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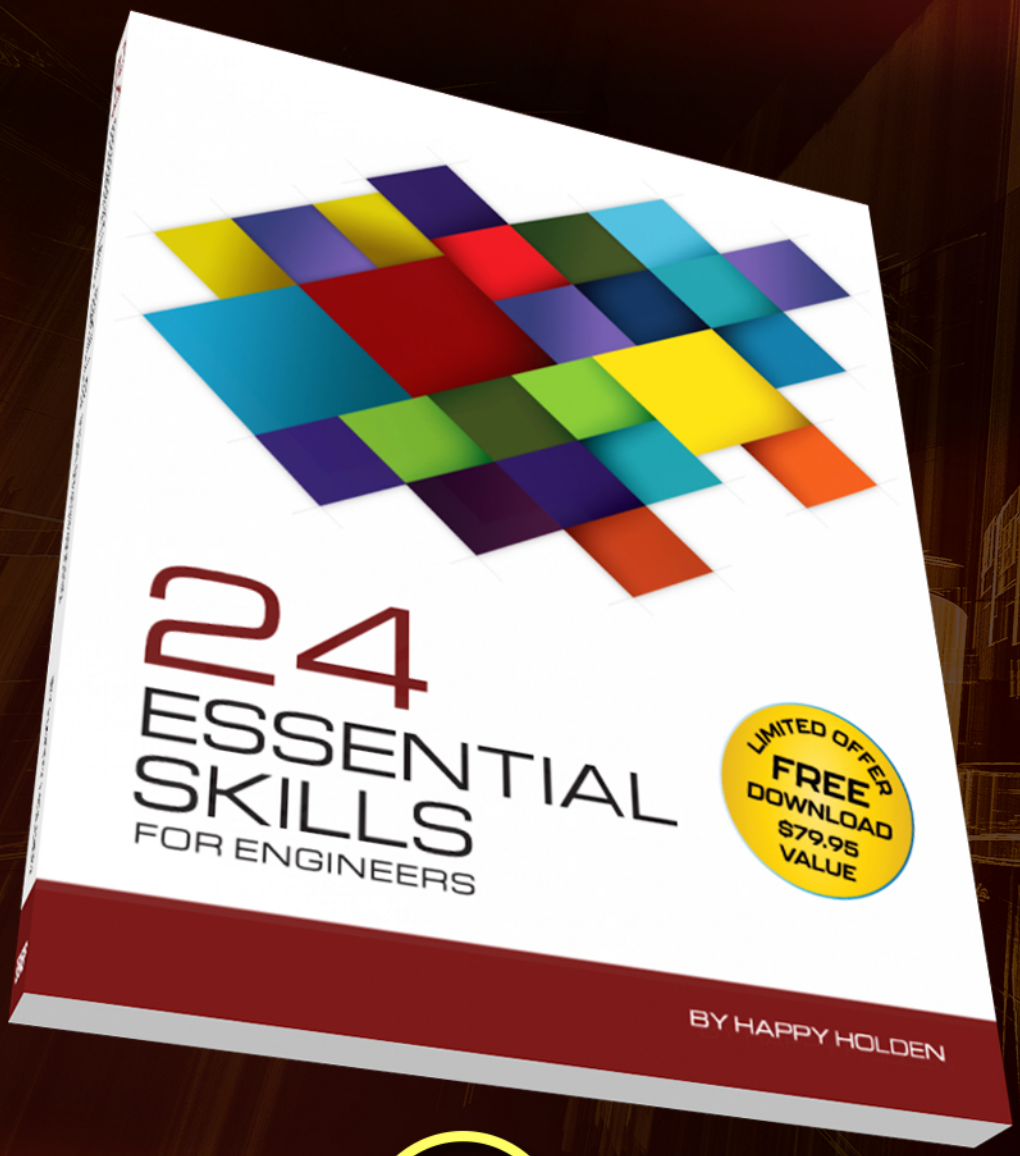

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Streamlining the Process

In the 21st century, streamlining processes almost always means an increased digital presence. That theme, we find, is scattered throughout all the process-related content in this issue. Whether it's a digitally optimized bill of materials, or increased automation in the manufacturing process, digital is pivotal.

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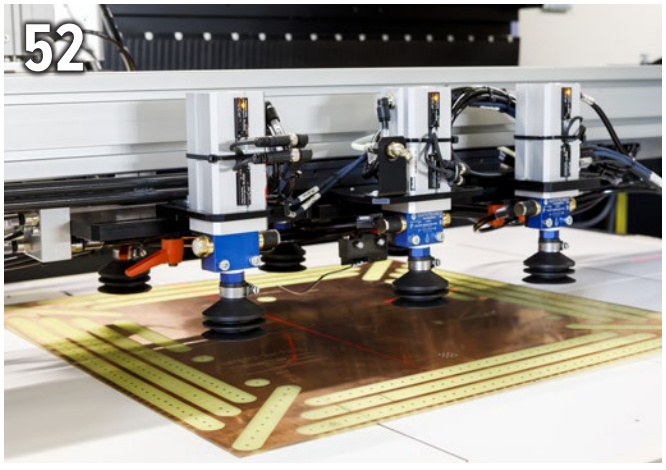

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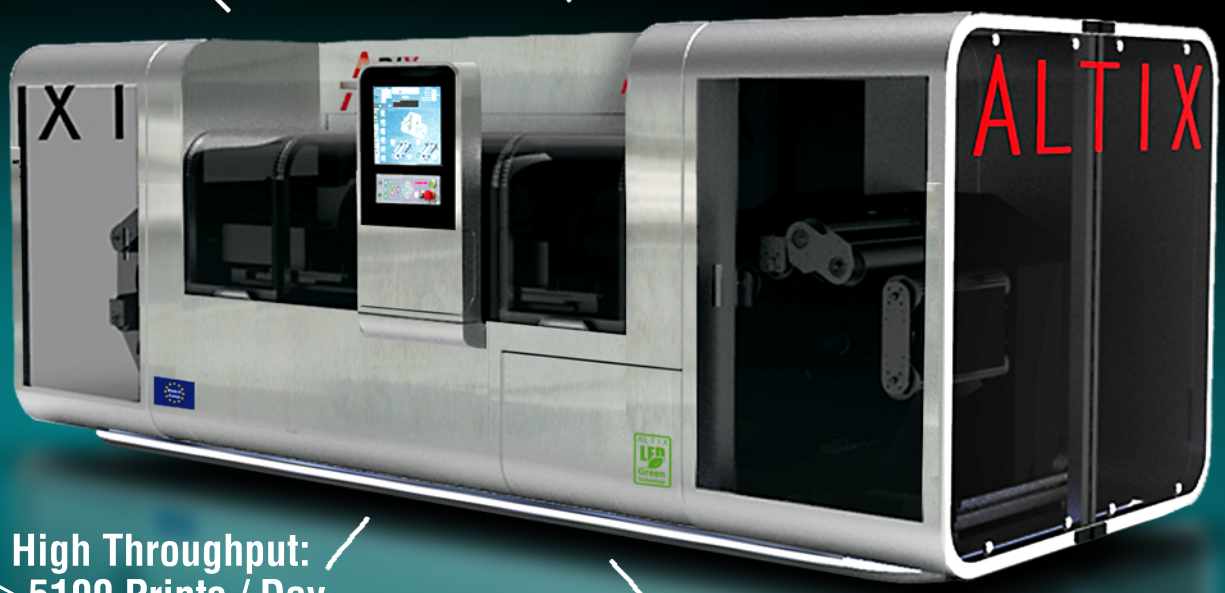

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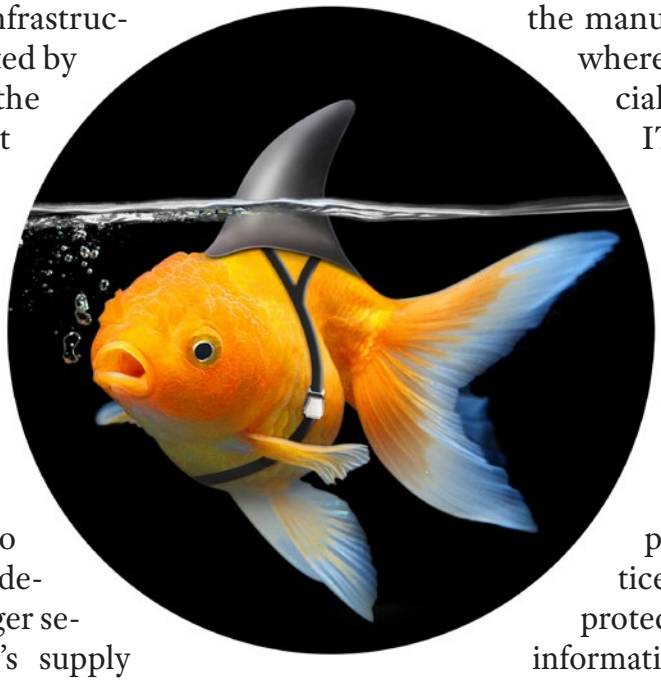
Streamlining Your Processes

Nolan's Notes

by Nolan Johnson, I-CONNECT007

It's late August 2021 as I write this column. Streamlining business processes has been the focus of this issue all summer. In front of me, however, my screen is full of coverage from the recent White House meeting between the U.S. President and major tech company senior executives discussing cybersecurity. President Biden is quoted, "The reality is, most of our critical infrastructure is owned and operated by the private sector, and the federal government can't meet this challenge alone."



Multiple sources report that Tim Cook, Apple's CEO, has responded to the meeting with plans to improve the security of their global supply chain. The idea seems to be to encourage (drive) widespread adoption of stronger security protocols. Apple's supply chain is gigantic; some reports state that there are more than 9,000 suppliers to Apple in the U.S. alone. Chances are good that many of our readers will be considered part of that supply chain. And that's not counting the supply chains for Microsoft, Alphabet (Google), and Amazon.

I find Amazon particularly interesting, given that the Amazon subsidiary, Amazon Web Services, provides a significant amount of the industrial cloud computing services[1]. Microsoft, Google, and IBM round out the global top five. Clearly, primary responsibility for cloud-based data security resides with these companies.

Furthermore, it seems that about 500,000 cybersecurity jobs remain unfilled in the U.S. economy. Not all these jobs are with the cloud services companies; many are on the manufacturer's staff, which is where they should be, especially if your company does ITAR work.

Enter the Cybersecurity Maturity Model Certification (CMMC). According to the U.S. Department of Defense (DoD), the CMMC will verify that companies in the Defense Industrial Base (DIB) have appropriate cybersecurity practices and processes in place to protect sensitive governmental information within unclassified corporate networks[2].

- The CMMC will review and combine various cybersecurity standards and best practices and map these controls and processes across several maturity levels that range from basic cyber hygiene to advanced. For a given CMMC level, the associated controls and processes, when implemented, will reduce risk against a specific set of cyber threats.

- The CMMC effort builds upon existing regulation (DFARS 252.204-7012) that is based on trust by adding a verification component with respect to cybersecurity requirements.
- The goal is for CMMC to be cost-effective and affordable for small businesses to implement at the lower CMMC levels.
- Authorized and accredited CMMC Third Party Assessment Organizations (C3PAOs) will conduct assessments and issue CMMC certificates to Defense Industrial Base (DIB) companies at the appropriate level.

This touches virtually all of the industry, "anyone who wants to do business with the DoD will need to be certified under CMMC. Subcontractors aren't exempt—every organization throughout the supply chain will need some level of certification"[3].

There are examples of similar "whole supply chain" programs, of course. Intel's CopyExact program (for fit, form, and functional interchangeability, not specifically data security) started over 20 years ago and was successfully instituted in Intel's supply chain. It's my opinion that Apple's supply chain program will be not unlike CopyExact, except concentrating on security and traceability. There will, however, be costs associated for each participating company. And that could be a problem.

In June, IPC issued a press release regarding an IPC survey that indicated U.S. electronics manufacturers may exit the defense market due to the high costs associated with CMMC[4]. In this survey, 24% of EM respondents said the costs and burdens of CMMC may force them out of the supply chain. In addition, 41% stated that applying this CMMC requirement will cause problems for their suppliers in their supply chain. IPC reported that the DoD's estimate for the cost to reach mid-level CMMC compliance is more than 77% of the respondents are willing to spend. And IPC points out that many smaller companies do not have cybersecurity-qualified staff on site.

This issue, however, is about streamlining your processes, so how does all this cybersecurity talk fit in? In the 21st century, streamlining processes almost always means an increased digital presence. That theme, we find, is scattered throughout all the process-related content in this issue. Whether it's a digitally optimized bill of materials, or increased automation in the manufacturing process, digital is pivotal. And since these process improvements rely increasingly on digital formats, data security becomes paramount.

In fact, I'm reminded of a manufacturing company hit by a ransomware attack. The point of entry into the company network? An unsecured computer controlling line equipment on the manufacturing floor. Data security is our collective responsibility, not the government's, and not the cloud services'. Data security is not simply a DoD requirement, either. Our customers should never question whether their intellectual property is safe in the hands of their manufacturing chain. No, we all have a part to play in this. What isn't quite so clear is how we're going to get there, and who's going to pay for it. **PCB007**

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

It's All About Time!

Feature Article by Happy Holden
I-CONNECT007

In any conversation about streamlining activities in printed circuit fabrication, two important performance characteristics always come up: lead time and lot size. I've been involved in PCB fabrication since 1970 and these two items have always been a center of conversation.

Introduction

When I worked at HP, printed circuit production was all manual until they installed their first NC-controlled, four-spindle drill to augment the four Excellon template-driven quad-drills. I was working mostly in plating and lamination, but production control was always an interest, especially that which made up our lead time and lot size. Our multilayer process had 20 significant work centers that panels proceeded through before shipping (this would significantly expand with the introduction of photoresist and new final finishes), each consisting of the six associated times (Figure 1).

Input/Output Control of Lead Time[1]

Over my career in printed circuits, I have seen the growth of electronic products and the rise of sophistication of the PCB to where it can have 32 to 46 significant work centers in manufacturing. If I visit a PCB fabricator, what I usually hear is, "This is how we manage our customers' technology demands." But what I usually see is:

- Excessive inventories
- Inability to make realistic delivery promises and meet them
- Excessive expediting
- Chronic lack of space in the plant
- Work centers that are always behind schedule

Why are there symptoms like this? The answer is simple: With all the fancy tools that have been developed, industry has failed to learn the fundamentals of lead time control,

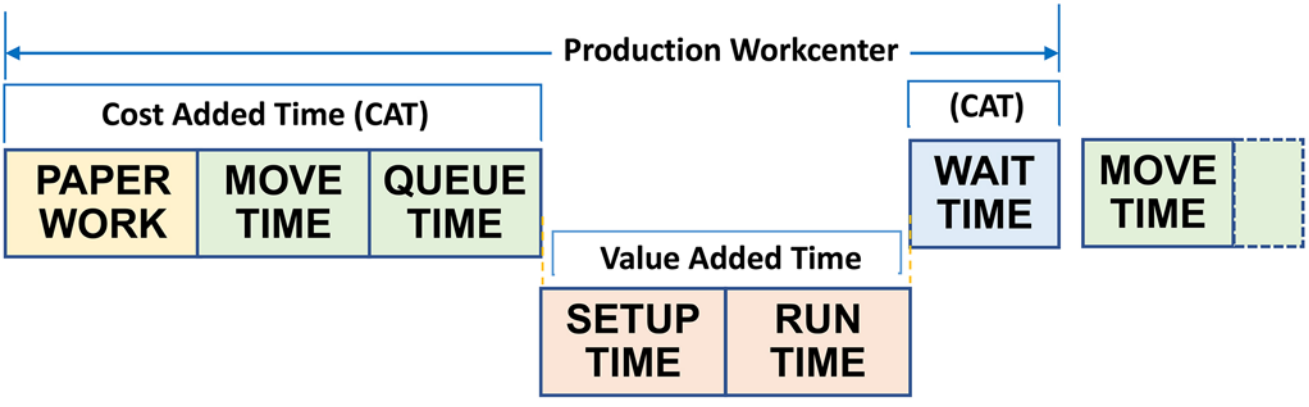

Figure 1: Times associated with a production work center[1].

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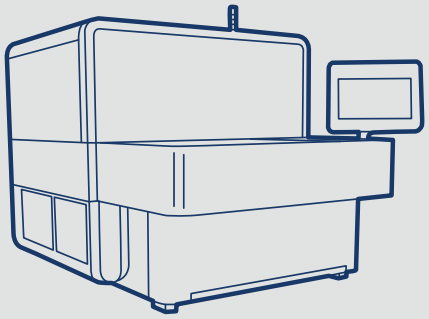

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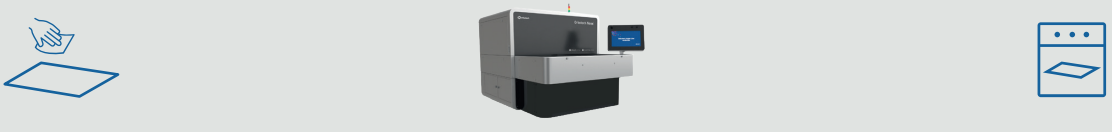

Cleaning → *Print Side A/B* → *Final Cure*

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especially as the manufacturing process expands and becomes more complex.

What is Lead Time?

Lead time can be defined as the time that elapses between the moment it is determined that an item is needed and ordered, and the moment when the item is available for use. Manufacturing lead time is the actual amount of elapsed time in the factory from the moment that a shop order is released to the factory to the time it is completed. This lead time can be broken into the following elements and descriptions:

Lead time = Set-up time + run time + move time + wait time + queue time

- **Set-up time:** The time when the job is sitting at the machine and the machine is being set up (prepared) with the proper tooling or information for this job
- **Run time:** The actual time the job is at the machine and being worked on
- **Move time:** The actual time the job spends in transit
- **Wait time:** This has been separated from queue time so that it could be arbitrarily associated with move time since, in many factories, the dispatching job is not highly organized, and the expediters usually don't get to a job as soon as it is ready to move
- **Queue time:** This is the time the job spends waiting to be worked on because another job is already being run on that machine or process

Depending on equipment layout and through-put, a substantial amount of time could be spent waiting for moves. In practice, most of the lead time turns out to be queue time.

As an example, the new GreenSource Fabrication facility is totally automated with digital barcodes or RFID tokens for set-up recipes and lot tracking. I have watched the final outerlayer process after lamination and drilling go from desmear through imaging, metallization, plating, etching, and solder masking to electrical test in 105 minutes[2,3,4]. Except for the occasional job that had special processes and was diverted to accumulators, the move-wait-queue and set-up times were miniscule.

There is overwhelming evidence in most manufacturing to indicate that the amount of backlog that exists is as much as the company can tolerate. Backlog on the factory floor is in evidence everywhere and there seems to be a variation on Parkinson's Law at work, since: "Work-in-process normally tends to expand to fill the space available."

Backlogs are the Problem

Since backlog is a fundamental cause of long lead time and lead time can only be controlled if backlog is controlled, let's look at the three major causes of large backlogs:

- Lead time inflation
- Erratic input to the plant
- Inability to plan and control output effectively

Lead Time inflation

During good times, and as business picks up, companies put more into the factory than they ship out. This builds up the shop backlog, and as a result, they find that their lead times are increasing. The plant always feels that if they just had a little more lead time, it would be a simple matter to get jobs completed on schedule.

Erratic Input to the Plant

Releasing jobs to the manufacturing floor without considering the through-put of each work center always results in a highly erratic input. This results in growing queue times, excessive expediting, and missed delivery dates.

Inability to Plan and Control Output Effectively

The basic principles of output control are to separate the planning and control of capacity from planning and control of mix. Plan capacity requirements in the largest possible groups

of processes. Put the required date on individual items at the last possible moment, i.e., forecast over the shortest possible horizon. Never put into a manufacturing facility more than you believe can be produced.

Input/Output Control: A Case Study

In 1996, our production control manager wrote a paper for the California Circuits Association Conference (1998) on the project to reduce our lead time and lot size for multilayer production[5]. This is the only paper I can find about a lot or lead time case study for PCB fabrication. This paper will be available in the I-Connect007 Technical Library.

Background

In the late '90s, Hewlett-Packard's PCB fabrication facility found itself with increasing orders and increasing lead-time. The production control manager, Bill Nordskog, took action and this is an account of his efforts to control its lead-time and throughput.

Motivation for Change

It was clear that lead time was the principal culprit creating our dilemma. To reduce the magnitude and duration of future demand fluctuations, we were certain that a significant lead time reduction was the required first step.

A second motivating factor was the emphasis top management had placed on improving inventory and accounts receivable control following the analysis that a disproportionate increase in the levels of these two assets was forcing the company to consider significant long-term debt financing for the first time. By implementing a reduction in our work-in-process, we could make a positive contribution to avoid that prospective debt.

Finally, recalling Oliver Wight's fine article, "Input/Output Control: A Real Handle on Lead Time,"[1] indicated to us that many other problems our shop was facing (late deliveries, production hold orders, date changes, excessive expediting, and failure of our priority system) could also be corrected.

Analysis and Objectives

A review of our order cycle times showed that, although we planned on an average of six weeks, our cycle distribution centered around eight weeks. Further analysis of our labor history indicated about one week's vouchered time spent on most orders, and seven weeks' worth of queue. In each of our 20 work centers, then, we averaged carrying between three and four days of orders waiting in queue.

A portion of our seven-week queue time was required to balance production rates among operations; however, most of it existed for two questionable reasons:

1. It was the level of queue we had always maintained.
2. It was comfortable: Supervisors had rarely faced the problem of running out of work for their work center.

Consider an alternative of half-day of queue per work center, which would allow for a total cycle of three weeks. This would allow us to expect that the accuracy of customer scheduling, the overall responsiveness of the shop, and the severity of future order fluctuations should be improved.

Methods

With the help of our engineering staff and the production supervisors, a three-step plan was created to immediately stop releasing work to the shop for three weeks so that the new cycle time would be three weeks.

1. The immediate goal was to become current on delivery by authorizing overtime and shifting workers from those first work centers that now had to work. This was reached six weeks later; two weeks of our excess queue were eliminated.
2. Rather than face the disruption of releasing no work for three weeks, we decid-

ed to hold off releases systematically over a three-month period, gradually phasing into our new cycle time and returning workers to the front end of our processing.

3. Most importantly, agreement was reached to redefine some of the responsibilities of shop supervisors and production control. On-time delivery became primarily the responsibility of first-line supervisors, and it could only be accomplished by maintaining a half-day or less queue at each of their work centers. A new attitude of urgency was formed regarding work sitting around. The shop manager was allowed to question any order observed at the same work center for two consecutive days.

Potential Problem Resolution

Most of the planning meetings were spent identifying and creating plans to minimize potential problems. Five problem areas were addressed and common to the plans made in each work center.

1. **Short-term load fluctuations.** Solution: A load smoothing effort was undertaken by production control to persuade our larger customers to balance their weekly requirements. Given that load balancing cannot be perfect, shop disruptions were minimized with a large-scale cross-training effort. A management attitude was formed viewing running out of work as not being all that bad, in fact, almost an objective from a production standpoint.
2. **Order holds and date changes.** Solution: We correctly felt that by shipping orders a month after they arrived, the opportunity for customers to change requirements would be slight and the accuracy of their initial scheduling would be greatly improved. A simple agreement was made with our customers: If the order was in the shop, we would not allow it to be held or pushed out; the order would either be shipped or cancelled.
3. **Machine downtime.** Solution: Production management, not maintenance, was assigned the responsibility to protect against this situation and more emphasis was placed on spare part levels, operator preventive maintenance, and repair priorities. The most critical, potential problem work centers were identified, and contingency plans were made for subcontracting.
4. **Poor load visibility.** Solution: The load smoothing effort coordinated with our customers would be a necessity to minimize these problems. Much more effort was made by our production control to work with customers in producing accurate three-to-six-month requirement forecasts. A successful project was completed by the purchasing department to translate these forecasts into our MRP system and large decreases were made in raw material levels.
5. **Labor productivity.** Solution: It had to become clear to our labor force that the jobs they would be working on tomorrow would be arriving today. With our "keep it moving" philosophy, emphasis was placed on picking the nearest job rather than sorting through priority lists. The movement of cross-trained personnel to the busiest work centers certainly helped prevent a deterioration of productivity. As much as possible, the overhead requirements for tooling or preventive maintenance, etc., were performed in periods of extremely low or zero queue. A curious change was seen as our queues were shortened. When work in one work center became low, the supervisor or lead person could usually be found in the earlier work center applying subtle pressure to get more work to them. It's possible this "pulling" technique is a more effective motivator than a ponderous queue.

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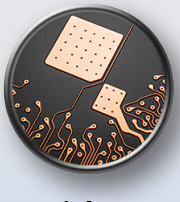

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Project Results

Within six months, the following results were achieved by this project:

1. Lead times were dropped from 15 to three weeks.
2. Order cycle time was reduced from eight to less than three weeks.
3. Work-in-process inventory was reduced over $500,000.
4. Raw material inventory decreased by $250,000.
5. On-time deliveries increased from 35% to over 98%.
6. Labor productivity, in terms of output per hour, almost doubled.

Lot Size: Minimizing the Set-Up Time

The two value-added times are set-up time and run time. Minimizing set-up time is key to reducing lot size, which allows for lower costs and more scheduling flexibility. But there are other benefits (Figure 2) to set-up time reduction:

- Increased flexibility
- Less inventory
- Better quality
- Reduced startup wastes and rejects
- Higher production throughput
- Higher machine utilization
- Simpler or no setup, thus requiring less operator skills
- Safer changeovers

Set-up Time Reduction Process Steps:

1. Separate internal and external tasks: Internal can only be performed once equipment is stopped, while external can be performed whist equipment is still running.
2. Convert internal to external tasks: Prepare required tools and instructions at the work center and analyze set-up actions into internal, external, and waste.
3. Streamline all aspects of the setup: Move any tools or instructions needed to the work center and use more than one person to eliminate unnecessary movements.
4. Eliminate adjustments: Establish reference points for all process settings to eliminate trial and error by establishing standard operating procedures (SOPs) or by networked automation.

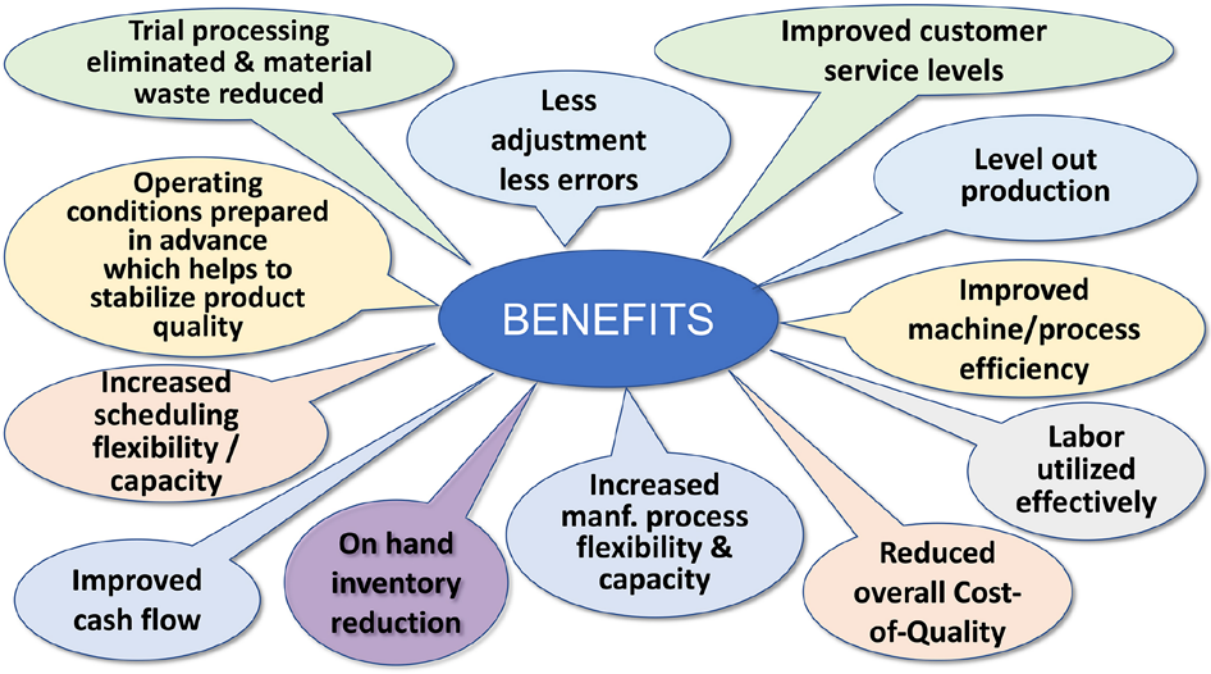


Figure 2: Benefits for setup time reductions.

Role of Technology

Run time is based on equipment and processes. In PCB fabrication, this can be complex and different for each fabricator. Equipment and processes are constantly changing and improving, many times to support new materials, constructions, or applications. But in the last 60 years, it seems like no printed circuit products have been obsoleted; only new products, equipment, or processes, PCB as a product just continue to become more complex, like HDI, cavities, flip-chip, flex-rigid, and SLPCBs.

Lean Manufacturing

Lean manufacturing is where you will find many tutorials on production control, lead time reduction, and reducing lot size.

The manufacturing strategies that allow smaller lot sizes and shorter lead times are:

1. Just-in-Time: Pull production and continuous flow strategies.
2. Jidoka: Autonomation where the human and machine cooperate to identify defects, eliminate causes, and prevent re-occurrence.
3. Kaizen: Continuous improvement of an individual process to create more value with less waste.
4. Heijunka: Leveling the type and quantity of production over a fixed period of time.
5. 5S: A methodical way to organize your workplace and your working practices. It is split into five phases, each named after a different Japanese term beginning with the letter "S": Seiri (sorting), Seiton (straightening), Seiso (systematic maintenance/cleaning), Seiketsu (standardize), Shitsuke (sustain).

Additional information on Lean manufacturing can be found in my new I-007eBook, *24 Essential Skills for Engineers.*

Available Software

There are various available manufacturing execution systems (MES) and enterprise resource planning (ERP) software solutions available today. They are a major factor in the Smart Factory and Industry 4.0 strategies (Figure 3). Most

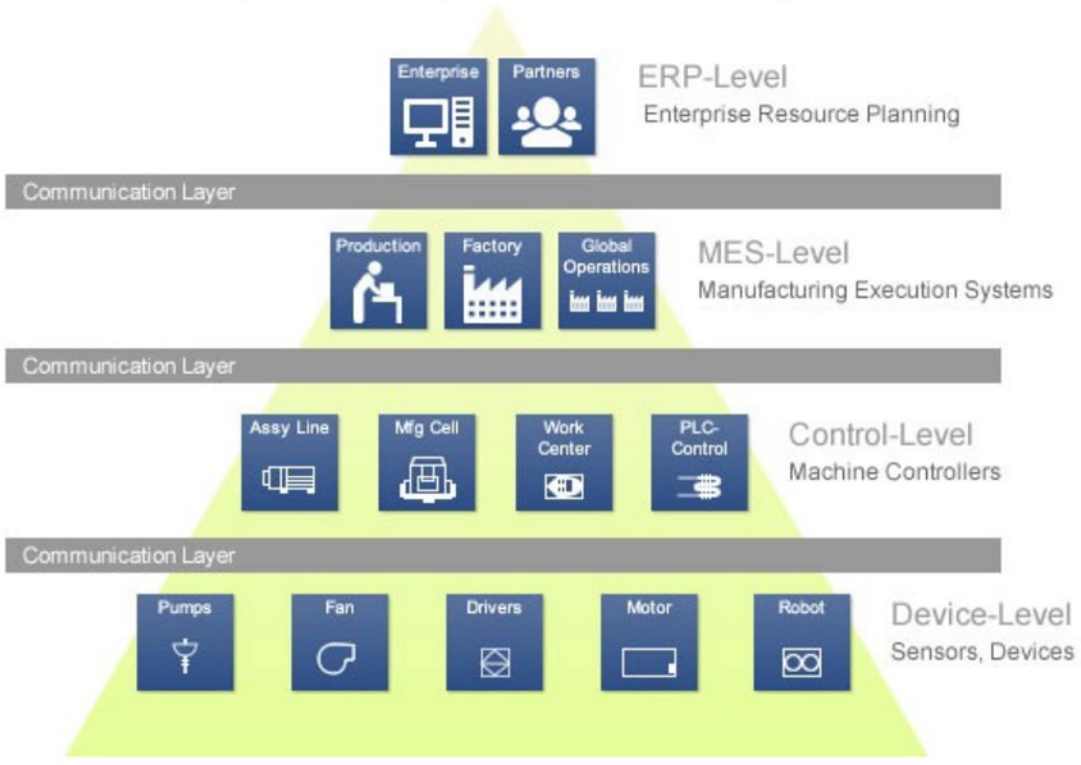


Figure 3: ISO95 computer hierarchy for Industry 4.0.

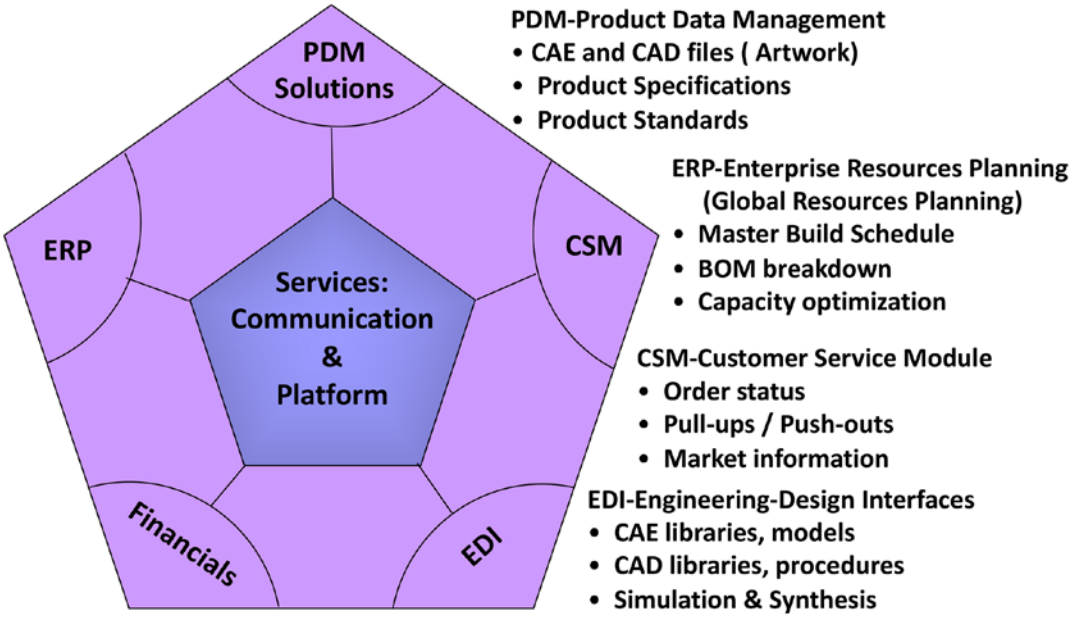


Figure 4: 21st century management platform elements.

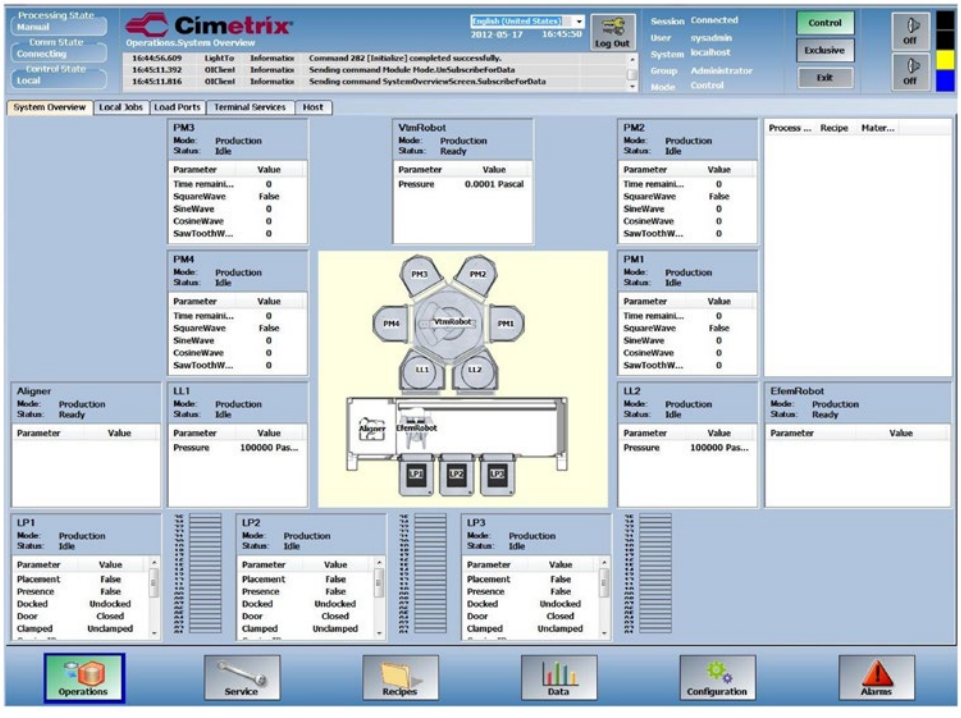
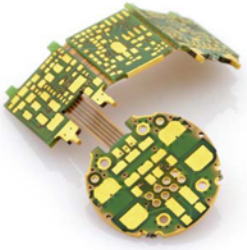


Figure 5: IC management software solution control equipment and processes with the SEMI SECS/GEM protocols. (Source: Cimetrix)

of the management systems assume a part-intensive fabrication or assembly-intensive environment. For PCB fabrication, the usual process intensive model needs to be applied, like those in food preparation or pharmaceutical creations.

For printed circuit fabrication, there is only one remaining management control system still available—APTEAN Cimnet System—but numerous process-focused ERPs are now available for customization (Figure 4). Those PDM/ERP/CSM and process/machine control software for wafer fabrication (ICs) like Cimetrix (Figure 5) are well suited for PCB fabrication as they focus on process capacity, test, and reject problem solutions.

Focused on Flex



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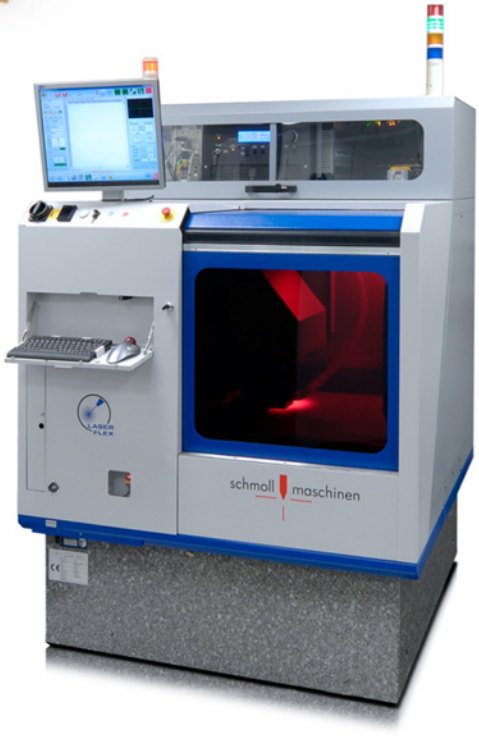

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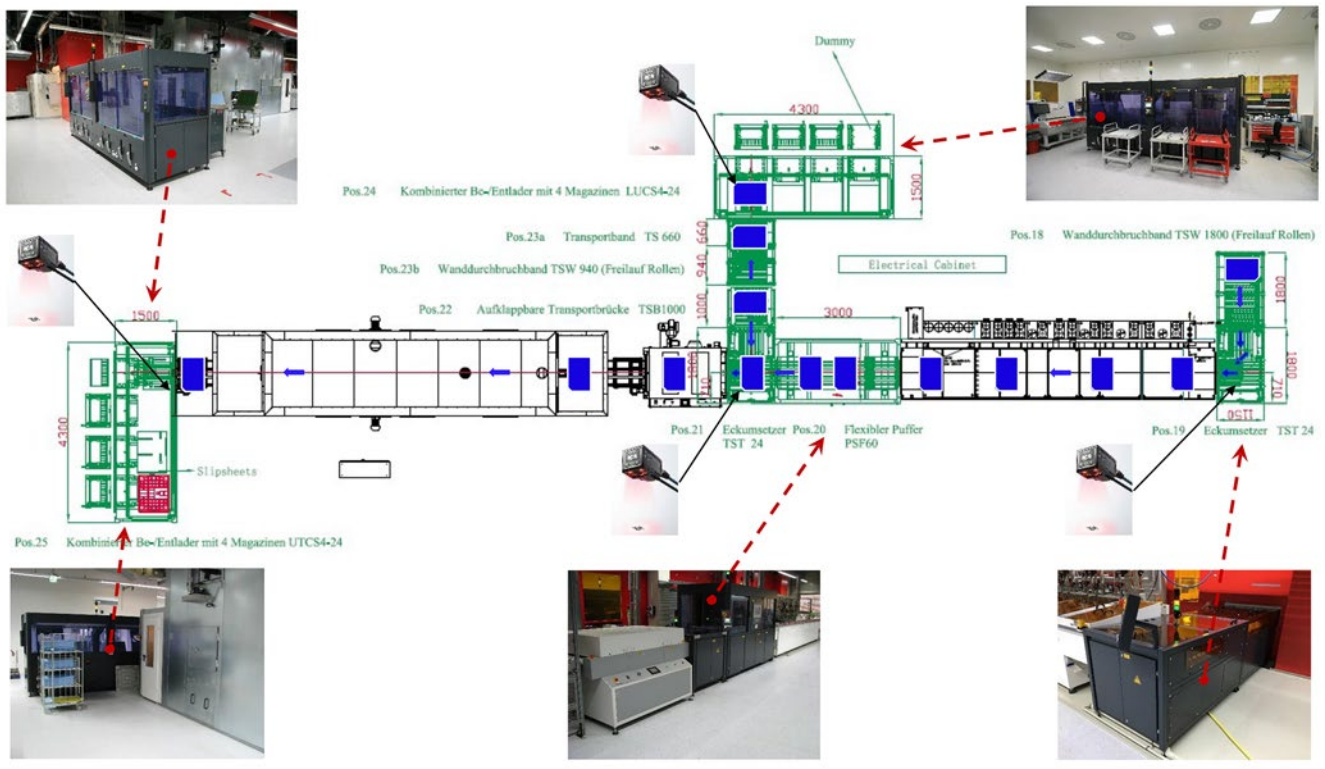

Figure 6: Recently installed bar code driven lot/setup automation for solder mask, hole filling, and legend processes in printed circuit fabrication. (Source: AWP presentation, CPCA Conference, Shanghai, China, Oct. 2018)

Conclusion

To consider all aspects of streamlining the PCB fab process, lead-time, and lot-size reduction, as well as automation strategies, should be employed. Figure 6 shows one of four major automation projects in one PCB facility in Europe that reduced lead time/lot size and costs while improving quality. More examples of move time and queue time with digital recipe set-up time automation can be seen in the PCB007 article about the 2018 CPCA Seminar[6]. PCB007

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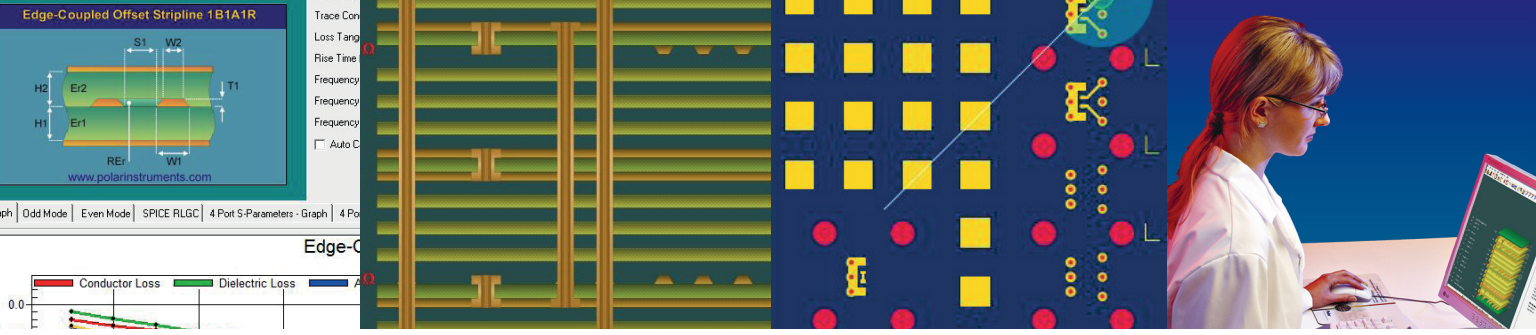
Happy Holden has worked in printed circuit technology since 1970 with Hewlett-Packard, NanYa/Westwood, Merix, Foxconn and Gentex. Happy is the the author of *Automation and Advanced Procedures in PCB Fabrication* and *24 Essential Skills for Engineers.* He is currently a contributing technical editor with I-Connect007.



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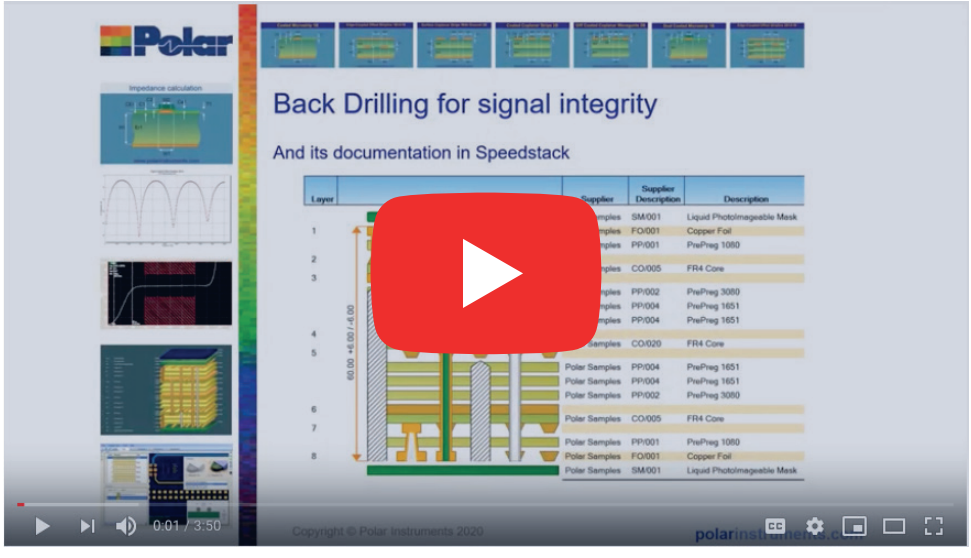

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Sunstone Streamlining the Process

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson speaks with Matt Stevenson of Sunstone about continuous improvement through factory automation and streamlining processes.

Nolan Johnson: Matt, let's start by talking about the automation of your processes. Is it strategic to your business model to streamline your processes, to grow and become more profitable?

Matt Stevenson: One of our key motivations is maintaining the profitability of the business. One of the ongoing points of emphasis is the increased cost of labor. Expenses across the industry continue to rise, but not nearly as rapidly as the costs to attract and retain skilled workers. At Sunstone the people we have are what makes the difference from a quality and leadtime standpoint. Without our people we would be in a far different position. Today, it's not a matter of cutting costs to increase margins, it's almost a matter of cutting costs to maintain margins and remain competitive. Sunstone always has relied on its people, partially because of our processes, and partly due to the experience within the manufacturing team. In the past, our team was almost as good as automation but fast forward 10–15 years, labor costs are going up very rapidly, and I don't see any end in sight. I think as the COVID pandemic sent a flood of people to remote work and essential worker status, work-life balance became a key desirable feature for many workers; manufacturing must continue to be creative to attract the best workers and maintain profitability.

When a manufacturing company—that operates on thin margins to begin with—starts to see its top expense item accelerate, as it has been over the past couple of years, automation and smart factory concepts need to have a

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Matt Stevenson

place in the strategic direction of the company. Automation becomes a big part of maintaining and improving margins, but as everything gets faster, cheaper, denser, and more complex, you also need that repeatability and reproducibility that automation allows to maintain your high quality standards and the product reliability that today's customers are expecting. Streamlining, continuous improvement, and cost reductions on a strategic roadmap make sense for a business like Sunstone today.

Five or 10 years ago, automation was a secondary thought for many of our manufacturing plans and not a frontline strategic plan. Today, we are really seeing the need to elevate these improvement concepts to be included with company-wide strategic initiatives. With planned improvements to our overall capabilities and our manufacturing technology, planning to retrofit some of our current processes and equipment with some more automation and repeatability makes a lot of sense for all those reasons we've talked about.

Johnson: Five years ago, Sunstone had strategic initiatives underway to set the stage for automation. Let's talk about that. What has been done and what results have you seen from them?

Stevenson: Almost five years ago, Sunstone removed its whole MRP skeleton and virtually overnight made it customer-facing by replacing our whole quoting module, pricing modules, ERP system, e-commerce website, and shop floor tracking software with the vision that we would be able to automate not only the quoting and ordering process, but through the front end, CAM engineering, and then into manufacturing to really help streamline that front end process.

It was so successful that we began to take orders that first day without really missing a beat in terms of the process itself. Were there hiccups and bumps? Were there unhappy customers? Yes, but that's all part of the growing pains of replacing an entire system like that. The number one objective at the time was to improve the overall experience for the customers, making it a more straightforward and simplified process as well as providing them new functionality that they had been asking for. A secondary objective was to streamline the entire front end of our process. In the years since then, we've continued to make improvements to the customer-facing portion of the process in support of the first objective, leaving little time to work on the secondary objective and have not automated the processes any more. If we had to do it again, would there be more focus on the streamlining objective? The answer would be a resounding yes.

We do have several programs in development today that are currently in the "proving the concept" and "validation of process" with our IS team that we should start rolling out by the end of this year—which I am excited to see. Some improvements are with our customer-facing site but also laying the groundwork for additional front-end automation. We are going to be jumping into the mobile website world, creating a great customer experience

down to smartphone dimensions. Seven years ago, when we created our current e-commerce platform, we thought, "People are not ever going to use this device (smartphone) for quoting and ordering circuit boards; we can see the need for as small as the tablet format." That turned out to be a shortsighted decision on our part. Now with the cloud and improvements in everything else mobile, you can just as easily use this device as you would with a laptop, tablet, iPad, or whatnot.

We're going to transition our online platform to a much easier-to-consume platform, meeting customers where they are and giving them a great experience with which to do it. We're also developing a program to help automate the front-end quoting portion of the web platform, improving the experience, accuracy, and time required to get your PCB quote. There's enough technology, knowhow, and horsepower with the cloud to allow that level of experience more economically and more accurately than it was ever before.

Johnson: Regarding online quoting, obviously that helps with the skilled labor and bandwidth in the CAM department. Does that improve the customer's experience? Does it give the customer more control?

Stevenson: It will give the designer more control and more accuracy up front. It speeds up their process and it reliably translates their design file into an accurate quote. I think the most benefit comes from the purchaser's standpoint, where they're not the expert on the design and maybe they are requested to input all the parameters of any given circuit board into a quote form and expect to come out with an accurate representation. This allows them to say, "Boom, here you go." You only have a few selections to make decisions at that point. The goal is to speed up their process, increasing the accuracy, hopefully there'll be less discrepancies now between the design files and the order form, allowing more of those orders to go through with less holdup and fewer delays.

Johnson: You put in a new ERP system; tell me about the one you had and then about the one that you moved to.

Stevenson: When I started 15 years ago, we had a rudimentary homegrown set of systems that controlled the manufacturing floor, tooled data and customer data that were, I think, even written in visual basic by our production manager at the time. There were multiple systems and websites, and none really seemed to talk to one another very well internally. It was effective for where we were in terms of sales, but it was not scalable. From a customer standpoint, that was invisible to them, and it was internally where the disconnects occurred. At the end of the day, it was not stable or secure by today's standards.

There were multiple systems and websites, and none really seemed to talk to one another very well internally.

For many reasons, we needed to upgrade that system. We began that process and soon the sunstone.com website came into existence (2006), that combined PCBExpress® and PCBpro® together into one website. We started merging a lot of that into a single set of databases, where things could all logically see each other. Though they were still in separate databases there was at least one overarching point that was able to see and interact with all the databases. It was still homegrown, it was more scalable but not ultimately scalable, and more securely written in a much more modern code base than we had at the beginning.

We had a vision of our website being a single point-of-use quote form rather than multiple quote forms, benefiting the customer because now you don't have to know which of Sunstone's products fits your needs up front. We will tell you what the product turns out to be at the end once you go through the process. Pointing them to a single quote form with all the features available required us, again, to improve our database structure, securities, and shop floor communication to be able to support it all in one place.

We developed a project to really explore everything that was out there off-the-shelf, PCB-specific systems, manufacturing tools, some of the big ones, the SAPs, and the other household name systems. But we had a special set of conditions, just the way we like to manufacture things, aggregating pieces together onto a single manufacturing panel. Most of the off-the-shelf databases, ERP systems, didn't have a good support mechanism for that nuance.

We were pretty limited in our choices, and the choices we did have still required customization. So, we embarked on that project and in January 2017, we were able to take an off-the-shelf ERP system that was highly customized, and integrate that with our new e-commerce website, pricing, and quoting, connected with all the APIs and web services, and launch that to the public.

It's been a stable system for us overall. The learning curve out of the gate was pretty high. We had a lot of additional customization and improvements that needed to be done over those first six months of service. It has been a good product for us and has allowed us to be out there in front of our customers with an e-commerce model that Sunstone has been known for over the years; it supports that part of our business effectively. Is it perfect? No. Does it have limitations? Yes. Is it going out and needing an upgrade? Yes.

Johnson: Do you feel that Sunstone has achieved a complete return on investment for that software? Has it paid for itself?

Stevenson: That is a difficult question to definitively answer. On one hand, I have a hard time seeing a true return in absolute dollars, but on the other hand, I think we can make a pretty strong case that, overall, we did benefit from undergoing this extensive process. The benefits to our customers through the consolidation of quote forms, databases, scalability, security, and the projects that it's made easier since its implementation in terms of cost and increase to the ROIs on those projects where they wouldn't have either been possible or profitable to do under the old scenario.

Johnson: I guess a comparison might be to ask if it would have been cheaper to continue to roll out your own and just pay software developers to write software specifically for you. Would that have been cheaper?

Stevenson: That was exactly the mode we were in prior to this project, and we made the conscious decision to pivot and go off the shelf, but looking back on it today, we may have saved a few dollars and gray hairs had we chosen to stay the course with the path we were on.

Johnson: Oh, really?

Stevenson: There were several factors at the time that really pushed that decision forward:

growth in the business, security, customer feedback, and continued long term support of vital systems. Had we continued to grow at the near exponential rate that we were prior to 2017, it would have been a home run decision, but now that we are in 2021 where the market growth rate has slowed, COVID happened, and the changes to the competitive landscape ... looking back on it, we might have made a different decision.

Johnson: Let's pivot into going forward. Does this system that you're using now do an adequate job as a platform you can extend?

Stevenson: Yes. Very much so. It's very easy. It's just a matter of having the appropriate tables in the database, adding the correct columns and the quoting, and updating the front-end system and the backend system to support it. Yes, it does a very good job where our old systems probably would have been a lot more challenging to make even small changes.

Johnson: Right. The value you're buying then is a much longer growth path. You were saying earlier that streamlining processes has become a first order strategic plan for you. What's the most important criteria to streamline right now?

Stevenson: In terms of streamlining, continuing to focus efforts on our front-end processes through CAM and tooling is our number one opportunity. Between our customer service team and our CAM team, we have many highly skilled, highly paid employees that we are not able to utilize fully. The streamlining of processes involves removing some of their daily menial tasks that are perfect for scripting and automation, freeing up time and allowing them to do what they do best. I mentioned earlier some of the website projects that we have going on to benefit both groups. Additionally, we can add functionality to the tools that we have, remove the menial tasks that aren't adding any value or benefit to those roles and get them just doing what they're really good at: serving our customers and building high quality PCBs.

In addition, on the manufacturing floor, we've added digital technology, LDIs, printers for legend printing, AOIs for inspection, and probe testers for electrical test to automate as much of that as can be done without the intermediate use of tools, films, and fixtures that eat the value and quality out of those processes.

We are digitizing and automating those types of processes as well as looking at equipment, where the footprint allows, for potential loading and unloading of product, allowing operators to do more value-added inspection, real time, so they can improve their process as they're manufacturing product. Again, it's taking out some of the menial tasks that don't add any value and replacing them with value-added tasks. On our manufacturing floor, we don't have a lot of extra space available and many of those loaders and unloaders take up a lot of floor space. It's a fun process though, figuring out the right technology, the right capability, and the best improvements that need finding and implementing a solution.

Johnson: Files submitted by customers can affect processes. What is Sunstone's take on Gerber vs. IPC-2581 vs. ODB++? Do you accept them all? Do the new ones help you streamline your process?

Stevenson: That's a great question. Basically, the processes in CAM take data from hundreds of different design programs and standardizes them to a single format to be used in manufacturing. The people on the floor don't feel the impact from different data types because it has been output in the formats needed for each department.

The people on the floor don't feel the impact from different data types because it has been output in the formats needed for each department.

A year ago, we would have said we prefer to only receive files in Gerber 274X format, but we have been seeing more and more customers moving to ODB++ data and with recent CAM software upgrades are in a better position to handle either type. All our automation is set up to use Gerber format for outputs, but our CAM team have gotten more familiar with ODB++ and in some cases are coming to prefer using it for the import of data. Some of the features that they have come to like are that the stackup is built in, preventing orders from going on hold for layer order requirements. Another is the hole sizes and plating requirements are available—again preventing holds asking whether holes are plated. From a CAM standpoint, though, Gerber has been around for a long time and has performed exceedingly well. There is a reason it has withstood the test of time. ODB++ has some great features, though, so we are quite happy to receive either one of those from customer.

A year ago, based on where we were from a CAM tooling software timeline, I would have said that we only want Gerber files. That's the only thing our process is set up to take and that's where the automation is at its best. Now we have upgraded much of our CAM software, especially on the automated side this year, and the ODB++ files have gained a lot of acceptance from our CAM team to the point where, though our automation may not be any better for it, the toolers feel better when they're able to import the ODB++ formats as opposed to the Gerber. They feel they get a better result, that they have a better look at the design using the ODB++ data as opposed to solely Gerber data.

Johnson: Okay. Can you go a little bit deeper into that?

Stevenson: There are a couple reasons for this. First, we're being pulled by the assembly houses a little bit, pick-and-place machines from a variety of different customers of ours that utilize the circuit boards; they find much more benefit to being able to take the ODB++ data. It really speeds up their programming in the pick-and-place machines. They are hungry to get that type of smart data ODB++ and I'm guessing the IPC-2581 as well, having a broader look at the design from components, footprints, and everything on the scenes, as well as the physical layout, pad size, apertures, etc., to make it more economical on their end. They're pulling from that end. Designers are seeing that and are pushing it from their end.

In the past, we were caught in the middle. We standardized on Gerbers and that's what we like but now we have more software tools at our disposal that are able to give us maybe not quite the view of the data as from assembly, but it is much more complete and actually comes through our automation with good results. Actually, the results may be even better than the Gerber files because there are so many different naming conventions with Gerber files for layer 1, layer 2, layer N, where with the ODB++ being more standardized brings it in, does a much better job of pulling what is

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necessary, omitting what is not, and really getting things in the right layer stack better than we've ever had before.

Johnson: And that gives the CAM team some confidence in what happens for the automation then?

Stevenson: Exactly. Getting to a point where they are not only comfortable but prefer that data type, will be good on the front-end side. Right now, we use them interchangeably, but as time goes on, if you've got the ODB++, we will gladly take that. It's fewer orders on hold, fewer questions, fewer delays in the cycle, and more benefit for the customer.

Johnson: We conducted a survey regarding data formats and packages, asking why they prefer using Gerber. The feedback indicated it is because that's what the fab tells the customer they need.

Stevenson: Yeah. And you know why? Because that's the way we've always done it.

Johnson: One of the forces pushing assemblers to use ODB++ or IPC-2581 is the smart factory. Then, there is the adoption of CFX, etc., to help the assembly process and the machinery up and down that line communicate with each other. Is it fair to say that you're starting to be called upon to feed that digital factory?

Stevenson: Yes.

Johnson: Does that push you to become a digital factory as well?

Stevenson: It does help open a conduit to becoming a better digital factory because, at least from a Sunstone standpoint, the equipment isn't all interconnected with software. Each process is on its own. Some of it is very mechanical and not necessarily digitized, if you will, but could it be? Yes. Having a data format that might flow better through a manufacturing facility opens that conduit.

Johnson: Not only are you passing the information along in your ERP process from gate to gate, but you're also passing along information that helps keep the fab steps within established process windows at the equipment level.

Stevenson: Exactly.

Johnson: Is gate-to-gate communication on your roadmap going forward?

Stevenson: Not in the next couple of years. We have several other high ticket/high com-

plexity projects ahead of that. Once we get to a place where we're stable within those product additions, I believe that a big data-driven project is a viable possibility.

Johnson: It sounds like managing the skilled labor resource pool is a higher priority than big data.

Stevenson: Yes. It's managing the labor pool, as well as increasing our technology from a customer driven standpoint, being more viable for an onshore domestic manufacturer, really upping our technology so that we're not competing with as much of the offshore bargain basement, price pressure, product, and still get margins on the product that we are building with even better margins, hopefully. That's our short-term strategy.

Johnson: Matt, how would you characterize Sunstone's market niche nowadays?

Stevenson: We are still very similarly niched to where we were five years ago. We are still known for short lead times and high quality on the work in our sweet spot. Despite increasing our technology and capabilities considerably over the past decade, it is difficult to change the customer mindset for such a well-established set of strengths. If you look at the data behind our product mix over that time, it's a relatively unchanged big picture. You do see tendrils of it moving up the higher layer counts, higher copper weights, smaller holes, etc., but not at the same rate as the adoption of these features in the market. We want to continue to grow the higher technology portion of our product lines and become less reliant on the PCBExpress® of yesteryear, 6-mil tracing space and 0.062" thickness and one ounce copper. That end of technology is where the most pricing pressure comes and conversely the lowest margins. It's still very successful for us and we are still very adept at making it. We can do it with our eyes closed but we want to keep our eyes open and keep moving forward with technology while knowing that this eventually will go away. It's going to dwindle. It's going to go offshore. It's going to go to those who can't improve their technology or don't want to.

We can do it with our eyes closed but we want to keep our eyes open and keep moving forward with technology while knowing that this eventually will go away.

Johnson: Do you have any words of advice for your colleagues in the PCB fabrication business?

Stevenson: I don't think it's very original, but you've got to keep moving forward. Otherwise, you're going to fall behind. You've got to be moving forward at a brisk pace. You can't just meander that way. Things are changing so rapidly—technology, software, with the consolidation of parts and chips and everything that's been going on—being flexible and moving forward must be where you're going. Otherwise, you will get buried by the market.

Johnson: Or bought.

Stevenson: Exactly.

Johnson: For cheap.

Stevenson: Right. And probably put out of business.

Johnson: Thanks, Matt. PCB007

Making Process Decisions in a Greenfield

Feature Article by Jessi Hall
SCHWEITZER ENGINEERING LABORATORIES

This spring, Schweitzer Engineering Laboratories (SEL) broke ground on a 160,000 square foot printed circuit board (PCB) manufacturing facility in Moscow, Idaho. The project is especially exciting because we started, quite literally, with a green field that sits on 150 acres in one of the most productive agricultural regions in the world—the Palouse.

The facility is being designed specifically for the high volume, low complexity mix of boards that go into SEL products, which protect, monitor, and control electric power grids and systems around the world. It is also being designed to be one of the cleanest PCB factories in the world.

Currently the SEL property team is hard at work on the construction of the building. Footings are complete, and the floor is in process of being poured. Our next major milestone is tipping up walls in September, followed by installing the roof in December. We expect to start moving in equipment in June 2022, and run our first production PCBs in January 2023.

As the SEL property team is constructing the facility, our manufacturing team is continuing to learn about PCB manufacturing and developing plans for the factory processes, equipment, chemistry, and factory layout.

While SEL is new to manufacturing PCBs, we have more than 35 years of experience in manufacturing. In addition to assembling our own PCBs and building completed units, we also manufacture many of the critical components used in our products and solutions, such as transformers and plastics. We are leaning on this experience to guide us through the multitude of decisions required for this greenfield build and for the PCB building process, and are following the same philosophy and priorities we embrace throughout our manufacturing division: Don't make process optimization the sole focus, instead prioritize—safety, quality, and lead time, in that order.

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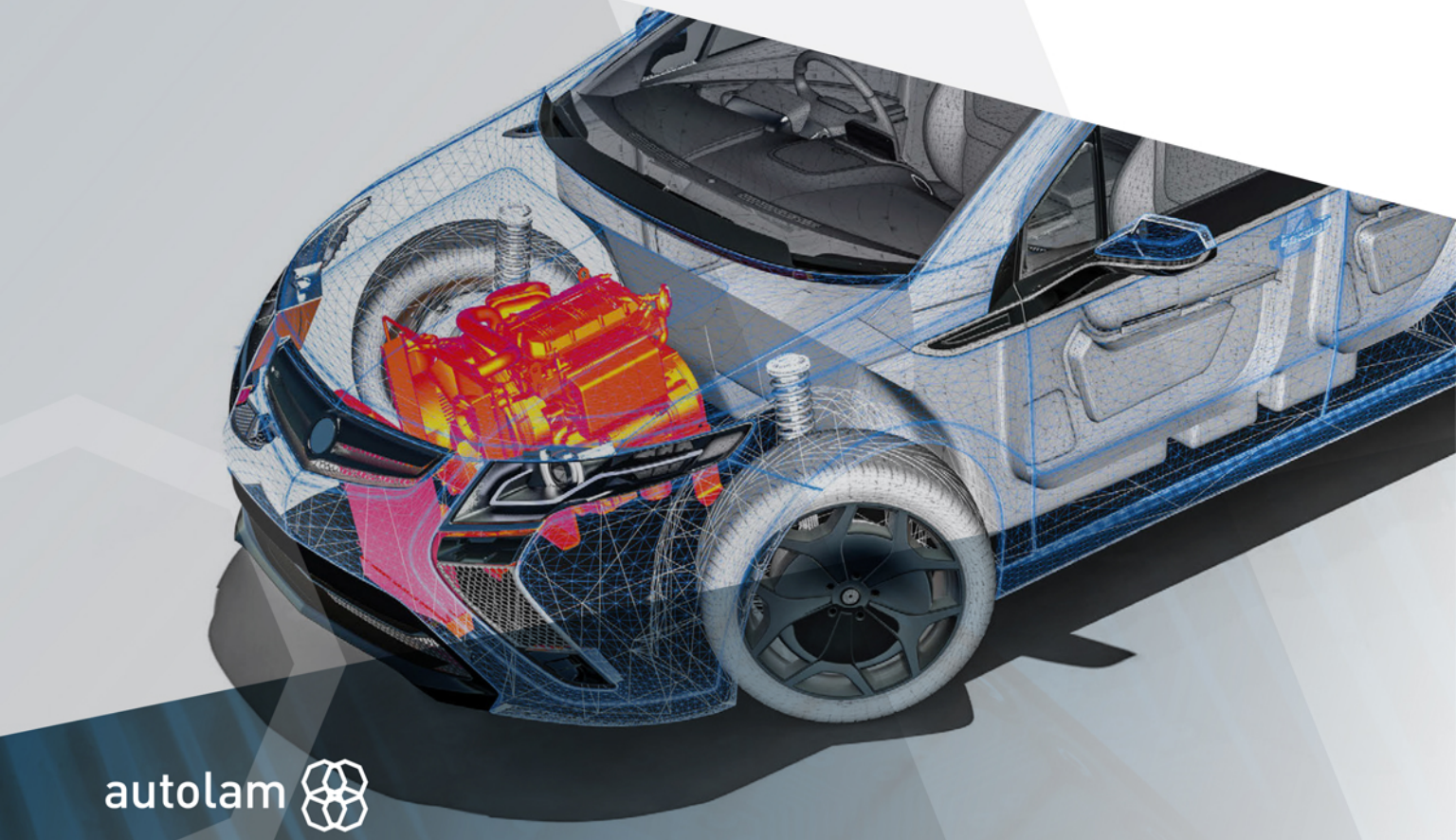

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Automotive electronics technologies are evolving at an increasing rate. Paying attention to the properties of materials at the substrate level is the first step towards achieving the most stringent performance targets of today's automotive manufacturers.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

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Construction crews working all hours to lay the pad for the new SEL board fabrication facility.

For example, when we originally discussed the processes and equipment for the layup room, we envisioned a manual process where employees would select the material and put together the PCBs and books. This is a common approach in the industry, particularly in the United States. After learning more about automation options, we decided to pursue a higher degree of automation in this area to improve quality by having material presented to employees to reduce the likelihood for errors.

Similarly, we determined we can improve ergonomics for our employees by automating the book building process and eliminating the need for them to maneuver heavy steel plates multiple times throughout the day—not only resulting in a process that is safer but also more consistent in terms of quality.

With our highly automated operation, we will have very little need for employees to move material throughout the processes and this will likely result in needing fewer employees to manage the process. However, we are choosing this approach because of our focus on quality. Experience has shown us that handling damage by people is one of the top defects throughout the manufacturing process. By automating the material handling, we will significantly reduce the likelihood of this type of damage.

In addition to our manufacturing priorities, the principles of world class manufacturing (WCM) are also an important focus for us and are influencing many of our decisions related to equipment selection and material flow.

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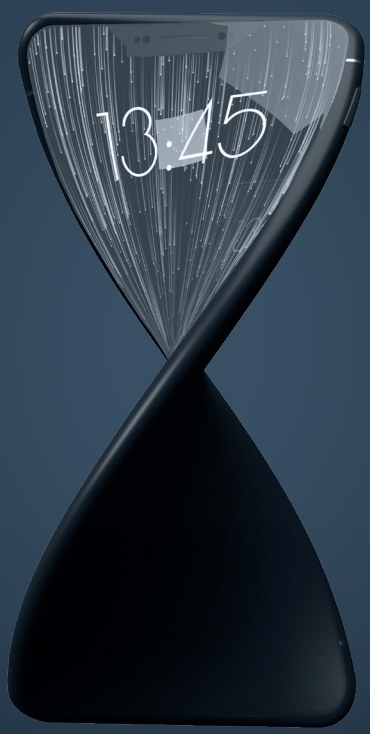
A new angle on bending performance – Optimal bending solutions for flex substrates



Today's technology combines fast-paced innovation with a commitment to more sustainability, performance, and comfort. For the PCB industry, it also comes with challenges, like meeting the changing requirements that new technological gadgets bring with them. To allow substrates to achieve market-leading bending performance, Atotech has developed two new processes: **Aurotech® Flex** and **Stanna®-Flex**. Both offer optimal efficiency while reducing chemical waste and easing the process flow. Aurotech® Flex is a bendable mid-phosphorus nickel finish for the plating of ENIG and ENEPIG. Stanna®-Flex is an immersion tin plating solution specifically designed for chip on film applications and fine structures. As two highly effective solutions, each one offers best bending performance for all kinds of flexible substrates.

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Architect's rendering of the new facility.

For our drilling and routing operations, we have decided to specify equipment with single drill heads. While the overall investment will likely be higher than if we chose multi-headed drill machines, this option aligns better with WCM principles. With the single-head machines, we have more redundancy in case of an equipment malfunction. Additionally, we can scale up our capacity in smaller increments with less investment and have greater flexibility if we need to move equipment. One other benefit to selecting single-head machines is that they align better with our goal of single-piece flow.

These decisions are all part of a discovery process where we're combining what we are learning with our own experience and priorities. We've had opportunities to tour many PCB manufacturing operations to see how others are building boards and to observe their processes in action. We are also learning from our suppliers who have provided training, opportunities for hands-on experience with equipment, and shared invaluable information and advice. We've been delighted by the generosity of the industry and look forward to being a part of it. **PCB007**

Jessi Hall is senior director of Vertical Integration at SEL.

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Altium's Nexar Platform Unites Design, Supply Chain and Manufacturing

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team recently spoke with Ted Pawela, chief ecosystem officer and head of the Nexar business unit at Altium. Part one of this interview was published in the Design007 Newsletter, and can be read here. In this portion of the conversation, Pawela answers questions on how this environment may streamline the process of transferring design data from OEM to fabricator.

Nolan Johnson: Ted, how do you see this Nexar environment improving market competition, helping participants become more competitive?

Ted Pawela: I think the competitive advantage is ultimately being able to provide more transparency and certainty to end-customers. We hear all the time that usually once they get the quote, other than any kind of technical queries or questions, they go back and forth multiple times with questions of all nature: What is the status of that board? Do you have everything on the bill of materials yet? Have you started fab yet? Where is it? Am I going to get it on the date you said originally?

We're trying to make it a more Uber-like experience. When I call Uber, I can see everything on my phone. When is the driver getting here? Where is he? We want to replicate that for the manufacturing floor. You will literally see where your board is in that overall fabrication or assembly process. Am I at step one of five, or step four of five? How long is the next one going to take? If there are any exceptions that have taken place, I want to know about it as soon as possible and see what's happening.

Johnson: You've now captured the design data from all the CAD tools in a cloud-based schema system. We've already discussed how that starts to remove file transfer steps. Is it fair to say that this architecture is sidestepping file formats entirely? Are you taking file formats out of the mix?

Pawela: In my mind's eye, that's absolutely the goal. What I've learned through the last year of working deeply with this is that fabs and contract manufacturers also have all kinds of equipment and systems, and EMS companies who are all set up to work with Gerber or IPC-2581 or ODB++. It's not a simple job to suddenly say, "You don't need to use that anymore." It's a change in process for them, so this

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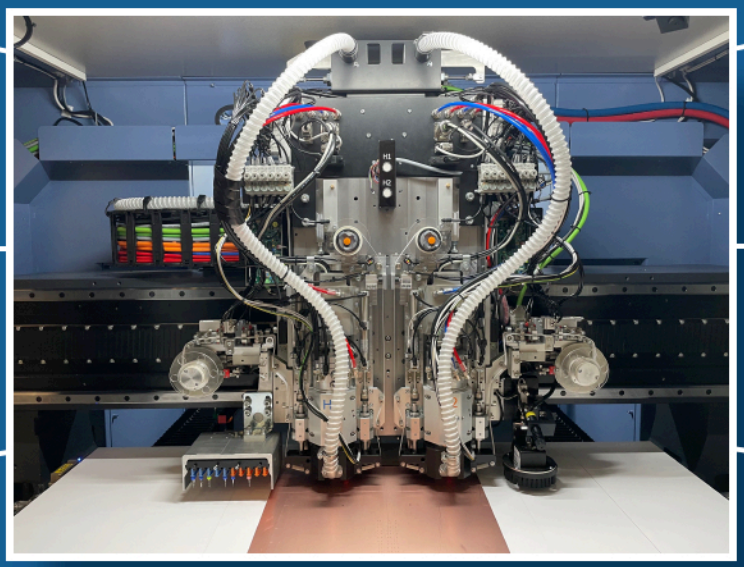

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Ted Pawela

is something that over the long-term we hope to make happen. In the short term, it's pretty difficult to eliminate it entirely, but I think there are certain things that could be done a lot better without file translation. It doesn't require them to change out all their systems and infrastructure and so forth.

Johnson: Then there's the other dynamic, where the fab gets the files, which they analyze and perhaps they make some tweaks and adjustments. They fix some acid traps and make it manufacturable, and what they actually build is not exactly what was sent by the customer. There's often an open loop in that backend annotation. Does the Nexar environment help resolve that?

Pawela: Yes. Actually, I'm really glad that you brought that up because I think that's another creative issue for us. Let's say you build some prototypes, and then a year later, you say, "I'm going to go to some level of production." Then you often find that you're possibly giving a different manufacturer a version of the design to build that's not actually what was built before. That's exactly the problem that you've highlighted.

We think having that metadata model underneath it, that represents the PCB in the schema as you said, will eliminate that as much as possible. We can keep that synchronized so that the design golden record always stays current with all the changes that take place, whether it was from changes that took place because my procurement people made a swap in a component that was unobtainable at the time.

Johnson: When I go to production, I don't want to go with the original data; I want the production house to be able to see what the prototype house did, because I want to duplicate my working approved prototype exactly.

Pawela: Yes. That's exactly right. This is one of the things that Nexar would enable and it's a problem that we're targeting to solve.

Johnson: How do you handle cybersecurity? Our industry includes ITAR, defense-related restrictions, and security issues. Will Nexar be secure enough to allow companies to get their qualifications?

Pawela: That's something we are actively working on with our cloud hosting partner, Amazon Web Services. A couple of things I would like to say about that. One, if anybody tells you that they're absolutely secure, impenetrable, and there's no risk with respect to cybersecurity, they're either ignorant or lying. It's just not possible. There are new threats all the time, and the unspoken thing is that often the biggest security issues are elated to people—the guy who sticks a USB stick into the computer and takes it home or leaves it on the bus, or whatever it might be. We've found, even internally, as we go through cybersecurity audits, it usually turns out that our own people and their behaviors are one of, if not the biggest, risk area.

However, there are many things that we can do. Amazon works with us to make sure that

the information we're hosting is secure. They have two versions: the standard Amazon cloud, and GovCloud, which is set up to meet ITAR requirements. Altium 365 and Nexar, that double-sided cloud platform, can run on either the standard Amazon cloud, which is quite secure, as well as the GovCloud that is generally acceptable in ITAR environments.

Johnson: How welcoming is Altium 365 and Nexar to other PCB design tools? Is this something where some of the other PCB design tool players can plug in and play?

Pawela: Actually, we would love for that to happen. For example, just last week we put out a press release about our partnership with Sintecs, a company in the Netherlands that is a HyperLynx reseller for Mentor.

Sintecs has built an integration with us on the Nexar platform to help Altium Designer and HyperLynx work together more seamlessly through that API access rather than the file exchange. That's the kind of thing that people would raise their eyebrows and ask, "Why would you want your competitor's tools to go into the hands of your customers?" But it's exactly for what you're saying: We are trying to build an ecosystem, and we recognize that we don't have all the capabilities that we need in order to support this end-to-end process from design through manufacturing. Sometimes our competitors have those things, and we want to invite them to bring their PADS, Allegro, Xpedition, KiCAD, or EAGLE files and be able to work with them in the same way they can with Altium Designer.

The reality is that for many—if not most—of our customers, their CAD environment is heterogeneous. They have some of ours, they have

some of theirs, and it's really important to allow them to be able to have multiple people work in the tool that they feel comfortable with.

Johnson: It feels like there's a shift here. I'm oversimplifying, but it feels like you're creating an industry-specific operating system within which the applications play. You used to develop apps; now you've created an operating system from design through to manufacturing.

Pawela: I think you're absolutely spot on. That's the transition that we're undergoing as a company. Look, we think we're pretty darn good in the CAD side of things, but our future and our aspiration is to be more than CAD. We know that's about solving problems for customers. That's what we've been talking about, and it requires an operating system for the industry, if you will. We hope to make it as open as we can; we hope we can draw everybody in from our competitors on the CAD side, to equipment manufacturers, to the fabricators and contract manufacturers, and everybody involved in that ecosystem.

Johnson: Back when the industry was driven by the application, and the CAD tool companies were at the fore, the CAD tool folks knew where their bread was buttered: it was the engineers who were buying the software licenses. Spending R&D money to put together channels to make manufacturing easier was not a money-maker. Manufacturers didn't have a way to buy in to become a customer, if you will. You have finally changed that, it seems.

Pawela: I want to be a little cautious not to overstate where we are today. Our goal is to change that, and we're taking the first small steps to make that possible. We're also trying to involve those stakeholders in a way that we're architecting this. Working with MacroFab, as an example, gives us the opportunity to see things through their lens and for them to provide us feedback, "No, design guys, you don't get the fact that something else happens over here in our world. These are the things we have to deal with, and you can't forget about those or what you're doing will not be relevant." Everybody has different needs and we're trying to open it up, to make it feasible for them, and take their feedback so that it's valuable to them as well.

Andy Shaughnessy: Can distributors who are competitors of Octopart join as a partner?

Pawela: Actually, component distributors are not competitors to Octopart but are really customers. Octopart doesn't sell anything, to be clear. It's just aggregating the information, and customers can purchase from Digi-Key, from Arrow, etc. They're in a business relationship together. But distributors are another set of stakeholders who we are trying to work within this ecosystem. It's interesting because often the distributors and component manufacturers are highly interested in what I would call intelligence about what people are designing and manufacturing. They can see that these are the components that sell the most or the chips that sell the most.

But what would be highly valuable to them is to get a sense of what people are designing for next year or six months, or three months from now. And what things are people searching on? Where are their interests? Component distributors are all highly interested, and we want to make that available to them in ways that don't compromise IP security.

Johnson: The semiconductor companies used to get that from their direct sales force, which now they no longer have.

Pawela: They can't continue to scale. There's not enough margin in the business to have armies of salespeople out there doing that reconnaissance. In fact, the information is there in CAD tools and the bill of materials; it's just a matter of whether you can aggregate it and put it together in ways that tell the tale of what's really happening.

Johnson: If I were CEO of a fabricator, I would ask you, "Can we get information from Nexar on just exactly what designers are ordering

for fab services? Can I get some understanding of who's building what? Is eight-layer blowing up? Do I need to be looking at different capabilities? What are the market trends?" You can feed that back, not just to the parts suppliers, but to the fabricators as well.

Pawela: That's right. That is something that we want to be able to do. To be clear, we're not doing that today, but it's a common request we are hearing from fabricators, distributors, and component manufacturers. Like you said, they don't need to know what a specific customer is doing. They just want to know what companies are making more of. Is it high speed or high density? Do these tend to be eight-layer boards or 16-layers? What are the most common layer stackups that people are building?

Johnson: You have an opportunity to add value to each participant in their own way.

Pawela: I think about that a lot. As often as they'll let me say it, this must become a destination that people want because it is valuable to them. It's valuable because it's better than what they use today, and it's different if you're a designer, a fabricator, a distributor, or anybody else. Everyone has different needs and we've got to make it valuable for each of them in their own way.

A procurement guy doesn't want to have to go into Altium Designer and use that tool; they just want to be able to see the bill of materials, for example. They want to be able to communicate about that BOM and make sure that what they're communicating is acknowledged by the designer and incorporated into their design. Meanwhile, a fabricator is interested in something else and frankly, they don't want to go into Altium Designer either. They might use a different set of tools like their CAM tools.

Johnson: It's savvy to make it a separate business unit. That allows the Nexar business unit to think industry-wide, to think operating system thoughts, and not be limited to the CAD tools sandbox.

Pawela: Yes, absolutely. That is important because, realistically, for the people now focused on those CAD tools, it's their job to make that the predominant solution in the industry. But if I take that viewpoint, I'm never going to build an ecosystem. I have to be able to think differently and operate independently to support their mission; that's exactly why we did that and how it's working today. But I do get questions from the CAD team saying, "Why would you work with...?" I mention Sintecs and HyperLynx and they say, quite logically, "Why would you do that? We compete with those guys." Well, that's what building an ecosystem is all about.

Johnson: Gerry Langeler, an EDA industry pioneer, used to say, "Once you have the customer by the database, their hearts, minds, and wallets will follow," as a core value in the business

model back in the industry's infancy. Is it time for that mindset to change?

Pawela: I think that it's very common, maybe even a dominant way of thinking in software technology and software as an industry. We think about creating this opportunity for vendor lock-in and so forth. My philosophy is that the way to win is not by creating the equivalent of trade barriers and closed systems. The way to win is to out-innovate your competition. When you follow the lock-in philosophy, your customers ultimately end up resenting you. They say, "You've locked me in, and now I'm stuck."

I personally believe, and as a member of Altium's executive team, to win in the market, we must innovate, not lock people in. I'm not personally taking credit for this, either; this idea is shared by our executive team and our board.

Shaughnessy: Ted, can you update us on the co-designer capabilities? What's been happening on that front? Does that work on the 365 side or on the Nexar side?

Pawela: Co-design is a way for the PCB designers to communicate with mechanical designers to make sure that their designs are going to fit properly with the rest of the product that's being made. Co-design is built using Nexar and the API, but it is exposed to users through Altium 365. That's the idea. There's one cloud platform, and users come into it through that lens of 365. When they use 365, they're leveraging Nexar.

Shaughnessy: Thanks, Ted. This has been very informative.

Pawela: Thank you. PCB007

Streamlining the DFM Process: Design Data Transfer Formats

Feature Article by the I-Connect007 Research Team

Over the past year, there have been some developments in design data transfer formats with updates to Gerber and IPC-2581. We started getting curious about the data format landscape: With ODB++ and IPC-2581 hot on its heels, is Gerber still used for most PCB designs?

To learn more, we asked our readers. *Design007 Magazine* conducted a research survey about design data transfer formats. The responses from that survey also shed some interesting light on potential areas to streamline in the file import and CAM engineering portions of board fabrication. We bring you some highlights from that survey here.

The Responses

There is more information in the survey than we are publishing here; we'll be bringing readers more detailed information in a future issue of *Design007 Magazine*. For now, we'll focus on the survey questions that highlight process streamlining opportunities.

In one question, we asked designers, "If you were to switch design data formats, or have recently switched, what would be the most important reason to do so?" The answer was quite clear (Figure 1).

A simpler process than currently in use is very compelling to respondents. Interestingly, all "other" responses boil down to the same answer: "Fabricator required a new data format."

From a fabricator's perspective, this is insightful, in that the fabricator is likely to get

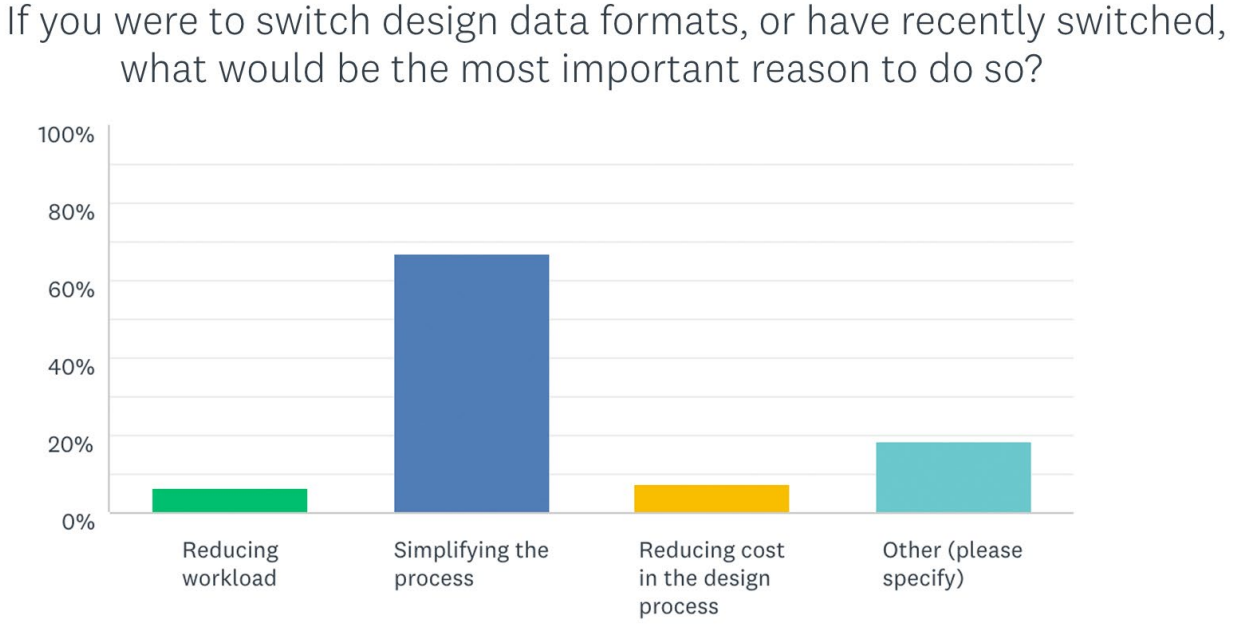

Figure 1.

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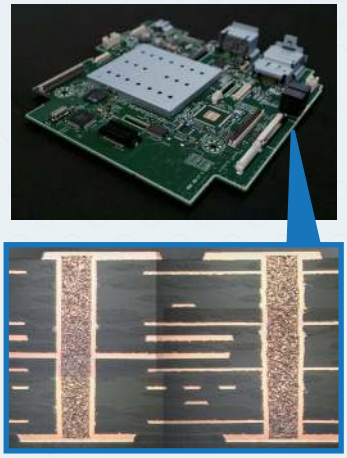

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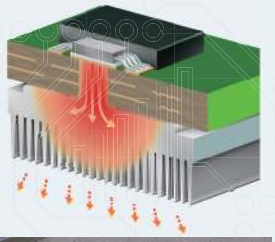

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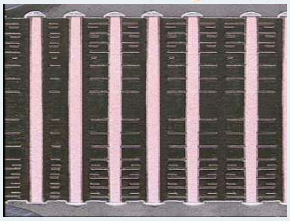

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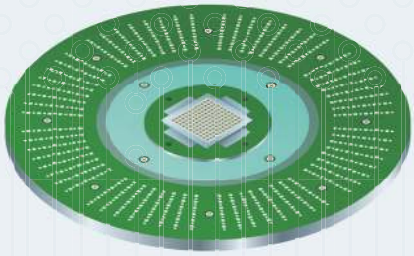
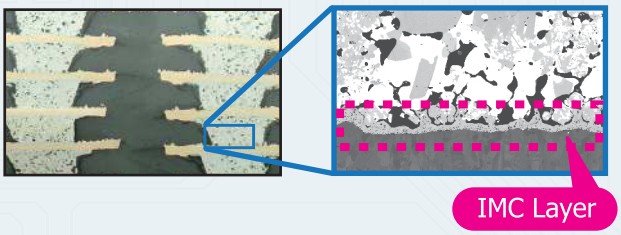


MP Series forming IMC layer



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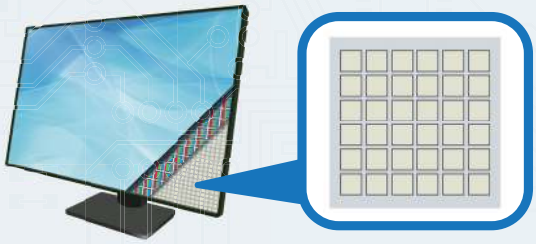
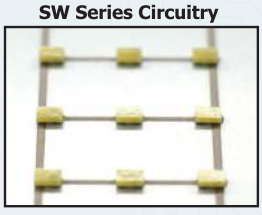
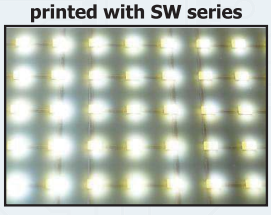


LED lights connected by SW Series Circuitry



LED powered by circuits printed with SW series



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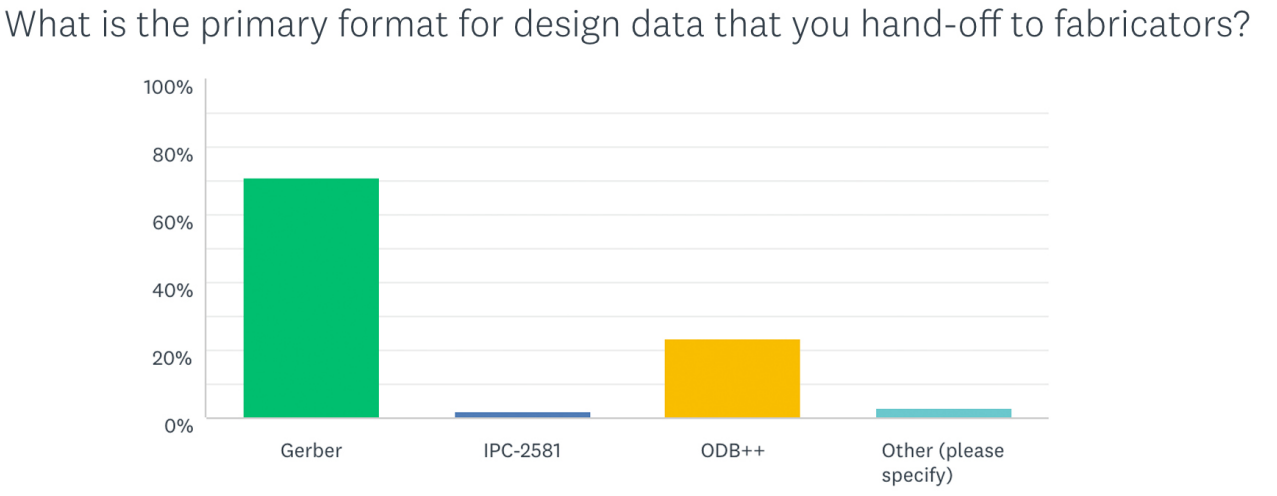

Figure 2.

whatever file format they ask for from a customer, as long as the process is simpler than the current process. Make it easier for your customers, and they'll follow the path of least resistance.

We also asked, "What is the primary format for design data that you hand off to fabricators?" Gerber was the leader of the pack, by far (Figure 2).

In other research conducted outside this survey, we found that—while functional and reliable—Gerber's multi-file format, and an involved process to generate the file set, were commonly mentioned as challenges by users. Yet, for all the talk about the newer "intelligent" data formats, and their simpler interface, the 50-year-old Gerber file format continues to dominate. This begs the question: Are customers enforcing the Gerber status quo, or are the fabricators?

As an aside, it is interesting to note that while the "other" responses are a very small percentage, films are overwhelmingly represented. This is quite a reminder that old methods sometimes die hard indeed.

When we went deeper into the topic and asked what the greatest challenges are facing designers when preparing design data for handoff to fabrication, respondents overwhelmingly cited these issues:

- Preserving data integrity: 24%
- Seamless data transfer: 23%
- Notes and documentation: 17%
- Complex file set management: 15%

These responses account for 79% of all challenges identified. Not only that, but all four categories can be further grouped as "Managing the Data Package."

"Manufacturer Request," at 8%, was the next category of significance, with 12% or so miscellaneous responses.

That users even have these topics on their mind suggests that the data package creation process, as it exists today, is error-prone and difficult. It is our opinion, for example, that, if we were to ask this question of PDF file format users sending documents to the printer, that none of these concerns would even show up in the survey results. A well-crafted export and production process eliminates these worries, as PDF document printing shows. There is, therefore, still room to improve designer/OEM experiences with design data transfer to manufacturing.

What Does It All Mean?

What we conclude from these responses is that designers find the process of preparing all the files for transfer to be onerous, difficult, and error prone. The easier the fabricator can make the transfer of not only the files but the design intent, the better in the eyes of the OEM customer. This is to the extent that fabricators can steer customers toward formats that are easy and reliable for the design team, as well as efficient for the fabrication CAM teams.

And despite all the developments in ODB++ and IPC-2581, Gerber continues to be the primary choice for most PCB designers. Gerber shows no signs of coasting into a well-earned retirement. **PCB007**

Additive Reality: Printhead Selection or 'Shop 'Til You Drop'

By Dr. Luca Gautero
SÜSS MICROTEC


Dr. Luca Gautero

The age of internet shopping released us from the hassle of moving ourselves from shop to shop to obtain the best deal on the most suitable product, which has resulted in an improvement to our quality of life. Still, such alleviation comes at a cost: dealing with almost perfect qualitative comparisons. Such comparison can be objective and final; thus, it should be easy to get it right the first time. Still, we are left to judge what is good enough and what is better than good enough.

If inkjet tools could be found on an e-commerce site, fitting nicely into the category of "industrial and scientific, and a subsection of "additive manufacturing products," aside from dimensions and weight, there would be several product specifications of which many would specify the jetting properties; these would basically detail the printhead(s) in the system. The knowledge needed for the right selection is how these specifications relate to the application at hand (for example, solder mask).

In my opinion, these are the most important properties of a printhead (PH):

- Native resolution, also known as nozzle per inch (NPI)
- Max frequency and driving voltage
- Minimum drop volume (assuming multidrop capabilities)
- Design for arraying, amount of nozzles and positioning compensation mechanism
- Heating and ink recirculation

In the following, each of these properties will be addressed and discussed. They will include a short note on the dot per inch (DPI) unit, which is the common printing resolution unit. An image as a 2D object needs two resolutions. Both dimensions often share the same resolution, therefore only one is present. Inkjet printing identifies and implements the two resolutions (even when equal in value) in a different way: the cross-scan resolution is a combination of NPI and small steps movements. Its orthogonal equivalent, the in-scan resolution, imposes the relation between speed and jetting frequency.

A solder mask print benefits from printing resolution in the tens of microns. A resolution of 2550 DPI delivers pixels just below 10µm size. A printhead with a NPI of 50 would need 50 small steps (steps of 10µm) to achieve such cross-scan resolution. At every small step, the printhead coats part of the pattern over the full length of the substrate. Despite any high printing speed, the compensation of a low NPI comes at the cost of precious time.

To continue reading this column, click here.

Electronics Industry News and Market Highlights

Inpixon, Ostendo Reimagine Hybrid Workplace With Wearable AR Display Glasses ▸

Inpixon, the Indoor Intelligence company, announced it has executed a strategic alliance and co-marketing agreement with Ostendo Technologies, Inc., a leader in quantum photonics and micro-display technologies.

LPKF Laser Technology Ushers in New Era in Medical Implant Industry ▸

A cochlear implant is a surgically implanted, electronic medical device that provides a sense of sound to people with hearing loss. In use for a few decades now, the device has enabled or restored hearing for 700,000 people.

IDC MarketScape Names Siemens as a Global Industrial IoT Platform Leader ▸

Siemens announced that is has been named a leader in the IDC MarketScape: Worldwide Industrial IoT Platforms and Applications in Manufacturing 2021 Vendor Assessment.

Quantic Electronics Acquires BEI Precision ▸

Quantic Electronics, a portfolio company of Arcline Investment Management, announced the acquisition of BEI Precision Systems & Space Company, Inc. from J.F. Lehman & Company.

Global Semiconductor Sales Up 29.2% YoY in June ▸

The Semiconductor Industry Association (SIA) announced worldwide sales of semiconductors were $44.5 billion in June 2021, an increase of 29.2% from the June 2020 total of $34.5 billion.

SEMI Teams with Manufacturing Institute to Help U.S. Military Veterans ▸

Helping to create pathways to careers in semiconductor manufacturing for U.S. military veterans, SEMI, the trade association representing the global electronics design and manufacturing supply chain, announced a new partnership with Heroes MAKE America, an initiative of the Manufacturing Institute (MI) to build connections between the U.S. military community and the manufacturing industry.

Intel Launches AI for Workforce Program for Students in 18 Community Colleges ▸

Intel is announcing a major expansion of its Intel® AI for Workforce Program to help educate the next generation of U.S. technologists, engineers, and inventors—and to help them land careers in their chosen fields, ranging from healthcare to nursing to business.

Hypersonic, Autonomous Flight Research Bolstered by $1.5 Million Grant ▸

Hypersonic vehicles, which fly more than five times the speed of sound, are constrained by an important aspect: computational power. Whether they are airplanes, missiles or spacecraft, the super-fast vehicles need to be autonomous, directing their own flight path without human interference.

A Dissolvable Smartwatch Makes for Easier Electronics Recycling ▸

Small electronics, including smartwatches and fitness trackers, aren't easily dismantled and recycled, so when a new model comes out, most users send the old devices into hazardous waste streams.

Package substrates are diverging to meet the needs of today's hybrid designs.

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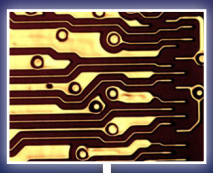
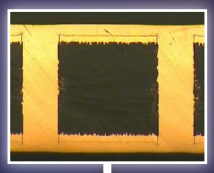


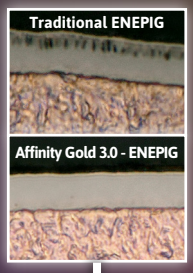
Systek UVF Series

2-in-1 Via Filling and Trace Plating for RDL



MacuSpec THF Series

Single Step Copper Through Hole Filling



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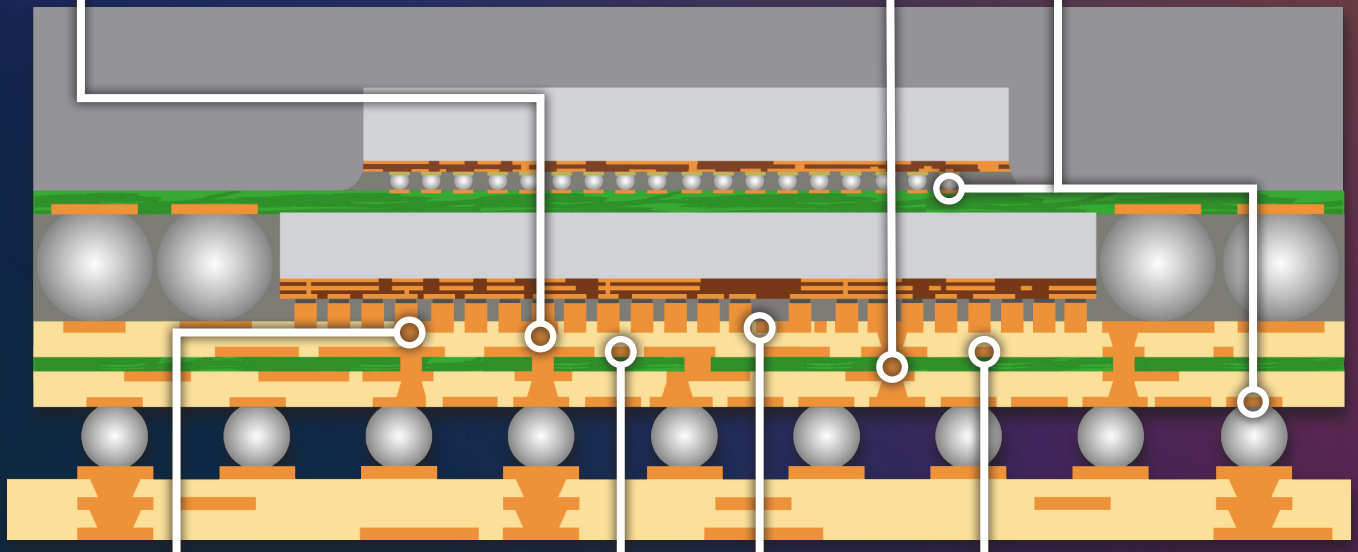
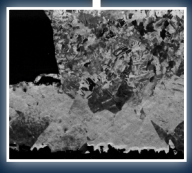
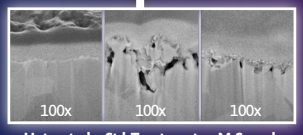




Systek SAP

Stress-Free Semi Additive Electroless Copper



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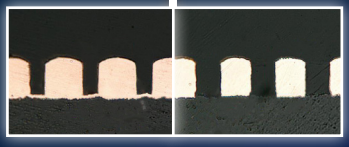

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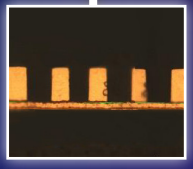

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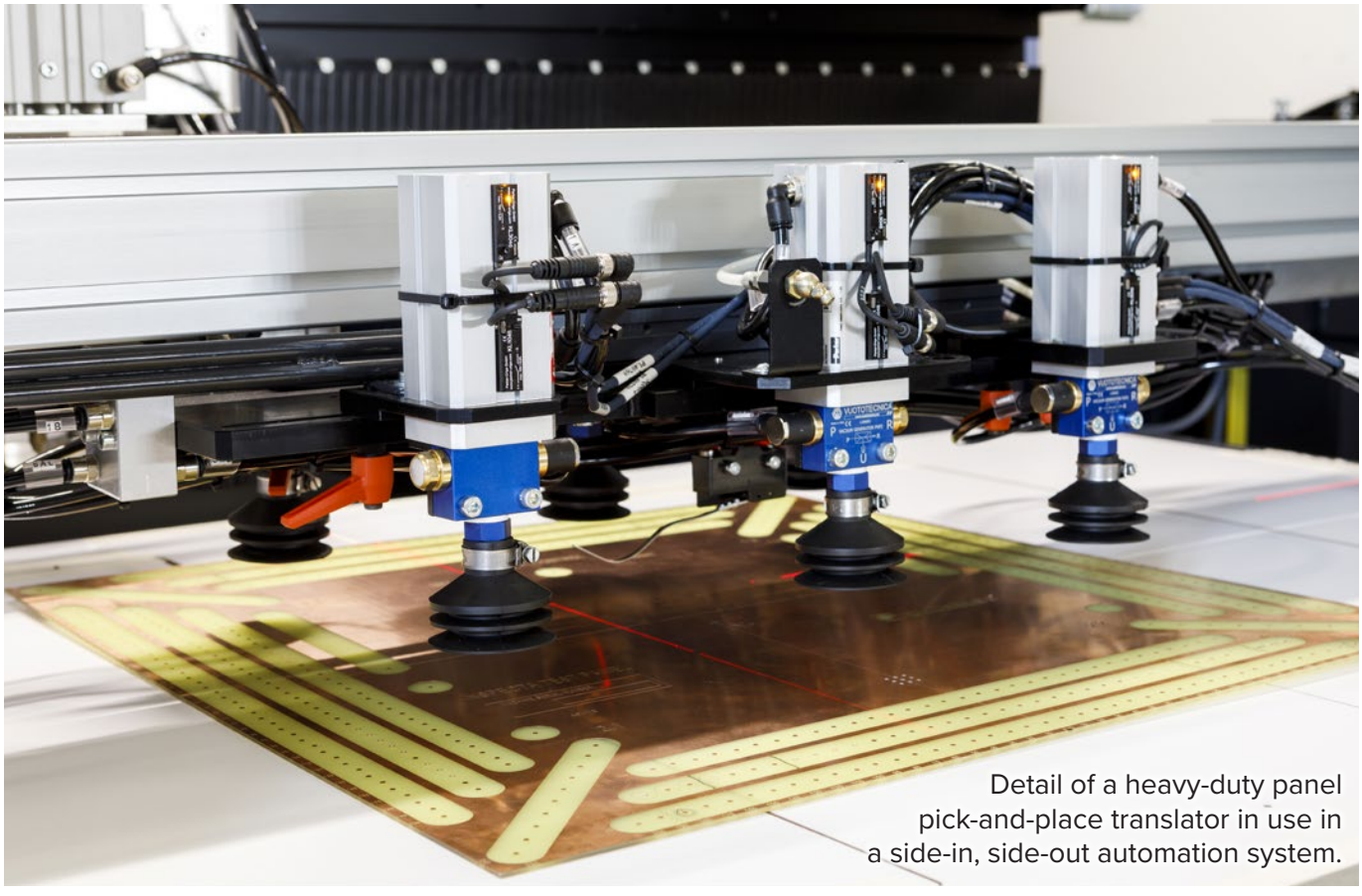

Detail of a heavy-duty panel pick-and-place translator in use in a side-in, side-out automation system.

Drilling Down With Pluritec

Interview by Nolan Johnson
I-CONNECT007

Costanzo D'Angelo talks about some of the new systems Pluritec is developing, including its new X-ray drill machine, with the hope of moving into the high volume and mass production market in China and worldwide.

Nolan Johnson: Tell me about the new X-ray drill from Pluritec, since it seems like there's a lot of interest in that. Can you tell me more about the drill and how the market is responding to it?

Constanzo D'Angelo: There is, as earlier said, a big drive in China toward high-end PCB manufacturing. PCB manufacturing requires a lot of technological support in different aspects of the process. PCBs are made with a low stability material; high-frequency PCB or microwave panels with thermoplastic material that has a high deformation; size and thickness of the panel itself can vary from 15 microns (high-end HDI or substrates to 10 mm (probe cards or backpanels). All this requires a less conventional approach.

The handling of these panels poses a lot of challenges, and Pluritec has been focused on this. Since last year we are able to handle panels from 25 microns up to 10 millimeters in thickness with manual and full automatic applications. The quality of the hole drilled on these PCBs must be higher compared to before. At the beginning of 2021 we introduced newly developed systems which allow us to process very thin material with a high-quality drilling outcome, thanks to special technical solutions

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that we will advertise during the show. We did great work on the improvement of the data information exchange as well.

Our machine has a fluent ability to always stand with the geometrical deformation of the panel. It can measure, collect data, drill, and deliver information to the manufacturing system such as the MES or other interfaces the customers wishes to communicate with. We are providing customers with unsurpassed capability to analyze the panel deformation, which is very important when it comes to dealing with highly volatile material, highly deformable material, or high accuracy requirements.

Linear Side-in / Side-out Automation composed of a loading station (either trolley or conveyor-in), a reject station for non-processable panels and an offloading station (either trolley or conveyor-out).

Johnson: A lot of computing power is needed to read each individual layer, to identify the unique deformities, and then to calculate the skew so that you maintain accuracy on each individual panel.

D'Angelo: That's correct. The role of a traditional X-ray target machine is to intercept the internal layer and index the panel with a number of holes necessary for subsequent processes. In our case we do more: Beside doing the traditional work, we are measuring the innerlayers in a very accurate way, drilling an unlimited number of holes any diameter anywhere in the panels, with or without geometrical compensation, but also putting together all measured data in a form that can be used directly by the customer or delivered to its MES or whatever processing control system they have. Even more, we can link each set of geometrical deformation data to the panel they belong to using a tracking system that reads a QR code into the innerlayer as a key to uniquely identifying it at any point of the manufacture. It's a fundamental step to process traceability.

Costanzo D'Angelo

Johnson: How does this new equipment improve throughput?

D'Angelo: We did a lot of work on making our machines more flexible and faster. The speed of work is something that we have been improving over time, but we have been developing features that help reduce manufacturing steps by integrating processes. The extensive use of automation allows these machines to deliver higher throughput by cutting human interference and operating around the clock.

Specifically, there are two key features that we have added to the new machines and that we are now promoting: One is the addition of a twin head for the second diameter drilling, and another is a continuous dispenser for an entry material deployment while drilling. We missed those kinds of operational behaviors, and since the beginning of this year, we have introduced a machine with the name SX TWIN, equipped with two spindles and automatic tool change,

which can handle seamlessly and efficiently multiple diameter drilling. The SX TWIN can accommodate an optional spooler able to dispense fresh entry material at every single hole for a best hole quality result, fundamental for today's high-end PCBs.

Johnson: Indeed. So, we have accuracy, we have higher quality holes, and we have multiple diameters of drilling onboard—all improving throughput.

D'Angelo: Yes, double diameter drilling normally requires double processing or lengthy tool changes. We are now doing this in one shot saving 30% of process time and improving the productivity for the HDI, mSAP, or substrate PCB's applications, which is the market we are targeting. This segment has been a little bit marginal for us because we have been focusing on very high layer counts, special material, complex boards, special applications, etc., for a long time. With these new machines, we want to move a little bit closer to the volume market, which is the largest in China.

Johnson: What has been the customer response to these machines?

D'Angelo: As we have developed the features by following market requests, we've gotten a good response. In our estimation, this kind of manufacture in China is growing and we expect that our leading edge will help more customers to achieve the level of accuracy and productivity required by that kind of product. Today this represents the largest manufacture volume, and those manufacturing plants are huge.

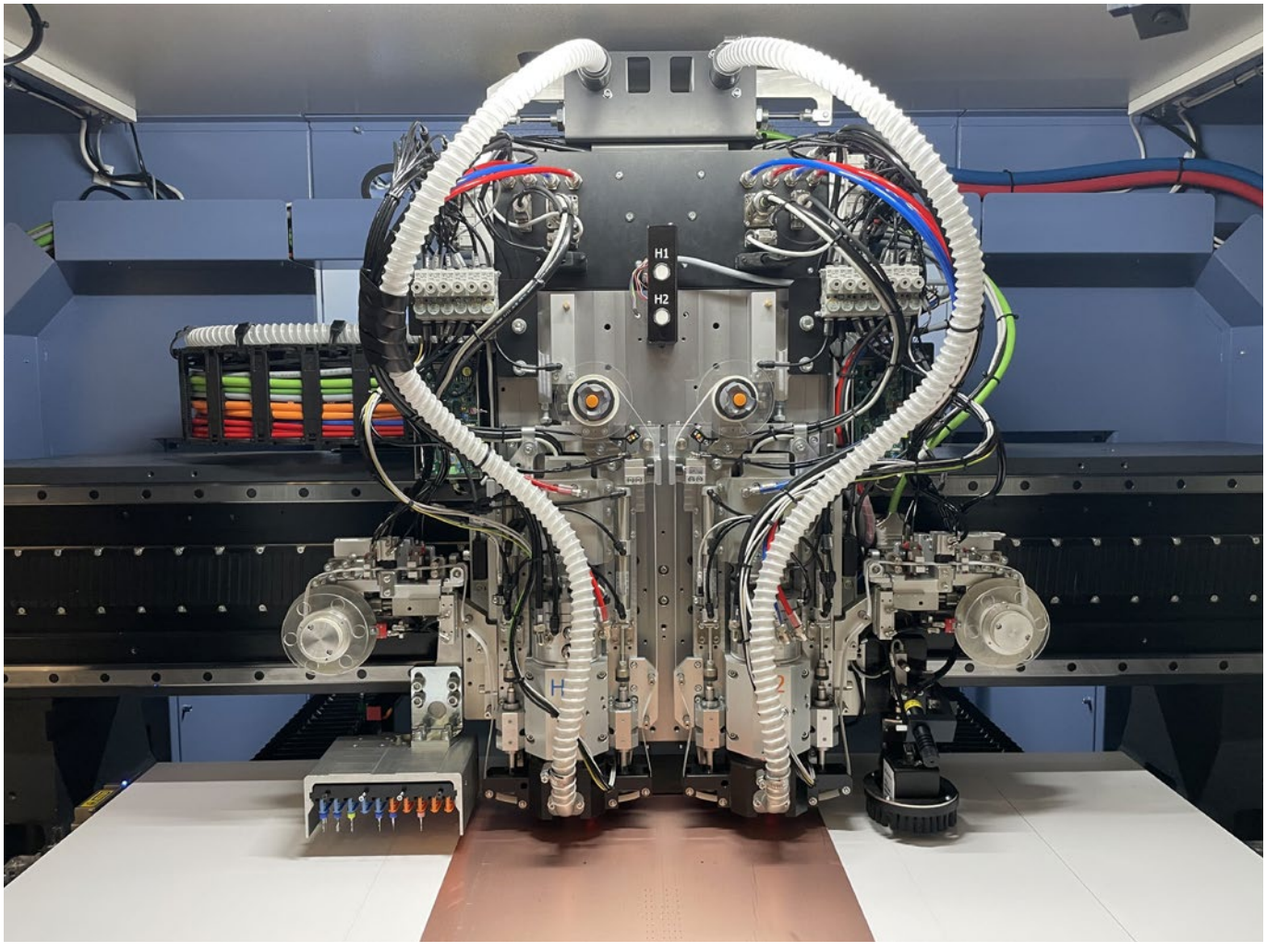
Johnson: Yes, they are.

D'Angelo: High layer count multilayers are normally produced in small volume, high mix, and in a limited environment while for HDI, high-end HDI, substrate, etc., the number of panels to be produced are orders of magnitude higher. This requires larger plants and more equipment. Many of these companies need automation to cope with the requirements of quality, traceability, and yield. That is the area we have been focusing on during the past year: automation, improving yield, throughput, connectivity, flexibility for any kind of production, and delivering useful data for productivity with the highest level of accuracy and quality.

Johnson: Usable data is now a critical function for machinery being installed on the manufacturing floor. With that, many pieces of machinery on the manufacturing floor, an efficient operator interface on your X-ray drill, and your machinery is important for labor savings. Has Pluritec done work to improve the user interface of the machine itself?

D'Angelo: With the number of machines in use growing and a higher volume of manufacture, the human interaction with the machine poses

Integrated automation of an X-ray INSPECTA SX using an anthropomorphic robot for front-loading and rear off-loading. Front loader is equipped with buffer stations to handle panel delivery queue while the off-loader takes care of scaling error sorting.



Detail of a twin-head application equipped with entry material tape spooler. This set-up is specifically designed for efficient double diameter drilling and high-quality hole drilling for substrates—thin or special materials.

new challenges. On one side, there is a physical limit of the human to handle the process because manual operation is volatile and subject to errors; on another, the need to have traceable products going through the production line is growing fast. The work we have been doing was to make our equipment be more connectable with a company's MES system for proficient interactions.

Every single operation can now be monitored, traced, and interchanged with a company to respond immediately to any change and reduce human errors. Our machines today have been designed to be interactive with automation, from AGV delivering system to robot handling, or just regular pick-and-place kinds of applications. We have developed, installed, and continue to work on any automation integration that is making our machines able to perform in an unmanned environment by keeping control of the process.

Of course, there is still a long way to go, but thanks to our worldwide customer base, which is offering new challenges and new requirements every day, our product line is growing, and we believe we are in an excellent position for automation integration and data interchange—which is a fundamental issue in high-volume manufacturing.

Johnson: It looks like you and your team have been doing some very good work.

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D'Angelo: Our R&D department hasn't gotten bored during this pandemic period (laughs). To be honest, we are a little bit too busy because we pushed a lot of innovation during this year, and it has been quite challenging. We are sure that all our products will be able to deliver new support for technological advancements, which has been making us proud to be part of it. We are happy that we can help this field to grow. We have been doing this for the last 50-plus years. We have been listening to every requirement and built our systems, putting together individual, global, or worldwide customer needs and requirements and growing together. Listening to everyone has been proven to be a reasonably successful attitude for us; China today offers a lot of challenges and opportunities. Being on the leading edge is not an easy task, but we like difficult tasks.

Johnson: Thank you very much for taking the time to talk with us about this. **PCB007**

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

Is Your Process Cluttered? Supercharge It!

Testing Todd

by Todd Kolmodin, GARDIEN SERVICES USA

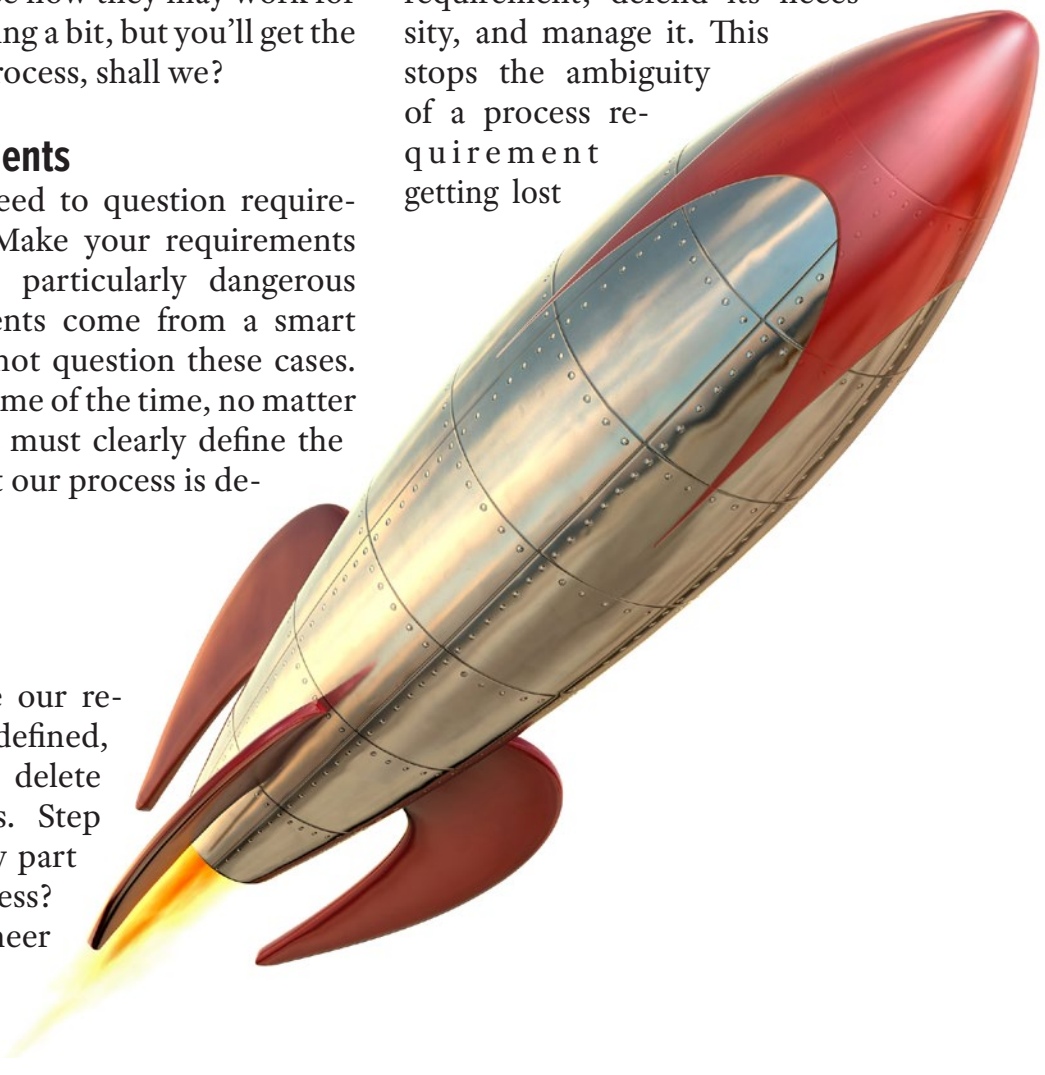
I recently came across a social media post regarding process development through the eyes of Elon Musk. Although there are many philosophies about process development, I found Elon's insight particularly interesting. He was talking about rocketry and evolution of the reusable rocket at SpaceX. I thought I would pass along his ideas and see how they may work for you. I'll be paraphrasing a bit, but you'll get the idea. Let's design a process, shall we?

Question Requirements

In step one, we need to question requirements. Elon says, "Make your requirements less dumb." This is particularly dangerous when the requirements come from a smart person. We tend to not question these cases. Everyone is wrong some of the time, no matter who you are. So, we must clearly define the requirements of what our process is designed to deliver.

Try to Delete the Part or Process

Now that we have our requirements (steps) defined, we need to try and delete the part or process. Step two: Is it a necessary part or step in the process? We tend to overengineer a process. In Elon's view, if you are not adding a process part or step back in at least 10% of the time, you are clearly not deleting enough. Also, a big mistake made in process development is that the process is assigned to a group or department. The process must be assigned to a person. They will take ownership of the requirement, defend its necessity, and manage it. This stops the ambiguity of a process requirement getting lost



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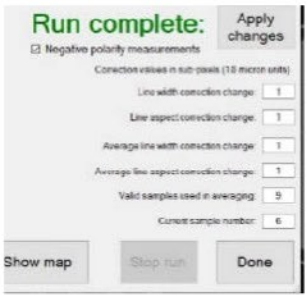

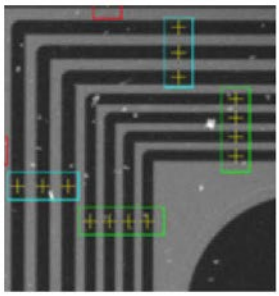

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and possibly constraining the overall goal. If not assigned to a person, the original person that may have come up with the requirement may have moved on and no one knows why the requirement is even in the process. This can have effects on process velocity.

Simplify or Optimize

Step three is a very important step and makes total sense. It is quite common for even a smart engineer to spend a lot of time optimizing a thing that shouldn't exist. We are all taught in high school and college to "answer the question." It's convergent logic. We cannot tell the professor that your question is dumb; we will get a bad grade. We must answer the question. So, we are trained to be in a mental straitjacket. Therefore, we then spend the time optimizing a step or part that should not exist. We need to step back and, before we simplify or optimize a process part or step, question whether that step is even necessary. If not, delete it. (See step 2.)

We need to step back and, before we simplify or optimize a process part or step, question whether that step is even necessary. If not, delete it.

Accelerate Cycle Time

In step four we want to go faster. We can always go faster. However, don't do this before you have done the previous three steps. If something has gone wrong in steps one through three, you don't want to dig your grave faster. You want to stop digging. One of the main things that slows cycle time is too many in-process testing steps. What happens is that we put quality checks in process and then forget to delete them. Albeit they are necessary during development to identify weakness or non-conformance, but if the final first pass yield is acceptable at end of line, there is no further reason for the in-process testing step and it can be deleted. By following this idea, the velocity of the process or line can be increased. It is too common that these steps are added during debug of the process and then forgotten. This leads to these unnecessary testing or check steps choking the line or process.

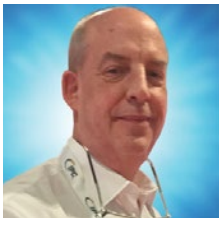
Automate

In step five, we automate. If all other steps have resulted in positive results, we need to pursue automation. This increases stability and repeatability. However, we need to think of the previous steps. We do not want to invest capital in automation when, after review, the automation is not needed, and the automation step should be deleted entirely.

Closing Thoughts

After reading Elon's ideas on process development, and developing many processes over the years, I can see I have fallen into the trap more than once. What happens is that we find ourselves doing the five steps in reverse order. After spending all the time and energy in process development, we have overengineered the process and have cost and steps that should never have been there in the first place. Doh!

Whether you embrace some of the above thinking, I found it very interesting and a good spin on process engineering. Thanks Elon. **PCB007**



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

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Supplier Highlights

Insulectro Printed Electronics Hires Substrate Expert Jeffrey Crawford ▸

Insulectro, the largest distributor of materials for use in the manufacture of printed circuit boards and printed electronics, has hired industry veteran Jeffrey Crawford as an Advanced Substrate Specialist.

Trouble in Your Tank: A Series of Questions on Price Increases ▸

Columnist Michael Carano speaks frankly about the current state of price increases in the PCB industry, and what needs to change to stay alive.

CIPSA Circuits Finds Success With Ucamco's Ledia Direct Imager ▸

Earlier this year, Barcelona-based CIPSA Circuits installed a Ledia direct imager from Ucamco along with an autoloader from Techno System-Benmayor.

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Atotech Reports Q2 2021 Results, Raises 2021 Full Year Guidance ▸

Atotech, a leading specialty chemicals technology company and a market leader in advanced electroplating solutions, reported record financial results for the second quarter of 2021 and raised its revenue and Adjusted EBITDA guidance for the full year 2021.

Altium, IPC Education Foundation, and Arduino Announce Student Electronics Design Competition ▸

Altium LLC, a leading PCB software company, is partnering with the IPC Education Foundation (IPCEF) and Arduino to launch the first student electronics design challenge to engage, educate, and enhance printed circuit board design capabilities while developing STEM solutions to environmental challenges.

Taiyo America Hires European Sales Manager ▸

Taiyo America, Inc is proud to welcome Stuart Down as the newest addition to their sales team staff. Stuart will take over the duties as European Sales Manager, effective September 1, 2021, and will be based in the UK.

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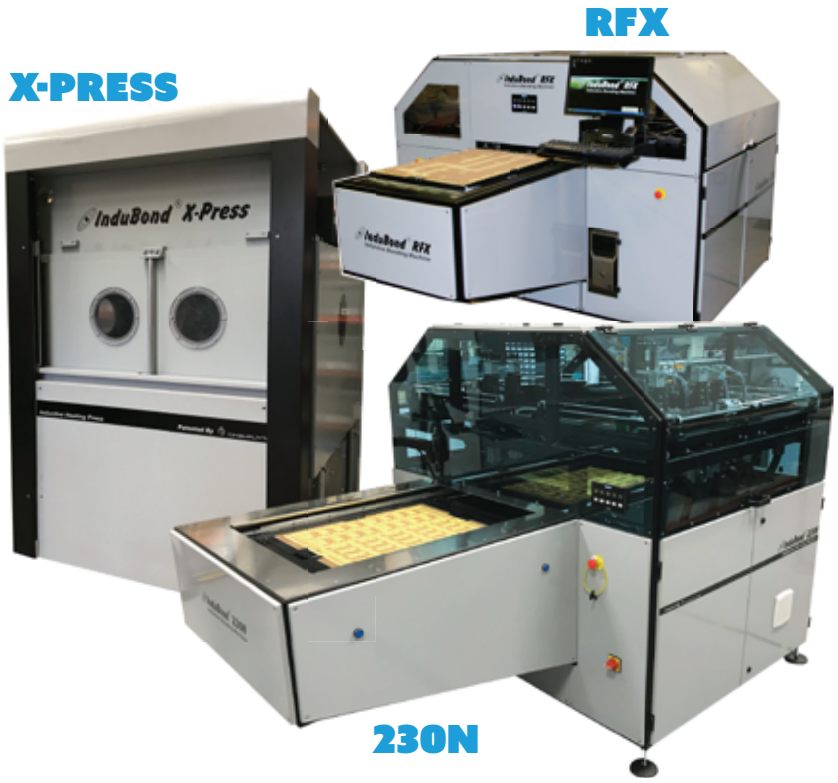

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Case Study—Interconnect Defects and a Few Other Problems

Trouble in Your Tank

by Michael Carano, RBP CHEMICAL TECHNOLOGY

Introduction

Over the past 18 years or so, my columns have focused on presenting a specific defect or defects, drilling down to the root causation of the defect, and quickly and efficiently identifying and subsequently eliminating the cause. For this month's edition, we are taking a slightly different approach—that of presenting an actual case study. However, the basic principles of these columns continue.

The Issue

The situation involves a large and well-equipped printed circuit board fabricator. The company had received returns for what was viewed as Type 1 ICDs; the electroless copper was pulling away from the interconnect. As is so often the case with defects, the non-conformance was only detected on a few panels. There was no correlation to the part design. All panels exhibiting the problem were multilayers, either 10 or 12 layers, with standard FR-4 construction. Microsectional analysis showed the problem (Figure 1).

The desmear/etchback was deemed sufficient. With such a degree of etchback, no smear should have remained.

So, what was the cause of this issue? Again, the defect was only seen on a few isolated occasions. Further examination of sections after plating showed some interesting anomalies.

Figure 2 shows a closer view of the interconnect. Looking closely at the section, one can see debris on the face of the interconnect. Clearly, the debris is the major reason why the electroless is not making contact with the

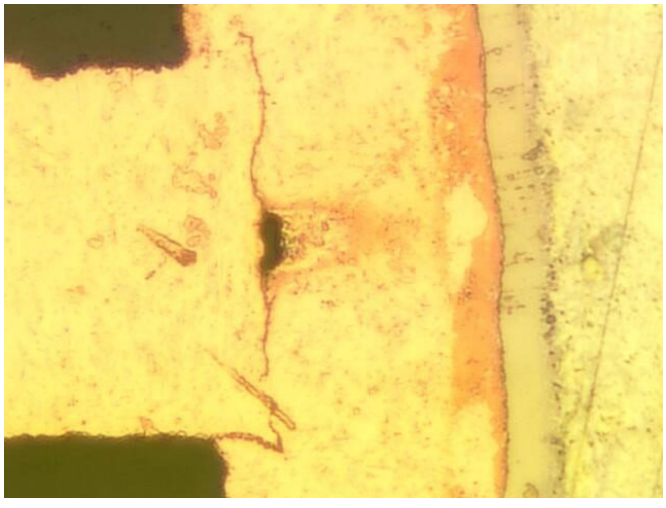

Figure 1: After 550°F solder float for 10 seconds. Separation noted on sections prior to etching the specimen.

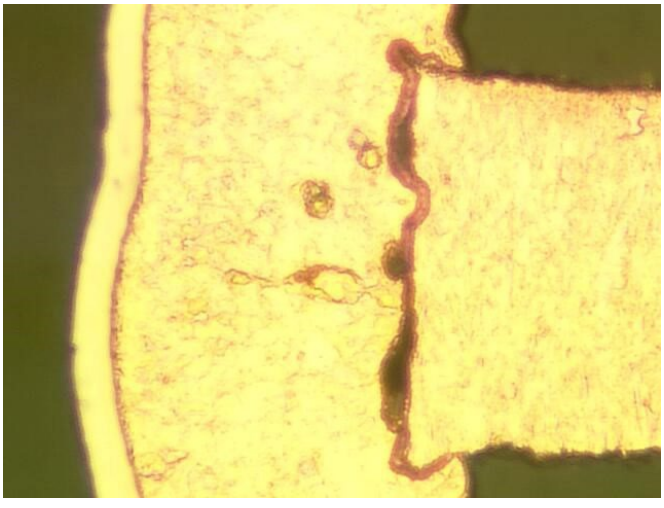

Figure 2: Clearly there is insoluble material interfering with the adhesion of the electroless deposit.

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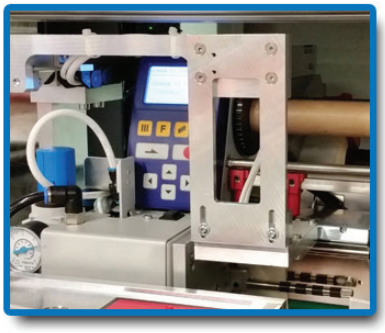

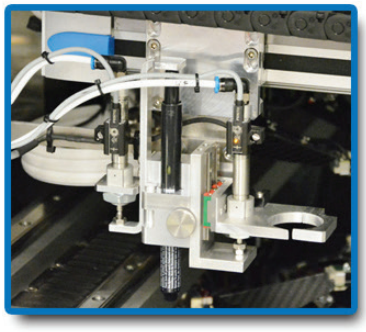

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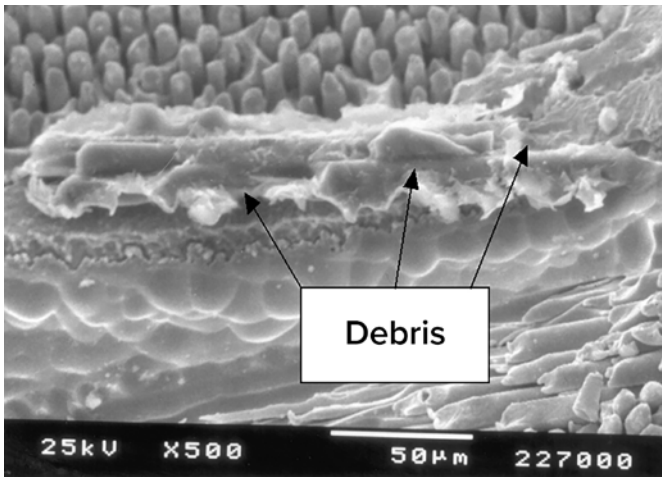

Figure 3: After electroless copper plating. Plating formed over debris.

innerlayer. Looking at sections of these panels under SEM yields additional information (Figure 3). Here, one can see the debris in the hole and detrimental effects.

Initially, the team considered that the electroless copper itself (plating rates, overall stability, etc.) was the primary cause. And with the detection of some sort of debris, there was a high probability that the source of the debris may have originated with the electroless copper solution itself. The question is: Where did the debris originate? Certainly, there are several potential sources for insoluble material to lodge onto the hole wall or interconnect.

Insoluble materials and particulate matter accumulate over time from various sources. This includes drag-in of chemicals from previous process steps that lead to formation of insoluable particles. Solutions—including the catalyst or the electroless copper solution itself—are a main source of insoluble matter. One should maintain filtration on the catalyst and electroless copper solutions at the very least. Palladium drag-in to the electroless copper tank will destabilize the process solution. The palladium (part of the electroless copper catalyst) drag-in will lead to copper dusting. This dusting, or literally the formation of copper metallic particles, will cause deposit roughness. Figure 4 shows a simple overflow weir. This set-up helps greatly to remove particulates and other materials that can cause rapid plate-out or roughness/blisters.

Another source of debris is introduced from the drilling process. Drill debris entrapment is a major source of particulate matter. One of the causes of the debris is from drilling too deep into the back-up material. One only needs less than one drill bit diameter turn into the back-up material. Over-penetration into the back-up material leads to additional debris introduced into the vias and the potential for drill bit breakage. Poor quality back-up material will contaminate the via as well. Most fabricators have opted for aluminum-clad back-up materials. Although more expensive than the phenolic materials, the aluminum clad will not contaminate the holes.

The vacuum system on the drilling machine is a very important facet in drilling vias. The vacuum cleans the drill bit flutes of chips and glass debris on each stroke. Low vacuum power will result in the chips and debris remaining in the via, thus adversely affecting the quality of the plating operation. Follow the drill equipment supplier's guidelines on proper vacuum operation.

In addition, inspect the drill area for dust. This could indicate there is static electricity in the room, allowing drill debris to settle on the equipment.

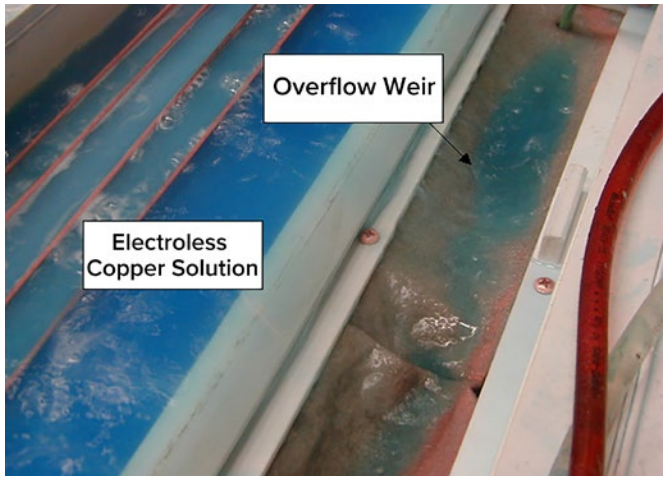

Figure 4: Top view of electroless copper process tank. Note the overflow filtration weir on the right-hand side of the photo.

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A Few Caveats

Debris issues aside, blistering or flaking of the electroless copper from the surface or in the holes can be attributed to the following:

- Electroless copper process chemistry is out of balance. Adjust the components into the proper operating ranges and ensure that the controllers are maintaining the solution components at the proper feed rate.
- Depending on solution loading (square feet of board per gallon of electroless copper solution), the reducing agent level (formaldehyde) may increase in concentration. This can cause the solution to become overactive and result in the flaking or blistering problem.
- Primary stabilizer in the electroless copper solution is low, leading to an overactive solution; deposition rate is higher than normal leading to blisters or flaking.
- Plating racks with loosely adherent copper deposits can cause these defects. Regularly strip the plating rack to remove these deposits; the rack should be clean of copper before each plating cycle (Figure 5). Copper flaking from racks can destabilize the solution, causing rapid plate-out and rough copper deposits.
- Monitor the specific gravity of the operating electroless copper process. Maintain the specific gravity at or below the supplier's stated recommendation; high specific gravity is an indication that the process may be overactive.

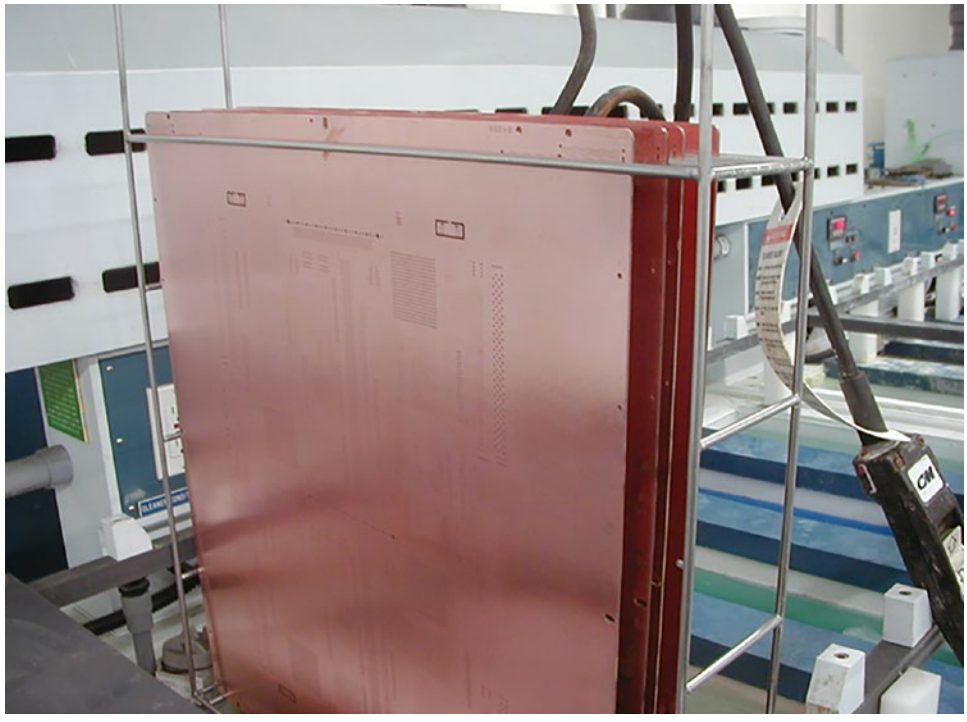

Figure 5: Panels ready for processing. Note the stainless-steel racks are clean and devoid of copper deposits.

- Process control: Regular replenishment additions based on square footage processes is ideal. A simple single-channel controller to monitor the copper content of the solution works efficiently. Other components are metered in according to pre-set pump settings. Do not wait to make large manual additions on an irregular basis.

Remember that the genesis of a defect or anomaly is not readily evident within a particular process or operation. The root cause may have multiple contributors. Be sure to look closely at the processes that may contribute to the defect. **PCB007**

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

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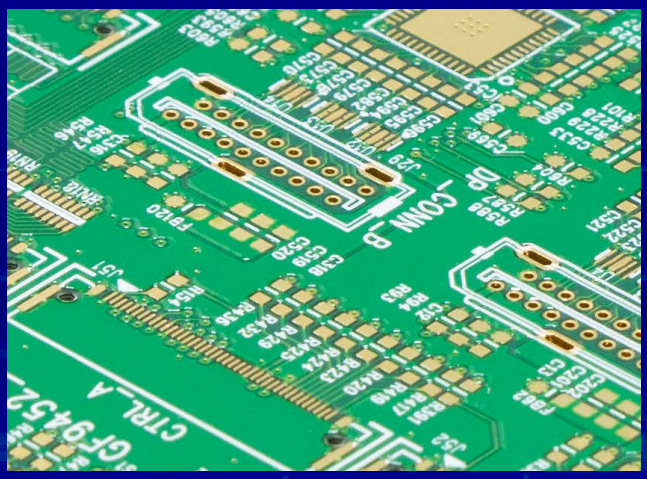

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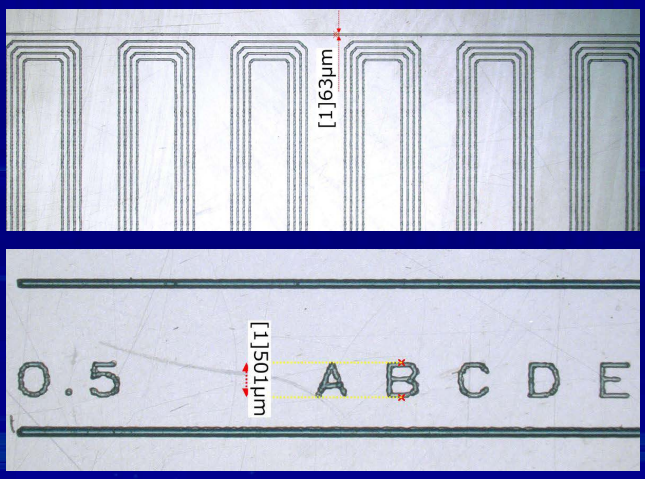

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The U.S. Government, the electronics industry, and academia must continue to step up their joint efforts to address risks and gaps in the defense electronics supply chain.

Defense Speak Interpreted: Decoding the Military's COCOM ▸

Have you ever followed Defense activities around the world and been confused by terms like CENTCOM or SOUTHCOM? Who's in charge of worldwide Defense activities—just "a big guy at the top" or regional commanders? How do Army, Navy, and Air Force stay coordinated around the world in various geographies?

Communicating Effectively with EMS Providers ▸

For the past several decades, OEMs have used outside EMS providers to build a multitude of products from PCBAs to complete box and cable assemblies. Communicating effectively is the key to success in getting products from concept to reality. For companies that want to form a good working relationship with EMS providers, there are several steps that should be followed to ensure a successful product build.

Catching Up With AMI's Jim Barry ▸

Jim recently accepted the position as vice president of business development at AMI in Maine. He discusses the company's plans, including its move deeper into the mil/aero market.

Micross, C-MAC Partner to Service U.K. Aerospace and Defense Market ▸

Micross Components Ltd., a leading global provider of mission-critical microelectronic components and services for high-reliability aerospace, defense, space, and industrial applications, based at Norwich, U.K., and C-MAC Electromag BVBA are pleased to announce a formal partnership, to offer a greater range of products and services to the U.K. Aerospace & Defense industry.

Adventures in Engineering: A Purpose-Driven Prototype ▸

Prototyping, simulation's fraternal twin, born from a desire for a finished product is a common methodology employed in PCB/PCBA development. Aside from merely being a means to an end, what is your prototype meant to accomplish?

TT Electronics Appoints Emma Darke as Group Sustainability Director ▸

TT Electronics, a global provider of engineered electronics for performance-critical applications, announced the appointment of its first-ever Group Sustainability Director.

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The IPC Surface Finish Specifications—Plating Subcommittee 4-14

The Plating Forum

by George Milad, UYEMURA

Specifications are reference documents to be called out by OEM board designers in specifying the attributes of a surface finish. Designers may take exception to one or more items in the specification to ensure that the product meets the requirements of its intended use. The term "AAUBUS" (As Agreed Upon Between User and Supplier) is part of any specification.

Specifications are consensus documents. They are agreed upon by a panel of interested industry participants composed of end users (OEMs), manufacturers, assemblers, and suppliers. If there is consensus, then the committee documents it in a draft specification for peer review.

In cases where no consensus is readily arrived at, the committee undergoes its own testing in what is commonly referred to as a "Round Robin" (RR) study. In a RR investigation, an agreed-upon test vehicle (TV) is designed and manufactured. TVs are then sent around to the different suppliers who deposit the agreed upon thicknesses to be investigated. The TVs are collected, and the deposit thicknesses are verified and documented. The TVs are then coded and sent around again to the different testing sites that test for the desired attributes like soldering, contacting, and wire bonding capabilities of the different finish thicknesses. The data is then collected, sorted out, and documented. At this point, a new attempt at consensus is made and, when achieved, the thickness specification is set, and the specification is drafted.

The "Draft" is posted for "Peer Review." Any IPC member can review the document and

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suggest technical or editorial changes. All comments are then reviewed, and all issues are resolved before the "Final Draft" is issued. At this time, the IPC takes on the task of publishing the document in its final format.

The IPC Plating Subcommittee 4-14 was active from 2001–2019. The committee was co-chaired by myself and Gerard O'Brien, president and owner of ST&S Group, a consulting and testing facility. The IPC liaison was Tom Newton. The committee had an extensive member list composed of OEMs, assembly manufacturers, suppliers, labs, and consultants. Members participated on and off in conference calls that they were interested in and as their time allowed. Not all members were on all conference calls. Below is a listing of participant companies.

OEM and CM: Lockheed Martin, Raytheon, Oracle, ADTRAN, Rockwell Collins, Hewlett-Packard, Alcatel-Lucent, Dell, St. Jude Medical, Delphi, Schneider Electric, Continental Corporation, Panasonic, IBM, Northrop Grumman, BAE Systems, Honeywell, Boeing, Tyco Electronics, Peregrine Semiconductor, Space Systems /Loral, Amonix, Celestica, Winstron.

PCB manufacturing: TTM, I3, Molex, Bergquist, Superior Processing, Alternate Final Finishing.

Suppliers: MacDermid, Uyemura, Atotech, Technic Inc, MEC, ECI Technology, Kulick & Sofa, Metalor, Fischer Technology, Hesse-Mechatronics.

Labs and Consultants: ST&S Group, Sandia Laboratories, DFR Solutions, TAS Consulting.

The committee met every other week for a one-hour conference call. Those in attendance made decisions. The minutes of the meeting were documented and distributed to the members.

Since its inception, the IPC Plating Subcommittee 4-14 has issued the following:

- IPC-4552 ENIG Specification 2002
- IPC-4553 Immersion Silver specification 2005
- IPC-4554 Immersion Tin Specification 2007
- IPC-4553A Revised Immersion Silver 2009
- IPC-4554 Amended Tin Specification 2011
- IPC-4552 Amended ENIG Specification 2012
- IPC-4556 ENEPIG Specification 2013
- IPC-4556 ENEPIG Amended Specification 2015
- IPC-4552 Rev A ENIG Specification 2017
- IPC-4552 Rev B ENIG Specification 2021

The ENIG IPC-4552 Specification was issued in 2002. No lead-free (LF) solder was in use at that time.

For thickness, IPC-4552 stated:

- The EN thickness shall be 3 to 6 µm (118.1 to 236.2 µin)
- The minimum IG thickness shall be 0.05 (1.97 µin) at four sigma (standard deviation) below the mean. The typical range is 0.075 to 0.125 µm (2.955 to 4.925 µin)
- No upper limit was set

Immersion Silver IPC-4553 issued in 2005. In 2005, there were two distinct types of commercialized immersion silver with different thickness recommendations, referred to as "Thin" and "Thick." Each required its own thickness specification.

The initial 4553 specification stated the following for thickness of deposit.

Two thickness specification:

- Thin silver: 0.05 µm (2 µ") minimum at -2σ from process mean as measured on a pad of area 2.25^2 µm (3600^2 mils). Typical value 0.07 µm (3 µ") to 0.1 2µm (5 µ")
- Thick silver: 0.12 µm (5 µ") minimum at -4σ from process mean as measured on a pad of area 2.25 µm (3600^2 mils). Typical value of 0.2 µm (8 µ") to 0.3 µm (12 µ").

The immersion tin specification was issued in

2007. For immersion tin, the committee specified a lower limit for thickness. The relatively thick value of 1 micron was chosen to ensure that enough virgin tin would be available at the surface for soldering after storage. It is well understood that tin forms an intermetallic (IMC) layer with the underlying copper, and that this layer continues to grow in thickness over time.

The immersion tin thickness will be: 1.0 µm (40 µ") minimum at -4σ from process mean as measured on a pad of area 2.25^2 µm (3600^2 mils). Typical value of 1.15 µm (46 µ") to 1.3 µm (52 µ").

The Immersion Tin Specification IPC-4554 was amended in 2011. The amendment addressed solderability testing and specified the allowed stress testing conditions for the deposit and the type of fluxes to be used for both tin-lead and LF (lead-free) testing.

Specification IPC-4555 for OSP (organic solderabilty preservative) was attempted in 2008. After more than one year of struggling with Specification IPC-4555, nothing was specified. There was no consensus arrived at. This was mostly due to the wide assortment of organic products that were used for solderability preservation for the various applications, each with its own recommended thickness values.

In 2009, the Immersion Silver Specification IPC-4553 was revised and Immersion Silver IPC-4553A was issued in 2009. The original specification with a thin and a thick specification was confusing and hard to understand. In addition, the industry settled on one type of immersion silver, and it necessitated the issuance of a single thickness specification, with the addition of an upper spec limit: IPC-4553A specified a single thickness with an upper limit:

- 0.12 µm [5 µin] minimum to 0.4 µm [16 µin] maximum at ± 4σ from process mean as measured on a pad area approximately 2.25 mm^2, example; 1.5 mm X 1.5 mm (60 X 60 mil). Typical value between 0.2 µm [8 µin] to 0.3 µm [12 µin].
- An upper limit was set.

In 2012, IPC-4552 ENIG specification was amended to reduce the lower limit of immersion gold thickness. The lower limit for gold thickness was reduced from 0.05 µm to 0.04 µm (1.6 µin) with restrictions:

- Limited time from manufacturing to assembly
- Demonstrate the consistency of the plating process
- Ability to measure low gold thickness

IPC-4556 ENEPIG, 2013

The document produced is very comprehensive and includes a wealth of information from the RR studies that were conducted. The appendix contains a documentation of these studies, each authored by the person who conducted the testing. It also includes a section on the proper methods of equipment setup for a reliable measurement of very thin layers of metal deposits.

Appendices 1–9

1. Chemical Definitions and Process Sequence; Martin Bayes, Dow Chemical Company
2. Round Robin Test Summary; George Milad, Uyemura International Corporation
3. ENEPIG PWB Surface Finish XRF Round Robin Testing; Gerard O'Brien, S T and S Group.
4. Factors Affecting Measurement Accuracy of ENEPIG Coatings by XRF; Frank Ferrandino, Calmetrics Inc.
5. ENEPIG PWB Surface Finish Wetting Balance Testing; Gerard O'Brien, S T and S Group.
6. Solder Spread Testing; Brian Madsen, Continental
7. ENEPIG PWB Surface Finish Shear Test Project; Dave Hillman et al., Rockwell Collins Inc.
8. Gold Wire Bonding; Stephen Meeks, St Jude Medical
9. XRF Thickness Measurements of thin

Au and Pd (ENEPIG): Recommendations for Instrumentation (Detectors) and their Limitations; Michael Haller, Fischer Technology

The thickness specification for ENEPIG states:

- Nickel: 3 to 6 µm [118.1 to 236.2 µin] at ± 4 sigma (standard deviations) from the mean
- Palladium: 0.05 to 0.30 µm [2 to 12 µin] at ± 4 sigma (standard deviations) from the mean
- Gold: minimum 0.030 µm [1.2 µin] at - 4 sigma (standard deviations) below the mean. No upper limit
- All measurements to be taken on a nominal pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area

The ENEPIG spec was amended in 2015. The amendment added an upper spec limit for immersion gold thickness. The thickness specification for ENEPIG states:

- Nickel: 3 to 6 µm [118.1 to 236.2 µin] at ± 4 sigma (standard deviations) from the mean
- Palladium: 0.05 to 0.30 µm [2 to 12 µin] at ± 4 sigma (standard deviations) from the mean
- Gold: minimum 0.030 µm [1.2 µin] at -4 sigma (standard deviations) below the mean, maximum 0.07 µm [2.8 µin]

If thicker gold is a design requirement, alternate gold deposition methods should be used, like:

- Electroless gold
- Reduction assisted immersion gold (RAIG)

All measurements to be taken on a nominal pad size of 1.5 mm x 1.5 mm [0.060 in x 0.060 in] or equivalent area.

IPC-4552 Rev A, ENIG

The IPC-4552 A, revised ENIG specification was issued in 2017. The revision added a new lower limit for the immersion gold and for the first time specified an upper limit. IPC 4552A also addressed nickel corrosion and specified a "Corrosion Chart." It also included a method for qualifying XRF equipment.

The IPC-4552 A, ENIG Specification 2017:

- The gold thickness shall be 1.6 (0.04 µm) to 4.0 µin (0.1 µm)
- The upper limit of 4.0 µin must be strictly adhered to

Corrosion Chart

Examine the corrosion spikes (if any) on the ENIG surface with an optical microscope at 1000X magnification, for frequency and depth. Three classification levels:

- Level 1: Acceptable (less than 10 spike defects with a depth <20% of the nickel deposit thickness)
- Level 2: Disputable (spikes and depth > than Level 1 and < Level 3)
- Level 3: Rejectable (>10 spike defects with >2 microns depth)

This was the first time that nickel corrosion was addressed and 4552A put a stake in the ground. It became clear that the way the corrosion evaluation was stated was problematic because it did not address frequency of occurrence.

IPC-4552B was initiated in 2017 to address this deficiency. 4552B maintained the levels set in 4552A but added a method to quantify frequency of occurrence. 4552B introduced the term "Product Rating." Seven specified locations in a plated through-hole, or five specified locations on a surface pad were examined for defects and their frequency of occurrence:

1. Product rating 0: Acceptable; No corrosion defects.
2. Product Rating 1: Acceptable; >60% of locations examined show Level 1 or less.

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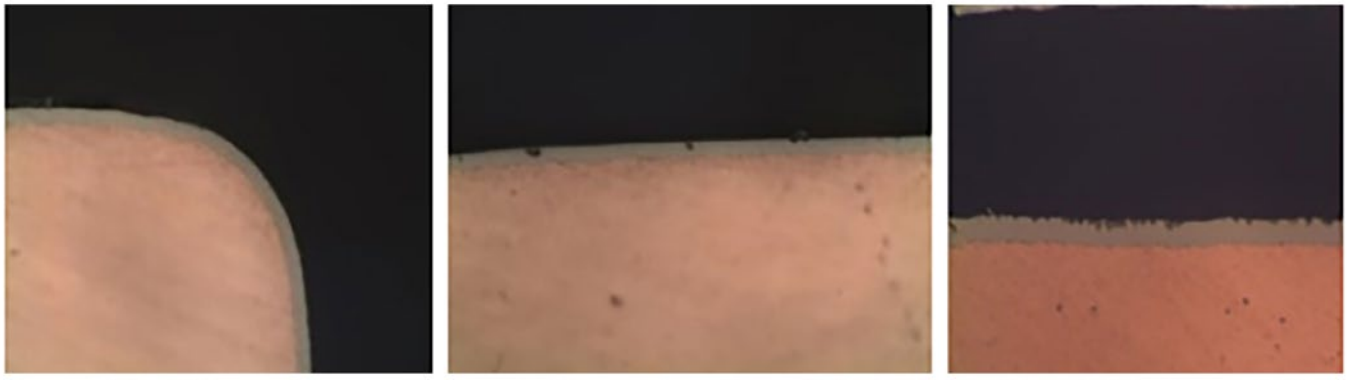

3. Product Rating 2: (Acceptable, provided that solderability requirements are met); defects and frequency greater than Product Rating 1 but less than Product Rating.
4. Product Rating 3: (Non-conforming;) More than 40% of locations showing Level 3 defects.

With the issuance of 4552A and 4552B there is now a way to quantify nickel corrosion. It is the author's experience that the availability of a quantifying method is already paying great dividends, as the occurrence of the defect is already showing signs of coming under control. OEMs or buyers can now specify acceptable levels of corrosion and the manufacturer and supplier have to make the required changes to meet those levels.

Presently, Subcommittee 4-14 is subdivided into subgroups, each with its own chair and vice-chair to address a single finish; for example, an OSP committee and an EPIG committee, etc.

All committee work is voluntary from participation in meetings to manufacturing test vehicles and testing. Companies allow their employees to spend time in committee work and these companies must be credited for the successful issuance of IPC specification. The author urges all industry personnel to sign up and participate in committee work in the areas of their interest. You will learn a lot by communicating and collaborating with other members and more importantly, you will give back to the industry and to the community at large. **PCB007**

George Milad is the national accounts manager for technology at Uyemura. To read past columns or contact Milad, click here.

Leadership 101—
The Law of the Inner Circle

The Right Approach

by Steve Williams, THE RIGHT APPROACH CONSULTING

Introduction

Good leadership always makes a difference; unfortunately, so does bad leadership. This leadership truth continues as we will be talking about the 11th of the 21 Irrefutable Laws of Leadership.

The Law of the Inner Circle

If you were to look at the leaders who have inspired you over the course of your career, I would argue that you will find it difficult to name a single one that did not have a great supporting cast. I believe that nobody does anything great alone; great leaders surround themselves with great people. This truth was on display in the Sonny Barger chapter of my last book Notorious (in a shameless plug, it's available on Amazon). One of the business lessons Sonny taught us is, "Great leaders know they don't have all the answers." In fact, my August 2020 column, "Leadership Lessons I Learned from Sonny Barger," included this lesson.

John Maxwell teaches, "A leader's potential is determined by those closest to him or her," so take a good look around and see who you surround yourself with. This is your team, and the Law of the Inner Circle is all about the team. Most people create an inner circle of people; to quote the great Jack Byrnes, who calls it the "circle of trust." However, during this process people are rarely strategic in doing so. Most people are naturally social, and we tend to surround ourselves with either people we like or people who we are comfortable with. Few people give enough thought to how those closest to them impact their effectiveness or leadership potential.

You Are Your Team

I have been fortunate to have gained some degree of success in my career, and one of my most memorable accomplishments was to lead my company to become the first ISO-certified printed circuit shop in the state of Illinois. What makes this particularly memorable to me is that not only was our initial certification audit perfect, but we maintained a perfect record through every surveillance and recertification audit until I moved on. During our first

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ISO rally after certification, I told the workforce that people will be giving me the credit, but I wanted them to know that it was a team effort; each one of them was a major contributor in our success as a team.

Hire People Smarter Than You

One of the most common obstacles I run across when doing leadership training is managers who are threatened by people smarter than they are. They don't do a good job training these folks and certainly don't want to share their experience for fear the employee will take their job. What a misguided thought process this is. Having been in leadership positions my entire career, I would always hire several people who did want my job; this was intentional and a hiring filter for me. My philosophy has always been that a person that aspires to have my position will do everything in their power to make the team, and me, successful so that I can move up and they can backfill my position. Of course, there are those who may want to take a superior's job by backstabbing, but these are easy to identify during the interview process.

Be Intentional in Relationship Building

To practice the Law of the Inner Circle, you must be intentional in your relationship building. You must give thought to the accomplishment of your mission and the success of the people who follow you. Only if you reach your potential as a leader do your people have a chance to reach their potential.

How do you find the right people for your inner circle? By asking and following these five questions:

1. Do they display exemplary character in everything they do?

Deception eats away at a leadership team like cancer. Dishonesty on the part of one member of an inner circle can bring shame and disaster to all. Entire organizations have toppled from the misbehavior of one bad apple.

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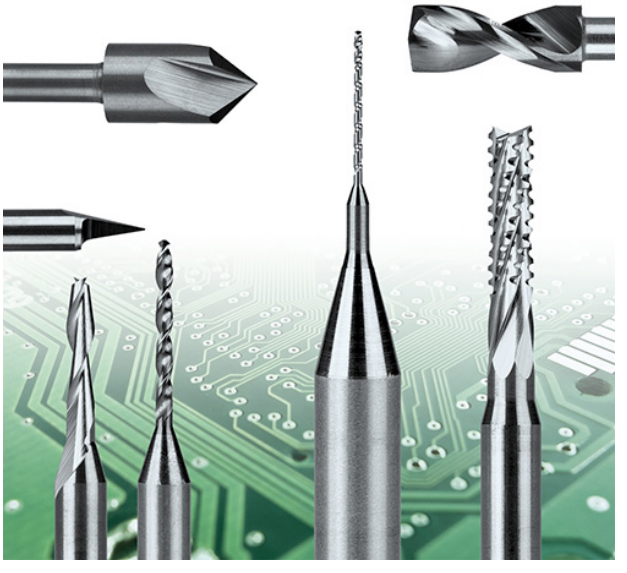

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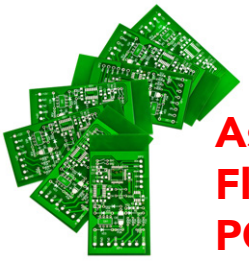

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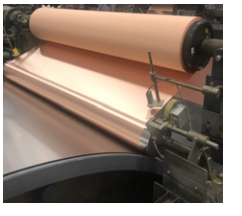

2. Do they bring complementary talents to the table?

Imbalance within an inner circle can attune a leader's ear to only one side of an argument. When putting together an inner circle, prioritize diversity of personality and perspective. By doing so, you widen the range of your vision and the breadth of your influence.

3. Do they hold a strategic position and have influence within the organization?

Members of the inner circle must have the platform and influence to implement a leader's decisions. If they cannot be relied upon to execute a chosen strategy, then they shouldn't be entrusted with a spot on the leadership team. In addition, inviting uninfluential advisors into the inner circle disrupts the political balance of an organization. High performers suffer a motivational blow when they see a less deserving colleague granted special access to top leadership.

4. Do they add value to the organization and to the leader?

When considering someone for the inner circle, you should be able to clearly articulate the value they will bring. Ask yourself the following questions: What will they infuse into the discussion? Where do they have expertise? What unique skills can they be counted on to bring to the table?

5. Do they positively impact other members of the inner circle?

If you've ever inhabited a house with a feuding husband and wife, then you can understand the need for leaders in close proximity to get along. Infighting saps energy and focus from a senior leader, forcing him or her to mediate conflicts with time that could be better spent elsewhere. Differences of opinion signal healthy debate, but personal animosities destroy a leadership team. Make sure members of your inner circle have the emotional intelligence to keep arguments from becoming too personal.

Developing relationships with the real leaders in an organization and honing your ability to form meaningful connections with others will become vital tools in your leadership toolbox. Develop and use these tools early in your relationships with others and you will quickly see the benefits. **PCB007**

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

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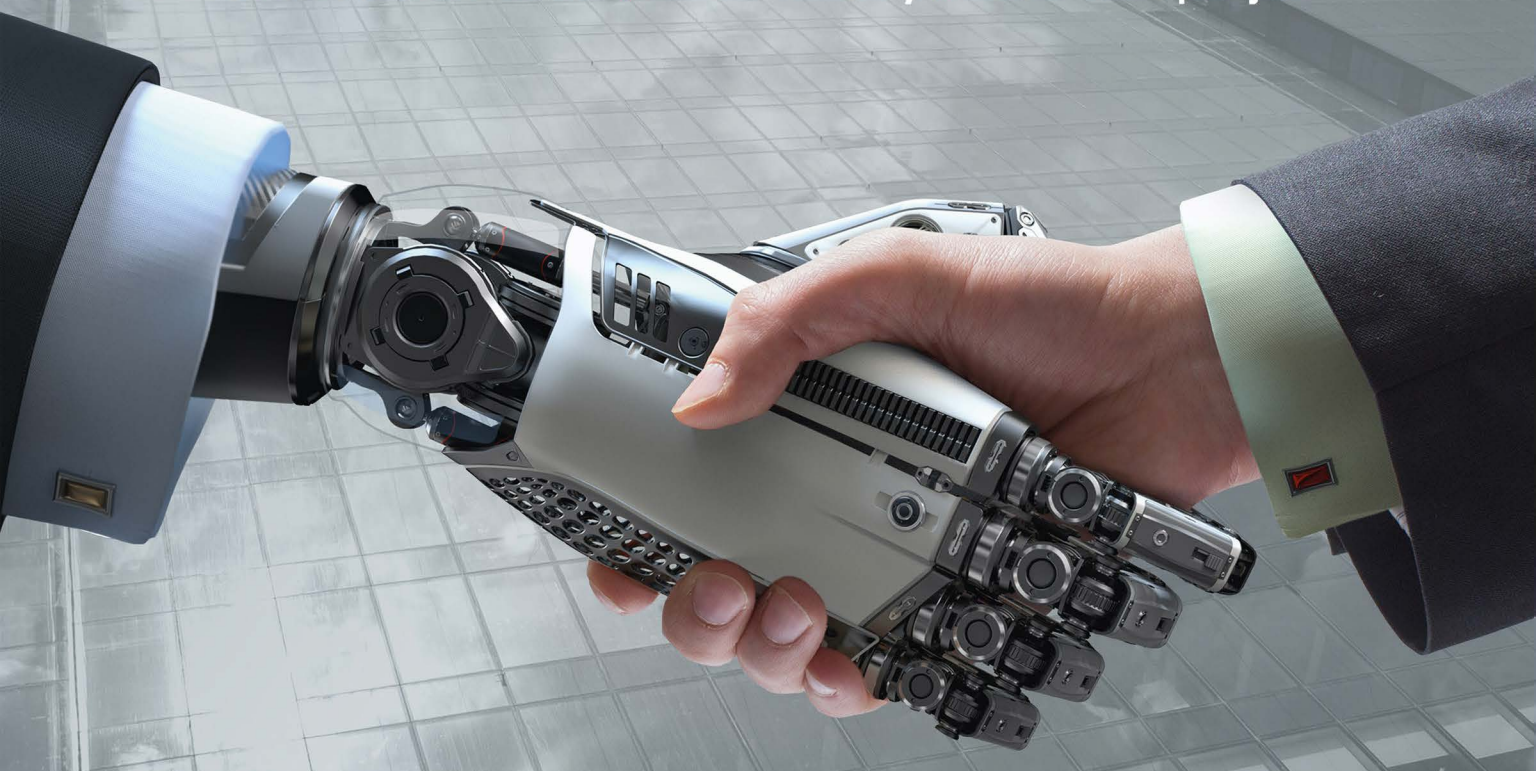

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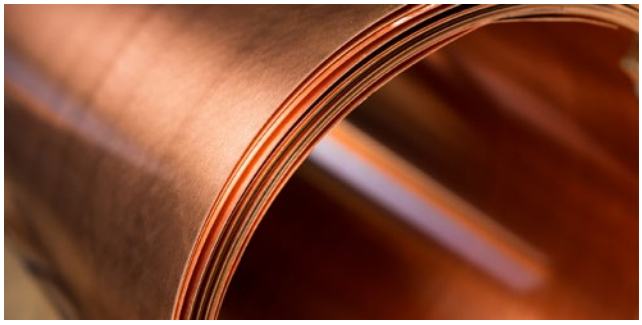
TOP TEN

EDITOR'S PICKS



The Demand for Copper

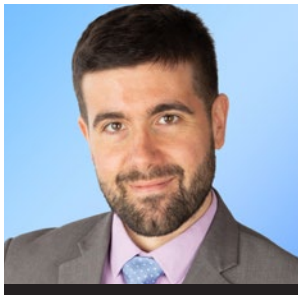
Nolan Johnson spoke with Michael Coll and Chris Stevens of Nippon Denkai, home of the last-standing ED foil manufacturer in North America, about the demands and projections they're seeing in the copper market currently.

Punching Out! 2021 Mid-Year PCB/EMS M&A Update


Tom Kastner

M&A activity is booming in the U.S. as the nation emerges from the COVID pandemic. Thanks to video conferencing and adjustments in procedures, M&A was also pretty busy in 2020. Now that the economy has opened and everyone is traveling, more deals are being discussed.

Additive Reality: Printhead Selection or 'Shop 'Til You Drop'


Luca Gautero

If inkjet tools could be found on an e-commerce site, there would be several product specifications of which many would specify the jetting properties; these would basically detail the printhead(s) in the system.

Ventec, Taiyo America Sign Exclusive Distribution Agreement for Mainland Europe, UK

Ventec International Group Co., Ltd., is pleased to announce it will be taking over the exclusive distribution of Taiyo products in mainland Europe, the UK and Ireland.

Riding the Wave of Copper Inflation Pricing

In this interview with Ventec's Mark Goodwin, he discusses the rising inflation hitting the electronics industry at the same moment as shortages of copper and other raw materials. He believes that, while the PCB industry has endured cycles like this before, this one feels different.

Designing With the End in Mind—How the Meaning of DFM Will Transform in the Future

Designers of today's complex printed circuit boards occasionally encounter setbacks due to their lack of early planning. In this article, Altium's Vince Mazur explains how designers can be served by a design for manufacturing (DFM) mindset to help assure first-pass success.

Dan's Biz Bookshelf: Damn Good Advice (For People with Talent)

Dan Beaulieu

If you want a book that not only shows how to be creative and spark your own creativity, but provides real-life examples of what true originality looks like, this is the book for you. It is a small book filled with 119 ways to spark your own creativity. I keep it on my desk so that when I get stuck for an idea, I look through it and find something that will get my engine running again.

Isola Responding to the Market

Isola's Travis Kelly provides an overview of many important topics the industry is facing, including how the global supply chain is being strained by materials, and what companies are trying to do to best manage the items within their control.

Royal Circuits Acquires South Coast Circuits

Royal Circuit Solutions, a digital manufacturing leader of custom circuit boards, has completed its acquisition of South Coast Circuits in order to further expand its quick-turn printed circuit board fabrication services.

IPC Welcomes U.S. Senate Vote on Infrastructure Bill but Questions Superfund Tax

IPC issued the following statement by its president and CEO, John Mitchell, on the bipartisan infrastructure bill approaching a vote this week in the U.S. Senate.

John Mitchell

Career Opportunities

Is your team growing?

Find industry-experienced candidates at I-Connect007.

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

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Career Opportunities

PERFECT POINT
PRECISION CARBIDE TOOLS

Field Application Engineer

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

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

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

Desired traits:

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

Send your resume to
shane@perfectpoint.us
for consideration.

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ventec
INTERNATIONAL GROUP
騰輝電子

Customer Service Representative, UK

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

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

Skills and abilities required for the role:

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

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

What's on Offer:

- Excellent salary & benefits commensurate with experience

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

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

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Career Opportunities

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

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

Laminator Technician

Nature of Duties/Responsibilities

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

Education/Experience

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

Wet Process/Plating Technician

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

Purpose

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

Nature of Duties/Responsibilities

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

Education and Experience

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

Production Scheduler

Main Responsibilities

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

Education and Experience

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

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Career Opportunities

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

Software Support Engineer

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

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

Experience

- Bachelor of Science in computer science or related field preferred

Applications Engineer

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

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

Experience

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

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Career Opportunities

PCB Field Engineer–North America Operations

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

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

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

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

RESPONSIBILITIES INCLUDE

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

REQUIREMENTS

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

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

SALARY

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

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Prototron Circuits

Sales Representatives

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

Reasons you should work with Prototron:

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

Interested? Let's have a talk.
Call Dan Beaulieu at
207-649-0879
or email to
danbbeaulieu@aol.com

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Career Opportunities

Application Engineer (m/f/d)—Fulltime, Germany

Our company is expanding its product portfolio into custom made products. This creates the need for an Application Engineer to provide technical support to our existing sales team and customer base.

Responsibilities:

- Analysis of incoming technical data and handling of engineering questions
- Technical consultation of customers (incl. new customer specifications and discuss with relevant technical and quality teams worldwide)
- Support and consultation for new projects
- Lead and/or participate in local, cross-location/global cross-department projects of various scale
- Develop and provide function-related trainings to existing and new staff in order to transfer and optimize know-how
- Provide technical solutions

Skills:

- Technical expertise in battery power solutions and technologies for Rechargeable and Primary cells and Battery Packs
- Mechanical background or knowledge to be able to discuss and manage other products, like custom made connectors, cable assemblies and keypad touch panels.
- Written and spoken English and German, any other European language a plus.
- Highly technical with a commercial flare.
- Self-motivated, ambitious, and eager to grow in a dynamic organization.

Interested? We are looking forward to your application!

Please send your application to **hr@cmit.support**. For any inquiries, please contact Mrs. Amélie Filler. For more information visit www.cml-globalsolutions.com

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Sales Manager (m/f/d)—Worldwide Locations

CML Group is a leading provider of Printed Circuit Boards. We develop tailor-made sourcing concepts for our customers worldwide creating strong partnerships and reliable connections.

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

Your Profile:

- Profound sales and technical expertise in printed circuit board industry
- Local market knowledge and ideally a customer base of contacts in one or more of the listed countries
- Have successful track records in developing new business opportunities
- Excellent command in spoken and written English and one additional local language
- Highly self-motivated, ambitious, eager to grow in a dynamic organization
- Able to work independently and have good communication skills and leadership skills
- Self-employed/contractor/commission-based agent also welcome

Your Target Markets:

- Europe: Spain, France, Germany, Netherlands, UK, Denmark, Sweden, Norway
- USA: New Jersey, Florida, Georgia, Michigan, San Jose, Bay area, Pacific Northwest and Canada
- Others: Singapore, Thailand, Malaysia, Australia, Brazil, Turkey, Russia, and South Africa

Interested? We are looking forward to your application!

Please send your application to **hr-china@cml-eurasia.hk**. For any inquiries, please contact Ms. Grace Feng. For more information visit www.cml-globalsolutions.com

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Career Opportunities

The Test Connection, Inc.

Rewarding Careers

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

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

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

Associate Electronics Technician/ Engineer (ATE-MD)

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

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

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Test Engineer (TE-MD)

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

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

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Sr. Test Engineer (STE-MD)

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

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

We proudly serve customers nationwide and around the world.

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

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Career Opportunities

EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Maintenance Technician

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

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Plating Operator

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

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EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Water Treatment Operator

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

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

apply now

Drilling Operator

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

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

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Career Opportunities

Sheldahl®

A Flex Company

Sheldahl, a leading provider of flexible interconnect products and electronic materials, is seeking candidates to join their diverse and skilled team.

We are looking for people who demonstrate:

- Intense collaboration
- Passionate customer focus
- Thoughtful, fast, disciplined execution
- Tenacious commitment to continuous improvement
- Relentless drive to win

Positions in America include:

Project Manager – Northfield, MN

Candidate will provide timely cost estimation and project budget definition, be responsible for maintaining customer relations, participate in meetings, etc.

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Program Manager – Specialty Films

Candidate will work with our Specialty Films in the Aerospace, Medical, and Commercial Aviation markets providing timely cost estimation and project budget definition, maintaining customer relations, participate in meetings, etc.

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Program Manager

We are looking for a candidate with a passion for customer service and a commitment to continuous improvement.

Responsibilities:

- Provide timely cost estimation and project budget definition; recommend pricing and estimate lead time.
- Maintain excellent relations with both new and existing customers.
- Review new applications and provide technical support.
- Keep apprised of relevant applications, quality and regulatory standards.
- Participate in contract review and price negotiations.
- Ongoing margin analysis; identify potential necessary price adjustment opportunities and cost reduction projects.
- Participate in the creation and maintenance of technical documentation.
- Manage the coordination of product life cycle activities with team including account management, customer service, purchasing, operations and quality on customer matters.

Requirements:

- Effective technical communicator
- Four-year Engineering degree or equivalent work experience
- PMP preferred
- 7-10 years Product Engineering or Product Management experience
- Well versed in Advanced Technical Materials (Aerospace and Defense preferred)
- Self-starter with trouble shooting/problem solving skills
- Computer savvy, quick learner
- Open to travel

Preferred Experience:

- Project management and planning, ERP systems, CRM Software, spreadsheets
- Experience with cost and project modeling

Benefits:

- Full range of medical benefits
- Life Insurance
- Matching 401K
- PTO
- Tuition reimbursement
- Employee discounts at local retailers

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Career Opportunities

ARLON ELECTRONIC MATERIALS

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

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

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

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

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

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

apply now

KOH YOUNG TECHNOLOGY

Logistics Assistant

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

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

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

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Career Opportunities

MivaTek Global

Product Manager

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

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

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

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

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

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.

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Career Opportunities

SIEMENS

Siemens EDA
Sr. Applications Engineer

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

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

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

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

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U.S. CIRCUIT

Plating Supervisor

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

Competitive benefits package. Pay will be commensurate with experience.

Mail to:
mfariba@uscircuit.com

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Career Opportunities

BLACKFOX
Premier Training & Certification

IPC Instructor

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

Independent contractor, possible full-time employment

Job Description

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

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

Qualifications

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

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

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

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

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

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

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Career Opportunities

Now Hiring

Director of Process Engineering

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

Job Summary:

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

Duties and Responsibilities:

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

Education and Experience:

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

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Now Hiring

Process Engineering Manager

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

Job Summary:

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

Duties and Responsibilities:

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

Education and Experience:

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

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Career Opportunities

INSULECTRO

Are You Our Next Superstar?!

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

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

View our opportunities at Insulectro Careers (jobvite.com)

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eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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Career Opportunities

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

apply now

Pre-CAM Engineer

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

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

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Process Engineer

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

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

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Career Opportunities

Manncorp™

SMT Operator
Hatboro, PA

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

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

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

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

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

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Manncorp™

SMT Field Technician
Hatboro, PA

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

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

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

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

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I-007e

ROUNDTABLES

Lively and insightful discussions from industry experts. Watch now!

App Notes
and Fab Notes

Process Ionic Contamination
Test (PICT) Standard

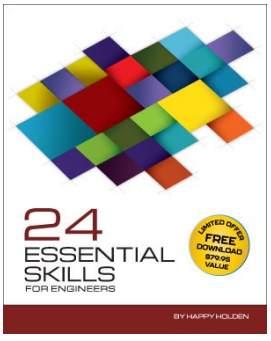
Achieving Operational Excellence
in Electronics Manufacturing

Use of IMS Thermal Materials
in Multilayer Stackups

I-Connect007
GOOD FOR THE INDUSTRY

New from Happy Holden:

24 Essential Skills for Engineers



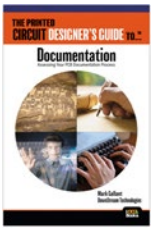
This book is a blueprint of the strategies that Happy has used for decades to overcome engineering challenges. Each chapter is devoted to a skill that engineers do not typically learn in college, such as problem solving, design of experiments, product and process life cycles, Lean manufacturing, and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

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

Thermal Management: A Fabricator's Perspective

by Anaya Vardya, American Standard Circuits

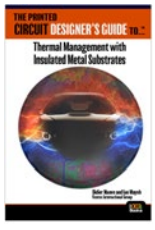
Beat the heat in your designs through thermal management design processes. This book serves as a desk reference on the most current techniques and methods from a PCB fabricator's perspective.



Documentation

by Mark Gallant, Downstream Technologies

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



Thermal Management with Insulated Metal Substrates

by Didier Mauve and Ian Mayoh, Ventec International Group

Considering thermal issues in the earliest stages of the design process is critical. This book highlights the need to dissipate heat from electronic devices.

Fundamentals of RF/Microwave PCBs

by John Bushie and Anaya Vardya, American Standard Circuits

Today's designers are challenged more than ever with the task of finding the optimal balance between cost and performance when designing radio frequency/microwave PCBs. This micro eBook provides information needed to understand the unique challenges of RF PCBs.

Flex and Rigid-Flex Fundamentals

by Anaya Vardya and David Lackey, American Standard Circuits

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

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

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CREATIVE TECHNOLOGIST: **BRYSON MATTIES**

COVER: **SHELLY STEIN**

COVER IMAGE: **ADOBE STOCK © WACHIRAPHORN THONGYA**

PCB007 MAGAZINE®
is published by BR Publishing, Inc.,
942 Windemere Dr. NW, Salem, OR 97304

September 2021, Volume 11, Number 9
PCB007 MAGAZINE is published monthly,
by BR Publishing, Inc.

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