I-Connect007

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SMT007 MAGAZINE

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Smart Processes

In this issue, we explore smart processes in assembly. First, we ask, “What is a smart process?” Then, we look wider and deeper at smart processes by examining the value of a chief process improvement manager (CPIM) in your organization, considering smart and optimized procurement practices, and much more.

FEATURES

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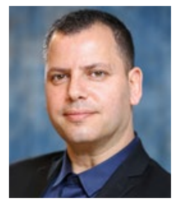
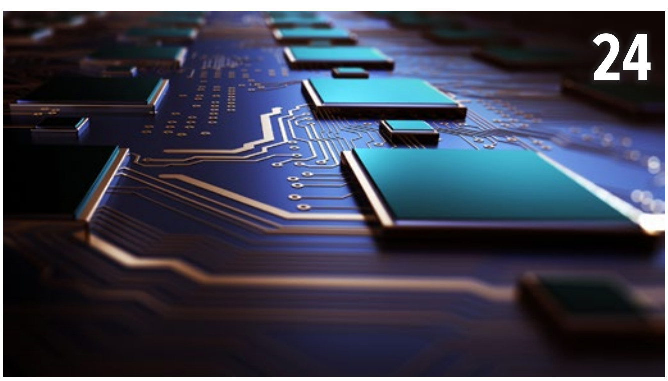
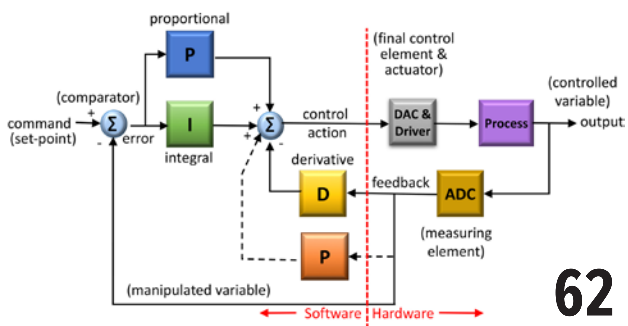






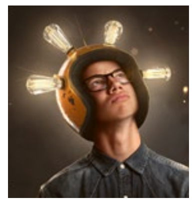
62

SMT007 MAGAZINE

ARTICLES

SHORTS

COLUMNS



HIGHLIGHTS

DEPARTMENTS

Who's Feeling the Pinch in a Smart Process?

Nolan's Notes

by Nolan Johnson, I-CONNECT007

In my February column, I shared the story of stumbling upon the 2015 BBC production titled "Building Cars: Secrets to the Assembly Line," hosted by James May. It seems that using automotive assembly as an example from which to learn is apropos these days.

As reported in *The Financial Times* on February 3, 2021, "General Motors has ordered a shutdown at three plants and slowed production at a fourth as it grapples with a global shortage of semiconductors," continuing to point out that "2021 production targets were under threat as a result." Back in December, Tesla was reported to be planning temporary shutdowns due to semiconductor shortages. Volkswagen, as well, is widely reported to be feeling the squeeze on the assembly line. The same is reported to be true at Continental.

Surprisingly (well, surprising to me), automotive manufacturers are reportedly quite far down the priority list when supply is short. DW's reporting (the English-language news feeds from German broadcaster Deutsche Welle) states, "The auto industry is known to be down in the pecking order as far as chipmakers are concerned. They favor consumer electronics companies, such as Apple, as their orders are larger, and they pay better."

Obviously, having parts shortages idle your manufacturing—your money printer, if you will—has a significantly negative impact on your ability to operate profitably. I don't know the actual numbers, of course, but my question is: Does the savings automakers realize by squeezing semiconductors so aggressively on price that they are now ranked as a low priority customer save them more than they lose in revenue after shutting down? Given that GM is warning investors that their 2021 sales targets are at risk, I'd have to venture to guess that the answer is "no."

These are powerful questions to ask, and meaty topics to investigate. In this issue, we explore smart processes in assembly. First, we ask, "What is a smart process?" Well, to be fair, Michael Ford asks the question in his article. We also look wider and deeper at smart processes, including the value of a chief process improvement manager (CPIM) in your organization. We consider, with the help of supply chain expert, Tim Rodgers, how smart factories and smart processes interconnect. We also bring you a recent technical paper on PCQR^2. Tuan Tran, director of customer solutions at Green Circuits, discusses the role and impact that assembly process engineering has on the profitability of your business. Michael Ford adds a second conversation, bringing us up to speed on CFX updates in v1.3.

Read closely and this issue highlights some key points repeatedly:

- Smart processes are not the same as automated processes
- Continuous improvement is not just for the manufacturing floor
- Process improvement is so important, it deserves a C-suite job function
- Procurement is also a candidate for smart processes
- Efficient and profitable companies approach continuous improvement as a standard business practice
- Lower component prices might just cost you more in the long run
- Smooth operational flow is the most significant contributor to efficiency

As we examine the effects of $X = X_c - 1$, this year we remind ourselves in this issue to make our processes smart—and sustainable—before launching into automation. Keep your business running smoothly above all else, and avoid the pitfalls currently felt by the automotive industry. **SMT007**

Nolan Johnson is managing editor of *SMT007 Magazine*. Nolan brings 30 years of career experience focused almost entirely on electronics design and manufacturing. To contact Johnson, click here.

Smart Is Not a Binary Concept

Feature by Michael Ford
AEGIS SOFTWARE

"Smart" is not simply an "on" or "off" state. Just like people, some solutions are "smarter" than others; as we see from the various ways of measuring intelligence within humans, there are many kinds of "smarts." When looking to invest in a smart manufacturing strategy, the playing field is more complex than it may appear. We should first understand and define what "smart" means, to what extent it exists, and the other requirements and dependencies that are needed to get the best value from investment.

Perhaps we should start with the IQ test, a measurement of intelligence attributed to people. Could we not have a scale for the intelligence of smart processes? As an adjective, "smart" sets expectations, but there is a huge gamut of actual intelligence or cleverness that can pass for smart. Perhaps we can create an AIQ (artificial intelligence quotient) scale to help us.

At the bottom of the AIQ scale, I would place the smartphone, which does nothing unless you press a button or configure an action to make it do exactly what it was programmed to do. The functions shortcut many otherwise manual actions. Smart functions are normally associated with software, though that is not to say that hardware cannot also be smart. A modern domestic sewing machine, for example, enables a novice operator with little skill or experience to create all manner of amazing stitching patterns. It is "smart" in that it augments human capabilities.

A mechanical manufacturing machine-based process—anything from a simple SMT placer to an assembly robot arm—is likely to be at least as smart as a smartphone. They basically do what they are told to do as a replacement of otherwise manual operations. Results of Six Sigma experiments tell us that there will always be variation in mechanical movements, resulting in slightly different results each time. Sensors are therefore built into machines and linked with the control logic, acting as feed-

back to make sure that the operational movement meets expectation, avoiding excessive or incorrect actions.

Machine Learning

Expanding on that principle of direct feedback in a smart way is machine learning (ML). For example, an inspection machine will modify its assessment of passes and fails as a result of changed settings determined from analysis of prior judgements. This expands out to become "closed-loop" feedback where two or more different machines are involved. For example, deviations in X, Y, and rotation position of placed SMT components are measured by an inspection machine. Then, by an analysis of patterns and trends in the data, parameters are changed to reduce the deviation in placement. Subtle live alterations to the placement process can be done automatically, or the alarm is raised to call for an operator to replace a worn nozzle, for example. Instances of defects are then avoided by not allowing any deviations to go beyond control limits.

These smart technologies, available today, are used to correct and refine actions that are performed, enhancing the effect of the original sensors. It is interesting to note that practical implementation of these steps has been enabled by expanded communication of data between machines that are likely to have come from different vendors. Technologies such as IPC-CFX (Connected Factory Exchange) have revolutionized the ability to share and utilize actionable data in a singularly defined format and meaning, without the need for middleware and IP exchange. This has been smart. We are certainly now higher up the AIQ scale, as demonstrated in this simple example, by the order of magnitude of defects found at test. But the losses are not yet reduced to zero. Our degree of "smart" is not yet perfect.

Are we not curious as to why these closed-loop technologies do not produce perfect yield? Clearly there is more variation going on than we thought, some of it subtle, and perhaps resolvable with a refinement of the rules within the closed-loop or machine learning software algorithms. The real loss of traction, however, is caused by significant external changes, such as:

- The change of any specific materials being used from one supplier to another, introducing a small dimensional change
- A new batch of PCBs that have slightly different positional distortions inherent to their manufacturing processes
- Just a change in the product being produced as the schedule for highly mixed production is followed

Incorporating Data

Expanding our horizons once more, to include logic around these sources of variance, means bringing in MES factory-level data, allowing the feedback analysis software to understand the root-cause of many more sources of variation and associated potential effects, enabling smart software to go beyond its current limitations, based on the existing scope. This next step puts us higher again on the AIQ scale, as we are incorporating more data into the decision-making process—again made possible using CFX-based best practices to eliminate needless costs and complexities.

All the steps discussed so far are referred to as being "smart," but clearly there is quite a difference in the degree of smartness, depending on each implementation, bearing in mind that this was just a simple example. Each successive step brought us up the AIQ scale, but has each step really been "smart" in terms of incorporating intelligence? The software still cannot think for itself; it is following pre-programmed rules and flows, just like the phone and sewing machine. It is simply the inclusion of more and more data, allowing more and more algorithms to be developed and applied. Some argue that people appear intelligent simply because of the sophistication of the sheer amount of data that we capture through our senses, and how the rules within us have evolved as we interact with our environment. Some even say that our actions are predestined, that we as people are also responding predictably to stimuli experienced in everyday life, albeit rather complex. What makes us and other higher forms of life different, however, is the degree of curiosity. People appear to have a will to think, which manifests as wanting to try new things, measuring the results, and learning from the result. But is curiosity still simply a result of getting data, making an analysis, and taking an action? As more and more data is shared between shop-floor entities, including inter-operability between solutions, making algorithms more and more sophisticated, will we at some point create artificial curiosity? Instead of the AIQ scale, we may want to consider a CQ scale, as we create the essence of real intelligence.

Conclusion

In the selection of smart technology, be it Industry 3.0 hardware automation, Industry 4.0 software automation, or preferably both together, the ultimate potential benefit as we create and evolve the sentience of manufacturing, is the ability to utilize more and more data, from many different sources, and from many different vendor solutions, all living on the same interoperable platform. The new IPC-2551 digital twin is intended as a way forward in this respect. The artificial tying-in and restriction of customer value based on proprietary data and related artificially imposed restrictions, prevent available solutions from expanding their value. This stifles innovation, and imposes repeated costs related to updated or replacement solutions. With a clear differentiation in the industry of those companies that do actively participate, and lead, in standards-based data exchange vs. others who continue to seek to profit from taking advantage of data exchange restrictions, the choices available to those investing in smart technology should be clear. **SMT007**

Michael Ford is the senior director of emerging industry strategy for Aegis Software. Ford is also an I-Connect007 columnist. Click here to read *Smart Factory Insights.*

What Makes a Good Process Engineer?

Tuan Tran, Green Circuits

Feature Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson recently spoke with Tuan Tran, director of customer solutions at Green Circuits, about what makes a successful process engineer. They also discuss a typical day in the life of a process engineer—from pre-manufacturing through post-DFM, for process improvement. As Tuan points out, there are a variety of paths to becoming a great process engineer.

Nolan Johnson: For a process engineer in PCB assembly, what's a typical day in the life? How do you identify areas for continuous improvement?

Tuan Tran: Process engineering in assembly is very important in the sense of the two different worlds: production and NPI. The NPI, which is the prototype, is more valuable, but even production is valuable. We get a product from a customer that we need to build. A process engineer's job is to make sure we build it properly. In order to build it properly, the process engineer should really engineer the job. Basically, we receive the data from the customer, analyze it, and figure out how we are going to build this job. Because the people on the floor are manufacturing people, they build what you tell them to build.

They look at the print, they look at the drawing, and they're going to build exactly what you tell them to build. It is the process engineer's job to look at that data, dissect it, figure out which type of solder we need to use, and how thick of a stencil I should order. What is the process flow the product needs to go through? Do we do the top side first and then the bottom side or vice versa, and then what type of solder do we use? No-clean solder or regular solder? Do we use leaded solder or non-leaded solder? The process engineer needs to read the data, then identify and figure out how to build this board. I can write a good, detailed process instruction and when I release it to the floor, the manufacturing people will understand it and build it correctly. In that sense, the process engineering is very important to be able to tell

the people in manufacturing how to build this board.

Now, the second part of the job for process engineering is after they have engineered this job we released on the floor. Does that mean it's going to be 100% perfect? Not necessarily, especially on product that we're building for the first time. It goes onto the floor and then we're building it, and sometimes there's a lot of catch-up or a lot of issues that come up and the manufacturing people say, "Wait a minute, this part doesn't fit." Or "How come I'm not getting the good results that I want? I'm seeing issues." The process engineer's job is now to dive in while it's on the floor, look at it and say, "I see a problem here. Let's figure out this problem." Either a) I go back to the customer and discuss this issue with whoever designed the product, or b) This is the problem I need to fix. I need to change the profile. The process engineer needs to get involved in that.

And then sometimes they need to get involved because the operator or the manufacturing people don't quite understand what needs to be done. The process engineer needs to explain it to them in manufacturing terms they understand so they can build it. Pre-engineering concentrates on DFM, design for manufacturing. Later, during the finished-product part of the process engineering, we call that post-DFM. We finished a product, it's done, but we found a lot of issues when we built it, so it's process engineering's job now to write up a post-DFM report for the customer. There are two things that we're looking at for post-DFM. We're looking for the issues we've found, such as: you need to fix this to make this more manufacturable next time, or here are some improvements; or, it looks good, but here's the stuff you can do to make this product easier to manufacture or to reduce costs.

The other thing we're looking for is to reduce cost. We had to put this part on by hand. If you turn it this way, we can do it by the machine and that will save you a lot of time, a lot of cost in production. Those are the three key things that a process engineer should do: use pre-DFM design rules and write it up so the manufacturing people know how to build it; support in-process manufacturing to figure out any issues and resolve those, and the post-DFM, how to make the product better; and identify the issue so the customer, when they redesign this thing, knows what to fix for the future.

Johnson: As you're doing this analysis in assembly, you're measuring, identifying, and making incremental changes to optimize and then measure the results of those changes. Are you constantly looking at each one of those jobs to see if you can find a way to improve it?

Tran: Yes, until you get to the point where stuff is being mass-produced. Like a cellphone, you can't build at that quantity for the first time in production, not prototype, and then say, "I figured it out the first time, now we can just produce 100,000 every week with no issues." Once you get to that 100,000, I can guarantee you that three months later you're thinking, "You know what? We've been cranking out 100,000 every month, but there's still a little thing I can tweak and make it better." And then when you've fixed that and you think you've got 100% of the bugs out, then you might say, "We're doing great, but I think I just found something else to make it better." So, that's continuous improvement.

Sometimes it has nothing to do with the product we're building, but it's the process we're building. We're finding easier ways to do things. If we do something by hand we figure out, "Oh, I put this on a machine, and I can actually change this on the machine and go even faster." Or after that, I might think, why don't we get another tooling involved so we can even go faster after that? It's always a continuous improvement. A process engineering job is not just, "Hey, I figured out how to build it." It is, "How do I improve it all the time?" And then sometimes it's not just improving the product, but it's also reducing costs. We built it very efficiently but how do I reduce cost? A lot of time cost comes into play in the sense of the cost of material and manufacturing. Can I get a better product cheaper and still get the same result? Or can I produce this faster, get the same results, and both of those will reduce costs?

Johnson: Are you able to do both? That becomes an interesting dynamic for you as you're continuously improving. You're basically finding ways to increase the margin for your company and/or the customer.

Tran: When you increase efficiency, sometimes it's just for yourself. A good example is the COVID vaccines coming out. The new thing I heard this week is that they were producing some percentage more. They're not reducing the amount of vaccine in the bottle; the efficiency of pumping it out has gone up. They just made it quicker. And how do they make it quicker? That's always process improvement.

Johnson: That's a great point.

Tran: That's where the process engineer plays a key role.

Johnson: How do you quantify your optimizations?

Tran: In our industry, a few things play into process improvement. First is quality—my yield. If I'm building 100,000 units and I'm getting 5% failure all the time, if I can continue manufacturing 100,000 units, but instead of having 5% defects I only have 2%, I basically just improved my process. The quantity of yield has gone up effectively, but the quantity produced is still 100,000.

And second is time improvement. Instead of 100,000 units in a week, can I do 110,000 units? So, I can improve it in two ways, quantity and quality. Those are the two things process engineering is always trying to get. How can I get better yield? Or how can I produce more without sacrificing yield? We can always produce 200,000 units, half garbage, and it comes up the same. I'd rather build 100,000 and have 95% yield than build 200,000 and 50% yield. It comes out to the same math.

Johnson: How did you come to this job, Tuan? What's your background?

Tran: I fell into this industry by mistake. I wanted to study law. It was a part-time summer job during my senior year of college right in the middle of the dotcom boom. They asked me to stay because I was doing pretty well, and then I started learning from the ground up. I was on the manufacturing floor and learning every station in customer service and program management. I worked myself from the bottom all the way up. I think that's very good for anybody who wants to get in any industry, because you understand what it takes from ground zero all the way to a finished product.

Johnson: What makes for a successful process engineer? What traits or skills should someone bring to the job? Do they need an engineering degree? Your background would say that it's not required.

Tran: An engineering degree is great to have as a background. Good analytical and critical thinking skills are very important because a lot of the issues that come to you are not always the same. For example, with my doctor, if my back hurts, it's very easy: just look at my back. Here, we get a board that doesn't work and there are 10 different things that could make the board not work vs. 10 different things where we have yield problems. You've got to have good analytical and critical thinking skills to be able to think, "What can I do to eliminate and get to the root cause of why we're having low yield or why the product doesn't work?" And then you have to able to dissect it from there, find a root cause and fix the problem.

Good analytical and critical thinking skills are very important because a lot of the issues that come to you are not always the same.

Johnson: Walk me through a day in your work life.

Tran: I'll give you today as a good example. I was pulled into a meeting this morning. We're having low yield on a customer product. I got into the meeting and I started walking through the steps. What are the steps involved in this product? What are we doing to this product? I go step-by-step. From there, I worked with the engineering team and we identified those areas where the product can fail, and we went through them one at a time. "Could it be this? No? Why? Tell me why it can't be this. Well, because we tested this section already. Okay, next section." I'm systematically eliminating issues. So now I'm down to two reasons why this thing could fail. Let's dive into those two reasons and figure out why it failed. And then once we figure out which one or both it is, we can say, "What do we do to implement so we can catch and get down to the reason why it failed?"

It's a lot of process elimination, analytical, step-by-step process control. Process control is huge because for what we do as a manufacturer everything has processes—whether it's five processes or 10 processes, to build a product. We just need to backtrack, figure out where in the process that it failed that's causing us the yield problem, the time delay, and then attack those processes to see if we can control them and make it better.

Johnson: You go through that sort of investigation nearly every day?

Tran: Yes, any time there's a failure. Sometimes I hear, "The customer wants us to build 1,000 units a week and we can only do 600." Well, let's look at it. What can we do to make it faster? How do we get the yield up? Do we use more manpower or machines to make it faster? Where can we eliminate that bottleneck or gap to make it better? As a process engineer, I'm always looking at how to improve the product better, whether it's time or quality. It's a constant battle.

Johnson: How much time do you spend on the initial analysis of a new build with a customer? As you see it, is that a significant part of the job as a process engineer?

Tran: Yes. I would tell you probably 80–90% of the product we build is cookie cutter and straightforward. There's 10–20% of our product

that we need to work on together with the engineer or the customer, because it's difficult or it's a brand-new product that hasn't been built before. We're spending sometimes a day or a week to go through the product and make a plan of attack. "What are the issues that can occur? How do we mitigate them and prevent them from occurring?" We spend quite a bit of time with customers resolving that. And when the product gets in-house, we will spend a lot of time diving into it. We answer questions like, "How do we plan to process this job?" and "How do we plan to build this job?"

What are the issues that can occur? How do we mitigate them and prevent them from occurring? We spend quite a bit of time with customers resolving that.

Then we keep an eye on what we think will occur and prevent it from occurring. That might include having a process engineer follow this project through the shop or having a stopgap for inspection; let's see if it looks good before we get to the next step. Usually, we'll do that on most new products to make sure we get a good view on it.

Johnson: Even when everyone is doing their job well, things happen. How do you respond? What do you do in your job to turn that around?

Tran: That can happen sometimes daily or weekly. A product shows up in your facility, and you think you have figured everything out and you build it, but you get poor yield or poor quality. That will happen. In those situations, it is the process engineer's job to look at that product from all angles and figure out if we missed something. If I didn't miss anything, then why are we having this problem?

When stuff like this happens, the best thing to do is start experimenting. Because it might be a product that you've never built before. Let's try a different type of material, a different type of process. Sometimes we might run sample boards three different ways and see what the yields are, gather that data together to figure out how we can get the best yield out of this process, and then apply that again to the product we're building and see if the yield goes up.

So yes, there are situations where you simply do not see it coming; it happens. And now you just have to figure it out. And the way to figure it out, a lot of times, is just sampling and experimenting—experimenting different angles, different ways to see if you can get a better yield.

Johnson: I'm hearing that you use intuition based on your experience, followed by scientific method in the form of going through systematic testing.

Tran: Yes. I will say in our industry, for process engineering, it doesn't matter what kind of degree you have, or what kind of background you have. The most important thing is being on the manufacturing floor, seeing the product being built, understanding it, and getting your hands dirty. That's where you can become a better engineer and understand products better. Everything that you read in your books and all the studies you do are great and will arm you with some knowledge when you come onto the floor, but nothing will get you more experience and get you ready to be a process engineer than being on the floor, getting that process in your hand, and getting your hands dirty.

Johnson: That's a perfect ending. Tuan, thank you.

Tran: Thank you, Nolan. SMT007

Coming Out Ahead With Smart Processes

Tim Rodgers

Feature Interview Excerpt

During a recent interview with Dr. Tim Rodgers that focused on supply chain management, the conversation also touched on smart factories. We've included Tim's insights on smart processes here.

Dr. Tim Rodgers is a faculty instructor at the University of Colorado Boulder, Leeds School of Business. Before joining the faculty at Leeds, Dr. Rodgers worked in a variety of senior positions in operations and supply chain management at both multinational corporations and mid-sized companies.

Barry Matties: Do you see automation as the big equalizer here in America? There's got to be a push for this as we're seeing smart factories, and such.

Tim Rodgers: Certainly, the companies that are investing in smart factories, smart technology, and more automation are going to come out ahead. I'm seeing a lot more of this in China than in the U.S. Part of that is because it's become a national imperative; the national government is supporting that push toward smart factories, whereas in the U.S., it tends to be more of an individual company initiative. I'm a little bit worried. I used to believe that we didn't have a lot to fear because American ingenuity and engineering would figure out the next best way to manufacture and those new technologies would derive from the U.S.

I'm a little less optimistic now, just because we're only seeing some smart factory islands and some innovations around the Internet of Things. All of that is wonderful, but it's not very well coordinated. It's meant to benefit individual businesses. I'm sure there are some academic partnerships that are helping to drive automation, but it's piecemeal as opposed to what we see in China.

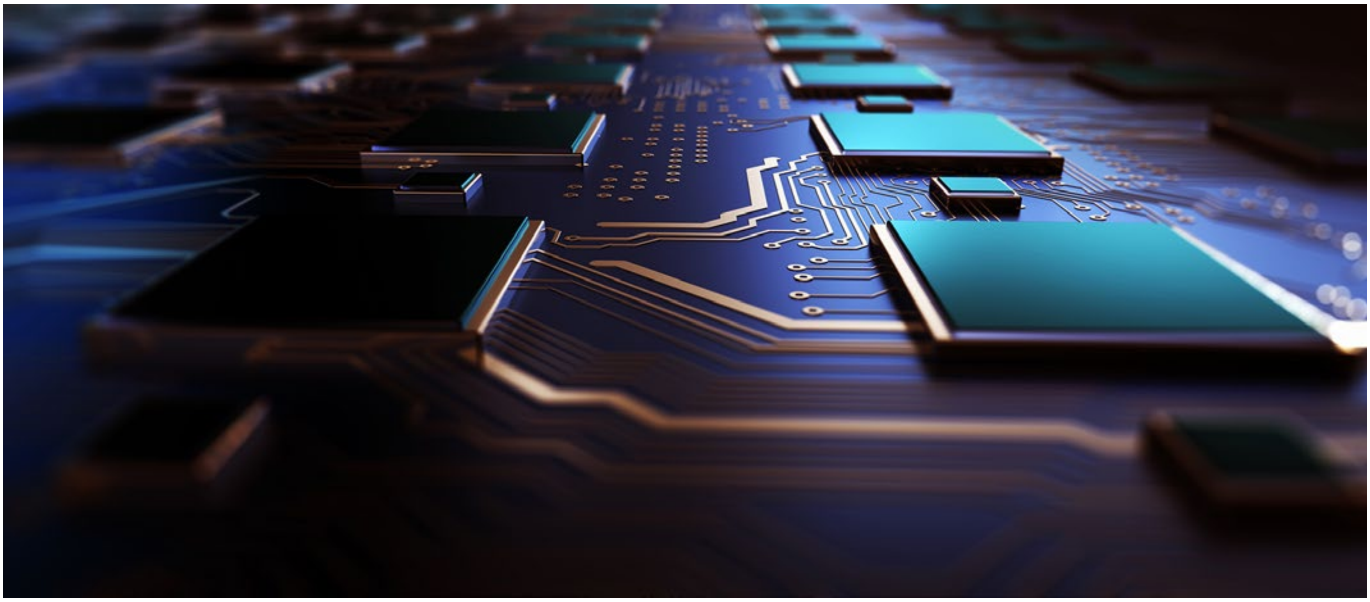
Matties: I wonder what the motivation will ultimately be, because if you can still go to China and buy it cheap, why invest in a smart factory here?

Rodgers: That's a good point. It's a significant investment, and it's also a significant change in the way these factories are being run. In some cases, the technology itself already exists. We don't have to invent anything new, but actually implementing it is still more expensive than just buying it off the shelf. We're always going to take the path of lowest resistance.

Matties: Maybe, as we see, there's an acknowledged shortage of engineering labor for implementing a smart factory.

Rodgers: Yes, there's a lot of emphasis on employment, which I think is important. I understand why people are worried, but these smart factories will require fewer people to run them. If our emphasis is on employment—keeping more people and just growing the size of the labor force or trying to save old 20th century jobs—we're going to miss the bus completely. **SMT007**

Look for the full interview with Tim Rodgers in an upcoming supply chain issue of SMT007 Magazine.



PCB Sourcing Using PCQR²

Feature by Al Block, Naji Norder, and Chris Joran
NATIONAL INSTRUMENTS

Editor's Note: A paper updating the IPC-9151D standard will be part of the IPC APEX EXPO 2021 technical program. We are publishing this precursor paper in coordination with the updated research to be shared during the conference.

Abstract

In a global market, it is often difficult to determine the best PCB suppliers for your technology needs, while also achieving the lowest costs for your products. Considering each PCB supplier has their own niche in terms of equipment, process, and performance, uniform test data from the IPC-9151D Process Capability, Quality, and Relative Reliability (PCQR²) Benchmark Test Standard can help find the right source for the board based on its specific technology requirements. By using a data-based approach to vendor selection, this can remove the subjective nature of sourcing, reduce the need for PCB process experts to map suppliers into technologies, and eliminate irrational sourcing decisions.

By incorporating the standard results into our corporate quote model, our company has significantly lowered costs, both by helping to get each board to the right supplier and by reducing failure rates during development, in production, and in the field. Using PCQR², the company screens for suppliers that can deliver consistent quality utilizing statistical process control (SPC) to monitor and control their process variables, filtering out those that rely on specific employees for temporary success.

In addition, the company can track PCQR² performance trends from submission to submission, allowing for the observation and correlation of capability advancement with improving equipment and processes. Using this data, the company can then push our supply base by challenging them to build higher-technology PCQR² samples when ready, which, in turn, moves them higher in the quote model and leads to more quoting opportunities and higher revenue.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WORLDWIDE ENVIRONMENTALLY RESPONSIBLE CLEANING TECHNOLOGIES

Introduction

Our company provides products and systems for a wide variety of applications. This requires a supply chain that can support and thrive in a high-mix, low-volume environment. With over 1,000 unique PCB designs, one of our challenges is sourcing boards to the "right" shop with the best mix of technology, capacity, and cost. Compounding this challenge, PCB sourcing is decentralized, so each R&D team has the ultimate decision on which shop is awarded the business. A data-based approach to supplier qualification using the IPC-9151D Process Capability, Quality, and Relative Reliability (PCQR^2) Benchmark Test Standard, built into a company quote model, guides each request for quotes to the correct subset of suppliers based on the board's technical requirements and allows R&D teams to focus on price and delivery when making the final vendor selection.

Background

Prior to PCQR^2, the PCB quoting environment was haphazard. Many sourcing decisions were of a subjective nature, based on individual R&D teams' past experience with a given vendor regardless of PCB technology requirements. Quote requests were sent in various formats (spreadsheets, documents, handwritten, email, etc.), sometimes lacking data pertinent to the PCB cost. Every supplier received every quote request, so some shops were being asked to quote, and in some cases, build boards for which they were not qualified. When this resulted in failures during prototype validation, R&D was set back and the product release delayed. In other cases, the experience of employees at the suppliers, working above and beyond the capabilities of their processes and equipment, could deliver boards of sufficient quality for validation and production. Such a production methodology—where key workers produce "art" instead of following a process to yield a product—represented a risk to supply continuity that presented itself as a challenge to our PCB commodity team.

Quote Model

To solve this challenge, the team needed a dynamic, automated solution, one that would scale with and adapt to changes in the supply base, technology, and market. The solution chosen was to develop a company quote model. A standard quote form, filled out by the PCB designer with the board specifications, expected volume, contacts, etc., captured data in a uniform format and ensured completeness. The PCB specifications could then be fed into the quote model database to determine qualified suppliers. Initially, suppliers were stratified into low, medium, and high technical capability, and only those suppliers deemed qualified to build a board, given its technology, would receive a request for quote. The R&D team could be assured that each and every received quote was valid, and they could evaluate based on a simpler subset of criteria: prototype or production costs, and lead times.

How, then, should we determine the proficiency of each supplier at each facility? Most vendors state their process capabilities on their websites. These are useful to determine rough competence, but they are also never 100% accurate or reliable. Onsite audits were and continue to be helpful, but these are still somewhat subjective, and using them exclusively to qualify suppliers could require us to retain or hire content experts above and beyond those required for any other commodity. A custom qualification board would allow shops to demonstrate their capabilities on the specific technologies required for the next few generations of company products, but this would require the commodity team to develop test vehicles and manage the evaluation of each sample, and it would be limited to only those suppliers who had received the test vehicle and built it. A better option was to use a third-party test vehicle, and the PCB commodity team chose the IPC-9151D test standard.

PCQR²

The Printed Board Process Capability, Quality, and Relative Reliability Benchmark Test Standard and Database, IPC-9151D, defines available test coupons and the tests to be performed on them. These coupons can be arranged onto a variety of test panels, currently 11 different options primarily differing in layer count, via structures, and trace geometries. Ideally, vendors would each produce the panel that best showed the transition from successful to unsuccessful production, establishing the boundaries of their production capabilities. To facilitate comparison of results between shops, we chose to focus on three panel types—10R, 18R, and 24VH—roughly corresponding with low, medium, and high technical capabilities. Vendors self-select the panel types they wish to attempt, though vendors who easily accomplish their chosen panel are encouraged to attempt a more difficult one on a future test cycle.

Figure 1 shows the dielectric and copper specifications, and through and blind via structures of the 10R-E panel intended as an entry point for the company's lowest-technology, lowest-cost suppliers. If a low technology vendor does not have equipment for microvia processing, they can choose not to build any or all of the V2 structures without impacting test of the rest of the panel.

As a supplier's technology increases, they can advance to a medium complexity panel, such as the 18R-E as shown in Figure 2. This board focuses on a higher level of technology with a reduced via size, highlighting a supplier's copper plating reliability and registration capability.

A more complex panel, such as the 24VH-E panel illustrated in Figure 3, allows higher-technology vendors to demonstrate more advanced via structures such as buried vias, skip microvias, and backdrilling, as well as the complex registration requirements of a higher layer count board.

To better evaluate suppliers' ability to maintain process controls over time, a test submission is built in three groups of three panels each, with the jobs spread out over several weeks. All panels are sent, untested, to a third party for evaluation of parameters such as conductor and space yield, via registration and

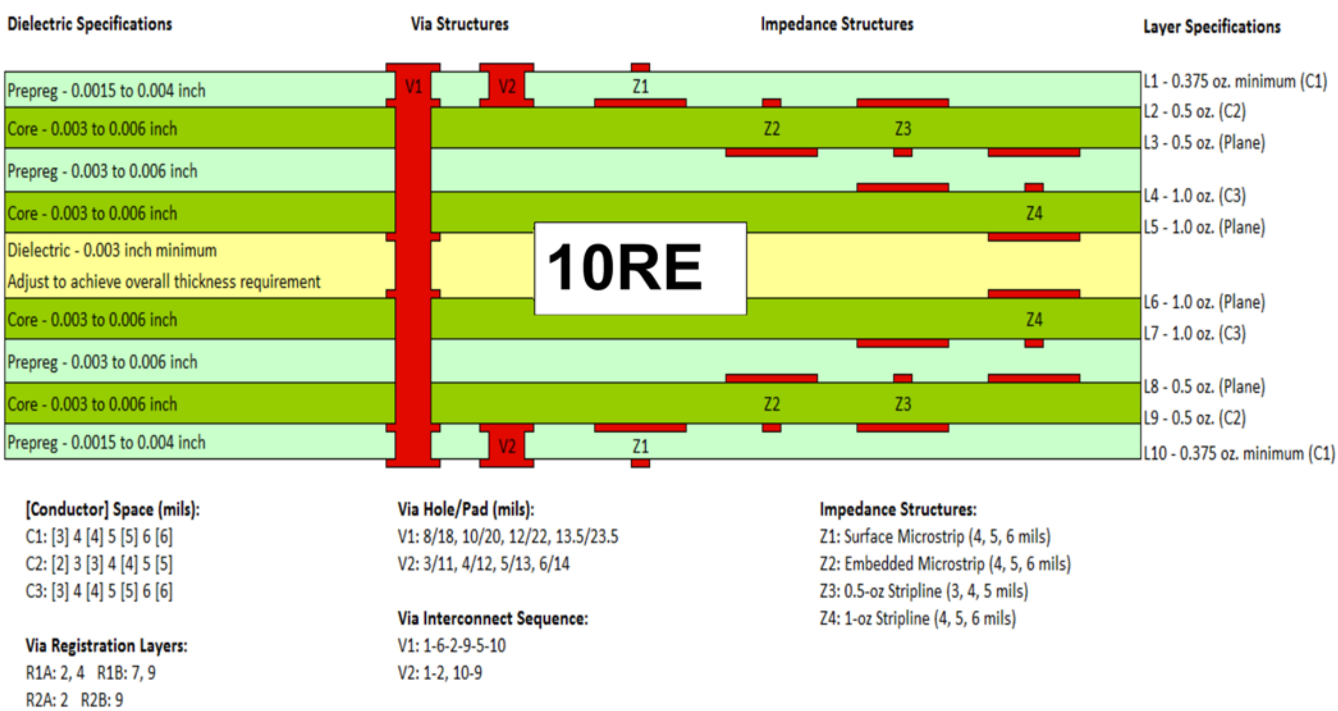

Figure 1: 10R-E panel stackup and via/trace structures.

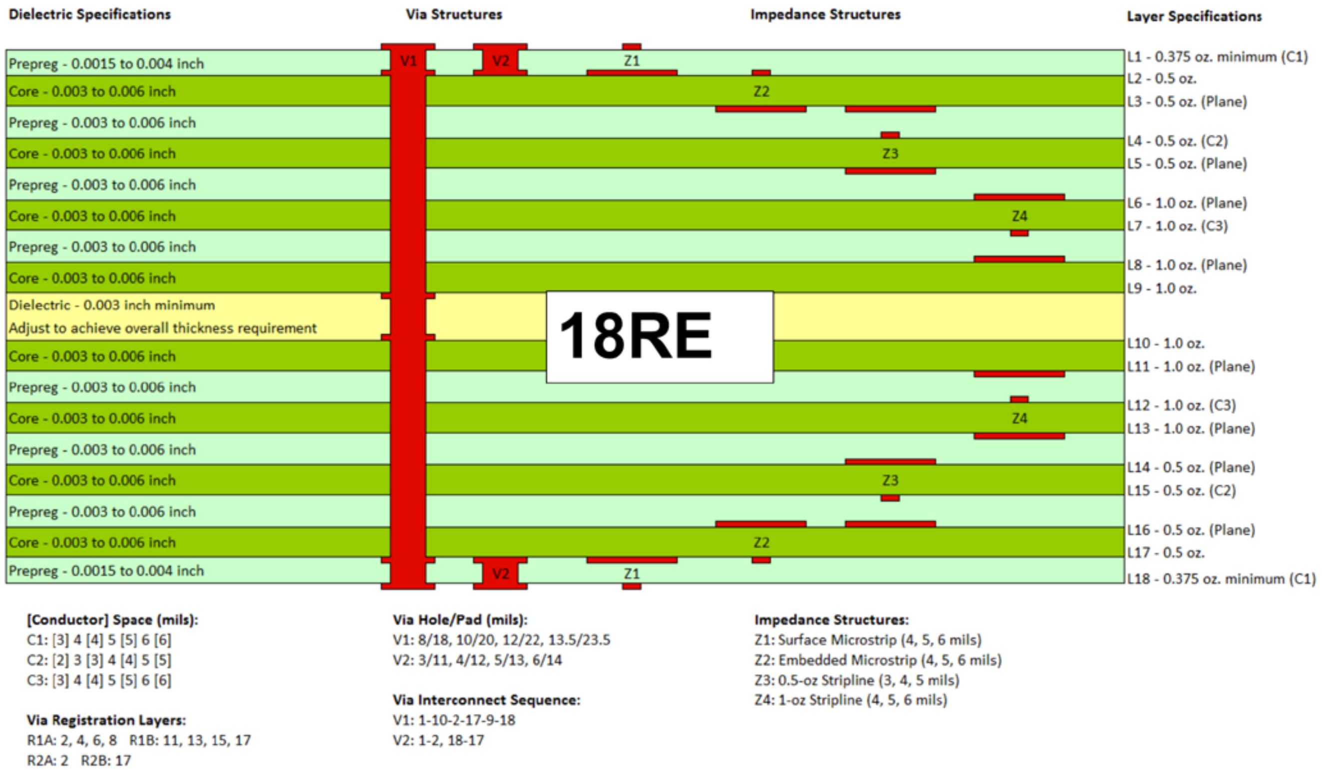

Figure 2: 18R-E panel stackup and via/trace structures.

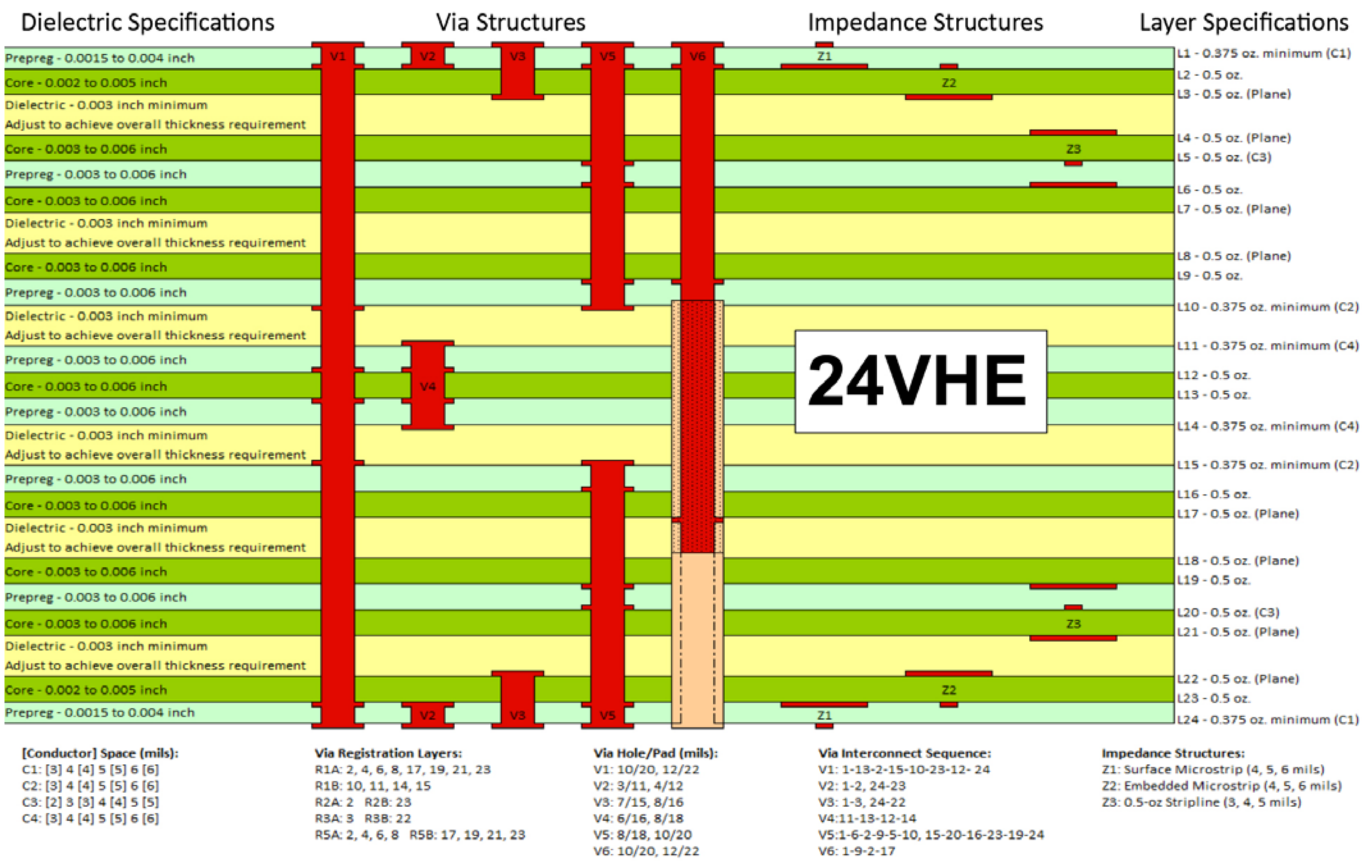

Figure 3: 24VH-E panel stackup and via/trace structures.

reliability, soldermask registration, and impedance control. Results are typically available in an online report or downloadable for processing. We compare the raw test data against an internal grading criterion to establish pass/marginal/fail limits based on company-specific needs.

As the quote model concept evolved, the original low/medium/high stratifications were supplemented with more than a dozen parameters related to specific board features. The smallest feature geometry on which a supplier can consistently meet the internal criteria drives that supplier's rating for that feature. By making PCQR² submission an annual requirement, vendors regularly demonstrate their ability to maintain their processes and the tangible results of their capital expenditures and process improvements.

Using PCQR² Results

These results can be quickly and objectively applied to our quote model. Figure 4 shows an example of quote model database logic. Boolean criteria are based on specific features the suppliers did or did not implement on their chosen submission, as well as other parameters such as ITAR capability and those established by audit. Minimum/maximum values are objectively established by PCQR² performance for each feature.

For example, consider the internal conductors of the 24VH-E panel. That test vehicle has internal conductors of widths 0.05, 0.075, 0.1, and 0.125 mm (2, 3, 4, and 5 mils). Most vendors are unsuccessful with 2-mil traces when compared against our grading criteria, while some succeed with 3-mil traces, more with 4-mil traces, and all with 5 mils. A shop that does not meet criteria at 4 mils but passes at 5 mils would be rated for a minimum of 5, while one that fails at 3 mils but is marginal at 4 and passes at 5, might be rated better (such as 4.5 mils) depending on the marginal performance. A flexible, customizable quote model can support other exceptions, such as that shown for Supplier 5 in Figure 4 where sequential lamination capability requires consultation with the PCB commodity team.

Collating the results of multiple submissions enables trend analysis. Data from four different PCQR² submissions are shown in Figure 5. The data in this example could be used in a trend analysis over time at Supplier #1 Site A, or between Supplier #1 Sites A and B, or between Suppliers #1 and #2. The results of such a trend

Control Mechanism for ITAR

Various Yes/No Criteria based on Results and Analysis

Various Min/Max values based on Results and Analysis

Tech	PCB Supplier	ITAR OK?	VP?	BD?	GF?	BB?	uVia?	SG?	SL?	Max Layer	Contr Imp	Thru Hole	Via in Pad	MinLine SL	MinSpc SL	MinLine Ext	MinSpc Ext	MinLine Int	MinSpc Int
H	Supplier 1 - Site A	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	28	5	0	0	0.006	0.004	0.003	0.004	0.003	0.003
H	Supplier 2	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	28	5	0	0	0.004	0.006	0.003	0.004	0.003	0.003
H	Supplier 3 - Site A	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	28	7.5	0	0	0.005	0.004	0.006	0.004	0.003	0.003
H	Supplier 1 - Site B	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	28	10	0	0	0.006	0.004	0.004	0.004	0.003	0.003
M	Supplier 4	No	Yes	Yes	Yes	Yes	Yes	Yes	*	18	10	0	0	*	*	0.004	0.004	0.003	0.004
M	Supplier 3 - Site B	Yes	Yes	No	Yes	No	No	Yes	No	18	7.5	0	0	N/A	N/A	0.0045	0.0045	0.004	0.004
M	Supplier 5	No	Yes	No	Yes	Yes	Yes	Yes	No	18	10	0	0	N/A	N/A	0.004	0.004	0.003	0.003
M	Supplier 1 - Site C	No	No	No	No	Yes	Yes	No	No	18	10	0	0	N/A	N/A	0.005	0.005	0.004	0.004
L	Supplier 6	Yes	Yes	No	Yes	No	No	Yes	No	10	10	0	0	N/A	N/A	0.0045	0.005	0.004	0.004
L	Supplier 7	Yes	No	No	Yes	No	No	No	No	10	10	0	0	N/A	N/A	0.005	0.005	0.004	0.004

VP?	Is approved for Via Plugging	uVIA?	Is approved for Micro Vias
BD?	Is approved for Back Drill	SG?	Is approved for Selective Gld
GF?	Is approved for Gold Fingers	SL?	Is approved for Sql. Lam.
BB?	Is approved for Blind/Buried	*	Conditional - Ask Al or Naji

Figure 4: Example of a quote model database.

Supplier Info				Conductor and Space 1.5 ounce (Outer Layer)																								4mil 1 Deep Blind Via		
				Trace								Space								
				3	3	4	4	5	5	6	6	4	4	5	5	6	6	Via Capability	Min Cycles to 10%	Min Cycles to Open
Supplier	Locations	Date	Stack up	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	DPMI 150<500	CV 6<10	250 >500	250 >500
Supplier #1	Site A	02/01/11	24 VHE	11.86	0	7.59	46	9.03	0	4.85	0	5.01	92	4.11	46	3.55	0	6.13	345.00	350.00
Supplier #1	Site A	03/05/12	24 VHE	13.09	433	7.97	238	11.03	95	4.64	142	4.08	1403	3.43	608	2.96	704	20.37	500.00	500.00
Supplier #1	Site B	08/01/11	24 VHE	10.86	327	7.27	0	6.03	0	4.52	94	4.83	1258	4.04	371	3.42	421	8.30	220.00	245.00
Supplier #2	Site A	10/12/12	24 VHE	0.00	0	0.00	0	6.03	0	0.00	0	0.00	0	0.00	0	0.00	0	7.10	275.00	285.00

Figure 5: Example of trend analysis.

analysis then help establish agenda priorities during onsite audits and can be correlated with production issues, or most importantly used to predict a production issue and resolve it before it occurs.

Benefits to the PCB Buyer/PCB Assembly Manufacturer

We see numerous benefits from sponsoring and sharing the test results of a third-party test vehicle such as $PCQR^2$.

- **Removes subjective sourcing.** Technical capabilities are established and advanced through objective metrics customized to our products' needs.
- **Helps weed out suppliers who do not support SPC/CIP in their corporate culture.** The test panels are designed to show the limits of a vendor's production capabilities and processes. Vendors that do not use statistical process control (SPC) cannot maintain consistency from lot to lot and submission to submission, and those without capital investment stagnate or fall backward in their test results. These objective measurements supplement audit results when deciding to address or disengage from a struggling supplier.
- **Drives supplier quality.** Figure 6 shows PCB PPM reject trending down as the technical capability of our suppliers (represented by the average layer count of $PCQR^2$ submissions) increases.
- **Reduces R&D time to market.** Any vendor that quotes a board has already demonstrated their ability to repeatedly and consistently build that type of board.
- **Right source/right price.** If technical capability is not an underlying concern, R&D purchase managers can focus on price as a deciding factor, helping drive business to lower-cost suppliers where the technology fits.
- **Drives supplier competitiveness.** We share generic results with all our suppliers, so they know where they stand relative to their peers.
- **Drives supplier technology and process improvements.** Quality issues can be correlated with weaknesses or slips in test results. Likewise, the benefits of suppliers' capital and process improvements can be tangibly demonstrated in their improved performance.
- **Increases customer satisfaction.** More products built through reliable and demonstrated processes means fewer failures and fewer escapes, leading to fewer field failures and customer returns.
- **Keeps manufacturing costs down.** Reliable products have fewer manufacturing issues and require less NCMR processing and out-of-sequence work. Moreover, using a third-party test vehicle is less expensive than developing an internal one.
- **Helps find new suppliers.** The test results are typically shared between all test sponsors, so we can see the results of all test submissions, not just those we sponsored.


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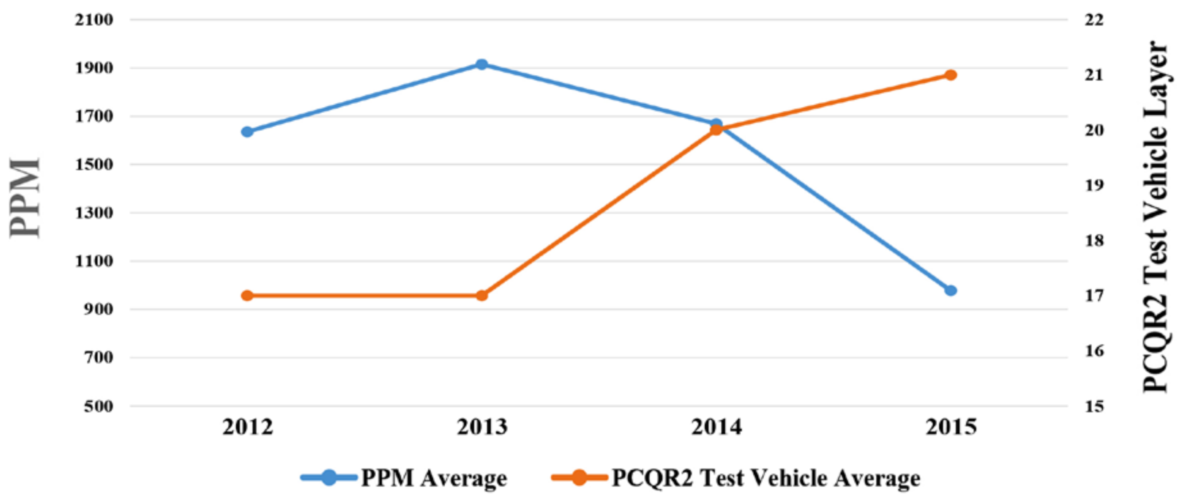


Figure 6: Quality improvement with PCQR.

Benefits to the PCB Vendor

Suppliers who embrace continuous improvement and regular performance assessment also see benefits from using the test standard.

- **Results are a marketing tool.** For their existing customers, $PCQR^2$ improvements provide tangible proof of the benefits of their capital expenditures and process improvements, and should lead to higher qualifications and more market share potential. In addition, because results are available to all subscribers (not just the one that sponsored the submission), good performance can lead to new customers.
- **Drives technology and process improvements.** Initially, suppliers were somewhat reluctant to use data sponsored by and shared with their customers to drive their internal process improvements and equipment upgrades. Now, however, suppliers eagerly anticipate their annual test standard submission as an opportunity to demonstrate, to both their customers and their management, the results of their capital investments.
- **Increases customer satisfaction.** Fewer field failures mean fewer unhappy buyers.
- **Keeps costs down.** Test vehicles let suppliers identify and correct manufacturing issues before they affect production yields or delay quick-turn and prototype jobs, saving scrap and the costs of defective product returns. And submission and testing costs are paid by a customer.

Conclusion

In choosing to utilize the IPC-9151D $PCQR^2$ database, PCB sourcing at our company has been streamlined by removing subjectivity and ensuring that awarded PCB technology aligns with each supplier's capability. Moreover, the process was implemented without investing in and maintaining company-specific test vehicles. This change has resulted in an increase in quality, higher customer satisfaction, and dramatic cost savings to both the company and our PCB supply base. **SMT007**

Al Block is chief manufacturing strategist, DFM Engineering, at National Instruments.

Naji Norder is hardware senior group manager, PCB Design & Services, at National Instruments.

Chris Joran is global indirect procurement manager, Indirect Procurement, at National Instruments.

Achieving Operational Excellence Is a 'Must Have'

Lean Digital Thread

by Sagi Reuven, SIEMENS DIGITAL INDUSTRIES SOFTWARE

I'd like to start with a quote by Aristotle: "We are what we repeatedly do. Excellence, therefore is not an act, but a habit."

Are current manufacturing processes no longer suitable for electronics? Newer consumer-buying patterns are pressuring factories to rely on technology to become more dynamic and agile. The latest technologies can be successful in streamlining certain processes, but the whole business process, entrenched in bad habits, merits real change.

Here we present five of the most shocking manufacturing statistics positioned to yield the best change-enabling opportunities—the pandemic and the tariff wars took it to the extreme.

1. Ninety-five percent of manufacturing businesses focus on optimizing just 1% of their total business cost.

The once competitive edge of accessing lower-cost labor by offshoring manufacturing is now insignificant. Yet, it holds our focus while we ignore other compelling factors.

The true proportion of manufacturing vs. other costs is profoundly obvious when you compare a light purchased from a Chinese website for $3.96 (with free shipping) and the same light priced at $19.97 at a local hardware store.

An onshore factory with direct shipping via a small internal, flexible warehouse would be positioned for far greater success than the manufacturing models offering the light for $19.97 with their current distribution setup.

The labor costs in the onshore example may be much higher than the corresponding factory in China, but those costs are small in comparison to the cost savings from distribution.

2. SMT operations often run at as little as 20% absolute productivity.

Why rely on methods of reporting that enable artificially inflated levels of production?

The truth is that very few SMT operations function in a high-volume way due to pressures to produce a high mix of products and cope with sudden changes in demand.

Setup time, changeover time, etc., are often (falsely) considered "unavoidable" losses. A factory running at 20% absolute productivity (instead of 80%) yields a startling manufacturing-per-product cost that is 400% higher than need be.

Lost productivity can be regained by employing common feeder setups that adapt dynamically to customer demand patterns, achievable with today's best software.

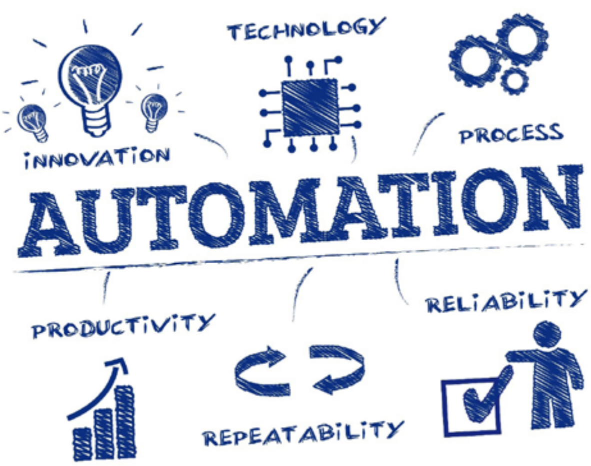
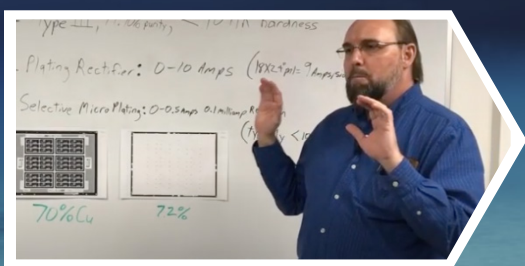
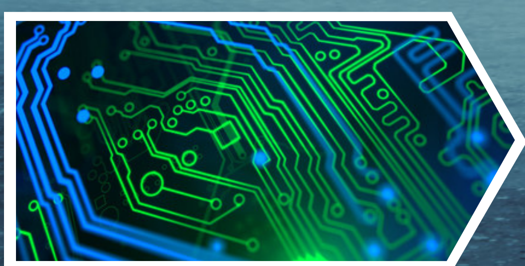


Figure 1: Automation is not only about hardware and software.





Adoption of Lean material management logistics can also enhance fluidity and mitigate losses.

3. Seventy-five percent of raw materials in an SMT factory need not be there.

Lean material logistics is essential to SMT production today, particularly for its effectiveness in enhancing inventory accuracy. Adoption of Lean material management can both remove 95% of WIP material on the shop floor and increase data accuracy via the collection of data directly from each SMT machine. Further, Lean material logistics can reduce warehouse inventory by as much as 75%, without the risk of shortage occurrences, and affords greater flexibility to production schedules.

4. Thirty percent of products leaving the factory were never tested.

Testing and inspection processes cannot find all defects. Let's move the emphasis for quality away from testing and toward three steps in manufacturing:

- Step 1: Verify setup and operations are administered correctly, consistent with instructions.
- Step 2: Strict operational adherence to a process; remove all operational variances.
- Step 3: The application and use of traceability data within manufacturing; data that is essential in finding the scope and elimination of any market-quality issue.

Complete and accurate traceability data can be a company's greatest weapon against market quality issues and can benefit your manufacturing far more than standard testing processes. Today, we can even offer another layer of traceability by using machine learning to identify counterfeit components.

Figure 2: Busy does not mean productive.

5. Eighty percent of factory management know these statistics, but feel powerless.

Executive leadership can view manufacturing as a nonprofit operation, a strictly budgeted entity creating a barrier that prevents performance issues from getting their due attention. It can and needs to be a crossable barrier. Put the above in financial terms and include a volatile customer base. The conclusion is that extreme flexibility from factories is becoming a requirement. It is not just the operation, but also the location of the manufacturing processes that need reassessment.

Applying the information above in a factory that is closely coupled with the market can yield very positive results, but only once people who are responsible for a business ask these questions in a serious way.

If you plan to achieve production excellence, please PM me on LinkedIn. **SMT007**

Sagi Reuven is a business development manager for the electronics industry at Siemens Digital Industries Software. Download your free copy of the book *The Printed Circuit Assembler's Guide to... Advanced Manufacturing in the Digital Age* and visit I-007eBooks.com for other free, educational titles. You can also view Siemens' free, 12-part, on-demand webinar series "Implementing Digital Twin Best Practices From Design Through Manufacturing."

MilAero007 Highlights

Catching up With Nano Dimension ▶

Dan Feinberg spoke with Valentin Storz, Nano Dimension's general manager of EMEA and director of marketing, about how the pandemic has affected their business this past year and what they have planned moving forward.

Wild River ISI-56 Platform Accelerates SerDes Testing ▶

We recently spoke with Al Neves, founder and CTO of Wild River Technology, about the release of their new ISI-56 loss modeling platform. Al explains why it is so critical that this tool meets the stringent requirements of the IEEE P370 specification (which he helped develop).

USPAE Launches $42M DoD Consortium ▶

The I-Connect007 editorial team recently interviewed Chris Peters, Kevin Sweeney and Shane Whiteside, members of the U.S. Partnership for Assured Electronics, about the award the association received from the Department of Defense to create the Defense Electronics Consortium. In this conversation, they discuss the objectives of the consortium, which was created to help the government identify and address potential risks in the electronics industry.

IPC Applauds U.S. Defense Department for Establishing New Defense Electronics Consortium ▶

IPC, the global association of electronics manufacturers, is applauding the U.S. Department of Defense (DoD) for establishing a new Defense Electronics Consortium (DEC).

Virgin Orbit Aces Second Launch Demos and Deploys NASA Payloads ▶

Virgin Orbit, the California-based satellite launch company, confirmed that its LauncherOne rocket reached space during the company's second launch demonstration, successfully deploying 10 payloads for NASA's Launch Services Program (LSP).

Sikorsky-Boeing Team Reveals Advanced Assault Helicopter Designed to Revolutionize U.S. Army Capabilities ▶

Sikorsky, a Lockheed Martin Company, and Boeing have released details of their advanced helicopter for the U.S. Army's Future Long-Range Assault Aircraft competition, known as FLRAA.

Defense Speak Interpreted: So, What's a JADC2? ▶

The term JADC2 was prevalent in the late 2020 debate about the National Defense Authorization Act. It is a new way defense is using electronics to shape battle strategy. JADC2 is Defense Speak for "Joint All Domain Command and Control." Sounds impressive, doesn't it? But what does that mean?

Ventec UK Continues to Maintain Highest AS9100 D Quality Compliance ▶

Ventec International Group Co., Ltd. is pleased to announce that the company's European headquarters in Leamington Spa, UK, continues to maintain highest AS9100 Revision D compliance in accordance with the Aerospace Supplier Quality System Certification Scheme following successful completion of its surveillance audit.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Hailo-8 AI Processor Targets Smart Factory Applications

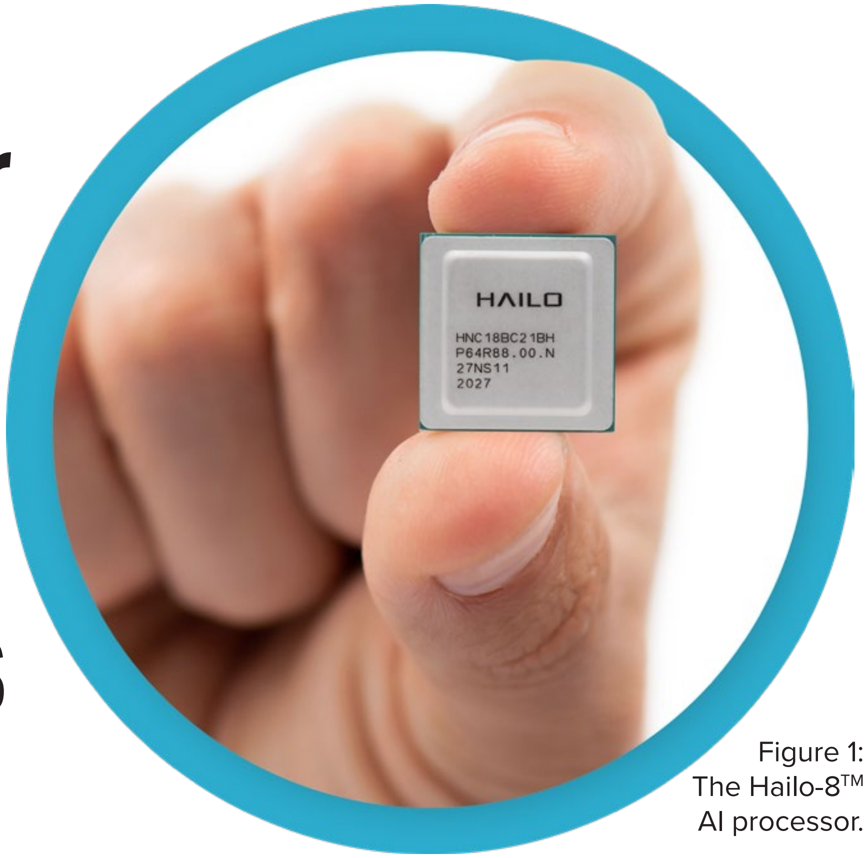


Figure 1: The Hailo-8™ AI processor.

Feature Interview by Nolan Johnson
I-CONNECT007

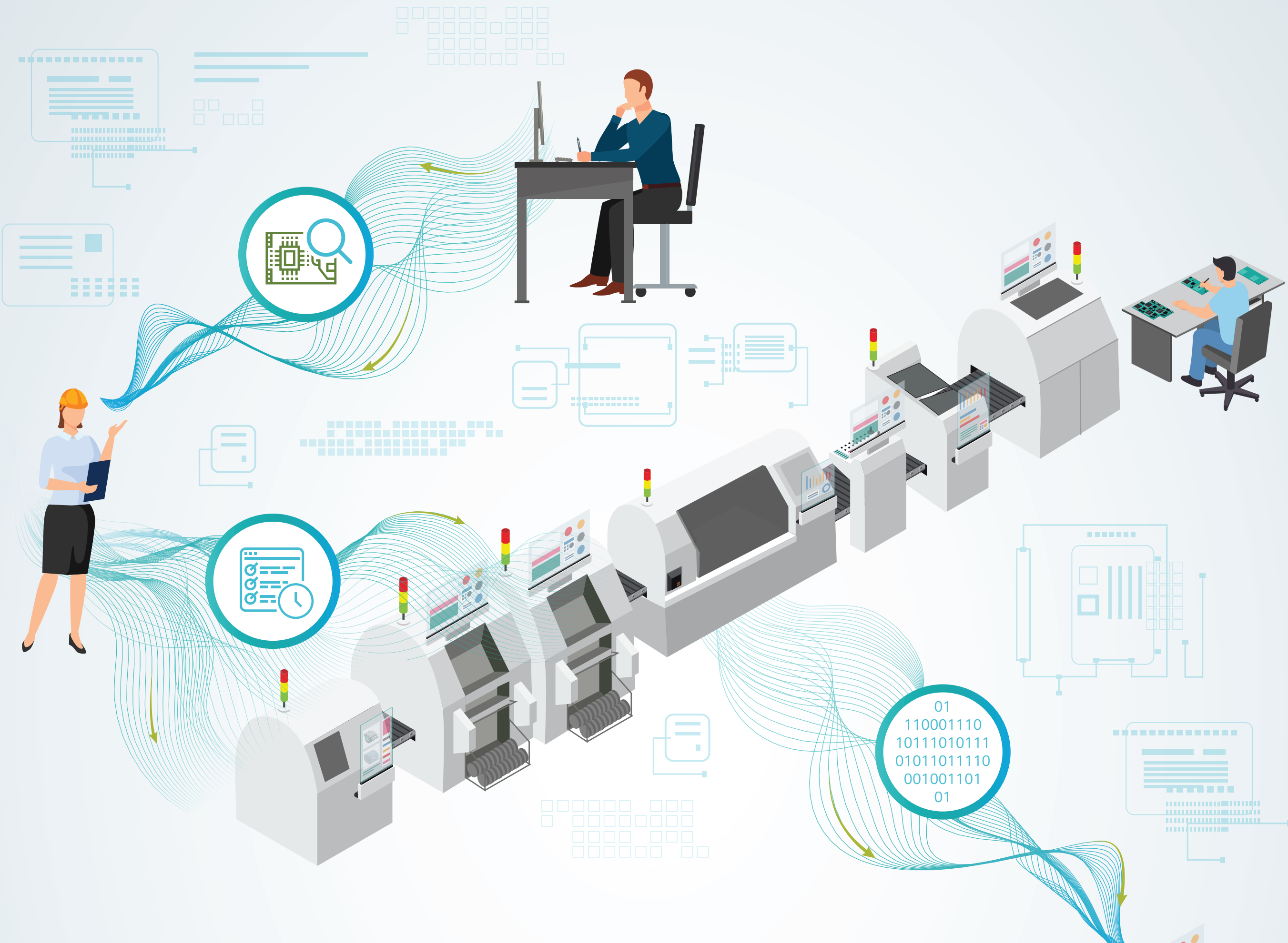
Liran Bar, vice president of business development at Hailo, spoke with Nolan Johnson about how the Hailo-8™ AI processor is helping drive factory automation forward and why companies like Foxconn and ABB are choosing it for their Industry 4.0 and smart factory applications.

Nolan Johnson: Liran, I am interested in learning about Hailo and what you're doing, especially in the area of Industry 4.0 because that is a specific application you highlight for your products.

Liran Bar: Hailo was founded in 2017 and is located in Tel Aviv. We have activities in many regions; in fact, during 2020 we opened offices in Japan and Taiwan, and we are in the process of opening branches in other countries. Right now, we have around 120 employees. It's a young company but we have a lot of engineers who came from large companies with extensive knowledge and experience in hardware and in software. Beyond the hardware, software is also a key component for our complete AI offering.

Hailo has developed an AI inference processor for edge devices. The chip itself (Figure 1), the Hailo-8, is designed to run AI tasks and it's designed for edge devices, not for devices relying fully on the cloud. It's not a general-purpose processor; it's dedicated to AI inference. Training will continue to be done on GPUs, on the cloud, and so on.

We've seen in the past few years a transition from running computing in cloud to the edge. There are many reasons for that, including latency, low power, low cost, privacy, and reliability. Also, from a demographic point of view, fewer and fewer young people want to work in occupations such as security or retail stores. Therefore, devices need to be smarter to make up for a lack of human resources.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Companies are moving to make edge devices smarter in automotive, drones, security, etc. That is where we are focused. Deep learning is everywhere—you can use deep learning in computer vision, audio, communication, and more.

Hailo is focused on vision-based applications. Obviously, there are many, many types of applications that you can see here. Also, we are seeing an acceleration of additional applications in smart retail, medical robots, last-mile delivery, and industrial robotics, which can likely be attributed to impacts from COVID-19.

Liran Bar

Johnson: Yes, there has been a shift in industrial robots, that is for sure.

Bar: That's relevant for our discussion on Industry 4.0. It's worth noting here that we raised our Series B round just last year, bringing our total funding to $88 million. And in the last round, we had two new strategic investors: NEC and ABB, the latter a major player in Industry 4.0 and industrial robotics.

It's important for me to give you more context on our processor as well. The Hailo-8 was designed internally from the ground up. It's a novel technology that we developed. There is no CPU/GPU inside. It includes 26 TOPS (Tera Operation per Second) in 8-bits, giving it high-power efficiency. That's quite a lot if you compare it to other available solutions.

The innovation comes from the Hailo-8 architecture, and one noticeable and important factor is the fact that the Hailo-8 does not require external memory. When you are talking about running neural networks, this is very important, because in traditional architecture, every time you transfer data from one layer to another, you need to access the DDR. As a result, you will add power and latency. In some cases, specifically on the industrial side when you have a pick-and-place machine, latency is very important.

In terms of the connectivity, Hailo's chip can be used as a standalone or as a co-processor. As of today, most of our engagements are using the Hailo-8 as a co-processor. Customers already have their product deployed in the field, but they are looking to improve the performance by overcoming the limitations involved with running neural networks at the edge. For those customers, we offer them a very fast time-to-market solution by connecting the Hailo-8 through high-speed interfaces such as PCIe and ETH, and to offload all the tasks related to neural networks to the Hailo-8.

Johnson: It's logical, at least to me, that more computation and analysis needs to happen at the edge within the sensor device itself. Then you're communicating data that is already partially analyzed and that frees up the central computer resources to work on higher-level things.

Bar: Definitely. The efficiency is very important. For example, some companies in this space offer solutions connected to the host accelerator, which is a fixed HW pipeline. You don't necessarily have better performance when you have more compute elements. Why? Because you will have a bottleneck somewhere in between the accelerator and the host; the AI HW accelerator finished the work very quickly, but the host cannot process it with the same speed as the HW accelerator, so it's meaningless. You need to think outside the box and design a dedicated processor such as the Hailo-8 to run DL-based applications.

Hailo's innovative structure-defined data flow has a completely redesigned processor architecture, with a distributed on-chip memory fabric (no external memory), novel control schemes, efficient interconnect, and a full-stack software toolchain called "data flow compiler."

Hailo has put a lot of effort on the software side. Actually, when Hailo was established, there was both a hardware team and a software team, so it's not like the hardware people designed the chip and the software people had to come and figure out what to do. Hailo has a comprehensive SDK offering already running dozens of different network topologies.

Johnson: And your markets?

Bar: There are several major markets that we are targeting. Currently we are targeting automotive, smart cities, smart homes, smart retail, and Industry 4.0.

As I mentioned earlier, ABB is one of our strategic investors. This is very relevant for us when discussing Industry 4.0 applications. We are also involved in an interesting collaboration with Foxconn and Socionext for Industry 4.0. Hailo's AI processor is integrated into the edge box developed by Foxconn—called the BOXiedge—making it smarter and more effective. In this case we are using the Hailo M.2 module that is plugged into an existing device.

Actually, the BOXiedge includes two slots of M.2, and a single Hailo-8 device is 26 TOPS. If you require more than 26 TOPS, you can connect two M.2 Hailo AI modules. It is a very fast time to market. While the host in this case is the Socionext A11 ARM, the Hailo-8 can be easily used with any other embedded hosts or x86 hosts.

This BOXiedge (Figure 2) is an example of a fanless device, so overheating is not an issue. The aim is to be able to process multiple video streams and different applications using a single Hailo-8 device, which makes it a very cost-effective solution, as demonstrated during CES 2021.

We are able to process around 20 camera streams, depending on the resolution and type of neural network that is used. In sum, this is a prime example for a use case in Industry 4.0. Foxconn is already using this enhanced device in their factories and getting better performance.

Figure 2: The aim of the BOXiedge is to be able to process multiple video streams and different applications using a single Hailo-8 device.

Johnson: Can I just clarify: Foxconn offers BOXiedge for sale?

Bar: Yes. They are using it internally and also offering it to customers in different regions and markets as well.

Johnson: So, this becomes a key component available to manufacturers to build up a more automated process.

Bar: Exactly. It is a great achievement for a company like Hailo to be able to collaborate with these two distinguished companies.

Johnson: It seems that the Hailo-8 is very well suited for edge use, especially if there's any sort of mobile or motion required for the application. It would work not only in automotive, but also in the robots themselves.

Bar: If you are a product owner and you need to develop something, you look at what is available today in the market that you can integrate into your product; NVIDIA, as an example, was available until companies such as Hailo and others provided something more dedicated. In short, it really depends on the use case. Companies approached us after they did a proof of concept with existing products and are now in the stage of optimizing the performance, size, and cost.

Johnson: That makes sense.

Bar: When we started to design the Hailo-8, we had an advantage as we didn't have any products before. It sounds a bit odd, but that's the reality as we weren't obligated to be HW or SW compatible to previous product generations like other big companies.

Back in the day, you had only the CPU and you could manage to run many tasks on a general-purpose CPU. Then you had the need to run some graphics applications on the mobile devices, so the industry adopted a dedicated GPU to do this kind of specific task. Later, you had the computer vision-based application, and we saw a dedicated, vision-based processor being adopted (DSP or vector processing devices). Now we see the need to have a dedicated AI processor to run DL-based task applications in the most efficient way.

Now let's connect it to the software because this is a very important aspect. Hailo has an AI HW core, but on the other end, we also have developers that develop their own software. How do we connect those two? To do that, we offer a combined in-house software development kit (SDK)/Software (the "Hailo Dataflow Compiler") that optimizes the neural network (offline) to run efficiently on the Hailo-8.

Johnson: This topography is reprogrammable?

Bar: Yes.

Johnson: That can be done in the field?

Bar: Yes. We have the dataflow compiler. Basically, they are using what we call software framework that enables them to train the network, to give them a lot of images for a specific task, let's say, in Industry 4.0, detection of defective items and so on. This network can detect a defective part in the factory.

After we've provided onboarding sessions to our customers, they are able to program the Hailo-8 using the Hailo SDK.

Johnson: This reminds me of the general architecture for a field programmable gate array. This is very similar, which makes you very reconfigurable.

Bar: That's right. It resembles an FPGA in that sense. We provide three products to our cus-

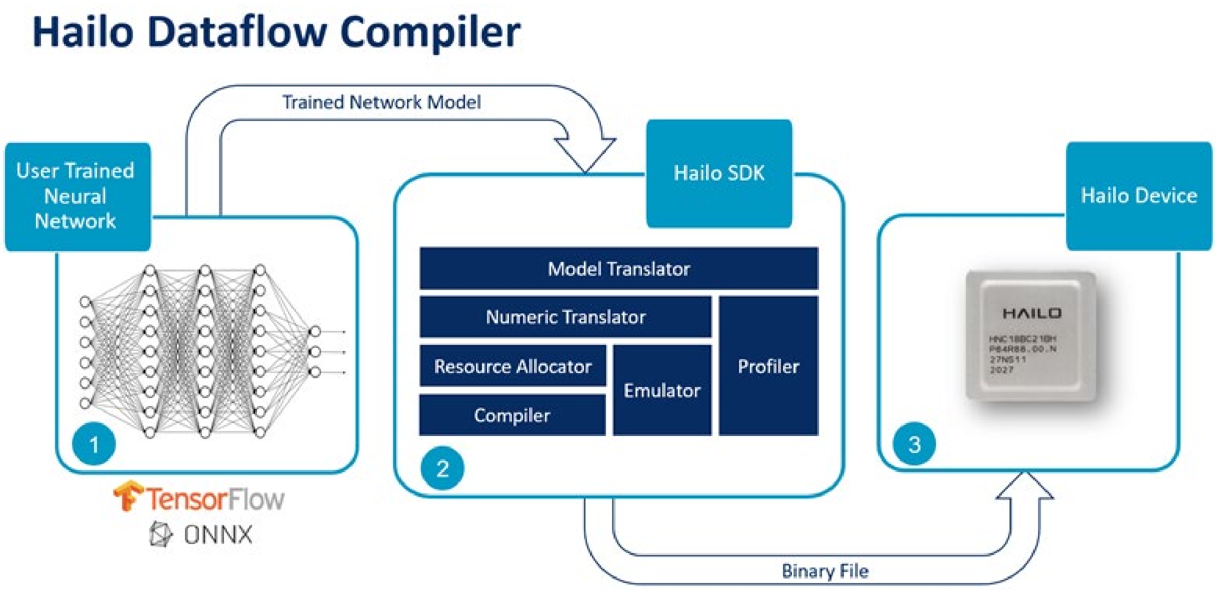

Figure 3: Hailo Dataflow Compiler.


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tomers. First, for those who are interested in having a very small, cheaper solution, there is the Hailo-8™ chip. It can be either consumer-grade, industrial-grade, or automotive-grade; as we mentioned, the Hailo-8 chip is 17 x 17 mm. The Hailo-8 has a Gen-3 PCI with four-lane interface, so it gives you all the bandwidth throughput here. Each one of the lanes is eight Gbps.

Johnson: So how are these different configurations currently being folded into Industry 4.0? We saw the example of Foxconn's product. Are there other examples, or do you have a vision of how these components would be used in Industry 4.0 applications?

Bar: In Industry 4.0, we have all the things related to the factory automation. We see interaction between machines and humans, because now they are using AI to keep employees safe in case of a disaster.

Johnson: Can Hailo connect to other process automation systems—say, chemistry sensors or the like—and then include the visual analysis from Hailo to create a more well-rounded process control?

Bar: Definitely. As I mentioned earlier, some of the companies we are working with are connecting several cameras to be processed. For computer vision, it's all open, and customers are doing really unique things and challenge us to take on different challenges as well. This is the reason why ABB eventually decided to invest in Hailo. We are flexible and always open to new tasks.

Johnson: Liran, are you able to comment on any other companies you're working with to integrate? You've got Foxconn on the record. In the Industry 4.0 space, are there other companies you can comment on?

Bar: Believe me, I wish I could tell you. But I respect their confidentiality and I cannot disclose anything else at this stage. I can tell you we are engaged with several other major players in the Industry 4.0.

Johnson: Look out a year or two into the future and where do you see Hailo helping factory automation move? What's going to be different two years out?

Bar: We'll see an increase in demand for AI-based solutions at the edge and Hailo can help customers with improving the performance, size and cost by shortening the testing time on the production floor, which is eventually translated into cost savings. We give them a higher detection rate and accuracy for different applications. We can overcome the latency issue as we are able to connect the camera directly to the Hailo-8 via a standard MIPI interface, for example.

Johnson: Are you shipping Hailo-8 products now?

Bar: Yes.

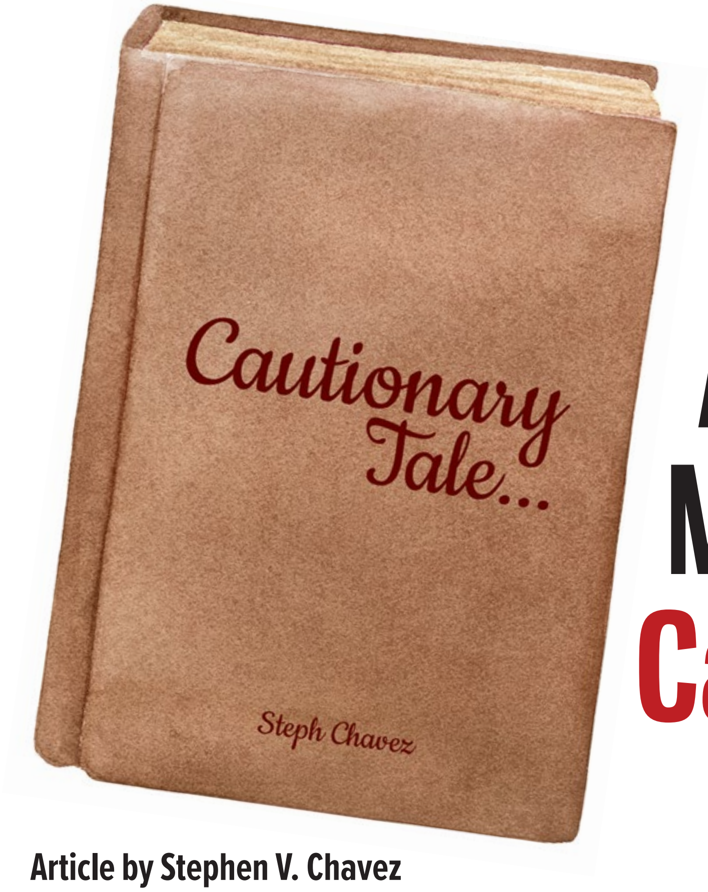
Johnson: Okay. The work you're doing around automotive and smart city and edge analysis is only going to make things more flexible, more creative to get into the factory automation space.

Bar: Yes, on one hand you have the extreme case, which is automotive, and you need a lot of demand. The good thing with Hailo is we do not need to wait until autonomous driving Level 4 or Level 5 will take place. Automotive customers can use the Hailo-8 right now in the Level 2 and Level 3 for ADAS applications.

Johnson: What a great strategy. Fantastic! Thank you for the overview and the time. I really appreciate this. It is very intriguing.

Bar: Excellent. Nolan, thank you very much.

SMT007



A Library Management Cautionary Tale

Article by Stephen V. Chavez
PCEA

The library management of footprints, land patterns, or cells—however you refer to them in your ecosystem—is one of the most critical items in the foundation of any PCB or CCA design. When I was asked to write an article on this topic, so many thoughts and experiences instantly flooded my mind. After 30+ years of designing PCBs throughout the industry, I have my share of experiences and stories about footprints.

One particular experience stands out—a project that I consulted on several years ago. My friend Vino asked if I could support a project that he was about to kick off. I said sure, as I had worked with him many times before. We discussed the initial PCB layout details, and we noted the extremely tight, aggressive schedule he was up against.

As we were planning our attack, the topic of library part creation came up, as usual. But this time, Vino wanted to farm out the library efforts to a third-party company that was unknown to me. I voiced my concerns about using this resource, and the importance of library parts being accurate and correct. Vino assured me that we'd be okay because this company came with high recommendations from a trusted source. I trust Vino, so a few meetings later, everything was put into motion.

The design at hand was a small, complex backplane card targeted for the end-product to go to a data center customer. The PCB measured 8" x 3." It had 14 layers, 0.062" thick, with about 1,000 parts, and eight cluster modules containing 2 x 2.5 Gbps per link on each of these modules. This is a high-speed digital design, with around 40 Gbps data rates and very fast edge rates. It also featured two additional daughter cards, two network switches and a backplane controller BGA consisting of several hundred pins. The team worked like crazy and hit all the initial targeted phase gates within the project schedule. After lots of analyses done on the design, including a final DFM check, the design went out for fabrication as scheduled, with no apparent issues. Happy ending! Or was it?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About four weeks later, I was at the office when Vino called my cellphone. I answered, expecting to hear some early success of initial testing of the assembly. But I knew something was wrong from the tone of his voice. “Steph, I need your help!”

My heartbeat quickened. Vino proceeded to tell me that upon powering up the CCA, it got extremely hot within a few seconds, especially the backplane controller BGA. He had already powered up two of the five CCAs we had built, and each had this similar issue. We scrambled, discussing possible issues that caused the overheating.

It was difficult to assess this issue, since I was at the office and didn’t have my personal laptop that contained the PCB design. (I always use my personal laptop for consulting.) Within a few minutes of our discussion, a bad feeling hit me like a ton of bricks. While Vino was describing what he was checking, I ran back to my desk and grabbed my business laptop. I asked him to provide the part number for that backplane controller. I downloaded a PDF of the manufacturer’s datasheet and jumped to the page that contained the BGA footprint details. I asked Vino to tell me where Pin 1 was identified on the actual part that was placed on the CCA, knowing that the part was placed on the secondary side of the design. Then, I asked him to tell me where the Pin 1 markings were located on the PCB itself. He told me where Pin 1 was located on the PCB and that it also aligned with the part alignment markings on BGA, so I asked him to open the design.

That very second, as we compared the footprint in the design to the footprint in the datasheet, we realized that our fate was sealed. We both knew the cause of our overheating: the footprint was designed incorrectly. It was designed as if you were looking through the board: basically backward. You can imagine the amount of F-bombs that were dropped by both of us as we combed through the manufacturer’s datasheet while triple-verifying the error, to no avail. We confirmed the worst-case scenario: a catastrophic mistake with no possible chance of salvaging the five CCAs.

What happened? The librarian from the third-party resource created the footprint manually and simply missed the one detail in the manufacturer’s datasheet located under the image of the footprint that stated in a large, bold font, “Viewed from Bottom Side of Device.” This was also missed by the individual who validated the part for release into the library. This one missed detail caused the footprint to be designed with the entire pin sequence 180° off. Devastating mistake with no potential of recovery? There was no choice in this case but to make the footprint correction in the library, redesign a major portion of the board and re-spin the board.

The ripple effect of such a mistake: Each CCA cost over $5,000 to fabricate and assemble. There were five total assemblies with very little parts remaining due to limited funding and extremely long lead time on some of the ICs and connectors. Figure 1 shows a photo of one of the bad CCAs.

The immediate follow-up meeting with the third-party library team was not pretty, to say the least. We had to deal with a missed scheduled window of marketing opportunity, additional unexpected cost, additional time to redesign and re-spin the board, and a very negative hit on our reputations. The rhetorical question is this: What is the true cost of this mistake?

And what is the lesson from this experience? Attention to detail is paramount in PCB design, especially when it comes to creating library parts. In my opinion, a good librarian is worth their weight in gold. You can do due diligence in circuitry design, design layout, signal analysis, and DFM, but if your library parts are not accurate, your CCA design may have a catastrophic ending.

Can this type of error be prevented? Absolutely. Whether a footprint is created manually or with any of today’s third-party automated library creation tools, attention to detail is key. I would even go one step further and suggest

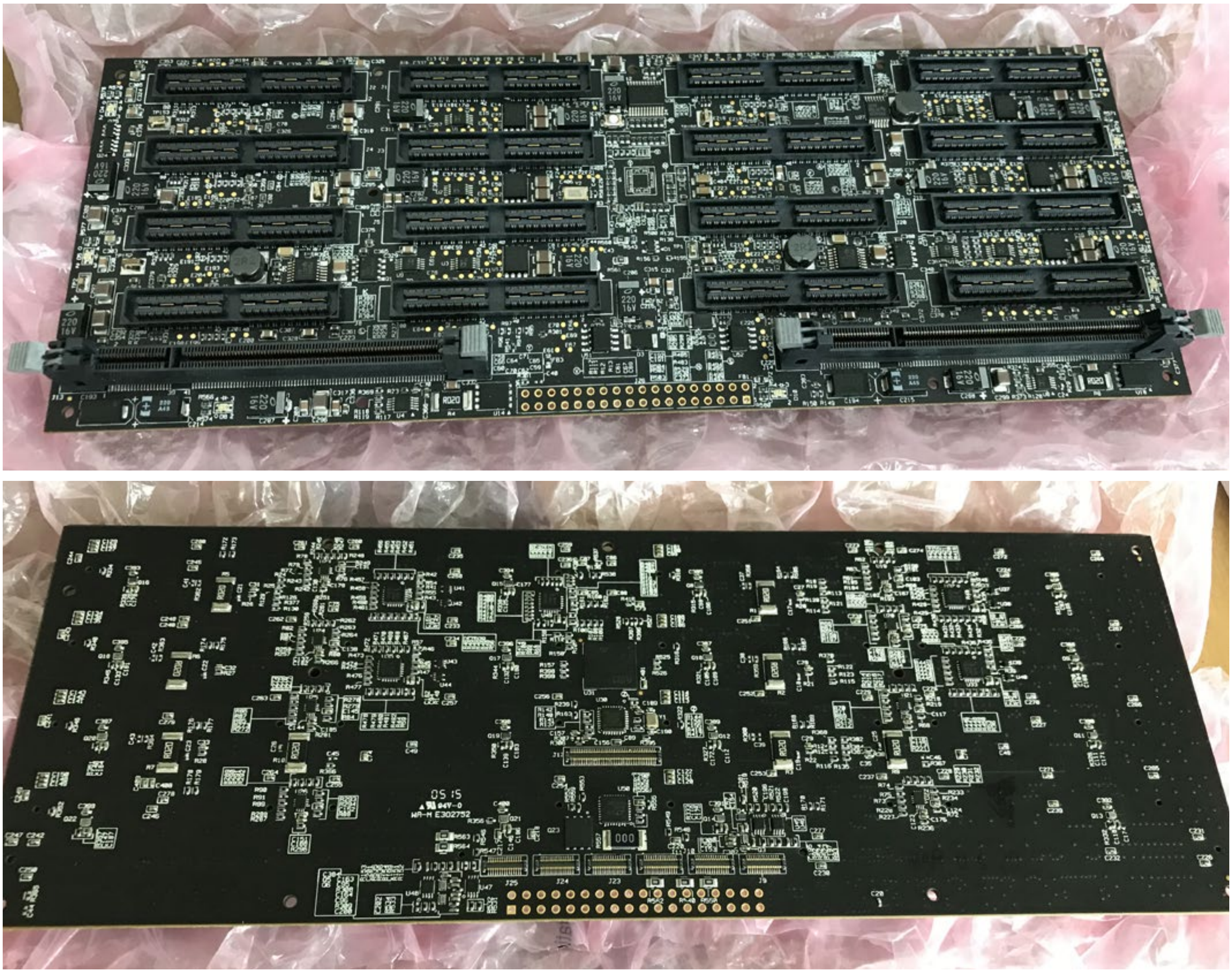


Figure 1: Photos showing the top and bottom of the CCAs that overheated due to a simple footprint error. Note the backplane controller BGA in the center of the bottom side of the board; this one CCA represents $5,000 out the window.

that a DFM check should be done at the library level using any of today's industry tools, such as Siemens' Valor VPL.

A DFM check and verification of a footprint for both fabrication and assembly should be done as early in the design process as possible. When done at an early stage, a design will have a higher percentage of success right out of the blocks, with no potential missed footprint design errors to worry about. A bad pin can easily be identified within seconds utilizing such a tool. A thorough DFM check between the 3D industry model of the component against the designed footprint, along with the appropriate solder fillets and overall assembly concerns, can also be quickly addressed to prevent downstream issues as well. This is what we now refer to as a shift-left approach.

In this design, no assembly DFM verification was ever performed. The board was redesigned successfully. Vino worked out the financial compensation with that third-party library team, but it was the last and only time Vino and I used them. **SMT007**

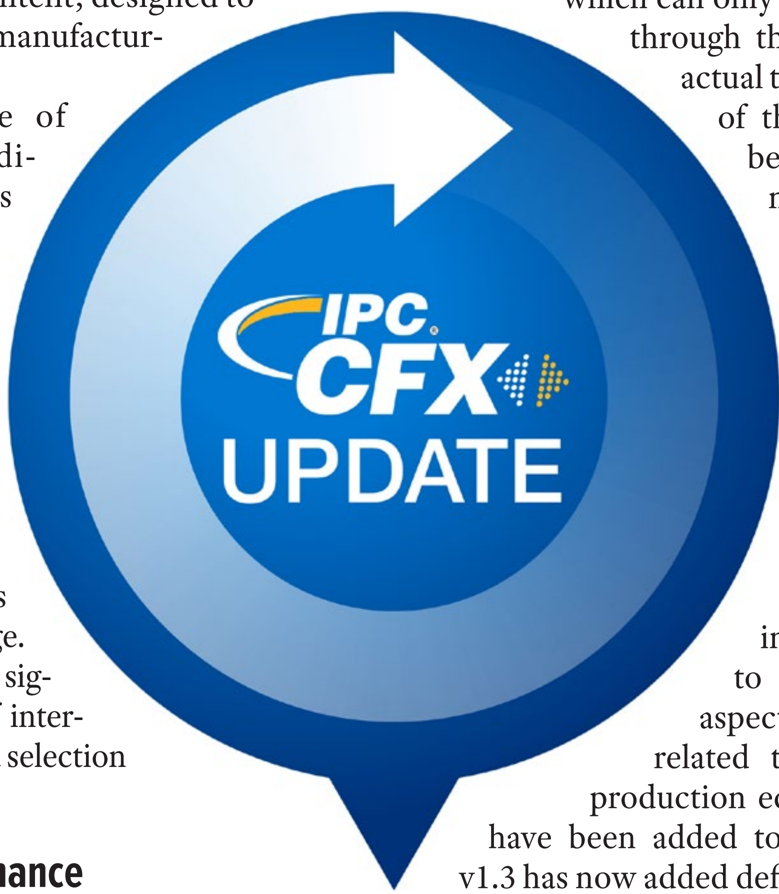
Stephen V. Chavez, MIT, CID+, is chairman of the Printed Circuit Engineering Association.

IPC CFX Update v1.3

Feature by Michael Ford
AEGIS SOFTWARE

By the time that you read this, version 1.3 of the CFX standard should have been published. There are some very interesting additions in this release, including messages for predictive maintenance and smart energy management. As CFX is an IPC standard, the industry is assured of open content, designed to evolve Industry 4.0 manufacturing for everyone.

For each release of CFX, a small, dedicated "A-team" meets online approximately every two weeks to review proposed content that normally is submitted through the CFX GitHub account. The A-team members rotate with each release, as the topics of discussion change. With CFX v1.3, some significant new items of interest have been added, a selection of which follows.



Predictive Maintenance

The most basic maintenance regime, scheduled, depends purely on the passage of time, such as getting the oil changed in your car every few months. This can be either wasteful or potentially damaging, as we each use our cars differently, depending on distance travelled, as well as more or less "aggression." A better maintenance philosophy is, therefore, preventative, in which the number of miles driven, and engine revolutions, are counted, bringing the maintenance date forward or backward, ensuring reduced waste of oil and servicing time, as well as the reduced risk of increased engine wear. However, there are other factors that can affect the need for the oil change, which can only be really understood through the knowledge of the actual trend in the condition of the oil. Were this to be possible, predictive maintenance would be used to ensure that maintenance is only performed at the exact time needed, based on the actual condition of the item that needs to be maintained.

In the manufacturing world, messages to communicate key aspects and measurements related to the condition of production equipment assemblies have been added to the standard. CFX v1.3 has now added definitions of key breakdown of machine assemblies, as well as associated types of measurements, including temperature, vibration, and energy consumption patterns, etc. Any authorized party can then utilize this series of CFX messages to apply the most advanced smart maintenance functions.

Energy Management

The use of smart energy meters, either at a machine or line level, helps us to understand where energy is used in the same way smart meters are now common in our homes. In the immediate instance, energy savings can be made by understanding opportunities to put equipment into sleep-states much in the same way your laptop screen sleep darkens when you are away from it for a few minutes, and then perhaps goes to sleep if left doing nothing for a while. With CFX, multiple sleep states for any piece of equipment are defined, with messages to control equipment into and out of sleep-states in a timely manner, ensuring that equipment is ready for the next product, whilst taking maximum advantage of any down-time to reduce energy consumption.

The rapidly increasing availability of renewable energy sources has dramatically increased the variability and volatility of demand for electricity from conventional sources and is difficult to manage without some form of demand management. The cost of energy is changing from a fixed-rate tariff to a variable rate, with free energy available in some cases at certain times. The CFX energy and schedule management messages allow solutions to plan and execute production activities matching energy demand to price. This helps achieve government targets for the reduced impact of manufacturing on the environment. It's helping your pocket while saving the planet!

Hermes Data Exchange

The IPC Hermes standard is the smart "upgrade" of IPC's SMEMA standard, responsible for the movement of products on conveyors between machines. The highlight of the simple upgrade is that Hermes supports completely random mixed production with fully automated changeovers, without the need for additional barcode reading at each machine. Messages have been added to CFX v1.3 that make it interoperable with the Hermes standard. For example, Hermes information can be transferred from line to line (such as topside to bottom-side) using CFX messages.

SPI Data Update

CFX supports the direct exchange of information between machines that are performing closed-loop analysis. Using CFX, closed-loop "AI" software can be provided by any machine vendor or third party, without the need for any technical or business dependency. Enhancements have been made to the CFX data exchange and remote parameter adjustment capability for SPI processes, enhancing potential value from closed-loop systems.

Assurance of CFX 'Plug and Play'

Having a unique fully-defined language of every message makes CFX unique in the industry. No middleware or translation software is required. Any set of machines and solutions should work together, reducing deployment time, the need for customization, and potential issues when software is updated. In order to provide assurance of the "plug and play" ability, the list of mandatory and optional requirements is now defined in the standard, which matches the tests that are carried out as part of the official IPC accreditation process. It is highly recommended that all CFX users insist that all their machines have had official IPC certification.

There are many other additions to CFX v1.3, all designed to create a richer experience. CFX is the infrastructure on which multiple Industry 4.0 solutions work together. It will take time for commercial solutions to fully support the opportunities that CFX provides. Any company can start to use CFX in their own unique niche applications as well as in-house developed machine processes. For internal development use, there is a small cost to buy the standard, plus there is a completely free and fully documented software development kit (SDK). CFX data can be automatically secured with TLS level encryption, making CFX data exchange globally across the shopfloor, totally secure.

CFX v1.4?

What's next is partially up to you. Feel free to contribute ideas to the CFX committee and A-team, including the direct submission of code. Discussion for v1.4 includes the ability for CFX to facilitate the secure transfer of design data in IPC-2581 format between design centers, digital manufacturing engineering solutions, and directly to machines themselves, for advanced, faster, and more accurate machine programming, as well as direct DFX feedback. Also up for discussion is the enhancement of messages for automated production logistics using AMRs (automated material handling). Another discussion is the "CFX Flight Recorder," which will save a copy of every CFX message, such that in the future, when additional smart manufacturing software is available, there is a history of data that can be replayed with which the "AI" component of the software can learn.

Keep in Touch

I would recommend that anyone interested in CFX join the IPC CFX committee. There is no charge or membership fee to do so. IPC is a purely industry consensus-based standards organization, with all work done by volunteers. No commitment is necessary; many committee members are happy to just follow what is going on, and be kept up to date with CFX news as it happens. Be a part of the Industry 4.0 manufacturing evolution. SMT007

Michael Ford is the senior director of emerging industry strategy for Aegis Software. Ford is also an I-Connect007 columnist. Click here to read *Smart Factory Insights*.

IPC-2231A—Insights from the IPC 1-14 DFX Subcommittee

Design Circuit

by Patrick Crawford, IPC

In mid-2019, IPC released IPC-2231 DFX Guidelines, a comprehensive guide for establishing best practice methodology in developing a formal DFX (design for excellence) process for laying out printed boards and assemblies. This process can be established at a systemic level—integrated into the workflow of departments of companies—or adhered to as an individual designer. DFX is multifold, and as defined by the document, includes design for manufacturing, fabrication, assembly, testability, cost, reliability, environment, and reuse. The sections pertaining to these major theme areas discuss how they impact the overall performance and cost of the final board assembly.

Of course, no document is perfect, and as is the case with nearly every industry standard, certain elements of the IPC-2231 were identified as needing to be changed shortly after its publication. Now, two years after its initial release, IPC-2231 is close to receiving an upgrade with a new revision—IPC-2231A. The standard is currently in Final Draft for Industry Review and the standard's subcommittee is in the process of forming a ballot group. (For those who are unfamiliar with IPC standardization processes: All IPC documents are subject to a final vote for publication via an open ballot.)

While it can be dangerous to speak of the features of a document in the middle of its development cycle, it is safe to say that nearly every section of IPC-2231 has received some kind of upgrade or addition, and an entirely new section regarding the impact of design choices on fabrication processes has been included. Speaking personally (not as a member of IPC staff), the new revision is a substantial upgrade; it's more focused and yet more rich in content, more easily digestible, and more valuable as a resource.

But enough of what I have to say about the document. After all, other than a few minor edi-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torial changes and tweaks, I am not the author; IPC documents are created "in the open" by industry volunteers. In fact, IPC-2231A is built from more than a century's worth of collective experience through the participants of the IPC 1-14 DFX Subcommittee. For this column, I thought that it would be interesting to highlight some of the 1-14's dedicated volunteers who have helped IPC-2231A come to fruition. Their insight and experience have helped to build the A Rev (and in some cases, the vanilla document) and I cannot think of any better individuals to speak on its need and promise. I spoke with a few of these supporters and asked them about their involvement in IPC-2231A's development as well as why they feel the document is needed.


Russ Steiner

Russ Steiner is a team leader in the ECAD Operations Department at CASCO Automotive, an Amphenol Company. He has been involved with the IPC 1-14 Subcommittee for the last two years. Russ manages a global team of engineering professionals who design robust products, and therefore has a critical need for a global DFX process that ensures complete compliance and integrity. When asked about the need for 2231A in industry, he responded, "Global operations and design portability is a key consideration for hedging against prospective manufacturing venue catastrophes, manufacturing redundancies, and predictable AQL/PPM."


Joe Clark

Others find value in how a guideline like IPC-2231A can help single employees work cohesively inside of a huge team, either as part of large companies or within manufacturing supply chains. Joe Clark of Lockheed Marin Missiles and Fire Control, PWB Fabrication and Design, has been involved with 1-14 for about a year. Referring to IPC-2231A, Joe said, "Knowledge continuity in the electronics industry is an issue at many companies since the design and manufacturing processes span many functions and roles. The IPC-2231 document helps bridge the gap in knowledge for those who may play a single part in the overall process." Indeed, by capturing the knowledge and needs of the complex chain of requirements imposed by manufacturing, testing, and lifecycle considerations, guidelines like IPC-2231A can become the leverage that designers can use to justify design decisions. Patrick Phillips of Northrop Grumman put that more succinctly by replying that IPC-2231A contained "tools for people to use for building a case to drive product improvements."


Pietro Vergine

Others still found that the general mindset of DFX will not only help individual companies cohere their processes internally or the processes of their contractors and manufacturing verticals, but also to create some alignment between companies in general—even competitors—who all would benefit from best practices offered by a consensus document. Pietro Vergine, president of Leading Edge, provided an excellent summary of this point: "I think that most companies are already using internally developed rules/methodologies that are DFX oriented, but maybe call them something different (i.e., designing documents with design rules, or rules for the assembly, or design rules for manufacturing, or electrical design rules). As with all other IPC standards, I think that having [IPC-2231A] that has a general consensus from the electronics industries with the collaboration of several companies may have a great impact on all of their activities. It might not be perfect, but it will let us think about the global picture, and not just a single problem."

Many found that certain sections of the document contained knowledge that is critical to help designers understand the effects of their design choices on downstream cost drivers, most notably manufacturing. Jasbir Bath has been integral in the development of the IPC-2231A, where he employed his experience as a support advisory engineer at Koki Solder to enhance its information regarding process engineering. "Manufacturing yield needs to be improved and documents such as 2231A [can] help designers understand more about the challenges in manufacturing to help design products with improved manufacturing yield," Jasbir said, adding that he was most excited about "generally updated information on soldering materials, processing temperatures, board finishes, and reliability concerns" within IPC-2231A.

Jasbir Bath

Jasbir was far from alone in feeling the need for more understanding of DFM within industry. Scott Vorhies, a primary contributor for all DFX-related information concerning the assembly of PCBAs within SpaceX, hopes that IPC-2231A will "provide a source of information helping manufacturing engineers troubleshoot assembly issues from start to finish," noting that "this document, if allowed to be a source of truth, would greatly enhance the ability of designs to be manufactured at a lower cost and higher reliability, and help bridge the gulf between design and manufacturing." Geok Ang Tan of DSO Laboratories agreed, and similar to Patrick's sentiments above, said that "with this, staff can share with management that there are a lot of details in the manufacturing process to produce electronics hardware; new staff will gain a lot from it."

Jon Bruer of Creation Technologies Inc. is most excited about the Design for Testability (DFT) section of IPC-2231A, which he has helped shape for the new revision by channeling his more than 32 years of experience in test engineering and DFT. Regarding the need of a DFX guideline in industry, Jon said that "certainly from a test perspective there is a huge need for a stronger understanding of DFT and test requirements for production test, mostly with respect to OEM engineering teams. That said, as a contract manufacturer, my company helps to provide input and helps to fill the gaps for our customers. I think that the more awareness there is in the industry for DFT thinking to occur at the earliest stage in product design, the more testable product designs will be as they move into the production area."

Jon Bruer

The overall outcome of IPC-2231A, according to Karen McConnell of Northrop Grumman and a current co-chair of the IPC 1-14 DFX Subcommittee, is to help companies that "do not have a DFX champion to facilitate the insertion of best practices into processes." Moreover, she expects that the practices described in IPC-2231A should and will be rolled down to subcontractors, so that excellence can be maintained throughout the supply chain.

Karen McConnell

Regardless of which "X" in DFX is being considered, all members of the 1-14 DFX Subcommittee agree that no company is perfect, and any design process can be enhanced. IPC-2231A DFX Guidelines is expected to be available in early Q3 2021, and until then, I will leave you with one of my favorite quotes from my poll of the 1-14 Subcommittee. When asked about the importance of DFX in design, Murilo Levy Casotti of Embraer, simply replied that "[DFX is] primordial. All 'design for' are very important." SMT007

Murilo Levy Casotti

Patrick Crawford is the manager of design programs and related industry programs at IPC. To read past columns or contact him, click here or email PatrickCrawford@ipc.org.

Supplier Highlights

Foundations of the Future: IPC Education Foundation Update and Looking Ahead ▸

The IPC Education Foundation takes pride in their accomplishments in their second year. The Foundation focused on a variety of digital/virtual exposure and engagement activities to share information about the electronics manufacturing industry.

ITW EAE Announces New SECS/GEM Communication Package for MPM Edison Stencil Printer ▸

SECS/GEM is a semiconductor market communication standard that provides a common interface between manufacturing equipment. The Edison package collects and logs process data which can be used to optimize the production line.

Ersa to Offer Demos in Interactive Virtual Showrooms during APEX Virtual EXPO ▸

Kurtz Ersa Inc., the world leader of electronics production equipment, announced plans to participate in the 2021 IPC APEX Virtual EXPO, scheduled to take place March 9-11, 2021 online at ipcapexexpo.org.

KYZEN Strengthens Florida Presence With Kurt Whitlock Associates ▸

KYZEN, a global leader in innovative, environmentally friendly cleaning chemistries, announces that it has partnered with Kurt Whitlock Associates. Under the new partnership, Kurt Whitlock Associates will promote, sell and support KYZEN's full range of high-performance cleaning products for the electronics industries throughout Florida.

ZESTRON, GEN3 Systems Collaborating on New Test Service ▸

ZESTRON and GEN3 Systems are proud to announce their collaboration on a new test service for the US electronics industry to help develop Objective Evidence required by the latest release of IPC-J-STD-001 Revision H.

Best Papers from SMTA International Announced ▸

The SMTA is pleased to announce the Best Papers from SMTA International 2020. The winners were selected by members of the conference technical committee. For these exceptional achievements, a cash award and plaque are given to primary authors of all winning papers.

NovaCentrix to Show PulseForge Soldering Batch, In-Line Solutions at IPC APEX EXPO ▸

NovaCentrix, the industry's leading provider of photonic curing tools, conductive inks and the new PulseForge® Soldering high-intensity pulsed-light solution, is pleased to announce its participation in the 2021 IPC APEX Virtual EXPO, scheduled to take place March 9-11, 2021 online.

Cogiscan Partners with ASM, Cyberoptics, Heller and C2MI ▸

Cogiscan, a leading connectivity and TTC solutions provider for the electronics manufacturing industry, has partnered with ASM, Cyberoptics, Heller and C2MI to implement a live showcase of smart factory solutions for electronics manufacturers.

A Short Overview of Control Theory

Feature by Martin Tarr
ELECTRONICS MANUFACTURING EXPERT—RETIRED

An excerpt from Automation and Advanced Procedures in PCB Fabrication by Happy Holden with Martin Tarr.

Control Dynamics

Control dynamics determine the signals to the solution replenishment equipment. Figure 1 displays the traditional control loop and proportional-integral-derivative (PID) controller. In this case, the derivative element is being driven only from process feedback. The process feedback is subtracted from the command signal (setpoint) to generate an error. This error signal drives the proportional and integral elements. The resulting signals are added together and are used to drive the process response. The alternate placement for the proportional element can be seen with the dotted lines. This can be a better location for the proportional element, depending on how one wants the system to respond to commands.

To see the effect of these control actions, Figure 2 shows the four controller response algorithms and their responses to a change in load or setpoint. On-off control is the simplest, slowest, and never returns to exactly the same conditions. PID is the fastest and the most complex because it responds to the

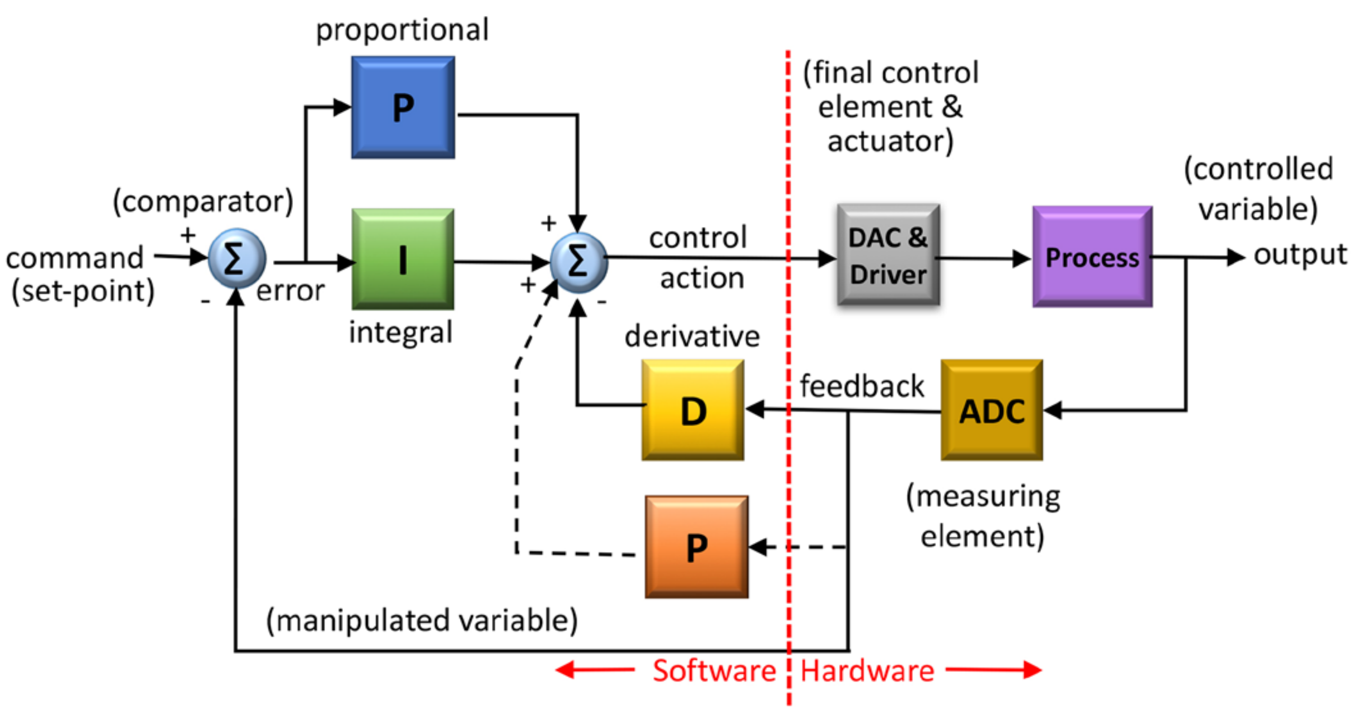


Figure 1: Basic PID controller. (Source: Tim Wescott [1])

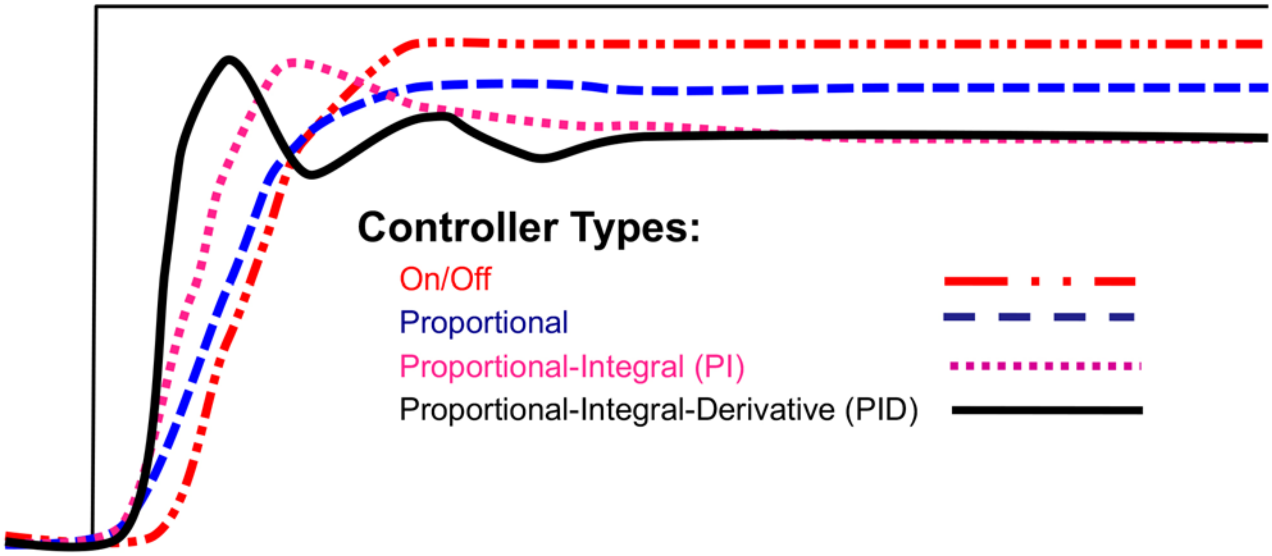


Figure 2: Control response dynamics to a change in setpoint.

Control Action	Overshoot	Decay Ratio	Rise Time	Settling Time	Period of Oscillation	Offset
On/Off	0.46	0.75	1.5 min.	52.3 min.	2.2	0.17
Proportional	0.49	0.26	1.3 min.	10.4 min.	5.0	0.21
Proportional Integral (PI)	0.46	0.29	1.5 min.	11.8 min.	5.5	0
Proportional-Integral-Derivative (PID)	0.42	0.05	0.9 min.	4.9 min.	5.0	0

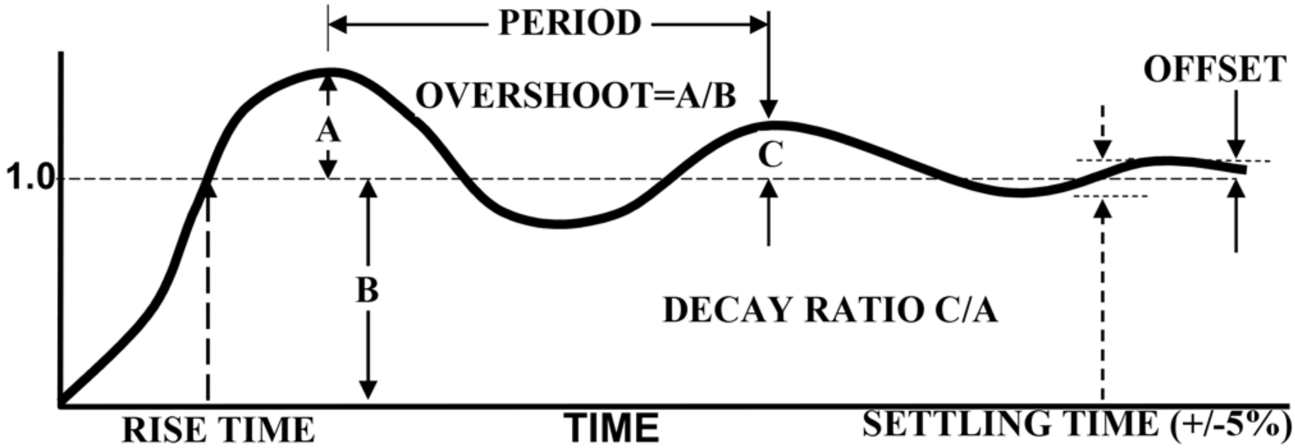


Figure 3: Characteristics of common controller responses.

magnitude of the disturbance (proportional), how long it has been off the setpoint (integral), and how fast the disturbance changes (derivative). The characteristics of common controller responses are seen in Figure 3.

On-Off

On-off control is the easiest feedback control to implement, but the slowest to react because it ignores the magnitude, speed of change, and length of the error signal (Figure 4).

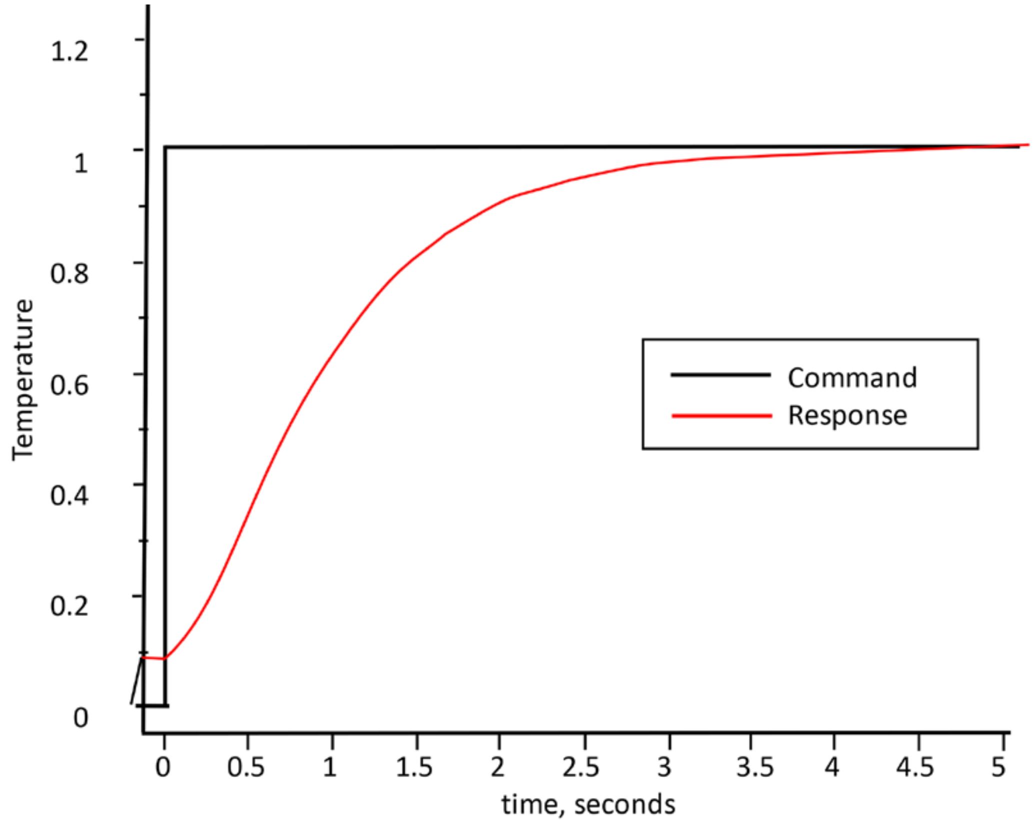


Figure 4: On-off control response [1].

Control Action	Elements	Factors	Effects	Results
Two position (on-off)	$m(t)= M_1$ for $e(t)>0$ $m(t)= M_2$ for $e(t)<0$	$m(t)$= output from controller $e(t)$= error signal	Control action initiated by predetermined absolute error.	Simplest control, but not sensitive to magnitude or change in error signal.
Proportional	$m(t)= K_c\, e(t)$	K_c = proportional gain (sensitivity)	Control action taken based on the error magnitude.	Improved control over on-off, but offset will result in the controlled variable
Integral (reset)	$m(t)= 1/T_i \int e(t)d(t)$	T_i = integral time (min.)	Integral action is an integration of the input error signal.	No offset and the steady state error must be zero.
Derivative (rate)	$m(t)= T_d\, de(t) / d(t)$	T_d = derivative time (min.)	Control action anticipates the effect of large load changes by increasing the output action, and is initiated when the error rapidly changes.	Difficult to implement and tune, and does not eliminate offset because usage is limited to lag compensation.
Proportional plus integral	$m(t)= K_c\, e(t) +1/T_i \int e(t)\, d(t)$	K_c = proportional gain T_i = integral time (min.)	Control action is taken based on the magnitude and duration of the error.	Improved response with no offset, but possibly unstable
Proportional plus derivative	$m(t)= K_c\, e(t)+T_d\, de(t) / d(t)$	K_c = proportional gain T_d = derivative time (min.)	Control action is taken based on the magnitude and rate of change of the error.	Improved response over on-off with lower offset and lag in the controlled variable.
Proportional- integral- derivative	$m(t)= K_c\, e(t) + T_d\, de(t) / d(t) +1/T_i \int e(t)d(t)$	K_c = proportional gain T_d = derivative time (min.) T_i = integral time (min.)	PID control action provides a rapid response by minimizing the error under varying loads.	Best control with rapid response and no offset, but difficult to tune.

Table 1: Control definitions and identifiers.

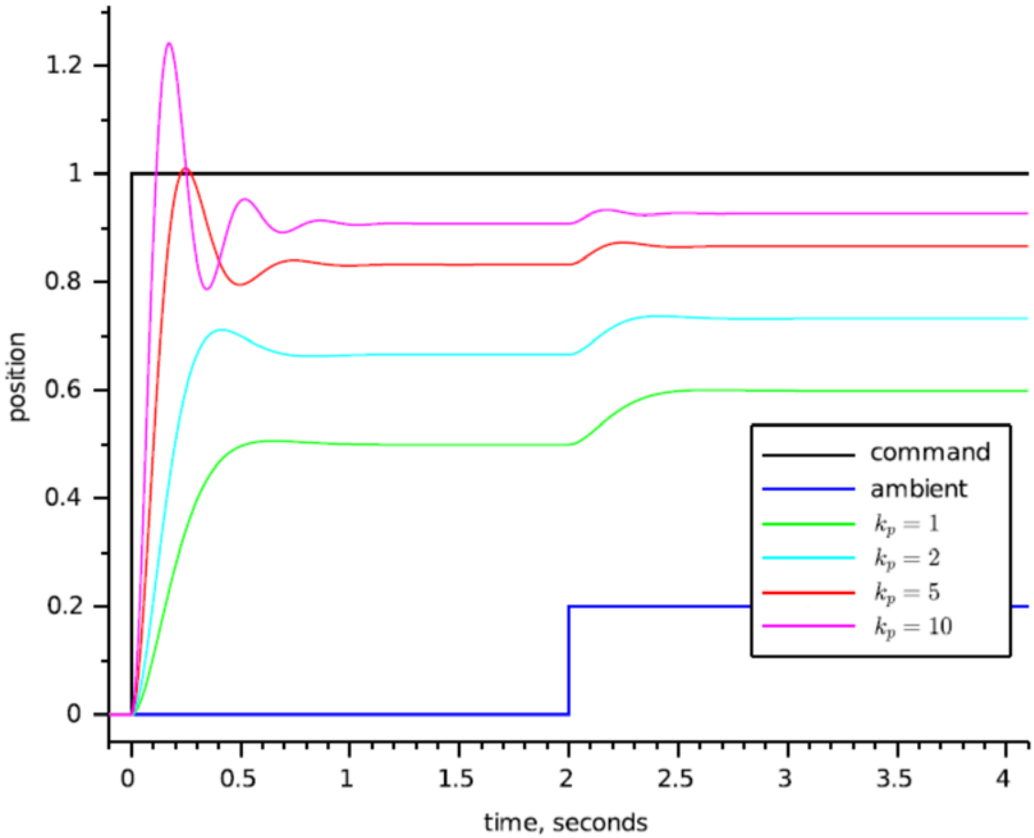


Figure 5: Temperature controller with proportional feedback. The kink at time = 2 is from the external disturbance [1].

Proportional

Proportional control is the most common kind of control loop. It is inherently stable when properly tuned. A proportional controller is just the error signal multiplied by a constant and fed out to the drive, but it experiences offset at steady state.

Figure 5 shows what happens when one adds proportional feedback to the motor and gear system. The motor goes to the correct target for small gains (kp = 1), but it does this quite slowly. Increasing the gain (kp = 2) speeds up the response to a point. Beyond that point (kp = 5 or 10), the motor starts out faster, but it overshoots the target. In the end, the system does not settle any quicker than it would have with low gain, but there is more overshoot. If gain continues to be increased, it most will eventually reach a point where the system just oscillates around the target and never settles. The system would be unstable.

Integral

Integral control is used to add long-term precision to a control loop. It is almost always used in conjunction with proportional control, which provides better dynamics responses than integral alone. Again, there is the possibility for instability.

Figure 6 shows the temperature control system with pure integral control. This system takes a lot longer to settle than the same plant with proportional control (Figure 52). However, notice that when it does settle, it settles out to the target value even with the added disturbance. If a problem does not require fast settling, this might be a workable system.

Meanwhile, Figure 7 shows the motor and gear with proportional-integral (PI) control. Compare this with Figures 5 and 6. The position takes longer to settle than the system with pure proportional control, but it will not settle to the wrong spot.

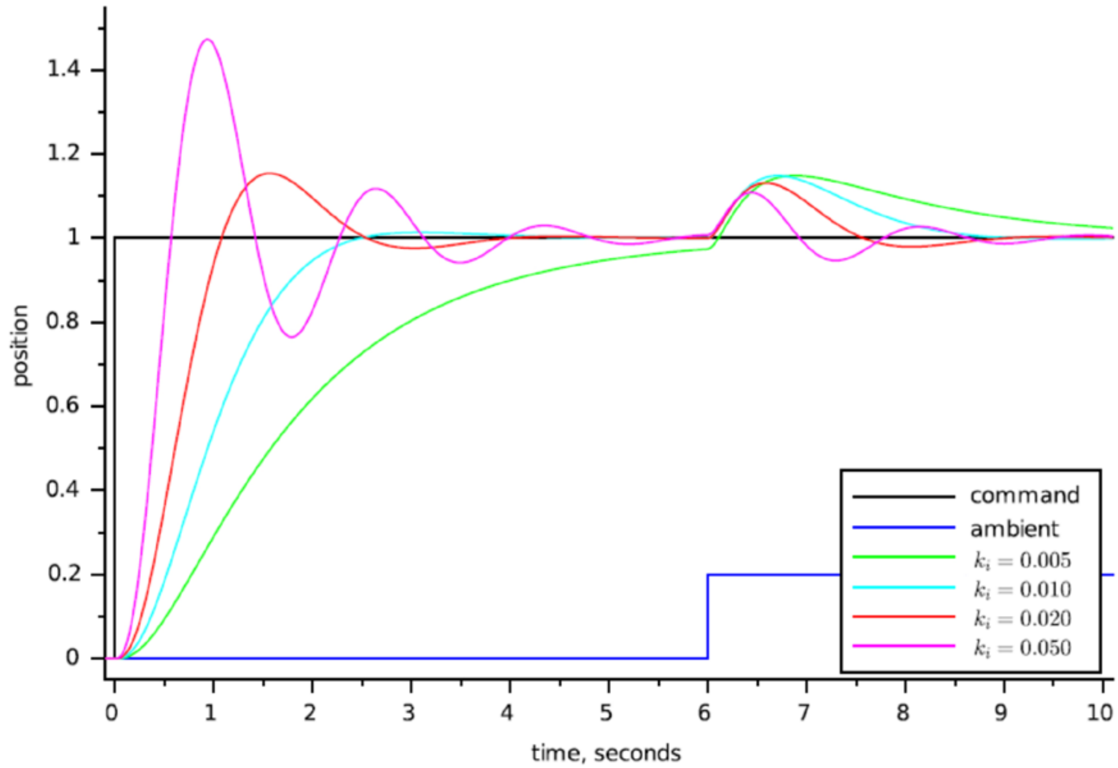


Figure 6: Integral control response. Motor and gear with proportional feedback position vs. time[1].

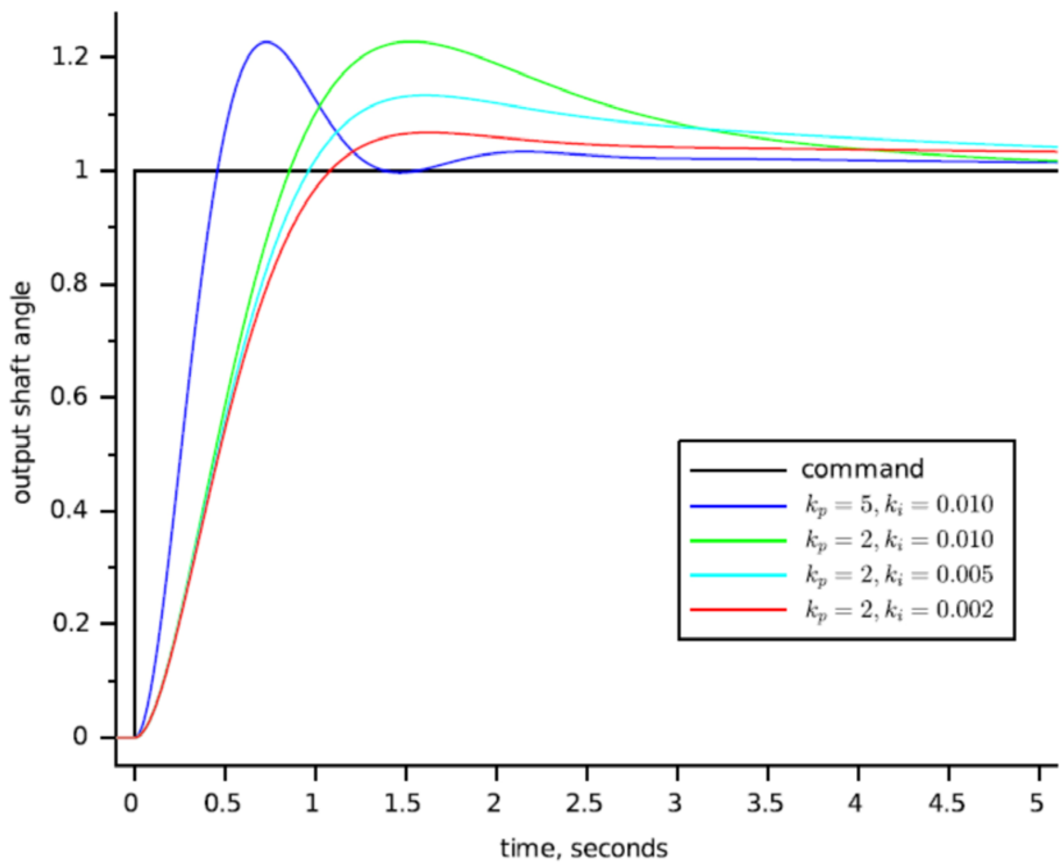


Figure 7: PID control response[1].

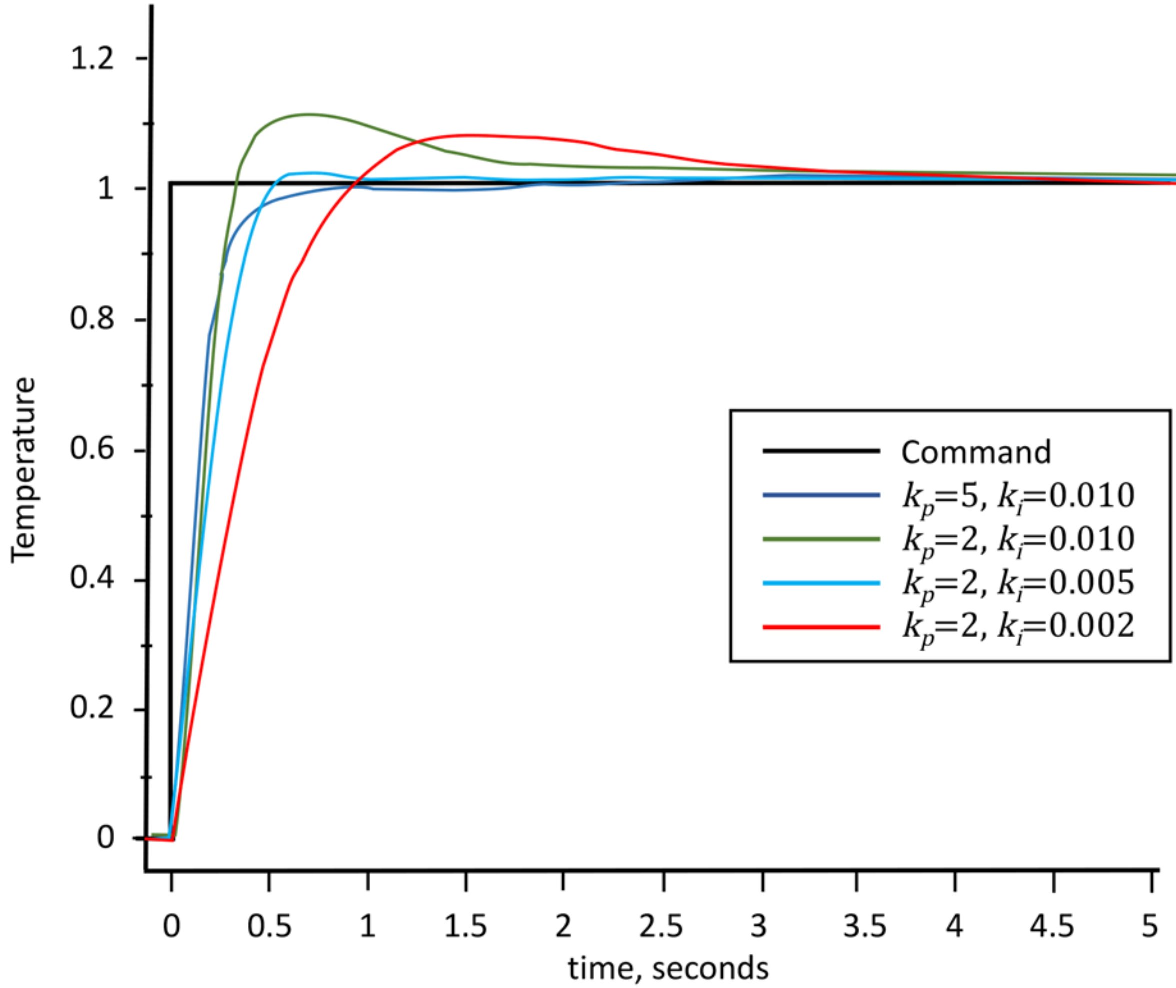


Figure 8: Response of the precision actuator system with PID control. This system settles in less than half a second compared to multiple seconds for other systems [1].

Differential

In general, if you cannot stabilize a process with proportional control, you cannot stabilize it with PI control. Proportional control deals with the present behavior of the process, and integral control deals with the past behavior of the process. If there was an element that predicted the process behavior, then this might be used to stabilize the process. A differentiator will do the trick.

The example shows the differential term of a PID controller. I prefer to use the actual process position rather than the error because this makes for smoother transitions when the command value changes. The differential term itself is the last value of the position minus the current value of the position. This provides a rough estimate of the velocity (delta position/sample time), which predicts where the position will be in a while.

With differential control, the precision actuator system can be stabilized. Figure 8 shows the heating system with PID control. Using the full PID control with this process can result in performance improvements. **SMT007**

Reference

1. Wescott, T., copyright 2018, reprinted with permission.

Download your copy of ***Automation and Advanced Procedures in PCB Fabrication*** by Happy Holden at I-007eBooks.

The Dark Side of the Chip Shortage—Counterfeits

X-Rayted Files

by Bill Cardoso, CREATIVE ELECTRON

It's February 2021, and as the world slowly recovers from the COVID-19 pandemic, another problem plagues the global economy: the electronic component shortage. What some economists have deemed to be a decade of immense prosperity and growth, the "Roaring Twenties" started with a hiccup. From cars to videogames, the lack of electronic components in the market has created a shockwave that is causing delivery delays and billions in losses to companies worldwide. U.S. car giant General Motors, for example, announced that it is shutting three plants and slowing production at a fourth due to the semiconductor shortage. The Detroit car manufacturer said this shortfall will cause a $2 billion reduction in its 2021 profits. GM is not alone. Ford said in January that it was shuttering a factory in Germany for a month, while Volkswagen said in December it will make 100,000 fewer cars this quarter as a result of the shortage.

All that in a year filled with excitement around the long-waited introduction of electric cars in the market: Ford with the passionate Mustang Mach-E, GM with the 1,000hp insane HUMMER EV (yes, all caps), and Volkswagen with the sensible ID.4 (Figure 1). All that excitement has been partially halted because a few ($60 billion worth of them) semiconductors are missing from the supply chain.

For sure nothing else can go wrong, right?

You should know by now, based on last year, that you should not ask this question. Of course, there's plenty else already going wrong. What most people don't realize is that right behind the chip shortage shockwave is another shockwave that is as damaging and as dangerous: the counterfeit components shockwave.

The following (non) scientific graphic displays how supply chain disruptions create the counterfeit shockwave (Figure 2). Let's start prior to the disruption. The world is trotting along, no major disruptions, and in this case supply and demand are well matched. In this case, there's not much for counterfeiters to do other than explore smaller pockets of disrup-

Figure 1: The all-electric 2022 HUMMER, 2021 Mustang Mach-E, and 2021 VW ID.4.

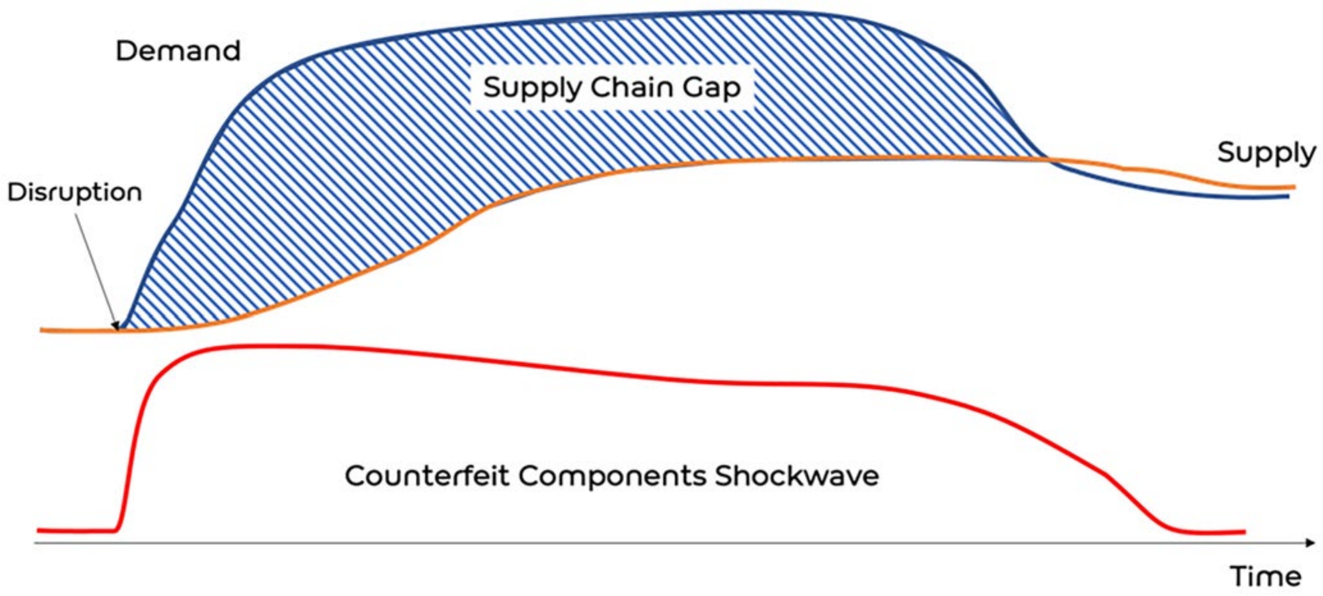


Figure 2: This graphic details how supply chain disruptions create the counterfeit shockwave.

tion often found in the obsolete markets. Military and aerospace companies are big targets because they constantly consume components that are no longer made due to their need to maintain platforms that must operate for 20 years or more.

Suddenly, a pandemic hits the world, millions of people are working from home and millions of kids are going to school on Zoom. The spike in the need to work and study remotely created a spike in the demand for electronic devices, thus creating a spike in the demand for components. The peak in the demand for components is not immediately matched by a spike in supply. Why not? There are several different reasons.

One, it's very expensive to ramp up the capacity in the electronic component supply chain. Semiconductor foundries are in the billions of dollars and take years to plan. And even if capital is available to make this supply investment, it is also unknown how long the demand peak will last. What if your brand-new plant is ready when the demand drops, and your multibillion-dollar investment is now collecting dust? In other words, the return-on-investment time profile is uncertain. The large companies that make semiconductors don't like that.

The supply-demand mismatch creates the supply chain gap we see in the plot above (Figure 2). This vacuum builds an incredible opportunity for the counterfeiting criminal enterprise. They see it as an amazing opportunity to partially fill this supply chain gap with fake components as desperate customers scour the market for parts. The desperation grows as companies see losses in the millions and billions because their manufacturing lines are halted, and as a result they are (sometimes) willing to look for these components in less reputable suppliers. That's how billions of counterfeit electronic components infiltrate the supply chain, causing unknown damages to the products they are assembled in and the companies that sell them.

Unfortunately, it is hard to quantify these damages, as they are often masked as product defects that are seldom investigated as caused by a counterfeit component. The lack of transparency in how companies deal with counterfeits is a major impediment to our understanding of how grave this problem really is. After all, I don't recall a single manufacturer happy to share how often they encounter counterfeit components. This information is usually shared under the veil of NDAs. Thus, I invite all companies to come forward: How often do you find counterfeit components? Let's be open; that's the only way we can improve this problem.

Companies that never find counterfeit components are often the ones that are not looking for them.

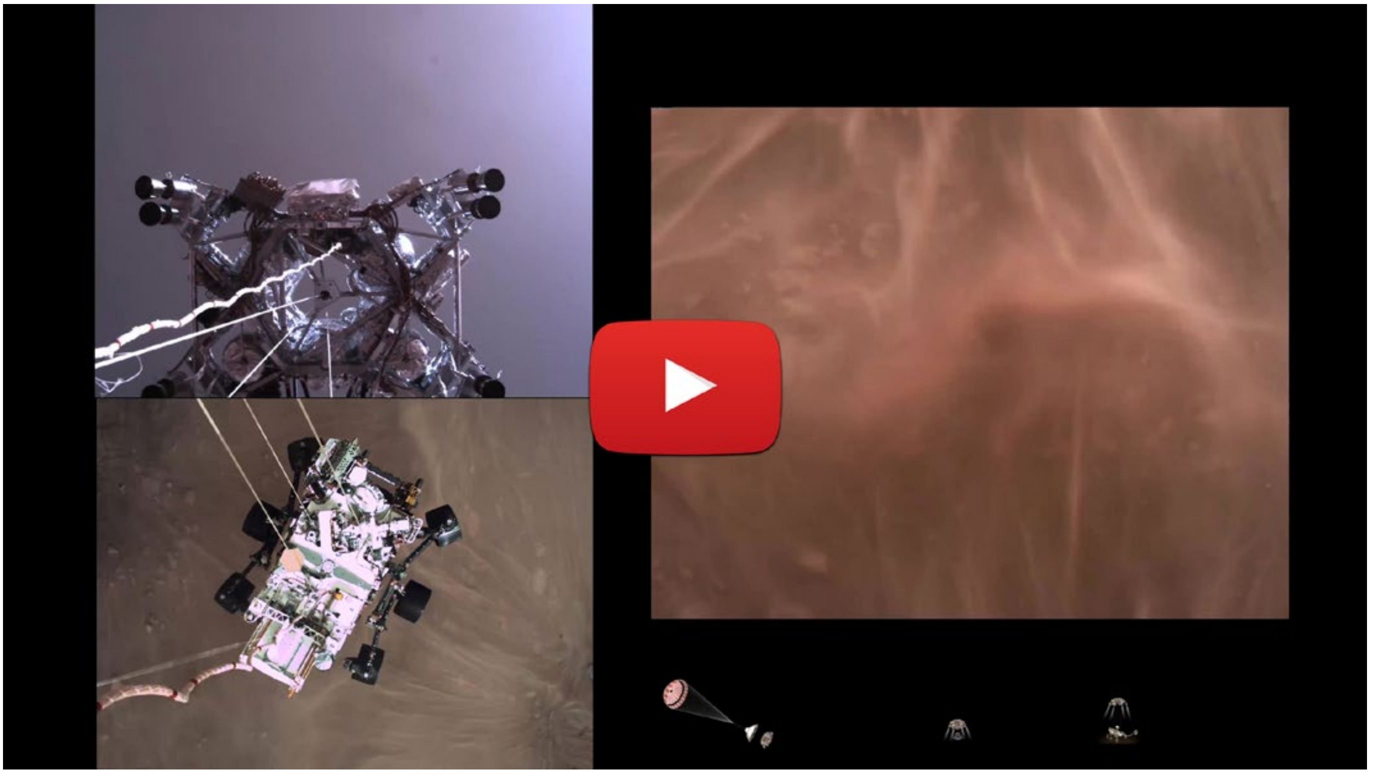
That brings me to the last piece of the puzzle: what to do with all these counterfeit components? This is not the first counterfeit shockwave we've seen. Every economic boom has created this shockwave. What's unique about the current shockwave is the impact the pandemic had on the supply chain. Not only do we have a spike in demand, but this increase is also met with a proportional decrease in the supply chain's ability to react. A double whammy.

We forecast an extended counterfeit shockwave, the size and extent of which we haven't experienced. It's never been more critical to have a good counterfeit mitigation program in place. That's the topic of our next article, so stay tuned! **SMT007**

Dr. Bill Cardoso is CEO of Creative Electron. To read past columns, or contact Cardoso, click here.

NASA's Mars Perseverance Rover Provides Front-Row Seat to Landing, First Audio Recording of Red Planet

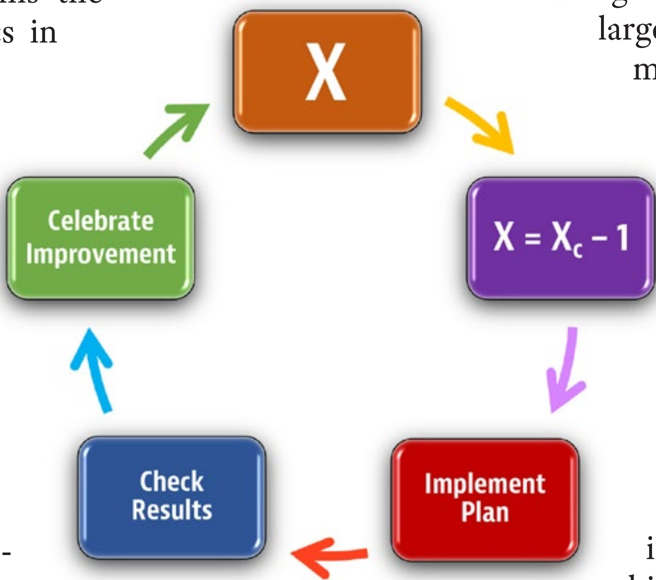
New video from NASA's Mars 2020 Perseverance rover chronicles major milestones during the final minutes of its entry, descent, and landing (EDL) on the Red Planet on Feb. 18 as the spacecraft plummeted, parachuted, and rocketed toward the surface of Mars. A microphone on the rover also has provided the **first audio recording of sounds from Mars**.



Do You Have a CPIM?

Feature by Barry Matties
I-CONNECT007

Process improvement is a never-ending endeavor for all companies; however, the difference is the pace at which a company pursues this idea. Some make it a proactive culture, others take a reactive approach, and there's a group somewhere in the middle. When you compare the types, the proactive culture typically outperforms the others in all key metrics in the long run.



Continuous improvement drives out waste in your processes, streamlines workflow, and gives you a competitive advantage. So why do some live and breathe it—and some don't? That has to be answered individually. As a customer, when you deal with a supplier that is dedicated to continuous improvement, you feel the benefits; when you deal with a supplier that doesn't have that mindset, you feel that as well. One is smooth and pleasant and the other can result in disappointment.

A Designated Role

Because continuous improvement is a daily task, the question is: Who is responsible for it? Look at the list of titles in your company and you will typically see CEO, VP, sales, accounting, manufacturing, and so on. The one that you rarely see is chief process improvement manager (CPIM), yet this may be the most essential position in your company. It may be hard for some to justify the added expense, but once you realize improvements, you will see the CPIM could be worth their weight in gold. Often in smaller organizations, you will see the leadership take on the role of CPIM, along with their other tasks. In large companies, this role may expand into a process improvement department.

Overall, the role of your CPIM is to examine, document, and work to improve all your processes. This includes your business processes as well as your manufacturing processes. As they do this, they will then begin to challenge the current processes by asking, "Why do we do it the way we do it?" Often, the answer is, "Because we've always done that way." *Why* is one of the most important questions they can ask: Why are deliveries late? Why do we have scrap? Why do we do this step? Why do we use this tool? Why do we have a bottleneck? Why is work in progress at a standstill in the hallway? By asking why, the status quo is challenged, and improvement begins.

Some people may feel threatened by the "why" question, feeling like it's a personal attack on their work. It is not, and an experienced CPIM will work with and train your team to realize that they are attacking process and not people. By doing so, they will be facilitating a continuous improvement culture and fostering teamwork.

Keep in mind that your CPIM does not need to be an expert on what you're doing; they need to be an expert on how to make systems more efficient and facilitate change within your team. The process owners will work with your CPIM and together they will drive out waste and optimize your company.

I found a good example of this in 2020 when I had a chance to visit Ventec International Group in Germany. That's where I first met Frank Lorentz, who was brought in as the general manager even though he did not have any previous laminate or PCB industry experience. Frank's expertise is logistics, and he is definitely a systems thinker. In a very short period, not only did Frank optimize key processes, but he created a culture of continuous improvement. Even though his official title is general manager, I would say that he's also their CPIM. A link to the interview I conducted with Frank can be found at the end of this article [1].

Unless you have a dedicated effort to continuous improvement you may be missing some real opportunities to have a competitive advantage. I am not talking about the big improvement plans, though they are a part of it. It's the small things that can add up in a big way. Here at I-Connect007, we have a focused commitment to continuous improvement. Here's one example of how a small change can have a big impact.

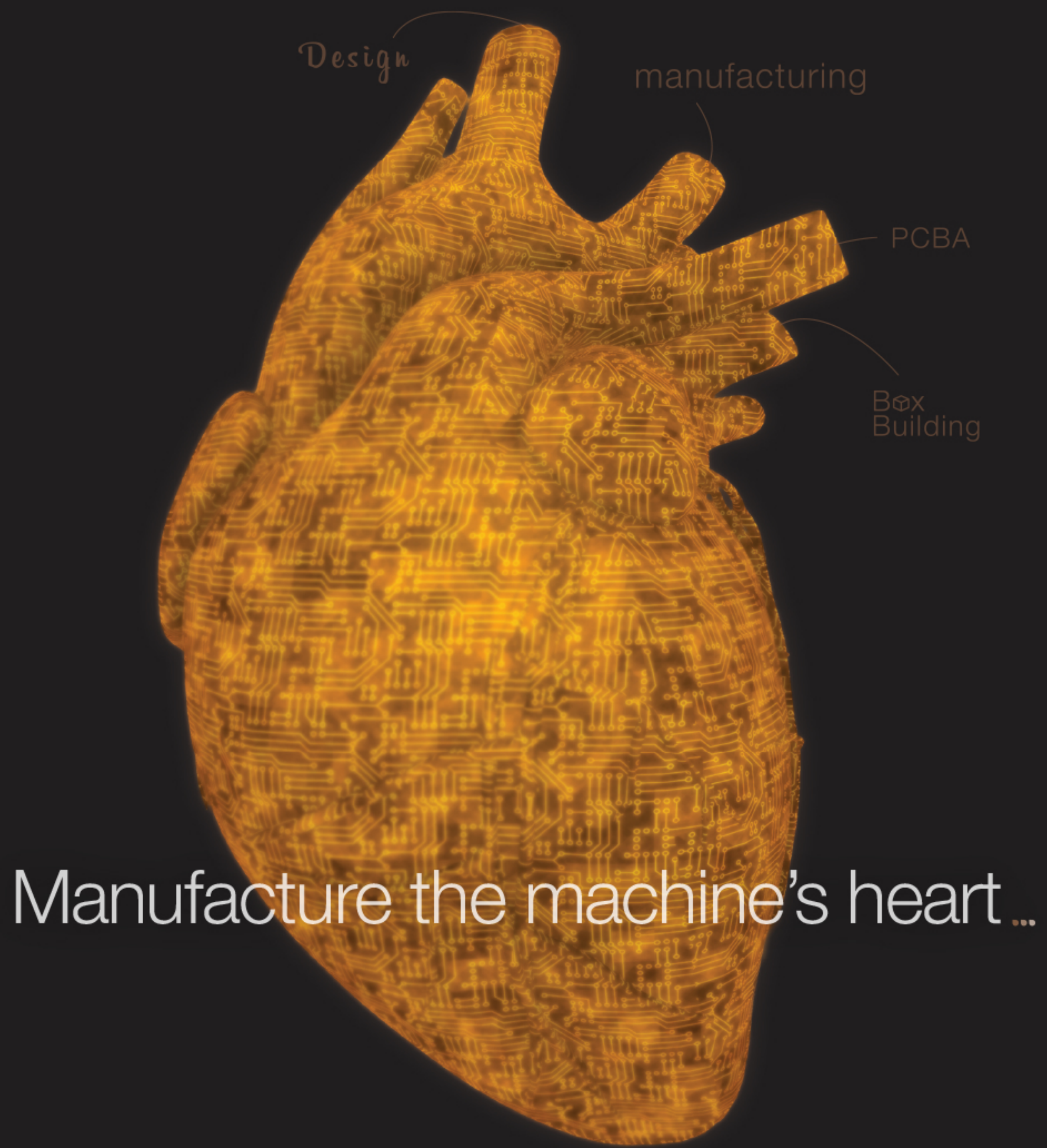
In this case, we examined workflow and discovered that if we just reordered one step in our process, we would save 40 labor hours per month and improve the product. Of course, we made the change, saved the labor hours, and found that other benefits rippled through our entire process. If we did not challenge the process with our *why* question, we would have just done it the way we had always done it. Having those hours back added extra capacity to our team and reduced our overall cost of producing our product. This is a prime example of how $X = X_C - 1$ works. If you would like to learn more about $X = X_C - 1$, our January issue of *SMT007 Magazine* is dedicated to this topic.

Process improvement can provide a huge return on investment. But like anything, if you are not committed to it, and you do not have a CPIM in your organization along with the resources needed, then you could really be missing out on removing waste in your processes and optimizing your organization. **SMT007**

References

1. *Logistics Are Frank Lorentz's Passion,* Ventec International Group interview with Barry Matties and Frank Lorentz, PCB007.com, January 2020.

This article originally appeared in PCB007 Magazine, Feb 2021.


Design
manufacturing
PCBA
Box
Building
Manufacture the machine's heart...

UL Certification for the Safety of PCBs

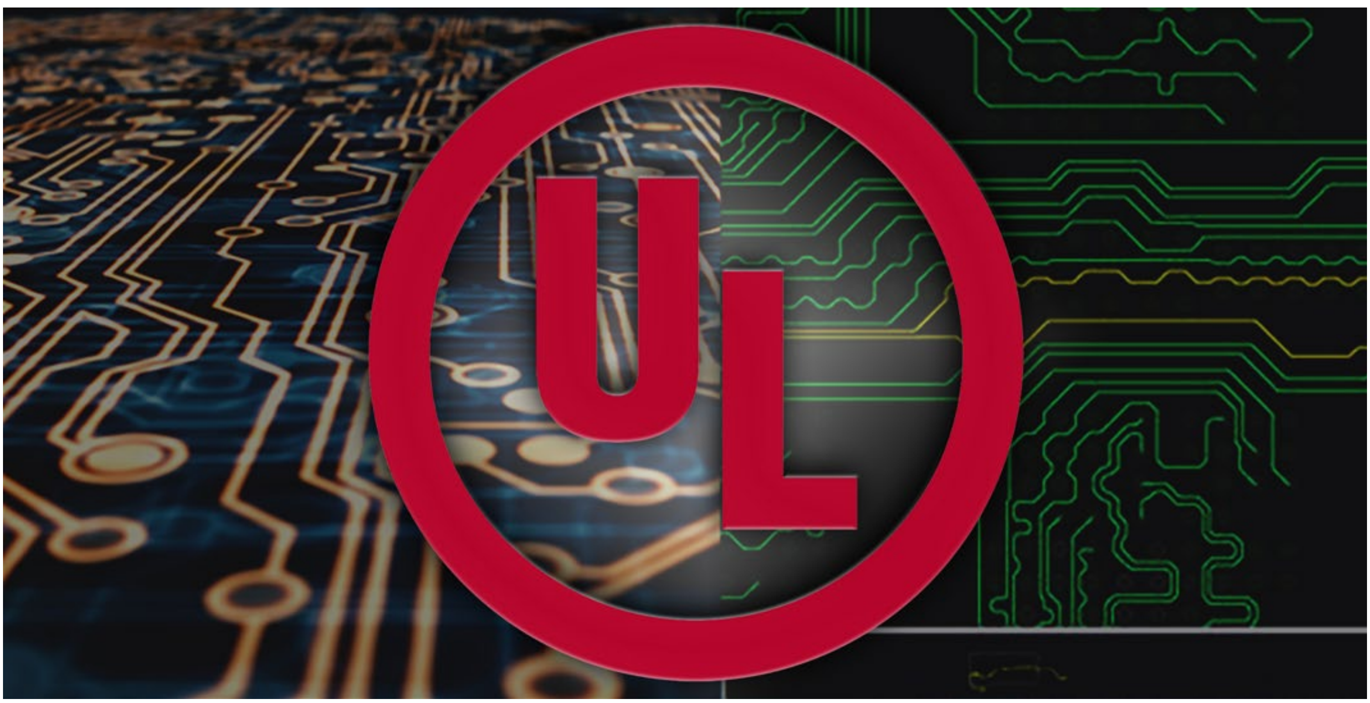
Fresh PCB Concepts

by Jeffrey Beauchamp, NCAB GROUP

Security is essential in the electronics industry. It is vital that users can rely on the finished products when considering factors such as fire and electrical safety, which means that both the PCBs and the materials they contain must measure up to the highest standards. To ensure that the boards do conform, it has become common practice to UL-certify the constituent materials or the PCB itself. In this column I am going to discuss UL certification, what's involved and why you need it.

The acronym UL stands for Underwriter's Laboratories. Founded in 1894, UL is a globally recognized organization headquartered in the United States with locations all over the world. UL describes itself this way: "As the global safety science leader, UL helps companies to demonstrate safety, enhance sustainability, strengthen security, deliver quality, manage risk and achieve regulatory compliance." It has more than 150 laboratories and 10,000 employees. In relation to PCBs, UL has almost 60 years' experience testing and approving materials to make a board as well as the board itself. This includes electrical and fire safety, and mechanical durability.

Having UL recognition ensures the end customer a PCB will not have to spend extra time and resources on their own tests while also sending a strong message that your company cares about safety and sustainability. It's also important to note that processes can affect



safety. Simply because all the materials used in PCB production are UL approved, materials can be influenced by the manufacturing or the design—say if two different materials are combined with one another.

Customers from around the world demand factories that can achieve UL recognition. Having UL recognition is very important for PCB factories to produce secure boards and be able to access the international market. Specifically in China, there are more than 1,200 PCB factories with UL recognition. All NCAB factories, for example, must have UL recognition for any given configuration they are approved to manufacture. This is one of the first steps in sourcing a new factory as a partner. Although it is still important to continuously evaluate this as PCB technology—and all technology—it increases and changes exponentially. As a new technology emerges, we need to make sure a factory is approved for that material and/or process. Also of note, UL does not mean the quality of the board is certified exclusively. For NCAB Group, it is just one of several factors we implement to determine quality of delivery.

UL recognition can also be required by law when exporting to some countries. The big challenge with UL is that for a PCB factory it is both costly and time-consuming to obtain UL recognition for all the base laminates, prepregs, solder masks, and so on, in various combinations of builds. There is a great temptation for PCB factories—even those in the USA and Europe—to take shortcuts with their recognition. The consequences can be disastrous for someone who supplies products without UL recognition or with incorrect marking. In the worst case, they would be forced to do a general product recall from the market—leading to huge costs and perhaps even bankruptcy. As a purchaser and user of PCBs, you risk falling into many traps regarding UL recognition. It is vital to thoroughly check that the factories' certifications really apply to the products you are buying.

When purchasing PCBs with safety in mind, I recommend always buying from a reputable source, and to inspect the UL marking on PCBs. All boards must be labeled in a specific way, to enable you to track where they were manufactured. UL has an online directory of certifications and a database for PCBs, laminates, and surface materials. When in doubt, contact your trusted PCB supplier. If they are unable to support you in this matter, beware. SMT007

Jeffrey Beauchamp is a field application engineer at NCAB Group. To read past columns, or contact Beauchamp, click here.

Electronics Industry News and Market Highlights

Nokia, Brazilian Research Group CPQD Partner to Develop 5G ORAN Solutions ▸

Nokia has announced a partnership with Brazil's Telecommunications Research and Development Center (CPQD), an independent government-affiliated research body, to jointly develop applications and solutions based on the Open RAN-compliant near-real-time RAN Intelligent Controller

How Unmanned Underwater Vehicles Could Become Easier to Detect ▸

Detecting the presence of an unmanned underwater vehicle is usually achieved by intercepting the noise radiated by its propeller. In a noisy harbor, this task is hindered because the acoustic signature of a UUV and the noise in the local environment often present too much signal complexity for current technologies to process.

Aramco, AEC Launch Cybersecurity Solution, Designed and Manufactured in Saudi Arabia ▸

Advanced Electronics Company, a Saudi Arabian Military Industries company, has signed an agreement with Aramco to launch a new cybersecurity product designed and manufactured in the Kingdom. Known as a "data diode," it is the result of cooperation between the two companies in designing and manufacturing the product.

TELUS, Google Form Strategic Alliance to Bring Digital Transformation to Key Industries ▸

Google Cloud and TELUS announced a strategic alliance to co-innovate on new services and solutions that support digital transformation within key industries, including communications technology, healthcare, agriculture, security, and connected home.

Avnet, ON Semiconductor Accelerate IoT Innovation with New Development Framework ▸

Leading global technology solutions provider Avnet and ON Semiconductor, driving energy efficient innovations, have joined forces to create a framework that helps OEMs more rapidly develop end-to-end Internet of Things (IoT) devices.

SVI, IDEMIA NSS Collaborate to Offer Most Advanced FMCW 4D LiDAR Biometric Recognition Solution ▸

StereoVision Imaging, Inc., an emerging leader in 2D and 3D/4D LiDAR based facial/object recognition and remote sensing technology, has joined forces with IDEMIA National Security Solutions to offer the most capable biometric recognition platform available today.

Smartphone to Become Car Key ▸

LG Innotek (CEO Cheol-dong Jeong) revealed recently that it had succeeded in developing a digital car key module with improved location detection precision and security.

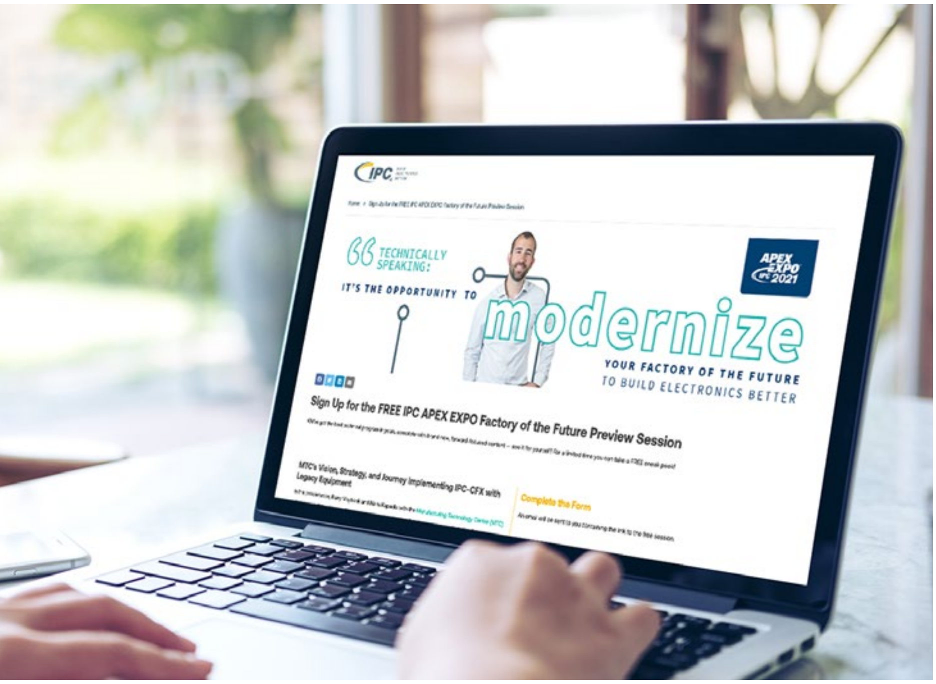
XAG Suggests Drones Could Outsmart Locust Swarms at Night ▸

The UN warned that East Africa remains under the threat of desert locust invasions, due to the prevailing favourable breeding conditions which enable new swarms to form and increase.

APEX EXPO IPC 2021

Smart Processes and Continuous Improvement Seminars at IPC APEX EXPO

IPC APEX EXPO 2021, taking place live but virtual March 8-12, offers a number of technical programs that relate to smart processes, continuous improvement, and factory automation. We've highlighted some of the process-focused sessions here. Of course, your specific needs for process improvement may benefit from one of the numerous other technical programs available to you (full program here) as a registrant. Remember, not only can you attend these sessions live, but some registration levels allow you to have 90 days' access to the recordings after the event.



Wednesday, March 10, 2021

10:00 a.m.–Noon

PCBA Quality, Reliability, and AI-based Inspection

Seminar Type: Technical Conference Session
Track: Quality, Reliability, Assembly, Test and Inspection

Speaker: Murilo Levy Casotti, Embraer and UFSC FIDES
Reliability Assessment of Electronics: A New Approach to The Lead-Free Process Factor

Speaker: Hailey Jordan and Wade Goldman, Draper
Analyzing Printed Circuit Board Voiding and other Anomalies when Requirements Covering the Anomalies are Vague

Speaker: Feng Xue, IBM
A Framework for Large-Scale AI-Assisted Quality Inspection Implementation in Manufacturing Using Edge Computing

Speaker: Jasbir Bath, Koki Solder America
Failure Analysis Cases Studies on Solder De-Wetting for Electronics Products

Thursday, March 11, 2021

10:00 a.m.–Noon

MTC Factory of the Future Advancements

Moderator: Naim Kapadia, Technology Manager, The Manufacturing Technology Centre
Seminar Type: Technical Conference Session
Track: Factory of the Future Implementation

Speaker: Barry Maybank, Manufacturing Technology Centre
MTC Vision and Journey Enabling Smart Factory for Electronics Manufacturing for Low Volume High Mix Environment

Speaker: David Varela, Manufacturing Technology Centre
Working with Augmented Reality/Mix Reality in Electronics Manufacturing

Speaker: Mike Wilson, Manufacturing Technology Centre
The Role for Automation and Robotics in Electronics Manufacturing

Thursday, March 11, 2021

1:30–3:00 p.m.

Traceability for Electronics Manufacturing

Moderator: Michael Ford, Senior Market Development Manager, Aegis Industrial Software Corp.
Seminar Type: Technical Conference Session
Track: Factory of the Future Implementation

Speaker: Michael Ford, Aegis Industrial Software Corp.
IPC-1782A: Traceability And Secure Supply-Chain 2021 With A Look Toward Component/Product Authentication/Provenance

Speaker: Radu Diaconescu, Swissmic SA
IPC-1782A: Traceability And Secure Supply-Chain 2021

Speakers: Michael Ford and Radu Diaconescu
IPC-1782A: Traceability Internal Traceability

Speaker: Radu Diaconescu, Swissmic SA
IPC-1782A: The Move Towards Authentication and Provenance

Friday, March 12, 2021

10:30 a.m.–Noon

Implementing Digital Twin for Electronics Manufacturing

Moderator: Radu Diaconescu, Swissmic
Seminar Type: Technical Conference Session
Track: Factory of the Future Implementation

Speaker: Michael Ford, Aegis Industrial Software Corp.
IPC-2551 Digital Twin Standard: A Glimpse into Values & Benefits

Speaker: Hemant Shah
IPC Digital Twin: Engineering

Speaker: Thomas Markscheffel, ASM (Assembly Systems) GmbH & Co. KG
IPC Digital Twin: Manufacturing

IoT is Changing How We Design PCBs

Connect the Dots

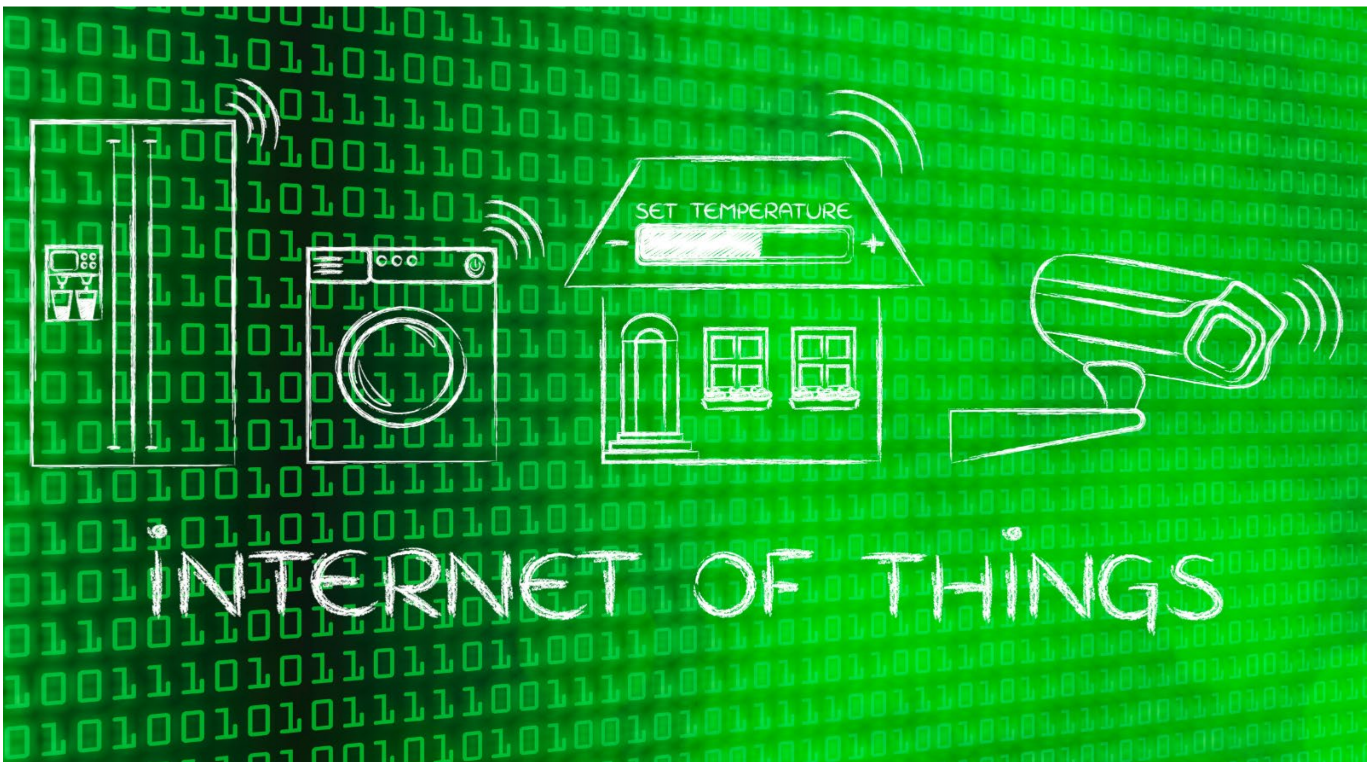
by Matt Stevenson, SUNSTONE CIRCUITS

"It's technology that helps you sleep, not keeps you up. It tells you when you've had enough. It gives you space to create or draw or write or learn, not refresh just one more time."
— Tim Cook, CEO of Apple

The Internet of Things (IoT) is everywhere now—purpose-driven technology that improves lives by making technology work for people, not the other way around. With nationwide 5G wireless capacity rapidly expanding, the demand for and deployment of IoT products is exploding. Households increasingly rely on networked smart appliances. Traditional watches have largely been replaced by fitness trackers, and more of us get our weather reports by asking Alexa than watching the local TV weatherperson.

Demand growth is fueled by business as well as consumers, with pandemic-accelerated healthcare and industrial machinery applications leading the way. IoT devices of every stripe will continue to improve and add functionality while also becoming smaller, lighter, and faster.

Pressure to create innovative solutions for these devices puts the PCB designer at the epicenter of IoT.



It's Time to Broaden Our PCB Design Horizons

Designing boards for these devices will take a lot of skill on the part of the PCB designer, as well as a willingness to learn new tricks. Device memory, CPU, and wireless circuitry can often fit onto a system-on-a-chip (SoC) component in the assembly, but chip designs will have to accommodate other critical components packed into a small layout.

Using the same old tech to design boards for IoT will get tougher and tougher. There are packaging technologies available to help designers create boards small enough in thickness and diameter to accommodate the needs of smaller IoT devices. Three-dimensional integrated circuits can help reduce power consumption on a smaller design footprint. Multi-chip modules allow multiple integrated circuits to function as one—potentially reducing the cost of the board while improving performance.

Designing PCBs for IoT also requires thinking about how the end-product is manufactured and put to use. For many IoT devices, PCBs are often embedded in other materials and must be flexible. That means your board design will likely feature newer materials like plastic, mesh, and flexible copper.

To move ahead, designers need to adhere to sound, established design methodology as well as tools that elevate their performance. Using more advanced PCB design tools will help designers respond to the demand for IoT devices.

Best Practices for PCB Designers on IoT Projects

John McMillian's 2017 white paper[1] remains the gold standard for IoT board design. Keep the seven design aspects laid out in that paper top of mind and it will help meet the challenges associated with IoT devices. We encourage you to download the paper and keep it on hand for reference. In the meantime, here is our take on McMillan's seven keys to IoT PCB design:

1. Know your design domains. IoT designs with multi-chip modules integrate analog-to-digital, micro-electrical mechanical systems (MEMS), and radio to make them function as one. The more experience you have with these types of circuit design, the more easily you can create a PCB for IoT that meets your functionality requirements.

2. Stay focused on design constraints. Often, the nature of IoT devices puts limits on size and weight that trickle down to your design. If you are adding connectivity to a well-established product, for example, that can really be a challenge for the PCB layout. New versions of established IoT devices need to do everything the last model did, plus more, without getting any larger or heavier.

3. Broaden your component vocabulary. Before you begin to design in earnest, make sure you are familiar with all the components that create functionality for data flow, device display, and Wi-Fi connectivity. You will be building your design around these components, so the more familiar you are with them, the better.

4. Your schematic needs to convey the design's intent. This includes issues such as physical constraints, cost considerations, and component availability. Keep this in mind as you create the bill of materials (BOM). Remember to verify part footprint sizes and height above the board as part of that investigation, especially on a highly constrained design.

5. Test early and test often using all the tools available to you. Model-based design and testing tools will allow you to test, simulate, and verify the design's functionality. Use them. This is how you catch problems and make changes before a prototype build.

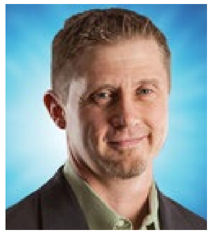
6. Learn the critical elements of board layout. Your CAD tool should allow you to visualize the board in its enclosure before you deal with routing and tracing. Using both 2D and 3D views for verification of things like flex circuit bends, you can more easily design within the device constraints.

7. Validate your design. Use your relationship with a PCB manufacturer and assembly partner to make sure your design will work. They will be able to provide feedback that will increase yields and reliability, as well as improve cost competitiveness.

The future of IoT is just around the corner. Expand and hone your design skills today, and perhaps be part of creating the next Alexa or Fitbit tomorrow. **SMT007**

References

1. 7 Design Aspects of IoT PCB Designs—Siemens EDA (pads.com)



Matt Stevenson

Matt Stevenson is the VP of sales and marketing at Sunstone Circuits. To read past columns or contact Stevenson, click here.

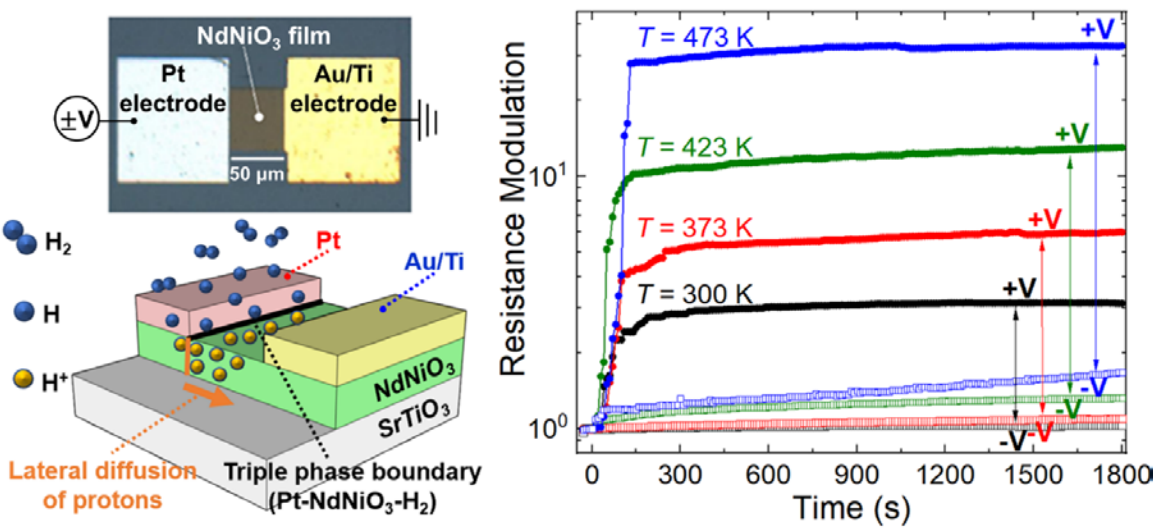
A Colossal Step for Electronics

Researchers at Osaka University demonstrated a new technique for modifying the hydrogen concentration of resistors by applying an electrical voltage. The generated electric field drove the diffusion of hydrogen ions deeper into the perovskite rare-earth nickelate lattice, which led to a tunable "colossal" increase in electrical resistance. This research can lead to new gas sensors and electrically switchable smart materials.

Computer chips depend on the careful control of electrical signals through semiconductors. Conventionally, the conductivity of silicon chips is modified by intentionally "doping" them with impurity ions. However, this process is usually done once at the factory, and cannot be changed later. Thus, the ability to dynamically control the doping of materials would open the way for novel switches and potentially even entirely new kinds of computer circuits.

Now, scientists at Osaka University have created thin films of neodymium nickel oxide (NdNiO3) with an electrical resistance that can change dramatically by controlling the distribution of hydrogen ions (protons) in the film. The hydrogen was added in a process called "gas-phase annealing" in which the thin film, which has a perovskite crystal structure, was exposed to hydrogen gas in the presence of an electric field which caused the formation of hydrogen protons. This reaction was sped up by platinum electrodes, which act as catalysts.

(Source: Osaka University)



Strongly correlated oxide proton resistor devices.

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APEX EXPO IPC 2021

Schedule at a Glance

As of January 2021:

Monday, March 8

8:45–8:50 a.m.	Welcome Message
9 a.m. –Noon	EMS Management Meeting
9 a.m. –Noon	Managers Forum: Managing Challenges in Periods of Transition—*Presented by the Raymond E. Pritchard Hall of Fame Council*
9 a.m. –Noon	Professional Development Courses
12:30–1:30 p.m.	Keynote Presentation *by John Mitchell, President and CEO, IPC*
1:30–5 p.m.	EMS Management Meeting
1:30–5 p.m.	Managers Forum: Managing Challenges in Periods of Transition—*Presented by the Raymond E. Pritchard Hall of Fame Council*
2–5 p.m.	Professional Development Courses

Tuesday, March 9

8:45–8:50 a.m.	Welcome Message
9 a.m.–Noon	Professional Development Courses
9 a.m.–Noon	Exhibitor New Product Presentations
12:30–1:30 p.m.	IPC Annual Meeting and Awards Ceremony
12:30–1:30 p.m.	A Virtual Escape Experience
2–5 p.m.	Professional Development Courses
2–5 p.m.	Exhibitor New Product Presentations

Wednesday, March 10

7:55–8 a.m.	Welcome Message
8–8:45 a.m.	Keynote Presentation *by Travis Hessman, Editor-in-Chief, IndustryWeek*
10 a.m.–Noon	Technical Conference Sessions
11 a.m.–Noon	Forgotten Tribal Knowledge with IPC Hall of Fame and Emerging Engineers
12:30–1:30 p.m.	IPC Emerging Engineers Roundtable
12:30 –1:30 p.m.	Exhibitor New Product Presentations
12:30–1:30 p.m.	Live Q&A with *Travis Hessman, Editor-in-Chief, IndustryWeek*
1:30–3 p.m.	Technical Conference Sessions
1:30–5 p.m.	Exhibitor New Product Presentations
3:30–5 p.m.	Technical Conference Sessions

Thursday, March 11

8:10–8:15 a.m.	Welcome Message
8:15–9 a.m.	Keynote Presentation by *Shawn DuBravac, Chief Economist, IPC*
9 a.m.–Noon	Professional Development Courses
9 a.m.–Noon	Exhibitor New Products Presentations
10–11:30 a.m.	Technical Conference Sessions
12:30–1:15 p.m.	IPC Education Foundation: Looking Ahead
12:30–1:30 p.m.	Trivia Networking and Name That Tune
1:30–3 p.m.	Technical Conference Sessions
1:30–5 p.m.	Exhibitor New Product Presentations
2–5 p.m.	Professional Development Courses
3:30–5 p.m.	Technical Conference Sessions

Friday, March 12

9–9:45 a.m.	IPC at a Glance (Standards, Education, Advocacy, Solutions and Industry Intelligence)
10–10:30 a.m.	Exhibitor New Product Presentations
10:30 a.m.–Noon	Technical Conference Sessions
Noon–12:15 p.m.	Closing Remarks

Salvaging Components for Other Uses

Knocking Down the Bone Pile

by Bob Wettermann, BEST INC.

Electronic components and their availability (or rather their lack of) have been in the news recently. Automotive suppliers are struggling with their supply chain as electric vehicle production, and the associated consumption of electronic components, continues to expand. Fabless semiconductor companies lacking capacity have also been in the news with their deliveries pushed out to 2022. All this news, and the ever-shortening life cycle of semiconductor devices, have left some electronic manufacturers wanting for supply. In some cases, shortages of given components can be met by harvesting them from existing assemblies.

The harvesting (Figure 1) of electronic components from circuit boards allows obsolete, expensive, long-lead-time order electronic components to be re-used. These components can be harvested from scrap piles, from obsolete assemblies, or by other means. Care must be taken to ensure that the components can be reused in a manufacturing environment, and given the greatest chance for a reliable component to be soldered in place.

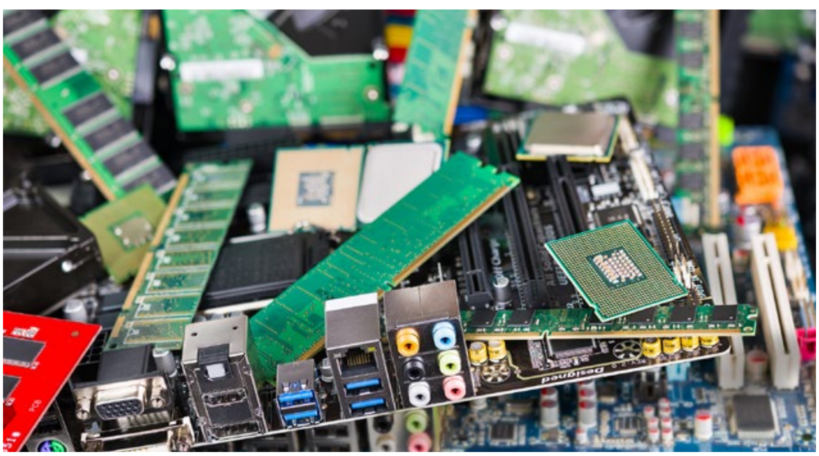

Figure 1: Should used printed circuit boards be considered scrap or salvage?

Disassemble the Hardware

The first step in salvaging components from an assembly where valuable electronic components are soldered in place is the dissembling of the hardware. This operation may include the backing out of screws, and the detachment of sub-assemblies and larger components, such as heat sinks, fans, and power supplies.

Begin the Salvage Operation

Once all the mechanical sub-assemblies have been taken off the board, the salvaging operation can begin. It is critical to understand all the requirements from the end user, including items like the packaging of salvaged components, removal or non-removal of conformal coatings, the MSL level of the components, and many other aspects.

MSL Level

If the PCBs have been held in open storage or are field returns, the moisture sensitivity level, (MSL) of the to-be-removed components generally requires a pre-bake of the components prior to removal. This will help ensure the long-term reliability of the component to be salvaged.


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Coatings

Not only should the MSL of the components be considered, but it should be noted whether the boards have been conformally coated, have had components staked in place, or underfill applied to the components. The presence of underfill or conformal coating on and underneath the components to be removed is significant as there are numerous stripping processes which can be employed as part of the removal operation. In some cases, this may cause difficulties, including throughput issues. It is important to determine the overall area of conformal coating removal at the onset. For example, if conformal coating needs to be removed from the component body, this process may have the unintended consequence of part number, date code, and other information being removed from the package.

Adhesives and underfills may soften during removal but their later removal from the component body may take too much time to make the salvaging economically feasible. In addition to the above items, the electrostatic discharge (ESD) sensitivity level of the component should also be considered during the salvaging process. Just because the parts are being salvaged doesn't mean that they should not be handled like "live" boards. The component datasheet will inform the remover of the type of ESD precaution that needs to be taken.

Labels

Another area of concern is the label on the component or the PCB. All the salvaging processes—including the conformal coating stripper, heat, cleaner and flux—will interact with the board where components are to be salvaged. The part or board label may need to be masked with Kapton™ or liquid mask to prevent the markings from disappearing during processing.

Other Operations

There are several operations on the components themselves which need to be considered. Small legged leads such as high pin count QFPs may need to have their leads straightened and formed to be coplanar upon removal to meet the JEDEC requirements so that they can be placed correctly onto a potentially new PCB. Solder balls will need to be re-attached to a removed BGA or CSP through a re-balling process to place it onto a new assembly. Part datasheets will help determine the correct ball size. Customer order details will determine the correct solder alloy.

For part salvaging, be careful of the maximum temperature the components can withstand. This will be important to understand as the right removal process tool and profile needs to be chosen. Proper profiling will ensure that the temperature limits of the component are maintained during the removal process.

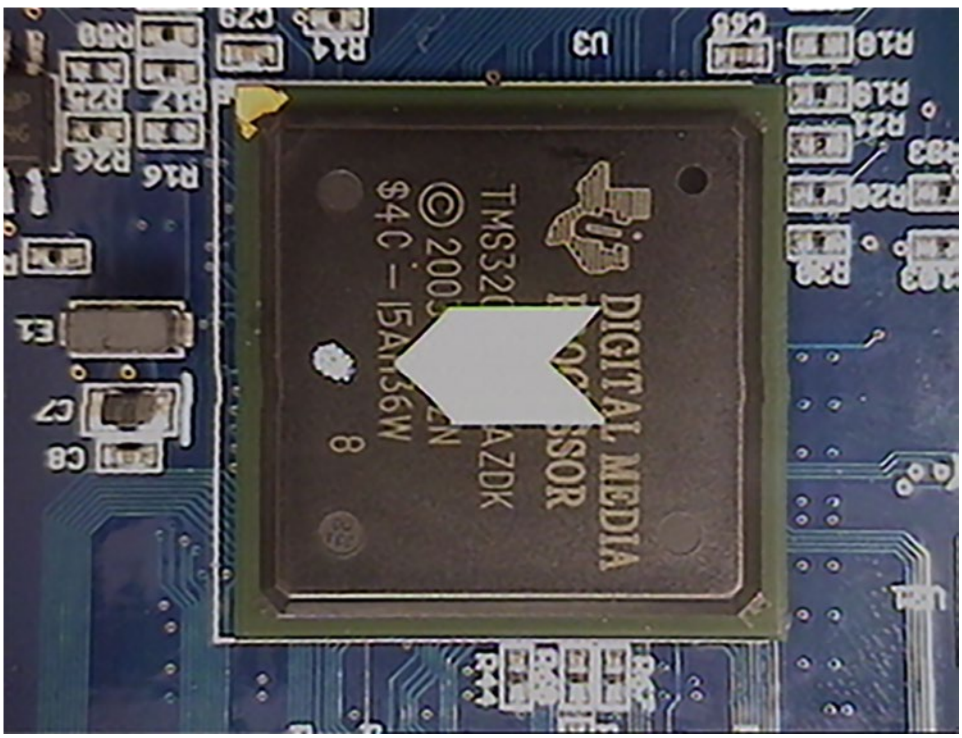


Figure 2: Re-balled BGA marking after salvaging.

Future Use

One of the criteria important in determining the requirements for the salvaged components is an understanding of how the components will be placed onto their next board. For example, if the components will be hand soldered in place, then co-planarity and amount of remnant solder left over on the component will be less than that of a component to be placed using automation.

One of the final criteria is looking at the kind of component packaging that will be required. The components need to be placed into tape and reel packaging, tubes or trays, in order to deliver the salvaged components to manufacturing operations. It is recommended that the components be marked (Figure 2) in some fashion to keep track of which components are going on to specific assemblies.

By considering these criteria, the salvaging of electronic components from circuit boards will go smoothly. **SMT007**

Bob Wettermann is the principal of BEST Inc., a contract rework and repair facility in Chicago. For more information, contact info@solder.net. To read past columns or contact Wettermann, click here.

UK-led Space Telescope to Unravel Mysteries of the Cosmos

The European Space Agency has given the green light to The Atmospheric Remote-sensing Infrared Exoplanet Large-survey, or Ariel as it's better known, the world's first space telescope dedicated to studying how exoplanet atmospheres form and evolve. Its mission is to understand the links between a planet's chemistry and its environment by charting approximately 1,000 known planets outside our own Solar System, arming scientists with a full picture of what exoplanets are made of, how they were formed and how they will evolve. Ariel has been put through a rigorous review process throughout 2020, and is now slated for launch in 2029.

Once in orbit, Ariel will rapidly share its data with the general public – inviting space enthusiasts and budding astronomers to use the data to help select targets and characterise stars.

The spectrographs aboard the observatory will study the light that filters through a planet's atmosphere as it passes—or transits—across the face of its host star. Instruments will also try to refine estimates of a planet's temperature by teasing out how light from its star changes when the body moves behind it.

Ariel will be able to detect signs of well-known ingredients in the planets' atmospheres such as water vapour, carbon dioxide and methane. It will also detect more exotic metallic. For a select number of planets, Ariel will also perform a deep survey of their cloud systems and study seasonal and daily atmospheric variations.

(Source: UK Space Agency)

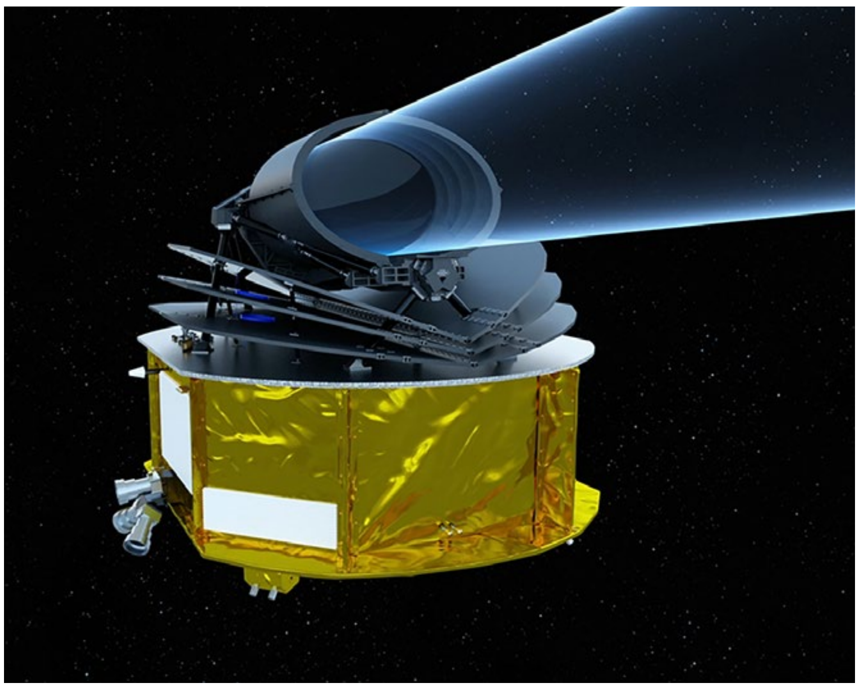
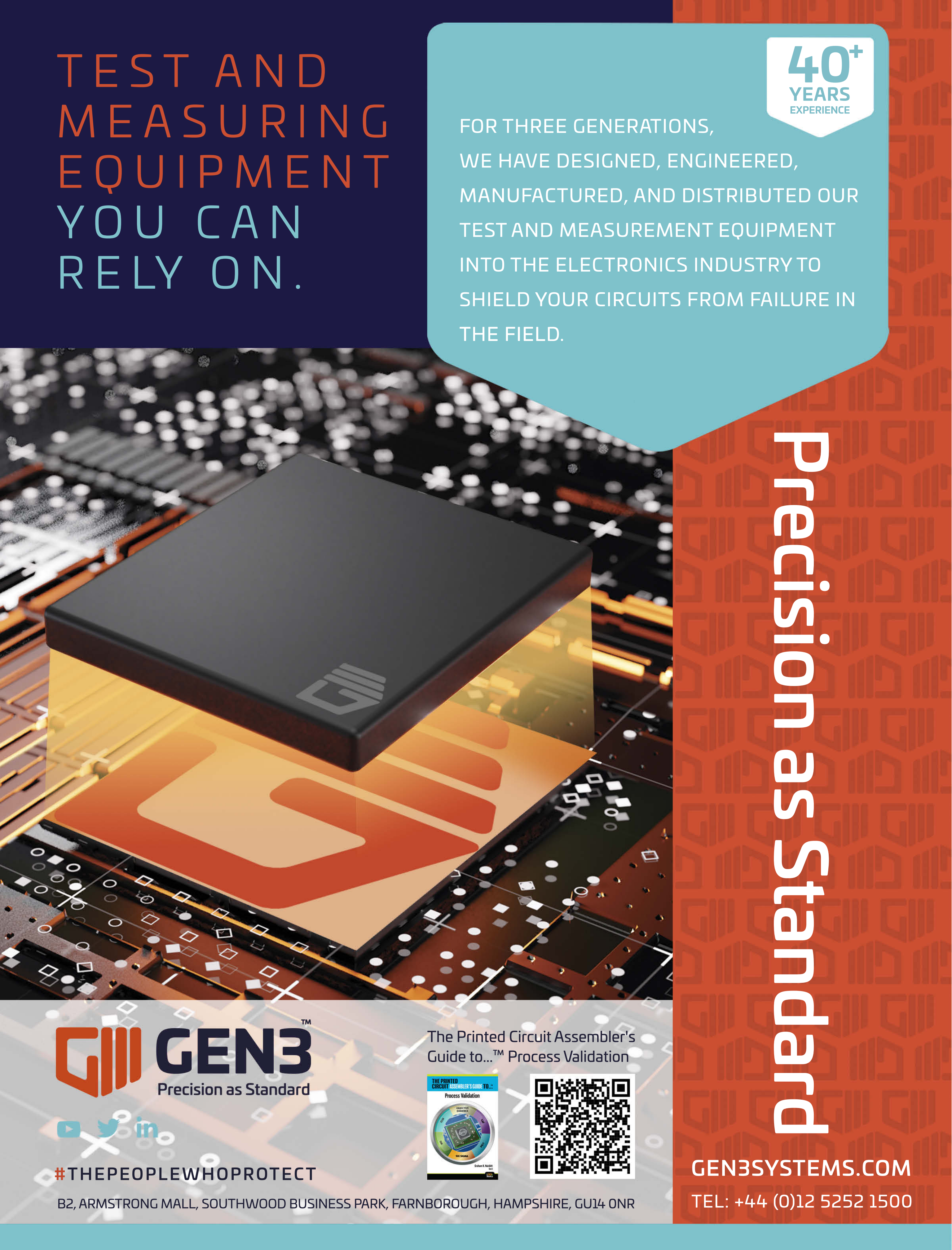


Figure 1: Artist's impression of Ariel (ESA/STFC RAL Space/UCL/UK Space Agency/ATG Medialab)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Editor's Picks from SMT007.com

1 Foxconn Announces FOXCONN NxVAE, Unsupervised Learning AI Technology ▸

Foxconn Technology Group, announced the launch of FOXCONN NxVAE, a new unsupervised learning artificial intelligence (AI) technology that ensures higher levels of efficiency and accuracy in the inspection of defects in manufacturing production lines when compared with traditional practices.

2 Tech 2 Tech: KYZEN's Short Technical Sessions a Big Hit ▸


Tom Forsythe

Nolan Johnson gets an update from Tom Forsythe on KYZEN's Tech 2 Tech sessions. These 15-minute sessions were set up during the pandemic by KYZEN for customers, prospects, and new engineers around cleaning, and have since found traction with their manufacturers, reps and distributors.

3 LITEON Technology January Sales Up 39% YoY ▸

LITEON Technology has reported January consolidated revenue of NT$ 14.08 billion ($502.86 million at $1:NT$28.00), up by 6% month-on-month and by 39% year-on-year. The company attributes this to the stable demand from its core business.

4 Lean Digital Thread: Achieving Operational Excellence Is a 'Must Have' ▸


Sagi Reuven

Newer consumer-buying patterns are pressuring factories to rely on technology to become more dynamic and agile. The latest technologies can be successful in streamlining certain processes, but the whole business process, entrenched in bad habits, merits real change. Here are five of the best positions for change.

5 5 Keys to Smart Process Success ▸


Steve Williams

In a truly connected factory, an ongoing continuous dialog between machines, business processes, suppliers and customers is happening in the background. This dialog is not only interactive, but proactive, as a constant stream of real-time data is tweaking and adjusting processes to drive improvement.

6 Global Connections: The Process of Overmolding ▸

In cable assembly, overmolding is the addition of various plastic coatings to seal and protect the connector and the harness. An injection die molding procedure is used, in single or multiple steps. The injected material is usually a thermoplastic elastomer; rigid first to seal and lock in the connector, then if a second overmolding is required, usually a flexible material to provide strain relief and or locking tabs.

7 X-Rayted Files: The Year of 2020 Vision ▸

What else can we say about 2020 that hasn't been said? We have so much to reflect on, both to mourn and to be thankful for. The global pandemic has made an indelible mark on us all, and we, like everyone else, are changed forever. With the year behind us, and light at the end of the tunnel, we take a moment to look back as well as look forward.

8 Webinar Review: Implementing Digital Twin Best Practices ▸

I-007e recently released a highly informative series of short webinars called Implementing Digital Twin Best Practices from Design Through Manufacturing presented by industry expert Jay Gorajia, the director of Siemens Global Digital Manufacturing Services. The webinar is an excellent overview of how data that is generated using a digital twin model can be effectively utilized to improve business execution using the Siemens tool suite.

9 Zulki's PCB Nuggets: Take a Deep Dive Into U.S. Medical Device Production ▸


Zulki Khan

There are new angles emerging for medical OEMs to consider in order to keep production in the U.S. versus overseas. The foremost thinking (biggest challenge) associated with those angles focuses on whether the product can be produced cost effectively in a timely fashion, so it's distributed in the supply chain for a given medical device OEM.

10 One World, One Industry: Join Us for IPC APEX EXPO—Virtually ▸

In person or online, our goal is to maintain IPC APEX EXPO's position as the premier event for the electronics industry by providing far-reaching insights and ideas. The challenge we face to provide a premier networking event is also an opportunity for growth.

For the latest news and information, visit SMT007.com. Subscribe to our newsletters or premium content at my I-Connect007.

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Career Opportunities

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Operations Manager, Elk Grove Village IL, USA

Want to advance your career by joining a globally successful and growing world class CCL manufacturing company and help drive that success? As operations manager at Ventec USA LLC, a wholly owned subsidiary of Ventec International Group, you will coordinate and oversee our organization's operations in Elk Grove Village, IL, and Fullerton, CA. Your tasks will include formulating strategy, implementing performance improvement measures, procuring materials and resources and assuring compliance. You will be a mentor to your team members, find ways to maintain and improve the highest quality of customer service and implement best practices across all levels.

Skills and abilities required for the role:

- Proven commercial experience as operations manager or similar role for minimum 5 years
- Knowledge of organizational effectiveness and operations management
- Experience with ISO9001 or similar QMS required
- Experience in budgeting and forecasting & familiarity with business and financial principles
- Excellent leadership ability and communication skills (English)
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- Degree in Business, Operations Management, or related field preferred but not required

What's on offer:

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Please forward your resume to jpattie@ventec-usa.com and mention "Operations Manager—Elk Grove Village" in the subject line.

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Our Summit Anaheim, CA, division currently has multiple open positions for planning engineers.

The planner is responsible for creating and verifying manufacturing documentation, including work instructions and shop floor travelers. Review lay-ups, details, and designs according to engineering and customer specifications through the use of computer and applications software. May specify required manufacturing machinery and test equipment based on manufacturing and/or customer requirements. Guides manufacturing process development for all products.

Responsibilities:

1. Accurately plan jobs and create shop floor travelers.
2. Create documentation packages.
3. Use company software for planning and issuing jobs.
4. Contact customers to resolve open issues.
5. Create TDR calculations.
6. Assist in the training of new planning engineers.
7. Review prints and purchase orders.
8. Create stackups and order materials per print/spec.
9. Plan jobs manufacturing process.
10. Institute new manufacturing processes and or changes.

Education/Experience:

1. High school diploma or equivalent
2. Minimum five (5) years' experience in the printed circuit board industry with three (3) years as a planning engineer.
3. Must be able to cooperate and communicate effectively with customers, management, and supervisory staff.
4. Must be proficient in rigid, flex, rigid/flex, and sequential lam designs.

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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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EAGLE electronics Inc.
MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

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

Career Opportunities

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Connecticut Locations

Senior Research Chemist:
Waterbury, CT, USA

Research, develop, and formulate new surface treatment products for the printed circuit board, molded interconnect, IC substrate, and LED manufacturing industries. Identify, develop, and execute strategic research project activities as delegated to them by the senior research projects manager. Observe, analyze, and interpret the results from these activities and make recommendations for the direction and preferred route forward for research projects.

Quality Engineer:
West Haven, CT, USA

Support the West Haven facility in ensuring that the quality management system is properly utilized and maintained while working to fulfill customer-specific requirements and fostering continuous improvement.

For a complete listing of career opportunities or to apply for one of the positions listed above, please visit us here.

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MacDermid Alpha
ELECTRONICS SOLUTIONS

We're Hiring!

Illinois / New Jersey

Technical Service Rep:
Chicago, IL, USA

The technical service rep will be responsible for day-to-day engineering support for fabricators using our chemical products. The successful candidate will help our customer base take full advantage of the benefits that are available through the proper application of our chemistries.

Applications Engineer:
South Plainfield, NJ, USA

As a key member of the Flexible, Formable, and Printed Electronics (FFPE) Team, the applications engineer will be responsible for developing applications know-how for product evaluation, material testing and characterization, and prototyping. In addition, this applications engineer will provide applications and technical support to global customers for the FFPE Segment.

For a complete listing of career opportunities or to apply for one of the positions listed above, please visit us here.

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Career Opportunities

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:

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

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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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Career Opportunities

Career Opportunities

eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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APCT

Passion | Commitment | Trust

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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Career Opportunities

U.S. CIRCUIT

Sales Representatives (Specific Territories)

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

- Florida
- Denver
- Washington
- Los Angeles

Experience:

- Candidates must have previous PCB sales experience.

Compensation:

- 7% commission

Contact Mike Fariba for more information.

mfariba@uscircuit.com

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MivaTek Global

MivaTek Global: We Are Growing!

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

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

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

Contact HR@MivaTek.Global for additional information.

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

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

ASSOCIATE EDITOR: **MICHELLE TE**
michelle@iconnect007.com

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

TECHNICAL EDITOR: **PATTY GOLDMAN**

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

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

SALES MANAGER: **BARB HOCKADAY**
(916) 608-0660; barb@iconnect007.com

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

PRODUCTION MANAGER: **SHELLY STEIN**
shelly@iconnect007.com

MAGAZINE LAYOUT: **RON MEOGROSSI**

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