and energy.

With the strength of domestic manufacturing, and backed by a global presence, Denkai America delivers both conventional cladding and application specific copper foils required by technology leading companies.



PACOTHANE®

PACOPADS®

TRIPAK®

PACOGARD®

PACO • CLUTCH™

PACOTHANE® PLUS

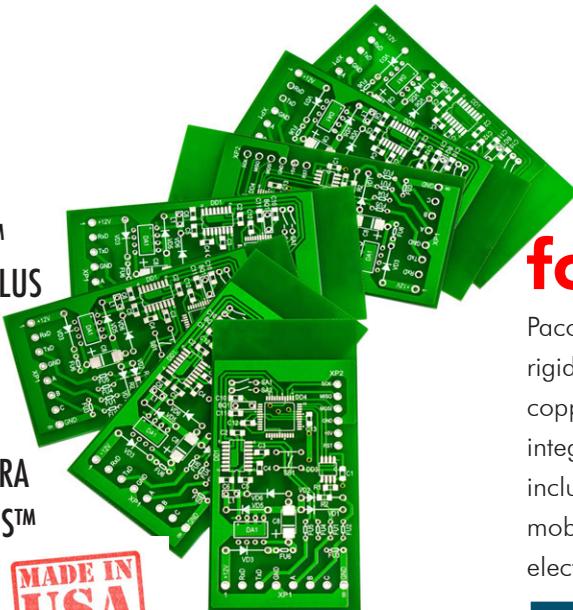
PACO • VIA

THERMOPADSTM

THERMOFILM™

PACOFLEX™ ULTRA

PQP QUICK PRESS™



Lamination Assist for Flex & Rigid PCBs

Pacothane services the worldwide PCB market, which includes rigid multilayer, rigid/flex, cover-layer flex, flexible multilayer, copper and unclad Laminates. These circuit boards are integrated into a wide variety of applications and markets that include telecom, data communications, high-speed computing, mobile devices, military, smart cards, medical and effectively all electronic products.

American-made. Worldwide leader.

INSULECTRO

20362 Windrow Drive, Lake Forest CA 92630 • 949.587.3200 • insulectro.com



When we were back there talking with them, they were encouraging you to come and spend some time to learn the skill and more about what they're doing.

Alley: Yes, I would absolutely love to spend more time with them to learn more about their craft. There has been encouragement and opportunity for me to do that.

What advice would you give a young engineer?

Alley: One of the big things is just knowing your customer, knowing who's going to get your product in the end. Be cognizant about manufacturing costs, how something's going together, and if there's a better way to do it. Make sure that your whole team is involved with your design, not just you. I find a lot of bad designs tend to be that way because there was no collaboration; it was all kind of a one-man show.

John, what advice would you give to a young student maybe just entering school or about to come out of school and move into industry?

Smoker: I would say you don't have to know exactly what you want to do. If you do, fantastic. But if you don't know, try to find out, gain breadth, network. Ask your professors or senior classmates to lunch, just talk to peo-

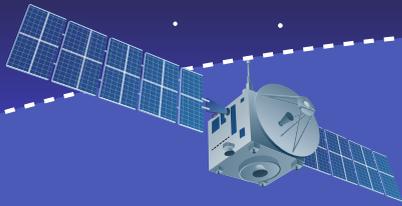
ple. That would be the biggest thing because the opportunities I had came from just talking to people and being curious about them. Ask "How do you get to do what you do? How did you get to where you are? What advice would you have for me?" And then the one: "Is there anything that I could work with you on?" That's a big question that a lot of people avoid, but ask! "Do you have a place for me?" And then that just adds to your list of potential things to do and directions to go.

Aaron, any advice you would give to a young engineer starting out?

Park: I would say don't spend all your time engineering behind the computer. Get out into a shop or out into the backyard with some sticks and nails and make something. Buy a cheap 3D printer, or whatever you can get your hands on, to learn manufacturing as well. You'll learn just as much about engineering by moving from design concept to creating something yourself. There's a whole other level of satisfaction that comes with that. Learn as much as you can for the entire process! And don't worry too much about the math and thermodynamics and all that stuff.

Great advice. Thank you so much. PCB007

The Heights of Flight



EXOSPHERE

440 to 6,200 miles



Exobase

THERMOSPHERE

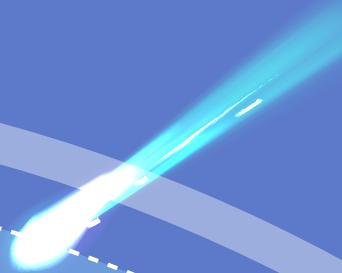
50 to 440 miles



Karman line

MESOSPHERE

31 to 50 miles



STRATOSPHERE

7-31 miles

STRATOS
AIRCRAFT



Ozone layer



TROPOSPHERE

0 to 7 miles



Smoothing the **Rocky Road** of Onboarding

The New Chapter

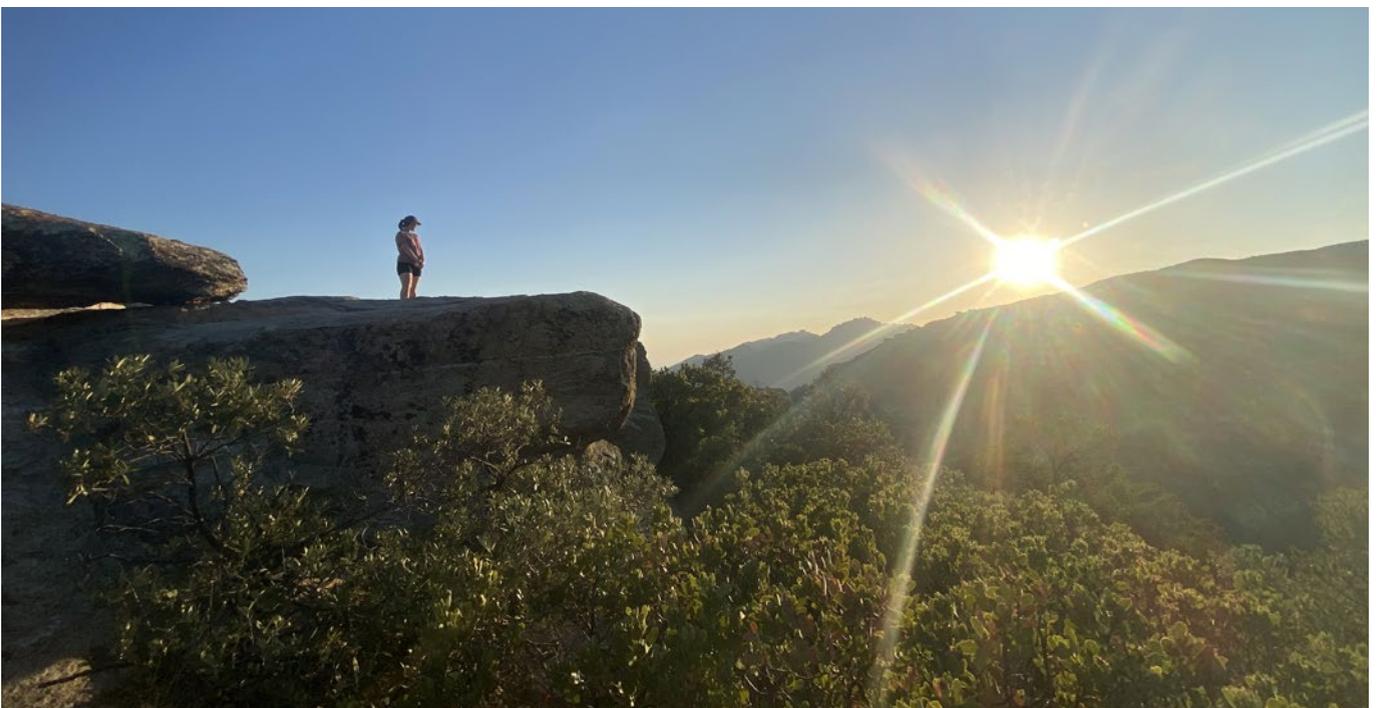
by Hannah Nelson, TEXAS INSTRUMENTS

Imagine you accept a job halfway across the country, move there with no family or friends nearby, and you're extremely overwhelmed by your living situation. It can be really tough.

To be honest, when I first interviewed for my current position, I was excited to move away from my home state of Indiana. I was thrilled about a new adventure on my horizons. When the recruiter gave me the option of moving to Texas or Arizona, I couldn't have been more delighted than to say, "Send me to the sunny state of Arizona." But what I didn't realize is how incredibly lonely and scary it is when you have no one to lean back on in your new surroundings. Indiana is the place I have called

home for the past 22 years of my life, so when I finally moved to Arizona in June, I entered a state of panic. Thankfully, some of my peers from my university had moved out here as well, but I still greatly missed my family and friends back home.

In Indiana, I had leaned on my family for security, discernment, and comfort, but when my parents dropped me off at my new apartment, I was left to fend for myself. I immediately felt scared and lonely; I desired to feel the comfort of home. Even more, I was terrified of starting my new job. I had no idea what to expect or what was expected of me. I felt incompetent from academia and, overall, I felt hopeless.





PCB AUCTION #1

View Full Lot Catalog Online Now

Location: Schwenningen, Germany

WEDNESDAY

SEP 20

11:00 AM CET

Register Now!

Complete Facility Closure of Renowned European Printed Circuit Board Producer - Equipment as Late as 2017



- (8) Schmolli AMX1 Drilling & Milling Machines
- ATG A7 & A5 Flying Probe Testers
- Europlasma NV CD1200 PCB Plasma Etch-Desmearing Machine
- (2) SUSS Microtec Pixdro JETx Inkjet Board Printers
- LHMT SCM 626 Scoring Machine
- Pola e Massa PMC-PEM Pumice Scrubber
- Cemco Quicksilver HASL (Lead-Free)
- Dynachem Auto-Cut Sheet Laminator 1600 G
- Schmid 45 Soldermask Developer
- Mass, Lohr Hermann, Kuttler Accumulators Stackers-Loaders- Unloaders



Entertaining Pre-Auction Offers on Major Machines. Scheduling Preview By Appointment Only
Please contact Scott Lonkart : +1 203 257-2184 • slonkart@thebranfordgroup.com



PCB AUCTION #2

View Full Lot Catalog Online Now

Equipment Location: Gracanica, Bosnia

WEDNESDAY

OCT 4

10:00 AM CET

Register Now!

Multilayer PCB Manufacturer High Tech Circuit Board Facility



- Schmolli MDI Single Table Direct Imager (2 Heads) yr. 2020
- Schmolli Drilling & Routing Machine LM2
- Jetrite Ink Jet Legend Printer
- Schmolli MX1-160 CCD Drilling Machine
- Auto PCB V-cut Machine, Model CK-1500
- ATG Flying Probe Tester A1-1037, 8 Probes
- HML LP 2000 VK 2 Lamination Press
- MIVA Photo Plotter, Type 2512E T3
- Camtek AOI, Type: Orion-604 & 808
- Targomat - hole drilling machine
- Numerous Laif-Corema-Mass-Weimer Loaders & Unloaders



Branford
GROUP

Maynards
SINCE 1902



<< SCAN ME

For Catalog & Auction Details

+1(203) 488-7020 | TheBranfordGroup.com | service@thebranfordgroup.com

WWW.THEBRANFORDGROUP.COM

Create a New Environment

The electronics industry is losing its workforce left and right to retirement, and companies are seeking out a new workforce to fill that space. They are contending with issues that include a generation gap, retention, filling the talent pool, and onboarding strategies that keep new hires fulfilled and interested in staying for more than a short-term stint. It's daunting, at best.

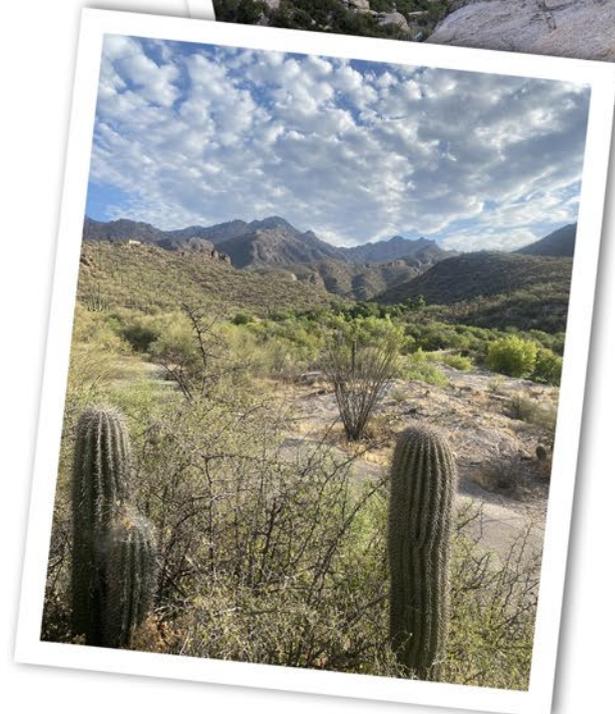
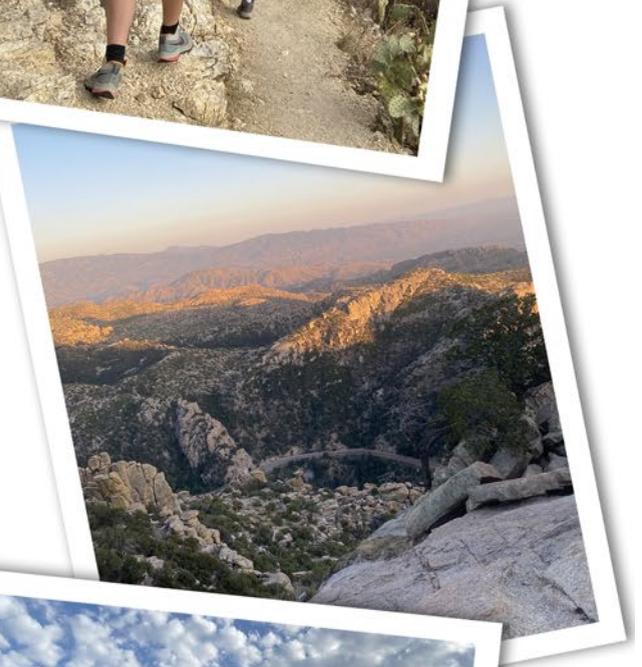
One thing that companies can do for new hires—especially ones like me who are new college graduates moving away for the first time—is to create an environment that feels like home.

During my first day of work, I was immediately greeted by my new co-workers. They quickly welcomed me onto the team and helped me see how some niche skills I had learned in college would aid me in my projects. I felt welcomed, needed, and even a little closer to home. That feeling of hopelessness soon turned into excitement. My employer's onboarding methods created a positive experience for me.

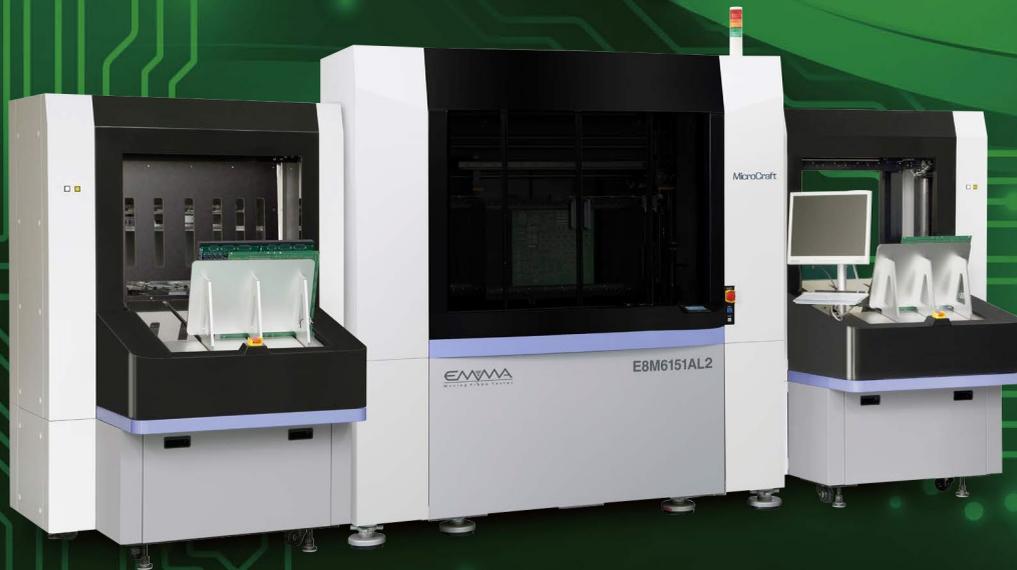
But it's not always this way, and I have the experience to prove it.

The Good, the Bad, and the Ugly of Onboarding Experiences

I had a negative situation at a previous internship. On the first day, I received a laptop and instructions to review the online onboarding materials. As I worked through the materials at my new desk, I could hear the conversations of my co-workers around me; they were all talking—to each other, and not to me. As I reflected on this at the end of the first day, I was distressed. I was in a new living situation with no family nearby, and I didn't know anyone, so I was already feeling uncomfortable. On the job, I was introduced to no one on my team, and even felt purposely excluded from the conversations at work. I truly felt like a “new hire” and even more isolated.



Fully Automated Unattended Operation



EMMA
MOVING PROBE TESTER

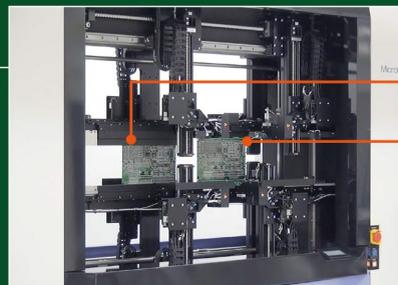
10,000
Test Points/mins.

Load up to
200 pcs

E8M6151AL2

Increased Throughput

Transfer speed reduced by **37%**



Ready for next test

Being tested

Built-in Scanner for Seamless Job Changeover

Improved Efficiency for
high-mix boards



Boards stacked
vertically for easy
operator access

Bar & QR
Code Reader



USA MicroCraft, Inc.

1247 N Tustin Ave, Anaheim, CA 92807
TEL (714) 482-2550

www.usamicrocraft.com
sales@usamicrocraft.com

[Visit Our Website](#)

[Watch Video](#)

Throughout the internship, it was hard to build those foundational work relationships because of what happened that first day. I had been unable to connect with my coworkers, so it was difficult to want to speak up in meetings, and even more so when my opinion needed to be heard. On new projects, I felt like I was wasting the time of others. I felt useless and so stupid! When I asked a question, the responses were short and quick, which additionally made my input on projects feel useless.

While I wish I hadn't had that experience, I know it taught me a lot, including that others may be having similar negative experiences that can be stumbling blocks to their success on a new team. So, how can you help your new employee have a positive onboarding experience?

1. Introductions. Make this happen on the first day in the first hour, to their team and others around the office.

2. Weekly one-on-one meetings. Check in on your new hire to see how they are feeling about their job. What questions do they have? By allowing them time to ask questions, you open the conversation for more input and improvement. Letting them ask questions even allows for learning. As a new hire, I absolutely do not know everything—especially things like acronyms that everyone around me is using—but with the opportunity to meet with my manager and ask questions during our one-on-one, I'm able to gain the tools and expertise necessary to bring value to my company.

3. Acclimation. Help new employees become familiar with the company and surrounding community. This can be through suggestions of places to eat, things to do, or even sports leagues they can join. Throwing a team lunch or happy hour for your new employee helps them feel more comfortable with their team. Happy hours can also help a new employee to learn about new restaurants in the area.

4. Employee community volunteer days. These help an employee reach out to their

(new) community and help those in need. Community volunteering helps the new employee know that no matter how small their impact is in the moment, they are truly making a difference in their new community. This leads to higher purpose and value in the company.

5. Resource groups. Give the employee an opportunity to join employee resource groups or clubs associated with the company. This helps them feel more connected to the company's purpose, values, and vision. It's also an opportunity to get to know their coworkers and help them feel like they've found a new home.

Although not part of the specific onboarding experience, I believe in rotational programs, especially for new hires coming straight out of school. A rotational program allows the new employee to work in multiple areas within the company, and especially to find new opportunities where they might thrive. It opens doors to areas of expertise where they might be a better fit, allowing for higher productivity and job satisfaction. Rotational programs are beneficial for both employees and their employer. They allow employees to attain valuable skills that they can bring back to their original team, again increasing productivity and efficiency.

Integrating even one of these practices can go a long way in helping your new hire feel fulfilled and excited about being on your team. I'm not saying that moving to a new state and new job is easy for anyone but knowing that my employer wants me to feel "at home" while I'm working has made all the difference. **PCB007**



Hannah Nelson is a validation engineer at Texas Instruments and in her third year of IPC's Emerging Engineer Program. She is a former IPC Student Board Member. To read past columns, [click here](#).

Summer issue available now!



 **LOOK INSIDE**

 **IPC**® BUILD ELECTRONICS BETTER

Advertise!



What's **Your Process** for Developing a Strategy?

Feature Interview by the I-Connect007 Editorial Team

Dr. Tim Rodgers might not call himself a “business strategies guru,” but the moniker certainly fits. As an adjunct faculty instructor at the University of Colorado, Tim specializes in project management, problem-solving, and streamlining processes in engineering and manufacturing. Plus, Tim knows the business side of PCB fabrication.

We asked Tim to discuss the process of developing a successful business strategy for PCB fabricators, why operational efficiency is not a strategy itself, and how smaller companies can differentiate themselves in an industry that’s becoming more and more commoditized.

Andy Shaughnessy: *Tim, would you share your thoughts on developing a business strategy?*

Sure. This is hugely important for companies to understand. We see a lot of examples of companies that fail because they don’t have a clear strategy. It really should start with asking, “How do you choose to compete? What can you do to create sustainable competitive advantage?” Companies that don’t have a clear strategy just zigzag back and forth. They take a lot of actions, and they may be very busy, but their actions are not consistent with any kind of strategic strategy. So, they end up

Unrivaled Test Speed with Full Automation



Introducing the newly designed atg A9a with 8 test probes and a new high speed “lights out” automation for unrivaled throughput.



Highlights:

- Small footprint (6 square meters)
- Dual shuttle pick & place automation
- High accuracy combined with high test speed
- Pen or label marking option

[Watch video](#)

[Get more info](#)

atg Luther & Maelzer GmbH
Zum Schlag 3 • 97877 Wertheim • Germany
Phone +49-9342-291-0 • Fax +49-9342-395 10
sales@atg-lm.com • www.atg-lm.com





Tim Rodgers

expending resources without really getting anywhere.

One of the big challenges for PCB fabricators is trying to figure out how to differentiate themselves, and that's really difficult. So many fabricators are basically the same; they use the same manufacturing processes, the same operating model, and there's not a lot of opportunity for differentiation. There are still breakthroughs in production capabilities and operating models, but it's getting harder and harder because the whole industry is becoming "commoditized," and when you start selling the same thing that everybody else is selling, then the power shifts to the buyer; the buyer has the power to basically do price comparisons. It's a difficult situation to be in.

A lot of what we teach about strategy comes from the work of Harvard Business School Professor Michael Porter. About 30 years ago, he published his idea that there are really three different ways to compete. One is based on differentiation, another is based on cost leader-

ship, and the final way is appealing to a niche market of some kind. Cost leadership basically means we will make the same thing, and provide the same services that everybody else provides, but we'll do it at a lower cost. We will beat everybody on cost. Walmart and Southwest Airlines figured out how to compete at very low cost and they can compete very effectively on that basis.

Differentiation means we will offer a product or service that is different, and customers will buy from us because we provide something they can't get somewhere else. A great example of that kind of strategy comes from Apple, which has a very clear differentiation around its operating system. I'm a Mac user, and I can get a cheaper PC, but we Mac users choose to spend more money in order to get what we think is a differentiated experience. The real question is how we can apply that to the world of printed circuit board fabrication.

The third one is niche. Can you appeal to a particular niche? If you can, your business will be small because it's a niche market of some kind, but it could be quite profitable. A good example of that might be trying to appeal to a specific kind of market, maybe medical devices, for example, manufacturers for the medical device industry have to submit to audits of their manufacturing practices. If you choose to specialize in this particular market, you may not get very big, but this strategy can help ensure competitive advantage in that niche market.

Barry Matties: Now, how does the smaller guy develop a strategy?

It's really tough to compete on the basis of cost; it tends to be a downward spiral as we keep cutting margins. With low margins, you don't have the money to invest in additional operational improvements, technology, and expertise. The alternative is to figure out what your customers are looking for, and really double down on that. It's not necessarily technology; you can differentiate yourself based on other kinds of services that you can provide.

Some PCB fabricators provide design services, for example. I would strongly recommend your readers consider getting into things like design services that make it harder to become commoditized. What are some of the other services that you can differentiate yourself on? Are you affiliated with an assembly site? Do you have assembly onsite? Can you do prototypes? Can you simulate the performance of the design before it's actually fabricated?

Matties: *Now, another area that Michael Porter talks about is operational effectiveness, which some people see as a strategy. It's necessary, but it's not a strategy.*

Operational effectiveness will definitely create opportunities for lower cost. Greater efficiency certainly allows you to lower your internal expenses and, in theory, be able to offer lower prices. If you want to maintain the same price and higher margins, it provides an opportunity for higher quality. We haven't talked about quality yet, because that could be an opportunity for differentiation as well. An interesting thing about strategy is that it helps define what you do. It also helps you to find what you're not going to do. It's a hard place for small fabricators to say, "We're not going to bid on that business because it's not a good fit for who we are."

Matties: *When your sales are down, it's very tempting to just say yes to keep your people busy. But oftentimes you just wind up sending a \$20 bill out with every board you ship.*

A good example of this is low-volume production, which doesn't make good utilization of your production assets. You can actu-

ally end up losing money on a low-volume work order. Now, there are situations where you might decide to do that anyway, because there's the possibility of higher-volume orders in the future, and those would make better use of your assets.

Matties: *When someone is starting to develop a strategy, they should look at operational effectiveness as a step in the process, but they have to realize that it's not the strategy.*

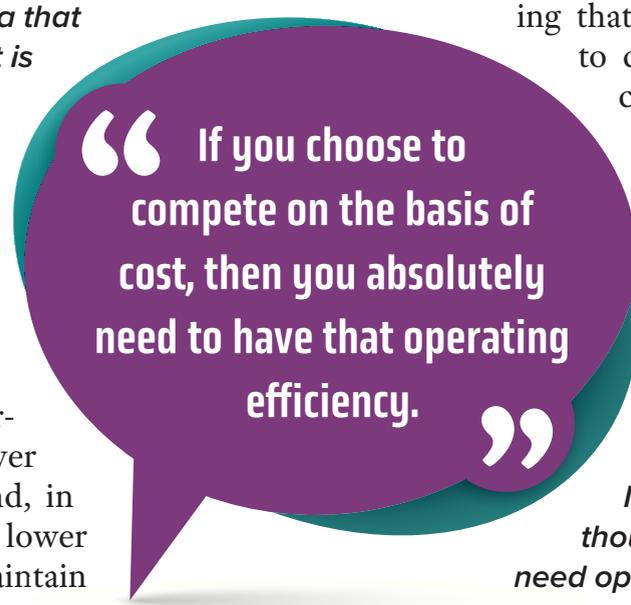
Operational effectiveness is a way of achieving that strategy. If you choose to compete on the basis of cost, then you absolutely need to have that operating efficiency. Going back to the example of Walmart or Southwest Airlines, that's what they're really good at—operational efficiency.

Matties: *I would argue, though, that you need operational efficiency regardless of what strategy you choose.*

Absolutely. You shouldn't be throwing money away under any circumstances.

Matties: *I agree. If you're in a red ocean, you had better find a way to put yourself in a blue ocean and make those others irrelevant, so to speak.*

In the world of printed circuit fabrication, can you come up with a new product offering of some kind? That's becoming increasingly harder, and it will only provide temporary competitive advantage, not permanent competitive advantage. Now, we see rigid board fabricators getting involved in full flex circuits, for example, or chip-on-board type technologies. That was revolutionary for a while, but it doesn't provide permanent competitive advantage because it's too easy for competitors to copy.



“ If you choose to compete on the basis of cost, then you absolutely need to have that operating efficiency. ”

Matties: *We came across an assembly company that was using information exchange and Industry 4.0 as a strategy. They said that every time a potential customer came in for an audit, they would close over 92% of those prospects. Their strategy was to create a connected factory as a showcase.*

Yes, that makes a lot of sense. Think about this from the standpoint of the client. When a client is shopping around for a supplier, what they want more than anything else is confidence. Yes, they're looking for a low price. Absolutely. But we've all been burned as individuals when we've chosen the lowest price. The lowest bid is not always a recipe for success.

Michael Porter also talks about the Five Forces model. His theory here is that if you want to improve profitability, you have to weaken the power of these five forces, and one of the five forces is the bargaining power of buyers. When buyers have power, they can negotiate lower prices in a commoditized environment. How do you reduce the buyers' power? One way to do that is to increase switching costs. You want to make it as hard as possible for your client to switch suppliers. You want to lock them in.

Why do I go to Starbucks? I go because I accumulate points, and I get a free drink every now and then. What would be a corresponding concept for a printed circuit fabricator? How can you lock your customers in like Starbucks locks in its customers? I'm not suggesting you offer frequent flyer miles, but how can you become an effective partner in the customer's overall production process, not just fabrication? How do you create that kind of

partnership? When you do, you have a situation where the client would never dream of cutting ties with you as a supplier, because that would mean having to recreate all of that tribal knowledge, understanding, and appreciation for who the client is.

Matties: *Still, as Michael Porter and others have said, it's easier to do nothing than to be blamed for making a bad decision.*

Yes, it's risky for both parties when a client is shopping for a new supplier. Again, that comes back to this idea of switching costs. Sometimes it's easier with the devil you know, rather than the devil you don't know.



“ When a client is shopping around for a supplier, what they want more than anything else is confidence. **”**

Matties: *What about validation certificates from a third-party organization?*

I think something like that is definitely needed. Everybody is ISO-9000 certified these days; it's kind of the ante to get you in the game. You can't play if you're not ISO 9000-certified, so it has lost some of its meaning.

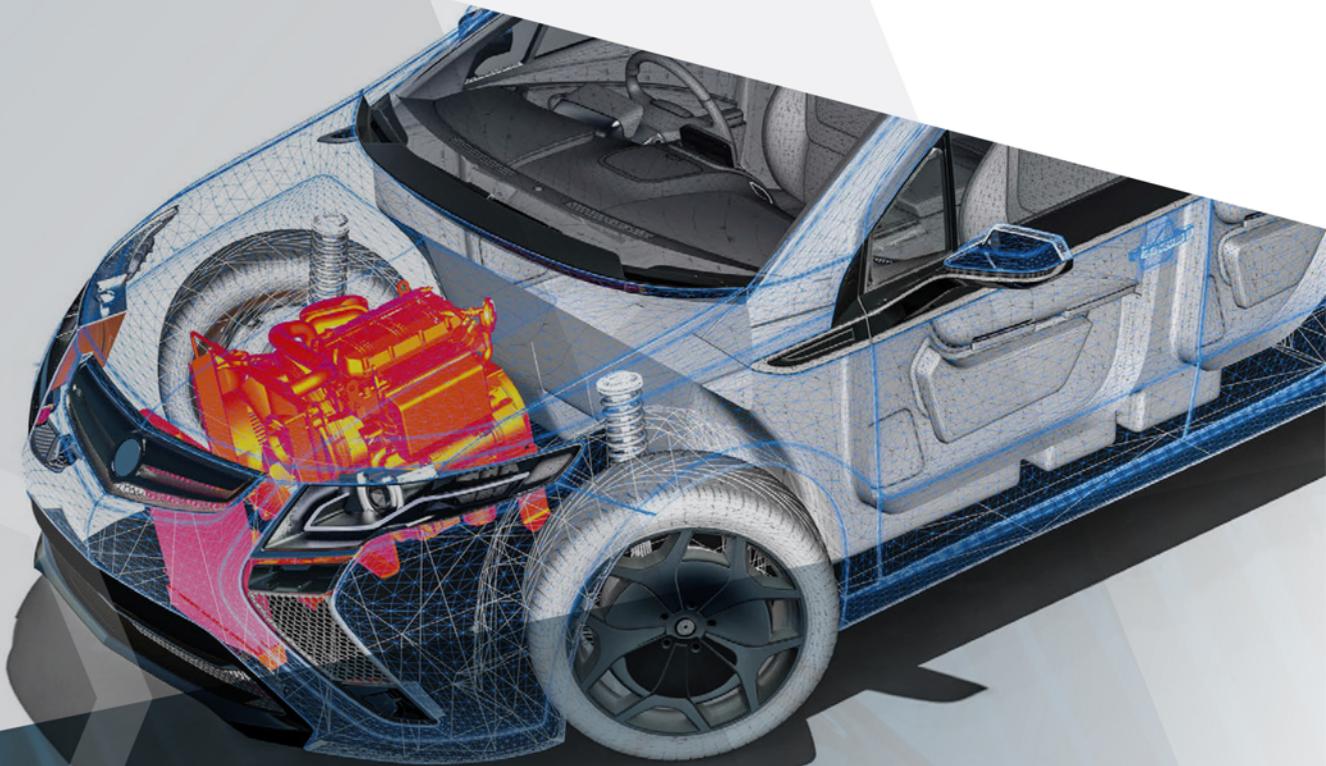
Matties: *Speaking of books, we recently read a book by Seth Godin titled **This is Marketing**. Seth points out that people often take a key and try to find the right lock. Like Seth, you're saying companies need to find the lock first, and then tune their capabilities to be that key.*

I agree with that analogy completely. It starts with an understanding of your market. What client base are you trying to appeal to? Are you trying to appeal to defense customers, medical device customers, or information technology customers? What do those clients want? What are those market segments? A defense customer wants something very different than what the medical device community wants. What is your



ventec
INTERNATIONAL GROUP
騰輝電子

autolam: Base-Material Solutions for Automotive Electronics



autolam 

Automotive electronics technologies are evolving at an increasing rate. Paying attention to the properties of materials at the substrate level is the first step towards achieving the most stringent performance targets of today's automotive manufacturers. autolam offers the solutions demanded by the diverse and unique requirements of automotive applications today and in the future.



ventecclaminates.com

target market? Now, you can still choose to support other segments, but you really have to win in your target market segment.

Matties: *I think the other thing we have to do is look beyond our competitors when we're benchmarking. For example, if you want to look at how to get people to move through a line, look at what Disneyland does, as they are able to move people through a line quite well.*

Good point. Benchmarking has fallen out of favor; you don't hear people talking about it very much. But benchmarking is not the same as competitive analysis, right? Benchmarking is looking at some element of your business and trying to figure out how you can do that better. Looking at another industry or a company that may be outside your industry may help you to understand your own processes better.

So how do we take the lessons from Disney on their queue management? Is there a way to apply that to how jobs are queued at a board shop? Is there something we can learn there

about how to prioritize work into batches? It's the same problem. Your fabrication facility has a limited capacity. You know Disney has a limited capacity for guests. Is there something you can learn from Disney about how jobs are queued up? Work is queued up at a printed circuit fabricator, right?

One thing I like about Disney is that you never see the entire line. If you saw how long the line actually was, you probably wouldn't bother. But the line snakes around, goes into a building, and it goes into another building. You don't actually see the entire line. There's a psychological aspect too. We taught Disney in some of my past classes. One of the things that Disney works on is the perception of waiting time. It's not just the actual waiting time; it's perceived waiting time. How do you keep your clients engaged during that period before they receive the product or service?

Matties: *This has been great, Tim. We really appreciate your time. Thank you so much. Thank you all. PCB007*

Protons Set to Power Next-gen Memory Devices

A proton-mediated approach that produces multiple phase transitions in ferroelectric materials could help develop high-performance memory devices, such as brain-inspired, or neuromorphic, computing chips, a KAUST-led international team has found.

Ferroelectrics, such as indium selenide, are intrinsically polarized materials that switch polarity when placed in an electric field. In addition to requiring low operating voltages, the resulting memory devices



display excellent maximum read/write endurance and write speeds, but their storage capacity is low. This is because existing methods can only trigger a few ferroelectric phases, and capturing these phases is experimentally challenging, says Xin He, who co-led the study under the guidance of Fei Xue and Xixiang Zhang.

Now, the method devised by the team relies on the protonation of indium selenide to generate a multitude of ferroelectric phases. The researchers incorporated the ferroelectric material in a transistor consisting of a silicon-supported stacked heterostructure for evaluation.

They deposited a multilayered indium selenide film on the heterostructure, which comprised an aluminum oxide insulating sheet sandwiched between a platinum layer at the bottom and porous silica at the top. The researchers gradually injected or removed protons from the ferroelectric film by changing the applied voltage. (Source: KAUST)

Congress Needs to Support American Made Printed Circuit Boards



OUR FOCUS

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

PCBAA advocates, educates, and champions legislation and policies that support this critical American industry.

[JOIN US TODAY](#)

PCBAA.ORG



India's Rise in the Global Electronics Ecosystem

Material Insight

by Preeya Kuray, AGC MULTI MATERIAL AMERICA

From resplendent silks to ornate architectural marvels, India is perhaps best known for her rich cultural heritage. Until the late 1980s, it remained a relatively closed economy. But in 1991, former Prime Minister Rao passed a series of radical economic reforms that opened its doors to foreign trade and investment. Since then, India has been steadily developing into a major economic powerhouse on the global landscape.

Today it is the world's fifth largest economy (behind the U.S., China, Japan, and Germany) and Goldman Sachs predicts that by 2075, it will be the world's second largest economy¹. With the largest workforce population in the world, it is no wonder there have been major incentives by the Indian government to

increase jobs and promote global trade, particularly in the electronics manufacturing sector. India's current contribution to the global electronics market is estimated to be just 3.4%². But slogans like "Atmanirbhar Bharat (Make in India)" and "Digital India" are steadily percolating across the nation, supported by federal incentives to bolster and accelerate domestic electronics manufacturing.

Earlier this year, President Biden hosted Indian Prime Minister Modi to discuss the burgeoning technological partnership between the two nations, and strategies to strengthen the commercial alliance between the U.S. and India. Several important agreements spawned from the meeting, including the greenlight for General Electric to start producing jet engines





pluritec®

MACHINES FOR PRINTED CIRCUIT BOARDS

WET PROCESSING TOOLS ARE BEING REDEFINED BY INTERNATIONAL SUPPLIES

DES: Develop Etch Strip line with automatic loading



- 100% digital control for reliable lights out operation
- Reliable 1 mil transport system
- Multi-chamber and digitally controlled etching zones
- Automated self-maintenance auto washing system

Scrubbox/Pumiflex system: an industry staple for 40+ years



- Now available with digital controls
- Fully automated
- 1 mil material support

Learn more at pluritec.com 

in India¹. HP also announced its intention to begin high-volume manufacturing of servers in India, with the aim of producing \$1 billion worth of servers in the first five years of operation^{3,4}. But perhaps the most interesting development came from Micron Technology's announcement to build a \$2.75 billion factory to assemble, package, and test semiconductor chips in India^{5,6}. While this deal has made headlines as a key technological breakthrough for India's electronics manufacturing industry, critics point out that the assembly, packaging and testing of chips is a relatively smaller piece of the semiconductor market pie.⁷⁻¹⁰

The semiconductor supply chain generally entails designing the chip, slicing silicon wafers into usable chips, layering, and assembling the chips into packages, before finally integrating the chips onto electronics to create end products for customers. Creating the actual silicon chip requires the highest level of advanced manufacturing, which is why it is the most lucrative part of the supply chain (roughly 83% of the market share)¹¹. Because of this, earlier this year, Foxconn and Vedanta (Indian mining conglomerate) agreed on a joint venture¹² to begin manufacturing silicon chips in India, with Foxconn agreeing to invest \$19.5 billion to set up a chip manufacturing plant. But as of July 2023, Foxconn has pulled out of the deal, leaving Vedanta to find another investment partner to fulfill the country's manufacturing goals.

While chip manufacturing is undeniably critical, it is just one part of the global electronics landscape. And while the Foxconn-Vedanta fallout may seem unpromising at first blush, there are signs of potential for other manufac-

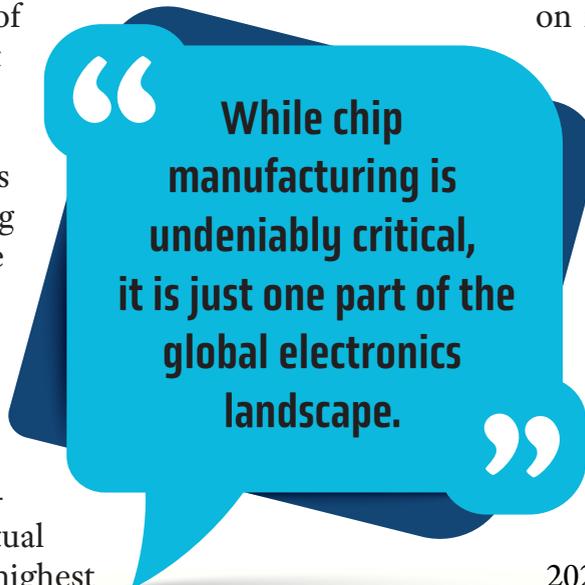
turing sectors in India, which could pay dividends for the United States and other trade partners. For example, unlike semiconductor assembly, PCB assembly yields a much larger profit margin than manufacturing. For this reason, in 2019 the Indian government passed a series of financial schemes that provide fiscal support for manufacturing and assembly of electronic components (including PCBs). The first scheme (PLI for Large Scale Electronics Manufacturing) gives companies financial support for PCB manufacturing, assembly, and testing by offering a yearly incentive of 4–6%

on incremental sales (for up to five years). The scheme also applies to the manufacturing and assembly of mobile phones and other specified electronic components in India^{2,13-18}. And the results from this scheme are showing. In 2022, Apple produced more than 6.5 million of its 200 million iPhones in India, with a target of 10 million by the end of

2023¹⁹. In July of this year, Tata (India's largest conglomerate) closed a deal to become India's first iPhone maker—the first time a local company would move into the assembly of iPhones.²⁰

This could be good news for the United States, if the goal is to diversify where consumer electronics assembly is happening. It is also promising news for India, since (unlike chip assembly) the fiscal gains of electronics assembly outweigh those of manufacturing. While the full impact of these schemes is yet to be seen for the PCB sector, it is starting to be felt by the mobile industry and beyond.

The Land of Many Wonders may be undergoing a manufacturing awakening. It has already begun with semiconductor assembly and testing, but it might possibly just reach the global PCB market next. **PCB007**



“ While chip manufacturing is undeniably critical, it is just one part of the global electronics landscape. ”

UcamX Pro+

The only CAM seat
with a missile launcher



- YELO Automatic DfM Adjuster
- Tombstone and Solder Escape Prevention
- Secure Etch Compensation with Horns
- Parallel Processing, 64 bit

References

1. “Why India Could Be the Next Big Destination For Global Investors,” by Frank Holmes, *Forbes Magazine*, July 2023.
2. “The National Policy on Electronics (NPE) 2019,” India Law Offices LLP.
3. “HPE Prepares for Spicy Affair With India To Churn Out \$1B Worth of Servers,” by Dan Robinson, *The Register*, July 2023.
4. “HPE to manufacture \$1 billion worth of high-volume servers in India,” by Shoma Bhattacharjee, *NBC*, July 2023.
5. “Micron to invest \$2.75 billion in setting up semiconductor testing facility in Gujarat’s Sanand,” by Aashish Aryan, *The Economic Times*, June 2023.
6. “Micron to set up \$2.75 billion semicon test, assembly plant in Gujarat,” *The Tribute*, June 2023.
7. “Aiming lower could be just what India’s semiconductor ambitions need,” *The Financial Express*, July 2023.
8. “India Will Pay 70% of Cost but Micron Will Own 100% of the Plant—A Curious Business Model,” by Prabir Purkayastha, *Counterpunch*, July 2023.
9. “India can aim lower in its chip dreams,” by Pranav Kiran, *Reuters*, July 2023.
10. “India’s Micron deal follows a curious business model,” by Prabir Purkayastha, *Asia Times*, July 2023.
11. “Mapping the Semiconductor Supply Chain: The Critical Role of the Indo-Pacific Region,” by Akhil Thadani and Gregory C. Allen, *Center for Strategic and International Studies*, May 2023.
12. “Can Vedanta pull off its semiconductor project without Foxconn?” by Manu Balachandran, *Forbes India*, July 2023.
13. “National Policy on Electronics, 2019,” *Regulatory Insights from India Tax and Regulatory Services*, March 2019.
14. “Design and Manufacturing of Electronics System,” *Indian Ministry of Electronics and IT*, March 2023.
15. “Production Linked Incentive (PLI) Scheme for Large Scale Mobile and Component Manufacturing” Pamphlet, *Indian Ministry of Electronics and Information Technology*.
16. “Extension of Tenure of the Production Linked Incentive Scheme (PLI) for Large Scale Electronics Manufacturing,” *Notification, Indian Ministry of Electronics and Information Technology*, September 2021.
17. “Frequently Asked Questions (FAQs) on Production Linked Incentive (PLI) Scheme for Large Scale Electronics Manufacturing,” Pamphlet, *Indian Ministry of Electronics and Information Technology*.
18. “Production Linked Incentive (PLI) Scheme for Large Scale Electronics Manufacturing,” PowerPoint, *Indian Ministry of Electronics and Information Technology*.
19. “Apple’s Complex, Secretive Gamble to Move Beyond China,” Mark Gurman, *Bloomberg Magazine*, April 2023.
20. “Tata Group Closes in on Deal to Become First Indian iPhone Maker,” by Sankalp Phartiyal, *Bloomberg Magazine*, July 2023.



Preeya Kuray, PhD, is a material scientist at AGC Multi Material America. To read previous columns, [click here](#).





MEETINGS & COURSES

APRIL 6-11

CONFERENCE & EXHIBITION

APRIL 9-11

Anaheim Convention Center | CA

WHAT'S NEXT BECOMES NOW

CALL FOR PARTICIPATION

IPC invites engineers, researchers, academics, students, technical experts, and industry leaders to submit abstracts for the **Electronic Circuits World Convention 16 (ECWC16) Technical Conference** hosted by IPC APEX EXPO 2024.

TECHNICAL TRACKS

- Quality, Reliability, Test and Inspection
- Design
- PCB Fabrication and Materials
- HDI, uHDI and Substrates
- Electronic Assembly Materials
- Assembly Processes
- Factory of the Future Implementation
- High Reliability for Extreme Requirements
- Sustainability for Electronics
- Emerging Technologies
- Market Trends and Outlook

Professional Development Course Abstracts Due

AUGUST 28, 2023

Conference Paper Abstracts Due

SEPTEMBER 18, 2023

Conference Poster Abstracts Due

JANUARY 22, 2024



IPC.ORG/APEXEXPO-CFP | [#IPCPEXEXPO](https://twitter.com/IPCPEXEXPO)



10 Steps to Outstanding

Feature Article by Dan Beaulieu

D.B. MARKETING GROUP

So often when I talk to PCB shop owners, they ask me how they can be outstanding. How can they position their own company to stand out from the crowd? That's because one of the issues PCB shops face these days is they all seem to be alike. While they used to be judged and differentiated based on performance, now they all have very good quality.

I am both pleased and disappointed by this question of how to be outstanding. I'm pleased because the owners are finally getting around to doing some branding, positioning, and marketing; I'm disappointed that it took so long. But, better late than never, right?

I love this subject; I live, eat, and breathe it. I make my living by talking, preaching, and sometimes screeching about it. I want to help

any way I can. So, here is a list of 10 things you can do today to make your PCB company stand out from the rest.

1. Develop a clear vision.

Think about what your company does best. Why do your best customers buy from you? Think about where you are, where you want to go, and what you want to be. Then start creating a plan to be there. In other words, create a clear vision and make it a reality.

2. Bring the customer to the table.

It is always about them. What does the customer want from you as a supplier? What does the market want from you as a PCB expert? Now, deliver it. Keep your eye on the customers at all times.



WORLD-CLASS SUPPLIERS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, salutes our premier suppliers.

CALL 949.587.3200 FOR MORE INFORMATION



REVOLUTIONARY LAMINATING & BONDING TECHNOLOGY

X-PRESS



RFX



230N

InduBond® has long been respected for tight accuracy in registration, its lamination presses, automation (automatic loading/unloading), and its eco-friendly best practices.

InduBond® X-PRESS lamination presses utilize a different way of producing the heat required for lamination using standard pressing methods.

The innovation of this technology is that it produces heat on the laminated material, and only the laminated material, of each layer of the press pack at the same time, at the same temperature level, without any thermal conduction.

X-PRESS - Inductive heating is the revolutionary new way of PCB laminates

RFX - High-precision (<10 microns) layer-to-layer registration

230N - Next-generation inductive bonding machine



Proven Performance Partner with InduBond® Presses!
COPPER-ALUMINUM-COPPER & COPPER-STEEL-COPPER
Contact us for more information.

3. Always be innovating.

What can you do better, build faster, and with better quality? Of course, make sure you are doing this for your customers. What do they want from you?

4. Invest in your employees.

Make sure they are happy. Better yet, make sure your employees are passionately motivated. Create a culture where they are always focused on doing things better, and especially doing them better for your customers.

5. Develop strong branding.

What is your brand? What do you want to be known for? When people think of you, what do they think of? Even better, when they think of a certain technology like flex and rigid-flex, for example, do they think of your company first? Are you the “Kleenex” brand of your technology?

6. Build partnerships.

You should be known for your collaborative partnerships with your customers. A good customer-vendor partnership will guarantee an outstanding relationship with that customer. They are looking for suppliers they can trust and count on in the long run. Make sure you are always focused on the long game of strong partnerships with your customers.

7. Do market research.

To be outstanding you must know your market and what it takes to be outstanding in that market. Always be studying the market. This should be a constant part of your effort to stand out in your industry.

8. Make data-driven decisions.

Please stop with the gut reactions. They don't work, they're not real, and they will put you on the proverbial road to perdition. Don't assume you know everything about the world. Don't listen to politicians about the state of the economy in this country or the world. Do your own research, collect your own data, and come to your own decisions. The worst thing you can

do in business is assume. Study the data and base your decision on that.

9. Engage in marketing and PR.

Hallelujah! Now we get down to it. If you do get involved in marketing, all these other things will fall into place. True marketing and the development of a marketing plan includes all the things we have talked about so far: from defining the market, to bringing your customer to the table, to studying the data. You must do all these things if you want to develop an effective marketing plan that will work. All that marketing encompasses is the way you get your name out there. It is the way to tell your story. You can be the greatest, most outstanding company in the industry, but if no one knows who you are and how to beat a path to your door, well, what's the point?

10. Listen to your customers.

There's no one better to tell you how to be outstanding than your customers. They know what they want, especially in an outstanding PCB supplier. Don't be afraid to ask your customers what they need both today and in the future. One of the key elements of being an outstanding supplier is to listen when your customers talk about what they consider an outstanding supplier. Simple enough, right?

In the spirit of under-promising and overdelivering, here's number 11: Be authentic, real, trustful, and genuine. Make sure your company has respect and regard for the market as a whole and that will go a very long way to making you an outstanding supplier. **PCB007**



Dan Beaulieu is president of D.B. Marketing Group, and an I-Connect007 columnist. To read past columns, [click here](#).



WORLD-CLASS TOOLS

Insulectro, the largest distributor in North America of materials used in the manufacture of printed circuit boards and printed electronics, provides game-changing precision cutting tools to our customers.

CALL 949.587.3200 FOR MORE INFORMATION

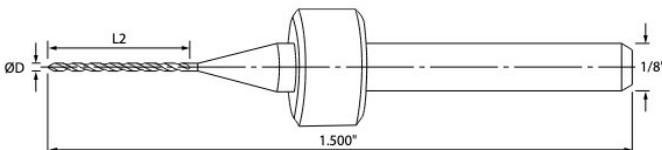


PRINTED CIRCUIT BOARD CUTTING TOOL SOLUTIONS

Kyocera designs and manufactures tight tolerance precision carbide cutting tools for PCB applications. Products include drills, routers, end mills, and specialized cutting tools ranging from: 0.05mm to 6.70mm diameters (0.0020" - 0.2638").

Drills, End Mills, Routers, Specialty Tools

Kyocera's renowned array of drills, routers, end mills, and specialty tools offer many benefits and advantages to customers for all their drilling and routing needs. Kyocera's tool reliability and design flexibility are key strengths of their products, along with a complete R&D facility in the US, new tool manufacturing capability, and local technical resources, all available to support customer needs.



4 Facet Point Geometry

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



Developing a **Fabrication** Business Strategy

Feature Interview by the I-Connect007 Editorial Team

Over the years, we've talked a lot about business strategies for PCB manufacturers here in the pages of *PCB007 Magazine*. But let's back up a bit and look at the process for developing a new strategy. Where should you even begin? What's your strategy for developing a strategy, if you will?

We asked Chris Chapman, a Lean/Agile leadership coach and publisher of the Digestible Deming newsletter, to share his thoughts on developing successful business strategies and how the management philosophy of W. Edwards Deming can help leaders in our industry take their companies to the next level.

Andy Shaughnessy: *Tell us about your background, and how you got into studying Deming and the process of developing strategies.*

I'm a software developer turned consultant turned management consultant, and I'm based in Toronto, Ontario, Canada. And I've been doing what I do for over 20 years.

I started as a software developer in the year 2000. I quickly discovered all of the problems that existed in management of software projects, and became exposed through that to the ideas and thinking of folks like Ken Schwaber and Jeff Sutherland, who created the Scrum framework, and Kent Beck, who created the XP (extreme programming) framework. And a lot of these guys were influenced by practitioners like Hirotaka Takeuchi and Ikujiro Nonaka, who discussed the new product development game in the Harvard Business Review in 1986. They were trying to figure out how to develop complex knowledge-based products

CATCH THE NEW WAVE IN VIA DRILLING TECHNOLOGY



The world's most advanced ABF via drilling system is here

Optimized for productivity. Built for the lowest cost of ownership. Designed for the most advanced materials. The new Geode™ A enables a greener manufacturing solution through 21% less floor space, 72% less weight, and up to 65% less power consumption than the competition. Our latest innovation is truly a new wave in via drilling technology.



Visit www.esi.com



Chris Chapman

in such a way that we can actually control the variation that exists.

The typical software projects that I was initially involved with were so big that you didn't see a release cycle in anything under several months. And the Scrum and XP and a lot of the Agile practitioners that were emerging out of the 2000s, influenced by the Japanese thinking around product development, were looking at releasing things in radically shorter timeframes. With more intense planning, this would happen in shorter, quicker bursts, with lots of touch points with customers, and lots of touch points with managers. This flew in the face of everything. I loved it, because I'm a contrarian. I really enjoyed learning about all these practices.

I worked for a number of small- and medium-sized companies along the way. The last large company that I worked for as a full-time employee was Microsoft, from 2008 to 2010, in their enterprise services consulting division. I was responsible for checking in on customers across the country and delivering materials training, advising, and producing reports on how to implement knowledge management systems I was responsible for.

Previously, I'd figured that if we just worked better as a team down in the software and

just improve our practices there, things would get better. It took me a long time to finally realize the constraints lay outside of the team. And that began to lead me slowly, inexorably, on a path towards discovering W. Edwards Deming.

I founded my own consultancy in 2011 and I haven't looked back since. Largely, what I do now is try to help leadership and their teams make sense of Agile the way it is practiced today. I've directed my attention there to try to produce improvements. That's what I do. I write, and I have customers—sometimes virtual, sometimes physical. And I work with them on learning the Deming management philosophy.

Barry Matties: Let's look at developing a strategy. Many times the problem is that leaders don't know exactly where they're going to take the business. What's the process for developing a "blue sky thinking" strategy?

Well, Deming would tell us that we've got to have constancy of purpose. And he says that that includes having a well-positioned aim, and that you understand what business you're in, what business you're not in, and that you've got plans toward the future. You see that expressed a lot inside of Japanese culture, like Toyota, for example, as a management philosophy. With the Toyota production system, they will set goals that help align and direct everyone so that they pull towards that direction or that objective, but they aren't necessarily something that you're ever going to achieve directly. You're always trying to move yourself towards greater and greater levels of improvement.

They've got to actually understand what it is like if they're going to set a strategy. Why are they moving in a particular direction? Have they considered, for example, whether they are in the correct business or not? In just the last six months, we've seen layoffs and restructurings of companies, and you can see that

they're shedding a lot of lines of business that they consider unprofitable. And you wonder why and how that ever actually aligned with their original objective. They're taking on a lot of mission creep and scope creep inside of the organization. And it's not yielding results. It's great to define strategy. But you have to have theory to actually shape what you're going to be pursuing things for.

Just think about mergers and acquisitions. Why are you buying that business? For example, is it to acquire a technology? Have you considered how you're going to ameliorate the disparate portion, and which parts of the business to align so that they can become productive and learn how you work as an organization? What are the things that you're doing right now that are perhaps alienating that effort toward the goals and objectives you're actually pursuing?

I'm always at odds with how the term "strategy" is defined and used in the prevailing style of management, because I often find that it leads to some very significant flights of fancy. Leaders don't directly address the challenge that really faces the business, and they often confound and confuse goals for strategy. They're just statements of desire, as opposed to what you need to overcome. Then as a consequence of that they're going to set bad strategic objectives. And they're going to fail to address the critical issues. For me, the critical issue, it keeps coming back to no matter what plan you want to put in action, if you haven't got a good theory to support how you're going to align the operations of the organization, it won't matter. You're just biding time to the next round of layoffs.



Matties: *Since leaders often confuse strategy, goals, and missions, what's the process that they should follow to separate those out?*

In my broad experience, I often come back to Richard Ronald's "Good Strategy, Bad Strategy." If you are going to chart a course for where you want to go, you want to make sure that you've got a diagnosis for explaining the nature of the challenge. You want to next have a guiding policy that's going to address the challenge. And then you want a set of coherent actions that are going to carry out the challenge.

Shaughnessy: *Where do companies start to go wrong when developing a strategy?*

Number one, they totally misinterpret or misdiagnose the challenge. And that comes from the prevailing thinking about how you manage and how you perceive the world. You're always stuck in this Catch-22 loop where you'll never get the escape velocity to actually get where you want to go.

I've seen some spectacular transformations and failures, and some of the biggest failures were championed by somebody in the executive suite. And there were literally people waiting to take their place and dismantle everything. When the theory is not diffused, then you will continually run the threat of having expended a tremendous amount of money, time and energy trying to change things that will never change.

I have a slide that I use to describe the scenario of leadership trying to implement change. It's a guy in a Darth Vader uniform standing knee deep in the ocean, with a Brita filter jug in one hand, and a two-liter bottle in the other. It's like one of those demotivational



The VP called me and said, “We’re having some problems; the rate of innovation is down, and the Board is upset. The engineers are not working fast enough and we think we need your help getting the engineers to work better together.”

“How many engineers do you have?”
“About 19-20.”

“How many salespeople do you have?”
“About 20-25.”

posters. The metaphor writ large is that you’re trying to desalinate the ocean into a tiny two-liter bottle and you haven’t done anything about the salt in the water. It’s all behind you. And it’s all waiting to just wipe out everything you’ve done.

In my career, I spent a good 10-12 years trying to fix things from the shop floor. I was desalinating the team. But the larger practices in the organization kept pulling my efforts apart. The number one question that I get as a cold call solicitation is, “Our people aren’t working well together, and there’s a problem with the team.” Really? Why is that? “Well, they don’t seem to be very communicative or cooperative. They’re short with each other.”

The next question I ask is, “How proximate are we right now to a performance appraisal? Has it just happened? Or is it just coming?” And nine times out of 10, that’s the case.

One call came from a manufacturer who makes augmented reality solutions for technicians in the field. The technology allows them to use a smartphone to do a real-time video feed, which automatically recognizes and pattern-matches the equipment being worked on, and transmits it back to a coach technician who provides a pinpoint diagnosis.

“Are they working on commission? If so, what are your latest incentives?” “Yes, and they’re all racing towards getting a Q4 bonus on selling maintenance plans.”

“So, what’s stuffed into your pipeline right now?” Then there was a long pause. I’m not a wizard, but apparently no one thought to ask about how their process is contributing to the fact that they’re underwater, and they’ve incentivized their way there.

Shaughnessy: Some of the managers in our industry are a little “old school.” What does it take for people to realize they need to consider a new strategy after 30 or 40 years in the business? Is it an “Ah-ha” moment?

In all of the stories about companies who have successfully changed their ways, especially with the people who are “old school,” as you say, it literally came from an epiphany, and it was brought about by somebody bringing an outside perspective to them to chew on. Unfortunately, they don’t all have the benefit of going to a four-day seminar on Deming and having their thinking deconstructed by him over two days, and then building them back up, so that suddenly the light goes off.

But, now there are better ways to learn Deming’s ideas, so that you don’t have to

UNLEASHING THE TITAN PSR-H

Standard Solder Mask Printing in 40 seconds*

*Print speed is based on one 18 x 24 panel side

The latest in direct imaging
technology from



CBTech[®]

Solder Mask and Dry Film Capable

EXCLUSIVELY AVAILABLE IN NORTH AMERICA FROM



TECHNICA, U.S.A.

1-800-909-8697 • www.technica.com

actually sit through a four-day seminar anymore. For example, The Deming Institute has just launched a new educational platform called Deming Next. You can go through and learn the individual modules and they're low time commitments, so that you can begin changing your thinking about your thinking. But the transformation has to begin with the managers, because they're the ones who can enact the most change within the company.

Shaughnessy: Some people may think that Deming is kind of abstract, but it sounds like there's a lot of practical information in his teachings.

Sure. You know, when you first start understanding Deming, it feels like you're going into the void. It's very risky. One person who helped me is a mentor of mine, Dr. Bill Bellows. He's a mechanical engineer by trade, and he's working

with Blue Origin now. He is one of the best modern Deming thinkers that I can think of, who actually helps you understand him. My own epiphany when I met Bill was that I finally understood where Deming was taking me, and that I actually had to transform. Bill uses the expression, "You can know as much as there is to know about ice, but still know nothing about water."

As I said, it's risky. What you're doing inside of the organization is weird, right? You're actually discarding some of your natural inclinations and behaviors. When you walk through the factory door, you suddenly treat everything differently. And Deming is trying to reveal—reflect back to you—that you should resist the inclination to overthink it. You just do it.

Shaughnessy: This has been great, Tim. Thanks so much for your time.

Thank you all. I can always talk about strategy and Deming. **PCB007**

RELATED VIDEO:

Why Deming, Why Now?

Is Deming still relevant for modern companies? Why?



As PCBAA grows, your impact in Washington grows



27

States

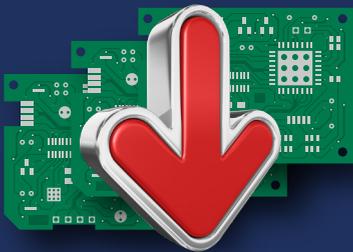
15,000+

Employees

\$15 billion+

to the US Economy

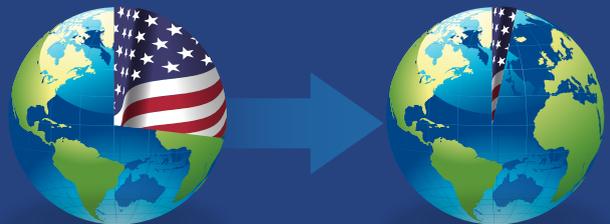
DOMESTIC PCB MANUFACTURERS



2002: 2,000

2023: 145

HELP US RESTORE OUR MARKET SHARE



2002: 30%

2023: 4%

PCBAA advocates, educates, and champions legislation and policies that support this critical American industry.

JOIN US TODAY

PCBAA.ORG





MilAero007 Highlights



Good News for U.S. National Security ▶

In case you missed it, President Joe Biden recently issued a presidential determination that prioritizes the domestic development of printed circuit boards (PCBs) under the Defense Production Act (DPA).

American Made Advocacy: Taking the Fight to Capitol Hill ▶

PCBAA hosted its second annual meeting, June 13–14, in Washington, D.C. It was great to see our founding members as well as many new corporate and individual members. On the first day, we heard from senior officials at the Departments of Commerce and Defense, as well as several members of the House and Senate.

A Front Row Seat for U.S. Military R&D ▶

It must be fun to work at a job that has a place in the history of the United States. Ryan Lang can tell you all about it. Ryan is a PCB designer at the New Mexico State University's Physical Science Laboratory, where much of the early research for rocket guidance systems took place. I recently spoke with Ryan about his job, as well as the milaero PCB design class that he took with IPC's Kris Moyer.

Nathan Edwards Takes Helm at USPAE ▶

The U.S. Partnership for Assured Electronics (USPAE) is a nonprofit organization dedicated to ensuring the U.S. government has access to resilient and trusted electronics supply chains. USPAAE members include companies, academic institutions, and nonprofit organizations from the U.S. and its allies, representing the entire electronics ecosystem from research to design, manufacturing, assembly, and test.

Designing Aerospace PCBs: A Galaxy of Challenges ▶

Jeffrey Boye designs aerospace PCBs at the Johns Hopkins University Applied Physics Laboratory. After a decade or so at the APL, some of his boards are currently floating in space. Jeffrey recently took a class with IPC instructor Kris Moyer titled "PCB Design for Military and Aerospace Applications."

Mil-Aero Design: Not Just Another High-Rel Board ▶

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

Green Circuits Achieves IPC Certification for J-STD-001 Space and Military Addendum ▶

Green Circuits, a full-service Electronics Manufacturing Services (EMS) partner to leading OEMs, is proud to announce that it has achieved the prestigious IPC certification for J-STD-001 Space and Military Addendum. This certification is a testament to Green Circuits' commitment to meeting the rigorous quality and environmental controls required by the aerospace and defense industries, particularly for soldered electrical and electronic assemblies designed to withstand the challenging conditions of space and military applications.

In a hurry? We're the fastest in the business!

- ISO 9001:2015 Certified
- AS 9100 Rev D Certified
- MIL-PRF-31032-C Qualified
- MIL-PRF-55110 Qualified
- ITAR Registered



Prototron Circuits
America's Board Source

Serving the industry for over 35 years  prototron.com  (520) 745-8515

Member Profile Q&A: Melanie Bera Anderson

American Made Advocacy

PCBAA

What was your path to Pro-Tech?

I learned the business from the ground up at TRC starting in 1997. I worked in shipping and as a receptionist. Eventually this led to working with engineers and gave me a practical understanding of design vs. manufacturing. We were doing some exciting work. We built the antenna on the Mars Polar Lander and the first GPS system for the Tomahawk Cruise Missile.

Five years in, the owners of the company wanted out, so I bought TRC. That was a tough period as work was moving to Asia. We dropped from 55 employees to 13. The only way we survived was to work across multiple industries, keep turning out quality products, and take on work from 10 small shops in Minneapolis that had gone out of business.

In 2018, TRC Circuits created American Circuit Corporation to purchase Pro-Tech Interconnect Solutions LLC. Pro-Tech was 10X bigger than TRC. In 2022–23, we combined TRC with Pro-Tech and have 83 employees at one facility in Chaska, Minnesota, as Pro-Tech Interconnect Solutions LLC. Pro-Tech is a 100% Owned and Operated Certified Woman Owned Small Business.

What interested you in this industry?

I enjoyed working with engineering groups from all over the world to build their boards with the challenge of emerging technologies, running rapid prototyping, and seeing them progress. For example, 3G to 20G in the man-



ufacturing of cellphones, industrial controls, and the continued advances by the Department of Defense in various technologies.

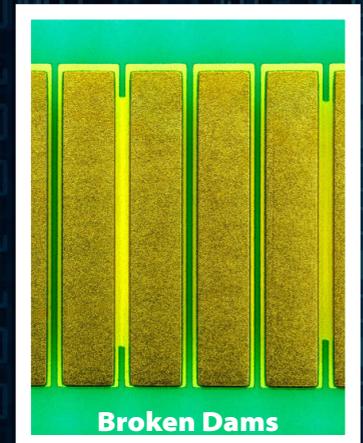
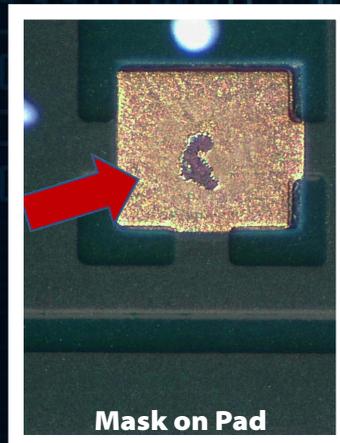
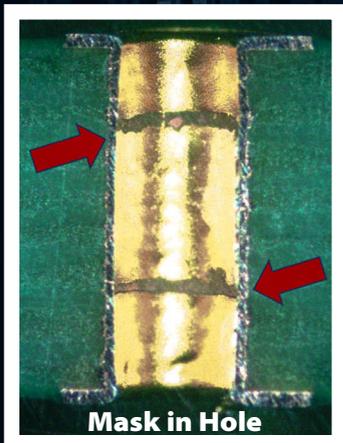
Where is the industry headed?

If we want this industry to grow, we need to get the same kind of support and attention that semiconductors have received. We need the boards built in the U.S. and have the semiconductors put on in the U.S. If we get the PCBS Act passed, it will help companies like mine to upgrade facilities and equipment to improve technology. The equipment needed to produce

Electraj[®] EMJ110 Inkjet Soldermask

What's the True Cost of Your LPI Soldermask Process?

Scrap • Late Delivery • Rework



Eliminate With Inkjet Soldermask
Electraj[®] EMJ110

PCBs is extremely expensive. The tax incentive in the PCBS Act would encourage OEMs to buy American-made boards. That would create the kind of demand that would help bring more manufacturing back to the U.S.

We recently had U.S. Rep. Tom Emmer (of Minnesota) visit our facility. He saw our operation and heard what we need to grow and protect the industry. I was also in Washington, D.C., in June at the PCBAA annual meeting where we met with other lawmakers to ask for their support. I joined PCBAA on the spot when Executive Director David Schild called last year, because I understood the importance of having a unified voice in Washington

and that we are essential in protecting national security in the United States.

How can we attract young men and women to a career in microelectronics?

I have found that the younger generation likes hands-on manufacturing. They pick it up quickly. We try to keep them challenged and give them the skills to continue to grow with us. We give them a clear path to their next stage here. Our employees are our greatest asset. **PCB007**

Melanie Bera Anderson is president of Pro-Tech Interconnect Solutions.

AI-based Technique for Predicting Crystal Orientation

A team led by Nagoya University researchers in Japan has successfully predicted crystal orientation by teaching an artificial intelligence (AI) using optical photographs of polycrystalline materials. The results were published in *APL Machine Learning*.

Crystals are a vital component of many machines. Familiar materials used in industry contain polycrystalline components, including metal alloys, ceramics, and semiconductors. As polycrystals are made up of many crystals, they have a complex microstructure, and their properties vary greatly depending on how the crystal grains are orientated. This is especially important for the silicon crystals used in solar cells, smartphones, and computers.

“To obtain a polycrystalline material that can be used effectively in industry, control and measurement of grain orientation distribution is required,” Professor Noritaka Usami said.

A Nagoya University team consisting of Professor Usami from the Graduate School of Engineering and Professor Hiroaki Kudo from the Graduate School of Informatics, in collaboration with RIKEN, have applied a machine learn-

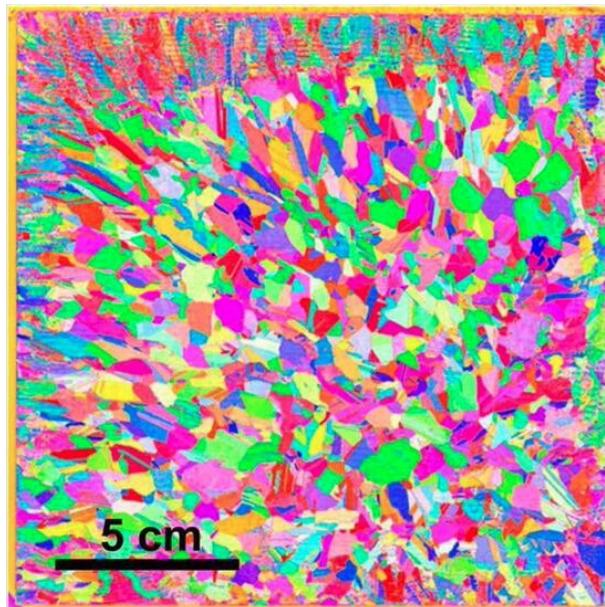
ing model that assesses photographs taken by illuminating the surface of a polycrystalline silicon material from various directions. They found that the AI successfully predicted the grain orientation distribution.

“The time required for this measurement was about 1.5 hours for taking optical photographs, training the machine learning model, and predicting the orientation, which is much faster than conventional techniques, which take about 14 hours,” Usami said.

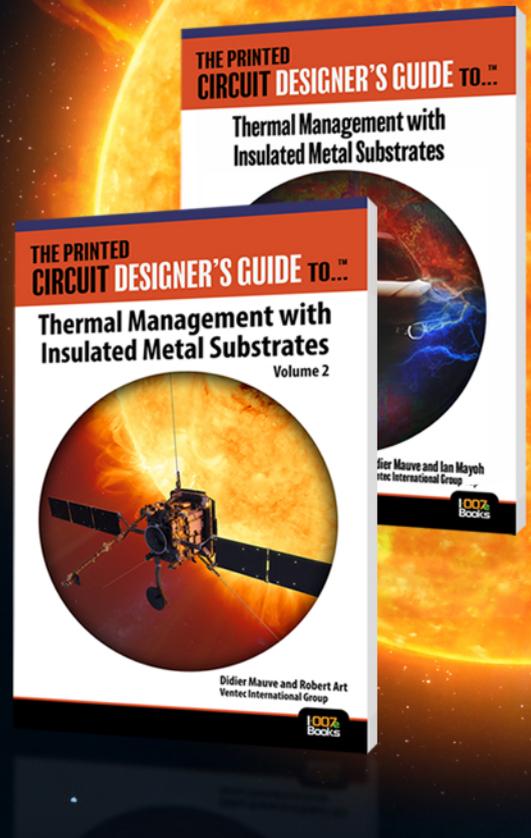
Usami has high hopes for the use of the team’s technique in industry. “This is a technology that will revolutionize materials development,” Usami said. “This research is intended for all researchers and

engineers who develop polycrystalline materials. It would be possible to manufacture an orientation analysis system of polycrystalline materials that packages an image data collection and a crystal orientation prediction model based on machine learning. We expect that many companies dealing with polycrystalline materials would install such equipment.”

(Source: Nagoya University)



Companionship at its Best



This must-read sequel to Ventec's book series on Thermal Management describes the applications, IMS products and support services to help you understand and overcome thermal management challenges.



Download Now

I-007eBooks

The Doctor's In: Beyond the Horizon— Exploring the Digital Future of Health



In today's fast-paced world, where technology has infiltrated almost every aspect of our lives, it is no surprise that the healthcare industry is undergoing a digital revolution. The convergence of health and technology has given rise to an era of digital health, reimagining how we approach patient care, monitoring, and even medical training.

APCT Acquires San Diego PCB Design



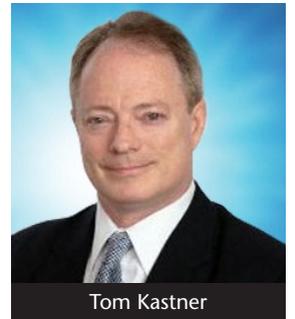
Steve Robinson

APCT, a custom manufacturer of advanced technology printed circuit boards, has completed the acquisition of San Diego PCB Design. APCT, headquartered in Santa Clara,

California, is a portfolio company of Industrial Growth Partners.

Punching Out: 2023 Mid-Year North American PCB and EMS M&A Update

The M&A market for North American PCB and EMS companies was quite active in the first half of 2023. In the PCB sector, our records show seven deals were completed in the first six months of 2023, compared to only five in all of 2022. In addition, two deals have been announced in July.



Tom Kastner

Recollections on Deming

In the early 1990s, I was working for EMD Associates, an EMS company (now a Benchmark Electronics operation in Winona, Minnesota), when I became familiar with Dr. W. Edwards Deming. EMD was an early entrant into the SMT provider world, and we were very focused on quality. Deming was one of several experts that we used as a guide for our company.

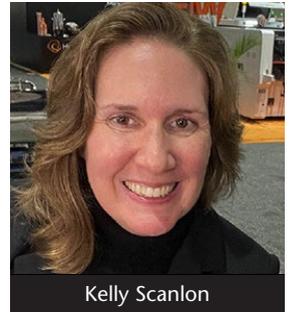


Global Sourcing Spotlight: My Six-step Process to Finding the Right Global Partners

I often get frustrated when companies underestimate what it takes to find a global partner. They tell me that all it takes to find the right partner is to gather some quotes, and then accept the one with the best price. When I hear comments like that, I think about what it really takes. I'll ask them, "Have you been to China, Taiwan, or Vietnam? It just makes a difference when you visit your suppliers in person."

Team Players: A New Industry Leadership Council Seeks Sustainability Solutions

In March 2023, IPC convened a Sustainability for Electronics Leadership Council to offer peer review and direction to IPC. The council is a response to the industry's requests for more attention on environmental, social, and corporate sustainability in IPC's industry standards, education, and advocacy.



Kelly Scanlon

Celanese: Fired Up Over Ceramics

With the ever-increasing diversity of performance needs in printed circuits, substrates are an ongoing area of development and innovation. At IMS Microwave Week, we caught up with Daniel Barish, a global strategy and west commercial leader at Celanese, to discuss substrates, low temperature co-fired ceramics, in particular.



Daniel Barish

North American PCB Industry Sales Down 15.8% in June

IPC announced the June 2023 findings from its North American Printed Circuit Board (PCB) Statistical Program. The book-to-bill ratio stands at 0.98. Total North American PCB shipments in June 2023 were down 15.8 percent compared to the same month last year.

A 21st Century Perspective on Data, Analysis, and TQM



Chris Chapman is a Deming management method practitioner and consultant who publishes "The Digestible Deming"

blog on Substack. Chris has been a student of Deming's agile, Lean, and related methods since 2007.

American Made Advocacy: Taking the Fight to Capitol Hill

PCBAA hosted its second annual meeting, June 13–14, in Washington, D.C. It was great to see our founding members as well as many new corporate and individual members. On the first day, we heard from senior officials at the Departments of Commerce and Defense, as well as several members of the House and Senate.

For the latest news and information, visit [PCB007.com](https://www.pcb007.com)

Career Opportunities



Find Industry-experienced Candidates at jobConnect007

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

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.

No contract required. Just send over your copy and company logo and we'll do the rest!

Contact barb@iconnect007.com to get your ad posted today!

+1 916.365.1727

I-Connect007
GOOD FOR THE INDUSTRY



Career Opportunities



ventec
INTERNATIONAL GROUP
騰輝電子

Senior Sales Representative Ventec Central Europe

Location: Kirchheimbolanden, Germany/Remote

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

Key Responsibilities

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

Job Requirements

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

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

[apply now](#)



Technical Support Engineer USA Region

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

Key Responsibilities:

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

Qualifications & Requirements:

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

[apply now](#)

Career Opportunities



Rewarding Careers

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

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

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

Associate Electronics Technician/ Engineer (ATE-MD)

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

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

apply now



THERMAL SYSTEMS

Sales Engineer SMT North Mexico

Rehm Thermal Systems, a leading German manufacturer of reflow soldering systems with convection or condensation and drying and coating systems, has produced energy-efficient manufacturing equipment for the electronics and photovoltaics industry since 1990. We also offer tailor-made applications related to the soldering, coating and hardening of modules.

Responsibilities:

- This position is responsible for expanding our customer network and maintaining existing customer relationships in the Northeast Mexico region. The Sales Engineer would work closely with the German headquarters and the General Manager Rehm Mexico to implement the sales strategy.
- A candidate's proximity to Monterrey, Mexico, is a plus.

Qualifications:

- An Engineering degree or comparable qualification with a strong technical background is required.
- Sales-oriented attitude, good communication skills and willingness to travel frequently within Mexico is essential.

We offer innovative products, a great dynamic work environment and exciting training opportunities in our German headquarters.

To learn more about Rehm Group please visit our website at www.rehm-group.com.

Please send resumes to: Mr. Luis Garcia at luis.garcia@rehm-group.com.

apply now

Career Opportunities



Europe Technical Sales Engineer

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

PRIMARY FUNCTION:

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

ESSENTIAL DUTIES:

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

QUALIFICATIONS / SKILLS:

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

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

[apply now](#)



IPC Instructor Longmont, CO

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

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

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

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

Benefits:

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

Schedule: Monday thru Friday, 8–5

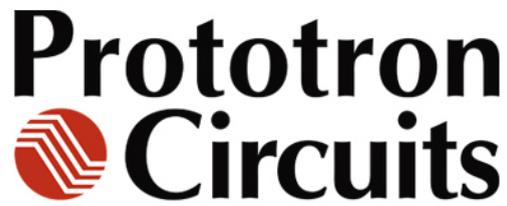
Experience: Electronics Manufacturing: 5+ years (Required)

License/Certification: IPC Certification—Preferred, Not Required

Willingness to travel: 25% (Required)

[apply now](#)

Career Opportunities



Sales Representatives

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

Reasons you should work with Prototron:

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

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

apply now



Regional Manager West Region

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

DETAILS OF FUNCTION:

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

QUALIFICATIONS:

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

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

fernando_rueda@kyzen.com

apply now

Career Opportunities



Technical Marketing Engineer

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

Requirements:

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

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

Send Resumes to: resumes@ema-eda.com

[apply now](#)



MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

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

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

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

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

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

Must be able to travel extensively.

[apply now](#)

Career Opportunities



Technical Service & Applications Engineer

Full-Time – Flexible Location

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

Responsibilities

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

Skills and Qualifications

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

Benefits

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

apply now



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

Career Opportunities

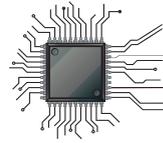


Are You Our Next Superstar?!

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

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

apply now



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



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

apply now



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

CAD/CAM Engineer

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

ESSENTIAL DUTIES AND RESPONSIBILITIES

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

ORGANIZATIONAL RELATIONSHIP

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

QUALIFICATIONS

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

PHYSICAL DEMANDS

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

apply now

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](#)



YOUR
JOB
AD
HERE

For information, please contact:
BARB HOCKADAY
barb@iconnect007.com
+1 916.365.1727 (PACIFIC)

I-Connect007
GOOD FOR THE INDUSTRY

NEW!

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

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



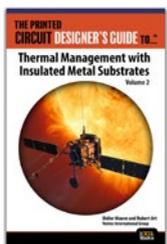
I-007eBooks The Printed Circuit Designer's Guide to...



Designing for Reality

by Matt Stevenson, Sunstone Circuits

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



Thermal Management with Insulated Metal Substrates, Vol. 2

by Didier Mauve and Robert Art, Ventec International Group

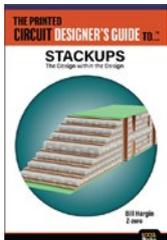
This book covers the latest developments in the field of thermal management, particularly in insulated metal substrates, using state-of-the-art products as examples and focusing on specific solutions and enhanced properties of IMS. [Add this essential book to your library.](#)



High Performance Materials

by Michael Gay, Isola

This book provides the reader with a clearer picture of what to know when selecting which material is most desirable for their upcoming products and a solid base for making material selection decisions. [Get your copy now!](#)



Stackups: The Design within the Design

by Bill Hargin, Z-zero

Finally, a book about stackups! From material selection and understanding laminate data-sheets, to impedance planning, glass weave skew and rigid-flex materials, topic expert Bill Hargin has written a unique book on PCB stackups. [Get your copy today!](#)

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

PUBLISHER: **BARRY MATTIES**
barry@iconnect007.com

MANAGING EDITOR: **NOLAN JOHNSON**
(503) 597-8037; nolan@iconnect007.com

EDITOR | COLUMNIST COORDINATOR: **MICHELLE TE**
michelle@iconnect007.com

CONTRIBUTING EDITOR: **PATRICIA GOLDMAN**
(724) 299-8633; patty@iconnect007.com

TECHNICAL EDITOR: **PETE STARKEY**
+44 (0) 1455 293333; pete@iconnect007.com

CONTRIBUTING TECHNICAL EDITOR: **DAN FEINBERG**
baer@iconnect007.com

CONTRIBUTING TECHNICAL EDITOR: **HAPPY HOLDEN**
(616) 741-9213; happy@iconnect007.com

SALES MANAGER: **BARB HOCKADAY**
(916) 365-1727; barb@iconnect007.com

BUSINESS DEVELOPMENT: **TAMARA SITES**
tamara@iconnect007.com

MARKETING SERVICES: **TOBEY MARSICOVETERE**
(916) 266-9160; tobey@iconnect007.com

ART DIRECTOR/PRODUCTION MGR.: **SHELLY STEIN**
shelly@iconnect007.com

MAGAZINE LAYOUT: **RON MEOGROSSI**

AD DESIGN: **SHELLY STEIN, MIKE RADOGNA,**
TOBEY MARSICOVETERE

CREATIVE TECHNOLOGIST: **BRYSON MATTIES**

COVER DESIGN: **SHELLY STEIN**

COVER IMAGE: **JOHN SMOKER, STRATOS AIRCRAFT**

PCB007

MAGAZINE

PCB007 MAGAZINE®

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

© 2023 IPC Publishing Group, Inc. does not assume and hereby disclaims any liability to any person for loss or damage caused by errors or omissions in the material contained within this publication, regardless of whether such errors or omissions are caused accidentally, from negligence or any other cause.

August 2023, Volume 13, Number 8
PCB007 MAGAZINE is published monthly
by IPC Publishing Group, Inc., dba I-Connect007

ADVERTISER INDEX

all4-PCB.....	47
atg Luther & Maelzer GmbH.....	71
Atotech.....	53
Branford Group.....	65
Burkle North America.....	21, 23
Chemcut.....	27
Electra Polymers.....	99
Excellon.....	43
I-007eBooks.....	2, 3, 101
IEC/Sigma Mecer.....	35
IPC.....	45, 83
IPC Community.....	69
IPS.....	13
Insulectro.....	5, 61, 85, 87
Linkage Technologies.....	49
Matrix USA.....	55
MicroCraft.....	67
MivaTek Global.....	41
MKS ESI.....	89
Notion Systems GmbH.....	29
On the Line with...podcast.....	39
PCBAA.....	77, 95
Pluritec.....	79
Prototron Circuits.....	97
Smart Process Design.....	17
Taiyo America.....	7
Technica USA.....	93
Ucamco.....	81
Ventec International Group.....	75

Problems solved!



SUBSCRIBE NOW