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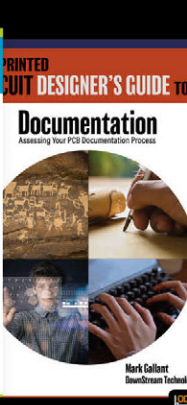
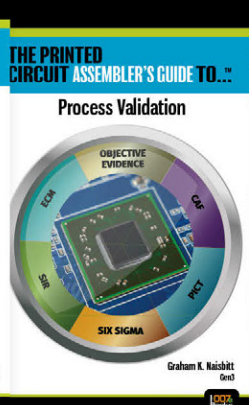
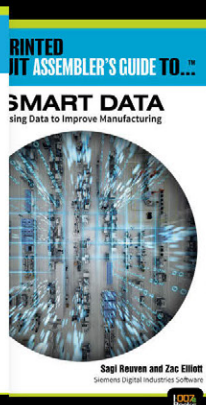
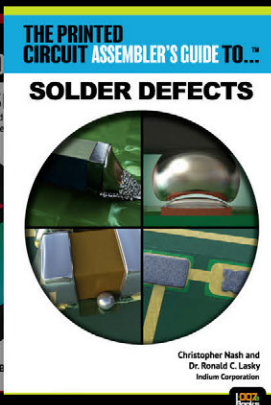
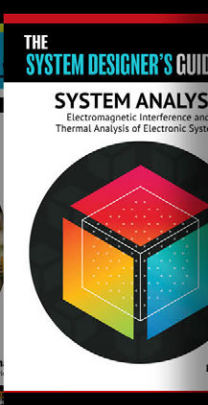
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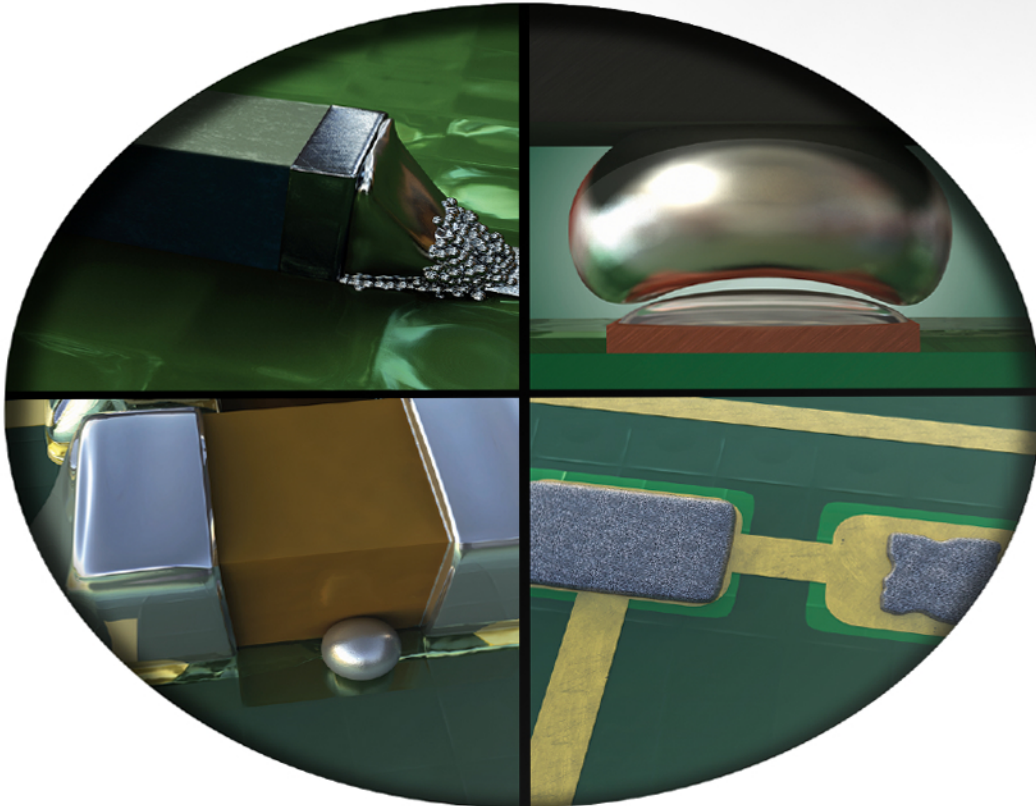


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Rising Input Costs

Rising input costs are causing EMS companies to rethink pricing, suppliers and supply chains, labor, and how all those interrelationships function. In this issue we report on the current status of increased input costs and explore strategies to help reduce the risk and cost associated with today's marketplace.



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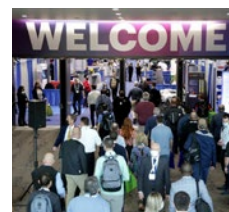


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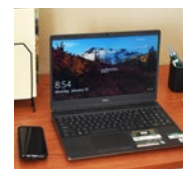
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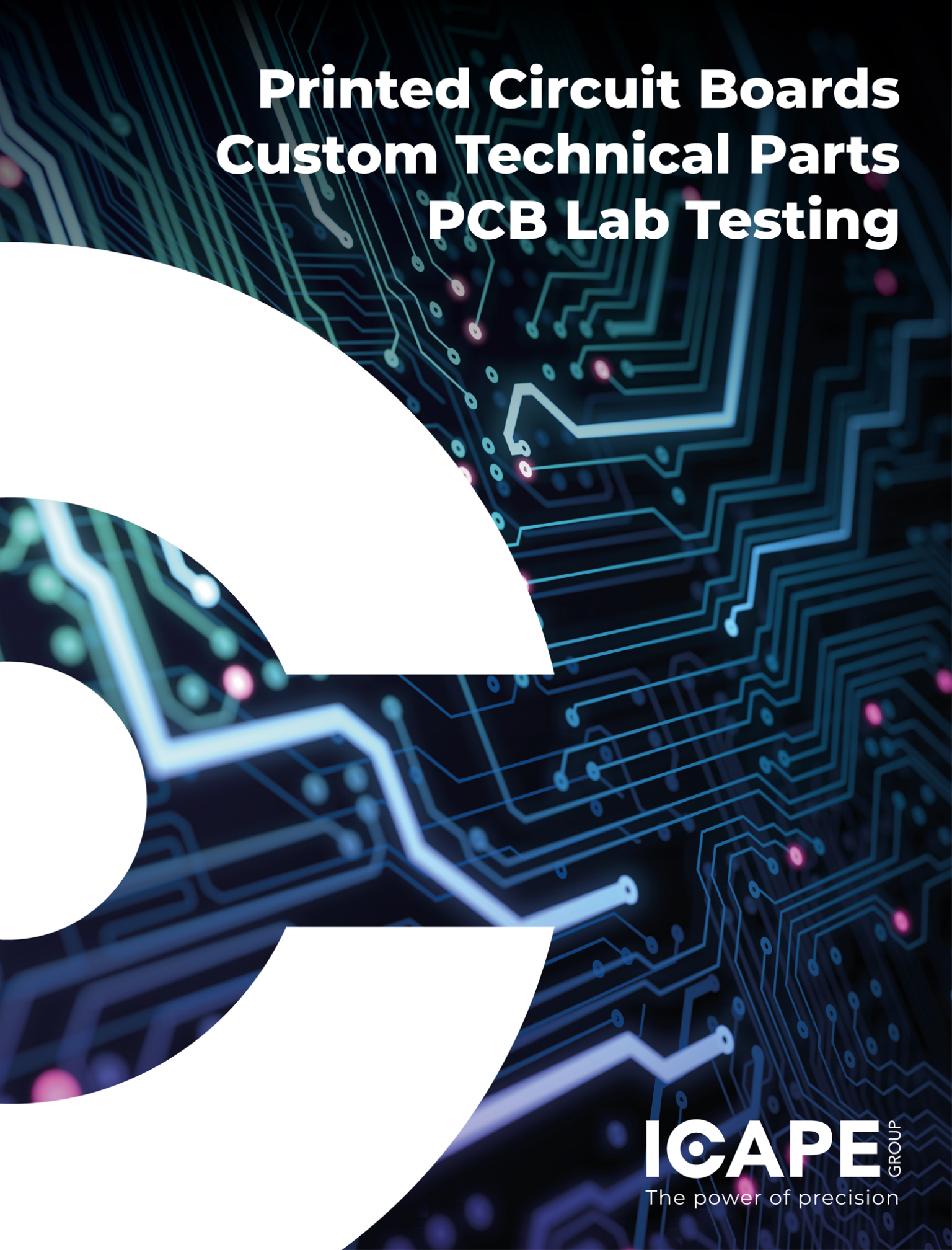


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Feeling the Heat of Rising Input Costs

Nolan's Notes

by Nolan Johnson, I-CONNECT007

About 10 or 12 years ago, one of the family activities I engaged in with my children was hot air ballooning. At one point, my son and I even had student pilot licenses for them. My daughter would have had a license as well, but she wasn't quite 14 at the time, which was a requirement to get a hot air balloon pilot

license. Most of our time, though, was spent as volunteers on the ground crew. My kids were right at middle school age at that time, so ballooning was a grand opportunity to teach physics, especially Newton's laws of dynamics.

The typical recreational hot air balloon that you see at festivals and such, with a basket just large enough to hold two propane tanks and three or four people, has the capacity to hold about 90,000 cubic feet of air, plus or minus. Imagine that nylon envelope holding 90,000 basketballs. At first, that seems like quite a lot of space, all floppy and stretchy. Except those balloons are definitely not stretchy.

Current designs for hot air balloons were, believe it or not, developed by the U.S. military in the mid-20th century as a potential "silent entry" military use vehicle. Ultimately, the propane burners were too noisy and too bright for night use¹. But the general structure they developed became the modern hot air balloon. The structure starts with a metal ring, milled out of billet aluminum, that is about 18 inches in diameter. Attached to that ring are a series of fabric straps (like those in your car's seatbelt), which make up the vertical support for the balloon. In fact, the basket will attach to the opposite end of all these vertical trusses. Horizontal straps of the same material will wrap around the balloon, defining the general shape



of the structure. Finally, the coated, air-tight nylon is added to enclose the shape defined by the straps. Everything hangs from the top ring; where the ring goes, so the balloon follows. That's why you always see ground crews holding a rope that goes to the top of the balloon—they're controlling the top ring.

To fly, the balloon's pilot adds heat to the inside of the balloon envelope, creating lift through convection. Once the warm air is inside the balloon envelope, the nylon becomes rigid and remarkably inflexible. With 90,000 cubic feet of space to cover when heat is applied by the burner, there is a distinct lag time between applying heat and getting a response in the flight of the balloon. Thirty seconds isn't out of the ordinary, in fact. Student pilots have a tendency at first to create a dangerous oscillation in the balloons' flight by pouring on too much heat while the balloon is still reacting, and then being forced to let heat out of the top vent to slow the ascent.

Inflation and upward pressure are the perfect metaphors for this issue of *SMT007 Magazine*. The global economy, because of gigantic shifts in supply, demand, and distribution in the wake of the COVID pandemic, is on the rise. Demand for product is huge, as is the demand for upstream materials and components. Of course, we have labor shortages and wage pressures to account for. As a result, this rapid increase in demand, applied to a fixed-capacity supply chain, exerts tremendous upward pressure on pricing. It's just like hitting the burner on a hot air balloon that heats up the fixed capacity of the balloon envelope and drives the whole contraption upward.



In this issue, we look at how these upward pressures on input costs are passing through pricing to your customers. Is there room in your margins to absorb these cost increases? Are there ways to change what you do or how you do it, so that you can minimize the price increases and possibly gain an extra level of competitiveness? How do you do your part not to overcorrect? While we explore these topics inside this issue, I also want to share some additional perspective.

In a recent [conversation](#) with I-Connect007, IPC Chief Economist Shawn DuBravac, noted, "If you look at the research that IPC is publishing every month, companies report that orders are up. But at the same time, costs are up and profit margins are down. So, they probably haven't raised prices as much as they should to offset higher costs."

To use the balloon metaphor, we're not done pouring heat into that balloon. DuBravac also states later in that conversation, "On top of that, I don't think we've seen the end of price increases. Contracts needed to be rewritten. And companies needed to see if the cost increases they were facing were tem-

porary or more permanent. Prices are up and companies will need to pass those forward. But I do think the rate of increase will slow.” One could conclude that DuBravac is speaking to the possibility of market oscillation due to overcorrections.

Of course, labor plays a part in this whole dynamic. DuBravac shares, “We’ll be more reliant on wage increases and business investment to drive growth. If you look at IPC’s newly released indices, the ability to hire skilled labor remains a major constraint for companies—at least over the next six months—so I don’t anticipate that to improve. In fact, most firms say that will deteriorate over the next six months. My rough estimate is that we have nearly 120,000 open jobs in our industry in the U.S.”

As this issue goes to print, we are just wrapping up IPC APEX EXPO in San Diego. I hope I saw you there. Watch for our upcoming special edition of *Show & Tell Magazine with IPC APEX EXPO*, out mid-February. **SMT007**

References

1. Historical development of balloon flight, Britannica.com.



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](#).

Global Semiconductor Industry Establishes Annual Record for Number of Semiconductors Sold

The Semiconductor Industry Association (SIA) announced global semiconductor industry sales were \$49.7 billion in the month of November 2021, an increase of 23.5% over the November 2020 total of \$40.2 billion and 1.5% more than the October 2021 total of \$49.0 billion. The cumulative annual total of semiconductors sold through November

2021 reached 1.05 trillion, which is the industry’s highest-ever annual total.

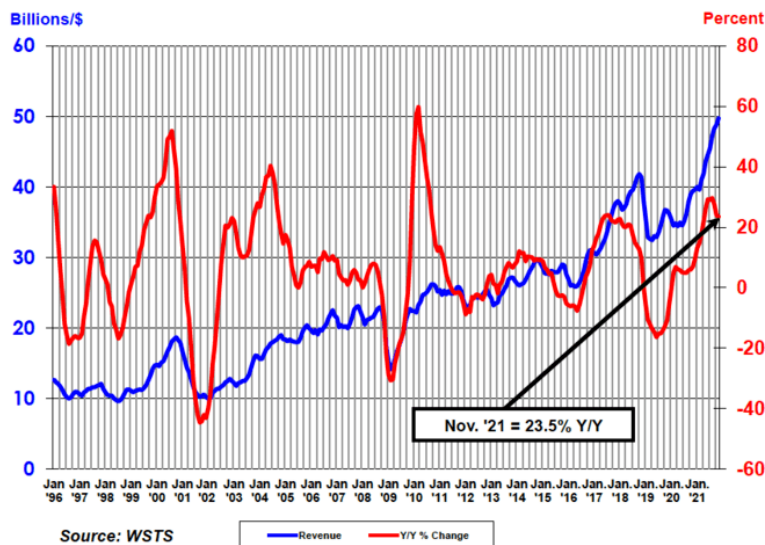
Monthly sales are compiled by the World Semiconductor Trade Statistics (WSTS) organization and represent a three-month moving average. SIA represents 98% of the U.S. semiconductor industry by revenue and nearly two-thirds of non-U.S. chip firms.

“Global semiconductor sales remained strong in November, increasing substantially on a year-to-year basis across all major regional markets and semiconductor product categories,” said John Neuffer, SIA president and CEO. “With one month of 2021 sales data still to be reported, the industry has already set a new annual record for total semiconductor sales and units shipped, as chipmakers have substantially ramped up production to address high demand.”

Regionally, year-to-year sales increased in the Americas (28.7%), Europe (26.3%), Asia Pacific/All Other (22.2%), China (21.4%), and Japan (19.5%). Month-to-month sales increased in the Americas (4.2%), Europe (3.1%), Japan (1.1%), and Asia Pacific/All Other (0.9%), but fell slightly in China (-0.2%).

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Critical Materials, A Compelling Case, Part 1

SMT Prospects & Perspectives

by Dr. Jennie S. Hwang, CEO, H-TECHNOLOGIES GROUP

The time has come for a deliberate and comprehensive national strategy that addresses critical materials/minerals. Doing so is increasingly critical to the long-term economy, national security, and the nation's global competitiveness.

Establishing Conflict-free Regulations

In the [March 2013 issue](#) of *SMT Magazine*, my column offered a snapshot of conflict materials. At that time, four minerals were classified to be “conflict.” These four essential elements—tantalum, tin, tungsten, and gold—have been a key to a variety of end-use applications for a wide array of industries ranging from electronics and industrial to consumers, avionics, and military sectors.

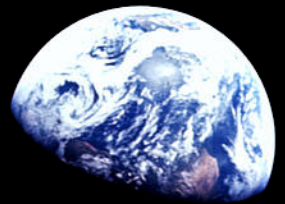
The primary mines of these four essential elements are situated in the eastern portion of the Democratic Republic of the Congo (DRC) and surrounding countries, and the minerals have been mined in the conditions of armed conflict and severe human rights abuses in the region. The region's armed militia groups intended to exploit the area's natural resources. This pervasive exploitation of natural mineral resources in this high-risk area caused a grave concern by the international community about the region's activities. Internationally, there was an increased attention on the acute violence and gross human rights violations in the mining of these minerals. Accordingly, this region was deemed as “Conflict Region.”



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At that time, the companies directly or indirectly sourcing from, or directly operating in this region, faced higher risk of contributing to the conflict. To that end, the electronics/microelectronics industry was on the front line. These concerns spurred much debate and led to substantial activities by the U.S. Congress in dealing with the issues. After a concerted work and plan, the Dodd-Frank Act eventually passed the U.S. Congress and was signed into law on July 21, 2010. In August 2012, the U.S. Securities and Exchange Commission (SEC) adopted a rule mandated by the Dodd-Frank Wall Street Reform and Consumer Protection Act, which requires companies to publicly disclose their use of conflict minerals that originated in the Democratic Republic of the Congo or an adjoining country. The first required report had to be filed by May 31, 2014.

Although it is not illegal to use conflict minerals, corporate social responsibility is on the line.

Basically, the U.S. Conflict Minerals Law contains two requirements: independent third-party supply chain traceability audits and reporting of audit information to the public and SEC. Dodd Frank 1502 is a disclosure requirement and places no ban or penalty on the use of conflict minerals. However, a company is required to assess whether any conflict mineral was “necessary to the functionality or production” of a product manufactured or contracted for manufacture by the company. To comply with SEC regulation, whether a company, which contracts out production, holds the influence over the item

being contracted is also to be assessed and determined.

Although it is not illegal to use conflict minerals, corporate social responsibility is on the line. The ultimate goal is to be “conflict-free.” On this front, some corporations are in the forefront. For instance, Apple released its “2011 Supplier Responsibility Report,” detailing how it traces its supply chain—first to the suppliers that created the subcomponents to their products and then to the smelters that processed the ores. Intel has conducted “on-site reviews on smelters” as part of the Conflict-Free Smelter Program.

Since then, the conflict minerals have been “managed successfully.”

Addressing Today’s Critical Needs

With the handling of conflict minerals as an exemplar, there is perhaps an even more urgent need to rally another concerted effort to tackle the critical materials/minerals. Overall, critical materials/minerals will have an overarching impact on the entire supply chain to all industries, and once again, electronics/microelectronics is on the front line.

At present, the supply chain is in an unprecedented state, filled with disruptions and hurdles as the result of a slew of factors and root causes. On top of an intertwined, complex system, the pandemic for the past two years has exacerbated the disruptions and further elevated the complexity. Simply put, the fundamental supply chain issues can be attributed to the decades of globalization, off-shore manufacturing, and continuing, fast-paced technological changes, in conjunction with many diverse suppliers being embedded in each product. Consequently, managing today’s global supply chain is a daunting task; securing reliable sources of materials/minerals is becoming ever an uncertainty.

It is time to reignite the spirit and reboot the system to set out a national strategy incorporated with a robust plan and actionable agenda to navigate through the pathway of securing

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the critical materials/minerals. It is a challenging pursuit but can be done.

The goal of a national strategy must embrace and cut across these multiple fronts to:

- Define “criticality” for materials/minerals that are critical to the nation’s economy and security
- Identify the elements that are the foundational component of critical materials/minerals
- Verify the natural resources of the elements
- Define the effective sources of critical materials/minerals
- Ensure the secure availability of critical materials/minerals
- Tackle on-going supply chain uncertainties
- Build the key capabilities and infrastructure of critical materials/minerals
- Strike a balance between economy and environment
- Anticipate future challenges related to critical elements
- Identify actions and approaches that the government and the private sector can take to meet these goals

It will take a global perspective, a holistic thought process, integrated information, and collaborative effort among the government, academia, and the industry to fulfill these goals and tackle the technologies, processes, and manufacturability relevant to the arena of critical materials/minerals. For instance, in business operation and management, the long-term investment in critical materials/minerals-related business may warrant deliberations and shed new light. In corporate governance, critical materials/minerals should be a board issue to be watched for in an enterprise risk management program. In government and academia, the funding requirements, structure, and research priorities should be re-visited, and actions taken accordingly.

Conclusion

My next column will discuss the key strategic tenets that should be considered and the specific materials/minerals that should be deemed critical to a robust economy and an impeccable national security. I welcome your thoughts and input on the specific materials and minerals that you and your company consider to be critical to your business, products, and services. Please feel free to contact me. **SMT007**



Dr. Jennie S. Hwang—an international businesswoman and speaker and a business and technology advisor—is a pioneer and long-standing leader to SMT manufacturing since its inception as well as to the

development and implementation of lead-free electronics technology. Among her many awards and honors, she was inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, named an R&D Star to Watch, and received a YWCA Achievement Award. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., and SCM Corp., she was the CEO of International Electronic Materials Corp. and is currently CEO of H-Technologies Group, providing business, technology, and manufacturing solutions. She has served on the board of Fortune-500 NYSE companies and civic and university boards; the Commerce Department’s Export Council; the National Materials and Manufacturing Board; the NIST Assessment Board; as the chairman of the Assessment Board of DoD Army Research Laboratory and the chairman of the Assessment Board of Army Engineering Centers; and various national panels/committees and international leadership positions. She is the author of 600+ publications and several books and is a speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees, as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For more information, visit JennieHwang.com. To read past columns or contact Hwang, [click here](#).

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Alex Stepinski: Taking Control of Input Costs

Feature Interview by Barry Matties
and Nolan Johnson

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Barry Matties and Nolan Johnson talk with Alex Stepinski about strategies to lower costs in brownfield facilities. Alex has extensive experience designing and optimizing manufacturing processes and is currently helping companies implement straightforward step-by-step solutions to move into smarter manufacturing across different industries.

Barry Matties: Alex, brownfield factories are stuck with space limitations and automation is a challenge. What could be a different way of thinking about a brownfield site and why it makes sense?

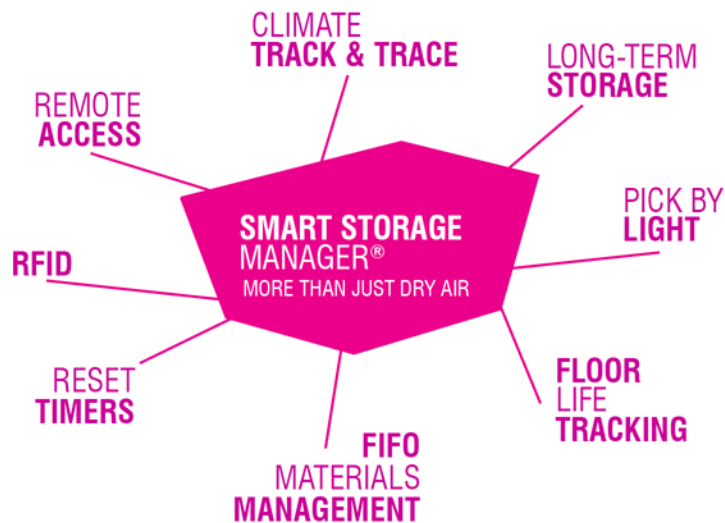
Alex Stepinski: First, I want to address a fundamental bias. Many people associate me with the greenfield sites that I've architected over the past years, and which became an Industry 4.0 example in the United States. It's not because that was the only way to do it, but because that was the business case. The business plan at the time was to build new facilities for OEMs that didn't have any PCB fab capabilities.

Brownfields do not follow the same plan to implement Industry 4.0. The investments to do so can be done over a longer period based on available monies and can be done to address the biggest opportunities first. I think there's a little bit of a roadmap that any brownfield can follow.

The first step is serializing your products, and there are many options to do this. The best ones, in my experience, are laser based, using lasers from some of the sensor suppliers in the market, and many of the suppliers can integrate this for you into a piece of equipment so you don't have to increase your footprint. It's probably one of the only things that you might need to add. It doesn't increase your footprint.

Once you serialize your products individually, then everything turns into a sensor-and-software problem, and this doesn't add to the footprint in most cases. Industry 4.0 is about correlating data and making decisions based on interpolations of data, doing regressions, and things like this. It's not advanced artificial intelligence. Advanced AI in business is

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Alex Stepinski

when you do image recognition, natural language processing; this is the forefront right now, as well as very advanced algorithms that are dealing with B2C sales, marketing analytics, self-driving, and so forth. This is where AI is focused because it is the biggest return. You can buy equipment that even has some of these features. You don't have to touch the concept of AI.

But on the PCB and EMS side, it's more "AI light," or "more-than-Excel algorithms." Something we called just a normal algorithm 20 years ago is now called AI. It's a sexy term. Robots aren't taking over the world any time soon. The fundamental things to do in a brownfield to tease out value from a planning perspective is just a step-by-step approach, one process at a time.

It's probably a one- or two-person engineering job. You give them subject matter expertise, availability, make sure they know how to do some basic coding, understand sensor options, and then they go process by process. What are some of the interpolations you can do? Well, just getting a time stamp. All you need is a photo sensor to know something went through the machine, and then you can

also code at some point when it went through, when it came out. You could do this in one step or multiple steps.

The sensor kit for most processes is generally \$5,000 to \$10,000 per tool to get time and basic settings, and then you save their recorded data, which is just the serial number that you scanned, the times it went through the machine; you save it into a database. If you can pull the error codes by time out of your machine and put that in a data table, then you can correlate the two together and you can know something happened: "I heard an alarm while this panel was being processed." Making an API to your other systems adds further interpolations that can then lead to predictive recipes/decisions.

The first step is understanding what is and is not important and being able to make some basic interpolation. Take AOI, for instance. This is a measurement site in PCB fab. The AOI machine has a lot of information built into it. It has all the false calls that it saw, and it says how long it took to start and finish the job.

You can also code information in there on the real defects and then take all of this, put it in the database, and correlate it to your serial numbers. When you test it later, you can correlate these serial numbers together and understand the root cause of escapes; a lot of escapes happen because of poor AOI setup, operator errors, things like this, and it gives you an opportunity to improve your procedures in these areas to reduce scrap.

This is an interesting area of focus to get a good return because in a layer, shorts and opens are typically the defects that we scrap boards for. You can reduce the frequency. Additionally, you have your use of regression in place of direct measurements. In PCB fab, for example, there are a lot of legacy specifications to cross-section everything. And when you have no controls in the process, cross-section is the only option.

But if you add some very simple controls, you can avoid cross-sectioning just about

everything. What are the simple controls? We get ideas from other industries. For instance, gravimetric measurement, or weight. Rather than chop up every panel to check the plating thickness, there are three things that you can do. Every circuit board shop has them. You need a scale, a CMI, and a CMM.

This is a great way to address legacy equipment that doesn't have a lot of controls. You can use some simple things in your factory to take measurements and not need a major upgrade where you only have one machine and it must be replaced, or you don't have space to put a second machine next to it. That's a big opportunity.

With a lot of the equipment, you can also get upgrades to get some better data collection to put into your database, and all this can be done with cloud computing. You just buy space as you need it and gradually scale up. The challenge with many brownfield sites is they have fully capitalized equipment kits, much of which is not suited for Industry 4.0. You can just add on some features, so it is suited because you don't want to spend money on a brand-new machine for just a few added features.

Now, if something is extremely old, you haven't maintained it, and everything is broken, then replace it. But if the equipment's being maintained and you only need a few things, then just do the upgrades. That's the approach for a brownfield. You start generating enough payback to do some new investments.

Then you start to get the culture of adding sensors and collecting data. This is where we need to be in this industry. If you're a process engineer and you can't code, then it's probably not for you. You need to take some classes, and if you're not liking it, it's not suited for you, and you need to hire somebody who can do it.

One of the challenges is this "missing generation" in our industry. There are a lot of gray-beard folks who don't code, and a lot of young folks who do, but they don't have subject matter expertise. And there are few people in the

middle, so this is the thing that needs to be overcome.

You need a team of subject matter experts, and you need the young folks so it's a little more effort than if you had good demographics. In other places, it's the more experienced engineers who have both skills, so you must create this bridge.

**You need a team of
subject matter experts, and
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demographics.**

Nolan Johnson: It sounds like the goal is to go through a relatively simple implementation process in an existing factory to get the data needed to be more predictive, and use that to become even more efficient in the processes and reduce waste, thereby improving input and operational costs and giving you more control over what your input costs will look like. Is that correct?

Stepinski: That is absolutely correct. That's the way forward in my opinion, because otherwise you're leaving a lot of money on the table.

You can't outsource these things economically, and here's why. A printed circuit board shop is not an engineered factory. A brownfield is not an engineered factory; it's an evolved factory. It's more like an animal. Over decades you added equipment, the varying vintages and suppliers, with different chemicals and procedures from one shop to another—all this evolved by trial and error mostly over time.

A little bit of engineering, but mostly trial and error because they didn't have PLM systems, or the tools do this in a different way.

Because of this, every factory is quite unique. If you call somebody and say, “Help me fix my factory,” you will get a standard solution which will be a lot more expensive than using your own small team to tweak this situation.

Johnson: The idea of the integration team you were speaking about makes a lot of sense.

Stepinski: I think that’s the right approach. I’ve seen how it’s done in different industries. I’ve gone to MIT to study Industry 4.0, and this is how people do it. It’s the most cost-effective way. In our industry, everybody is very supplier-dependent, but the supplier is biased to get you to spend money on upgrading your equipment, and then you don’t really have Industry 4.0 because you blew your money on one or two pieces of equipment.

What’s better for the whole ecosystem is for board shops to have a process engineering team that does these processes step by step. Then you generate enough funding to do some significant investments that have a good NPV through the cash flows that emerge from these improvements. This is better for everybody. It’s better for the suppliers and the board shops, and you have a more robust industry. To me, this is the best approach.

In PCB shops, there aren’t really any processing engineers; they’re manufacturing engineers in just about all PCB shops. They trou-

bleshoot problems with parts, deal with downtime situations, and occasionally bring in a piece of equipment. Process engineering is implementing Industry 4.0, going ahead and making systems, collecting data, doing predictive studies, and doing this without the supplier as much as possible.

If you’re very reliant on the supplier, the supplier is running your factory in their interests, not in yours. You must always have a balance. Working with suppliers is great if you can stand on the same footing as they are. A dialogue, a dialectic, is the best opportunity to create value. But when the supplier is much more knowledgeable than you are about all these things, it turns into a zero-sum agreement, the supplier wins, and you get something, but you left a lot of value on the table.

That’s my assessment. It’s about doing your own R&D. You just need a two-person engineering team; you get them set up with some subject matter experts in the factory and go process by process. In a few years you’re fully Industry 4.0.

Johnson: So, you have process by process and start collecting the data to put into the database. The first phase is collection. From there, you can start to track escapes, go back to find out what was going on in the processing of that particular part number that ended up being an escape, being a fault. I get that. But as you start moving, then what?

Stepinski: Then you can make very inexpensive changes to your procedures to address this, and you’re going to use some money emerging out of the factory system improvements for yourself to do further investments.

Johnson: Right. As we’re looking at phase one, how does that help in a practical sense to control your input costs or your process costs?

Stepinski: You must pareto your wastes. Where do you have the most waste? There are many



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different types—overproduction, inventory, just scrap, cycle time, not meeting commitments. You need to assess what you feel is most impactful to your business, and that's what you target for your first project.

Industry 4.0 is based on engineered sensors which, when combined with data science, allow the emergence of foresight to improve efficiencies. You put sensors on your equipment and make simple control boxes—this is very easy stuff at the end of the day. Engineers coming out of school know how to do this, but they get thrown into a PCB shop with a bunch of dinosaurs, and slowly they turn into dinosaurs themselves. Don't let the Jurassic ecosystem absorb them. Get them to focus on what they know best.

They shouldn't be led by pre-existing biases about how things are done. Use their education and give them information they need to do a better job of it. This is one of the challenges when you have senior people who don't know this stuff. It creates a challenging dynamic to manage younger engineers who do know. You don't want a situation where the young people are leading everything because they're missing a lot of experience too.

They shouldn't be led by pre-existing biases about how things are done. Use their education and give them information they need to do a better job of it.

It requires that the more seasoned folks take some online courses, something very common in different industries. They don't become the coders, but they learn enough to manage these folks.

Johnson: I'm starting to imagine that a one- or two-engineer team is comprised of an elder manufacturing expert and a younger process expert.

Stepinski: It could be, or you have two process people for redundancy who just poll the experts, just because one of the great risks in this data engineering data science is people get enough knowledge in a competitor, customer, or supplier, which then hires them. A big issue with the "AI space," which is data engineering, data science, and analytics, is it's very underserved. There is a constant need for a hundred thousand people to fill these roles. So, you must keep them happy, and be very careful. There are many cases of companies losing their whole departments because they found a better opportunity.

Keeping your folks educated is not hard to do using online courses through Coursera, IBM, Google, and more. Everybody needs to spend a few hours a week learning (think old world apprenticeship). If you've been in the business for 30 years, you don't have to learn how to code if you've never done it. But you can learn enough to say, "Hey, new hire, this is what we're thinking from a scope perspective of how we want to approach this," and lead them in the right direction. Then, they can take care of the details for you. That's the most cost-effective way to approach this, and everybody benefits.

At the end of the day, you free up more capital for investment, eventually new equipment, but at the beginning, it needs to be a home-grown program.

Matties: We often hear that hiring is a great challenge to begin with, and labor costs for operators generally have gone up. When people think of lowering costs, they think of automation. But in a brownfield site, they'll often say automation doesn't fit in their factory. How does your strategy help lower labor cost?



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Stepinski: The first one to two years will be a little challenging. You can reduce your capital purchases and invest a little bit of this, or you could finance some of your capital equipment if you're not doing it now, so you don't have a spike in cost for the short term.

This is a proven approach in many other industries. But what's missing is the general education of how to do this. While there are many resources online, people need to take the time. I've heard from many companies that implemented AI or Industry 4.0 that it's important the stakeholders in the organization commit themselves to spending a couple hours a week reading, listening, or watching something to learn how the rest of the world does it.



Matties: Regarding direct labor cost, I'm understanding that if a metric is revenue output per employee, then productivity will go up because of yields, throughput, and so on. What is the right measure for someone today to say we want to reduce our labor cost by whatever the X happens to be for them, without necessarily getting rid of people? Because like I said, they don't see where they can bring in an automated line especially in a brownfield site.

Stepinski: I think this is an old idea where you say, "I'm going to automate the factory, so I don't need any labor in a brownfield. Alex built

a brand-new automated factory; boy, we wish we had that because we wouldn't need so much labor." That's not the way to look at it.

There are challenges as boards get more complex and there is a tendency for human error the higher the complexity gets in PCB manufacturing. No matter who you have, they will make errors. Some make less than others, but as you add steps to build the boards, it gets more complex. You're fighting this all the time.

It's getting more difficult to find direct labor. In the near term, you say, "Hey, I really need to upgrade all the equipment in my shop. I can't afford to do it, so the first step is to make things as efficient as possible to free up capital so I can go and do it in a systematic way over the next few years."

You need to have a strategy, which should be to refresh the equipment kit so that you are not so dependent on your experienced operators, more dependent on your systems and processes, and you develop a body of knowledge on how to manage that process. Once things are documented, you can tolerate higher rates of turnover in these situations. You're not going to have trouble finding direct labor to work in your sloppy place because it won't be sloppy after all this is done.

I've been hearing the same excuses for many years, now that I was doing these past projects, and anyone who started this when I built my first factory at Whelan, they'd be finishing up right now, and be very happy. And they wouldn't have spent very much money at all. Upskilling the workforce is the key, the ones who can provide the most value right away, making sure all the stakeholders are knowledgeable on how to do this, and not trying to hire a supplier or hire a company to do it all for you. That's very expensive.

Matties: The takeaway is to become a process-oriented company that relies on systems rather than people.

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Stepinski: Yes. Most PCB shops have an ERP system, but you need to go a step further. You need to get an MES system. The cost is typically \$500–\$2000 per user for an annual license. It will do all your correlations for you. You don't need to do too much, just add sensors and put in measurement plans. There's not much to it.

But how many PCB shops in America have MES systems? It's not something they do. The more advanced facilities overseas already have this. You take it a step further and you get a product lifecycle management (PLM) system to manage your NPI process for you, so you can group products into families and have a predetermined engineering process for how you do things, so you're not just doing trial and error all the time on new products.

There are a lot of complexities and no one person knows all the constraints in the factory at any one time, unless it truly is a mom-and-pop shop.

You can have more predictive results that you'd be able to extrapolate, "I'm taking this order. It's got these conditions." You have an MES system, a PLM system, it automatically tells you it's not going to make it by the date you committed. It's going to be four days late, for example, or it's going to be four days early. But you must use a system like this to know this. There are a lot of complexities and no one person knows all the constraints in the factory at any one time, unless it truly is a mom-and-pop shop.

That's the approach, but we are really late to the game. These tools have been on the market for years now. Other very complex industries

have adopted it, but PCB is just behind in this area for whatever reason.

Johnson: How do you make that leap from capturing the data with the sensors, looking at your error situation, and then moving into a more predictive system? You started making the point that by using your systems, over time you could start to predict things like the expected weight of a new part number as it goes through the process. How do you get from data collection to using that to predict and then check against those predictions?

Stepinski: The CAM software systems on the market have the tools built into them to tease out the key input variables that you need to correlate to the data. You take this information and build your correlations, your regressions—whether they're linear or nonlinear, it's immaterial—and then you have equations based on simple correlations that you can use to predict your recipes. It's very straightforward.

Johnson: Alex, phase one is setting up sensors and collecting the data. And if phase two, for example, is starting to be able to do predictive work using that data, is there a phase three?

Stepinski: Phase three is now you've made your efficiencies such that you can do more. Now, what does "more" mean? Once you learn how to do your own process engineering instead of outsourcing it to the suppliers, which is what I would say is being done right now and it's encouraged even by ISO to do things like that, use your suppliers for everything.

I think you need to have native capabilities to do this kind of work, and then you can take on bigger Industry 4.0 projects. Do that by partnering with suppliers now that you're on a stronger footing with them so you're not doing zero-sum discussion so there's value creation happening. You can also just take on bigger R&D projects, add a couple people to your team, and do bigger things yourself.

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All the developments that I did in our first factory at Whelan were internal. The wastewater technology, unique processes, and everything, that was just time—measuring things, breaking things out, analyzing them and having the time to do that. Process engineering should be independent of the manufacturing group. In the U.S. PCB shops, it's not the case. It's part of the manufacturing group. It's not an independent group that just does process engineering and development.

They're just working on parts all the time. There aren't enough people to get things done. This is really the challenge. You must staff it. You do that either with adding people or killing people with hours if it's a family business, I guess.

Matties: Right. Well, part of it is capital. People say that there's not a lot of profit left in circuits, and so it's that chicken and egg thing. You have to commit to your future to invest the dollars today.

Stepinski: Barry, I think if you can improve your yields and reduce your cycle time, you can charge more for your product. First, people will tolerate that to some extent because you're adding value. Second, you reduce your costs internally for wastes. It's knowing up front the best way to approach it. You must analyze your existing organization and see where the weaknesses are. Ideally you do it by getting rid of the weaknesses, adding the talent, and paying for it that way. This is one way to approach it if you truly have not one penny to spend.

Matties: You must make your choices. I think the word you used earlier was culture. What you're describing is, back from the 1980s, TQM or total quality management. The goal is to reduce waste, and we have evolved tools to help us do that in ways that we didn't have then. When we start looking at that, it's about eliminating waste in every step of your process.

Right now, we're talking about manufacturing processes, but when you look at total input cost, this attitude should be carried out through all your systems, sales process, and accounting processes, because you're talking about a culture of continuous improvement, as we've been talking about or defining.

Stepinski: I think we need to rest on the agile lean stuff that's been done. Particularly, there are a lot of agile tools in the market that are very inexpensive that you can get out of the cloud and start setting up your different process steps. You can do business processes with many different tools. ERP, for example, is for finance people. Manufacturing needs an MES system. Engineering needs a PLM system. This is what's needed to make the whole package work. The finance people make the decisions when the margins are so low because it's what it comes to at the end.

Matties: But as you're talking about education, I also think there's a level of training or education of process improvement, generally logistics and systems education, that needs to happen on a general level.





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Stepinski: The neat thing is there are so many online resources for this, you can do it in your spare time. You can take systems engineering courses four hours a week for six months, and then you are pretty well versed in how to design complex systems. Many schools offer this, it's inexpensive, and you can take all the coding overview courses. The key is being able to scope out a project. You don't even need to do it yourself. You need one or two people hands-on in the factory to scope it out. But at the end of the day, you're not necessarily the ones coding it. You just need to communicate to a freelancer. Try [freelance.com](https://www.freelance.com) or [remote.com](https://www.remote.com) and hire somebody for a couple weeks for a project. They might even be on the other side of the world and could be extremely inexpensive.

The neat thing is there are
so many online resources
for this, you can do it in
your spare time.

Matties: A great way to invest dollars into your company is to invest in people who will learn these skills like systems training and what you're describing.

Stepinski: Exactly. Anybody can do it, but if you don't have any coding background, it's going to be a bigger learning curve and you must understand that. My approach would be if I had an existing factory, I would force the experienced people to learn X, Y, and Z, but not too much because they're holding everything together at this point. I would bring on one or two people who have an easier time learning all this information, then you just develop your project scope documents and outsource it for cheap money. It might cost a couple

hundred dollars to outsource some of these things. That's it.

Matties: For a manager, they don't have to learn all the steps. They just have to learn what's possible and practical for their application so that they can communicate based on understanding what's possible.

Stepinski: There are different levels of magnitude. Right now, people think, "If you want to have Industry 4.0, you've got to buy a whole new factory." And then some think you just need to buy a few machines. But if you spend a few hours a week reading something, you're going to find that it costs hundreds to low thousands of dollars to get the programming done, and you're just going to buy a few sensors for hundreds and low thousands of dollars. You just need to have one or two people who can implement it. That's all.

Matties: Was there any one thing, Alex, thinking back to as early as Whelen or perhaps before or currently, in terms of a book or something that really changed your thinking that someone could go read or any other sources that you would recommend?

Stepinski: I would recommend *System Architecture: Strategy and Product Development for Complex Systems*, by Bruce Cameron, Daniel Selva, and Edward F. Crawley. Another good one is *Industry 4.0 for SMEs: Challenges, Opportunities, and Requirements*, by Dominik T. Matt, Vladimir Modrak and Helmut Zsifkovits.

Matties: Okay, great. Thank you.

Johnson: This has been very insightful learning how an existing facility can move toward Industry 4.0 while gaining additional control over input costs, all without a lot of expense!

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Welcome to APEX Photo Coverage

by Barry Matties
I-CONNECT007

It's good to be back. Though not everyone who normally would be here was in attendance, the spirit of the people who are here is strong. There are in-person reunions in every corner of the convention center. Heartfelt greetings that they have missed for the last two years are shared. The team of people working Registration, the security team, organizers, teamsters, exhibitors and the rest who make up our community are truly glad to be here, all while embracing the new rules and order of things. If a mask and other precautions are what we must do to be together, then so be it. It won't be like that forever; we are just on the path to the future.

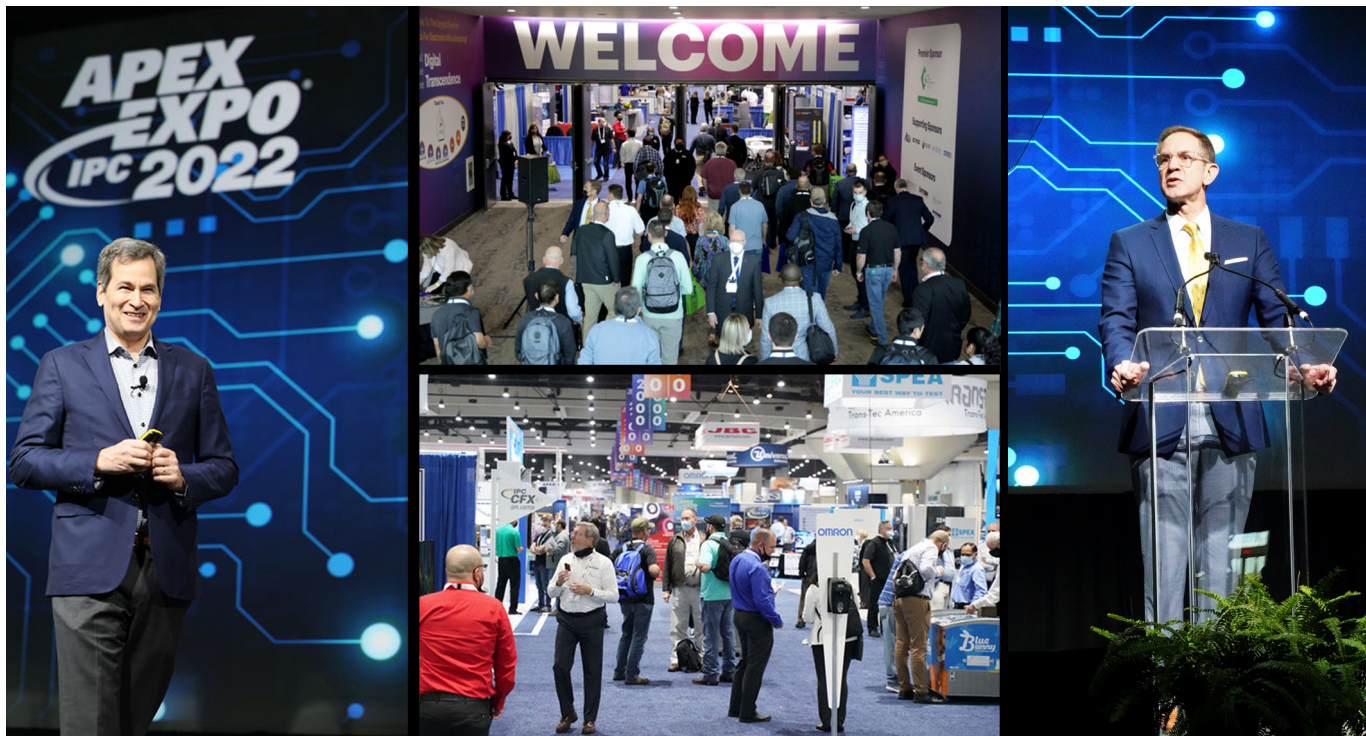
As you walk the show floor, you see the familiar. It's what you expect: signs overheads, carpet on the aisles, equipment in booths. Yes, I was pleasantly surprised to see the amount of equipment that made it here. With all the challenges of supply chain, materials, labor and shipping, it is won-

derful to see the commitment and determination of so many companies to have equipment on the show floor.

As far as attendance goes, most expected it to be very low, myself included. I think the best way to describe it is that it clearly exceeded expectations. This is the comment I heard frequently throughout the event. Comparing attendance to years past just did not seem like the metric that made sense for the return of an in-person event.

Our team covered the event in many ways—videos, interviews, meetings, booth tours, and photos. The photos that you will see throughout our special *Real Time with...* IPC event coverage are the result of a collaborative effort between our team and Josh Sears, the official IPC show photographer. From the opening ceremony, conferences, keynotes, show floor receptions, STEM event, and much more, our team was there to capture the moments.

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Supply Chain's **Risky** Behavior

Feature Interview by the I-Connect007
Editorial Team

Barry Matties and Nolan Johnson speak with Joe O'Neil, CEO of Green Circuits, about something that seems to be on everyone's minds—the rising cost of, well, everything. Joe's background in marketing and finance, as well as his leadership at Green Circuits, positions him as an expert on managing costs related to labor, facilities, lead times, employee training, and the future of the industry. But what rising costs actually surprised him? This is a must-read for us all.

Barry Matties: Joe, costs are going up and fabricators have tried to compress the cost, to not pass it on. But you can only compress for so long. In the past, you might have seen a fluctuation in a particular material or some components, but now it seems to be everything from shipping to labor to utilities. Is it everything?

Joe O'Neil: It's not everything, but it is most things and they're the big things. From an EMS

provider standpoint, 60–80% of every dollar of revenue is materials, depending on the sector or region you're serving. The supply chain is strained, inventory levels are down. We're at the beginnings of the bubble of double and triple ordering. Everyone has horror stories about price gouging. Customers are suddenly okay with taking broker risk, as long as you test and do other things to mitigate the risk. Two years ago, it was, "Absolutely not," and now it's, "Whatever could make that two-year lead time turn into tomorrow, we're open to looking at it." They're salvaging bone yards and pulling parts—so that's the material piece.

There's definitely a cost increase in labor. Entry-level jobs around here are \$20 an hour and that's if you just want to flip burgers. If you have somebody who will be dedicated, show up every day, and learn a trade, you expect to pay more. One area going the other direction is selling, general and administrative (SG&A) expenses. There's an opening of the mindset to accept remote workforce, which allows you to contract out your workforce to areas where costs are lower. Our industry was late to



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Joe O'Neil

the party, and we've made gains, although not enough to offset the direct labor increases.

Another surprise to me was factory costs, leases, and real estate. Because of that remote workforce, I thought commercial industrial real estate would go down. Instead, it has skyrocketed; it was a surprise, but it's up like everything else. Equipment costs are brutal right now because of what our customers are going through. We buy equipment from OEMs, who are typically our customers, and they're getting hit with cost and lead time increases. It certainly seems like a big inflationary environment.

Matties: With the mention of lead times up to two years, can you expand on that?

O'Neil: It used to be a 52-week lead time, and "we just don't know how to tell you that it's been discontinued," or that "we haven't gotten it out of the lab yet." There can be 51 weeks of supply already committed, and you can be in line at 52, so it's different. One part that seems to be improving is the decommit and recom-

mit chaos. We had those three or four months of chaos on the lead time, where one day you heard it was two weeks, and the next day it was 52 weeks. How does the thing that you ordered two weeks ago suddenly turn into 26 weeks when it's supposed to be here today?

In years past, you would see that maybe once a week. But it went from one or two things per month, to one or two things per week, to one or two things per bill of materials, to a handful of things per bill of materials. It's an exponential set of problems, so more resources must be dedicated to validating the supply chain data and ensuring that we've got tracking numbers. You come to not trust your "trusted" suppliers because you keep getting burned. You need to validate everything, because you can't get a production schedule without having some visibility on materials that you can rely on.

Nolan Johnson: And that specific challenge is a direct labor cost as well.

O'Neil: Totally. Lack of reliable visibility hurts scheduling, which causes related inefficiencies, which negatively impacts overhead absorption, and it stacks onto that pricing pressure. We try to absorb it, just like the PCB fab industry did for decades. We've seen customers ask, in a way, what the pain is, and how they will have to share in it. For the most part, there's an acceptance that costs, and therefore prices, are going up.

We want to be seen as partners. There are some things we can do to mitigate the cost increases, and we're encouraging our customers to do some of the same things as well. Look at your order, your order quantities—are you betting it all on a just-in-time methodology? Can adjustments be made to give the supply base more visibility to a longer window, giving them some more tools for planning, and that hopefully can offset some of the pricing issues? With the supplier consolidation putting more spend in fewer places, especially in the PCB fab realm where you can take off a bigger chunk

of their factory overheads, it's been hard. We are trying to keep them at an efficient level, so their cost structure will be a little more advantageous for us.

Matties: You're talking about the buyers; obviously they're going to pay the price, because it's not like they can go next door and get it any quicker or cheaper. There's no alternate source that's not in the same boat.

O'Neil: For the first six to nine months of the pandemic, new customer acquisition was down, and the amount of customer attrition was basically zero because any supply chain changes which were in process were basically put on the back burner.

Or it was, "We're not going to introduce risk by looking for new suppliers right now. We're going to go with known commodities, because we can't afford to have a hiccup and not be able to get on a plane and put eyes on a problem." Everything was about de-risk. But in this "pandemic 2.0," it's about doing everything you can to keep supply flowing. That might mean seeking new sources that you haven't vetted as much as you would have done pre-pandemic; there's all sorts of, say, risky behavior going on to try to address the problem.

Matties: The threshold for risk has certainly dropped. What other compromises do you see? For example, is there a simplification of products? Are they trying to get a result with less supply-based demand? Is there a simplification going on to keep the number of components down, to keep technology to just absolutely what's necessary?

O'Neil: That's a good question, and I don't know. I know that designers are being held to best practices a bit more. If you've got a component library, design engineers must stick to it. Before, it was, "I've got a 1% and a 10% tolerance option in my library, and I want to put 5% in there; okay, I can do it." Now it's, "If you've

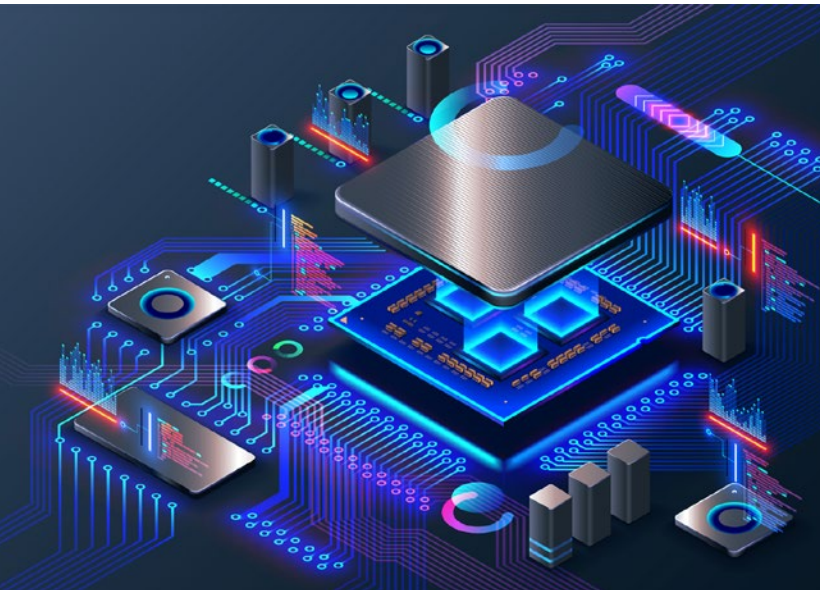
got 1% and 10% in there, choose one of those two. Don't introduce a new part number." It's that mentality. There is a lot of pressure on that design community to design for availability, if you will. There's still six to 12 weeks from the point they make that component selection to when they're going to have any kind of demand beyond a first five units.

It's a tough ask for them to manage that supply chain sustainability at a future date for an unknown quantity. There has always been some appreciation for designing with things that actually exist and that are available in a reasonable cost window. Cost has always been in the equation, but availability has likely overtaken that cost piece.

**Cost has always been
in the equation, but
availability has likely
overtaken that
cost piece.**

Johnson: Joe, some of the design teams that I've talked to or heard about seem to be designing with multiple BOMs, so that they can use this or that component depending upon what's available while maintaining fit, form, and function equivalence. But that makes for four or five flavors of their product in different configurations depending on what they can get. How does that complicate things for EMS companies?

O'Neil: I think the typical BOM breaks down into active components, passive components, connector sets, and maybe some boards. Traditionally, with passive components, you could throw anything in there and they would say, "It's a capacitor, just throw one in there," to a better practice such as, "There are three or four



O'Neil: You just hope they don't cost lives; that it's your flashlight that doesn't work, not your airplane.

Matties: Exactly. If you look at percentages, what sort of percentage and increases do you think you have on your input cost?

O'Neil: Overall? That's tricky. We've got anecdotal stories of the penny part that now costs \$2. A 200 times increase overall is not what we've actually seen. There are the one-offs, but on the material side, it's somewhere between 5–10%. It might be a little less, but that's the trend we see as

we finish up budgeting for next year. On labor, insurances, and other labor related costs—the traditional items getting cost reduction attention—it's still in that 5–10% range.

The rate of change is also surprising. For example, the rate of obsolescence is increasing. We have customers with legacy products, or longer-life capital equipment-type products, where they'll have the same design in production for five to 10 years, or longer. They are getting hit hard because the component manufacturers seem to be dedicating their capacity to newer projects. Component manufacturers are cutting off the tail more aggressively, dedicating their limited capacity to their higher revenue, or higher margin, newer products. Those long-life programs will be seeing up to 20% increases. We do a ton of NPI prototype work and there's no increase per se because it's the initial cost, and the baseline is set higher.

Matties: Are you seeing a reduction of NPI work? Or is there still a growing demand for that?

O'Neil: We saw a pause as the pandemic started; everyone trying to figure out if there was a market to go after. I don't know if that contributed to pent-up demand, or it was just that the economy took off, but there is defi-

listed, and any of the above will work." Now we're seeing not only a willingness to look at the fourth or fifth option that we can propose, but an appreciation for the fact that we're even proposing it. It has shifted greatly. There's some verification and validation, some testing before we load hundreds or thousands of them as a drop-in replacement.

Now we're seeing that mentality move out of the passive realm into some actives and connector systems, and other places. That's where it gets interesting. It looks good on paper, but there are nuances.

There's so much out there that is not direct channel, or authorized distribution. There is a lot of pressure to go to sources that aren't verified or validated, which likely will lead to other problems in the marketplace.

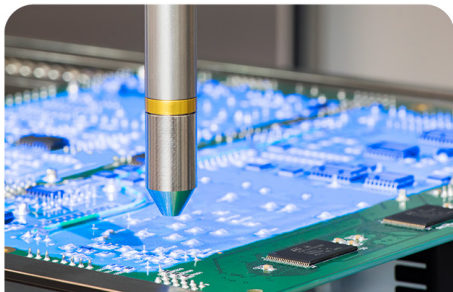
When major systems were compromised due to counterfeit components or haphazard engineering changes in the past, they typically happened in this kind of environment, where getting product to market starts to weigh more heavily than safety and security, rather than a resilient supply chain that's trusted and verified. We forget over time those lessons and we unfortunately relearn them.

Matties: Those are tough lessons to learn or relearn.

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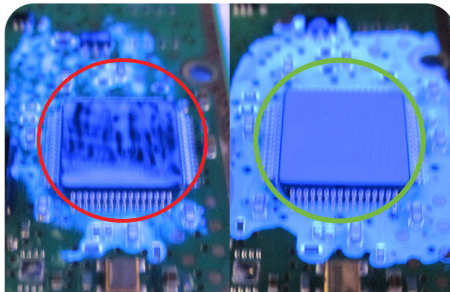


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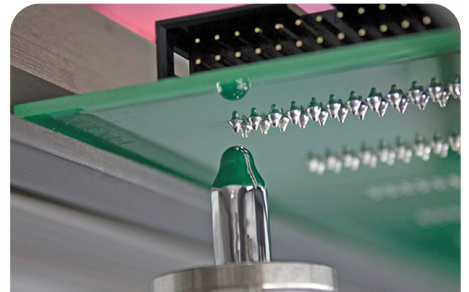
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nite demand. There's the internet of things, the "connect everything" mentality, that's driving a ton of activity. There is transportation as a service—more on the commercial realm of the automating every type of transportation—that is booming. Medical and defense are still strong as well. We can't get any components because they're getting gobbled up into every nook and cranny of our lives. There's an attitude that "if you can get the product to market, somebody's going to buy it."

Matties: Is this rate of increase sustainable, or do you see it flattening out?

O'Neil: No, it's not sustainable. But I think some of the trends are going to continue. We print a lot of money and put it out there. I don't think anyone's surprised that we're going through some inflationary periods. But in terms of supply chain—the behaviors of double, triple, quadruple ordering—will lead to something like the telecom bust. The distribution and visibility throughout the supply chain should keep the bubble from getting too big before it needs to release, but that correction will happen.

You're not going to get back to a vehicle with less than 25,000 electronic components in it. But when we were forecasting that they were going to have 2,500 and they have 25,000, that can cause a definite ripple in the supply chain.

We will get back to some rationality. When times are good, you look at the distribution

guys and ask, "Why are they making more margin than the PCB fabricators, the EMS providers, or even the OEMs?" They're just providing a pass-through service, right? In most cases, they don't even touch the component. Well, right now they're earning their money and they're going to have to get us out of this mess.

Johnson: If this cycle isn't sustainable, and we're working toward a bubble, what is the best way to manage these costs? Do you start from an offensive or a defensive strategy? How do you approach the situation so you're as protected from the bubble as you can be?

O'Neil: That's a great question. I think some OEMs and some EMS companies look at it like a boxing match. Others look at it like a marriage. Those companies have different sourcing. We've approach it as, "We're partners here;" if 10 of our customers catch a cold, we're going to be the ones that get sick and die. Conversely, if they have 10 suppliers, their top 10 suppliers catch colds, they're going to get sick and die, so we had better make sure we're both healthy.

We ask, "How are we going to get through this together? What are the options on the table? What are the possible levers that can be manipulated?" It puts us both on the same side of the table, which is where the fun is. When you can later say, "Remember when we had that big problem and we figured it out



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together?” That’s the glue that keeps those relationships strong. It’s why you have customers who have been around for decades, and people who could trust you in the tough times.

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Matties: It wasn’t so long ago, though, that visibility was intentionally guarded. The communication was limited, and companies weren’t sharing their future.

O’Neil: That’s right. We would get buy signals like, “We’ll tell you two weeks before it needs to be on our doorstep.” And sure, we can work on a razor’s edge with no safety net, when everything’s super lean and super-efficient, and we’re all squeezing every penny out of the carrying costs. That’s all well and good until there’s a massive supply chain disruption, which basically breaks all those systems apart, and it’s not hard to see where they fell apart.

It’s just hard to react effectively and quickly enough. How do you instantaneously drive up those inputs, your safety stock, and your inventory? All those things need to be increased almost immediately. And, even if you’re relying on data (which I think was deeply flawed in the beginning, because it didn’t look like there was a problem), you’d hit refresh, and in five minutes it went from unlimited supply to zero. No one had reliable data.

Matties: As we emerge from this and things get back to whatever is our new equilibrium, the cooperation and communication aspect of what we’re doing now I expect will stick and be

adopted in a stronger fashion because there’s too much success with it, even in these challenging times.

O’Neil: People are making money and growing. I appreciate the optimism, but I think we’ll manage to unlearn the lesson. Players will put profit margin pressures higher up on the premium decision-making matrix and try to take all wastes and costs out. And we’ll repeat it. You look at how we might be able to get out of it, the amount of information that’s out there now. You look at block chain vs. supply chain, and whether there was actual, reliable data.

Something on the chain that said, “Look, there is one component here and it is being consumed here,” and it isn’t just a compilation of spreadsheets coming from nowhere. That would create an auditable chain of where everything is and be something that you could rely and plan on. That’s a future state, but I think it’s one that will probably happen faster than I expect, by people way younger and smarter than I am.

Johnson: Joe, in this market, is it a good time for M&A?

O’Neil: A growth market is a good time for M&A; there are opportunities. It’s a simple equation for consolidation of SG&A expenses and facility costs, so that’s another big benefit. This inventory problem has caused some cash crunches, so there are probably some opportunistic opportunities with M&A as well. I think customers having pushed a lot of orders into backlog is nice from a M&A visibility standpoint.

Then there are the challenges and uncertainties. This supply chain caused a lot of hiccups. On every earnings call, the OEM or EMS provider will cite, “This percent is down due to supply chain issues.” Those are surprises and anomalies that make that M&A effort a little bit harder, but I think they’re within bounds. They can be overcome. It’s not a 50% impact to

revenue; if the buyer and seller are seeing the same thing, then you can get through it.

Johnson: What about the other side of the coin? Is this a time to spin out business units as appropriate? Is it better to start to spread out and specialize a little bit more, rather than gather things together?

O'Neil: I still think there's more for value in integrating now than spinning out, but that is mostly from a service industry standpoint. From an OEM standpoint, or by a hardware company or technology company, it could be the opposite.

Matties: What are you doing inside your factory, Joe? We talked a lot about getting parts and labor, but what about the processes? Obviously, building it right the first time is more important than ever.

O'Neil: Automation is tied into that. The labor market has hit a breaking point. There are certain-sized companies that look at automation as if it's something the big guys do. But now, it's very attainable. You can have a single arm moving product from point A to point B. It's not "Terminator" just yet, but it's at least entry level AI to provide some more feedback on process and quality.

Regarding M&A or spinning things out, it's a good time for bringing in partners. Some of these solutions are so deep and complicated that it pays to bring in real subject matter experts and put them on your team. To me, it's like the early days of basic IT services—you hired a guy and you hoped he had your 2400 baud modem working correctly. He kept your fax machine paper full, for example, and

then at some point it became complex enough that either you had IT as a standalone department or you hired a third-party solution to make it a valuable and differentiated, almost a profit center for your company.

This kind of machine learning and AI connected factory stuff suggests you either are on a scale to have your own department, or you benefit from real subject matter experts who come in and really change your factory.

Matties: The challenge there, of course, is finding the experts who are available to come in and do it.

O'Neil: It's easier to find experts who are bringing solutions to market as their own piece vs. finding someone to whom you would pay a lot of money and they work within your factory. There are enough of them, at least here in the Valley, that were raised with no electronics manufacturing background, and have products and solutions where they need to come in, learn your business, and something to the effect of, "You're this part of the supply chain. We understand what you do. Here are the things that we can do in the AI or machine learning space for you."

Matties: What about employee training? How are you approaching that in these times?

O'Neil: We have always been dedicated to upskilling, cross-training, and having a flexible workforce. The sad truth is having the dis-



cipline to say, “I’ve got 40 hours of work for everyone this week, and I need to take four of those hours and not deliver product so that we can train for work.” That’s discipline that I don’t have all the time, so the nice part about the supply chain piece is you get windows of inefficiency.

For example, we had 48 hours of work this week, and due to the supply chain challenge, we’ve only got 32 hours of work now.

Let’s take those eight hours and get everybody recertified on Six Sigma, Lean concepts, or whatever it is that we’ve fallen behind on. Then, you take a handful of people and move them up the path with managerial skills and other supervisor training. That’s magical because everyone tends to notice, whether they admit it. Across the board, everyone is pushing a little harder; the team comes together when the leadership comes from within.

Johnson: Earlier, you said that commercial real estate is skyrocketing. People are looking at putting together new facilities or using a facility expansion to pivot into some new challenges. Do you have a handle on why, in general, commercial real estate has skyrocketed?

O’Neil: I was very surprised, because it’s not just Silicon Valley, which can be 180 degrees off the rest of the country. I’m hearing it in other areas. It’s just the general economy, and the number of startups and expansions. I thought this remote work trend would create a glut of office space, and we would have a ripple effect as people repurposed buildings, but it certainly doesn’t seem like that’s been how it played out.

Matties: It seems everything is in demand. What final thoughts do you want to share?

O’Neil: Buckle up. It’s probably a good time to figure out how much time your senior management team wants to dedicate to things that are 10 years out. The industry has come a long way with practices that were in place 20 years ago and, if you’re in the board business, you’ve come a long way with practices that were in place 40 years ago.

The industry is ripe for disruption. I don’t pretend to know what that looks like, but I sense it coming. There are opportunities for companies of all sizes to be at the tip of the spear, causing that disruption and being a beneficiary of it. The danger is, in these environments, that you put 100% of your focus on the stuff right in front of you

and you might miss the bigger play that’s a little bit further out.

It takes lifting your head up and looking at the horizon. What’s going on in other industries, with your competitors, your supply chain, and your suppliers? There are a lot of new tools and tricks of the trade out there that can be brought to bear within each of our businesses. A couple of them might get combined into something that changes things dramatically.

Matties: That’s good advice. In today’s market, we don’t know what’s coming our way next; these are challenging waters we’re navigating, that’s for sure. Thank you for sharing your thoughts, we certainly appreciate your time.

O’Neil: Yes, absolutely. Thank you. SMT007





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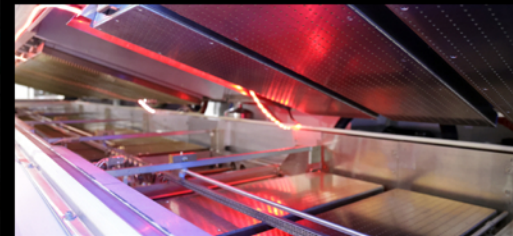
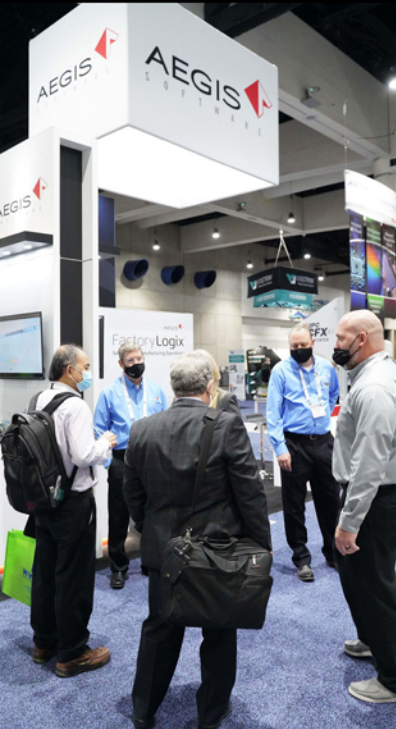
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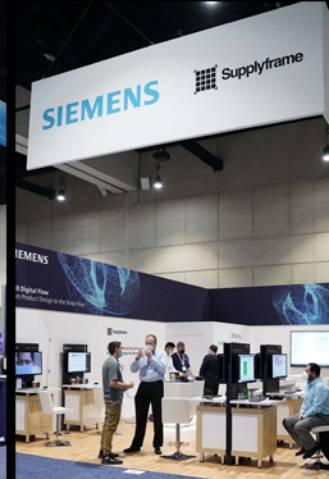
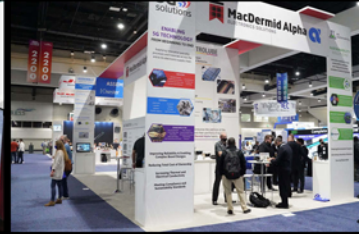
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Going Global: **Bridging** Today's Labor Gap

Feature Interview by the I-Connect007
Editorial Team

No doubt you will relate to Foad Ghalili when he expresses his concerns about the rising costs to doing business, whether it's getting the right components, delivery times, or price increases. But what's unique for the president of Epoch International is the way his company has leveraged its U.S. and China operations to make the most of the other thing on everyone's mind—the labor shortage. If you're not already implementing his ideas, you will walk away from this interview with some sure-fire ideas for your own business.

Barry Matties: There's a lot of reporting on inflation and the supply chain, but what about the input cost impacts for the EMS providers, strategies you're utilizing to mitigate those costs to help your customers and navigate for the future. What are the trends and pressures you see right now?

Foad Ghalili: When you break down the input costs into direct material, direct labor, and

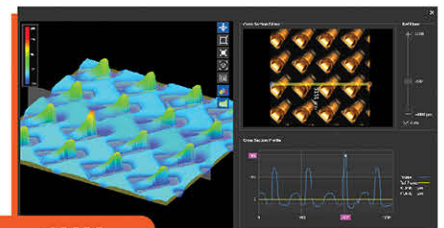
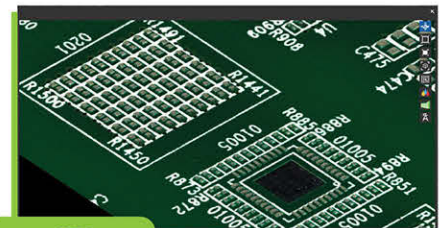
include facility and transportation cost, they are all under pressure right now. We are seeing a rise in every aspect, especially with semiconductors, at around 20%—that is, if you can get them. We are struggling to get components and spot buy has become a daily activity as we constantly look for different sources. We've seen semiconductors at prices two to three times than what we were paying about a year ago.

Labor cost is also on the rise, both in China and in the United States, though not as bad in China. In the U.S., besides the cost, we are also dealing with a constant transition of staff in a tight market, where everyone is looking for that higher salary.

We also see infrastructure costs on the rise. In China, we see a 2–3% rise in power consumption. The other is transportation where not only costs are increasing but also delivery time. Before, we could count on delivery times of three to four days between China and the United States through FedEx. Now, if we can get things in a week, we are lucky. Generally, you are seeing a major shift in every area. Demand is still strong, and the market is

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Foad Ghalili

expanding, but to keep up with the demand is a major challenge.

Matties: How are the customers handling the price increases?

Ghalili: Some customers understand, everybody knows the price of components, as they are readily available. An intelligent customer understands what is happening in the market and they're willing to work with you.

Matties: In the U.S., we're having a hard time finding people to take the jobs. Is there a trend in China, like the U.S., where people aren't wanting necessarily to work, or is it more job-hopping?

Ghalili: In China, we don't have much problem with finding or maintaining the labor. It's nothing like our facility in Fremont [California], where finding and keeping employees has become a challenge. In China, we are finding and maintaining our workforce, but salaries are on the rise, and we expect it to continue.

Matties: Where do you see this headed? Do you see a plateau in the wage increases or do you see a sustained rate of increase?

Ghalili: I think it will plateau in China. In the past 15 years, we were seeing 15–20% pay increases. It's starting to plateau around 4–6%. In our industry, we've been a bit on the upper end, running around 6% and anticipating the same next year.

The U.S. is a completely different market where the difficulty is just in finding the labor force. Engineers are hard to find, and the demand for the engineering and technical field is very high.

Labor cost increase is a constant struggle we are having in both the U.S. and China. We are trying to see how much we can leverage each facility, for example, the engineers here (in China) supporting the engineers in the United States. We want to build synergy between the two companies in supporting each other.

Matties: How are we ultimately going to solve this engineering gap problem?

Ghalili: I see two areas we need to address to bridge the gap. In China, especially, we are bringing in more people right out of college, training and building them up. In the U.S., we are looking at it from a couple of different perspectives; besides the traditional training, we are leveraging our China engineering team to bridge the gap in the U.S. In China, we've set up a semi-control room, where our process engineers will log into all the equipment in the United States and support them in running the machines in the United States.

We have people coming in late at night in China to work with our team in the United States, supporting them in running the operation on that side. I can see that happening globally where we are going to leverage people from different areas supporting each other. I can see engineers in India supporting and running operations in China and or in the United

States. I think that there's going to be a global interconnect in the technical field that will address regional gaps.

Matties: A remote or virtual engineering team, if you will, to service facilities?

Ghalili: Exactly.

Matties: That makes a lot of sense when you must manage limited resources.

Ghalili: It does.

Nolan Johnson: I'm trying to imagine how a company that doesn't have the resources, or the multinational presence, can achieve this sort of staffing.

Ghalili: That will be a bit of a challenge, but I am also seeing a lot of companies, for example, in the U.S., that are now farming out their programming on their SMT or AOI machine to India and other areas. You have a team in India that is not part of their entity, but they do the programming and then they feed the machines. At least the programming aspect of it can be done somewhere else.

In our case, not only the programming can be done remotely, but the actual operation of the equipment as well. Because of potential IP issues, not everyone may be able to do this, which could be a challenge.

Johnson: How are you implementing the remote operation of the equipment?

Ghalili: In Fremont, we have seven or eight cameras, and we have dedicated, high-speed lines between the two shops. With the cameras the engineers can see the entire operation, including inside the SMT machine, and then instruct the operators. The engineers are logged into the SMT line using software such as TeamViewer and can operate the systems remotely.

Johnson: So, that happens for the day shift in the U.S. as well as second or third shift?

Ghalili: Right now, for the day shift, we have more staff and a lot more capability has been built up, so we are doing less of that. Where this will become more dominant is the second shift. We can maintain very limited resources in Fremont and support them entirely from China. That's the only way we can resolve our labor shortage in the U.S.

Johnson: Given the different environments for staff and labor in the two markets, what is the U.S. staff bringing as a value-add back to the China staff?

Ghalili: No matter what, you need staff on the ground. One is when you're dealing with a U.S. customer, you need U.S. staff to work with and understand that customer. For example, we are building a much stronger quality team out there. Our material management is becoming more regimented in Fremont. So, the customer needs and requirements are transferred by the U.S. staff to the China team. The operational part, as much as possible, is being automated and can be done from anywhere.

**When you're dealing
with a U.S. customer, you
need U.S. staff to work with
and understand that
customer.**

Johnson: It sounds like the general trend in Fremont is to move the jobs toward a more skilled or more educated job description.

Ghalili: Exactly. Even in China, we are moving toward automation. The challenge we have on



both sides is to find highly skilled engineers as we move toward more automation. We look for individuals to operate these systems rather than basic manual work.

Matties: This certainly is a way of keeping costs down. It's the type of strategy you must incorporate these days to stay competitive.

Ghalili: Exactly. If nothing else, COVID has taught us about the interconnectivity in the world. We must remove all the barriers and see how we can leverage individuals in different parts of the world. Just looking at it from the time difference, you can be running operations in the daytime with six to eight people in the U.S. Then at night, with only one or two operators with support from China which is their daytime. There could be reciprocal advantages for everyone.

Matties: Now, what trends are you seeing from the customer's point of view? Are they more patient with the delivery times or are they still demanding quick deliveries?

Ghalili: It depends on the customer. Sometimes it takes a lot of discussion for them to come to terms that delivery is directly connected to prices. For example, right now one of our major customers uses Intel parts. Intel just raised the price 20% on one component; we are trying to explain the impact of this increase not only on

the material cost but cost of inventory and cashflow. We have increased our component inventory level 15–20% trying to meet customer demand.

There's a lot of forecasting that's going on, and a lot of risk buying that we must do. With the way the market is right now, there is no other option than by making some projections, and going forward; otherwise, we're going to be stuck.

Matties: But even with building your inventory by 15–20%, that must be a challenge in finding the parts to begin with and having them arrive to keep that level you want.

Ghalili: Exactly. We've had components we could locate on a spot buy, and then we go to the customers and say, "We can find these components with 40–50% higher pricing. Are you okay with that?" By the time we get the response, the components are off the market; somebody's already bought them. Our purchasing department is regularly juggling seven or eight different balls at a time, trying to figure out how to keep the operation running with this tight market.

Matties: I recall that you were building some inventory control units. In today's world, counterfeit is a growing issue. Are you still building your own equipment and how is that helping?

Ghalili: All the equipment we have built for inventory management is our own, with patents on a few of them. It has been a great help because we have connected all that throughout our supply chain and our Oracle ERP system. Because it's our own, the software that we've developed leads to our own system, which has been a major help. We would be challenged daily without those. The way it is set up right now, the goods come in, go through quality, to the cabinet and from cabinet to the feeders. It's also helping a lot to reduce manpower and excess inventory sitting in the lines.

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Matties: Where are counterfeit components fitting in?

Ghalili: We have been lucky. Procurement has been exceptionally adamant about verifying the source and making sure it is indeed the right source before we even take a chance of paying them any money or getting parts. We generally cannot get parts to check and verify, so we must be very cautious in this area. I know that we've delayed production because procurement was not comfortable with the source.

**I know that we've
delayed production
because procurement
was not comfortable
with the source.**

Johnson: What would be your recommendation for the industry to manage input costs? For example, if you had to work just with the Fremont facility, how would that change your strategies?

Ghalili: We had the manufacturing facility in China first, and then we set up the U.S. facility. But if I didn't have the China facility, then setting up the Fremont operation would be a major challenge for me because I wouldn't have the backup resources I have now. I know that it's not going to be easy for anyone starting off, but if you specialize in the market and you have good connections with one or two major customers that you can work with, that may change the dynamic. But I would not have started at Fremont if I didn't have the full support of the China operation.

Johnson: Is this a time to be pursuing mergers and acquisitions or is this more akin to a time to, well, start something up?

Ghalili: When I think about our Fremont operation, it was a great time to set it up and go forward because once you have the capability to leverage resources globally, it works. There are a lot of entities, for example in India and other areas, that can support you, whether it's a procurement of raw materials, or maybe programming of your systems. If you're able to leverage that, then I think you're in a good position to start.

But the old style of doing it all yourself, hiring your own procurement and engineering program teams is going to be a challenge. There are a lot of available resources and it's not a bad time to experiment. I don't think that many people are doing that yet.

Matties: How is China dealing with the chip shortage?

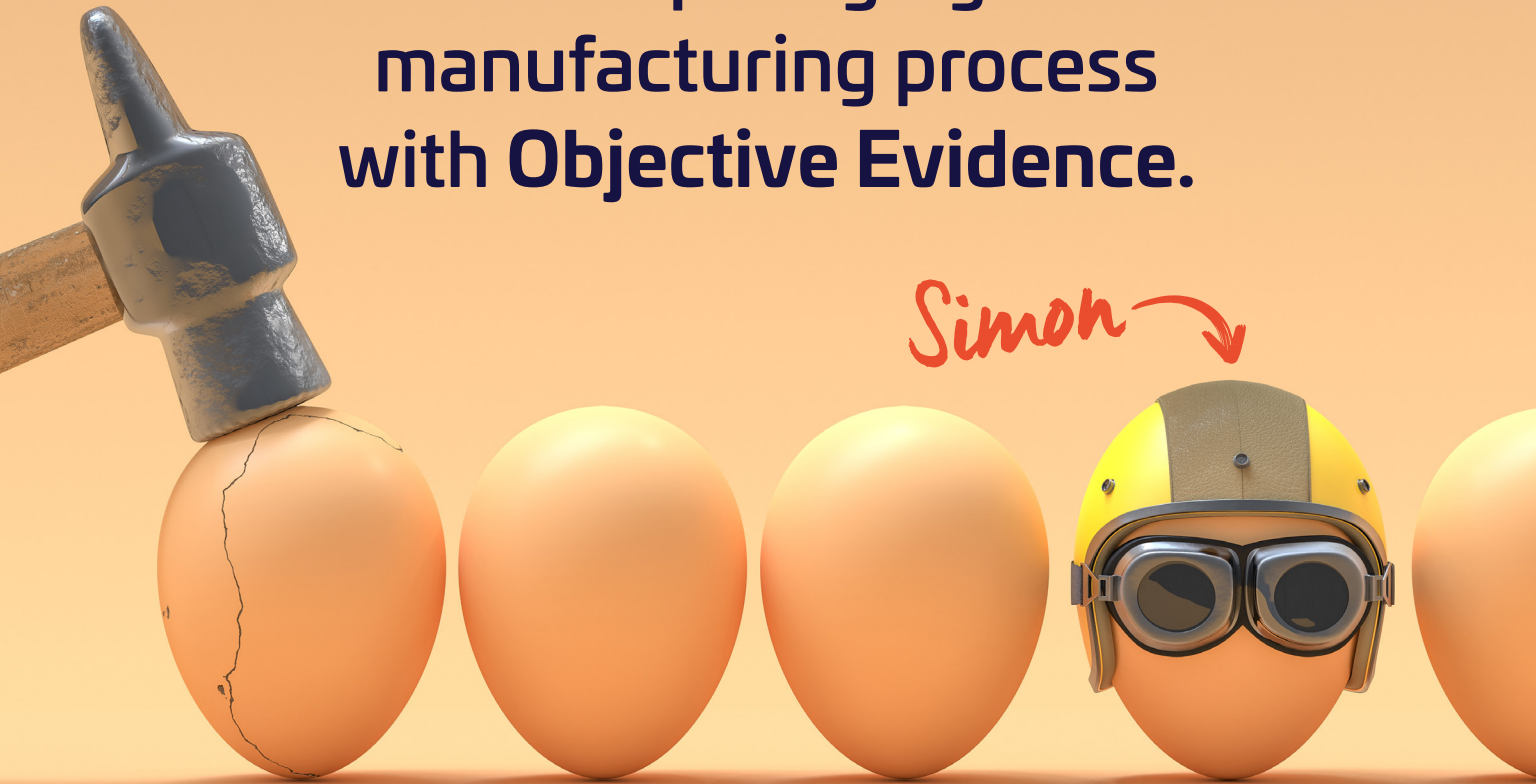
Ghalili: The chip shortage has impacted everyone, especially in China. A few of the factories supplying automotive parts have been shut down for weeks. The ones supplying mechanical parts can supply components. But due to shortages of semiconductors upstream, supply has been impacted.

Matties: Oftentimes, the Chinese government will step in, help subsidize and get things moving again. Is there any of that conversation or is this left to the private sector?

Ghalili: From what I know, they are investing a lot just like I think the U.S. is in semiconductor fabs. But this is not something that they can change overnight. It will not impact production right now. In our city, for example, the government has been aggressively seeking to bring semiconductors and fab shops into the city. Everyone is working on it, but nothing is going to happen overnight. This is one area where it takes time to build a fab and bring it up.

Matties: It just depends on how much red tape is in the way in any country and how willing

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Ghalili: I can tell you that in China, if they want to get things done, they will bypass all the red tape. If you can set up a factory and you need approval, they'll give it to you immediately.

Matties: Knowing that, it seems like time to market would be quicker there than in other places—unless those barriers are removed in other locations as well.

Ghalili: Definitely. China is building a lot of semiconductor and fab shops. Keep in mind that the issue with China is not so much scaling, it's the technology that they're struggling to catch up on. For high-end semiconductors, China is still behind, and everybody knows that. For other components they can pour money and scale up rapidly.

Matties: What is the greatest challenge for the coming year?

Ghalili: It is the unpredictability. You have no idea what to expect next. A year to two years ago, we didn't think we would see a shortage of semiconductors like this. We had components readily available and suddenly it's hit us. The unpredictability is the challenge. You just can't put your finger on where the next problem will pop up.

Matties: You must rethink your tolerance for risk in these markets and be willing to take a little more risk.

Ghalili: Exactly. That's what we were talking about with materials and inventory levels. You just have to take a chance and hope for the best.

Matties: Where do you see the market going for 2022?

Ghalili: From what I see, the market is growing very rapidly. I don't think there is any issue with the market, it's just the supply. The question is, can the supply chain keep up with the market demands?

Johnson: These market conditions would make it a good time to start a business except the supply and the infrastructure won't support you.

Ghalili: Exactly. It's a great time to start a business, but you must be sure you have the technical support, and your supply chain team must be creative in supporting the demand. If you can fulfill these needs it can be very profitable if you come online now.

Matties: But you're in the same boat as a startup or even a few steps behind because you may not have all the relationships that you need for the supply chain right now. That's the challenge, and the technical knowledge and skills gap is hard to fill. What are you going to do for 2022?

Ghalili: We will continue to support our current efforts. We need to be creative on our supply chain, our management, and inventory control. Right now, our staff members are aware that even losing one component on their SMT line is not acceptable. We must get more Lean in our production and in our supply chain, and it's not only because of cost, but also not being able to get the components. We must find creative ways constantly to get these products out.





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Matties: Is your goal to reduce overall cost while getting these products out, or is it just to get the products out and do whatever it takes?

Ghalili: The most important is to get the product out. We cannot afford to lose components in the line not because of the cost, but just because we cannot get it. So even though we reduce cost by being leaner, the focus is getting parts out.



Matties: In today's market, I would think that the customer is willing to pay the increase in price to get the finished product.

Ghalili: Exactly. You can always pass on the cost.

Matties: In the meantime, your strategies of virtual, technical, operations, and engineering support will help keep your costs down in this climate, which should give you an advantage. People are getting creative and doing things in a way they had never considered before because they didn't have the pressure to think creatively in their approach.

Ghalili: In some ways, this has helped us rethink our strategies and how to do things. And as I said, one thing for sure COVID has done is remove all borders and boundaries. To be successful we need to reach outside of our boundaries to get support for our operation.

Matties: Do you have any final advice for the industry?

Ghalili: Think outside the box and think globally as you look at your operation. You may have an operation only in the U.S., but you need to see how you can leverage people globally to run your operation in the U.S.

Matties: A good solution for your sharing resources and getting the job done.

Johnson: It's interesting that just as there's a lot of talk and discussion about making the supply chain less global and single source, right along with that is a shift in thinking to embrace globalizing labor and engineering expertise. Just as one is shifting back to be more multichannel, the other one is becoming more global.

Matties: Everyone is reconsidering their supply chain and looking for local sources and they don't necessarily want to depend on shipping that's hung up at ports. They want to be sourced locally.

Ghalili: My thought has always been that you're going to manufacture in the region for the region. The actual physical manufacturing, no matter what, is going to shift, but the human resource part of it, we can leverage global resources and help each other grow. The physical product manufacturing, long term, really needs to be in the region. Just the mere fact of how much energy we waste on shipping goods across the globe is wasted energy that doesn't need to be.

Matties: All right. Well, thank you very much.

Ghalili: Thanks a lot.

Johnson: Thank you. SMT007

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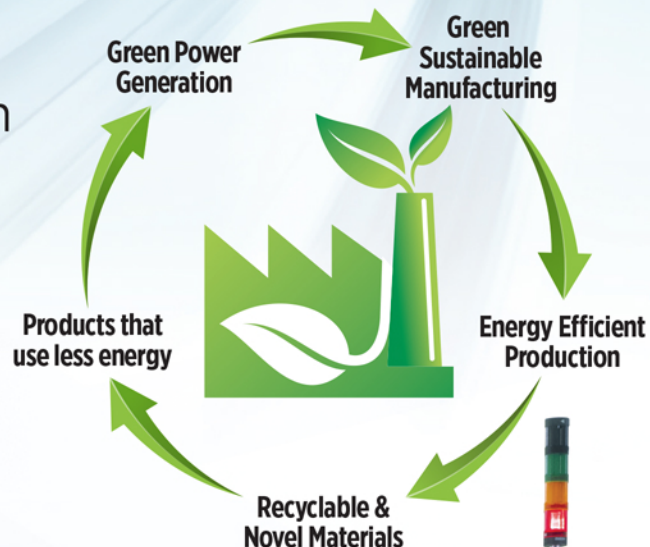


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Real-time Strategies to Offset **Soaring** Expenses

Feature Article by Nolan Johnson
I-CONNECT007

Supply chain, distribution, and price inflation are headline news topics these days. To better understand how EMS companies do—or could—respond to pricing pressure from input costs, we asked both EMS industry company representatives and EMS equipment manufacturers to comment on how the industry can respond to current pressures.

Q: How is your company adjusting to the pricing changes you see on your input costs? Are you still absorbing any price increases or passing them along to customers now? What other adjustments are you making?

Charlie Capers, vice president and general manager at Zentech, an EMS provider located in Dallas, Texas, shares that, as an EMS provider, “Prices are changing by the hour these days and what you quoted a week ago has probably changed. Since we are the manufacturing extension for our customer, we typically must pass the additional costs along to them. Margins are razor thin these days, so if the PPV is $\pm 1\%$ then we possibly will want to re-quote to capture the additional cost.”

MEC/Screaming Circuits is based in Milwaukee, Wisconsin, with Duane Benson leading the marketing out of the company’s Portland, Oregon office. He shares a similar perspective, saying, “We absorbed prices where we could and for as long as we could. We have had to pass along direct materials cost increases for a while now, but until recently we absorbed most cost increases related to indirect sources.

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At some point, though, the expectation is that we all will share in the impact. We've found that the best approach is to keep our level of service up where we want it and support a solid long-term relationship with our customers.

"Entering into this market trend, then, with margins so tight to begin with, it seems there wasn't much room to absorb the costs. So, we turned the questioning to upstream suppliers to see what's happening with pricing incoming from suppliers."

As a manufacturer of equipment for EMS assembly, Manncorp's CEO Henry Mann faces a different set of challenges, sharing, "As Manncorp has faced pricing changes, we have not passed the increases onto our customers directly. Each year, we update our pricing after evaluating the big picture. Our products (SMT equipment) are of a more stable nature than many products on the market, and this allows us to issue price changes only when absolutely necessary."



Henry Mann

Q: How have your upstream suppliers adjusted to pricing changes? For example, are they still absorbing the costs, or passing them along to you? What other adjustments are they making?

"Typically, when we issue a purchase order using our quoted cost, the supplier may make slight adjustments based on the current market price," Capers says. "We adjust our purchase order accordingly. If the PPV is negligible, then we may choose to absorb the additional cost. The main issue we are dealing with now is lead times. Pricing on some items has remained fairly steady, but lead times are extending 52-plus weeks on certain component types."

Benson highlights the added flexibility, not-

ing, "Upstream suppliers have been passing costs along to us for most of the pandemic. However, they have been very flexible with terms and that has been quite helpful. We appreciate their spirit of partnership. I don't know that I could call out any one specific incident. It's really the same all around."



Duane Benson

While it's unclear how much the upstream suppliers may have absorbed the cost in their respective margins, what is clear is that some of the pricing pressure the suppliers are feeling has pushed through to the EMS providers.

As a supplier of capital equipment to the EMS industry, Mann's answer sheds some light from further upstream, saying, "As individual companies decide to increase pricing for customers, it is based on their own costs and profit margin. For manufacturers, it is important to decide whether the products you are purchasing at inflated rates are truly worth the cost. A key aspect of keeping revenue stable is retaining existing customers. By meeting the needs of the customers you have, and not raising the pricing astronomically, you can keep cash flow consistent and even out the fluctuations that come."

If you're a reader of Anaya Vardya's I-Connect007 column, then you know he promotes ongoing dialogue between supplier and customer to create the most collaboration in the working relationship. So, we asked about that.

Q: How have your customers involved you in their adjustments to rising input costs?

"Between us and our customers, their pricing needs and our cost requirements are always a dialogue rather than a demand," says MEC's Benson. "I can't give you a specific example due to customer confidentiality, but in gen-



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eral, customers will communicate the cost and market pressures they are under, as will we. Between that, we'll come up with pricing that both companies can live with."

Capers looks to the horizon, saying, "A lot of our educated customers are looking far beyond this year in terms of cost and availability of materials. They utilize us as their supply chain partner to locate, secure, and purchase the materials used to build their products. In addition, most customers are willing to pay for materials far in advance of the build to mitigate and avoid additional delays."

Q: What are some actions/responses (strategic or tactical) that colleagues in the industry can do right now to offset input costs?

In answering this question, Capers echoes Vardya's partnership columns, noting, "If you're an EMS provider, I think you should be talking to your top customers and discussing product forecasts for the next couple of years. Look at the BOMs to identify long lead materials and components which are susceptible to large price increases (ICs, connectors, bare boards, etc.) For example, we just received a purchase order for materials needed for 2023 production orders."

Benson offers a technical spin, saying, "While it may not seem directly related to pricing pressures, encouraging minor design spins can be very helpful. The overall pricing situation is affected by components shortages as well as vendor price increases. When one or two parts are not available out of a 100 line-item bill of materials, the contract manufacturer will still need to purchase the remaining available parts. That leads a large increase in inventory carrying costs, which eventually



Charlie Capers

need to be absorbed down the line. A small redesign for a different package, or similar but more available part, can allow the boards to be built, mitigating that inventory burden."

"With in-house production, companies can be flexible, adjusting what they choose to purchase and when they choose to purchase it." Mann points out, "Anyone who is currently outsourcing their production should strongly consider bringing manufacturing in-house so they can have better control and lower costs. By fixing your costs, owning your assets, and having good personnel, you can weather the ups and downs and continue to serve customers in the best way possible without your company suffering losses."

Q: How do you see this increased pricing pressure affecting your business relationship with existing suppliers and customers?

Benson says, "Though we've weathered many supply-chain and inventory challenges before, this cycle seems to be different. Unlike some times in the past, suppliers and customers all seem to understand that this is just the world that we live in right now. No one is happy about it, but there is a sense of cooperation that we haven't seen in the past. That understanding that we are all in this together really helps."

Capers adds, "I have never lived in a world where cost of living has gone down. Inflation is reported at +10% as of yesterday's news. Our industry is no different and most customers understand the increases, but we do all we can to lessen the sting of rising costs. Loyal customers understand that pricing is not going to be much different at another EMS company."

Q: What is the biggest challenge you're facing right now with respect to input costs?

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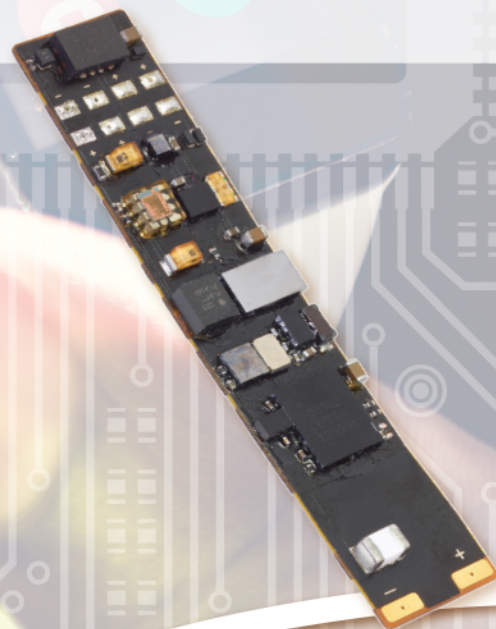
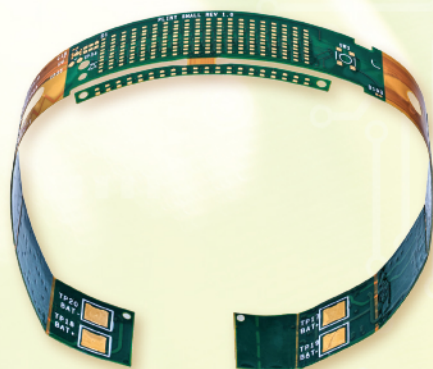
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“Throughout this shortage of supply and personnel, Manncorp has weathered the storm by owning our assets, having fixed costs whenever possible, and having an excellent team of in-house employees,” Mann says. “What can be done in-house (such as marketing, advertising, customer service, information technology, operations, and sales) are being kept in-house. This in-house model allows for control and lower overall costs. This model also allows for the things that are not up to us (such as the rising costs of shipping) to be averaged out. We absorb some input costs and only pass on minimal price increases, thanks to the flexibility of in-house production and staff.

“Our biggest challenge is keeping up with rising costs and lead times. We usually must touch a quote two to three times before we receive a purchase order. Supply chain issues and rising costs have added a lot of additional quote time on the front end. We can expect this to continue for the foreseeable future, so our goal is to plan way ahead of the need and try to get ahead of the curve.”

Over at MEC, Benson says it’s “just the mechanics of keeping up with it all. Even though almost everyone is understanding, we still don’t like price increases either coming in or going out. Quality and delivery are always our top priorities, but we always want to give good value too. There are so many moving parts to this current environment: hiring challenges, COVID safety procedures, COVID cases, shortages, customers’ own uncertainties, and more. It’s just a big challenge to keep up with it all. The saving grace is that we are all in this together.”

The biggest challenge, therefore, is the extra labor resources that go into managing this challenging time in the supply chain. Once again, the challenge to hire qualified staff likely means that other employees are redirected from their primary job function to help fill in the gap. If this extra effort pulls labor resources away from other projects like capital equipment upgrade planning, or similar strategic improvements to staff the overstressed quoting team, there can be significant long-term impact from this short-term situation. **SMT007**

Toyota Adjusts Production Plans due to Impact of Continuing Demand for Semiconductors

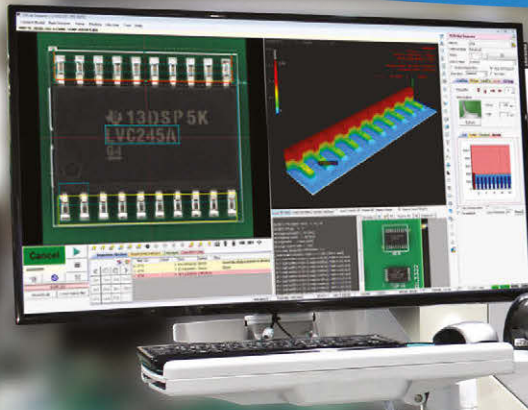
Toyota’s global production plan in February 2022 is expected to be around 700,000 units. Current demand is very strong, therefore Toyota is aiming for a high February production plan. However, due to the impact of the continuing demand for semiconductors across all industries, the company has adjusted its production plan by around 150,000 units globally.

As a result of the revision, the full-year production forecast for the fiscal year ending March 31, 2022 is expected to be lower than the previous forecast of nine million units.

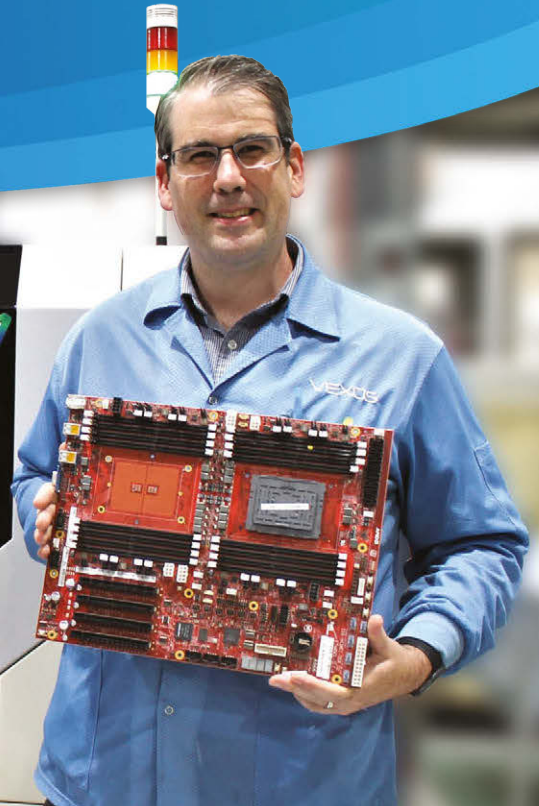
With regards to the shortage of semiconductor-related parts, the company will continue to examine the situation and consult with all companies involved in considering the use of substitutes where possible in anticipation of a continuing shortage.

It will also continue to work with our suppliers in strengthening the supply chain and make every effort to deliver vehicles to our customers as soon as possible.

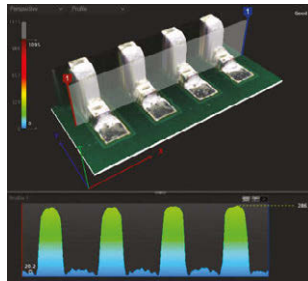
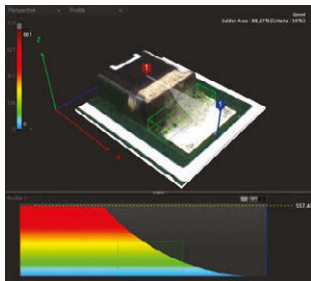




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Supplier Highlights



Real Time with... IPC APEX EXPO 2022: Blackfox Mixes It Up With Training Opportunities ►

Andy Shaughnessy speaks with Jamie Noland, master IPC trainer and marketing manager for Blackfox Institute, about current and upcoming training opportunities and what you can expect from them at the show.

Dr. Cordell Hardy Appointed to CyberOptics Board of Directors ►

CyberOptics Corporation announced that it has increased the size of its Board and appointed Dr. Cordell Hardy to its Board of Directors.

Operations Suspended at Taiyo Yuden Philippines ►

Operations are currently suspended at Taiyo Yuden (Philippines) Inc., the subsidiary of Taiyo Yuden in Lapulapu City, Cebu Province in the Philippines, amid minor damages caused by the recent Typhoon Rai.

Indium Introduces Indalloy 291 Supplemental Bar Alloys ►

Indium Corporation announces that it is now offering supplemental bar alloys for Indalloy 291 wave solder pots designed to maintain recommended solder pot specifications.

YINCAE Launches New Underfill SMT 88UL2 ►

YINCAE is excited to announce that we have developed and upgraded SMT 88UL to SMT 88UL2, a fully flux residue compatible, room temperature fast flow and easily reworkable underfill.

Aegis' IIoT-based MES Platform to Improve Speed, Quality, and Traceability ►

Aegis Software, a global provider of IIoT-based Manufacturing Execution Software (MES), announces that CARI Electronic, EMS partner in Valence near to Lyon, France, has chosen FactoryLogix as a key part of their MES Industry 4.0 journey.

Digi-Key Partners with CalcuQuote to Integrate Quote API ►

Digi-Key Electronics has partnered with CalcuQuote to integrate its technology with Digi-Key's Quote API, providing customers with an easier entry point to connecting with the company's leading APIs with less development investment.

Successful Restart for the Electronics Industry in India ►

From December 16–18, electronica India, productronica India, IPCA Expo, and MatDispens, back in their physical format, were held at the Bangalore International Exhibition Centre (BIEC) in Bengaluru and concluded this special edition successfully.

Lockheed Martin Achieves First Ultra-Secure, IIoT-based Smart Factory With IPC-CFX, Aegis' FactoryLogix ►

Aegis Software announces that Lockheed Martin's Lufkin facility has connected key SMT machines of all key types using the IPC-CFX standard, providing IIoT data for Aegis' FactoryLogix MES platform in a single standard language, contextualizing accurate, timely, detailed data into smart manufacturing values, all in a highly secure environment.

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Preparing the **Next-gen** Tech Workforce

Feature Article by Marc Carter

Knowledge transfer, especially from the “graying-out” experienced technical workers in our industry, is a complex, difficult family of problems. It differs wildly between companies, and even within divisions of the same company.

As if we needed any more impediments to replacing the “old gray guard,” even in companies that have the internal wherewithal to train replacements, there are barriers from internal forces. One of the biggest barriers is the full manufacturing schedules in North American electronics companies that don’t leave any slack time—and the 40-hour work week is a complete fantasy for many.

We can look at it from a slightly different perspective. Decades of margin pressure from, among others:

- The chicken and egg dynamic of outsourcing
- “Leaning” of tech staff
- Profit and loss pressure to minimize replacement of staff and equipment

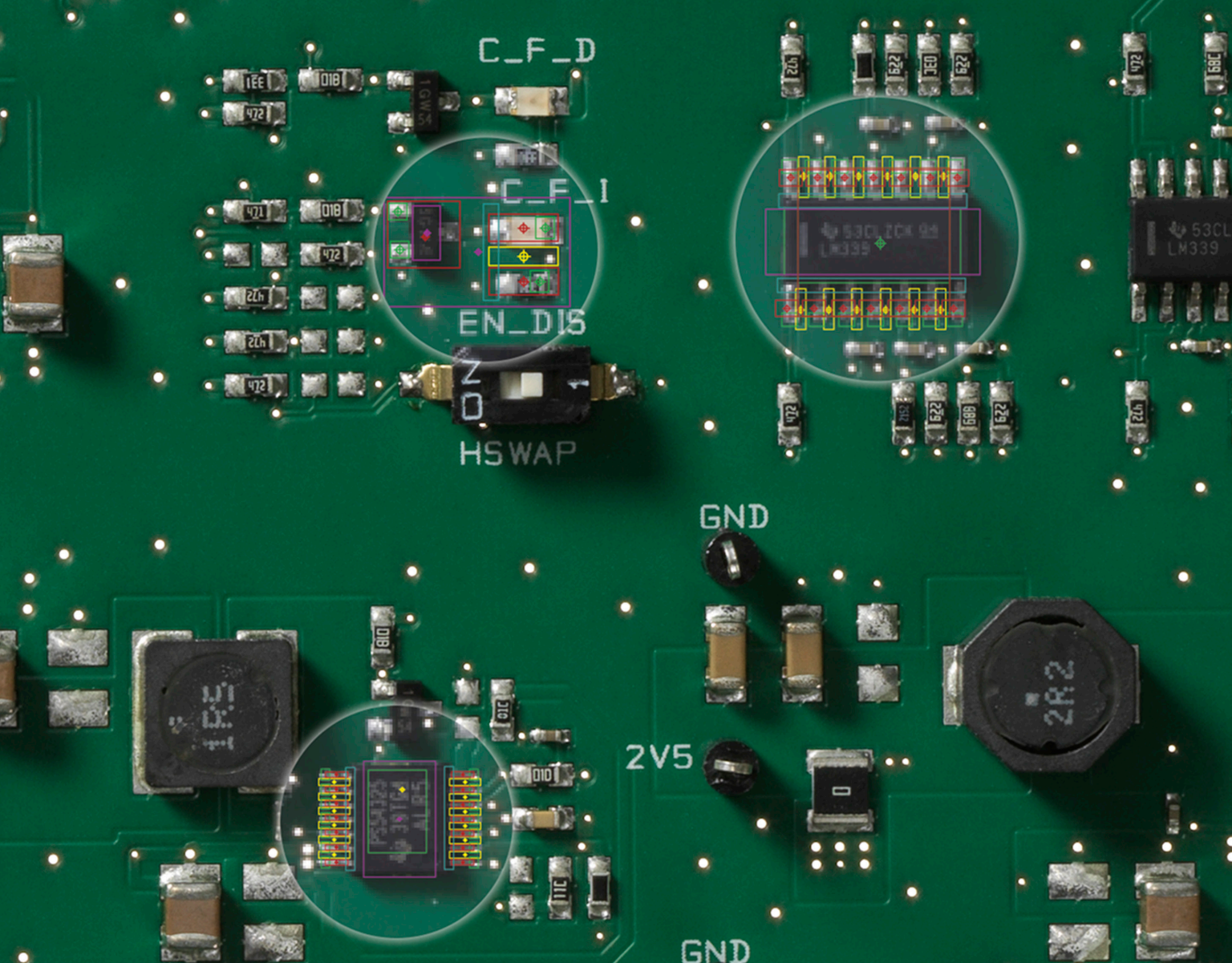
have greatly reduced the number of manufacturing knowledge/experience holders (subject matter experts) in the workforce that could provide the basis for a meaningful knowledge transfer program

In other words, some of the factors that go into the short-term focus on the balance sheet have eroded availability of the knowledge resources necessary to the hand-off of knowledge and experience.

That same thinning of the knowledge/experience ranks often leaves that “thin gray line” without enough time to do a proper job of keeping up with their operational duties, much less any organized knowledge transfer. The subject matter experts are harried, tired, and in some cases, discouraged.

It’s a unique (and commendably foresighted) company that will actually provide those subject matter experts with the necessary insulation from the daily damage control to devote any serious, compensated time to an organized knowledge transfer effort.

The declining number of subject matter experts are recognized by their peers as good at



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their jobs, which too often is technical firefighting, and very occasionally, technical improvement implementation, customer calming, and corporate reporting. The SMEs literally don't feel they have any alternative to "go get Fred" when the wheels come off.

To what extent does corporate culture help or hinder effective knowledge transfer? One contributor is the difficulty in justifying the easy-to-capture (and immediate) direct costs of paying employees' wages, against the difficult-to-monetize (and much longer-term) benefits to the organization.

At least we're starting to recognize and study the problem. Acceptance and effectiveness of well-intentioned knowledge transfer policies varies between companies, levels, and even between "silos" within companies. A 2019 study by Tandemploy¹ suggested only one-third of employees surveyed believed "their company promotes the exchange of information and knowledge," though managers were almost twice as likely to believe that statement than non-managers. Lack of time set aside during the workday was a recurrent reason given for inhibiting the sharing of knowledge, though a considerable majority wanted to share with their colleagues the knowledge they had gained.

Given our Western emphasis on the bottom line, it seems logical that demonstrating the value of a knowledge transfer's contribution to the financial health of the organization should make a compelling argument for passing on the experience and knowledge to the new technical workforce. Failure to effectively transfer that knowledge could be a real, monetary cost over time. A collaborative study² with an associated "lost-cost-opportunity" calculator³ purports to make real dollar penalties associated with failure

to effectively share knowledge within an organization available to decision makers. I have no independent way to evaluate its accuracy, but even the fact that it exists is hopeful.

Here are a few actions decision makers might consider:

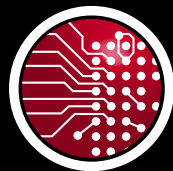
- **Committing resources:** A hypothetical North American company that realizes its long-term interests are better served by facilitating the offline time for knowledge transfer, visible evidence of their commitment would be permitting these knowledge transfer activities to be scheduled, at least partially, during the regular 40-hour work week. Arguably, that would be visible evidence of a company's commitment.
- **Incentivization:** The argument can be made for a company to pay overtime for a series of sessions that equally divide hours between those at work and those after work. Back before the margin pressure got too great, one of my employers did just that, though eventually, the afterhours part became an unpaid expectation which was unstated, but clearly understood, of salaried workers.
- **Speculation:** Many companies have (by various names) a "total cost of ownership"

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tool for comparing competing bids on more than just price. Could contract award systems include as a factor in that “bid-weighting” calculation, an allowance for tangible evidence that a bidder had in place real knowledge transfer processes? This could be included in the total cost of ownership bid adjustment equation along with things like minority hiring, small business sourcing, community support, tech support availability, etc.

These are just a few of my own ideas about this complex problem and is not intended as a comprehensive set of corrective measures. But if we don’t do a better job of it, somebody will, and I contend they’re likely to be more successful. **SMT007**

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2. “Developing a Strategy to Facilitate Knowledge Transfer,” by Susan Jacobs, Learning Solutions, Aug. 24, 2018.
3. “The Workplace Knowledge and Productivity Report, Panopto.com.



Marc Carter has worked in the electronics interconnection industry since 1984 in a variety of roles in fabrication and assembly materials, processes, environmental compliance, and supply

chain management activities around the world. He has had the honor and privilege of working with and learning from many of the true giants of this industry in multiple functions over many years. His experience includes a major mil-aero OEM, field and development work at materials suppliers to the printed circuit industry, and an educational stint as the sole proprietor of a manufacturer’s agency representing multiple high-tech mil-aero material suppliers. He is also an I-Connect007 columnist. To read past columns or contact Carter, [click here](#).

SEMI Urges Upcoming French Presidency of the Council of the European Union to Make Semiconductor Industry a Top Priority

SEMI, the global industry association that unites the entire electronics manufacturing and design supply chain, urged closer cooperation among European Union member states on technology and prioritization of semiconductor technology ahead of the French Presidency of the Council of the European Union that begins January 1, 2022.



Paul Boudre

SEMI Europe President Laith Altimime and Soitec CEO Paul Boudre, vice chair of the SEMI Europe Advisory Board, sent a letter to Emmanuel Macron, president of the French Republic, to request that the upcoming French Presidency of the Council of the European Union make it a key priority to encourage deeper collaboration among member states in the interest of advancing the semiconductor industry.

“Only strong leadership among member states and a comprehensive semiconductor strategy can help Europe secure its technological vision,” Altimime said. “SEMI encourages strong member state partnerships to ensure Europe’s long-term resiliency, economic growth and prosperity.”

France is well-positioned to further Europe’s technological ambitions and the value of its electronics manufacturing industry. The region is a key pillar of Europe’s future industrial leadership and resilience, as stated in the recently published description of the European Chips Act and the Alliance on Processors and Semiconductor Technologies, key building blocks of Europe’s technological vision and strategy.



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ein Electronics Industry News and Market Highlights



Enevate Ramping Its Pioneering Battery Technology to Address Global EV Battery Demand ▶

Enevate, a pioneering battery innovation company featuring extreme fast charge and high energy density battery technologies for electric vehicles (EVs) and other markets, met and exceeded its goals for 2021.

2022 AMPA: Opportunities for Global Aftermarket, Automotive Electronics Industries Worth \$390B ▶

In 2021, thousands of visitors from 65 countries reunited in Taipei AMPA, organized by Taiwan External Trade Development Council (TAITRA), to take part in one of the biggest automotive trade shows in Asia.

IDC Expects Internet of Things Spending in Asia Pacific to Reach \$437 Billion in 2025 ▶

Asia Pacific spending on IoT will expand by 9.6% in 2021, accelerating from 1.5% in 2020. The latest release of IDC's Worldwide Semianual Internet of Things Spending Guide indicates a gradual growth of IoT market in the region across the forecasted years (2021-2025) and is expected to reach \$437 Billion by 2025 with a CAGR of 12.1%.

Artificial Intelligence Magnifies the Utility of Electron Microscopes ▶

With resolution 1,000 times greater than a light microscope, electron microscopes are exceptionally good at imaging materials and detailing their properties. But like all technologies, they have some limitations.

Mobileye Autonomous Cars Piloting in Paris ▶

Mobileye, an Intel company, is adding Paris to its rapidly expanding global autonomous vehicle (AV) testing program and announcing its first autonomous on-demand service in the city of Paris, in collaboration with RATP Group, the world's third-largest public transportation operator.

Ericsson, Telstra, Qualcomm Set Uplink Speed Record of Nearly 1Gbps ▶

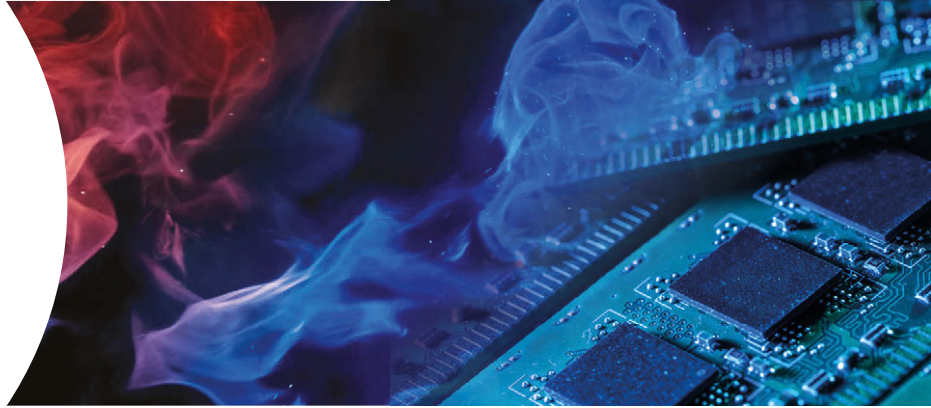
Ericsson, Telstra, and Qualcomm Technologies have achieved the highest uplink peak rate ever recorded on a commercial network during a live demo in Queensland, Australia.

Qualcomm, Z-ONE TECH Build Strategic Relationship ▶

Qualcomm Wireless Communication Technologies (China) Ltd. and Z-ONE TECH announced a strategic cooperation relationship to deliver intelligent cockpit experiences by utilizing the 4th Generation Snapdragon Cockpit Platforms with Z-ONE TECH's Galaxy Full Stack Solution 3.0.

Georgia Tech Student's Microchip Startup Reduces Energy Waste, Amplifies Power Systems in 5G Space ▶

Edgar Garay's company is a microchip design startup focused on improving energy efficiency. Its ultra-efficient, silicon-based power amplifiers and front-end modules will be used in 5G technology, the fifth-generation global wireless standard for machines, objects, and devices.



Low Temperature Soldering is a function of design.

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Reduce Costs With In-House Production, Out-of-the-box Thinking

The Manifest

Feature Column by Emmalee Gagnon, MANNCORP

Case Study: Tesla's Success Amid Crises

Despite a global shortage of critical components needed for car manufacturing, Tesla's electric car deliveries have increased by 87%. How did they achieve this unprecedented surge in production? Through a mix of vertical integration and ingenuity.

Elon Musk decided to utilize in-house equipment and in-house software engineers. By not outsourcing the manufacturing of their PCBs, software writing, and other stages of the creative and assembly processes, Tesla has retained control over its production.

One report by Rebecca Elliot of the Wall Street Journal states that leaning on "in-house software engineering experts" allowed Tesla to "keep production lines running" and "quickly rewrit[e] the software necessary to integrate

alternative chips into its vehicles¹." Deciding to keep production in-house has helped Tesla deliver over 936,000 vehicles in 2021, while the rest of the auto industry has been waiting for outsourced chips that are slow to arrive.

What can we learn from Tesla's success amid the chip shortage?

1. Use the resources available to you.

Rather than seeing the shortage as something unavoidable or unbeatable, Elon Musk chose to look at what was available instead of what wasn't. Other companies can do the same. Whether rewriting software with on-staff engineers or reworking printed boards to retain and reuse much-needed components (rather than letting them go to waste), there are many resources available when we think outside of the box.

2. Keep as much of your process in-house as possible.

By producing in-house, like Tesla, you will not have to wait your turn as an offshore factory decides if you are a priority, endure ridiculous lead times, or pay the inflated rates present in today's market. Tesla bypassed a lot of the problems facing many in the automotive industry by having an in-house engineering and assembly model, and so can many other forward-thinking companies.

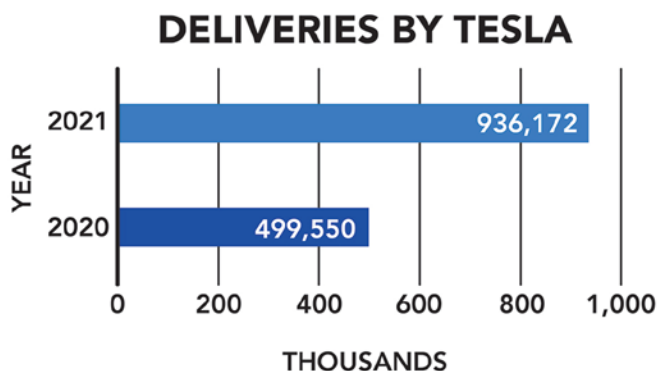


Figure 1: Number of deliveries provided by Tesla in 2020 and 2021.¹



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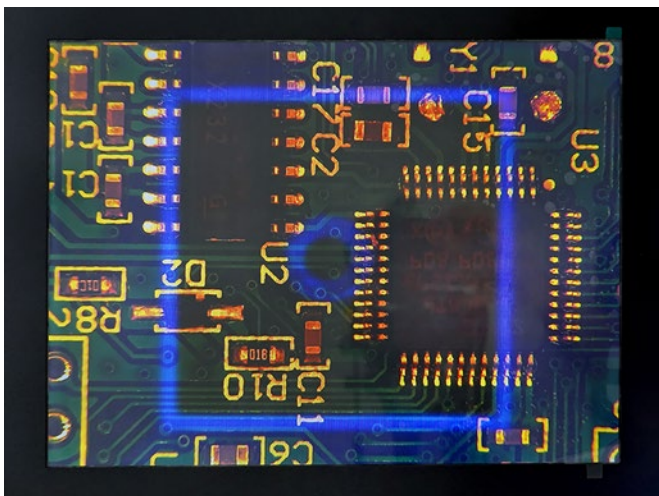


Figure 2: Rework alignment taking place, shown on a PCB.

With high-quality machines and a small group of good employees, any business with some ingenuity will be able to achieve:

- Flexibility of output levels
- Quicker product turnaround
- Ability to label as Made in America
- Increased business with local customers

Owning an assembly line can be game changing. If your product relies on surface mount technology, an equipment line will help with your bottom line and your inventory levels. Instead of money going toward subcontractors, fees, and inflated rates, you will only be paying for your materials and labor. According to an article by Tom Beck titled, “Bringing Your SMT Assembly In-House: Case Studies of Its Effects on Lead Time, Inventory, Quality, and Overall Cost,” you can save an average of 35–40% by choosing to do your own assembly.

Owning Equipment as a Growing Business

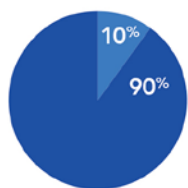
As an example, the aquarium supply company CoralVue Inc., recently moved its pro-

The True Savings of Owning Equipment

We are not all Tesla. But even if you aren’t, owning SMT equipment leads to a lower cost of manufacturing. With production in-house, you are no longer at the mercy of the excuses provided by subcontractors. You have control over the raw materials that you choose to use, and you can be flexible in finding replacements if your first-choice content is not available.

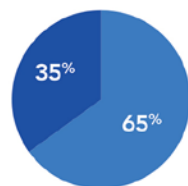
Where’s the Money Going?

BEFORE:

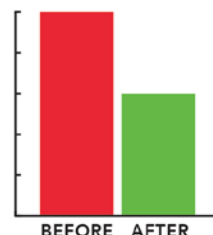


■ Raw Materials
■ Assembled Boards & Subcontractor Labor

AFTER:



■ Raw Materials
■ In-House Labor & Equipment



40% Reduction in Inventory Costs with In-House Production

Figure 3: A series of graphs demonstrating a 40% difference between in-house and outsourced production costs.

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- Electronics Assembly for Operators
 - IPC-A-610 for Operators
 - IPC-J-STD-001 for Operators
- Wire Harness Assembly for Operators



2/3 of electronic industry companies have difficulty finding production workers.¹

vs



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

duction in-house and doing so has drastically improved its process. When asked about their experience, CoralVue CEO David D'Aquin said that while outsourcing production, they were “getting notices of 52-week lead times².” These lead times and the rising “cost of using overseas PCB manufacturers” led them to purchasing their own equipment. With in-house production, D'Aquin says they have experienced “flexibility when it comes to inventory” and it has “helped ease [CoralVue’s] cash flow.”

With an automated SMT line, only a few people are needed to operate it, making it especially advantageous in this time of increased labor scarcity. As a growing business, CoralVue’s success provides insight into how a forward-thinking company can take advantage of this opportunity and prosper.

How Tax Advantages Can Lower Equipment Costs

While owning your own equipment will be financially beneficial in the long run, the large outlay of cash at the start can be daunting. It is good to know that there are financing options

available, including ones where payments are delayed so you can get set up and start creating revenue before anything is due.

Another helpful tip is to utilize Section 179 when filing taxes. Section 179 can help your company maximize savings by writing off the entirety of your purchase. In 2018, Section 179 made it so companies could receive a deduction equal to the total amount spent on equipment within the past tax year (up to \$1 million³). This makes it a great option for small businesses, in particular.

Deciding to Start In-House Production

As the U.S. manufacturing sector has been stagnantly demand-driven, with issues appearing in the supply chain, in labor resources, and in delivery from suppliers, many are searching for a solution. The current dominantly successful solution is: Take control of the production that has been moved overseas. In-house production works because it is relatively cost-effective; financing and cost-offset options are available; owning the equipment and directly paying for components and labor results in significantly reduced overhead.



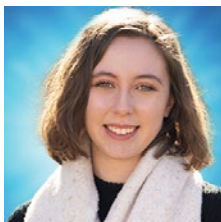
Figure 4: A full SMT equipment line installed at CoralVue as supplied by Manncorp.

In today's economy, the main issue is you can't sell what you don't have. Companies now have the choice to take advantage of resources available to immediately improve production and experience long-term savings. This will allow companies to shed extraneous burdens of paying for air shipping, overtime, and other expenses in efforts toward getting products to customers quickly. By having your production in-house, none of those expenses will be necessary for reaching demand. Thinking outside the box allows companies to offer consistent, high-quality, quickly delivered goods at a fraction of their previous overhead.

To anyone considering purchasing their own equipment, as in the case of CoralVue, David D'Aquin has some final advice: "Given the state of the world economy and political climate, we felt it was best to take control of as much of our business operations as possible. If PCBs are vital to your business, then an investment in an SMT production line could determine your future success." **SMT007**

References

1. "Tesla Car Deliveries Surge by 87%," by Rebecca Elliot, *Wall Street Journal*, January 3, 2022, pages B1-B2.
2. "How to Ditch Insanely Long Lead Times: An Inside Look with CoralVue on Switching to In-House Production," Manncorp blog post, December 20, 2021.
3. If the amount spent on the equipment purchase exceeds \$2,500,000, the deduction begins to phase out dollar-for-dollar.



Emmalee Gagnon writes about SMT-related topics and customer stories for Manncorp. To read past columns or contact Gagnon, [click here](#).

Gartner Says Worldwide Semiconductor Revenue Grew 25.1% in 2021, Exceeding \$500 Billion for First Time

Worldwide semiconductor revenue increased 25.1% in 2021 to total \$583.5 billion, crossing the \$500 billion threshold for the first time, according to preliminary results by Gartner, Inc.

"As the global economy bounced back in 2021, shortages appeared throughout the semiconductor supply chain, particularly in the automotive industry," said Andrew Norwood, research vice president at Gartner. "The resulting combination of strong demand as well as logistics and raw material price increases drove semiconductors' average selling price higher (ASP), contributing to overall revenue growth in 2021."

"The 5G smartphone market also helped drive semiconductor revenue, with unit production more than doubling to reach 555 million in 2021, compared to 250 million in 2020. U.S. sanctions imposed on Huawei resulted in other Chinese smartphone OEMs gaining share and fueling growth for 5G chipset vendors such as Qualcomm, MediaTek and Skyworks. Meanwhile HiSilicon, Huawei's chip subsidiary, saw revenue decline from \$8.2 billion in 2020 to around \$1 billion in 2021."

Samsung Electronics regained the top spot from Intel for the first time since 2018, with revenue increasing 31.6% in 2021 (see Table 1). Its memory revenue grew 34.2% in 2021, in line with the growth rate of the overall memory market. Intel dropped to the No. 2 position with 0.5% growth in 2021, delivering the lowest growth rate among the top 25 vendors.

Memory was again the best-performing device category, primarily due to increased server deployments by hyperscale cloud providers to satisfy remote working, learning and entertainment needs, as well as a surge in end-market demand for PCs and ultramobiles. Revenue increased \$42.1 billion over 2020, which amounted to 33.8% of overall semiconductor revenue growth in 2021.

Within memory, DRAM had the best performance with revenue growth of 40.4% in 2021, increasing revenue to \$92.5 billion in 2021. Strong demand from servers and PCs created a DRAM undersupply that drove double-digit ASPs through most of the year.



MilAero007 Highlights



Defense Speak Interpreted: Who Won the Project Convergence War Game—Evil Chaos or JADC2? ►

I know you have been on the edge of your seats since my September column, “What Does Convergence Mean to Defense?” or back to my February column, “So, What’s a JADC2?” While I tackled some other government defense topics, I realize I have left you hanging concerning the big interservice war game maneuvers, Project Convergence (PC), which tested out the information connection described in the JADC2 effort.

Georgia Tech Leads Effort to Strengthen State’s Defense Manufacturing Industry ►

Department of Defense grant enables collaboration with Spelman College, Technical College System of Georgia, and the Georgia Department of Economic Development in pilot project.

IPC: Supply Chain Challenges Continue to Hamper Electronics Production ►

IPC’s January 2022 Economic Outlook report finds that supply chain challenges remain acute and have improved little from the previous month. Shortages continue to hamper production levels and lead-times remain long.

Nano Dimension Sells Another DragonFly IV 3D-AME System to Leading Western Defense Force ►

Nano Dimension Ltd. announced that it has sold another DragonFly IV 3D-AME printer and FLIGHT applications software package to a leading Western defense force.

U.S. Market Première of Ventec aerolam Base Material Solutions for Aerospace & Defense Electronics ►

Ventec International Group Co., Ltd. recently premiered “aerolam” in the U.S. market. A base-material solutions set, aerolam is specifically curated for the diverse and unique requirements of aerospace and defense applications.

James Webb Space Telescope en Route to Discover Origins of the Universe, Study Exoplanets ►

A joint program between NASA and its counterparts in Europe (ESA) and Canada (CSA), Webb will observe the beginnings of our Universe by reaching back in time to just a few hundred million years after the Big Bang. It will also observe exoplanets—planets outside the Solar System—that are comparable to our own. The ultimate aim of this successor to the iconic Hubble space telescope is to discover galaxies that reach back to the relative beginnings of the Universe.

Space Telescope Ushers in a New Age of Astronomy ►

A “game changing” new telescope was blasted into space on Christmas Day to embark on a lonely 1.5-million-kilometre orbit around the sun to provide a clearer view of the ever-expanding universe. NASA has successfully launched the James Webb space telescope into orbit, giving scientists the opportunity to peer back further into the universe’s history than ever before.



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A Buying Strategy Primer

Maggie Benson's Journey

by Ronald C. Lasky, INDIUM CORPORATION

Editor's note: Indium Corporation's Ron Lasky continues this series of columns about Maggie Benson, a fictional character, to demonstrate continuous improvement and education in SMT assembly. The January column concluded with these questions: Will BE buy Ivy Electronics? What will the price be? What is in the action plan? What is 5S and the 8 Mudas?

Maggie asked Frank and Chuck to spend an extra day investigating Ivy Electronics. Afterward, the team (Maggie, John, Frank, and Chuck) discussed whether they should buy the company.

"Well, team, what's the scoop?" John asked.

"So, Ivy Electronics has a lot of room for improvement and growth, which may be good

news," Chuck said. "Their rework stations are a mess, but I worked with Phil Consol to apply 5S¹ methods and we straightened one up within only an hour or so (Figure 1). I think Phil became a 5S convert. We also identified Muda² issues (Figure 2). I'll let Frank comment on inventory issues in a moment. Regarding the Muda issues I observed, 'motion' was a big problem. A PCB is required to travel to a second building to have rework performed. Then, in anticipation of future orders, we found 'overproduction.' Some of their future orders never materialized and became scrap. In addition to this, their first pass yield is only 90%, so there is also a 'defects' issue."

"What do you think? Are these issues solvable?" Maggie asked.



Figure 1: A desk before and after 5S was applied.

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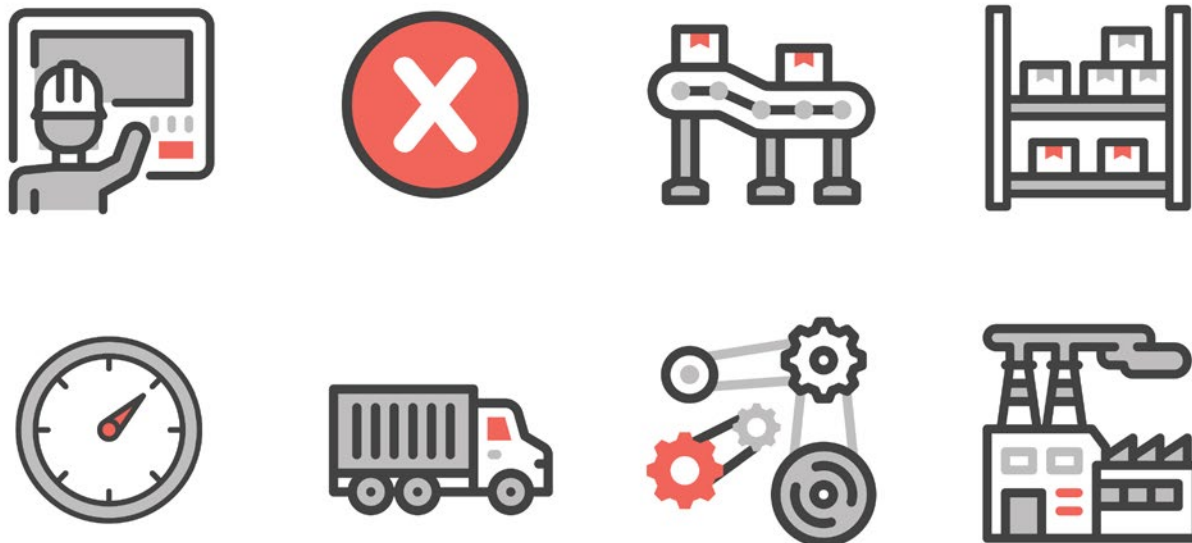


Figure 2: Many of the eight Muda were present at Ivy Electronics.

“Definitely,” Chuck said, confidently.

“Tell us about inventory, Frank,” Maggie requested.

“Ivy has about 10 weeks of inventory,” he began. “Some of it is dated, so potentially unusable. A rule of thumb is that each week of inventory costs 1% of a year’s inventory in tax. When you consider they purchase about \$10 million in inventory per year, that’s a \$1 million tax.”

“Can we improve on that?” John asked.

“I’ve estimated that we will be able to cut it in less than four weeks,” Frank replied.

“Don’t forget uptime is only 12%, so there is opportunity there as well,” John chimed in.

“It’s interesting that a cheapskate like Price missed so many ways he was losing money,” Maggie commented. Murmurs of agreement followed.

“So, what is the bottom line? Should we buy it for the \$1.5 million that Price is asking?” John asked.

“Well, sales are \$15 million, and profit is \$250,000 after Price gives himself a \$500,000 salary. He is asking \$1.5 million, but this comes with no assets as they rent the building and the equipment is worthless. We would be essentially buying ‘goodwill.’ However, in electron-

ics assembly, a price-to-earnings ratio is typically 10 to 20 (Note: $10 \times \$250K = \$2.5M$), so the \$1.5 million doesn’t seem too high at all,” Frank said.

There was a lull in the discussion as the team members thought over the information.

Frank added, “I’m extremely optimistic that we can make this work for us, as Price granted me permission to speak with their main customers. These customers have difficulty finding assemblers, as they have small lot sizes. I spoke with them, and they will stay with us. All seemed quite happy that we might take it over.”

“Let’s offer \$1.25 million, as we will need to invest quite a bit of time and money to bring it up to reasonable standards,” Maggie said.

“Chuck, if this deal goes through, you will become the general manager at the business we plan to call Ivy Benson Electronics,” John said. “What do you think about using Phil Consol and Tanya Brooks as your two lead engineers?”

Chuck was not the type of chap who easily became embarrassed or emotional, but his face grew a little pink and, if you looked closely, a slight tear could be noticed in the corner of each eye.

Epilogue: One week later, Ned Price accepted a negotiated offer of \$1.4 million. He insisted



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Sourcing components for a full order is a challenge nowadays, often impossible. To prevent machines from sitting idle and to accommodate partial batches, manufacturers need to do more changeovers than ever. Digital twin technology is key to managing frequent NPIs and efficiently meeting the engineering demands of high-mix, low-volume production.

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that the team needed his help running the business for the first six months, for a \$250,000 salary, but the team turned him down.

How will the workers receive the new management? How will the team handle the takeover of Ivy Electronics? Will they clean up the bathrooms?

Stay tuned to find out. **SMT007**

References

1. 5S, Wikipedia.com.
2. Muda, Wikipedia.com



Ronald C. Lasky is an instructional professor of engineering for the Thayer School of Engineering at Dartmouth College, and senior technologist at Indium Corporation. Image of Maggie Benson by Sophie

Morvan. To read past columns, or contact Lasky, [click here](#). Download *The Printed Circuit Assembler's Guide to... Solder Defects* by Dr. Ronald C. Lasky. You can also view other titles in our full I-007eBook library [here](#).

Global Fab Equipment Spending Projected to Log Record High in 2022

Global fab equipment spending for front end facilities is expected to rise 10% year-over-year (YOY) in 2022 to a new all-time high of over US\$98 billion, marking a third consecutive year of growth, SEMI highlighted in its quarterly World Fab Forecast report.

The fab equipment spending increase in 2022 would follow a 39% jump in 2021 and 17% in 2020. The industry last saw three consecutive years of growth from 2016 to 2018, more than 20 years after logging a three-year run in the mid-1990s.

"The semiconductor equipment industry has enjoyed a period of unprecedented growth with increased spending in six of the past seven years, as chipmakers expand capacity to meet secular demand for a wide range of emerging technologies including artificial intelligence, autonomous machines and quantum computing," said Ajit Manocha, president and CEO of SEMI. "The capacity buildout extends beyond the robust demand during the pandemic for electronics vital for remote work and learning, telehealth and other applications."

Spending by Sector

The foundry sector is expected to account for 46% of total spending in 2022, a 13% YOY increase, followed by memory at 37%, a slight dip from 2021. In memory segments, spending for DRAM is forecast to decline while expenditures for 3D NAND will edge higher.

Microcontroller (with MPU) spending is expected register a staggering 47% surge in 2022. Power related devices are also projected to show strong growth of 33%.

Spending by Region

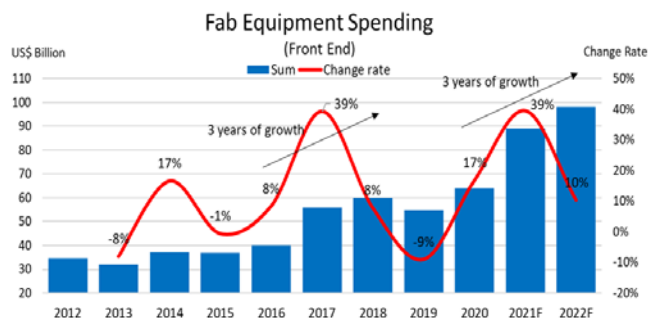
Korea is expected to rank at the top of equipment spending, followed by Taiwan and China, combining to account for 73% of all fab equipment spending in 2022.

After a dramatic increase in 2021, fab equipment spending in Taiwan is expected to rise at least 14% this year. Spending in Korea also showed a sharp increase in 2021 and is projected to climb 14% in 2022. China is expected to decrease spending by 20%.

Europe/Mideast, the next largest spending region in 2022, is projected to see remarkable 145% growth for the year. Japan is expected to grow by 29%.

The SEMI World Fab Forecast report lists 27 fabs and lines that began equipping in 2021, most of them in China and Japan. Twenty-five fabs and lines are expected to begin equipping in 2022, with Taiwan, Korea and China accounting for most of the equipping starts.

The World Fab Forecast report lists 1,422 facilities and lines globally, including 138 future facilities and lines with various probabilities that are expected to start volume production in 2021 or do so later.



Source: World Fab Forecast Report, 4Q21 Update, Published by SEMI.

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Don't Hit the Snooze on Cybersecurity

I have good news for small manufacturers looking for ways to stand apart from the competition:



By delaying the launch of the Cybersecurity Maturity Model Certification (CMMC), the Department of Defense may have done you a favor. They've handed you a golden opportunity to zig when everybody else is zagging.

Philippines Plant to Be Murata's First Overseas Site With 100% Renewable Energy

Philippine Manufacturing Co. of Murata, Inc., a manufacturing subsidiary of Murata Manufacturing Co., Ltd., will be switching all electricity consumed at the plant to renewable energy from January 1, 2022.



Mycronic is Bullish on Data-Driven Production

Nolan Johnson speaks with Mycronic's Clemens Jargon and Göran Frank about data-driven production technology and strategies. With the introduction of new data-driven software, Mycronic has made monitoring the line easier to use, faster to learn, and more purposeful.



Rising Material, Labor Costs Continue to Plague Global Electronics Manufacturing Supply Chain



IPC's January 2022 global electronics manufacturing supply chain sentiment report found that materials and labor costs continue to be the largest issue facing the electronics supply chain, with nine in 10 electronics manufacturers reporting rising materials costs and more than three-fourths reporting rising labor costs.

Smart Factory Insights: Digital Transcendence—Fear of The Unknown

The first three industrial revolutions have brought us automation of physical tasks through adoption of mechanical and electrical machines, the benefit of which has been quite easy to appreciate. Industry 4.0 automation, however, is driven almost exclusively from the digital realm, representing a whole new world of intangibility.

X-Rayted Files: 2022's Word of the Year is... Resilience

On balance, this last year goes down as a pretty good one. While we are not as far along in putting the pandemic behind us as we might have hoped, the progress is promising. With consumer demand high, the coming year and its prospect of a return to "normal" will likely offer substantial opportunities.

Don't Miss Further Discussion of Materials Testing in Episode 6 of GEN3's 'Predicting Reliability in Electronics'

The sixth episode, "[Materials Testing—Process Materials](#)," can be viewed in under four minutes. Presenters share information on paste vs. flux vs. rework, limitations of standards, hand soldering/rework cautions, and more. Designed to complement GEN3's book, *The Printed Circuit Assembler's Guide to...Process Validation*, this entire webinar series can be viewed in about an hour and covers a comprehensive range of topics.



MacDermid Alpha's Kester Brand Announces Partnership with Proactive Process Solutions Group, LLC

The Kester brand of MacDermid Alpha Electronics Solutions is proud to announce a partnership with Proactive Process Solutions Group, LLC.



Hanwha Techwin Enters 45th Year as Global Provider of Smart SMT Line Solutions

Hanwha Techwin Automation Americas, formerly Samsung C&T Automation, is pleased to announce its 45-year anniversary. The company started in the machine tool business in 1977.



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

What's on Offer

- Excellent salary & benefits commensurate with experience

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

Please forward your resume to:
Jvance@ventec-usa.com

[apply now](#)



pluritec®
MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer **Location: West Coast, Midwest**

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

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

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

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

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

Must be able to travel extensively.

[apply now](#)

Career Opportunities



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

Wet Process Engineer

ASC, the largest independent PCB manufacturer in the Midwest, is looking to expand our manufacturing controls and capabilities within our Process Engineering department. The person selected will be responsible for the process design, setup, operating parameters, and maintenance of three key areas—imaging, plating, etching—within the facility. This is an engineering function. No management of personnel required.

Essential Responsibilities

Qualified candidates must be able to organize their own functions to match the goals of the company.

Responsible for:

- panel preparation, dry film lamination, exposure, development and the processes, equipment setup and maintenance programs
- automated (PAL line) electrolytic copper plating process and the equipment setup and maintenance programs
- both the cupric (acid) etching and the ammoniacal (alkaline) etching processes and the equipment setups and maintenance programs

Ability to:

- perform basic lab analysis and troubleshooting as required
- use measurement and analytical equipment as necessary
- work alongside managers, department supervisors and operators to cooperatively resolve issues
- effectively problem-solve
- manage multiple projects concurrently
- read and speak English
- communicate effectively/interface at every level of the organization

Organizational Relationships

Reports to the Technical Director.

Qualifications

Degree in Engineering (BChE or I.E. preferred). Equivalent work experience considered. High school diploma required. Literate and functional with most common business software systems MS Office, Excel, Word, PowerPoint are required. Microsoft Access and basics of statistics and SPC a plus.

Physical Demands

Exertion of up to 50 lbs. of force occasionally may be required. Good manual dexterity for the use of common office equipment and hand tools.

- Ability to stand for long periods.

Work Environment

This position is in a manufacturing setting with exposure to noise, dirt, and chemicals.

Click on 'apply now' button below to send in your application.

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Career Opportunities



Engineering Project Manager Graphics/Film

The primary purpose of this position is to manage Process Development, Process Scale Up and Capital projects in the Global Process Engineering Group (GPEG) function.

THIS INCLUDES:

- Managing the complete life cycle of the highly complex projects including approval of the projects, the planning and execution of the projects, and then the closeout of the projects to ensure planned results are achieved on a timely basis.
- Develop budgets timelines, and ensure progress to plan, as well as tracking project achievements.
- Define projects' objectives and ensure progress to plan, as well as tracking project achievements.
- Interface with internal customers to agree upon specifications, deliverables, and milestones.
- Represent project and the team and present project results to customers and internal management.
- Recommend new process and tools to achieve advanced project management.
- Manage project status in the form of formal briefings, project update meetings, and written, electronic, and graphic reports.
- Address problems through risk management and contingency planning and present solutions and/or options to executive management.

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Technical Marketing Specialist Waterbury, CT

JOB DESCRIPTION:

Responsible for providing technical knowledge and support to marketing communications professionals. Cross training and acting as liaison between the Innovation and the Marketing Communications teams for both Circuitry Solutions and Semiconductor Solutions.

Chemist 1 Waterbury, CT

JOB DESCRIPTION:

Perform analysis—both chemical and mechanical—of customer-supplied samples. These include both structural and chemical testing using various instruments such as SEM, Instron, ICP, and titration methods. Perform various failure analysis functions, including, but not limited to, chemical analysis, SEM analysis of customer parts, and cross-section evaluation.

Applications Manager Waterbury, CT/New England Region

JOB DESCRIPTION:

Applications Manager in the Electronics Specialties/Circuitry Solutions group to provide applications process knowledge, training and technical support of new products leading to sales revenue growth. Requires working through the existing sales and technical service organizations to leverage this knowledge globally. Experience in multilayer bonding along with dry film and solder mask adhesion processes a plus.

[apply now](#)

Career Opportunities



Sales Engineer Germany, Austria, Switzerland, Southeastern Europe e.g. Italy

Ucamco is looking for a sales engineer for our front-end software in the German-speaking area (Germany, Austria, German Switzerland) as well as adjacent markets in the South and East.

Ucamco is a market leader in PCB CAM, pre-CAM software and laser photoplotters with more than 35 years' experience developing and supporting leading-edge, front-end tooling solutions for the global PCB industry.

Responsibilities:

- Selling software solutions
- Selling support contracts and upgrades
- Developing and implementing customer acquisition plan
- Organizing and taking part in roadshows, seminars, exhibitions
- Follow up of current customers and sales
- Contributing insights into the marketing plan
- Reporting to Ucamco's sales director

Requirements:

- Fluent in German, good knowledge of English; other languages a plus
- Frequent traveling to prospects and customers—live contact is important
- Feeling for technical software
- Motivated to succeed as a solution seller
- Strong empathy for the customer
- Self-starter, able to work independently, organized
- Honest, trustworthy, dependable, credible
- Sales and technical expertise in PCB industry a big plus
- Knowledge of market and customer base in German speaking area a big plus
- Used to working from home office
- Traveling to headquarters in Gent (Belgium) for sales and customer meetings
- Good feeling for software is more important than strong sales experience

This is a salary-based position with a commission plan, company car, expense reimbursement, and benefits like health insurance.

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Galvanic Systems Director

Whelen Engineering Co. seeks FT Galvanic Systems Dir. in Charlestown, NH to lead technical team to optimize GreenSource Fabrication, LLC Division's first-gen equip. by applying PCB mfg. concepts per cust reqs. Ensure process engg. meets co.'s needs; develop and validate process changes; plans to improve process capability using statistical & root cause analysis & eval'ing equip, including Atotech equip, thru design of exper & testing; travel int'lly 15-25% to eval biz plan & strategy to markets. Min reqs: U.S. Bach degree or foreign equiv. in chem sci or chem engg; knwl of entire PCB mfg. process, including process flows, indiv. processing steps, & tooling, w. knowledge of PCB pattern plating, including subtractive etching processes, additive processes, and printable techs as demo'd by 12 yrs' exp. in PCB industry; Theoretical knwl of PCB Plating Processes, including MLB, HDI, and SLP-type PCB fab processes, as demo'd by 10 yrs' exp w. PCB plating processes; 5 yrs' exp working w. Atotech Equipment prod lines & their specialty chems; Prior work exp in R&D enviro. including app of lab analysis concepts and knowledge of cross section and wave form patterns.

Apply to: Corinne Tuthill,
ctuthill@greensourcefab.com or at
Greensource Fabrication, LLC,
99 Ceda Rd, Charlestown, NH 03603

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Career Opportunities



Account Manager (SPI | AOI | AXI)

Omron Automation Americas is actively seeking an energetic and focused Account Manager to help support our Automated Inspection Solutions product business (SPI, AOI and AXI).

This position is based within any major city covering the Western-US region (including Dallas, Austin, Phoenix and Northern/Southern California). The goal is to work independently and alongside our strong rep. partners in the territory to further expand our business in industries and market segments where we have high potential for continued success and growth.

This is a rare opportunity to join the dynamic team of professionals at Omron and work for a true, industry leader.

To learn more about this exciting role, please contact us directly via:

shawn.arbid@omron.com

apply now



Service Engineer Schmoll Laser and Direct Imaging

Reports to: Field Service Manager

Location: North America

SUMMARY:

Provide expert-level service on multiple laser drilling and direct imaging product lines. Maintain high customer satisfaction, timeliness, accuracy, efficiency, cost effectiveness, and safety.

DUTIES AND RESPONSIBILITIES:

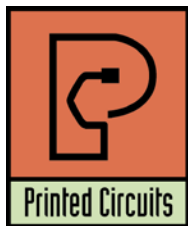
- Install, commission, and maintain Schmoll products at customer sites. Perform modifications and retrofits as needed.
- Troubleshoot, diagnose, and calibrate products via telephone or at customer sites.
- Handle a wide variety of problems, issues, and inquiries.
- Provide training for customers and others in the effective operation, calibration, and maintenance of all products.
- Lead the project management team for retrofit/upgrade requests and recommendations for Schmoll equipment until the end of commissioning and final payment.
- Assist customers with potential optimization of their machine operations and work with clients on application improvements.

QUALIFICATIONS:

- Must possess a valid driver's license, clean driving record, major credit card (for business travel), and passport.
- Ability to read and interpret technical documentation, compile reports, and compose routine correspondence, define problems, collect data, and draw a valid solution.
- Must be able to travel extensively, partly international, to support customer needs. While Burklee makes every attempt to avoid Sunday and Friday evening travel, sometimes it is required.

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Career Opportunities



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

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

Laminator Technician

Nature of Duties/Responsibilities

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

Education/Experience

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

Wet Process/Plating Technician

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

Purpose

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

Nature of Duties/Responsibilities

- Load and unload electroplating equipment
- Fasten circuit boards to racks and cathode bars
- Immerse work pieces in series of cleaning, plating and rinsing tanks, following timed cycles manually or using hoists
- Carry work pieces between departments through electroplating processes
- Set temperature and maintains proper liquid levels in the plating tanks
- Remove work pieces from racks, and examine work pieces for plating defects, such as nodules, thin plating or burned plating
- Place work pieces on racks to be moved to next operation

- Check completed boards
- Drain solutions from and clean and refill tanks; fill anode baskets as needed
- Remove buildup of plating metal from racks using chemical bath

Education and Experience

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

Production Scheduler

Main Responsibilities

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

Education and Experience

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

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Career Opportunities



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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SMT Field Technician Hatboro, PA

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

Duties and Responsibilities:

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

Requirements and Qualifications:

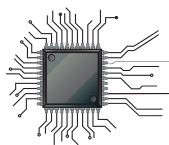
- Prior experience with SMT equipment, or equivalent technical degree
- Proven strong mechanical and electrical troubleshooting skills
- Proficiency in reading and verifying electrical, pneumatic, and mechanical schematics/drawings
- Travel and overnight stays
- Ability to arrange and schedule service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

We Offer:

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

[apply now](#)

Career Opportunities



MivaTek

Global

Product Manager

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

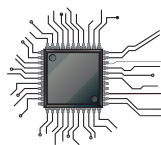
The product manager role will serve as liaison between the external market and the internal design team. Leadership level involvement in the direction of new and existing products will require a diverse skill set. Key role functions include:

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

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

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

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MivaTek

Global

Field Service Technician

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

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

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

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

More About Us

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

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Career Opportunities



Rewarding Careers

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

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

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

Associate Electronics Technician/Engineer (ATE-MD)

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

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

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Test Engineer (TE-MD)

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

- Candidates must have at least three years of experience with in-circuit test equipment. A candidate would develop and debug our test systems and install in-circuit test sets remotely online or at customer's manufactur-

ing locations nationwide.

- Candidates would also help support production testing and implement Engineering Change Orders and program enhancements, library model generation, perform testing and failure analysis of assembled boards, and other related tasks.
- Some travel required and these positions are available in the Hunt Valley, Md., office.

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Sr. Test Engineer (STE-MD)

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

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

We proudly serve customers nationwide and around the world.

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

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Career Opportunities

SIEMENS

Siemens EDA Sr. Applications Engineer

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

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

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

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

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Prototron Circuits

Sales Representatives

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

Reasons you should work with Prototron:

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

Interested? Let's have a talk.

Call Dan Beaulieu at

207-649-0879

or email to

danbbeaulieu@aol.com

[apply now](#)

Career Opportunities



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

- Engineering
- Quality
- Various Manufacturing

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

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

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

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

[apply now](#)



PCB Field Engineer– North America Operations

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

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

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

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

RESPONSIBILITIES INCLUDE

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

REQUIREMENTS

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

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

SALARY

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

[apply now](#)

Career Opportunities



American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

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INSULECTRO



Are You Our Next Superstar?!

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

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

View our opportunities at
[Insulectro Careers \(jobvite.com\)](#)

[apply now](#)

Career Opportunities



IPC Instructor

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

*Independent contractor,
possible full-time employment*

Job Description

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

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

Qualifications

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

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

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

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

[apply now](#)



U.S. CIRCUIT

Plating Supervisor

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

Competitive benefits package.

Pay will be commensurate
with experience.

Mail to:
mfariba@uscircuit.com

[apply now](#)

Career Opportunities



eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

- Ability to operate from home. No required in-office schedule
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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.

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The Printed Circuit Assembler's Guide to...



Solder Defects

by Christopher Nash and Dr. Ronald C. Lasky, Indium Corporation

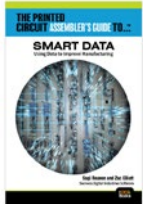
This book is specifically dedicated to educating the printed circuit board assembly sector and serves as a valuable resource for people seeking the most relevant information available.



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

An in-depth insight into new and exciting true 3D inspection technology is provided in this book, along with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



Smart Data: Using Data to Improve Manufacturing

by Sagi Reuven and Zac Elliott, Siemens Digital Industries Software

Manufacturers need to ensure their factory operations work properly, but analyzing data is simply not enough. Companies must take efficiency and waste-reduction efforts to the next phase using big data and advanced analytics to diagnose and correct process flaws.



Process Validation

by Graham K. Naisbitt, Gen3

This book explores how establishing acceptable electrochemical reliability can be achieved by using both CAF and SIR testing. This is a must-read for those in the industry who are concerned about ECM and want to adopt a better and more rigorous approach to ensuring electrochemical reliability.



Advanced Manufacturing in the Digital Age

by Oren Manor, Siemens Digital Industries Software

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