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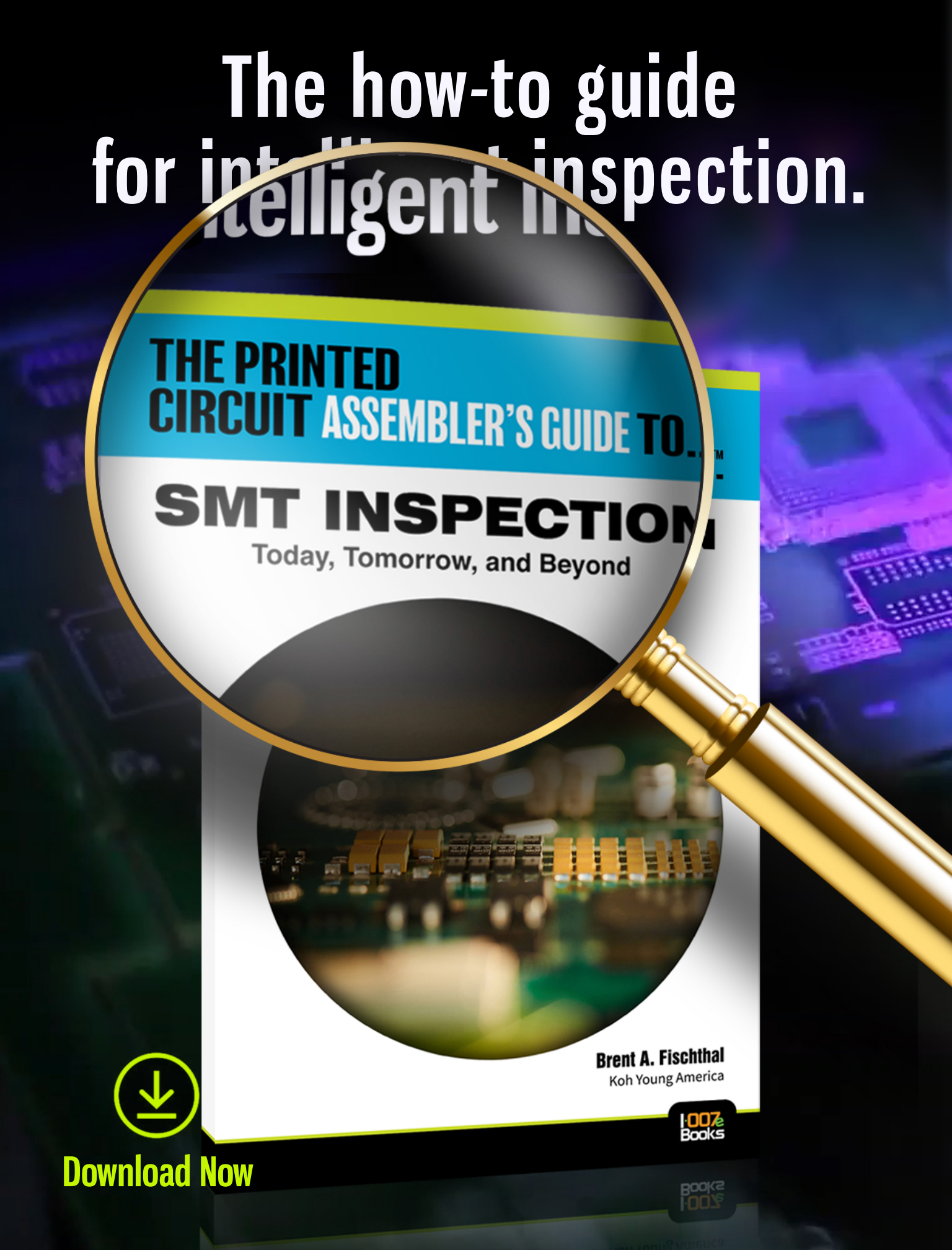

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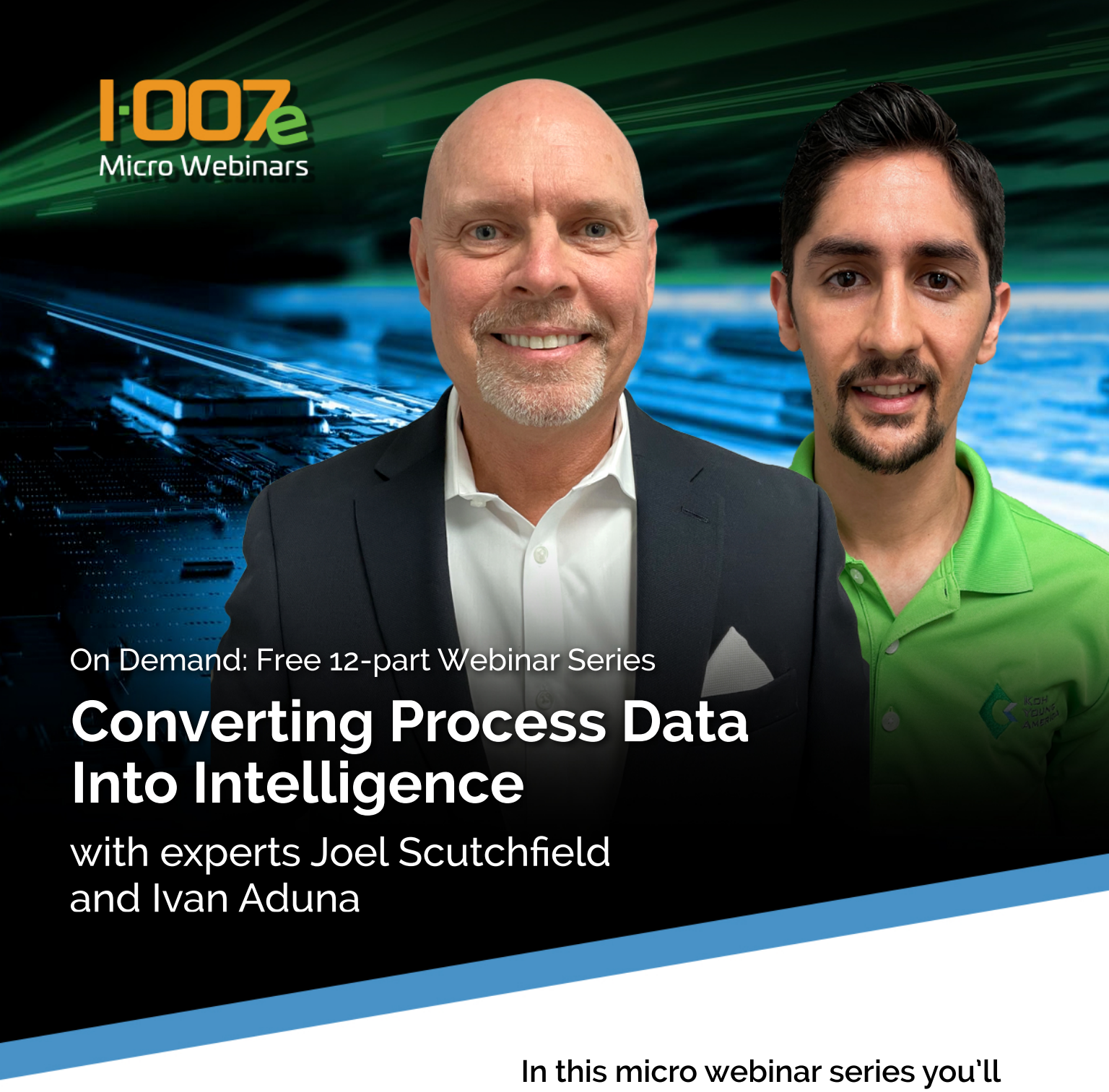

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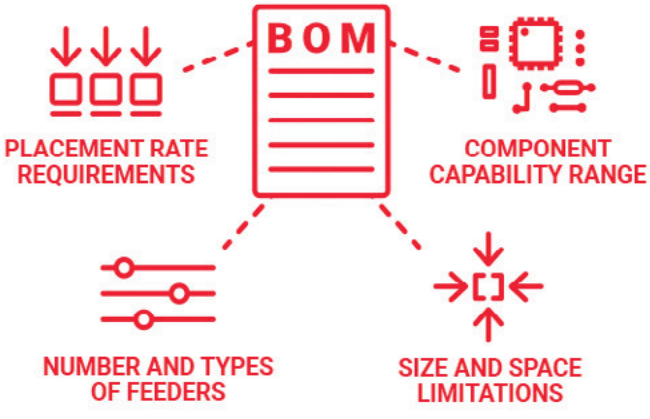

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CapEx Planning

Nolan's Notes

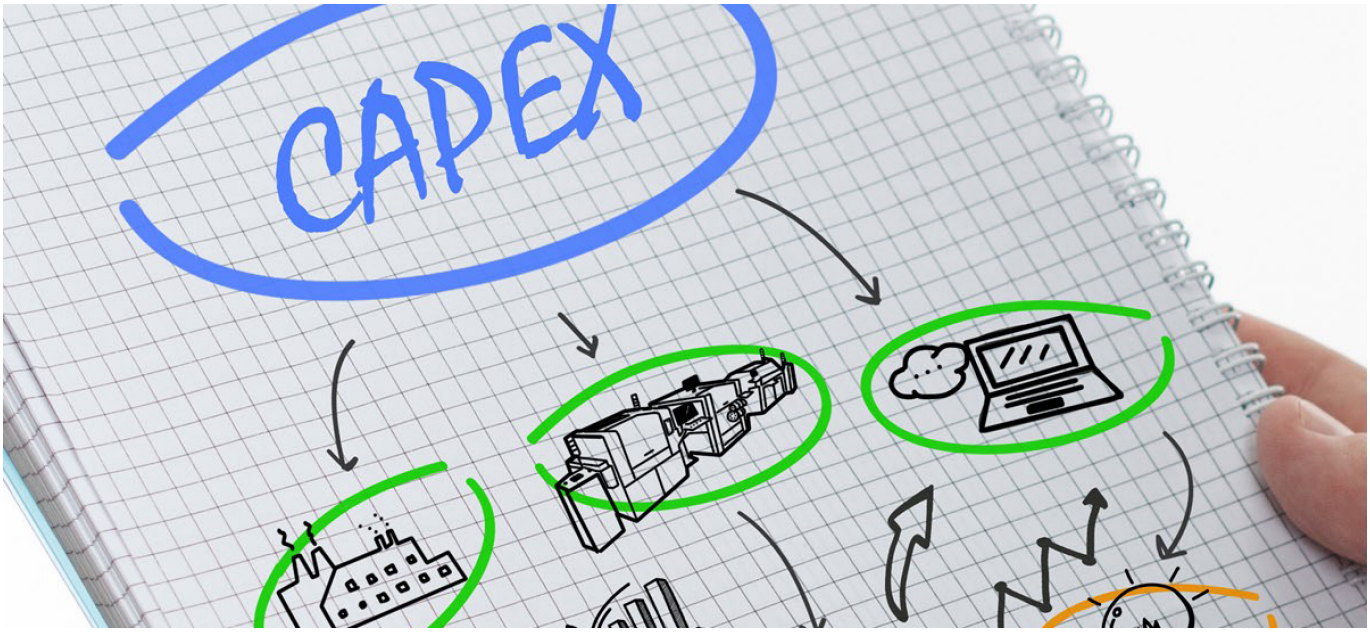
by Nolan Johnson, I-CONNECT007

Have you found yourself investing more in capital expenditures to improve your facility? No, I'm not talking about your factory; I'm thinking about your home. If you are, then you're in good company as it seems that a lot of us are putting on our "CapEx" thinking caps and exploring new solutions to make our spaces more productive.

According to a national survey by The Freedonia Group in December 2020[1], 39% of consumers reported undertaking home improvement projects because of changes associated with the pandemic. Some added home gyms or offices, installed decks or pools, started gardening, or simply repainted their living spaces. This, overwhelmingly, was due to a shift in how we use our living spaces since the start of 2020.

In terms of logistics, a home that normally accommodates a family for only a few hours each day has become a round-the-clock workplace, schoolroom, and entertainment and recreation venue, points out *American Lifestyle Magazine*[2]. The authors stress that it results in a lot of added pressure on the spaces to perform. In smaller homes, the requirement is double-duty, with the ability to make any given room work for the family's changing needs. In our homes, these changing needs have trended toward more occupants for a better part of the day. This contrasts with the general trend to reduce commercial building occupancy. For many of us, this brings an extra concern for—and investment in—how healthy our homes are. So where is that household capital investment going?

Healthier homes: Better ventilation and air quality. Anterooms and service porches are on the rebound, creating a transition zone be-



tween the outside world and the home's interior. Since home delivery has increased as a pandemic coping behavior, these spaces provide a place to process packages while keeping the home cleaner.

Smarter homes: Smart home integration is occurring, especially in the kitchen—the closest thing to a manufacturing floor we have in our homes, after all.

Security and privacy: Security upgrades are motivated by a variety of factors, including more time at home and a greater need to supervise children while working.

Expanded outdoor spaces: According to CNBC, outdoor space renovations are up by 300% year over year as homeowners look for more living, dining, entertaining, and recreational space in their own backyards. Just as we've tended to move outside for other hospitality services, so too are we making use of the outside in new ways.

Dual home offices: No surprise that the need for dual home offices is one of the largest drivers of home renovation. Houzz, a home improvement online community site, reports seeing requests for home extensions and additions up 52% over 2019.

Rock-bottom interest rates also make home improvements more attractive. In a report on NPR, Frank Morris reminds us that in unsettling times, spending on one's home can be a comforting investment[3].

Business is following suit, and it only stands to reason. A Bloomberg headline from September 11, 2021, reads: "Capex Booms as Companies Prepare for a Post-Pandemic World." The author makes the point that both supply-side and customer-side issues are motivating this expenditure. Companies have been burned by supply chain issues and are diversifying in creative ways to add resiliency to their supply chain. Simultaneously, those companies are also upgrading capacity and capabilities to deliver for customers. If the company happens to live in the middle of the supply chain (like EMS companies do), then investing in our capabilities is seen by our customers as upstream supply chain resiliency.

Of course, on the governmental front, we've recently seen encouraging bipartisan effort to improve the country's infrastructure. It certainly seems that, overall, the U.S. will be emerging from the pandemic with updated, and optimized, working and living spaces.

So, how have you and your organization responded? It stands to reason that capital expenditures are on our collective minds for 2022 planning. In a recent I-Connect007 survey, 80% of the responses indicate that they do have a capital expenditure plan, and that 60% of the respondents see the existence of that plan as "very important."

When we asked about the cashflow/financial strategy for funding capital expenditures, the responses all weighed in about the same: paying cash, financing with terms, leasing, and renting. I guess it's not about how you get there, just that you do get there.

After all this preamble, what are we bringing you in this issue? Now more than ever, market drivers, technical advances, factory automation, and customer demand are pushing assembly capabilities into new territory. And with these advancements comes the need to incorporate new equipment. In this issue, we investigate strategies and tactics for planning capital expenditures. **SMT007**

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1. "DIY Home Improvement Industry Booms During COVID-19," May 6, 2021, marketresearch.com.
2. "Pandemic Home Renovation Trends," Sept. 10, 2021, *American Lifestyle Magazine*.
3. "Why Home Improvement Has Surged And How It's Changing America," Sept. 11, 2021, NPR.

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

Reliability Primer—A Pragmatic SMT Perspective

SMT Prospects & Perspectives

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

Manufacturers and customers alike embrace a product's reliability as the priority. Accordingly, if I say "reliability" is a relative term, would you respond with "Why is it relative?" Well, when we look at the reliability, be it associated with a physical product or virtual service, there is a set of performance expectations from the users or the customers. Take a smartphone or a car as an example; a manufacturer provides the product warranty with a specified timeline and other specificities. If the product does not perform within the warranty time, the manufacturer or the authorized distributor will fix the problem free-of-charge, although the user (the customer) prefers not to experience any inconvenient return or repair. By the same token, if the product encounters a problem outside the warranty, it is the customer's luck—or out of luck, such as if a new car sadly crashes and the warranty is not honored.

Another materiality worth noting is that a literally "perfect" product is hard to come by, if ever. This can be vividly illustrated by the continued rollout of new models of smartphones since its debut approximately 25 years ago; every new model offers additional performances that are useful and enjoyable to use. And every new model of the smartphones has approached another level of perfection and reliable performance.

What does this mean to us? Is perfect the enemy of the good?

What is Reliability?

Reliability, in reference to the Oxford Languages dictionary, is defined as the quality of being trustworthy or of performing consistently well; trustworthiness is doing what the system is expected or designed to do.

A product's reliability is an operational reliability, which can be practical-

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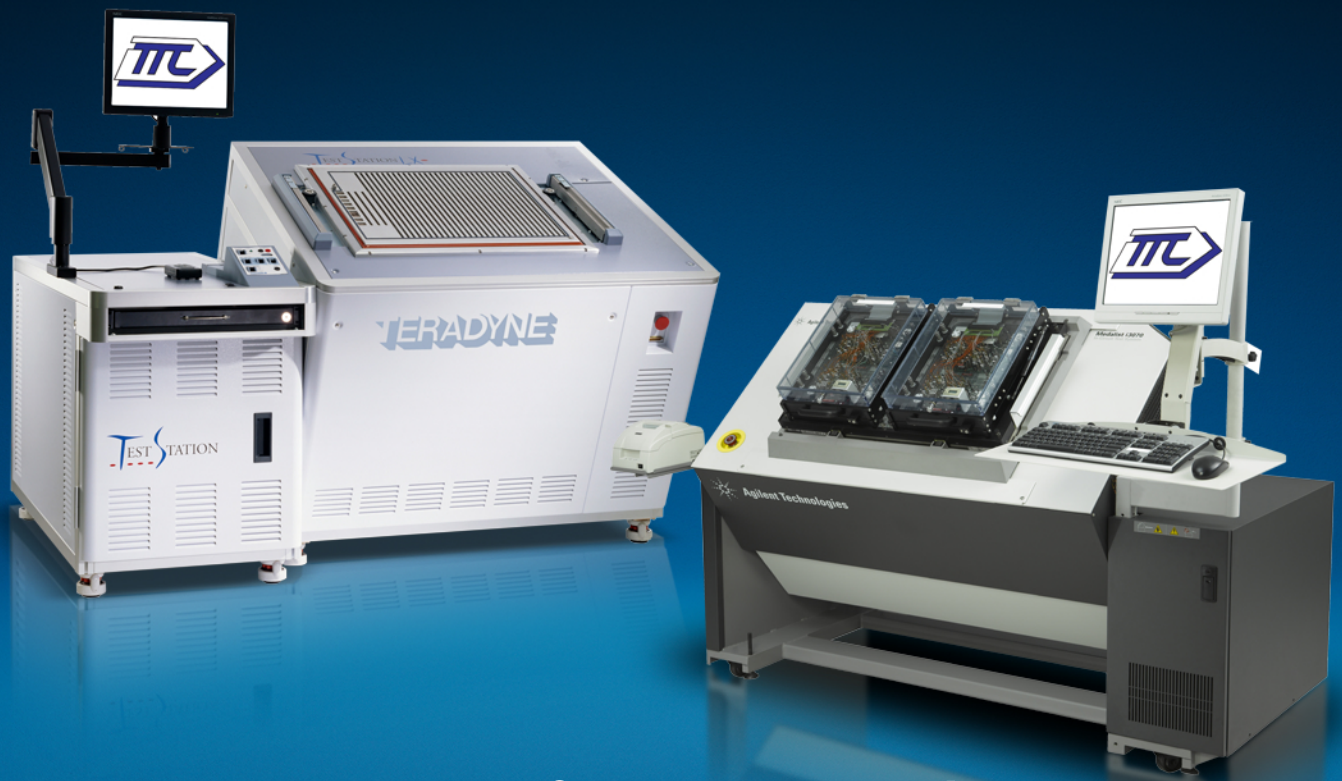

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ly defined as a product performing its expected functions for a designated period under an anticipated set of service conditions. A product should be designed and built not necessarily for the maximum reliability, rather for the operational reliability that is subject to practical requirements and desirability, such as the targeted time-to-market, the acceptable cost to manufacture, the overall manufacturability, and the total cost of ownership.

Is Cost a Factor?

The total cost of ownership covers the full cycle of making a product from procurement to production to reliable service during a product's life span. Factors such as production yield, defects, rework, a set of product functions, and the targeted reliability add up to a product's total cost.

An absolute reliability is not always the isolated pursuit as reliability does bear a cost. A qualitative relationship between the system cost and the level of system reliability for the pre-shipment and the post-shipment stages can be illustrated in Figure 1.

Within the realm of surface mount technology (SMT), the assessment of the cost requires one to consider the total cost of ownership. This comprises:

- Solder material cost per unit weight
- Process operational cost
- Cost of components
- Cost of PCB
- Equipment capital expenditure and depreciation
- Production yield and defects
- Cost of rework, if any
- Product reliability

Accordingly, a viable product is the result of a tradeoff and a balance among the performance, manufacturability, cost, and business terms to deliver the expected reliability.

How Does SMT Operation Affect Reliability?

In the SMT manufacturing operation, the main players of reliability include the PCB bare board, all components before assembly operation, all components after assembly operation, solder interconnections, and the manufacturability. The resulting system's reliability hinges on the quality, practicality, compatibility, and reliability of each of the players, and the interplay among the players.

On the PCB, the solderability and planarity of surface finish and the PCB internal structure integrity before reflow/wave and other process steps, the PCB internal integrity after reflow/wave/rework, and other process steps are key parameters to watch for. In particular, PCB vulnerability to high temperature excursions escalates with the level of PCB complexity (e.g., higher number of lay-

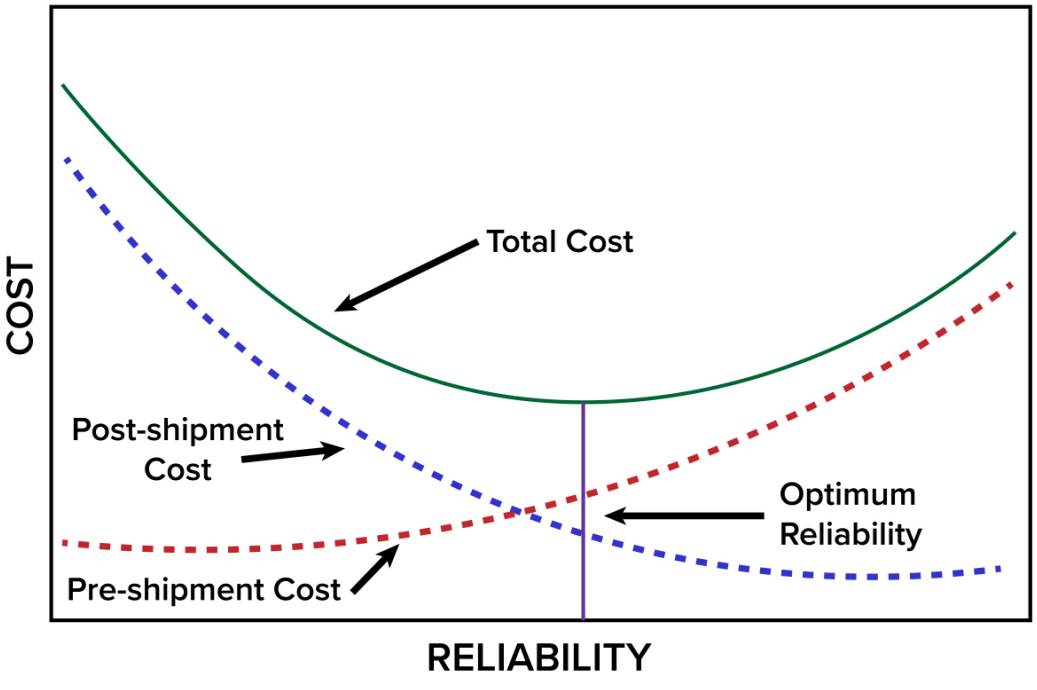

Figure 1: Reliability vs. cost, pre- and post-shipment.

ers, larger PCB size, thicker PCB) increases. Being free of degradation after high temperature processing, which may lead to production defects and/or product failure, such as the result of pad-cratering, pad-lifting, or de-lamination, must be assured.

On solder interconnections, the initial solder alloy selected to use is equally important to the solder joint integrity resulting from the manufacturing-related factors. In combination, both dictate the quality and reliability of the resulting solder interconnections. With respect to solder alloy, four fundamental correlations are worth noting:

1. The alloy composition determines the process temperature required.
2. The alloy's compositional makeup dominates the microstructure, which in turn reflects on the solder joint behavior during its service life.
3. The microstructure and its evolution dictate failure mechanisms.
4. An intrinsically inferior alloy cannot deliver a superior performance, i.e., the maximum performance is limited by the intrinsic properties of an alloy.

From an SMT reliability perspective, the goal in selecting an optimal solder joint material is to deliver the plausible metallurgical properties and the anticipated behavior while not requiring an elevated process temperature, i.e., rendering the process temperature as close to that of SnPb eutectic alloy. To accomplish this goal under the established manufacturing infrastructure, a lead-free composition must resort to the metallurgy of a quaternary alloy (not doping elements); I have presented this scientific predication in my professional development courses at various international events and numerous locales spanning the last 25 years.

How Does Manufacturability Play a Role?

Is manufacturability a critical element of the product's reliability?

The answer is a resounding affirmation; reliability and manufacturability are closely linked. To have a sound manufacturability, four essential practices should be observed:

1. An adequate process window (e.g., reflow profile setting).
2. A sufficient material performance latitude (e.g., solder paste wetting ability).
3. Compatibility between process and material (e.g., reflow profile being in sync with properties of solder paste).
4. Process control.

Each of the process steps must deliver an adequate process window and each of the materials selected should possess an adequate performance latitude. This is particularly true in the reflow step—a narrow process window is expected to marginalize the process, which often causes higher defect rates on the production floor and/or product reliability issues during service.

Closing Thoughts

To ensure the target reliability, a holistic approach should be exercised to plan for reliability, to design for reliability, to select materials for reliability, to select components for reliability, and to manufacture for reliability. Additionally, utilizing the knowledge in known failure sources or mechanisms coupled with practicing the know-how to prevent likely failure processes from occurring further enhance a product's reliability.

After all, the Second Law of Thermodynamics and the metallurgical Dislocation Theory do not change. In a nutshell, the golden rule is to integrate three best practices:

1. Deliberately and systematically prevent likely known failure causes.
2. Diligently set up a robust manufacturing operation.
3. Prudently utilize the profound scientific and engineering principles to take care of the unknowns.

Presentation

Dr. Hwang will deliver a professional development course, "Solder Joint Reliability—Principle and Practice" from 9 a.m. to noon November 1; and a course on "Reliability of Electronics—Role of Intermetallic Compounds" from 2 to 5 p.m. November 1, at the SMTA International Conference. **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.

I-Connect007 Launches New Micro Webinar Series: 'Converting Process Data Into Intelligence' Presented by the Experts at Koh Young

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Designed to complement Koh Young's I-007e-Book, *The Printed Circuit Assembler's Guide to... SMT Inspection, Today, Tomorrow and Beyond,* throughout the series, presenters Scutchfield and Aduna share highly focused educational information on the use of data gathered during the inspection process.

This entire webinar series can be viewed in an hour and covers a comprehensive range of topics surrounding 3D inspection and the use of smart data gathered during the inspection process. Most of the 12 segments can be viewed in about five minutes.

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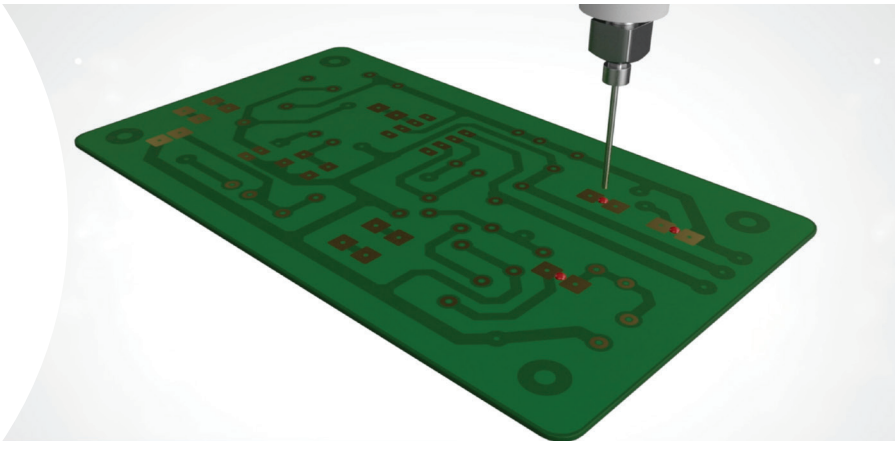

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CapEx Planning With Summit Interconnect

Feature Interview by the I-Connect007 Editorial Team

The I-Connect007 Editorial Team recently spoke with John Vaughan, Greg Halvorson, and Brett McCoy of Summit Interconnect about their capital expenditure (CapEx) strategies. They discuss the challenges they face when planning CapEx after acquiring fabricators with different capabilities, and the need to have dedicated funds ready for expenditures each year.

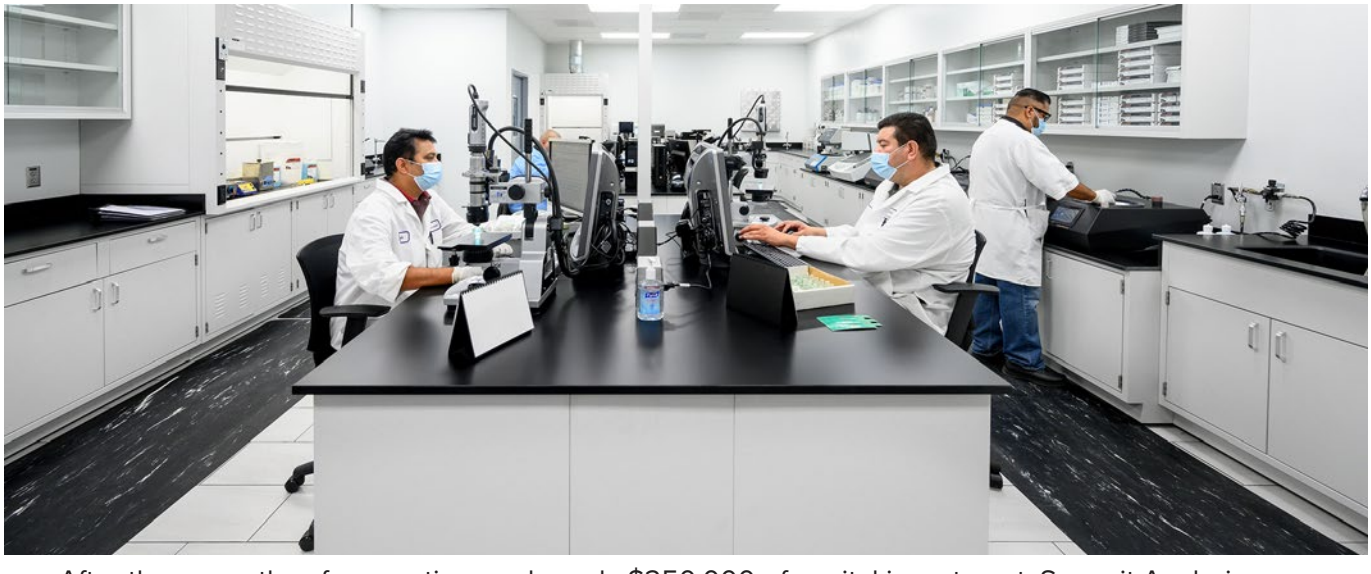
Nolan Johnson: Let's start with the recent growth at Summit.

Greg Halvorson: Yes. Summit is growing both organically and through acquisition. With the tailwinds in the industry, we're typically following the approximate same percentage growth as in the industry in general. Specific to our core market in defense, the growth is more pronounced.

Johnson: That leads us into our discussion on capital expenditure. There are two flavors to capital expenditure thinking for you. One of them is what you need in order to integrate the different companies you're bringing together through acquisition, and then what you need in order to meet changing market opportunities. Is that a fair assumption?

Halvorson: Yes. We divide our expenditures into growth CapEx, and maintenance CapEx; the driver behind the majority of our decisions are what we would foresee as gaps in the industry where we can provide services that we see some of our competitors are weak in, as well as just listening to the customer and following the direction of their technical roadmaps and where they're going, both via capacity requirements as well as technical requirements.

Johnson: Let's start with the growth drivers first.



After three months of renovation, and nearly $250,000 of capital investment, Summit Anaheim was excited to open the doors to its pristine 900 square foot laboratory earlier this year.

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Greg Halvorson, SVP, COO.

Halvorson: On the growth side of the business, we're really looking at the type of equipment that provides capacity to meet our customer's product needs. That is a bit of a moving target. With the talents of people like our VPs/GMs Brett McCoy in Chicago, Jack Evans in Anaheim, Mike Graves in Santa Clara, Barry Ling in Toronto, Bill Sezate in Orange, CA, and the rest of our team, they're really identifying equipment that is multi-use. So not only can we target an immediate need or a need that's in the imminent future, we also look to position as a company that is flexible enough to provide a wide range of technology.

John Vaughan: Greg alluded to customer roadmaps, and increasingly it's all about miniaturization. So that drives a lot of our decisions as we need to process even more complex via structures and smaller space and trace width and miniaturization to meet all the size, weight, and power reduction requirements, particularly by the military sector, but also by the electronics industry in general.

Barry Matties: When you start looking at the equipment, I understand market opportunity and adding capacity, but in the decision-making process, how important is the smart process or smart factory consideration as well as cycle time reduction? Where does that fit into your CapEx strategy?

Halvorson: I think both of those aspects are very important. Obviously, there's a labor shortage out there, so we're always looking at ways to maximize productivity, create a smarter factory, and create tools that build-in their own preventive maintenance programs through online monitored equipment performance.

Matties: As you're ranking your capital equipment list, does that go to the top of the list?

Halvorson: No. I think the more important thing for us is productivity, reliable service, and proven tools. For the tools we install in the factory, we're looking for a supply base that is stable. When it comes to the smart factory, there's a little bit more of a risk profile because it's still in its infancy. When we're looking at the type of products that are being manufactured, especially in defense, they're not usually extremely high volume, so our equipment has to have a lot of flexibility.

Matties: What about the life cycle of equipment when you're looking at an expense? Do you have a range of service expectation for that piece of equipment?

Halvorson: That's really tough to answer because it's all over the map. Some of the equipment is targeted at a particular reliability offering to the customer. Some of the customers are adapting and adopting these types of requirements into their delivery requirements, but without it being a widespread industry requirement, it's hard to say if it's going to be something here to stay. We're very careful on that, and we'll also utilize outside services to

bridge that gap in bringing the product or the capital expenditure in-house until the longer-term market need is clearer.

Matties: Now, part of CapEx is also the software infrastructure, IT infrastructure, and data analysis. How are you integrating those components of CapEx into your strategy?

Halvorson: Budgeting IT has become a top priority in our businesses. Data storage is another top priority, and data accessibility is a priority. Fortunately, most of the people that are real survivors in the industry, like us, have made a commitment to IT, and that's a big part of our CapEx programs.

Brett McCoy: Right. I think cybersecurity probably tops that list.

Vaughan: You're absolutely right. With the cybersecurity model certification looming and the requirement for the PCB fabricators in the defense sector to be CMMC level three, coupled with the NIST 800-171 and IPC-1791, which almost all of our facilities are now certified to, advanced IT systems are an imperative. It's been a significant commitment on our side because we know that for our customer base, which is approximately 70% defense-oriented, those flowdowns are going to be in their contracts from the Department of Defense. We've been very proactive and positioned ourselves at the front of the line on compliancy; of course, that takes a lot of IT infrastructure as well as manpower and commitment by the organization.

Johnson: I'm curious about how you frame this up. It's got to be a very different approach when you're trying to measure out capital expenditures and integrate what you just acquired from the various merged companies.

Halvorson: We're actually very fortunate that we have a wide range of technology through the five factories that we operate on a day-to-day basis. Our capital expenditures are not only shared throughout the facilities, there's also a bit of a trickle-down effect based on the spearhead of the technology and some of the lower tech offerings that are also within Summit. We can actually re-utilize existing CapEx, which helps open up the doors for higher technology purchases in the right factory if there's a real change in productivity of the equipment itself. I'll use drilling, for example. In those scenarios, we'll tend to just buy all the factories a similar high-speed system vs. trying to recapitalize or re-utilize traditional lower-speed drilling systems.

McCoy: To add to what Greg is saying, we really can take advantage of the ability to ross-pollinate, if you will, our business between all the plants and to utilize different strengths of different facilities, whether it be production, prototype, or high-reliability rigid-flex. We're able to take advantage of our strengths across a multi-platform organization.

Vaughan: That's an important point, but you have to remember that we have five locations, and while there is some cross-capability between the locations, there's also some very directed energy at certain markets. For example, Santa Clara is our leading-edge facility. It's in Silicon Valley, and we tend to do the extreme technologies at that location, which requires, as Greg alluded to, very advanced, leading-edge equipment sets. At Anaheim, it's more production-oriented military programs that are primarily rigid-flex in nature. Summit Orange is a high-density interconnect and RF facility. Chicago specializes in really rapid turns; they have to be extremely agile. Toronto has a lot of production capabilities, as well as the ITAR § 126.5 exception because it's part of the Canadian Goods Program. Two years back, Greg purchased leading-edge equipment sets in the Santa Clara operation to support those

John Vaughan, VP Strategic Markets.

super-high technology builds, and then that equipment over time can migrate down in our organization. Did I capture that accurately, Greg?

Halvorson: Yes, and the key to the success of the migration of the equipment, is having a really strong technical transfer program. Fortunately, we have that in place with our engineering group.

Johnson: So far, this conversation has focused on the strategy you have for building the business, and how the capital expenditures and the acquisition strategies dovetail into making all of that happen. Are facilities something that you're focusing on as well?

Halvorson: Yes. Leasehold is part of our strategy. We are continuing to expand the existing sites. We have a clear vision of how large we want each site to operate at, because even though they operate as a team, they also operate as an individual P&L location. So, planning at the site level is performed by the ability to support the growth through their existing P&Ls.

Vaughan: Right. And just to scale the operation for everyone on the call, we're currently five sites. That's three in California, one in Chicago, and one in Toronto. In the aggregate, we're 300,000 square feet with over 900 employees and approximately $200 million in revenue.

Andy Shaughnessy: Greg, it sounds like, with so many different locations and capabilities, you can't really have a one-size-fits-all CapEx strategy, can you?

Halvorson: No. It's critical to look at each site as an independent location and understand what they do well, and then target our sales team to sell to our customers what we do well and target the work at that particular location.

Matties: Are you seeing an onshoring or reshoring growth in sales over the last year and a half?

McCoy: Definitely.

Vaughan: Yes. It's more important to manufacture closer to the original point of consumption. We understand that. I think just one comment. Our business is 70% defense, so we probably see that dynamic a little less than some of the more commercial shops. That would be my response. Greg and Brett, do you have a different view?

McCoy: At our site specifically in Chicago, we've seen an increase in reshoring, primarily due to the supply chain interruptions which have led to extended lead times and price pressures. This has opened some opportunities for us to engage at a larger level with certain customers, where we're seeing prototypes and small-to-medium volume production become more prevalent.

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Brett McCoy, VP/GM Chicago.

Vaughan: And I would add that one of the primary rationalizations for the acquisition of ITL in Toronto is that they did have the Canadian Goods Program status, and they are 126.5 ITAR excepted, so we can build U.S. DoD product in Toronto. We believe that the defense sector will continue to grow, so there's only two ways to approach that, and one's to greenfield an operation and stand it up to bring on additional capacity. The route Greg and the rest of the senior team chose was to add that additional capacity through the Toronto operation to help support our DoD growth. Kind of a different mindset from the typical fabricator that's clinging to the hopes of the reshoring actually materializing, right?

Matties: Right. Now you guys have mentioned capacity as a CapEx driver, but what about technology? What challenges or technology changes are driving CapEx expenditures?

McCoy: Generally speaking, miniaturization is continuing, plus a march toward higher-speed material platforms. It changes a little bit of the dynamic as far as what we're looking at from a CapEx perspective as we continue to support these trends.

Vaughan: I have to say one of the secrets to CapEx is, of course, having access to funds to execute on whatever your CapEx strategy is. That's an important dynamic. Look at the landscape. We did an informal head count on our side over the past, say, six months, and we believe we are down to around 185 U.S. fabricators. If you look at defense, the spend is about $1.3 billion for defense in North America. And if you take the top five fabricators, of which we are one, and you aggregate that up, you get to about a billion dollars. Your top five guys are supporting 90% of the business and that tells you something.

And then, of those 185 fabricators, you have 135 of them that are sub $25 million that haven't had the access to the capital to reinvest the business. We see it as a very fragmented market, and that's kind of how we approach it and how we differentiate. Our customers keep demanding more support for emerging technologies to support their emerging program objectives. As long as we keep our CapEx aligned with their roadmaps and where their programs are going, we feel we'll be extremely successful.

Matties: It's nice to have a wish list, but if you can't act on it, you're left behind in these markets.

Halvorson: Yes. The additional challenge is just what's happening in the world today through transportation and ability to obtain the equipment once it's been manufactured; to transport it to the facilities and being able to have the equipment installed by quality technicians from the factories is a challenge point today. There is equipment within our factories and within our competitors' factories that that is ready to be installed, needing to be in-

stalled, but we can't get people on location due to quarantines or barriers to travel. That has affected the market over the last, let's say, 18 months, and I think we will still be impacted probably over the next 18 months with what's going on with COVID. With traditional equipment, we typically can get that installed, the out-of-the-box type equipment, but the more complex or the automated factory equipment, it has become and is a real challenge to get on-site and running.

Matties: You're right. Does that change your range of planning to where you're looking at a longer window, from one year to maybe a three-year window in terms of investment?

Halvorson: I think any company that is successful and growing right now really needs to look at a five-year window, and that's where we're driven.

Vaughan: Another important thing to think about, too, is that the equipment has changed. We've all been doing this a long time, and you used to be able to pick up an exposure unit for $50,000 or $70,000, once upon a time. Now, those are laser direct imagers, those are half-a-million dollar-plus investments, and on and on it goes across the drilling platforms and everything else that we do. The capital requirement has increased pretty dramatically to support the technology curve.

Matties: Right. When you look at equipment like DI, though, you're eliminating so many other processes. It's an easily justified expense, as you know, yet it's still an expensive piece of equipment.

Vaughan: Yes, exactly. You still have to write the check.

Matties: Yes. One of the key takeaways from this conversation is the labor shortage and the thinking that we have to bring equipment in to basically eliminate labor positions. That's the only way that we can really move forward, especially with what's going in the market today.

Halvorson: I think for the most part, we're not eliminating labor. We're augmenting our current labor forces to ensure that they're stable while we grow the company.

Matties: Well, yes, and that's the point. You're eliminating the labor for the added capacity. You're not hiring more people to build boards. You're bringing in smarter technology to build more product.

Halvorson: Yes. Our operators are fairly technical. The difference that we see with today's equipment is that it's less boutique, and the automation within the capital that we're purchasing itself ensures quality. So even though it requires, let's say, a different skill base in the employee, it's still very important that the employee is aware of quality and our requirements so that they can ensure the equipment is operating properly. So they've turned into technicians versus pure operators.

Matties: Exactly. Is there anything else about CapEx that we should be sharing with the industry?

McCoy: I think we covered the questions pretty well. CapEx will continue to be a challenge, but with good planning and good management, I think installs will be successful and capital will be properly utilized to serve our customer needs.

Matties: All right. Thank you so much.

Vaughan: Thank you, Barry. Always a pleasure.

SMT007

Maximizing ROI and Usage of Test Equipment

Feature Article by Dirk de Waart
ELECTRO RENT

The Challenge

With so many variables to consider, making informed acquisition decisions around modern electronic test and measurement equipment can be challenging. While this article focuses on electronic test and measurement equipment, the basic principles of asset optimization can be applied to almost any hard asset. In the context of test equipment, asset optimization represents total equipment life cycle management to reduce costs and improve efficiency and productivity.

Sorting through more than 100,000 products from 300 manufacturers and deciding whether to buy, rent, or lease requires thoughtful consideration. Tracking equipment costs and ownership expenses, making assets readily available for engineers, and evaluating labor and asset utilization rates are also part of the equation.

Across industries worldwide, we estimate that there is approximately $100 billion of test and measurement assets deployed in R&D labs, production facilities, and field service organizations. According to Frost & Sullivan, only about 30% of these assets are actually in use, leaving $70 billion of capital unused[1]. Yet, for all that investment, detailed data on asset utilization, testing costs, and the status and availability of test equipment is often inaccurate, incomplete, or unavailable. In fact, most companies would struggle to create a complete and accurate list of test equipment across all labs and facilities.

Another common sign of ineffective asset management is equipment boneyards, in which unused or rarely used equipment occupies storage space and incurs unseen costs for calibration, repair, insurance, taxes, depreciation, and other related costs—even when not in use.

Many organizations use a mix of partial but generally ineffective asset management solu-


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tions, including shared spreadsheets, ERP systems that are not designed for test and measurement equipment, and an assortment of partially effective programs and applications. Because these systems tend not to share data, they cannot provide the holistic insights needed for informed decision-making. Without basic information such as asset location, availability, calibration status, and financial metrics, opportunities to improve efficiency and productivity remain out of reach.

As Uber, Airbnb, and other asset sharing companies have shown, expensive and underutilized or underperforming assets can be shared to increase ROI, provided the initiative is supported by the right technology platform. With centralized access to real-time information, companies can gain insights needed to reduce CapEx and OpEx requirements, improve operational efficiency, and accelerate time to market.

Organizations can address this challenge by deploying the latest asset management solutions. This brings numerous benefits, including cost reduction, operational efficiency, productivity improvements, and reduction of duplicate purchasing and overspending, which increase utilization and ROI on test equipment.

Now these asset management and optimization tools are available to owners and users of test and measurement equipment. With thoughtful strategies for the optimized use of test assets, leaders can make more informed decisions while ensuring continual access to the latest test equipment and technology.

The Solution

Achieving a meaningful improvement in utilization across the global test equipment portfolio is a two-stage process. In the first stage, companies gain a complete and accurate view of their existing asset base, including which assets are unused or underutilized, and which can be sold or disposed of. This not only generates new capital for reinvestment in the asset

pool, but also lowers the cost of storage, calibration, and other associated ownership expenses.

In the second stage, assets are shared among users to further reduce capital requirements. This stage requires an underlying technology backbone to identify where each asset is located, which assets are not in use or intended for use, and an advanced search tool that can locate needed assets by specific parameters set by equipment users.

As a result, more assets will become available, when and where they are needed. In addition, more informed purchasing decisions can be made as requests for new assets will be vetted against available alternatives, which are now more visible. Operating costs for calibration and repair activities can also be reduced through better workflow management.

Case Study Synopsis

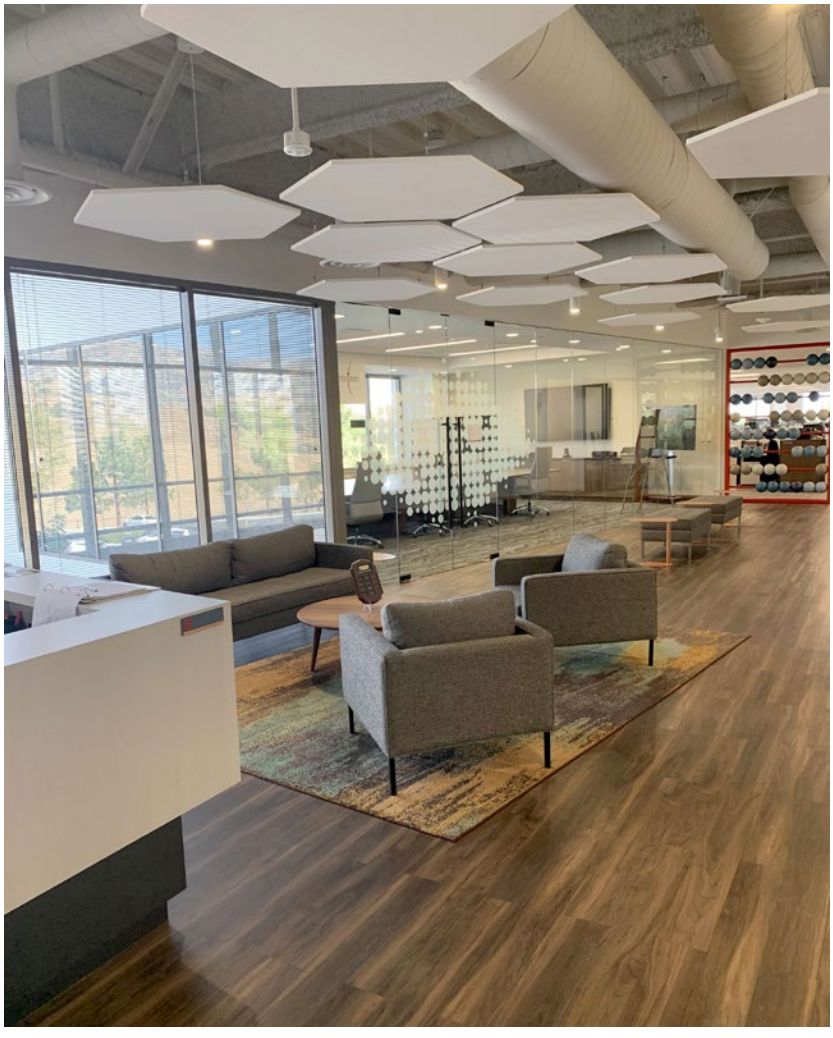
When the R&D division of a high-tech electronics manufacturer had challenges tracking and managing their test and measurement assets, they deployed an Electro Rent asset optimization solution that allowed engineers, lab managers, and others to assign test assets to specific projects.

Over time, project scheduling and R&D operational efficiency improved significantly, reducing project delays and cost overruns. The comprehensive nature of the asset optimization solution encouraged asset sharing and provided the data needed to reduce the size of the test fleet asset base.

After three months with the new system, 12% of the company's assets were identified for disposal, generating capital for investment in much-needed new equipment.

Our experience shows that organizations could reduce their overall cost of test 20–25% by implementing our full asset optimization solutions. Most of the value will come from:

- Lower ownership costs: As the asset base is reduced, the costs associated with owning equipment such as storage, insurance, and calibration are reduced
- Recovery value of unused equipment: A cash infusion can occur from selling unneeded assets in the secondary market
- Lower operating costs due to a smaller overall asset base: The cost of calibration, storage, insurance, inventory management and tax will be reduced
- Improved practical availability: Although harder to quantify, there is a real benefit associated with having the right asset available, where and when needed. This



The Electro Rent offices in West Hills, California.

reduces product development timelines and helps get products to market faster

Getting Started in Seven Steps

In most cases, realizing the benefits of asset optimization includes the following steps:

1. Any asset optimization initiative starts with setting clear goals and baselining current inventory and performance. This could include an audit of current inventory and utilization levels as well as the cost to serve the existing test fleet.
2. In the second step, an onsite team assesses the existing process and quality of asset data to determine what will be required to load accurate information into the database and update existing processes.
3. In most cases, existing asset information often has missing data and is insufficient to use in an asset tracking and optimization system. Missing fields such as equipment options, location, and other similar information need to be identified through a full audit. It is not uncommon at this stage to find assets that the client was not aware it owned.
4. In parallel with the asset audit, assigned users are fully trained on the optimization tools and processes. At the end of this step, the users have been trained, the database is clean and complete, and from this point forward assigned "super users" are responsible for maintaining the integrity of the database.
5. Several months later, when sufficient information has been collected, we use this data to analyze usage patterns and identify opportunities to reduce the asset base.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6. From this analysis, organizations will be able to identify a set of assets for sale. Using our consignment service and experience with pre-owned equipment sales, companies can offload these assets in the market to generate cash for future equipment investment.
7. From this point forward, testing organizations will leverage a full suite of asset optimization tools to further reduce the asset base, avoid unnecessary purchases, improve asset sharing across labs, and fine tune calibration and repair activities.

Based on experience with clients in the aerospace, semiconductor, electronics, and field service industries, Electro Rent has identified three critical success factors to achieve asset optimization benefits in the shortest time.

First, a clearly articulated vision is required. It should communicate the potential benefits of the asset optimization solution and how that solution can change asset utilization in the organization. Second, strong executive sponsorship is required. Because asset optimization builds a new capability inside the organization, it requires changes in processes, system, and metrics. As change is not easy, a strong sponsor who can act as a change agent can help accelerate the process.

Lastly, IT support is critical. From the first download of existing asset data to possible integration with the existing ERP system, strong collaboration with the IT group is crucial for timely rollout of the asset optimization solution. **SMT007**

Reference

1. "Asset Management and Integrated Service Delivery: Expansion of Traditional Business Models in the T&M Market," Frost & Sullivan.

Dirk de Waart is the chief operating officer at Electro Rent.

Schlumberger New Energy Enters into Agreement With EnerVenue for Metal-Hydrogen Stationary Energy Storage Solutions

Schlumberger New Energy announced an investment and collaboration agreement to deploy EnerVenue's uniquely differentiated nickel-hydrogen battery technology, which is a key enabler of stationary energy storage solutions. Schlumberger New Energy and EnerVenue will work together to progress large-scale deployment of nickel-hydrogen battery technology across selected global markets.

Energy storage solutions are critical to the evolution of the energy mix as the energy transition demands greater contribution from renewable sources. The focus on expanding electrification is accelerating the need for large scale deployment of safe, cost effective, sustainable, and reliable stationary energy storage solutions. There is a rapidly growing market for such solutions across utility-scale grid storage, off-grid commercial and industrial storage, and residential sectors.

"At Schlumberger, we're eager to leverage our technology expertise and global footprint in introducing EnerVenue's technology to this important emerging market," said Ashok Belani, executive vice president, Schlumberger New Energy. "We are excited about the potential this technology holds for the energy transition."

"Schlumberger New Energy will emerge as one of the long-term energy transition infrastructure leaders," said Jorg Heinemann, CEO, EnerVenue. "We look forward to supporting Schlumberger's new energy vision, and to working with the company to bring our battery technology to organizations across the world."

(Source: Business Wire)

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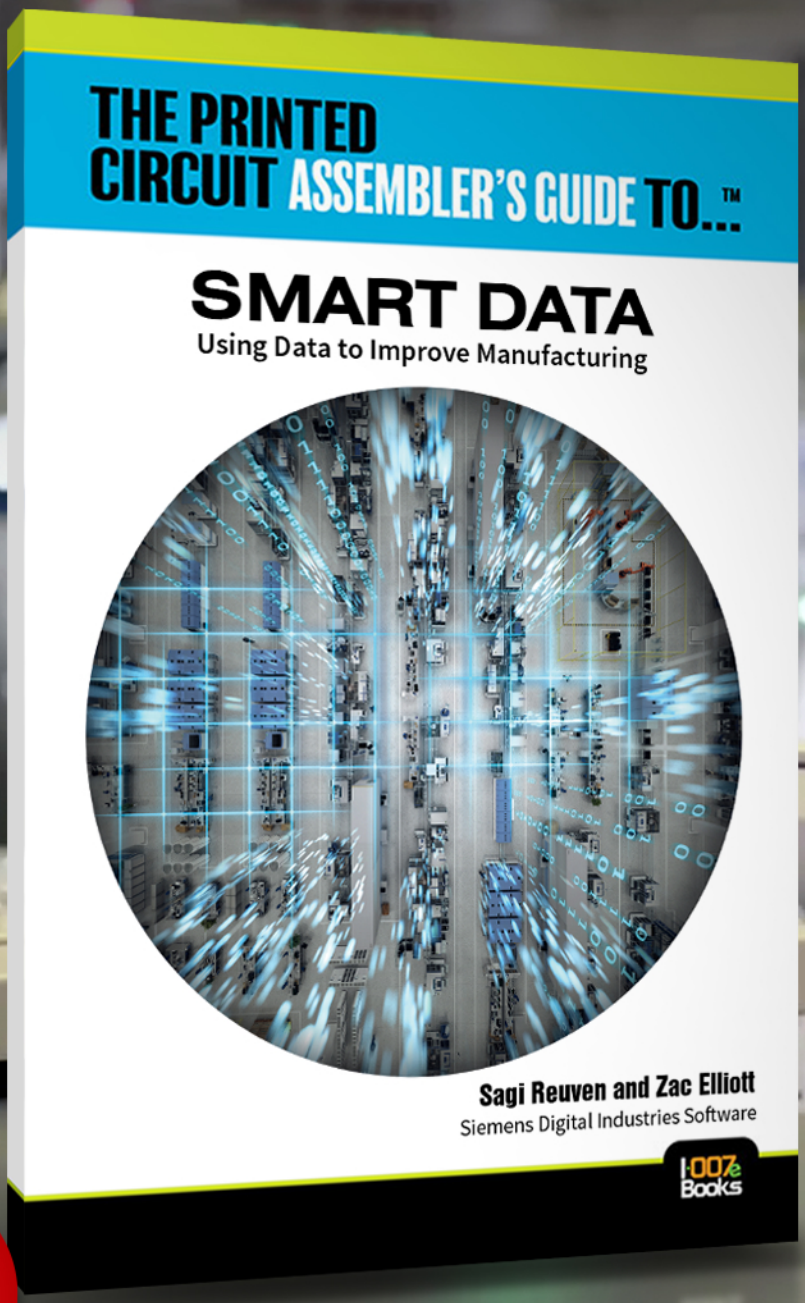

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Excerpt from *24 Essential Skills for Engineers* by Happy Holden

Chapter 17: Planning and Implementing Factory Automation

We have discussed the basics of manufacturing technology, application hierarchy, and automation (mechanization and systemization) for the factory of the future in the free I-007 eBook, *Automation and Advanced Procedures in PCB Fabrication*. Sometime in every engineer's career, they are called upon to consider automation, new processes/equipment, and capital expenditures. Let's review the goal settings, process benchmarking, and automation strategy that will determine your approaches to automation. The analysis of your facility's performance and your goals to improve make your facility more competitive and may take many forms. These opportunities are always there:

- Waste reduction, and yield and quality improvements
- Cost reductions and productivity improvements
- Customer and market expansions
- Technology improvements
- Customer needs
- Exploiting new product opportunities
- Digitization of data and systems

Start With the Basics

The greatest gains will result from opportunities that are presented as obstacles to higher profits and performance. This will be different for every manufacturer, but the basic performance for quality, productivity, inventory management, labor efficiency, delivery, cycle time, sales/customer support, and technology capability are but a few.

Figure 1 shows the six stages of planning an automated factory. Most of the elements will be your current equipment and any new islands of automation. The arrows are of important significance, as they outline the flow of information that will be an important new part of your factory information system.

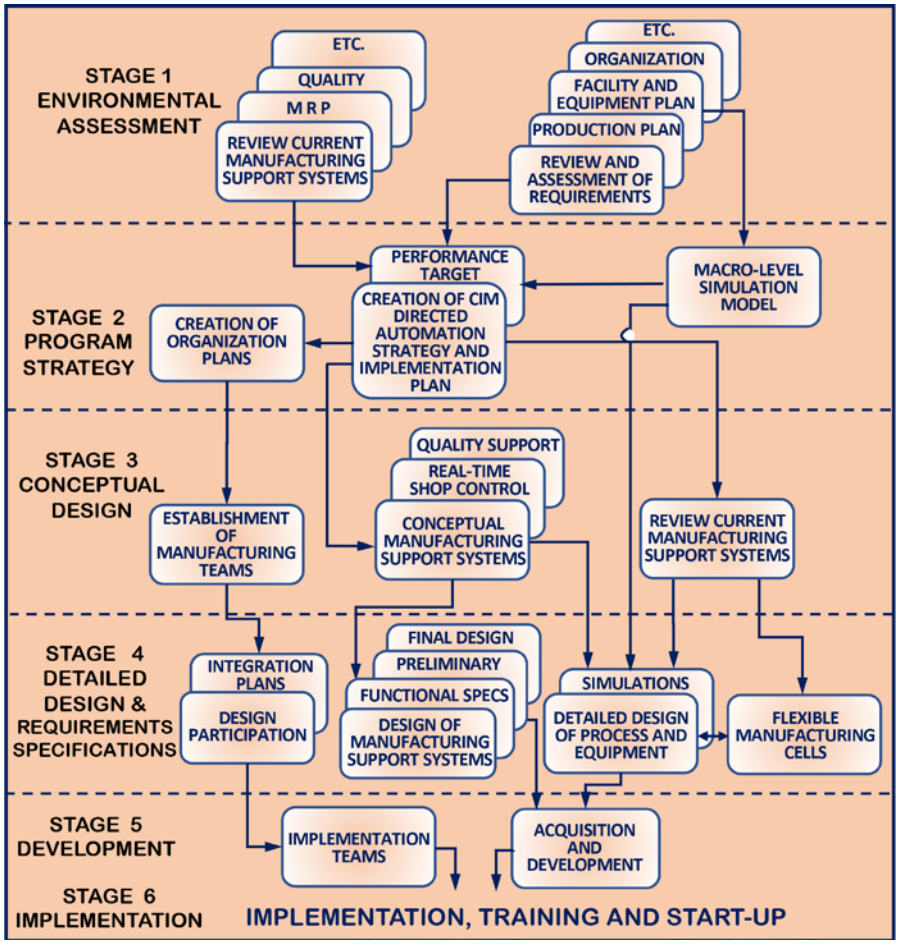

Figure 1: Priority one is to establish a strategy on how and what your Smart factory will look like. (Source: HP Computer Museum)

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PHASES	ACTIVITIES	DELIVERABLES
1 ENVIRONMENTAL ASSESSMENT (4-8 weeks)	• Conduct Systemization Review (flow, quality, etc.) • Conduct "The CAD/CAM Audit" • Perform "The Process Scan" • Perform organization review • Analyze business forecast	• Profile of systemization/mechanization opportunities • CAD/CAM systems specification input • Assessment of organizational impact • Rationale for cost/benefits analysis model
2 PROGRAM STRATEGY (6-10 weeks)	• Perform macro-level stimulation for CBA • Establish performance targets • Create CIM strategy and automation plan • Develop documentation methodology for CIM system	• Documented CIM strategy and implementation plan • CIM architecture • Organization and staffing plan • Database mapping of functional processes
3 CONCEPTUAL DESIGN (6-10 weeks)	• Exploration of preliminary process equipment and automation alternatives • Initiation of requests for information (RFI) • Develop conceptual specs for MFG support systems • Organize manufacturing technology teams	• Budget profiles on equipment/software development created • Documented conceptual specifications for functional approvals
4 DETAILED DESIGN AND REQUIREMENTS SPECS (13-26 weeks)	• Generation of detailed process/equipment designs • Generation of detailed manufacturing support sizing of system specs • Involvement with technology suppliers • Creation of integration plans • Execution of simulation model on automation alternatives • Creation of RFP specs for supplies	• Transaction (I/O level) design document for manufacturing system • REF Specification with functional sizing of system • Detailed cost/benefits model document • Implementation plan
5 DEVELOPMENT (Cycle depends on Phase 4 scope)	• Selection of equipment, hardware and software suppliers • Implementation of development hardware and software • Software programming • Debug and test subsystems	• Completed system software • Installed, operational equipment
6 IMPLEMENTATION (Cycle depends on Phase 4 scope)	• Construct ATP • Execution of system test • Construct system and user documentation • Execute ATP • Trainer of end-users	• Acceptance of test procedures • Operational CIM systems • Technical and user documentation

Table 1: Details in creating the six phases of a factory automation strategy.

Table 1 provides more details on creating the automated factory strategy. The timing is approximate, based on how many resources are assigned to the job. The activities are straightforward, but the deliverables are essential to having a successful project.

Benchmarking Your Process

To start the analysis process, first you must benchmark your current manufacturing process in great detail. As an example, I have selected the multilayer lay-up process. As seen in Figure 2 (4), it is important to use as complete a benchmarking analysis as you can afford in order to have the details required in the next automation planning step. Information flow is important!

Planning to Define the Automated Factory

Computerization Basics

Once the computer became available at a reasonable cost (in the early 1970s) it was used in manufacturing. Figures 3a and 3b are

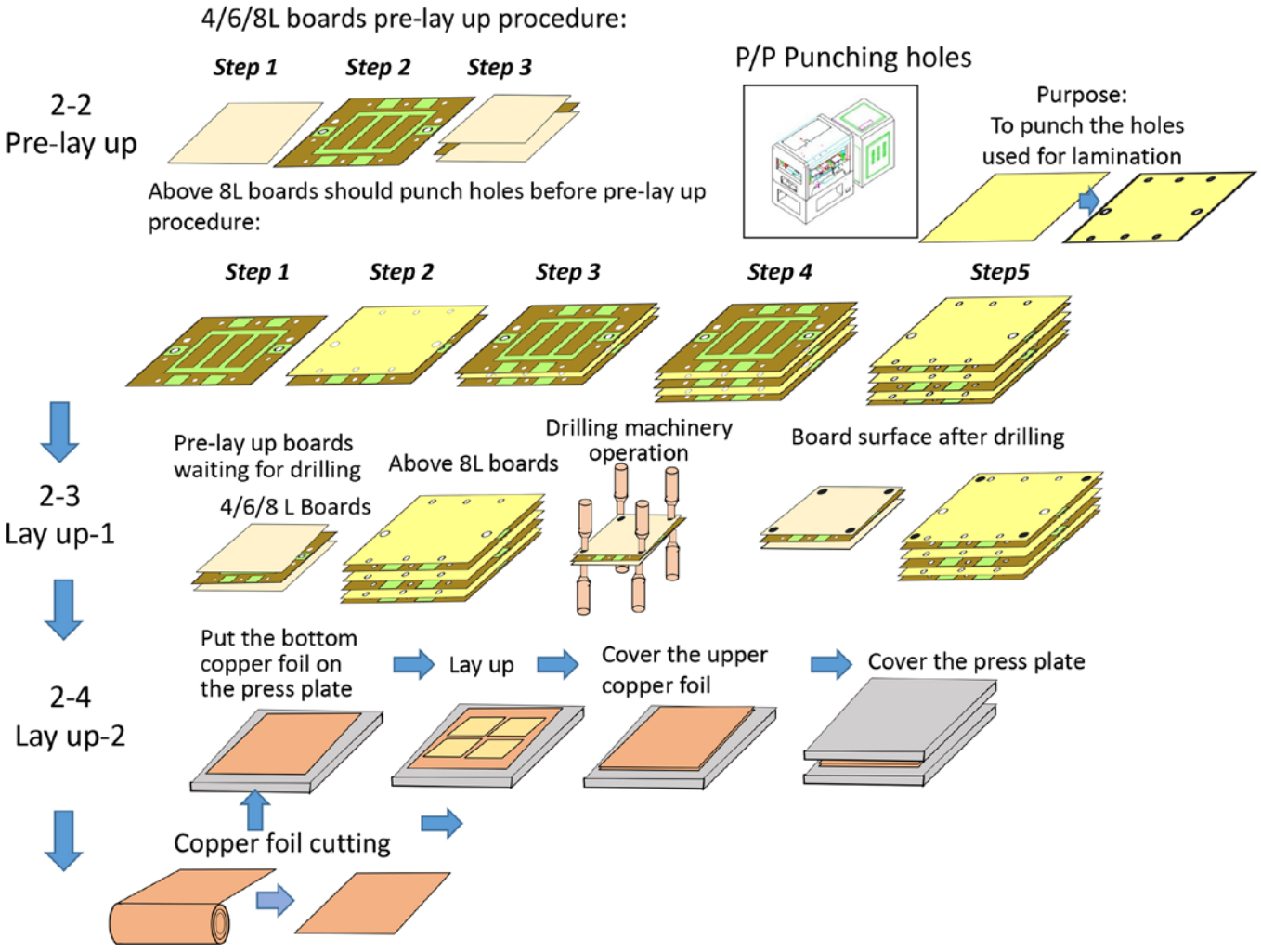

Figure 2: Benchmark detail of the manufacturing process. This example is the multilayer lay-up process.

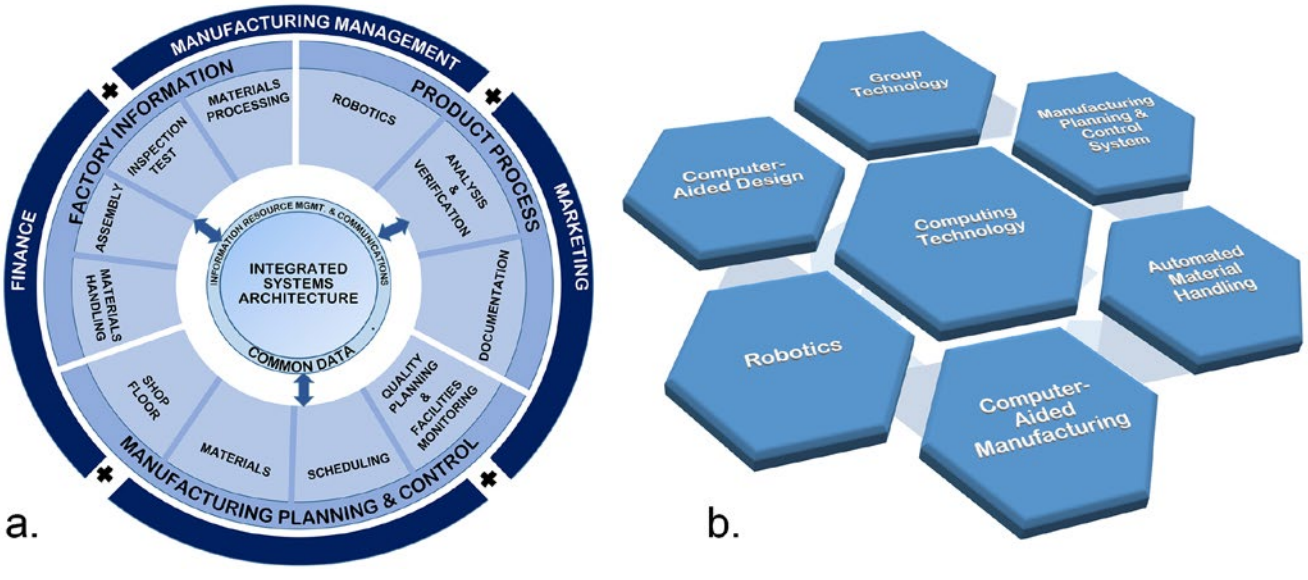

Figure 3: a) The CIM wheel defined by CASA/SME; b) The five arenas of a CIM strategy. (Source: CASA of the SME)

computer applications defined by the Computer and utomated Systems Association (CASA) group of the Society of Manufacturing Engineers (SME) in the 1980s.

Planning Process

The planning process can be as simple as the four steps seen in Figure 4; simple like the HP process (Figure 2), or as elaborate as the six phases seen in Table 1. Whatever methodology is used, thorough planning will make the project proceed more smoothly and ensure success.

Systemization vs. Mechanization

The two automation elements are determined by the total machine time for a process step (system information and mechanical work) vs. the time human labor is added to this process step. These two axes are:

1. Systemization (information) Levels (1, 2, 3, 4, 5, 6)
2. Mechanization (work) Classes (A, B, C, D, E, F)

Networking Communication vs. Material Handling

These elements are introduced in my book on automation: "The automation methodology consists of automation plans for each work center plus plans for material flow and information flow between work centers," the automation methodology to cover material handling and network communications between cells and work centers. This important third axis is:

- Material handling degree (a, b, c, d, e, f)
- Network communication extent (I, II, III, IV, V, VI)

These axes are seen in Figure 4.

Worksheets: Times and Throughput

Now that you have determined your competitive position and core competence in the PCB manufacturing market and have established a competitive position that you want to enhance, it's time to plan. If automation/new technology is one of those strategies, it is time to do

	PLAN	DEFINE	DEVELOP	IDENTIFY	SELECT
Senior Management	Define company objectives, strategy, goals & ambitions	Invest in automation plans and budgets			Approve budget and resource allocation
Business Planning Staff		Propose engineering operations manufacturing objectives and strategies			Review automation budget, revise if necessary
Senior Operating Staff		Assign engineering responsibility Define manufacturing objectives and strategies	Develop automation program identify, resources and requirements		Propose automation budget for approval
Local Functional Staff			Collect and prioritize functional needs for automation	Support automation program and resources to solve functional needs	Revise automation program, functional needs and interfaces
Technical Staff				Identify automation products and services Develop resource requirements and reservoir	Select automation program, staffing, projected growth, budgets, specifications, and user interfaces

Legend: Business Driven — Technology Driven

Figure 4: Defining the axis of the automation matrix.

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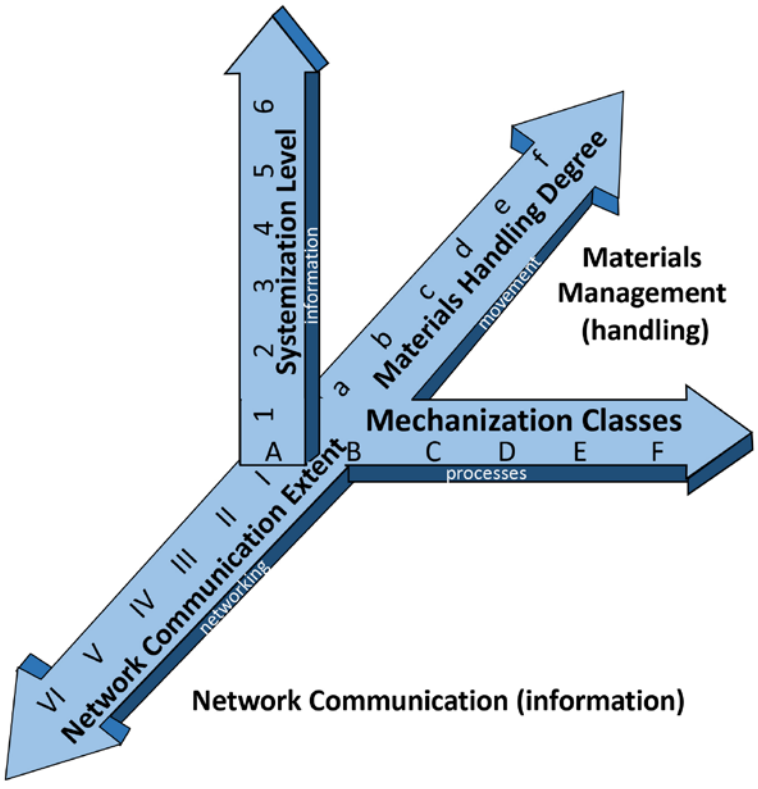

Figure 5: Planning the automation program will help insure successful completion.

the detailed workcell analyses for the affected manufacturing workcell processes. This involves the entire organization as seen in Figure 5.

The methodology will involve timing all the work and information for this manufacturing process, including set-up times and information logging and instructions from work orders. Table 2 shows the analysis of the current manufacturing process.

The process work center analysis (PWA) is the multilayer lay-up process, as seen in Figure 5. Human set-up time to collect all the materials was 15 minutes. It took five minutes to read instructions from the work order traveler. The inner layer for the multilayer will be stacked and drilled for tooling holes—25 minutes machine time and 25 minutes human time. It took 20 minutes to record in the production log.

Table 2: Worksheet for benchmarking systemization/mechanization times.

PROCESS WORKCENTER ANALYSIS		
PRIOR PROCESS STEP I/L Material Prep: 1.4	PROCESS DESCRIPTION Multilayer Lamination Lay Up: 2.0–2.4	NEXT PROCESS STEP Lamination: 2.5
Mechanization Class (A-F)		
Human setup time __15__ Human run time __25__ Total human time __40__	Machine run time__25__ Total run time __65__	Machine % __38__ Mech. Class __C __
Systemization Level (1-6)		
Human setup time __5__ Human info time __20__ Total human time__25__	Machine info run time__0__ Total run time __25__	System % __0 __ System Level __ 1 __
Material Handling Degree (A-F)		
Human setup time __20__ Human move time __20__ Total human time __20__	Queue time __0__ Machine run time __0__ Total run time __20__	Mach. Handling % 0 Handling Degree __a __
Networking Extent (1-6)		
Human setup time __0__ Human info time __0__ Total human time __0__	System run time__0__ Total Network time __0__	Network % __0 __ System Extent __ I __

Table 3: Worksheet for future systemization/mechanization times.

PROPOSED PROCESS WORKCENTER ANALYSIS — PHASE I		
PRIOR PROCESS STEP I/L Material Prep: 1.4	PROCESS DESCRIPTION Multilayer Lamination Lay Up: 2.0–2.4	NEXT PROCESS STEP Lamination: 2.5
Mechanization Class (A-F)		
Human setup time __5__ Human run time __0__ Total human time __5__	Machine run time__20__ Total run time __25__	Machine % __80__ Mech. Class __E __
Systemization Level (1-6)		
Human setup time __0__ Human info time __0__ Total human time__0__	Machine info run time__1__ Total run time __1__	System % __100 __ System Level __ 6 __
Material Handling Degree (A-F)		
Human setup time __0__ Human move time __20__ Total human time __20__	Queue time _____ Machine run time __0_ _ Total run time __20__	Mach. Handling % 0 Handling Degree __a __
Networking Extent (1-6)		
Human setup time __0__ Human info time __0__ Total human time __0__	System run time__0__ Total Network time __0__	Network % __0 __ System Extent __ I __

Automation is not planned from lay-up to lamination. Currently this is a manual conveyor and plans call for it to remain that way. Lamination material transfer is 20 minutes, all by hand. There is no networking of information between lay-up and lamination, and it will remain that way.

The proposed new automation (Table 3) is an optical layer registration system that does not need holes; it welds (induction melting) each layer together to form the stack. Set-up information, part number-WO ID, tolerances, and logs are created from a barcode reader on the material tray.

A summary of these two steps is seen in Figure 6.

These steps are repeated for as many work centers as you have designated for improve-

WORK CENTER	CURRENT		NEW IMPROVEMENT		AUTOMATION MATRIX
	SYSTEMIZATION	MECHANIZATION	SYSTEMIZATION	MECHANIZATION	OBJECTIVE
2.2 Multilayer Lay-Up	•Manually adjust machine parameters •Manually collect data •Report in production log	•Manually stack materials •Manually start drill •Move materials to lay-up •Lay-up layers on pins •Move pin lay-up to caul plates	•On-line information for operator instructions •*Process supervisory sensors* •*On-line quality system* •On-line report in production log	•Auto registration of layers-vision •Welding of layers together •Material movement •Automatic board cleanliness system	6 0 5 4 3 2 1 X A B C D E F

X CURRENT MASS PRODUCTION STATUS 0 IMPROVED MASS PRODUCTION STATUS

Figure 6: Work center requirements definition.

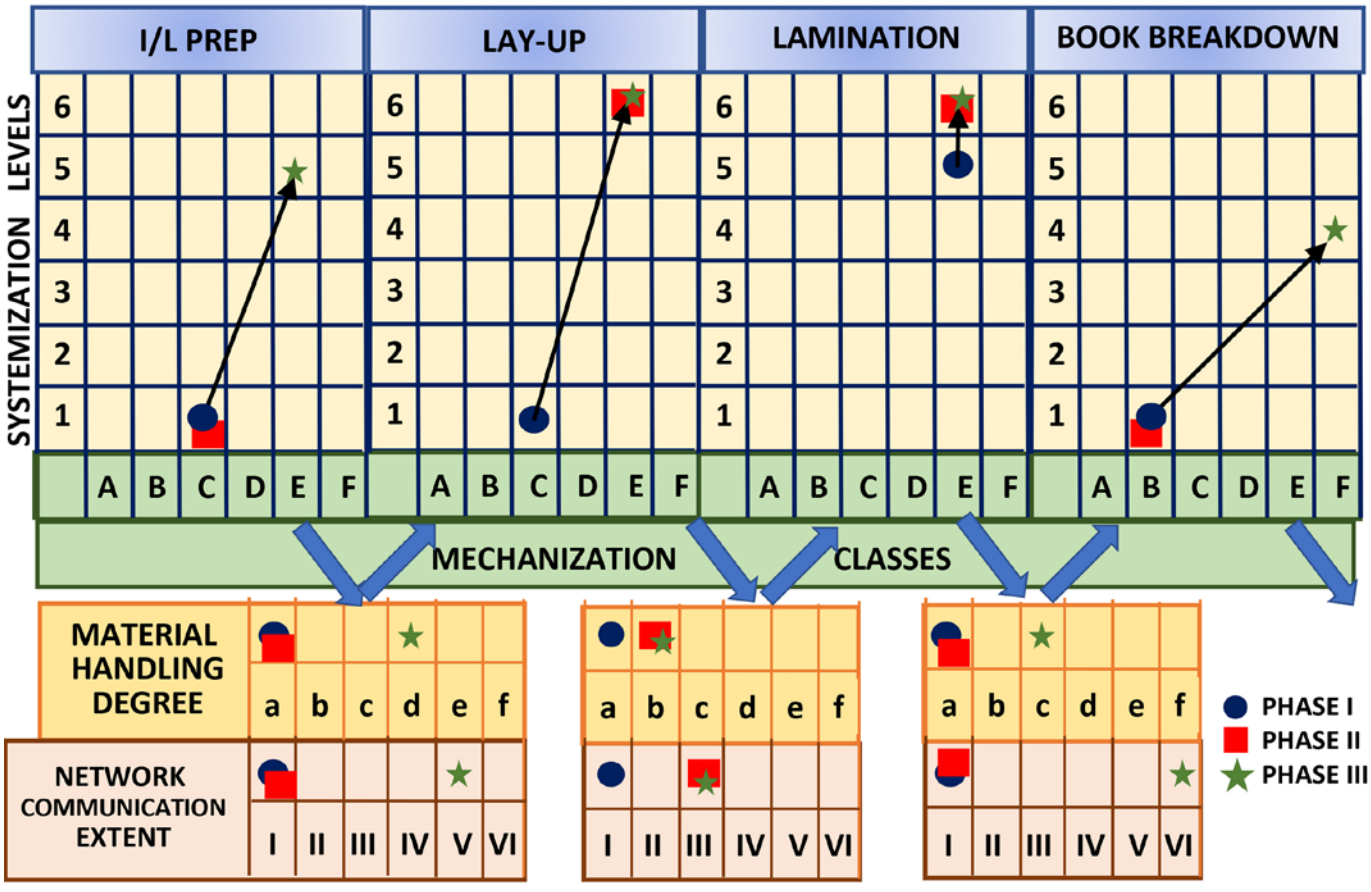

Figure 7: Series of workstations in the plan.

ment. The role of automation can be a simple one of adding loaders and stackers for material handling to new equipment that improves quality, productivity, or technology. For a "connected" series of process steps, as seen in Figure 7, the implementation may be in phases that add incremental equipment like smart conveyors and sensors to networked recipes that control the processes of lay-up and lamination. SMT007

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

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Fane Friberg on Capital Expenditure Project Planning


Fane Friberg

Feature Interview by the I-Connect007 Editorial Team

In a recent survey, about 75% of SMT007 readers indicated that their organization uses a capital expenditure plan; about 25% do not have a planning process in place. Based on this information, the I-Connect007 Editorial Team reached out to Fane Friberg to discuss capital expenditure planning and execution.

With more than 35+ years of experience in supply chain, operations, manufacturing, distribution, and sourcing, including small- to mid-size and Fortune 500 companies, Fane has proven success in supporting the development and execution of successful operational strategies. Fane's expertise is in taking the strategic business plans and converting those to clear/concise tactical initiatives within manufacturing, logistics, and sourcing operations.

You speak of a standard operating procedure for capital expenditure planning. Can you give an overview of that concept?

Fane Friberg: Companies grow and change. Many times, with established companies, people within the organization have various methods that they used in the past for the CapEx process. To that end, it is critical that companies have a well-documented standard operating procedure for capital expenditure projects. This document should clearly define the necessary steps required from proposal to implementation of the project. It also helps correlate the relationship between the annual planning/budgeting process and the standard approval cycle for such capital expenditure submissions.

The complexity of the approval cycle can vary from organization to organization. For example, some organizations require a simple form completion consistent with the capital plan as part of the annual operating plan (AOP). Other organizations require multiple pitch meetings, multiple tollgates and package submissions, and a finalized formal CapEx approval binder (including specific elements) that are maintained/retained consistently, and responsibly manage the approval of large and long-

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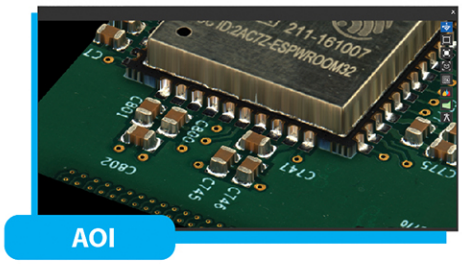

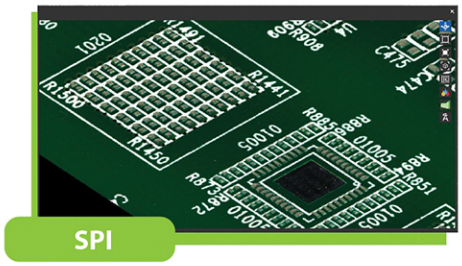

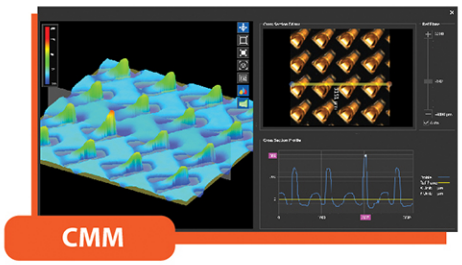

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term financial decisions. Whatever the process at your company, it will need to be clearly documented and followed.

We've heard you point out that the value and importance for the NDA in the CapEx planning process is often overlooked. How does that fit in?

Friberg: Since there are many times where the CapEx is part of a company's fulfillment and go-to-market strategy, it becomes critical to have the nondisclosure agreement as part of the CapEx standard operating procedure (SOP.) Most companies have the NDA as part of their supply chain SOP; it should not be overlooked in the CapEx processes as well. This is because a capital expenditure is an important part of the supply chain sourcing and buying process. When capital equipment is thought of as a supply chain item, all the normal vendor authorizations make sense. It is generally good business practice to have an NDA any time you want to share something valuable about your company and/or business strategy. You want to make sure that the other party doesn't use any of that disclosed information without your approval. This protects any information that is not widely known (new technology, new location, new distribution model, etc.).

An example of information that needs protection might be when a company is examining their overall fulfillment network and determines that there are too many distribution nodes away from the point-of-manufacture. It is critical that this information not move prematurely through the enterprise, as that could result in panic within the business, or the possibility that a key competitor gains knowledge about your execution strategy and can identify a competitive advantage within the market—costing you market share erosion.

Walk us through the role that a statement of work (SOW) plays in the CapEx process. Isn't the SOW primarily about execution of the plan?

Friberg: The SOW inside the CapEx process clearly defines what work, equipment, deliverables, and the timeline for generating the final CapEx approval and the period-of-performance where the business will start to see the ROI to the financials. Having an SOW as part of the process precludes conflicts and problems in contract execution on the technical tasks and subtasks within the overall project.

Do these processes change when the capital expenditure is for facilities or infrastructure rather than equipment?

Friberg: No. CapEx items are assets that the company uses in the process to manufacture/deliver products and services to the consumers. So, by definition, capital goods are not finished goods, but rather are used to make the finished goods. Whether it's a building or a pick-and-place machine, the general process is the same.

You've previously mentioned having contingency plans for CapEx monies. What are some common strategies and approaches?

Friberg: Other than not delivering the CapEx to schedule, even more troubling to the corporate leadership would be "surprises" in the cost of the CapEx. Most successful CapEx projects implement a 10% contingency into both the financial and scheduling aspect of the project. As part of the CapEx standard operating procedure, the scenario planning section is used to proactively outline potential cost, delivery, and minor changes to scope that would impact the planned execution dividend of the CapEx.

You specifically recommend that the team "overcommunicate." Normally, that's not a desirable thing. What do you mean when you use that specific term?

Friberg: Communication, in a consistent format, gets rid of annoying email trails, off-line spreadsheets, and delayed approvals (if outside

the aforementioned contingency). A monthly communication to all stakeholders, specifically those on the CapEx approval routing, keeps the enterprise apprised on the progress and performance to the overall cost and timeline. Since CapEx adds to the book value and the long-term financial health of the company, the project needs to be fully transparent and open to scrutiny/review.

Much of this sounds like traditional project management. Should a company bring in a project manager for capital expenditure execution?

Friberg: If a company has a program management team, using that team would be a possible solution. However, the CapEx process is typically initiated and managed by the department seeking the investment and goes through approval paths involving senior leadership. This is because, within the business unit P&L, the depreciation cost would validate the ROI as part of the standard EBITDA metric. If you have an interest in having your process developed/assessed/refined, a consulting firm may be a good starting point. SMT007

Fane Friberg is client director at BDS Supply Chain.

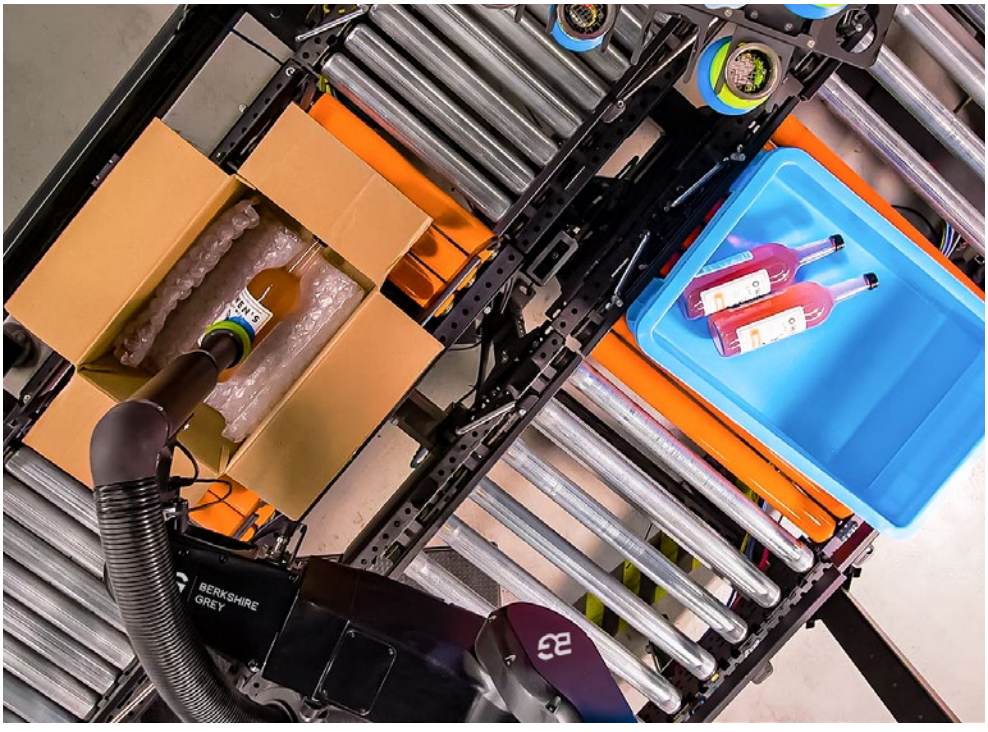
Berkshire Grey Announces Global Availability of Robotic Pick and Pack Solutions

Berkshire Grey Inc, a developer of AI-enabled robotic solutions that automate supply chain processes, announced global availability of its Robotic Pick and Pack solutions. Berkshire Grey RPP solutions automate picking and packing of items directly from inventory totes to outbound customer shipping packages. This solution improves operational efficiency for fulfillment centers, reduces shipping costs and lowers the environmental impact of eCommerce orders.

Berkshire Grey's RPP solution is now in deployment—including at SoftBank Logistics' flagship fulfillment center in Ichikawa, Japan—and is now available to customers across the globe needing to improve throughput at their eCommerce fulfillment operations while facing unprecedented labor shortages. The Berkshire Grey RPP solution is engineered to integrate with eCommerce operations commonly run by retailers, third party logistics (3PL) providers and pure-play eCommerce brands.

Berkshire Grey's RPP system was designed and built to optimize SKU processing, improve picking and packing efficiency, and speed operational throughput. It autonomously picks and packs consumer orders while ensuring items remain in pristine condition—satisfying customers, minimizing returns and reducing damage costs.

(Source: Globe Newswire)



Perfecting the Application of Conformal Coatings Without a Capital Investment

Feature Article by Zsolt Pulai
HZO, INC.

Printed circuit boards (PCBs) are marvels of science and one of the most disruptive innovations of the last 100 years. Since inception, they have undergone numerous alterations, improvements, and transformations with the most profound being driven by the miniaturization of electronics. PCB manufacturers are being pushed to create smaller and more densely packed boards with increased electronic capabilities. As amazing as they are, their Achilles heel is contamination. In this article, we will review the history and applications for thin-film conformal coatings, and introduce a new service for conformal coating application, potentially adding coating capability without adding capital investment.

Background

Sensitive circuitry is affected by harsh environments. Extreme temperatures, dust, dirt, chemical vapors, and moisture from humidity, rain, and snow can have a detrimental effect on PCB health, thereby putting their end products at risk of seizing and performance breakdowns.

Thin-film conformal coatings have a solid position as the protective coating of choice for protecting PCBs from external factors in operating environments. They provide a protective barrier or film, layered over the critical substrates. When applied accurately, conformal coatings prevent sources of moisture, vapors, and other contaminants from damaging or corroding interior circuitry.

There are five types of conformal coating available on the market today: parylene, acrylic, silicone, polyurethane, and epoxy. They each possess a unique set of characteristics and properties. Of these, parylene is often considered the protective coating of choice for a PCB's challenging applications.

Research chemist Michael Szwarc isolated the parylene polymer series in the late 1940s at the University of Manchester, England. He discovered the polymer as one of the thermal de-

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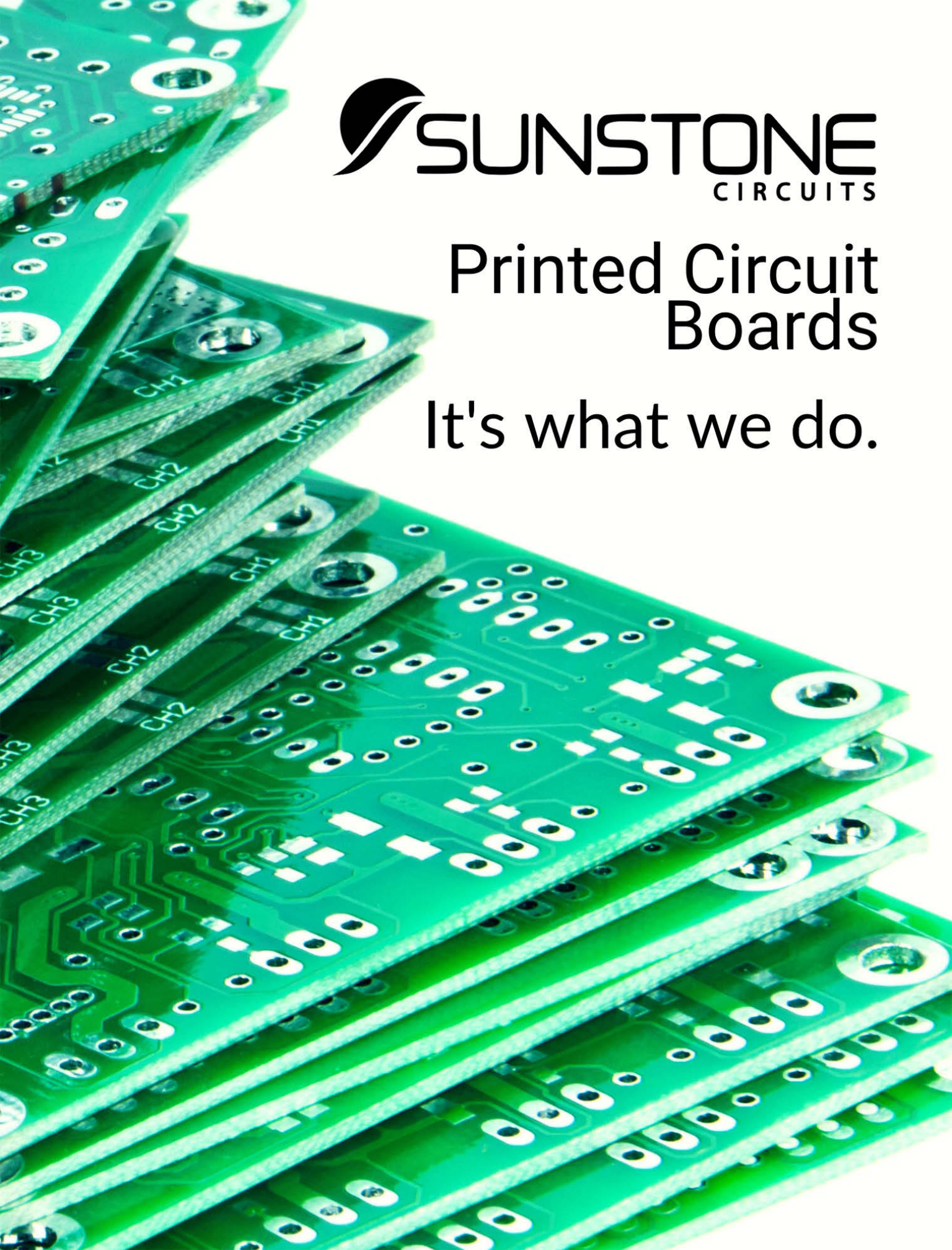

composition products of a common solvent, p-xylene, at a temperature between 700 and 900°C. Union Carbide scientist William Gorham later developed a deposition process to apply the film. He deposited parylene films by the thermal decomposition of di-p-xylylene at 550°C and in vacuum below 1 Torr, a process that did not require a solvent and resulted in chemically resistant films free from pinholes. In 1965, Union Carbide commercialized the material and the chemical vapor deposition (CVD) process that is unique among conformal coatings.

While the barrier properties of parylene are unmatched, it adds minimal mass to coated surfaces and contributes no cure or thermal expansion forces to threaten delicate components.

While the barrier properties of parylene are unmatched, it adds minimal mass to coated surfaces and contributes no cure or thermal expansion forces to threaten delicate components. Parylene has exceptional tensile and yield strength, is dielectric, and can cover the entire board to protect component leads, solder joints, exposed traces, and other metalized areas. It provides protection from corrosion, and shields the whole PCB from spray, moisture, fungus, dust, and other contaminations from harsh environments. Parylene even helps prevent damage to circuitry and sensitive components from thermal and mechanical stress as well as rough handling, or in the case of AMRs, bumps, and jarring during deployment.

Parylene conformal coatings consist of a protective polymer layer 12–25 µm thick (<20 µm typical) that conforms to a PCB's shape and components. They provide resistance to solvents and chemicals, are heat resistant, and help prevent light component leakage and corrosion. They are the best protective strategy for PCBs that will be exposed to unfavorable environments.

The impediments to parylene's wide adoption have been cost and scalability. The raw materials have been historically high-priced, and scalability with manufacturing integration is complex. HZO has broadened the scale of usage for this robust, organic material by making it available to companies and manufacturers that could not previously consider it an option. At the foundation of its offerings are engineers and scientists with deep domain and industry expertise in conformal coatings, and its in-house proprietary equipment.

Although there are different ways to apply coatings—brushing, spraying, dispensing, and dipping—HZO uses the chemical vapor deposition (CVD) process to create truly uniform conformal coatings. CVD is a coating method that flows reactive gases into a vacuum chamber containing the target substrates, where the chemistries combine or react to form a conformal coating. In HZO's case, these reactive constituents are formed thermally, but the reactions on the product happen at room temperature.

HZO's optimized chamber size and shape ensures uniform parylene deposition and a proprietary state-of-the-art controller that can remotely monitor and control real-time critical factors, like temperature, pressure, and other essential operating parameters.

The precision and control of its systems extend the use of parylene to more consumer electronics, medical devices, IoT, industrial, and automotive applications by meeting tighter tolerance, thinner film depositions, and higher quality standards. HZO's equipment employs a proven application method for both small batch and high-throughput environments. Semiconductors, printed circuit board

assemblies, subassemblies, and devices are placed inside the equipment's chamber where a protective coating is applied as a vapor, forming the protective conformal coating, measuring thinner than a human hair.

The Coating Process

The first steps of the HZO process with a potential customer involve a detailed evaluation of the product, where the coating process can be introduced in the production flow, and what protection level the customer needs. This evaluation considers the components that require protection and the level of protection required, whether splash resistant, sweat proof, submersible, solvent or corrosion resistance, or operating temperatures and environment. A detailed process plan is developed, and prototype runs occur to test environmental performance and reliability of the coated customer parts.

There are three distinct steps in the HZO process: pre-process, coating, and post-process.

Pre-process

Because CVD coating vapor can penetrate micron-sized gaps, masking may be required for areas of the PCBA or component that should not be coated, such as screens, sensors, lenses, connectors, and other components whose functionality may be hampered by coating. Much of HZO's intellectual property is based on innovative materials and processes designed to streamline the masking process, whether for manual masking, semi-automated masking, or seamless automated masking. Its masking products and solutions are unique and not found anywhere else in manufacturing.

Coating

Once the masking process is completed, if applicable, products are ready to be coated within the large, efficient cubic coating chambers. Custom tray configurations ensure high throughput and safe handling of the product. They are then placed on racks inside the coating chambers where the coating process commences.

Parylene coating is applied as a single material application. The parylene raw material, which is a powder form, is added to a vaporizer and sublimed from a solid to a vapor form. The vapor, which is a non-reactive dimer initially, passes into a higher temperature pyrolyzer, "cracking" the raw material into two activated monomer units.

The coating chamber is under vacuum at room temperature, allowing the vapor to disperse evenly in the chamber. The monomer can flow under and around components before polymerizing, creating a uniform, thin-film polymer barrier around the electrical components being coated.

Post-process

After coating, which can take several hours, parts can be removed from the chamber fully protected—there is no curing or waiting time with parylene. Masking materials are removed, and parts are inspected to ensure coating is where it needs to be (and nowhere else). Coating thickness can be verified with an optical measurement and has very tight batch-to-batch and part-to-part repeatability.

HZO can also work with multi-layer material coating applications by depositing specific materials on top of one another. This results in unique, strong, and long-lasting coatings that

meet the protection needs of products where other solutions may fall short. HZO has multiple projects in development for its Spectrum of Protection™.

Lastly, HZO uses a process called atomic layer deposition (ALD). Unlike CVD, which is a one-coating process from a vapor form, HZO applies multiple layers of robust materials, including metals and ceramics. ALD coatings provide significant coverage for miniature to microscopic components. There are two types of conformal coating application methods or processes for ALD: thermal and spatial. The thermal, or stationary, method involves injecting one material at a time into the coating chamber, waiting for it to attach itself to the component to be coated, then purging the remaining residual from the chamber. A second material is then added to the chamber to cause a chemical reaction to the first one. This process is repeated with each additional layer of material until the desired number of atomic layers have been applied. The spatial method uses a divided chamber to separate the precursor reactions to different zones. Parts are moved quickly between the zones to facilitate rapid layer on layer growth.

Conclusion

For companies who directly manufacture, conformal coating solutions are available in the form of direct sale or lease. For companies without their own production capabilities, protection services are available to provide coating protection on finished product as an outsourced send-and-return process. **SMT007**

Zsolt Pulai is vice president of engineering at HZO.

Tower Semiconductor, Quintessent to Create Foundry Silicon Photonics Platform With Integrated Quantum Dot Laser

New capability to address optical connectivity in Artificial Intelligence/ Machine Learning (AI/ML) and disaggregated computing (datacenter)

Tower Semiconductor, a leading foundry of high-value analog semiconductor solutions, and Quintessent, a leader in laser integration with silicon photonic integrated circuits, announced their collaboration to create the world's first silicon photonics (SiPho) process with integrated quantum dot lasers, addressing optical connectivity in artificial intelligence/machine learning and disaggregated computing (datacenter) markets. According to the market research firm Yole, the silicon photonics transceivers market for datacenters is expected to grow rapidly at a CAGR of 40% to reach $3.5B in 2025.

The new foundry process will build upon Tower's industry-leading PH18 production silicon photonics platform and add Quintessent's III-V quantum dot-based lasers and optical amplifiers to enable a complete suite of active and passive silicon photonic elements. The resulting capability will be an industry first in demonstrating integrated optical gain in a standard foundry silicon photonics process. The initial process development kit (PDK) is planned in 2021, with multi-project wafer runs (MPWs) following in 2022.

"Quintessent and Tower are re-defining the frontiers of integrated silicon photonics under this effort," said Dr. John Bowers, UCSB Professor and Quintessent Co-Founder. "I'm very excited by the prospects for a new class of high-performance lasers and photonic integrated circuits on silicon, leveraging the unique advantages of quantum dot materials."

(Source: Globe News Wire)

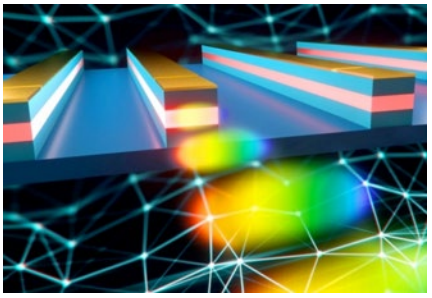

Image credit: Brian Long, UCSB

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Financing Simplifies Process Improvement Through Capital Expenditures

The Mannifest

Feature Column by Emmalee Gagnon, MANNCORP

The saying, "You have to spend money to make money," rings true when it comes to handling in-house production. Having up-to-date equipment is a key aspect to ensuring your SMT assembly process is the best it can be, and that requires a level of capital expenditure. Trying to avoid this expense will likely cost you more in the long run. Equipment downtime, slowed-down production, damaged PCBs, and more can be the result of not investing in the future of your equipment. By investing in machine upkeep and, when needed, equipment upgrades from reputable suppliers, you will experience fewer issues and better returns.

What Is Capital Expenditure and Why Is It Important?

Capital expenditure is the money your company spends to buy, maintain, or improve its assets—such as equipment. Now more than ever, companies with in-house production should safeguard their futures by upgrading equipment as needed. Also, companies currently outsourcing production will greatly benefit from transitioning to an in-house production model. As factory automation and customer demand push the boundaries of assembly capabilities, owning machinery—and periodical-

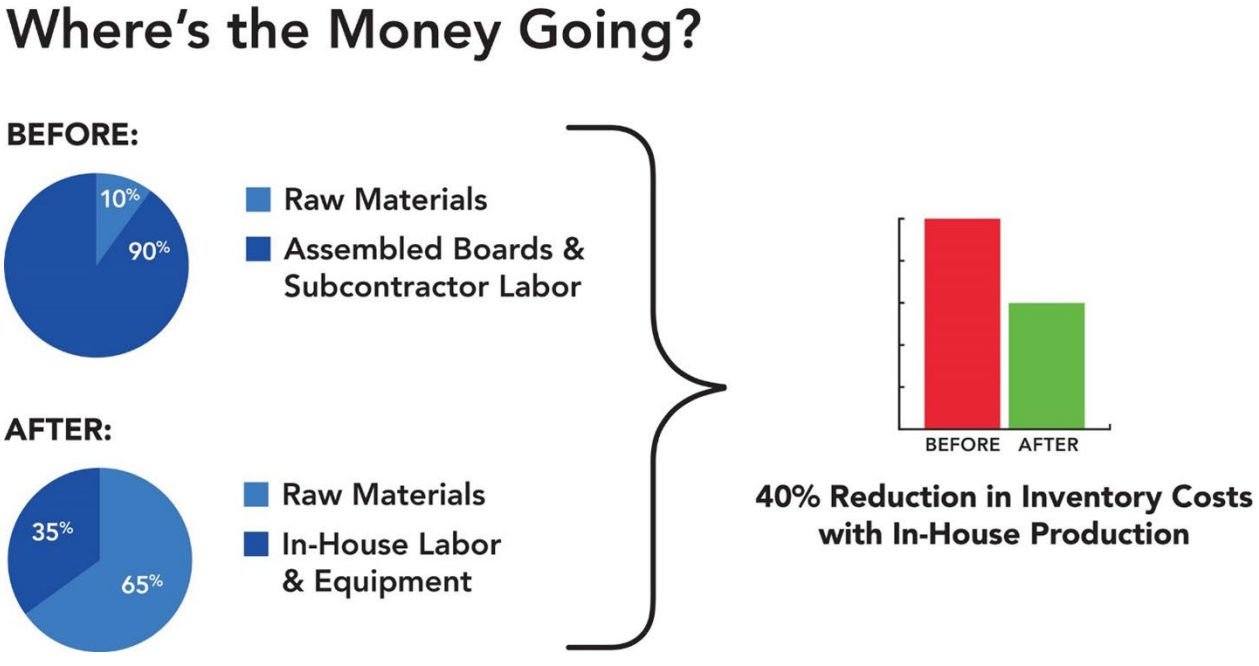

Figure 1

While others struggle just to keep pace, we stay ahead of the curve by constantly investing in the equipment, people and resources needed to be the best total PCB solutions provider in the industry.

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ly investing in new machinery—may become necessary for your company to continue being competitive in the marketplace.

Choosing to start in-house production is certain to reduce your overhead by an average of 35–40%. And by adding select equipment to your assembly line through strategic capital expenditures, you can always stay ahead of the curve. However, you should exercise caution, always making sure that what you are adding to your production line through capital expenditure will truly be a long-term investment that will be helpful for years to come.

Key points on capital expenditure:

- A capital expenditure is the money your company uses to purchase, upgrade, or extend the life of SMT equipment (and/or other assets)
- Types of capital expenditures include purchases of equipment and software updates
- Your capital expenditures should only be made on assets that will last for a year or more, making them investments for your company

Bringing Production In-House

If you don't already own and operate your own SMT line, choosing to purchase equipment can be a great investment. Looking at an SMT equipment purchase from a total cost vs. savings standpoint, there will be a quick payback period and the benefits to business operations and overall cost savings will be so substantial that the cost of equipment will be small compared to continuing with alternate expenses.

In light of these savings, what companies should make absolutely certain is that they don't underspend when it comes to installing their first SMT assembly line. Nothing is more frustrating than trying to produce a high-quality product with equipment that isn't up to the task. There's certainly no need to overspend either. The key is to purchase the best equipment that will get the job done effectively, while keeping an eye toward future needs and upgradeability.

Upgrades to Equipment

In the manufacturing industry, even high-quality SMT equipment needs repairs and upgrades. If you are working with a reputable equipment supplier, there should be warranties in place to help with software upgrades and replacement parts; on average, you can expect these warranties to last one to three years, depending on the machine. But the time will come when the warranties expire, or the needs of your company change, and it is time to invest in your line again. It is important to keep up to date with the available technology, or you may risk a loss of customers, reputation, and even key employees.

Figure 2.

When it is time to purchase new equipment, companies may decide to finance their upgrade. By choosing financing, you can achieve a better equipment lineup without egregious spending, breaking up payments over a span of time.

Figure 3.

Financing your Equipment Upgrade

Owning an SMT line could be easier than you think; by taking advantage of lower financing rates that are currently available, you could save big over an 18-, 48-, or 60-month leasing period. Depending on the company you go with, there may be special deals available (such as 0% APR for the first year), so it is always good to ask. There may also be a minimum purchase requirement (such as a $50,000 expenditure or more) and first and last payments will likely be required up front. Make sure to investigate the details and ask questions throughout the process to ensure you understand the requirements and to ensure you get the best deal possible.

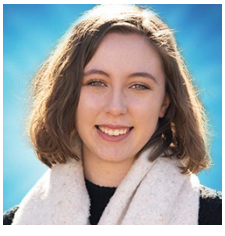
Bonus Tip: If you have working equipment in-house, keep what you have, fixing and upgrading it along the way. It is more profitable to have it out on the floor than collecting dust. It is good to have slower machines running in the background, and then have newer, high-speed equipment in the forefront. Also, if customers and visitors come to see your manufacturing set-up, there will be a larger range and bulk of equipment for them to view.

Tax Advantages of Upgrading Equipment

During your company's profitable years, purchasing new equipment and investing in existing equipment can open you up to tax advantages. You can retain cash and save on taxes by writing off equipment purchases through Section 179. Since Section 179 was updated in 2018 to allow for a 100% first-year deduction, even a single invoice of a machine purchase or lease during this tax year can lead to a full write-off for your company. Taking advantage of this opportunity can help reduce your overall capital expenditure and make your next equipment upgrade an even more profitable investment.

Moving Forward: Equipment as Investment

Overall, deciding to bring production in-house or deciding to upgrade your existing equipment are both examples of capital expenditure done well. This short-term expense is a long-term investment in your company's future. Like any effective capital expenditure, it will ensure that spending a little now will result in saving a lot later. If you are looking to get started with your own production—or have noticed that an equipment upgrade may be in order—don't wait. Shortages worldwide are making lead times longer, so it is best to ensure you have what you need when you need it by ordering early. Current lead times for new equipment are 16 weeks or longer on average. As a final point, repair the machines you own and invest along the way, purchasing before the upgrade you need becomes critical. **SMT007**



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

Increase Production Yield by Investing in Leading-Edge Equipment

Feature Article by Brent Fischthal
KOH YOUNG AMERICA, INC.

As we wind down 2021, we eagerly anticipate the new year, which should bring new opportunities. With the start of the new year, we often see new capital equipment budgets roll out, and production engineers and operations managers begin to evaluate how to best spend their newfound resources to improve the processes. There are multiple papers readily available from industry experts like Chrys Shea of Shea Engineering about the significance of solder paste inspection (SPI) equipment. Therein, you can find justification about why adding a solder paste inspection machine should be the first piece of inspection equipment considered. SPI will immediately reduce assembly defects.

Therefore, let us consider automated optical inspection (AOI). AOI technology has been available for decades, but only since the introduction and industry adoption of real 3D measurement has it emerged as a major area of focus to prevent defects and improve production yields in pre-reflow and post-reflow positions. Yet, many manufacturers are using antiquated 2D or quasi-3D systems that increase false calls and escapes.

In the early days of optical inspection, SPI and AOI systems were based on 2D inspection technology. These 2D systems were looking at different grey levels for solder joint and component detection. Most decisions were made by a "good/bad" comparison to reference images or "golden boards." While many 2D AOI systems remain in use, the effort needed to keep this technology at a low level of escape and false-call rates can be exceptionally high. These antiquated 2D systems facilitate false calls and failure escapes. This is because the concept of comparing reference images is still the main technique applied in 2D systems. To help the situation, some equipment manufacturers have added additional cameras and projectors to create a "quasi 3D" or "2.5D" inspection technology, but it is still based on the same inadequate concept of comparison or color assessment.

Now, after the introduction of 3D AOI, a transition to true 3D measurement is taking place. The benefits are clear: rock-solid

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threshold and inspection tolerances that minimize escape and false-call rates with minimum debugging effort. If you are facing production quality challenges due to your old 2D AOI equipment, it may be time to upgrade.

Measurement-based Inspection

Process optimization is desired by every manufacturer, as well as equipment suppliers. However, it has been difficult to realize due to the limitation of two-dimensional (2D) imaging, which was the de facto standard for the past decades. Not only it is difficult for 2D automated optical inspection (AOI) systems to identify defects on curved and reflective solder joint, 2D AOI systems do not generate reliable data. Every aspect of the 2D inspection process relies on contrast, not quantitative measurement. As such, 2D AOI users must either scrap or repair defective boards, which increases costs and eliminates process improvement opportunities.

The introduction of 3D imaging to the inspection market solved some of the problems. By measuring components and solder joints, and then offering critical height information to the inspection algorithms, users could locate errors like pad overhang and insufficient soldering. However, the validity of the measurement data remained questionable as most of the 3D AOI systems use "blob detection" to find the component body; but, this technique is susceptible to external factors like board warpage and component proximity. Since finding the component body is the critical first step in the inspection process, it can negatively affect the whole inspection sequence if inaccurate.

Koh Young technology has overcome this challenge by using 3D technology for all component types to extract their bodies (Figure 1). True 3D measurement is processed by a parallel computing engine. While 2D inspection technologies are combined with real-time PCB warp compensation to offer accurate inspection data, the new platform goes much further. Using patented shadow-free 3D technology, we provide improved results by measuring every aspect of the component and solder joint in accordance with the IPC-A-610 standard. This system's ability to generate a significant set of reliable measurement data can be found, for example, in our KSMART analysis and optimization solutions.

Ground-breaking Transparency

In this hyper-competitive world, manufacturers place ever-challenging demands on process solutions. Manufacturers want to monitor and adapt the process to achieve zero defects by accessing all the data at anytime, anywhere. They must also cope with shorter life cycles, so

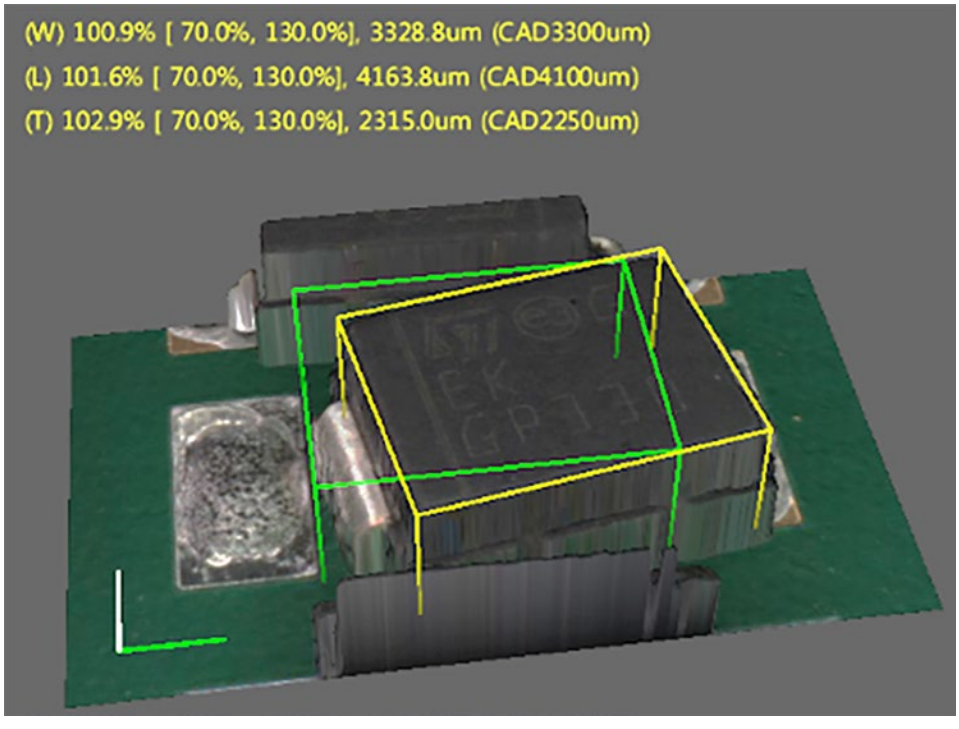


Figure 1: Mapping the component body by using 3D measurement technology.

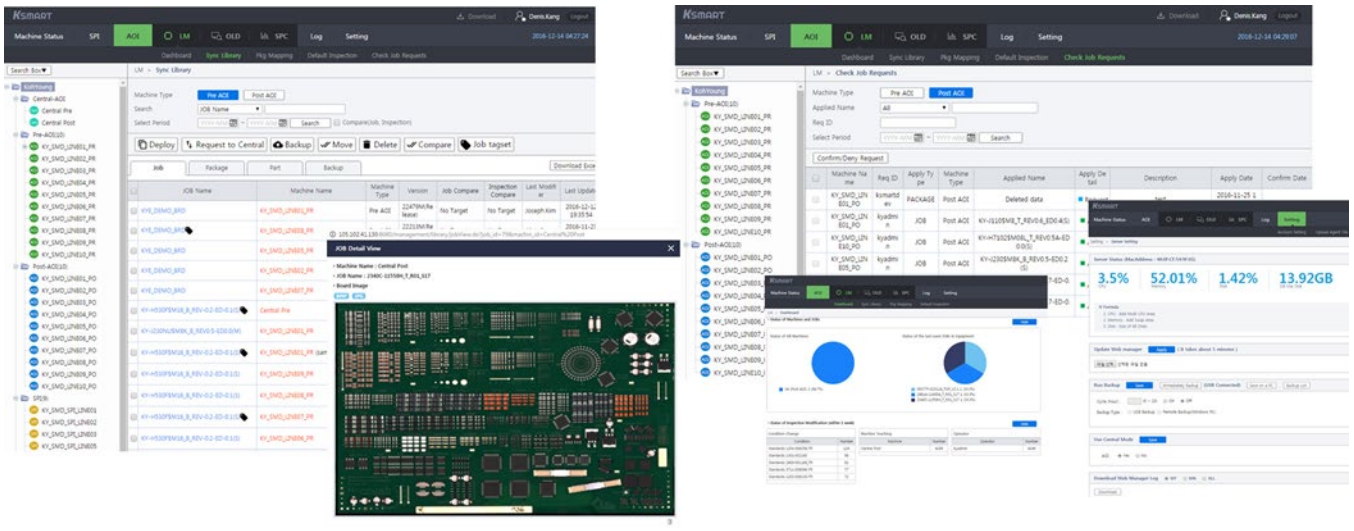


Figure 2: KSMART Library Manager module on web interface.

inspection solutions should be able to collect and analyze a large amount of data to produce traceable results.

Our approach to the analysis solution is to collect all inspection and measurement data from all equipment via a hub, and then provide the data anywhere within the network through a web-based application. Big data is a foundation for Industry 4.0, so advanced inspection systems must evolve from simply judging "pass/fail" tools into highly intuitive, dynamic decision-making systems, which emphasizes the need for reliable, traceable data.

This traceable data can then ensure the highest levels of transparency by showing all conditions of the lines, including machine configuration and software version, while providing the required documentation for changes to the job file, package, part, and more. Users can quickly verify whether all lines are within the ideal conditions. If a variance occurs, the user can instantly upload optimized programs and inspection conditions without fine tuning with the Library Manager module (Figure 2). The software module provides a complete central management solution for component libraries, programs, inspection conditions, and more. Library Manager combines all equipment into a single centralized library. All changes are traceable and manageable by user level Identification. Such controlled data management allows continuous analysis of the raw data and helps guide experts towards the right direction.

Eliminates the Bottleneck

Of course, maintaining quality, repeatable measurement data is not enough to realize a smart factory. Instead, analyzed data needs to be instantly visualized with relevant indicators like yield rate, NG analysis, PPM analysis, Gage R&R, offset analysis, and more to allow users to compare board performance and identify process deviations. Using the real-time statistical process control module, users can identify the exact defect origin by checking false calls and NG parts from the dashboard, as well as evaluate, and optimize default settings.

For instance, if the thickness was the major problem in a worst-case part, users can click the part to view analysis result and find the root cause. An X-bar chart of measured thickness of the part will be shown across time with average, minimum, and maximum values, plus tolerance levels (Figure 3). If values frequently deviated from average values and tolerances are too tight, users can adjust the tolerance levels to minimize false calls. On the other hand, if the process was stable, operators can tighten the tolerance to prevent

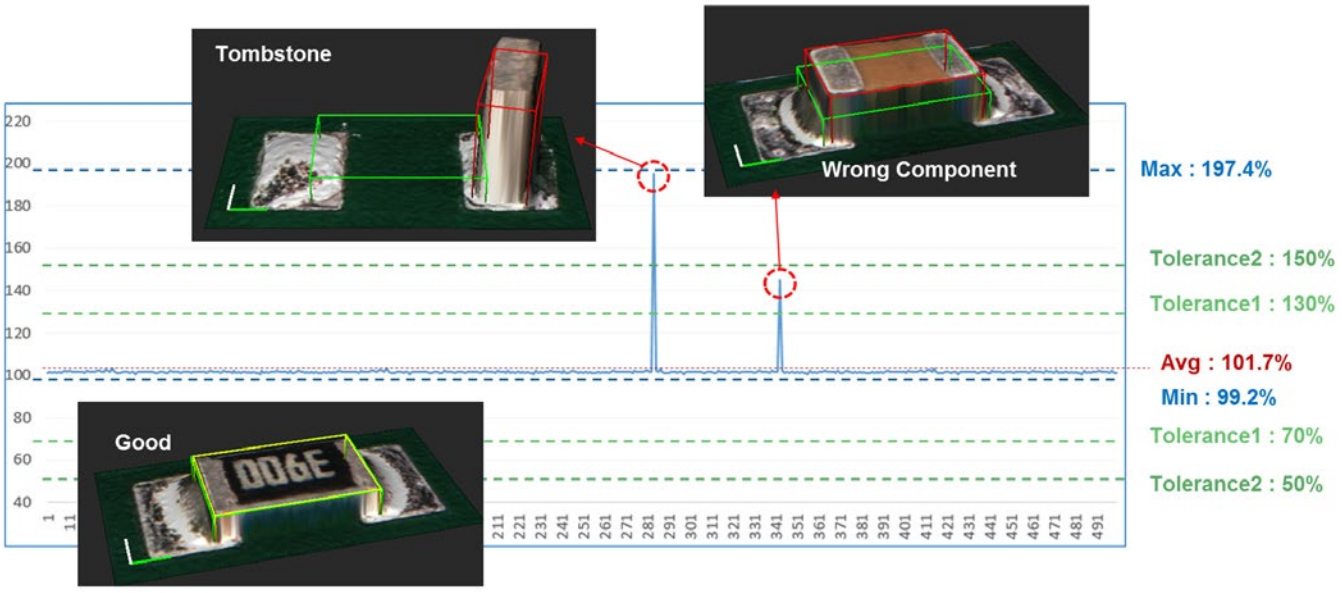


Figure 3: X-bar chart for thickness of R1005 part.

future escapes. The measurable data helps improve the process.

In the meantime, operators have the ability to load and debug identified defects with accumulated historical real data from all lines and simulate the results of any adjustments without affecting production. Users verify if the adjusted setting is "suitable," then, deploy new, optimized programs and inspection conditions to all production. These iterative actions optimize processes based on objective, real measurement data, not merely by a user's experience. In some use cases, we see users achieve as much as a 98% false call reduction.

Connecting Big Data

A single inspection system has limits and cannot manage and optimize a complete line while in isolation. Working with our partners, we are developing connectivity solutions that optimize the process by exchanging real-time measurement data from SPI and AOI systems with every machine on the production line, feeding real measurement data such as offset, volume, height, area, and warnings to other systems, while analyzing trends for process optimization and traceability. When this solution is combined with CFX and HERMES, it can help manufacturers define correlations between distinct processes (Figure 4).

Using this advanced communication, the AOI can feed correct mounting position values to mounters, which ensures components are mounted in the targeted position. This feature improves process repeatability by automatically adjusting component placements and catching the shifting trend to make further position corrections.

Autonomous Process Optimization

Understanding the increasing importance of networked intelligent systems in the smart factory, the modular platform is designed for future growth and expansion. When new modules are released, a manufacturer can implement the upgrades as needed, extending capabilities beyond automated adjustment toward a comprehensive infrastructure for autonomous process optimization.

Budgeting for Capital Equipment

Clearly, the capabilities of leading edge AOI equipment will help manufacturers improve their electronics manufacturing process, and just like SPI equipment, the benefits will be immediate. Now, it's time to consider the in-

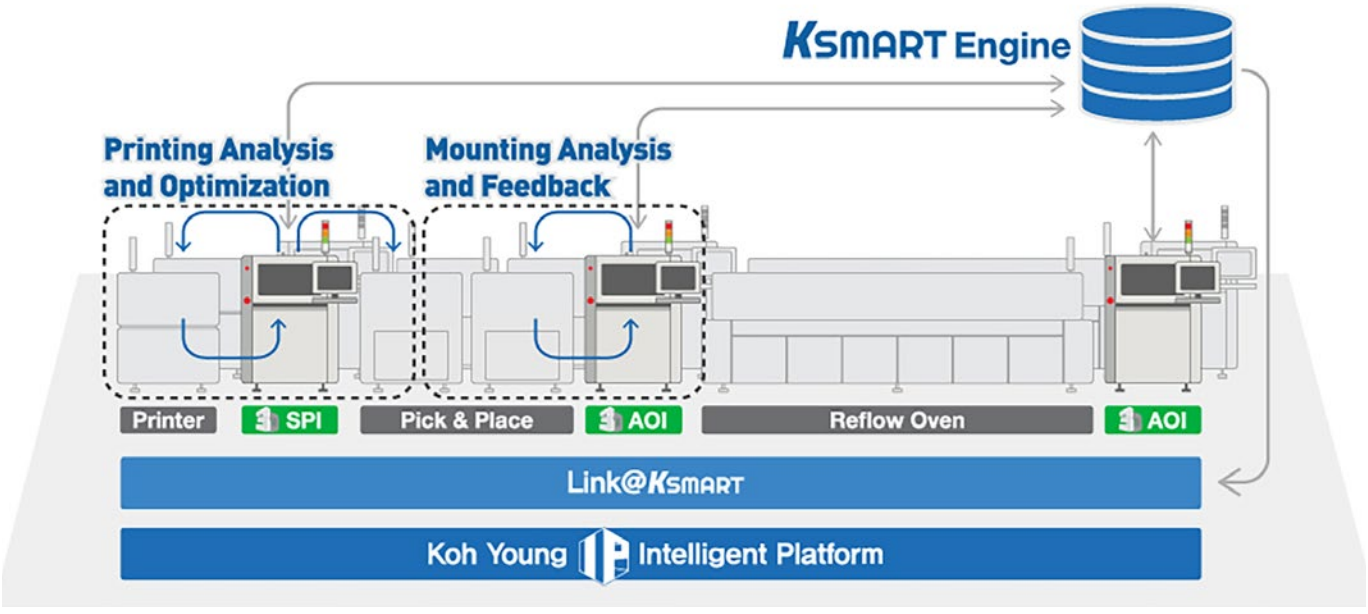


Figure 4: Achieving a smart factory by using 3D inspection process information.

vestment. Of course, many companies opt to purchase the equipment.

Owning the equipment your business uses to operate gives you the highest degree of control over how you manage your resources. You can sell the equipment at any time or continue to use the equipment for years if that use remains productive. When you buy capital equipment for your business, you own the equipment, get the use of the equipment for as long as it lasts and can depreciate the cost on your taxes.

With a lease, you trade some of that control for more simplicity in the operation of your business. With a lease, the equipment is delivered, you make the payments, and the equipment is either purchased or removed at the end of the lease. You spend little or no time managing the equipment compared to if you owned the equipment. Leasing the equipment instead of buying might cost more in terms of cash flow, but leasing comes with its own set of advantages.

Leasing as a Viable Alternative

Why is it important for electronic manufacturers to have the right financial solution for SMT investments? The world is changing faster than ever before. While some equipment can inherently withstand the pace of change, other equipment cannot keep up with the technological or business challenges. Many equipment suppliers are just not able to provide future-proof equipment solutions, which means many electronics manufacturers are investing in equipment for upward of 10 years with the inherent risk the equipment will not fit their business model or production needs in the future.

Leasing is a solution to overcome this issue. Lease companies can provide 100% financing with a $1 purchase option. This approach allows the manufacturer to pay for equipment as the equipment pays for itself with production runs. Some firms offer options to increase working capital by deferring the initial lease payment for up to 90 days. The application process once deemed complicated and burdensome has evolved. For instance, credit approvals up to $500,000 can be obtained without financial statements for qualified customers. This requires only a one-page credit application; a credit approval can be obtained in only a few days. Manufacturers can lock in low finance rates for as long as seven years. There is a reason equipment leasing has been and will remain a viable option to help acquire capital equipment.

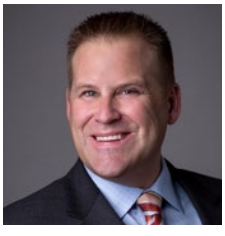
Now let us consider a novel leasing option. What if manufacturers could update the SMT equipment every few years to match the changing production requirements or change equipment simply because equipment suppliers have introduced more capable solutions? Companies like SMT Renting offer a flexible lease concept with service and warranty. Not a traditional financial lease, like banks are offering, but a full operational lease with maximum flexibility, tailor-made towards electronic manufacturers. They focus purely on the electronics manufacturing industry, working closely with the top equipment vendors within the industry to provide manufacturers the option to "stop & swap" equipment regularly—at attractive monthly rates. This gives several benefits to electronics manufacturers such as production flexibility, increased working capital, and faster time to market. Consequently, many electronics manufacturers are changing their financial solution for SMT investments to leasing.

Conclusion

Overall, inspection systems and the exceptional data they produce are making a huge contribution to the digital transformation of the factory floor and the drive to Industry 4.0. AI-engine and deep learning research and development continue to achieve this vision with a focus on next-generation cooperative efforts that expand process capabilities and factory performance. To this end, the company has established three additional R&D centers worldwide to facilitate a quantum leap in technological leadership and competitiveness, even paving the way into new markets and industries beyond SMT. **SMT007**

Download your copy of *The Printed Circuit Assembers Guide to... SMT Inspection Today, Tomorrow, and Beyond.*

Attend the on-demand, free 12-part webinar series, "Converting Process Data Into Intelligence," with experts Joel Scutchfield and Ivan Aduna.

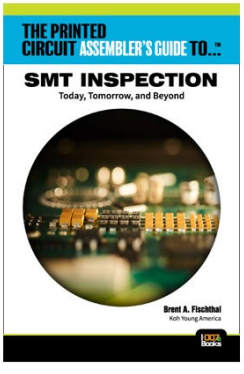


Brent Fischthal is senior manager, Americas Marketing and Regional Sales, Koh Young America, Inc.

Excerpt: ***The Printed Circuit Assembler's Guide to... SMT Inspection: Today, Tomorrow, and Beyond***

Chapter 7: Smarter Manufacturing Enabled by Inspection

There is much that inspection can offer the world of manufacturing, and in this book, we have focused on the current state and the near-term future. Right now, inspection plays an increasingly important role in making manufacturing smarter. Inspection allows us to deliver the quality we know is essential for the products being manufactured right now, and in the future. It is providing the data that allow companies to improve their own performance and efficiency. Data from inspection is contributing to almost every process on the SMT line, providing real insight into faults and their root cause. This inspection data is also providing immediate feedback to other processes in the line, often in real time, making on-the-fly adjustments that reduce scrap, downtime, and even the use of consumables such as solder paste and cleaning materials. Inspection is picking up the slack in terms of skill shortages, allowing lower-skilled operators to manage lines or parts of lines and, thanks to intuitive software, allowing fewer operators to manage more machines and lines. All in all, inspection systems and the exceptional data they produce are making a huge contribution to the digital transformation of the factory floor and the drive to Industry 4.0.



But what of the future beyond the short- and medium-term goals of digitally optimized factories? How far can inspection and data take us?

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MilAero007 Highlights

Electronics Industry Summit With U.S. DoD Spawns More Dialogue, Collaboration ▸

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

Rocket Lab Spacecraft Confirmed for Mars as NASA Greenlights ESCAPADE ▸

Rocket Lab, a global leader in dedicated launch and space systems, announced it will begin final mission design and manufacture to supply two interplanetary Photon spacecraft for a science mission to Mars, delivering Decadal-class science at a fraction of the cost of typical planetary missions.

IPC to Hold Training Course on PCB Design for Mil/Aero Applications ▸

IPC will be holding a training course on PCB design for military and aerospace applications. Scheduled every Monday and Wednesday, August 30 to October 6, 2021.

Kodiak Assembly Solutions Now ITAR Compliant ▸

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

BAE Systems Utilizes VJ Electronix's XQuik II ▸

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

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

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

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

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

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

The Institute of Circuit Technology continues to deliver first-class on-line events. This year's ICT Autumn Webinar presented papers by leading experts on high-voltage testing and advanced antenna materials. It was introduced and moderated by ICT Chair Emma Hudson.

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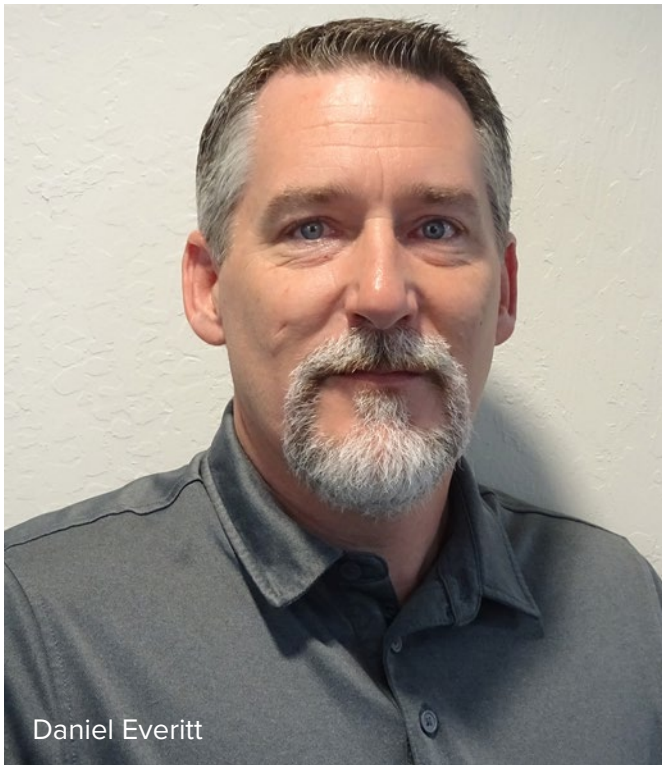
Daniel Everitt

Naprotek

Knowing Your Value and Maximizing It

Interview by Nolan Johnson
I-CONNECT007

Nolan Johnson talks with new Naprotek CEO Daniel Everitt about Naprotek's value-add for customers, the market dynamics, factory automation, and more.

Nolan Johnson: Daniel, the last time I spoke with Naprotek, there was someone other than you in the CEO seat. This is news.

Daniel Everitt: Absolutely. The founder, Najat Badriyeh, started the business 25 years ago. Interestingly, she was working in the industry at the time, and she saw something even then, where the business she worked for wasn't supporting the customers in their high mix, low volume, high level of customization from prototype through early NPI. She went out on her own, taking the risk to build a company that would support those kinds of requirements, with an emphasis on custom-engineered electronics products. It's more than just "putting tops on bottoms," like you see in traditional EMS. She spent 25 years perfecting that model and providing a service level to key customers across the various high-reliability segments of defense, space, medical, precision semiconductor solutions, and semiconductor capital, as well as complex industrial tech solutions. She deliberately avoided supporting commercial good-enough, simplistic products that would generally transition to an offshore manufacturer. The idea was to stay pure to the model, and support the highly regulated markets. It has been my pleasure to take the reins of the business as Najat has transitioned to our Board of Directors.

Johnson: That includes quite a bit of detailed interaction and service, I would have to think.

Everitt: It stops being a labor and supply chain arbitrage game, and it's more about the complexity of manufacturing and developing the processes to support those custom solutions for our customers. Arguably, Naprotek is providing a technology and service solution to our customer rather than a traditional manufacturing service.

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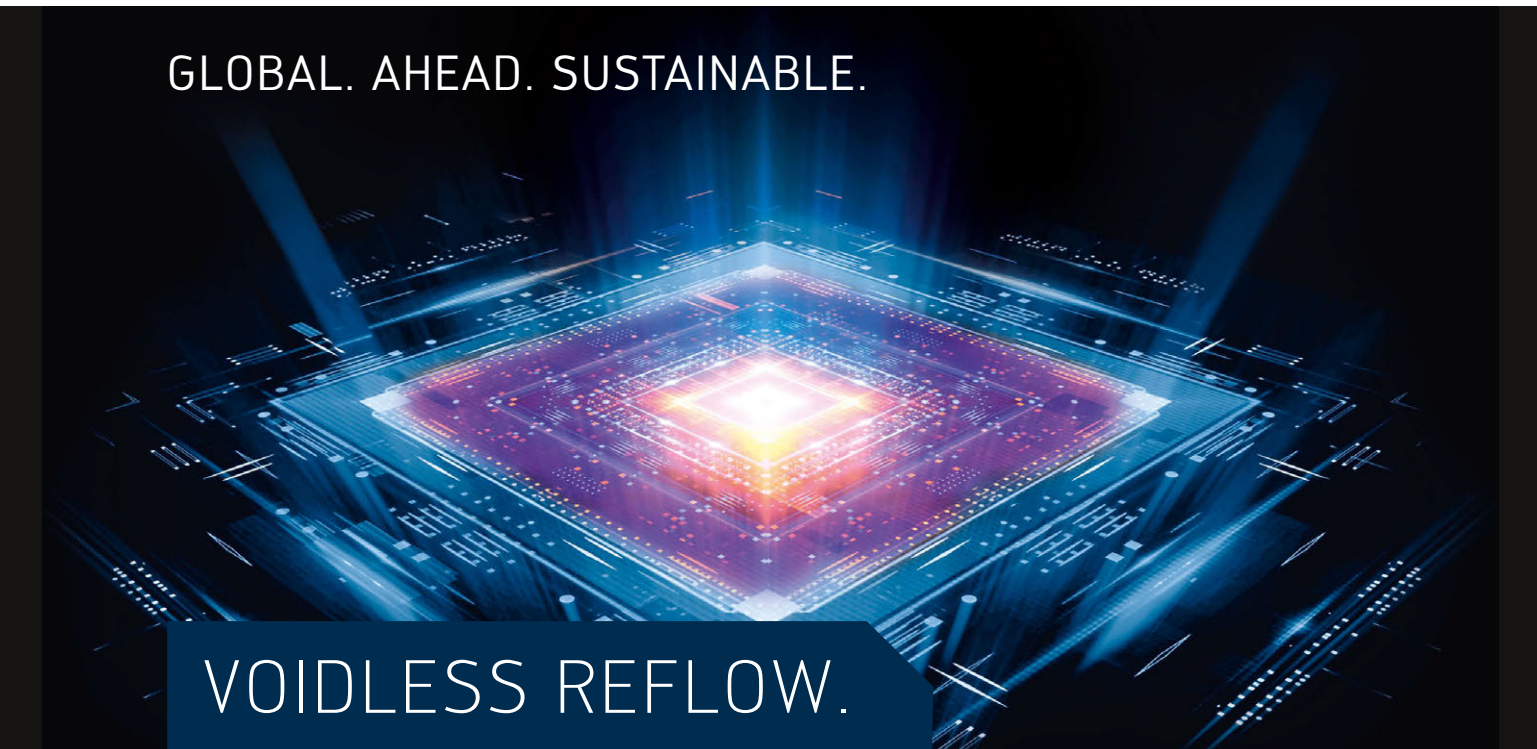

VOIDLESS REFLOW.

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Ersa EXOS 10/26: Voidless reflow soldering with vacuum.

With the EXOS 10/26, Ersa offers a vacuum reflow soldering system with eleven heating zones, three heating circuits for the vacuum chamber and four cooling zones for extremely voidfree connections in electronics production.

The absolute highlight of the EXOS is the vacuum chamber, which is part of the peak process area - this allows the void rate (depending on paste, component and PCB) to be reduced by up to 99 %.

The conveyor system is divided into four segments. Infeed, preheating and peak zone, vacuum module as well as cooling zone are equipped with their own individually controllable conveyor. The conveyor system of the vacuum section is free of lubricants and therefore - like the system as a whole - very low-maintenance. The EXOS software also allows the operator simple and intuitive operation of the various functions and ensures safe continuous operation.

Ersa EXOS 10/26 convection reflow soldering system with vacuum module

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www.driven-by-kurtzersa.de

The manufacturing floor at Naprotek's San Jose, California based headquarters.

Johnson: There's a lot of discussion about becoming both more nimble and more complex in the North American market segment. It seems like you're already well-positioned there. What's your assessment of the market?

Everitt: The U.S. supply chain has had a deeply diminished capability in hybrid technologies. If you want to mix microelectronics and SMT to achieve a hybrid manufacturing typology, there are very limited supply chain options in the U.S. for that. Couple that with the U.S. taking a stronger stance on certain technologies that include optics, silicon photonics, artificial intelligence, and RF technologies; many of these technologies are now more closely controlled under current regulation, so it has created this momentum in the high-reliability markets to bring some of that capability back into the U.S. and invest in those capabilities.

Johnson: That seems to me like you're going a little bit against the prevailing winds in North America.

Everitt: On its face, it may sound that way. I would offer as a hypothesis that many of the U.S. manufacturers have driven manufacturing to Asia—and China, in particular—and have broadly lost the ability to innovate. Look at what the DoD is directly investing into companies like Intel and IBM to build industrial capacity in advanced microelectronics.

That is very real, happening now, with funding. There is a reason for that. Certain technologies, as we integrate these technologies together, become controlled, and, as a result, difficult to export. If your only solution today is to go to China for certain technologies, you may not have a manufacturing solution to bring your product to the marketplace. As the Naprotek team looks at both organic and acquisitive growth, we're going to look for those capabilities that add strength in those targeted areas—advanced microelectronics, hybrid manufacturing, photonics, and RF technologies—allowing us to take our purpose-built model, add that strength of capability, and offer it to the marketplace.

Johnson: There is a lot of U.S. government involvement, finding ways to help incentivize and revitalize electronics manufacturing in our industry. But what I'm seeing is that the primary focus is on semiconductors. We need that technology in place. I don't see a lot of PCB money included in those discussions. What's your take on that?

Everitt: It is happening, but it's got a bit of a pull function to it. If I'm a chip designer, I'm developing these new products for government, for federal use chip platforms, silicon photonics, etc., and that's addressing other bandwidth problems and data rate problems that they're working to address. The next thing you've got to do is figure out how to package it.

How do I get that technology to where I can consume it? If I am a U.S. government customer and I'm developing a radar or missile system,

my quantities and volumes may feel like high volume to me, but they're not high volume relative to consumer electronics. So, where do I find those partners that are going to package my components and then be able to take those packaged components into the board level, module assembly, or even a sub-system or into full box build? Today, that's deeply fragmented with insufficient capacity.

If I'm that same chip designer, I'm going to look for a boutique SMT packaging house, then I'm going to look for a boutique integration house. I have to manage a disparate supply chain because the capability to do vertically integrated custom manufacturing solutions is rare. Where it does exist right here in the U.S., and has existed for a long time, is with specialty companies. They're not multi-market generalists where they're offering their capability to defense customers, space customers, etc. There are really good defense shops that focus on electronic warfare that can do all those things, but they stay in the electronics warfare segment. There are good space shops. Same story there. If it's not going into a payload, they're not doing it.

The next level of problem-solving is most of those companies are "IP inflexible." If they don't get some design content, they're not going to play. That is a very traditional way of thinking about our U.S. supply chain—you've got the government, or the prime or the major contractor, maybe a medical, defense, or space company. They often work with a Tier 2 who has some design content in the systems, and then work with various manufacturing service partners who have no design content. What happens when that needs to collapse a step because the design authority is at the top and not in the middle? That creates this new

Since the founding 25 years ago, Naprotek has specialized in serving highly regulated product markets.

gap in the marketplace where the big chip or system company who is designing for federal or government use, the space, rocket, or medical companies, want to be their own design authority, so they need a manufacturing partner who's not going to insist on having IP. You've got to be IP flexible to capitalize on this new trend.

Johnson: Right. Now, 30 years ago, those same semiconductor companies would have had an in-house manufacturing arm to do that, to create a finished goods board subassembly; generally, all that is gone now.

Everitt: In the past, companies managed their own prototypes, their new product introductions, their early batch, their pilot build, or production verification builds. Use whatever terminology you prefer, it depends on the market. Many have lost the in-house board manufacturing capabilities and the associated innovation. Growing up in the manufacturing world, one thing I've learned is most of the innovation comes from interaction between the technical staff and the manufacturing floor, solving real world problems on how you make things and how you make things better. That ability to innovate has been severely diminished within the U.S. supply chain. It is one of the things I found so interesting about Naprotek. Our engineers and our customers' engineers are working hand in hand with the shop floor on custom process solutions, custom manufacturing solutions every day, and it directly influences how to design the product better. It creates this virtual cycle—making a better product equates to designing better products.

Johnson: How do you see digital twin fitting in your business model? Is digital twin a strategic vision for you?

Everitt: The conceptual idea of a digital twin is highly relevant to the design community, and I would expect that the concept will be deployed more broadly in the high cost of build, and high cost of failure systems, (e.g., rocket engines and launch vehicles). It would be reasonable to assume that the data we collect through our manufacturing would be used in our customer's virtual models, simulation, and systems digital twins; however, we are not the design authority, so this is not directly on our roadmap. We will of course continue to drive the rigor in our systems to collect the relevant data for our high reliability customers to support their successful data integration.

Johnson: Are implementing capabilities such as CFX and machine intercommunication up and down the manufacturing?

Everitt: Yes, we leverage a multi-axis approach to essentially produce a "connected factory." You can run this process on one of two axes, including the product or process axis. Because we have such an incredible diversity of customers and part numbers that we support, we run our process control at the process axis level rather than the product axis. We might build only 10 of an assembly for a customer in a year,

but to build that 10, we will use the same process across 50 customers and several hundred part numbers. We look at process excellence over the individual product excellence, and that's really a necessary artifact of being able to support prototyping.

To give you an example, we will look at AOI failures and then correlate AOI failures across multiple products. We look at it from a process perspective, and then say to ourselves, "What can we do in our process to improve our underlying capabilities on 10 or 15 products, not just one product?" Because we want to know that our process is going to be capable for the next prototype that is going to be equally wild, wicked, and unruly. This ferocious focus on process has driven us to be constantly looking at capability and inspection, and how we close the loop between test, inspection, and manufacturing. When you support high-mix, low-volume production, you don't get the chance to say, "Well, we will perfect the build process over the production ramp." In our world, you often only get one chance to get it right.

Johnson: As an incoming CEO, what are your strategic initiatives for the next 12 to 24 months?

Everitt: The answer starts with what's happening in the market and then backing back up to what it means to us. We all know we're still transitioning into something new, a "new normal." There is significant pent-up demand in the customer space for design activities and support of their design activities, so we want to support our customers in this phase. Broadly speaking, the industry is also seeing challenges in parts availability, material obsolescence, and lead time expansion.

Naprotek continues to explore growth opportunities through equipment and new market opportunities.

I think we're going to see a wave of material and parts obsolescence over the next six to 24 months that will be unparalleled in the past 20+ years. I don't know if it will be the worst we've ever seen, but it will be an enormous challenge. Looking at that trend, then looking at what's happening with large semiconductor companies developing new technologies in silicon photonics, integrated RF technologies, greater consumption of custom technologies because design cycles are moving ever faster... looking at all of that, we back up and say, "What can we do about it?"

First, let's continue to be the best and leverage our current business model. We want to develop custom manufacturing solutions and be able to offer turn times in days, not weeks or months. We know that if we get our customers to test and they get empirical data, and the faster we can cycle, the faster they can iterate through their design cycle. We're going to continue to focus on velocity because that is the secret to supporting development customers.

Second, we're looking at expanding our capabilities in our offering, whether that be organic or through acquisitions. We'll be looking at areas such as custom semiconductor components that can help customers address their obsolescence issues, where we could step in with a high-mix, low-volume custom solution to address the supply or capability gap.

And then a deep focus on hybridization of technology, being able to take SMT technologies along with chip and wire and bring them together so we can help customers achieve a level of form factor density and system performance that they may not be able to get from just one typology or the other. If we can achieve even a portion of our plan of record for the next 12 months, I think we will be answering the mail for many of our customers immediately and be standing by and ready as the customer community in the high-reliability markets makes their transitions into the future. They'll know that there's somebody standing by to support them.

Johnson: What are your thoughts on partnering more closely with PCB fabs? And how would you characterize fabricators, with respect to their ability to respond to Naprotek's needs?

Everitt: If you look at a lot of the high-end HDI shops in the U.S., the HDI fabs, many are pushing toward fine features, high layer count and passive component integration.

Things are getting faster. The parallels are getting closer together. Components are going to finer pitch. That's going to put a stress or even a gap on SMT capabilities, because the board shops could probably go to finer features than what could actually be manufactured, but the current state-of-the-industry SMT capability has a floor on both the pitch and tolerance that can be placed in high speed.

Here's a very specific example. If you have a decent end-to-end, two-sided SMT line, and you can place a 250- to 280-pitch part at 10% tolerance on accuracy of placement, you're down at 25 to 28 microns of accuracy, whereas if you want to place a silicon photonics chip, you need to be sub-micron.

If you could hold one-micron accuracy today, you would be in good shape to support the development, but you need to be sub-micron to be able to support the long-term roadmap of that technology.

If the global capability and capacity in SMT today cannot place a component below 25-micron accuracy in high speed, we have an emerging capability gap. The fab suppliers may have to retool or invest in new capabilities. We're going to have to develop and, as an industry, invest in new manufacturing technologies, including advanced microelectronics and high-speed placement in advanced microelectronics. The equipment providers in that space are really stepping up. They see what's coming, and they're developing automation that will support that as well. But I would equate where we are, as an industry today, to a time when everybody was doing through-hole and hand placement in SMT, and then high-end automation came into play. And there were a lot of companies who just sat back and said, "We're okay," until they weren't. I do not mean to imply that SMT as we know it is going to be usurped; that would be ridiculous. Rather, high-speed and high-performance applications will demand a level of precision that cannot presently be supported, and hybrid manufacturing approaches will likely become more commonplace as industry marches toward the future.

Johnson: Thank you. Great perspective on where the industry is going forward as well, Daniel.

Everitt: I appreciate your time. SMT007

Supplier Highlights

MIRTEC Launches AI-based Smart Factory Automation Solution 'INTELLI-PRO' ▸

This technologically advanced software and algorithm package is specifically designed for the purpose of improving the performance and convenience of MIRTEC's complete line of AOI machines.

Saki Develops Next Generation 3D AOI System with Artificial Intelligence (AI) ▸

Saki Corporation, an innovator in the field of automated optical and X-ray inspection equipment, is pleased to announce a qualification by DENSO Corporation that officially approves Saki's next generation 3D Automated Optical Inspection System (3D-AOI).

Nordson Announces Agreement to Acquire NDC Technologies ▸

Nordson Corporation has signed a definitive agreement for the acquisition of the NDC Technologies business, a global provider of precision measurement solutions for in-line manufacturing process control, from Spectris plc.

Mycronic Receives Order for SLX System ▸

Mycronic AB has received an order for an SLX system from a new customer in Asia. The order value is in the range of $4–$6 million. Delivery of the system is planned for the third quarter of 2022.

Dymax Releases Dual-Cure 9771 Light + Moisture-Cure Conformal Coating ▸

Dymax, leading manufacturer of rapid light-curing materials and equipment, is excited to announce the release of its unique conformal coating, 9771, specially developed for the use of printed circuit boards in missiles, satellites, and spacecraft.

ETL Dorset Boosts Surface Mount Capacity With Europlacer's Specialist Rapid Productivity Solutions ▸

Long-term Europlacer customer Electronics Technicians Ltd (ETL), located just 10 miles from Europlacer's UK HQ, has embarked on a broad modernization investment programme at its Dorset-based contract manufacturing facility, which includes the purchase of new assembly equipment and accessories to expand its surface mount production capacity and capability.

VJ Electronix Announces Competitive Price Reduction on XQuik X-ray Component Counters ▸

VJ Electronix, Inc., a leader in rework technologies and global provider of advanced X-ray inspection and component counting systems, announced a competitive price reduction on its XQuik Series Component Counters.

Rehm Thermal Systems Introduces Environmental Management System ▸

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Flux and Cleaning—How Clean Is Clean? Part 2

SMT Solver

by Ray Prasad, RAY PRASAD CONSULTANCY GROUP

The selection of a flux and cleaning process determines, to a large extent, the manufacturing yield and product reliability of electronic assemblies. In Part 1, I discussed various types of fluxes and why we use them, followed by various types of cleaning materials and processes. In this column, I will discuss cleanliness requirements to know whether the boards have been cleaned enough to meet their functional requirements for their intended applications.

I will discuss the cleanliness requirements in two parts. First, I will summarize the industry requirements as established in the latest industry standards, IPC 610 Rev H, and J-STD-001 Rev H, followed by my recommendations for cleanliness requirements without violating industry standard requirements.

Industry Cleanliness Requirements

Among many other requirements such as setting up accept/reject criteria for solder joints, IPC 610 and J-STD-001 also establish cleanliness requirements for electronic assemblies. Here is what the latest revision (Rev H) of IPC 610 and J-STD-001 have to say about cleanliness requirements. Please note the use of the term shall instead of should in the standards to avoid confusion.

General Industry Cleanliness Requirements

As is the case for many other quality acceptance requirements, IPC has essentially left it to the users and suppliers to determine the cleanliness requirements. I will highlight some

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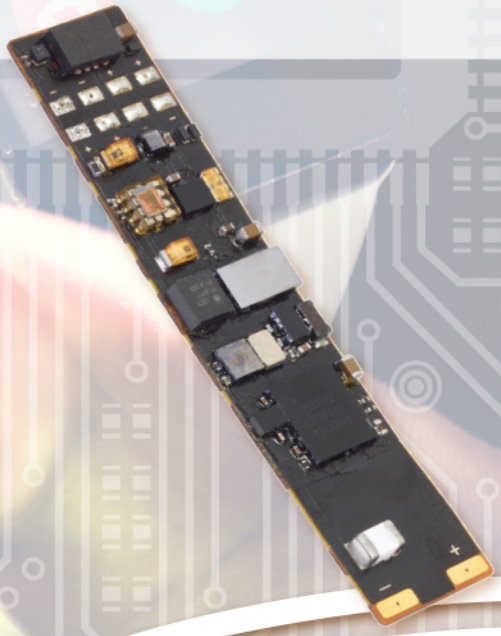

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of the major points in the standard (IPC-A-610H and J-STD 001H).

"Unless otherwise specified by design, or by the User, the acceptability of the residue condition shall be determined at the point of the manufacturing process just prior to the application of conformal coating, or on the final assembly if conformal coating is not applied."

The requirement is essentially based on process control parameters, since changes in manufacturing materials or process parameters may detrimentally end item residue levels and product reliability, which may necessitate requalification. Manufacturing materials and/or process changes fall into two categories: major or minor, with major changes requiring validation, and minor changes with supporting objective evidence.

Qualification testing is generally considered to be more extensive in nature. Minor changes with supporting evidence are generally lesser efforts, involving shorter duration SIR tests or focused chemical characterization tests.

Again, the standard specifies that the degree of process change and associated required notifications of change are left to be established between manufacturer and user. However, IPC does provide some practical guidelines as to what to do. Here are some examples:

1. You should not have discernible residue, but flux residues from no clean fluxes are acceptable.
2. However, flux residues that inhibit electrical testing or visual inspection are not acceptable.
3. Similarly, dull appearance is acceptable but colored residues or rusty appearance are not acceptable.
4. Any foreign objects that potentially may be conductive are not allowed especially if they violate minimum electrical spacing requirements.
5. White residues which may contain chlorides and cause corrosion are not acceptable.

Here are some more guidelines in the standard:

"Unless otherwise specified by the User, the Manufacturer shall qualify soldering and/or cleaning processes that result in acceptable levels of flux and other residues. Objective evidence shall be available for review. The use of extraction testing, i.e., ROSE, IC, etc., with no supporting objective evidence shall not be used to qualify a manufacturing process.

Supporting objective evidence shall be test data and/or other documentation demonstrating that the performance of the actual hardware is not adversely affected under conditions anticipated in the service environment. This may include:

1. *Surface insulation resistance (SIR), possibly in combination with ion chromatography testing, to demonstrate acceptable levels of residue.* (Author's note: However, no specific value is mentioned as to what the SIR value should be. I will provide some numbers as to what that should be based on historical data as to what you can expect if you follow some common process control.)
2. *Historical evidence, including field returns, warranty service records and failure analysis, demonstrating that ionic and other residues on delivered products have not caused failures in service.*
3. *Electrical testing results, with power on, during extremes of temperature and humidity, which simulate the end use environment. Electrical failures should be subjected to failure analysis to determine whether ionic or other residues have caused the failure. This testing may occur during product qualification or outgoing acceptance testing. Rework processes shall be included in the process qualification.*

When it comes to visible residues, the requirement is that assemblies subjected to cleaning processes shall be free of visible residues. However,

the visible residue requirements are established between Manufacturer and User."

The bottom line is, IPC leaves it up to users and suppliers to establish mutually acceptable requirements based on the applications for their products. The standards also provide some references and white papers for additional guidance that users and suppliers may decide to use to establish their requirements. What it boils down to is that different users and suppliers can have different cleanliness requirements for the same applications and same products. I am not sure if that is a good thing.

My Views on Cleanliness Requirements

As discussed above, IPC does not tell you what the specific cleanliness requirements should be. But it does give a roadmap as to how to go about establishing the requirements. As noted earlier, IPC does have some very specific requirements when it comes to visually acceptable residues such as flux, white residues, and foreign objects, things you can visually see. However, when it comes to specific cleanliness requirements such as surface insulation resistance or micrograms of solvent extract requirements, you are on your own.

Many would argue that the solvent extract test is relevant only for rosin. That must have been the reason for making the change in the J-STD-001, going as far back as 2005 when revision D was released. Now, more than 15 years later in 2021, we have revision H and the requirements for cleanliness are the same even though we have now more widespread use of components with practically no gap between the bottom of the component and the top of the board. But what have we been doing for the last few decades, starting in the 1980s? You guessed it: Solvent extract (aka ROSE), and I am talking about this test being used for all kinds of fluxes and all kinds of applications.

In addition to solvent extract, another test method that has been used extensively is surface insulation resistance (SIR). Previously, the industry used aggressive water-soluble fluxes; an SIR value of 500 MΩ/square (per square and not per square inch) on a production board under chip components, on a sampling basis, was the acceptance criteria. When I was at Intel, this test helped us discover many problems, such as poor adhesive cure profile that was trapping flux due to voids in the adhesive. We also had to make sure we didn't ship any product with corrosion potential in the field.

In addition to solvent extract, another test method that has been used extensively is surface insulation resistance (SIR).

The argument for not specifying a cleanliness requirement for RE and OR fluxes is that you cannot possibly develop acceptance criteria with repeatable test methods when you don't really know what kinds of substrates, solder masks, and coatings these fluxes will interact with in some unknown environment. This argument may be valid, but we can ask the same question when it comes to RO fluxes. Besides, this problem can be solved by being more conservative and accommodating RE and OR fluxes in a very humid environment, as we have done for R0 fluxes. We can make an exception for applications where you are sending a manned mission to Mars, and you can afford to do all kinds of tests in the book if you are using RE and OR fluxes. But we are not all sending the assemblies to Mars.

If you are going to have a corrosion problem, does it really matter which kind of flux it came from? For example, you can have a corrosion problem from rosin flux if you use it generous-

ly for rework, leaving behind lots of flux that was never heat activated to become benign.

Recommendations for Cleanliness Requirements

Based on data over multiple decades now, my sense is that there are three simple requirements that should be considered (and may be given the force of an industry standard such as J-STD-001 and IPC 610 in future revisions).

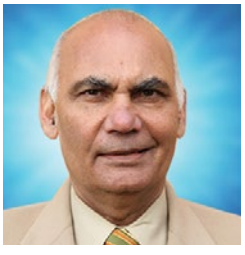
1. There should be no visible flux residue except for some no-clean flux residue. But there should be no white or corroded-look appearance no matter what kind of flux residue is on the board.
2. Because solvent extract (ROSE) is commonly used, the 10.06 μg/in^2 that has served the industry for so long should be used for all fluxes. However, if users and suppliers agree, they can use some other test, such as ion chromatography (IC) or other mutually acceptable tests, and the level of NaCl equivalent from 2.5 to 4.5 μg/in being used by some companies for IC.
3. The most important criteria, at least to qualify the flux before use, the surface insulation resistance value taken in a humidity chamber at 100 VDC should be 500 MΩ/square to detect any trapped flux under components with practically no stand-off.

Of the three tests, given the fact that there is widespread use of low stand-off components such as BTC, LGAs and fine pitch QFPs with practically no stand-off (almost no gap between the bottom of the components and the top of the board), SIR test is the most reliable test. If there is any flux trapped under the components, SIR value will not meet the 500 megohm (10 to the power 8) requirements. Most boards, when properly cleaned, will show cleanliness as high as 10 to the power 12 or more, no matter what flux is used. There should be two SIR patterns on the board (on production boards for products meant for critical applications). One of those patterns will be covered with the components with lowest stand-off and the other pattern should have no component on it. This will serve as a control since you should always get very high SIR value as there should be no flux at that spot. Please refer to SIR pattern guidelines as discussed in the referenced chapter[1].

Finally, it must be noted that there is no such thing as the best flux, the best cleaning method, or the best method for determining cleanliness. These variables depend on the application. Thus, using the guidelines discussed in this column, the user must establish requirements for flux, cleaning, and cleanliness testing based on empirical data for a particular application. This means that the cleanliness tests (SIR, solvent extraction, and visual) should be performed on cleaned randomly-selected assemblies as a check on the process. There is no substitute for good process control because, if a bad board passes the cleanliness test, the failed assembly lot cannot be recalled, recleaned, or retested. **SMT007**

References

1. Ray Prasad, *Surface Mount Technology, Principles and Practice,* second edition, Figures 13.13, 13.14 and 13.15.



Ray Prasad is the president of Ray Prasad Consultancy Group and author of the textbook *Surface Mount Technology: Principles and Practice.* Prasad is also an inductee to the IPC Hall of Fame—the highest honor in the electronics industry—and has decades of experience in all areas of SMT, including his leadership roles implementing SMT at Boeing and Intel; helping OEM and EMS clients across the globe set up strong, internal, self-sustaining SMT infrastructure; and teaching on-site, in-depth SMT classes. He can be reached at smtsolver@rayprasasd.com and regularly offers in-depth SMT classes. Details about classes can be found at rayprasad.com. To read past columns or contact Prasad, click here.

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Electronics Industry News and Market Highlights

Inpixon, Ostendo Reimagine Hybrid Workplace with Wearable Augmented Reality Display Glasses ▸

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

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

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

Cable Manufacturing & Assembly Acquires Cablecraft Motion Controls ▸

Cable Manufacturing & Assembly (CMA) announced that it has completed the purchase of Cablecraft Motion Controls, a leading designer and manufacturer of high-performance, critical application mechanical motion control products.

FIH Mobile, Stellantis Establish JV to Deliver Cockpit Solutions for the Automotive Industry ▸

Hon Hai Precision Industry Co., Ltd., together with its subsidiary FIH Mobile Ltd., and Stellantis N.V. announced that they have entered into a joint venture agreement. Mobile Drive, the joint venture entity, will focus on delivering a smart cockpit solution for vehicles that will disrupt current design conventions and foster the development of intelligent connected vehicles.

Epishine Signs Distribution Agreement with Farnell to Enable Light Energy Harvesting within Electronic Design ▸

The Swedish manufacturer of printed organic solar cells and development kits, Epishine, has signed a new franchise agreement with Farnell, an Avnet Company and global distributor of electronic components, products, and solutions.

Thales Receives Contract from Network Rail for FOAS ▸

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

Lenovo, RealWear Join Forces to Bring Assisted Reality Solutions to Enterprise Customers ▸

Lenovo, a global technology leader, and RealWear, the world's leading provider of assisted reality solutions for frontline industrial workers, announced a global collaboration to bring assisted reality solutions to enterprise customers.

North American Semiconductor Equipment Industry Posts July 2021 Billings ▸

North America-based semiconductor equipment manufacturers posted $3.86 billion in billings worldwide in July 2021 (three-month average basis), according to the July Equipment Market Data Subscription (EMDS) Billings Report published by SEMI.

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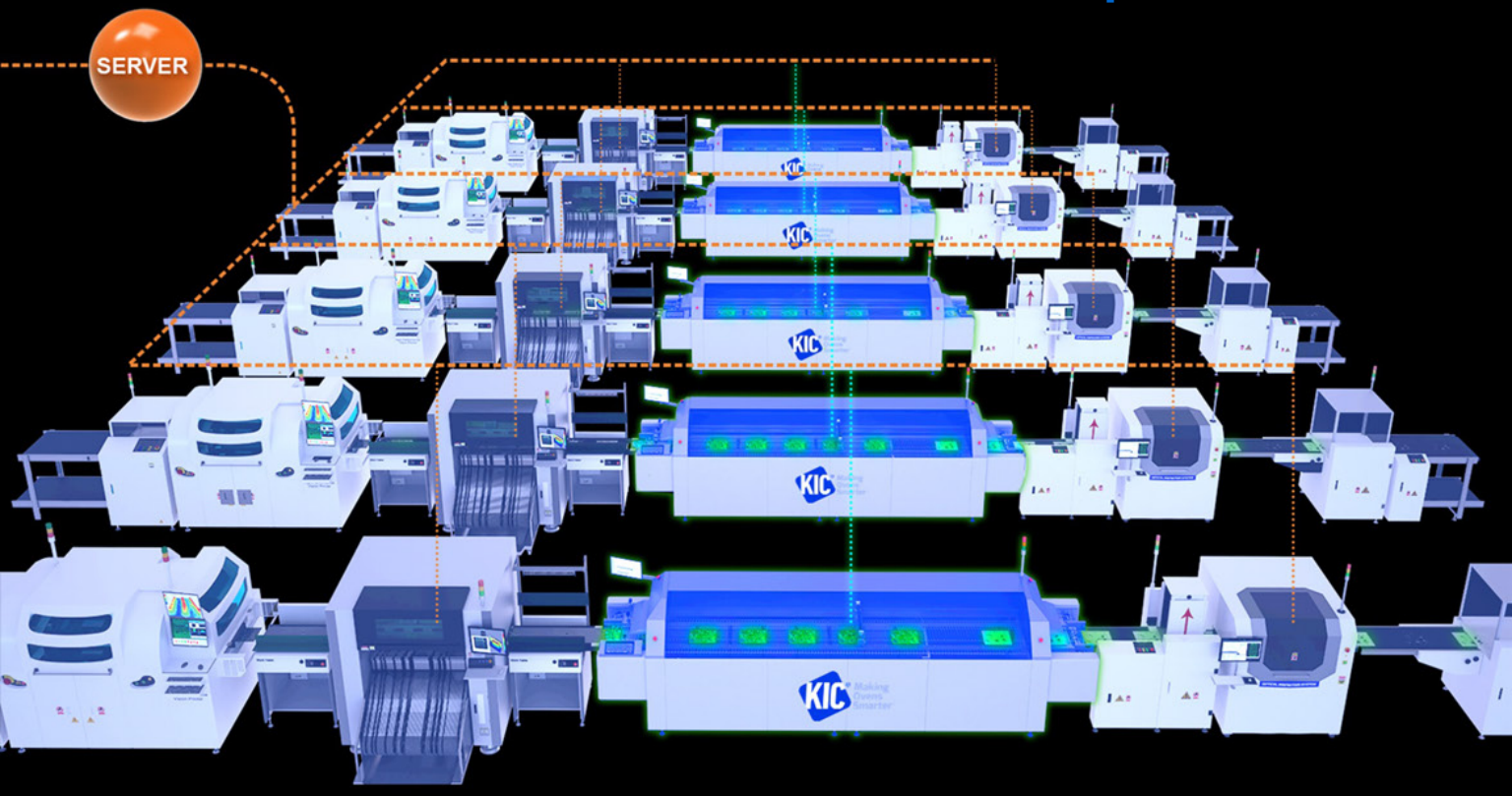

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The Law of Exponential Profits

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.

Chuck "The Tower" Tower had never been so nervous. No, it wasn't the upcoming meeting with Benson Electronics owners, Maggie Benson and her fiancé John, to discuss process improvements; it was his plan to pop the question to Tanya Brooks. He had the ring but was looking for a place to ask for her hand. He thought he would ask John. After all, John had just proposed to Maggie with success.

Chuck saw John walking through the assembly area and approached him.

"John, I have a personal question to ask you," Chuck said.

"Sure! Let's go to my office," John replied.

As they walked to the office, John was curious as to what the topic could be, as Chuck looked extremely nervous, which caused John some concern.

As John shut the office door, he asked, "What's up, Chuck?"

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"I need to ask your advice," Chuck replied. Chuck's unease was evident.

"Glad to help," John responded.

As Chuck started to talk and explain his situation, his nervousness vanished.

"So, you want some advice on where to propose to Tanya?" John asked. "How about The Prince and the Pauper restaurant in Woodstock, Vermont? I know the owners, and I think they would be willing to set up something special for you," John went on.

Maggie Benson

For a few more minutes, they discussed this topic. Chuck left John's office grateful and relieved.

Three hours later...

The team of John, Maggie, Frank Emory, and Chuck sat in Ivy University Professor Patty Coleman's office. The topic was how to keep Benson Electronics' lines up over the lunch hour.

After introductions and a few minutes of small talk, Maggie began: "Professor..., erm, Patty. Chuck has led a continuous improvement effort and we have increased our lines' uptime from about 19% to over 30%."

Maggie and the others still had trouble calling the professor "Patty."

"Over 30% is not too bad," Patty responded.

"But we still shut the lines down for lunch and lose about an hour of uptime," Maggie continued. "Even though the lunch break is only 30 minutes, the line is actually down much longer. Frank ran a model and concluded that we could pay the workers $2 more per hour if they could figure out a way to keep the lines running. What are your thoughts?"

"Maggie, John, you may remember that we discussed a similar case in one of our classes," Patty started.

Maggie and John both looked a little embarrassed as, at the same time, they remembered this lecture.

Patty said, "It was the first project I ever worked on with The Professor[1], when I was at ACME Electronics[2]. I suspect it's the same issue: the workers don't want to keep the line running as it would require some of them to miss lunch with their group of friends."

"Exactly," Maggie, John, Frank, and Chuck groaned in unison.

"Well," Patty elaborated, "we did some brainstorming with the line operators and agreed that if they could keep the line running during lunch, we would raise everyone's salary by 10%. It ended up being a financial windfall for the company."

"Can you explain how it worked and why it was so beneficial?" Frank asked.

"There were about eight people running each line, but a number of those people were doing future setups, getting components, solder paste, etc. So, to keep the line running for 30 minutes, the teams of operators for the two lines felt that just two people were needed to keep things going. The two teams worked together so that during the 30 minutes, two people could keep it running. Sometimes they need three people; sometimes only one," Patty continued.

"How did it work out?' John asked.

"Actually, profoundly better than expected," Patty replied.

"Why?" Maggie asked.

"Well, you could argue that keeping the line running for an extra hour at 30% uptime should result in 0.3 hours of extra uptime. It ended up being more like 0.7 or 0.8 hours," Patty explained.

"Why?" John asked.

"We think it is because so much focused effort was spent keeping the line up that it typically ran for the entire hour," Patty elaborated.

While they were chatting, Frank was using his cost-modeling program to calculate the change in profits.

Title of Run	Total Sales	Unit Profit	# Units	Total Profit
Benson Electronics 30% Uptime	$33,776,011.50	$ 9.56	292,433	$2,796,514.97
BE with No DT for Lunch = 40% Uptime w $2 hr Raise	$45,405,244.50	$ 13.44	393,119	$5,285,209.50

Figure 1: Frank's calculations of the profit improvement if the line runs during the lunch hour.

"Wow! The increase in profits is too much to believe," he said. "I ran a model—based on our most common product, which sells for $115.50—and the results were amazing. Gross profits would go from $2.79M to $5.29M on one line. It doesn't seem possible."

"It's likely correct," Patty commented. "Who can tell me why?"

Chuck seemed hesitant, but Patty gave him an encouraging look.

"Go on Chuck," Patty said.

"Well, we are producing more product and all of the product is at a reduced price," Chuck explained.

"Precisely," Patty said.

Everyone in the room was impressed that Chuck grasped the concept first.

"For those of us that are dummies, could one of you explain this?" John implored.

"Let me try, with a simple example," said Patty.

"Let's assume we make 1,000 units at a cost of $95 and a sell price of $100. We make 1,000 x $5 = $5,000. Now we increase productivity so that we produce 33% more so we have 1,333 units to sell. However, our fixed costs such as labor, rent, and machine amortization have not changed. We might have a little more cost in electricity, consumables, and machine repair, but these are second order effects. Our unit cost might go to down to $92. Profits are now 1,333 x $7 = $9,331," Patty explained.

"So, we have more units to sell, and all of them are cheaper to make," Maggie concluded.

"Precisely," Patty replied.

"Of course, we have to have the demand to buy the extra product," Frank warned.

"Not to worry, folks; we have been turning away orders," John said, excitedly.

"This situation is what The Professor calls 'The Law of Exponential Profits.' With increased productivity, each unit produced is cheaper to make and you have more of them, so profits increase exponentially," Patty explained.

Cost Breakdown	Per PCB	Percent	Total
PWB Cost	$16.000	15.103%	$4,678,928.00
Components Cost	$68.000	64.189%	$19,885,444.00
Paste, Stencil, Squeegee	$0.415	0.391%	$121,214.28
Machine Amortization Cost	$3.239	3.057%	$947,155.36
Labor Cost	$14.339	13.536%	$4,193,280.00
Floorspace & Utilities	$0.681	0.643%	$199,215.32
Rework	$0.343	0.324%	$100,402.00
Inventory	$2.920	2.756%	$853,857.57
Yield Loss	$0.000	0.000%	$0.00
Misc	$0.000	0.000%	$0.00
Total Cost	$105.937	100.000%	$30,979,496.531

Cost Breakdown	Per PCB	Percent	Total
PWB Cost	$16.000	15.678%	$6,289,904.00
Components Cost	$68.000	66.630%	$26,732,092.00
Paste, Stencil, Squeegee	$0.415	0.406%	$162,948.92
Machine Amortization Cost	$2.409	2.361%	$947,155.36
Labor Cost	$11.429	11.198%	$4,492,800.00
Floorspace & Utilities	$0.507	0.497%	$199,215.32
Rework	$0.377	0.369%	$148,074.82
Inventory	$2.920	2.861%	$1,147,844.58
Yield Loss	$0.000	0.000%	$0.00
Misc	$0.000	0.000%	$0.00
Total Cost	$102.056	100.000%	$40,120,035.003

Figure 2: The cost breakdown of a PCB that sells for $115.50. The top column is before the line is run during the lunch break and the bottom column is after the line is run during the lunch break. Note that the labor cost per board (circled) went down $2.90 ($14.339 – $11,429) and machine amortization produced another $0.83. These two accounted for the bulk of the reduced cost.

Frank was excited. "Comparing the details of the models of each case supports what Patty explained," he said. "The labor cost alone went down almost $3 per PCB."

Patty mentioned that Frank's calculations were just a model and they should proceed with caution, but the team was already excited.

Epilogue: Maggie and John plan to work with the BE team to implement having the lines run over the lunch break. Stay tuned to see how it works out.

Oh, and Tanya said yes! SMT007

References

1. The Professor is a mythical figure at Ivy University. Few know his name. He is an expert in process optimization. He is a polyglot, speaking more than 10 languages. He was and is Professor Patty Coleman's main mentor.

2. ACME is the company that Patty worked at before becoming a professor at Ivy University. There is a book written about her adventures called The Adventures of Patty and the Professor. Contact Dr. Lasky at rlasky@indium.com for a free soft copy.

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.

US Signal Scales Its Storage as a Service (STaaS) Offering to Help Meet Growing Demand

SoftIron Ltd., a world leader in task-specific appliances for data center solutions, and a global leader in Ceph expertise and implementation, announced that it has successfully engaged with Michigan-based IT solutions company, US Signal, to seamlessly upgrade and expand its Storage as a Service (STaaS) infrastructure. The initial implementation, which immediately increases US Signal's storage capacity by over a petabyte, leverages SoftIron's storage appliances and is being facilitated with a no-downtime migration across multiple distributed data center sites in four Midwest states, including Illinois, Indiana, Michigan, and Wisconsin.

The US Signal expansion is being driven by the company's need to scale its critical infrastructure due to increasing customer demand. "The strategic focus for this project was to ensure a truly future-proofed and seamless growth plan for US Signal, providing the best outcomes for both our business and our customers," said Derrin Rummelt, Executive Vice President of Engineering at US Signal. "We chose open source Ceph as a foundational building block for our needs early on because of its innate power and capability. Ceph's virtually infinite scalable nature combined with an uncompromising feature set made it a natural fit for our company, which provides world-class services in a highly competitive, mission-critical environment. SoftIron quickly demonstrated its deep understanding of complex storage environments, and how to maximize Ceph to provide the best of its wide-ranging feature set. They've delivered value over and above the hardware and software, providing expert guidance and support as we execute on this project together."

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

TOP TEN

EDITOR'S PICKS

Volunteers Honored for Contributions to IPC and the Electronics Industry

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

Creation Technologies Acquires Computrol Further Expanding its Reach Into High Reliability End Markets

Creation Technologies, an end-to-end, scalable Global Electronic Manufacturing Services provider, announced that it has acquired Computrol, Inc. The combination expands Creation's network of manufacturing facilities and design centers operating across the USA, Canada, Mexico, and China.


Chris Mitchell

The Government Circuit: A Summer Advocacy Update From IPC

It's been a busy summer here at IPC, with policy debates heating up across the globe. Here in Washington D.C., the U.S. Congress adjourned for its August "District Work Period," but not before the U.S. Senate passed a major bipartisan infrastructure package, which we believe would positively affect our industry.

Review: Emerging Opportunities for Additive Electronics


Pete Starkey

The special feature at SMTA's virtual Additive Electronics TechXchange 2021 was a presentation by Dr. Matthew Dyson, senior technology analyst at IDTechEx, entitled "Emerging Opportunities for Additive Electronics."

The EMS/Designer Relationship: Kelly's Story


Kelly Dack

In a recent discussion with John Vaughan and Kelly Dack, we explored how parts availability information can reverberate back to the design team in unexpected ways. In this part of the interview, Dack details how a parts availability issue can restart the design all the way back with the OEM design team.

How To Get Started With IIoT

Every company will have to decide just how much IIoT technology they want to bring into their environment, and how fast. In this article, we will offer some general advice and suggestions for those who want to experiment with a few IIoT devices before committing to a larger IIoT project.

Knocking Down the Bone Pile: X-ray Imaging and BGA Rework

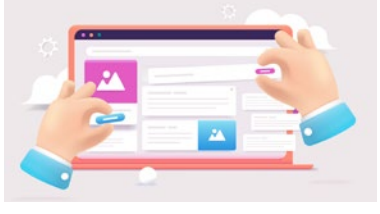

Bob Wettermann

X-ray imaging prior to the removal of a BGA for rework will help the rework technician point out potential issues which may be challenges to successfully removing and replacing the BGA.

Siemens Healthineers Honors Zollner with the Supplier Award

Siemens Healthineers, the renowned provider of medical technology, awarded Zollner Elektronik AG for its competitiveness and excellent collaboration.

Luminovo Cuts BOM Waste, Improves OEM/EMS Communication



Luminovo founder Sebastian Schaal says his company is using its experience as an AI provider to help implement LumiQuote, a new EMS RFQ software tool. Sebastian explains how LumiQuote helps cut down the waste in the BOM process and friction between OEM and EMS providers, and gives designers the EMS data they need earlier in the design process so they can make more informed decisions.

BOM Connector: A Ready-Built Solution

Kevin Decker-Weiss of CircuitByte and Mark Laing of Siemens explain how a tool called BOM Connector can improve quoting and manufacturing flow. Mark and Kevin are openly enthusiastic about this topic; this conversation launched immediately into a technical discussion.

Career Opportunities

Is your team growing?

Find industry-experienced candidates at I-Connect007.

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

In addition, your ad will:

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- appear in our monthly Careers Guide, emailed to 26,000 potential candidates

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Career Opportunities

PERFECT POINT
PRECISION CARBIDE TOOLS

Field Application Engineer

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

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

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

Desired traits:

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

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

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ventec
INTERNATIONAL GROUP
騰輝電子

Customer Service Representative, UK

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

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

Skills and abilities required for the role:

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

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

What's on Offer:

- Excellent salary & benefits commensurate with experience

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

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

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Career Opportunities

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

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

Laminator Technician

Nature of Duties/Responsibilities

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

Education/Experience

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

Wet Process/Plating Technician

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

Purpose

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

Nature of Duties/Responsibilities

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

Education and Experience

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

Production Scheduler

Main Responsibilities

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

Education and Experience

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

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Career Opportunities

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

Software Support Engineer

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

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

Experience

- Bachelor of Science in computer science or related field preferred

Applications Engineer

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

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

Experience

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

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Career Opportunities

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

ICAPE GROUP

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

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

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

Responsibilities:

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

Skills:

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

Interested? We are looking forward to your application!

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

apply now

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

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

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

Your Profile:

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

Your Target Markets:

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

Interested? We are looking forward to your application!

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

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Career Opportunities

The Test Connection, Inc.

Rewarding Careers

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

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

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

Associate Electronics Technician/ Engineer (ATE-MD)

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

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

apply now

Test Engineer (TE-MD)

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

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

apply now

Sr. Test Engineer (STE-MD)

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

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

We proudly serve customers nationwide and around the world.

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

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Career Opportunities

EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Maintenance Technician

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

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Plating Operator

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

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EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Water Treatment Operator

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

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

apply now

Drilling Operator

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

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

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Career Opportunities

Sheldahl®

A Flex Company

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

We are looking for people who demonstrate:

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

Positions in America include:

Project Manager – Northfield, MN

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

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Program Manager – Specialty Films

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

apply now

Program Manager

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

Responsibilities:

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

Requirements:

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

Preferred Experience:

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

Benefits:

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

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Career Opportunities

ARLON ELECTRONIC MATERIALS

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

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

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

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

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

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

apply now

KOH YOUNG TECHNOLOGY

Logistics Assistant

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

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

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

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Career Opportunities

MivaTek Global

Product Manager

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

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

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

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

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

apply now

MivaTek Global

Field Service Technician

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

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

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

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

More About Us

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

apply now

Career Opportunities

SIEMENS

Siemens EDA
Sr. Applications Engineer

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

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

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

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

apply now

U.S. CIRCUIT

Plating Supervisor

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

Competitive benefits package. Pay will be commensurate with experience.

Mail to:
mfariba@uscircuit.com

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Career Opportunities

BLACKFOX
Premier Training & Certification

IPC Instructor

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

Independent contractor, possible full-time employment

Job Description

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

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

Qualifications

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

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

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

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

apply now

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

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

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Career Opportunities

Now Hiring

Director of Process Engineering

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

Job Summary:

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

Duties and Responsibilities:

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

Education and Experience:

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

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Now Hiring

Process Engineering Manager

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

Job Summary:

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

Duties and Responsibilities:

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

Education and Experience:

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

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Career Opportunities

INSULECTRO

Are You Our Next Superstar?!

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

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

View our opportunities at Insulectro Careers (jobvite.com)

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TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

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Career Opportunities

APCT

Passion | Commitment | Trust

APCT, Printed Circuit Board Solutions: Opportunities Await

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

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

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

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

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EAGLE electronics Inc.

MANUFACTURERS OF QUALITY PRINTED CIRCUIT BOARDS

Pre-CAM Engineer

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

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

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Process Engineer

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

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

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Career Opportunities

Manncorp™

SMT Operator
Hatboro, PA

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

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

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

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

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

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Manncorp™

SMT Field Technician
Hatboro, PA

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

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

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

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

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INTERNATIONAL ELECTRONICS CIRCUIT EXHIBITION (SHENZHEN)
国际电子电路(深圳)展览会

HKPCA SHOW

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支持单位
Supporting Organization

CCPIT

承办单位
Event Manager

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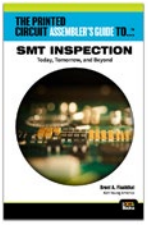
Watch and Learn!

Our latest micro webinar series examines 3D inspection, AI, CFX, connectivity and smart factory success in 12 easy-to-digest segments. Designed to complement Koh Young's I-007eBook, *The Printed Circuit Assembler's Guide to...SMT Inspection, Today, Tomorrow and Beyond,* the presenters share highly focused educational information on the use of data gathered during the inspection process.

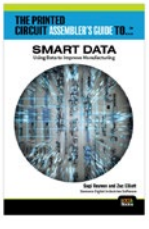
I-007e Books: The Printed Circuit Assembler's Guide to...



SMT Inspection: Today, Tomorrow, and Beyond

by Brent Fischthal, Koh Young America

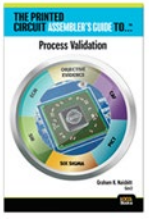
An in-depth insight into new and exciting true 3D inspection technology is provided in this book, along with a look into the future of leveraging big data management and autonomous manufacturing for a smarter factory.



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

A must-read for anyone looking for a holistic, systematic approach to leverage new and emerging technologies. The benefits are clear: fewer machine failures, reduced scrap and downtime issues, and improved throughput and productivity.

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

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