AUGUST 2023

I-Connect007

SMT007 MAGAZINE

FLYING HIGH WITH DIGITAL TWIN

I-007e Books

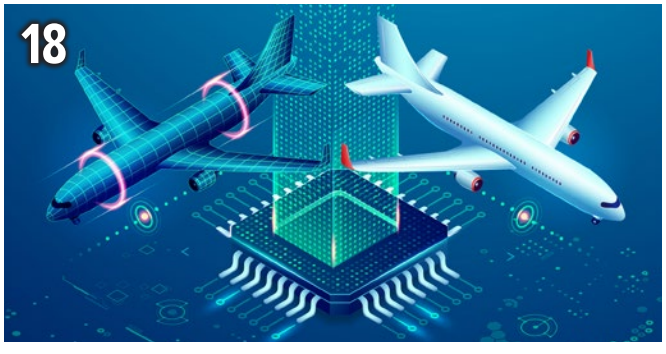
Download

RELATED WEBINARS

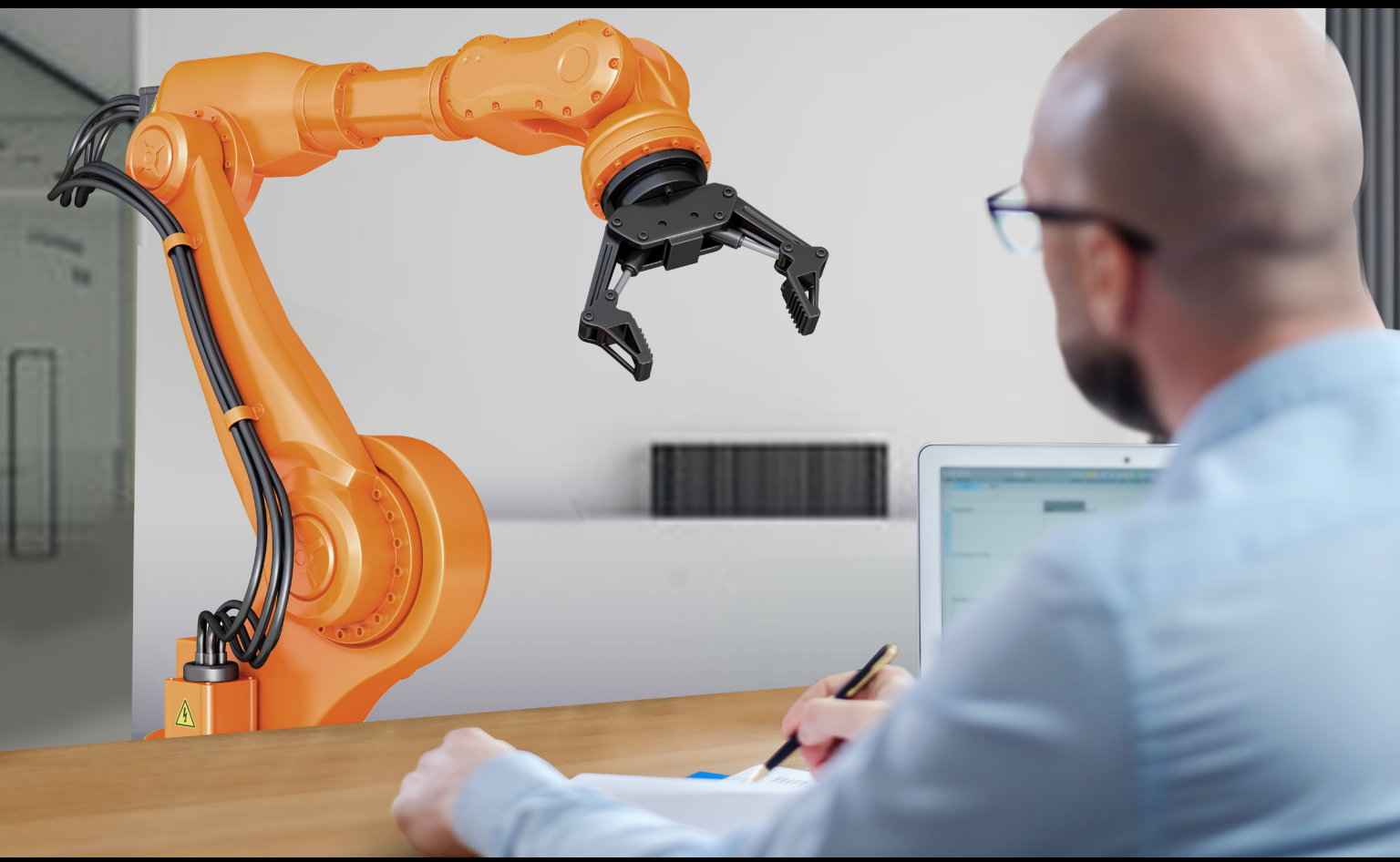
SMT007 MAGAZINE

Flying High With Digital Twin

We've been accustomed to the idea of a digital twin in the OEM and design worlds, so why not a digital twin for your manufacturing processes? The opportunity to use manufacturing simulation as a test bed for job planning and process optimization brings continuous improvement into the modern age. This may be an all-or-nothing type of project, but it's worth the investment.



How to interview a robot



It's important to know in the interview if the job-seeking robot:

- Fits into your culture
- Works well with others
- Avoids unscheduled breaks
- Is willing to work overtime
- Has all the latest anti-virus vaccines
- Avoids foul computer language

Technica and our Automation Partners have the knowledge and experience to provide a solution for your PCB or substrate manufacturing facility.

For over 35 years we've been connecting our customers with the right solutions. We'll be happy to show you how to properly interview a robot!

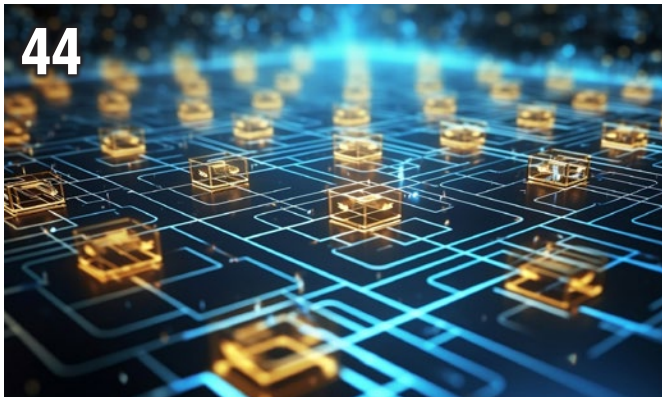
TALK TO TECHNICA FOR YOUR AUTOMATION SOLUTIONS

TECHNICA, U.S.A.

technica.com | 800-909-8697

CELEBRATING 35 YEARS

SMT007 MAGAZINE



SHORTS

COLUMNS

ARTICLES

HIGHLIGHTS

DEPARTMENTS

AMITRON

FACTORY 5.0

Manufacturing for the future.

Automation

Gather data from equipment and processed into a central data storage platform.

Procedures

Machine learning (AI) and operational procedures to handle data and processes.

People

Teach and train people how to react to changes in processes in real time.

LEARN MORE ABOUT FACTORY 5.0

www.amitron.com | (847) 290-9800
support@amitron.com

Digital Twin in Manufacturing

Nolan's Notes

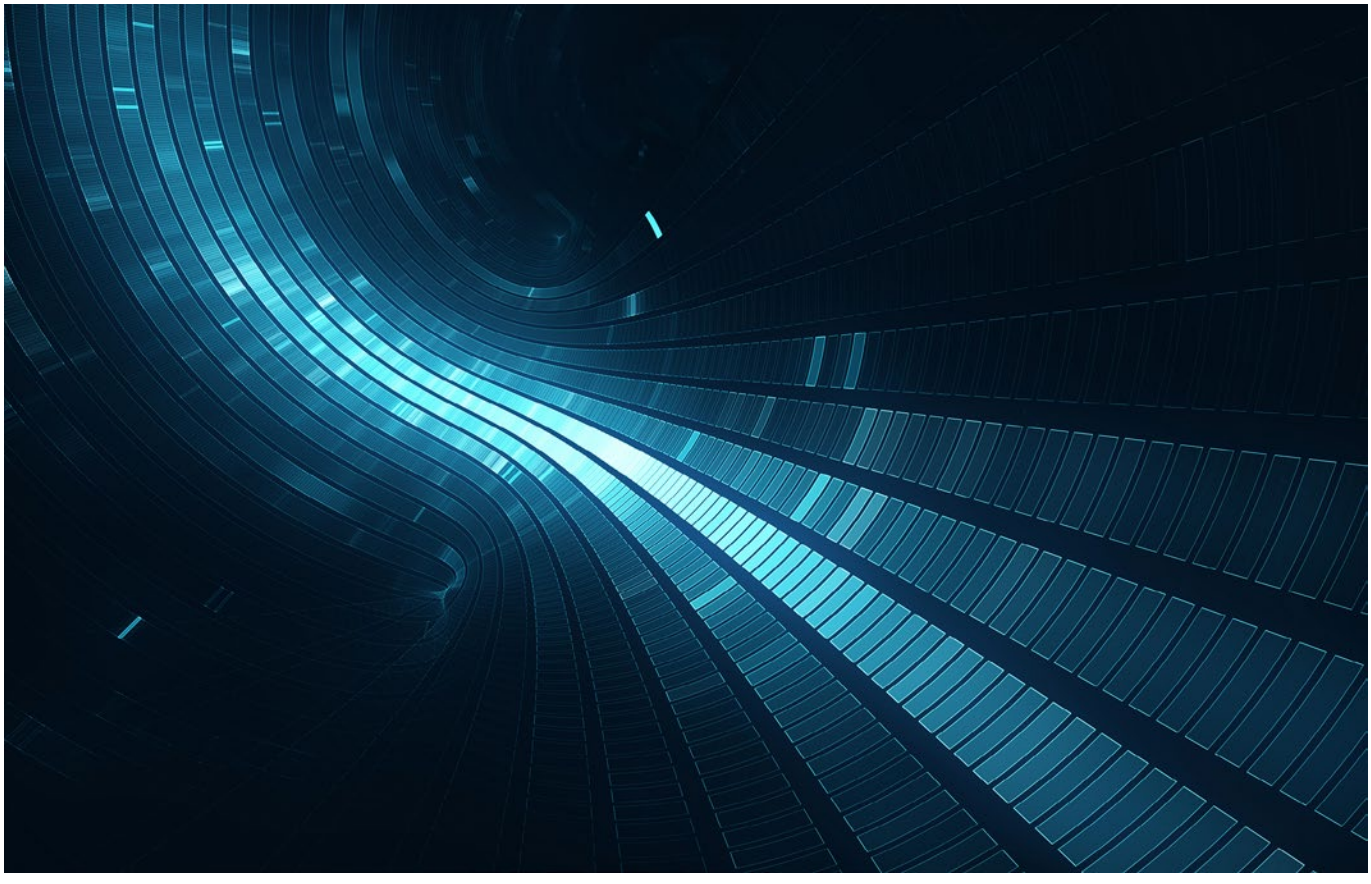
by Nolan Johnson, I-CONNECT007

This month, we look at digital twins in manufacturing. Normally, when we say "digital twin," we think of design data. But that's not what we're talking about; this time, we're discussing a digital twin for your factory itself. Our discussion follows along with the idea that business operations themselves can have a digital twin. Now why does this even matter?

The folks over at themagical.nl have developed some interesting SIM games based on Disney rides. The idea is that you are the ride operator, and your job is to keep the ride moving smoothly and efficiently even as park guests queue up unpredictably. It's not as easy as you might think.

Themagical.nl currently shows 14 different ride operator simulations on their website. Naturally, each ride has its own picadilloes to account for; knowing how to operate one ride does not necessarily mean you're qualified for the others.

While cute and entertaining, I see quite a lot of similarities here. These ride simulators are,



without any doubt, digital twins for real rides in real Disney parks. It's easy, from the perspective of the operator, to view a ride as an assembly line. Guests run through a conveyor belt of experiences much like printed circuit boards run through a conveyor belt of assembly operations. In both cases, operators are charged with keeping those conveyor belts running efficiently and continually, while faced with constantly changing conditions in the input queue.

As a game player, if I could, say, set up certain conditions in the game, and then launch the simulation to test possible solutions, I could try strategies to optimize the ride's operations. If I could reconstruct the ride, I would test optimizations in flow as well as guest experience. I hope you understand my line of thinking: A similar digital twin of your manufacturing floor would allow your team to explore ways to optimize operations. That might be in the form of determining which of your lines is the best choice for a particular job, or it might mean adjusting throughput rates to account for one particularly time-consuming step. It could even mean exploring changes to the setup of your line to decrease operator efforts. There are so many ways to use this kind of digital twin.

It's a freeing feeling, I'm sure, to experiment on the simulator, especially when it feels so risky to try those experiments directly on the manufacturing floor.

I'm reminded of a story from the NASA Apollo missions. Armstrong and Aldrin were working long hours in the lunar lander simulator. Now, in those days, the simulator was almost entirely a mechanical contraption, not necessarily a digital thing, but bear with me. Occasionally, as a landing attempt started to spin out of control, Aldrin would ask pilot Armstrong to abort the attempt. Armstrong, it's been said, often wouldn't comply, and would try to recover. Those situations frequently turned into crashes. Apparently, Aldrin took issue with those failed attempts and talked to Armstrong, whose reply was something like, "When we're up there, we'll have one chance. We need to know exactly where the line is between success and failure. We can only learn that by crashing in the simulator." This interaction was dramatized in Tom Hanks' HBO docudrama series from the late 1990s, "From the Earth to the Moon." If you've not watched that series, it's well worth your time.

And that's my point: It's in the simulator where you can safely explore the boundary conditions and understand your processes better.

In this issue, we introduce our topic through an interview with Don Kinard, a senior fellow at Lockheed Martin, and one of their experts on digital twin in the manufacturing space. If you haven't crossed paths with Don, he's been presenting occasionally at conferences on the different levels of digital twin in industry. Columnist Michael Ford weighs in on manufacturing simulation and, true to form for Michael, he's looking beyond the horizon with respect to factory simulation; it's a good read. We also connect with Phil Voglewede at Marquette University's Omron Advanced Automation Lab, as well as Cogiscan's Sylvain Perron. And we bring you perspective from digital twin players such as Critical Manufacturing, Instrumental, and Cybord.

All the issues of *SMT007 Magazine* are a joy to shepherd, and occasionally one particular issue will somehow stand above the rest. Maybe the content was particularly educational or compelling. For me, this is one of those standout issues. I thoroughly enjoyed chasing down these stories and I sincerely hope you enjoy reading them just as much. **SMT007**

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

Lockheed Martin: Flying High With Digital Twin

Feature Interview with the I-Connect007 Editorial Team

While at a conference in Dallas, Barry Matties listened to a presentation on digital twin from Don Kinard, a senior fellow at Lockheed Martin. Later, we reached out to Don, who was happy to provide a deeper understanding of digital twin's role in the manufacturing space. What does digital twin mean when the product you manufacture is an eight- or nine-figure combat aircraft packed full of electronics?

Barry Matties: Don, let's start with your background and experience at Lockheed.

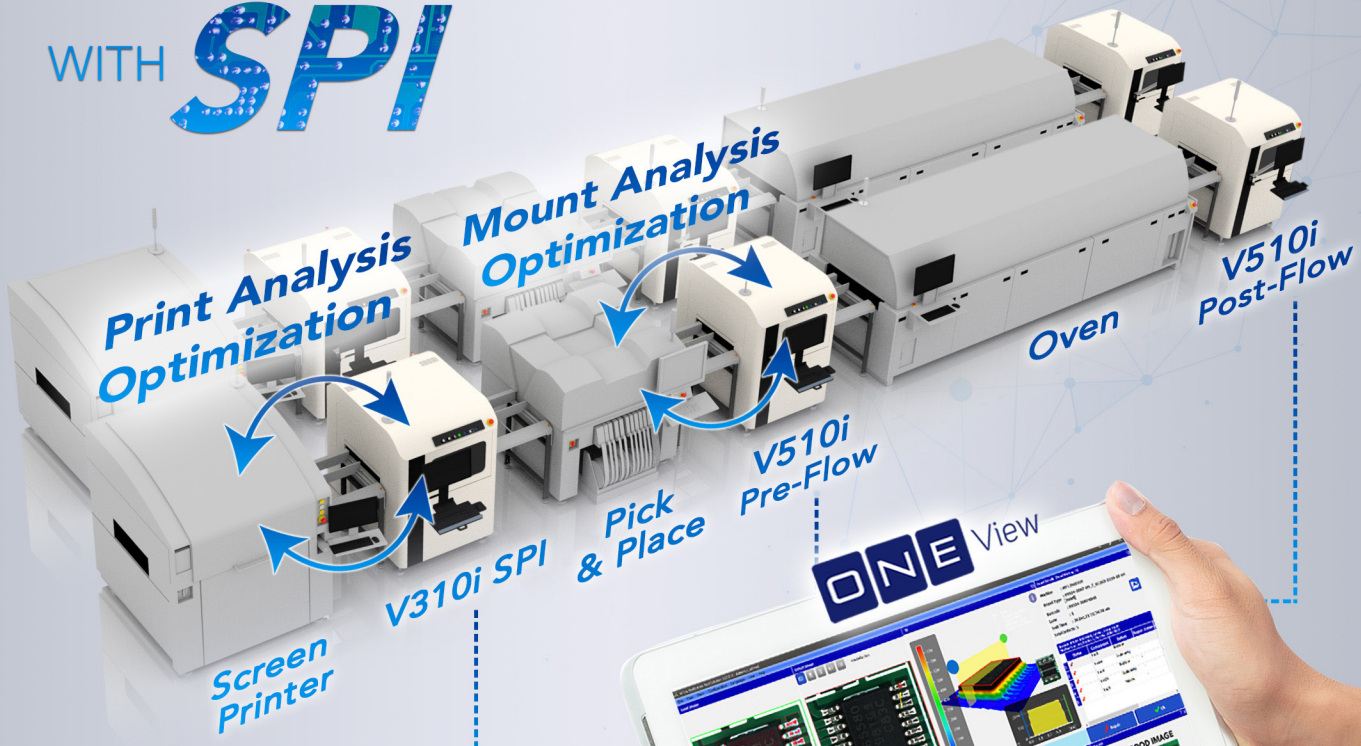
I got my PhD in polymer science at Texas A&M, and I worked for an oil company for a couple of years followed by a couple more years in marketing in Belgium. I came to Lockheed Martin because I didn't like being a salesman. Here, I worked in composite materials for a few years, then as a contract program manager. I was assigned to the F-22 as composites lead, then as a design team lead, followed by the engineering lead for the factory, and finally deputy director for the Mid Fuselage Build Team. Later, I became the director of F-35 production engineering and restarted the program with a large team in a new configuration, which we're currently building. We've delivered nearly 1,000 F-35s to date. I've had the opportunity to be a senior fellow at Lockheed for the past 12 years, with the last seven or eight working in digital transformation in one form or another.

This is my 39th and last year with Lockheed because I'm retiring next year. I've been a

ViTrox®

ADVANCED PROCESS OPTIMIZATION

WITH SPI



Provides Real-time and Easy Traceability for Accurate Analysis Across Multi Platform

SPI FULL SERIES

Inspects Up to 52"x 52"

- 5 mins Ultra Smart AI Programming
- Extensive Solder Defect Coverage
- M2M Capabilities Accessible
- High Speed Inspection

ViTrox Technologies Sdn. Bhd.
Tel : +(60)-4-545 9988 Fax : +(60)-4-545 9987 Email : enquiry@vitrox.com
www.vitrox.com

Don Kinard

program person for the F-22, F-35, and some F-16s, and now I'm just trying to head us on the right path with digital transformation as I walk out the door, so to speak.

Matties: How did you get started in digital transformation?

Digital transformation in our industry started with 3D modeling. Lockheed got involved in the mid-'90s when we started developing 3D models and common PLM systems. I think Boeing even started a little earlier than that. The F-35, for example, started as a digital program. We used the digital thread—3D solid models—for everything. Everybody accessed a common database so those models could be passed along from engineering to manufacturing. That was the beginning of digital transformation.

Nolan Johnson: Does your digital twin exist just within the mechanicals?

Actually, 3D models were the tip of the iceberg. As the years went on, we realized what the real cost drivers were. Today, we're trying to use advanced modeling and simulation technology—computational fluid dynamics, high-powered computing, and graphics processing units—to get better configurations, better loads, more maturity, and better models.

Digital transformation is not just about model-based engineering, but a model-based enterprise where we're combining PLM systems. For example, our IT systems are typically siloed: PLM, MES, ERP, and sustainment systems. They tend to grow up under Conway's Law, which is the idea that IT systems take on the bureaucracy and characteristics of the organization that own them: Engineering owns PLM and CAD, manufacturing owns MES, and finance and supply chain own ERP. The problem is that the systems don't talk to one another; they require manual data transfers between the systems. The next generation of digital twins will be as much about the data as about the product itself. Artificial intelligence is the enabler for the next generation of tools that integrate systems and provide fingertip access.

Johnson: How does Lockheed pull together simulation? You have mechanical, electronic, electrical, and, I assume, optical pieces in the system. Those are very different disciplines, so how do you do that?

We have vehicle system twins, and twins for fuel, hydraulic, and ECS systems. I have twins for flight control, structural finite element models, software, and mission systems. Not everything goes together yet because there are different disciplines and software.

Not all of those are needed for what we call "top level." The joint all-domain environment models are Level Five digital twins; this includes operational analysis twins used in mission planning, and to fulfill the desire of the customer in a battle environment. The customer wants us to be able to collect various twins in the same ecosystem so that they can engage. It's very difficult because that software tends to be very homegrown and highly IP-oriented. It's difficult to get everything standardized.

Of course, in manufacturing, you have digital twins for all kinds of things. They're mostly for simulating the manufacturing processes, or the engagement between robotics and our airplanes. There are dozens upon dozens of twins, and they're all pieces of the puzzle. Part of the issue here is that we really need to get academia, government, and industry involved so that we can better use academia. They could be fundamental in increasing our overall capabilities in modeling and simulation. We will need all the help we can get.

Matties: Digital twin is designed to mirror a real-world object. How close are we to that now?

Keep in mind that it can take 10 years of testing to develop the digital twin. They're good because they're modeled after real life and, at that point, they're not really simulations. They've used physical flight test data or structural data to populate the models. Dr. Will Roper was at the DoD for a long time, and his idea for software was always laptop-to-airplane. Today, it's laptop-to-very-expensive-laboratories-to-airplane. We're looking long-term to get there.

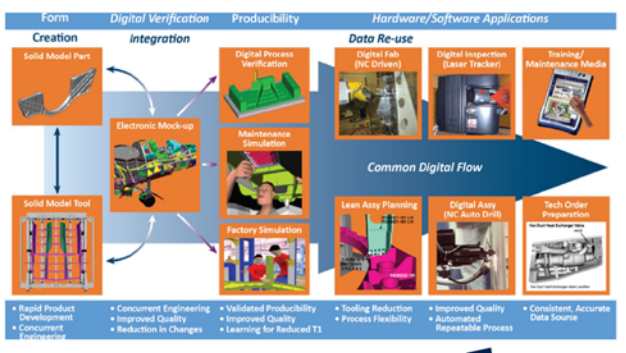
Matties: When you look at your manufacturing tools and processes, how are you creating that digital twin so you can predict the outcome for the factory?

Let me give you some examples. In the case of circuit board production, you want to program it to lay out the board, then you want to have an inspection system that compares that finished board in a very fast manner to the finished product and validates that everything is where it's supposed to be. We're doing the same thing on our airplanes: We use laser scanning and structured light to compare as-designed to as-built 3D configurations. If the technology had been invented a little earlier, we could have saved a lot of money because you could find issues very early in production instead of waiting for the tolerance to come back and bite you.

Matties: How fast can a manufacturer capture the equipment's operating windows, high and low, and throughput into a system so they can predict or use that to create a manufacturing digital twin in their factory?

Frankly, the tools are there at the lowest level. Take the F-22: We didn't have enough airplanes when I worked that program to really justify a

DIGITAL TWINS AND THE DIGITAL THREAD



Testing and Field Experience Validates the Digital Twins and Provides Feedback for MBSE Initiated Product Upgrades and Improvements to Processes and Virtual Tools to Increase Future Products Development Speed

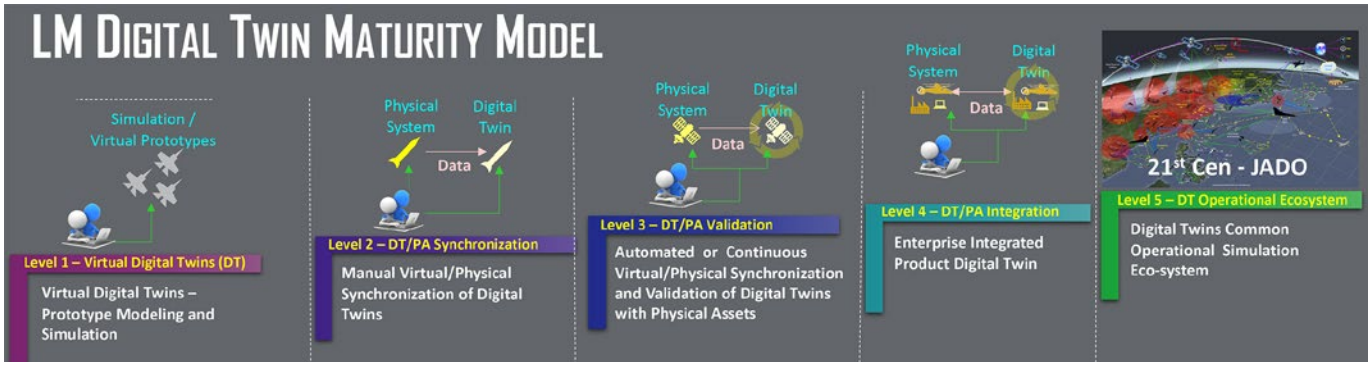
Through MBSE/MBE, the Digital Thread Enables Creation of the Digital Twins Which are Matured through Product Testing and Qualification

Digital Thread/Twin Concept

Key Attributes:

- Complete, fully accessible digital data
- Tools for accessing, integrating & transforming data
- Virtual representations of systems in a modeling & simulation environment
- Probabilistic framework for quantifying, forecasting, and updating system performance capability

Source: Lockheed Martin Corp.



lot of automation, even if it had existed. Today, the F-35 is probably the highest volume production of a sophisticated fighter in the world today. That's a whole different ballgame and it really depends on what you're doing.

Johnson: You mentioned Level Five digital twins. Tell us about these levels.

Level One is virtual twins, where all product is in the design stage. You start with something and then go into a program for the configuration because you have some idea that the configurations work. You've done the computational fluid dynamics, maybe a bit of layout and configuration, but you haven't built anything yet. The better we get at Level One, the smoother the transition will be into development and production because they're more mature.

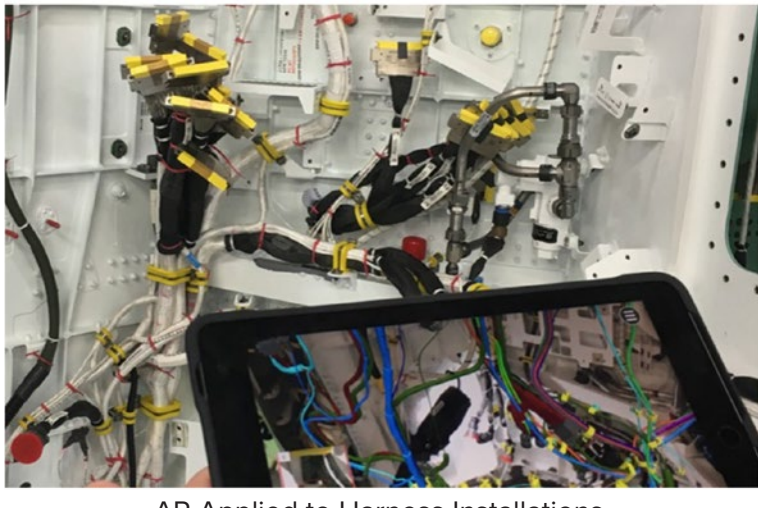
Level Two is where I start getting some system-level test data. This may be structural development, vehicle systems, or test data from our suppliers on their individual components and qualifications. At Level Three, we're into a full-scale structural laboratory testing for software with hardware in the loop. This level means we're putting the aircraft together and getting the system done. Level Four twins predict the behavior of the aircraft using modeling and simulation. At Level Five, I take that that Level Four twin and put it in an ecosystem so it can play with other twins.

Johnson: Do these levels translate into manufacturing processes?

Yes, exactly. We lay out the manufacturing plan in Level One and develop the manufacturing plan and tooling concepts in Level Two. At Level Three, we can predict the manufacturing plan, staffing, tooling, and everything else. Not everything will go to Level Five. In fact, only those things that are used routinely to support the aircraft in the field even go to Level Four, but you need all kinds of those things.

Johnson: You also talked about field data and bringing that data back in to understand how the systems are performing in the real world. How does that feed back into your manufacturing processes?

The field data feeds back from a system reliability point of view. For example, if we find that we have certain issues on the airplane they find in the field, we have a system to capture that data in manufacturing. We also collect enormous amounts of data for each aircraft in



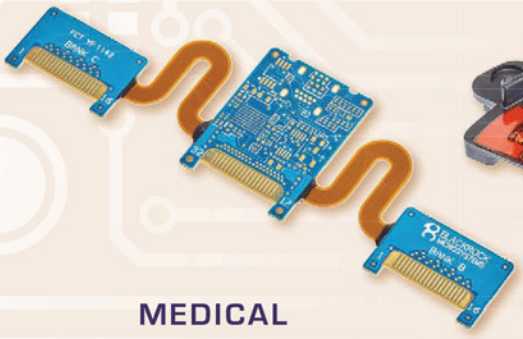
AR Applied to Harness Installations. (Source: Lockheed Martin Corp.)

PREMIER GLOBAL SUPPLIER of **FLEXIBLE CIRCUITS**

FLEXIBLE CIRCUITS | EMS/ASSEMBLY | CONTRACT MANUFACTURING

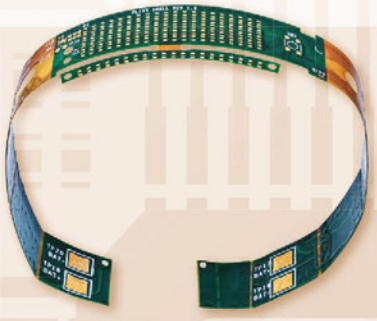
Superior design consultation & support
Flexible Circuits
Rigid Flex
Flexible Heaters
Flex/Rigid Flex Assemblies
Membrane Switches
Plastic Moldings
Specialized EMS/Assembly
Product Module to Complete Box Builds

EXPLORE the POSSIBILITIES!



MEDICAL

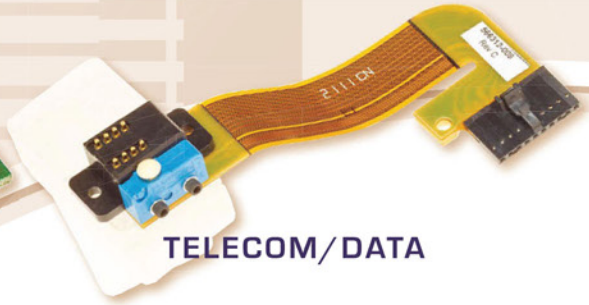
AUTOMOTIVE



CONSUMER PRODUCTS

WEARABLES

INDUSTRIAL



TELECOM/DATA

FLEXIBLE CIRCUIT® Technologies

Flexible Circuit Technologies
9850 51st Ave. N. | Plymouth, MN 55442
www.flexiblecircuit.com | +1-763-545-3333

our missions, trying to verify the way the system performs, so we get data from maintainers and from the airplane. All that helps us determine how can improve the performance and reliability of the aircraft.

Matties: What advice would you give PCB assemblers who are considering the digital twin?

The bottom line is making sure they understand what capabilities they need to accomplish. You don't do digital twin without first thinking about what you will do with it. Every digital twin should have a purpose and a set of capabilities associated with it. Create a cost-benefit analysis; don't do it just because it's there. I've seen automation pay off in quality, more so than anything else. Replacing people isn't our motivation, at least not in our business. We automate because we can get better quality with automation.

Matties: We certainly appreciate you taking time out for this meeting, Don.

Thank you. **SMT007**

Lifetime Achievement Award Presented to Don Kinard

Don Kinard was recognized by the Manufacturing Leadership Council for Digital Engineering with the 2023 Lifetime Achievement Award on June 28 at the 19th Annual Manufacturing Leadership Awards Gala, JW Marriott, Marco Island Beach Resort, Florida.

When Don accepted the award, he was joined on stage by Mike Packer, retired vice president of production at Lockheed Martin and chair of the MLC Board of Directors, and Dan Dwight, CEO of the Cooley Group and vice chair of the MLC Board of Directors.

F-35 By the Numbers

THE U.S. NAVY PAID
$6,000
IN 1916 FOR ITS FIRST AIRPLANES

Source: Popular Mechanics

TODAY, THE F-35 COSTS
$110M+.

Source: Popular Mechanics

$41,986
OPERATIONAL COST/HOUR

Source: Air & Cosmos Intrernational

1,900+
SUPPLIERS AROUND THE GLOBE

Source: Lockheed Martin

945+
AIRCRAFT DELIVERED

Source: Lockheed Martin

EACH HELMET COSTS
$400,000
AND IS FITTED FOR A SINGLE PLANE

Source: War History Online

I-007e
FAST FACTS

Manufacturing Digital Twin: Spanners in the Works

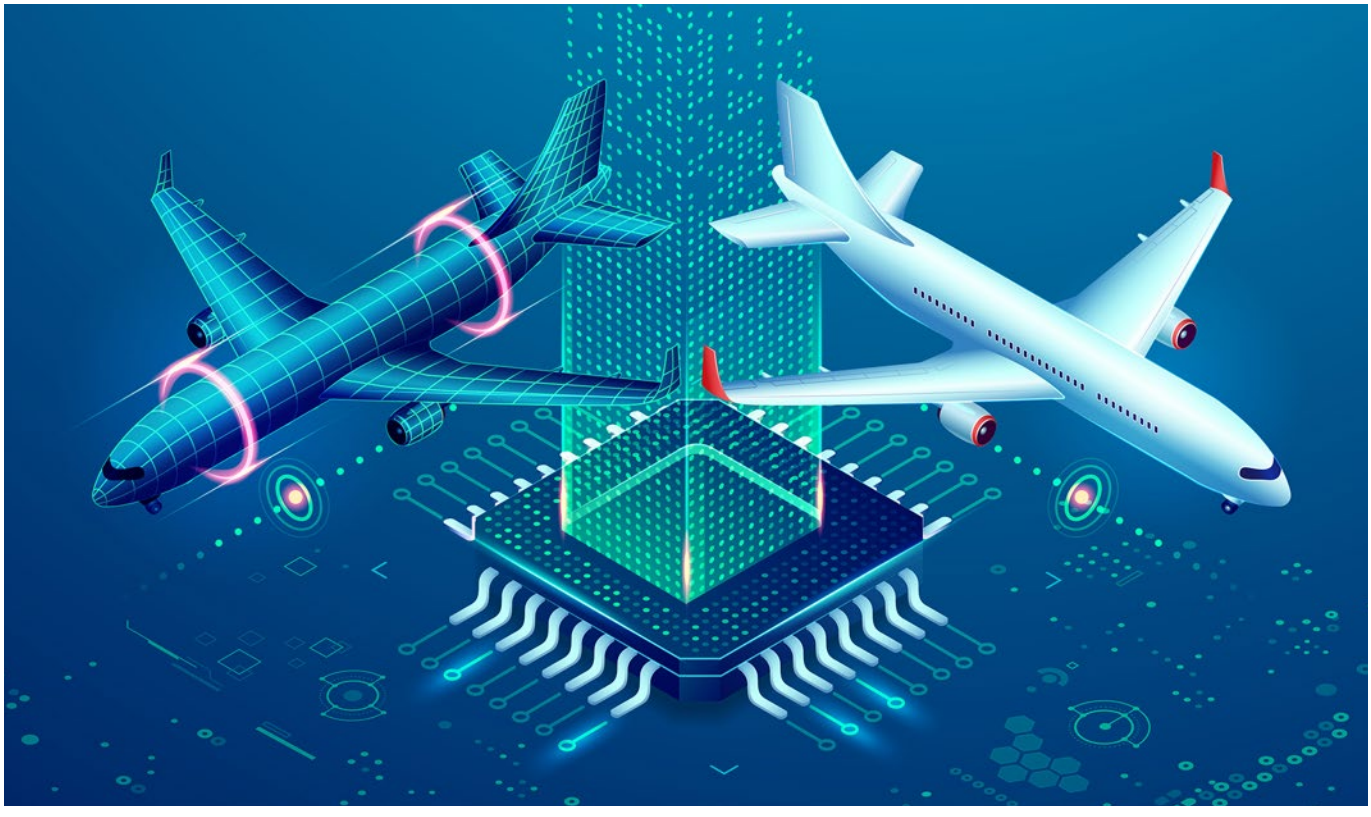
Smart Factory Insights

Feature Column by Michael Ford, AEGIS SOFTWARE

Current thinking says legacy simulation of manufacturing is obsolete and the use of operational manufacturing digital twins is too expensive. The technology that replaces these approaches, however, is somewhat exciting.

I still like watching simulated production graphics, where we see cartoon-like images of predicted production operations taking place on a projected timeline in order to discover limitations and bottlenecks. For each of these to work, you must expect exceptions and assumptions, depending on the depth of the simulation: What about coughs, effects of mistakes, badly timed bathroom breaks, machine breakdown or human error, and changes in the product or in the customer order?

In the manufacturing world, we all know that unexpected changes are unwelcome, yet we endlessly strive to control them. The new normal of frequent product revision updates and more personalized production renders the optimization of continuous flow obsolete. The original application of Six Sigma optimization and value-stream mapping always came with a sting in the tail. A machine, line, or even factory—by those reckless enough to attempt it—could be simulated and optimized to the nth degree, only to find that a change in customer



The Test Connection, Inc.

Leading in Quality Test Engineering Since 1980

Test Solutions & Services for Test Programming, Board Test, Testability In-Circuit, Flying Probe, Functional and Boundary Scan

Fast Turnaround for Board Tests!

ASTER Technologies

TestWay

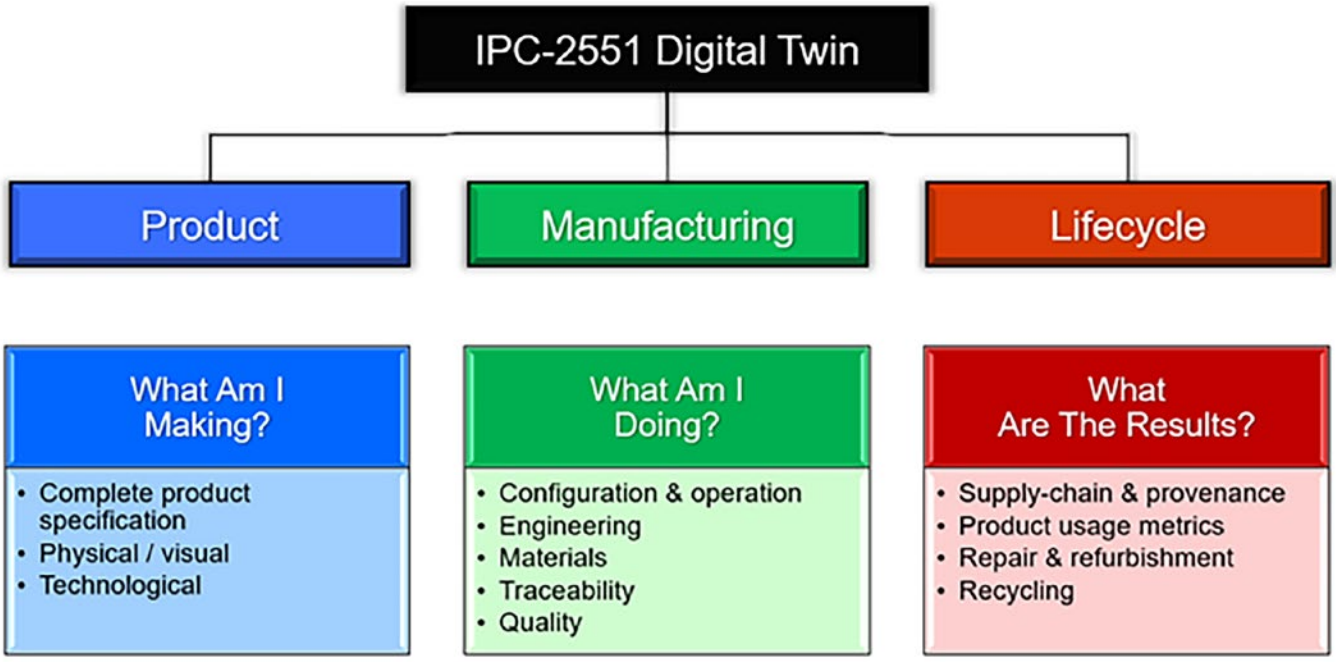
ANAB
ACCREDITED
MANAGEMENT SYSTEMS CERTIFICATION BODY

ITAR Registered and NIST 800-171 Compliant

112 Lakefront Drive, Hunt Valley, MD 21030, USA
Phone: (410) 205-7300 • E-mail: info@ttci.com

www.ttci.com

We have the latest equipment – What sets us apart is our team!



demand meant that utilization would only ever be 80%.

The lesson to be learned is that any simulation or prediction needs to be flexible, and must be based on the contextual elements of capabilities, requirements, and circumstance. It must be continuously evolving, rather than a massive, fixed interpretation. It is quite possible to achieve this, but it brings the requirement for a real-time simulation engine—and a whole lot of live data.

The second experience is the sheer cost of digital twin development when it's done in the wrong way. The IPC-CFX (Connected Factory Exchange) standard is a great example of how the approach of standardization reduces the cost of data by orders of magnitude, and we need to apply the same principles to the digital twin.

CFX replaces legacy interfaces, which need middleware and customization to translate data formats and protocols, such that data from many different sources can be contextualized within an application. For manufacturing digital twins, it's required to understand complex physical and operational specifications, capabilities, constraints, and temporal behaviors. Every piece of equipment and manual operation is different and requires a very significant interpretation and translation of data because of where it originated from and how it was managed.

We also have this desire to "see" something; the value of software, especially in manufacturing, is often very hard to really understand. The use of 3D models—the cartoons of the production operation—help investors and users visualize that value while the action is taking place. Thus, it drives trust, understanding, and of course, cost.

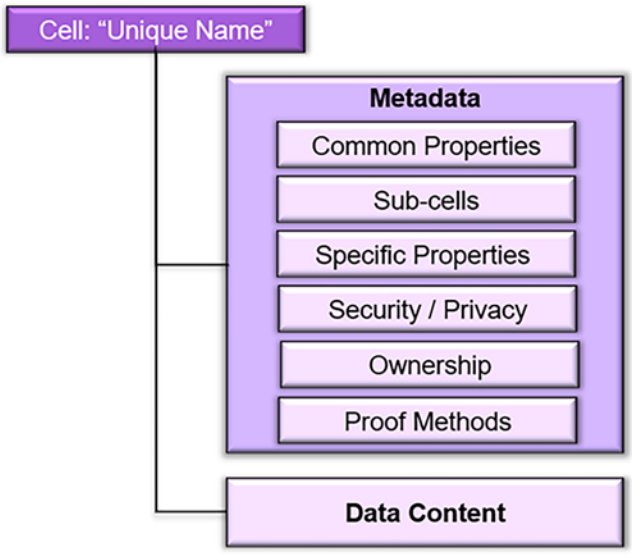
In the earliest cases, the 3D animated machines and processes cost millions of dollars to develop and showcase, as the physical components of each machine had to be drawn in 3D and associated correctly with other 3D components so that they appeared to interact together seamlessly. The result looked great, but should we have been spending Hollywood budgets on manufacturing terminals?

There is currently some excellent software on the market, each with a proprietary version of its manufacturing digital twin, fed from disparate data sources, and limited in expansion and functionality by the exponential need for data derived progressively from further afield.

The CFX standard came to the rescue for machine-related shop-floor communication, and the IPC Digital Twin (IPC-2551) standard is the next step forward. The standard defines the single specific data formats and languages to be used. In the case of CFX, it will be used for IIoT-based communication. To bring such standardization to the digital twin, the process is quite simple. For those old enough to remember, playing a video file on any Windows-based PC was fraught with issues. Certain media file types and content combinations, which were often proprietary, could only be played on certain players, or on those with certain software extensions or licenses. Today, we simply click on a media file, and our chosen player displays it, no matter what file structure, video codec, resolution, etc., has been adopted in the coding.

The way this works with digital twin is also simple: Within the file, there is a section of data called metadata that explains the media content and how to decode it. The IPC Digital Twin standard adopts the same principle using a hierarchical cell structure in which each cell contains metadata that describes the content and format. Cells from many different sources are combined to create the complete manufacturing operation, all the way from the enterprise down to individual tools, such as nozzles. Examples would be digital twins of SMT machines, assembly robots, conveyors, and storage solutions, etc., all combined at the highest level of the hierarchy to represent the digital twin of an entire production line.

There are other very important aspects that must be addressed regarding sharing data between solutions using a digital twin. The first is basic security to ensure that data is only utilized for intended uses by intended parties. Expected uses of the IPC Digital Twin standard include design through manufacturing automation, supply network trust, material and product provenance, and sustainability, as well as the many potential uses for optimization, simulation, and automated decision-making.



User credentials verification and encryption are the basic security tools; at a higher level, the use of innovative new technologies, such as W3C verifiable credentials, which allow facts to be exchanged without the exposure of specific data elements, ensure privacy and the protection of intellectual property. In addition, consideration must be given as to the source, ownership, and integrity of the data.

The effect of adopting solutions using the IPC Digital Twin architecture for data exchange means that, as in the case of CFX, data from different machines about different aspects of their operation can be put together like building blocks without the need for specific customization or middleware. This saves orders of magnitude of investment and, crucially, enables rapid response to changing manufacturing conditions, including customer demand.

As well as covering manufacturing, the IPC Digital Twin includes branches to represent design and events occurring in the market, such as telemetry and product performance data capture, provenance, repair, recycling, etc. The IPC Digital Twin standard was first published in December 2020, but requires industry best practice leaders to further evolve its content. Currently, sustainability data is a very active area of development, which com-

bines materials, energy consumption, provenance, and design elements.

In essence, the concept of digital twin exposes two key directives that are needed for successful digital transformation in manufacturing. The reality is that all software solutions, from the simplest to the most comprehensive, from the oldest to the latest AI apps, have their own digital twin architecture already inside. Any contextualization of data, applied algorithm, or rule set that exists to make analyses or decisions, are all based on their own proprietary digital twin resource—which inherently limits their scope, scalability, and opportunity to create value.

The IPC Digital Twin standard does not replace these nor affect them in any way but provides the interoperability between such internal digital twins in different solutions. The two choices to connect digital twins are to use either expensive customizations and middleware for each and every solution-to-solution integration—which causes exponential cost burdens and delays—or to utilize the IPC-2551 Digital Twin standard data exchange mechanism. This provides the opportunity to address data from design, manufacturing, and beyond with a single "language," in a way that suits many applications, and is sustainable.

Several years ago, with the advent of the CFX standard, it seemed daunting to think that machine vendors would natively adopt "yet another standard" for data communication across the shopfloor. Over a relatively short time, however, the unique approach and principles behind CFX have already made it the dominant standard within the industry. The same should be true for the IPC Digital Twin standard in the solutions. We do, however, need to build the same critical mass that CFX has achieved. Anyone interested in joining the team that continues to shape and evolve this standard should contact any IPC standards representative. **SMT007**

Michael Ford is the senior director of emerging industry strategy for Aegis Software. To read past columns, click here.

Careers In Electronics: Aerospace Engineer

An aerospace engineer designs, tests, and manages the electronics manufacturing of aircraft, spacecraft, satellites, and missiles. They also test electronic prototypes to make sure they function properly according to design, and they develop new technologies to be used in space exploration, aviation, and defense systems.

Aerospace engineers can specialize in a specific type of electrical aerospace product, such as missiles and rockets, military fighter jets, spacecraft, helicopters, or commercial aircraft. Or they may choose to specialize in specific areas, such as instrumentation and communication, navigation and control, electronic structural design, guidance, or production methods.

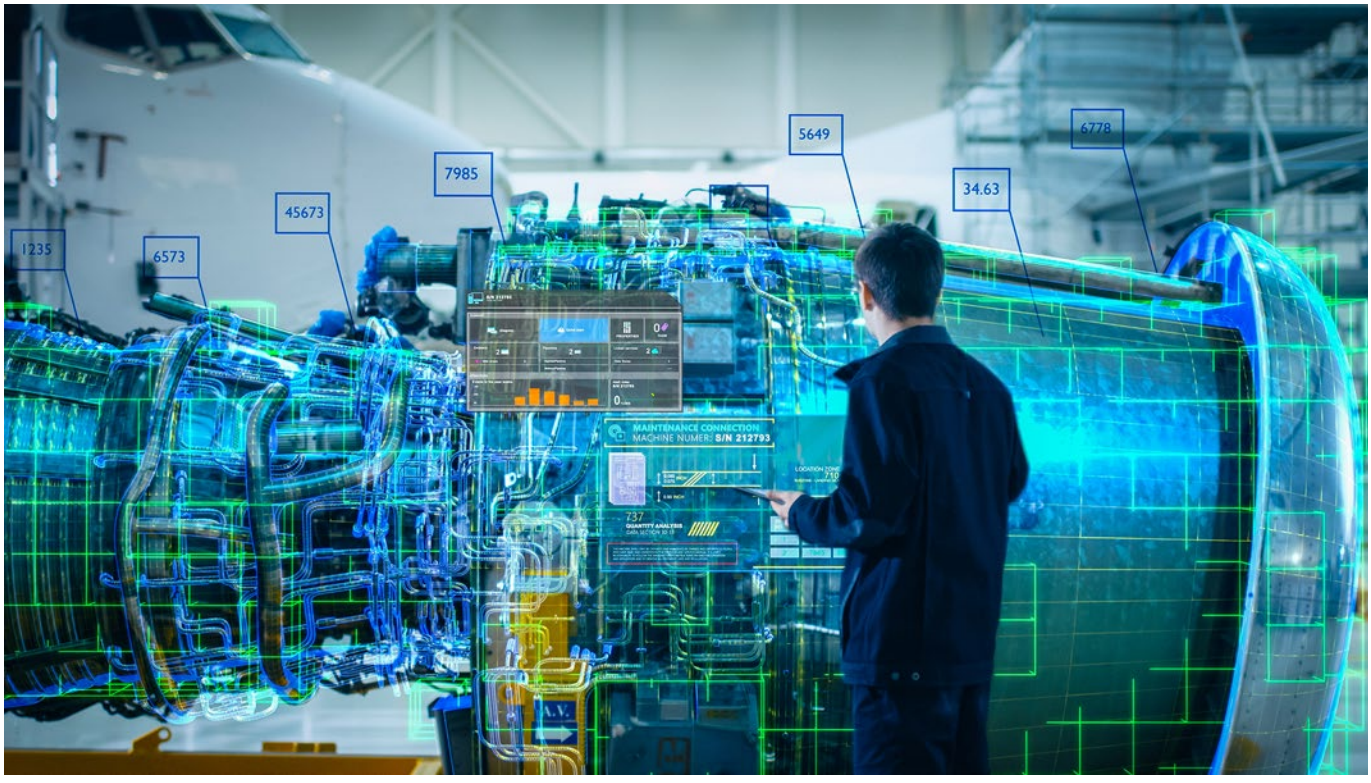
Learn more

careers in ELECTRONICS

Second Volume Now Available

Download

I-007e Books



Drilling Down on Digital Twin

Feature Interview by the I-Connect007 Editorial Team

Phil Voglewede is a professor and the associate chair of mechanical engineering at Marquette University and was recently named the director of the Omron Advanced Automation Lab at Marquette. Digital twin, he says, isn't just mimicking what humans do; it's not inventing flight by flapping our arms. Rather, it's looking at automation in ways you hadn't looked at it before. It's trying something new and different, but ultimately effective.

Barry Matties: Phil, how do you think about digital twin?

Digital twin is not just having a simulation of what you're seeing, but bringing in all the other information that you get along the way, which makes the design, manufacturing, delivery, and performance in the field even more robust and higher performing with that information. Digital twin is so much bigger than just, "Hey, I have a CAD drawing or a simulation." Now I can get a higher fidelity model because I know everything along the way: how it was manufactured, what were the torques on the belts, the order of the screws being put in, what truck it was on, the power it is consuming in the field, etc., and how that affects the overall performance.

If we can understand how each subassembly and assembly and delivery all come together, we can totally rethink the approach to how these things work together. Why, for example, does it need six bolts? Why not three snaps and a clasp, especially when we can make it easier, like with a push fit, or something else? We can understand the big picture, the goal, and your constraints. This is similar to Industry 3.0, when we start talking about Six Sigma and Taguchi, and pushing that information back into the design. Ultimately, you're look-

asc-i.com

WE ARE READY TO BRING YOU THE FUTURE

Our new Ultra HDI technology allows us to produce PCBs with parameters never seen before in our industry. With lines down to 1 mil with a line aspect ratio of 1:1 at production volumes, the future is here!

Check out our UHDI capabilities

American Standard Circuits

Creative Innovations In Flex, Digital & Microwave Circuits

ing at a system. If you're simply automating what the engineer or operator does, you won't be successful with the digital twin. You need to be pushing what more information can be garnered from AI. However, for all the promises of AI and such, we're not there yet. We have to manually look at this process differently, and what makes sense for the machine.

You know, when people first tried flight, they were mimicking the birds' mechanics, flapping their arms like birds. It took the Wright brothers to stop and ask, "What are we really trying to do? We're trying to fly. So, let's rewrite the laws of fluid mechanics and start to look at that better." That led to the thinking that, if we want to fly, maybe we shouldn't fly the same way as the birds. Perhaps we should use what we learned from the birds but fly differently.

It's the same thing with automation and AI. We'll do the same thing. We can't just mimic the human by making a humanoid or an artificial neural network when what we really want is to improve the entire process, including the design, automation, and delivery through the supply chain. In my mind, that's the vision of the digital twin.

Matties: We're already doing a version of digital twin in design. With the digital twin of the manufacturing process, first you need to benchmark the processes, collect the (digital) data, and do it in real time so the digital twin is current and active. That seems to be the greatest challenge. Maybe they don't see the ROI in doing it.

It's both. It's hard to justify the ROI. I'm working with some companies right now, where they struggle with the question, "What's the payback?" My advice is that there won't be much immediate payback. If I put sensors in a furnace, for example, to better understand what's happening inside with temperature, and one sensor shows the temperature is off the set point, then you know that one part of the product will get a much different temperature profile than the other. That might explain why you're getting a certain output that you didn't think you would get. It may help you understand the process but may not immediately yield better ROI. It's hard to put an ROI on that.

Phil Voglewede

Now we have AI and machine learning which we can use to see trends that we weren't able to see before. I've struggled to model the processes that I've worked with, just trying to correlate into curve fits. I do all this stuff, and it's beyond me. But an AI will start to see patterns—when this, this, and this happens, then that tends to happen over there. You might think you can get some ROI on that information, but you can't justify the costs to sensor-size the system upfront. I don't know what those things are until I find them; I can't justify what I can't predict. It's hard to do that, but that's what Industry 4.0 and the digital twin can help with.

Matties: Phil, thank you for sharing your insight.

My pleasure. **SMT007**

APEX EXPO IPC 2024

ecwc16 ELECTRONIC CIRCUITS WORLD CONVENTION

MEETINGS & COURSES
APRIL 6-11

CONFERENCE & EXHIBITION
APRIL 9-11

Anaheim Convention Center | CA

WHAT'S NEXT BECOMES NOW

CALL FOR PARTICIPATION

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

TECHNICAL TRACKS

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

Professional Development Course Abstracts Due	**AUGUST 28, 2023**
Conference Paper Abstracts Due	**SEPTEMBER 18, 2023**
Conference Poster Abstracts Due	**JANUARY 22, 2024**

WECC World Electronic Circuits Council

CPCA 中国电子电路行业协会 CHINA PRINTED CIRCUIT ASSOCIATION | JPCA | KPCA | THPCA THAILAND PRINTED CIRCUIT ASSOCIATION | TPCA Taiwan Printed Circuit Association

IPC.ORG/APEXEXPO-CFP | #IPCAPEXEXPO

MilAero007 Highlights

Altium 365 GovCloud Offers Increased Security ▸

Altium recently launched Altium 365 GovCloud, a dedicated platform accessible only to—and managed solely by—U.S. persons. The company says that GovCloud can help customers to be in compliance with ITAR, EAR, and other requirements. I spoke with Bruno Blasigh, director of Cloud Security for Altium 365, about the new platform, how it functions, and how GovCloud can help to keep foreign entities from accessing your data.

Flexible Thinking: The Adjacent Possible ▸

In the inspirational and informative book titled *Where Good Ideas Come From*, author Steven Johnson uses the term "the adjacent possible." This term, which immediately captivated my mind, originated with a theoretical biologist named Stuart Kaufman, who used the term in his book, *Investigations*, to describe the circuitous path of biological evolution.

Filling Critical Traceability Gaps With AI ▸

Traceability means being able to track the origin of any given electrical component throughout the supply chain. For OEMs, this is no longer optional or "nice to have." Yet industrial traceability capacities are sorely lacking throughout industries. Today, the most widespread standard for traceability is "batch traceability," which aside from tracking the production lot, serial number, and exact board placement for components, fails to analyze the individual components themselves, thus jeopardizing the quality of the goods they compose.

Averatek Names New CEO ▸

Averatek is pleased to announce Scott Meikle, Ph.D. as CEO. Dr. Meikle has more than 30 years of experience in the semiconductor industry.

Designing Aerospace PCBs: A Galaxy of Challenges ▸

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

Summit Interconnect Welcomes Brian Kamradt as New Chief Financial Officer ▸

Summit Interconnect announced the appointment of Brian Kamradt as chief financial officer. Kamradt brings over 20 years of finance, accounting, merger and acquisition, and IT experience to Summit's leadership team. He will succeed Tom Caldwell, Summit's initial CFO, who will be retiring after leading the company's expansion for the past four years.

CERcuits Wins Second Place in US Army's xTechInternational Competition With 3D Ceramic Circuits Solution ▸

CERcuits BV, a Belgian technology company specializing in ceramic electronic circuits, proudly announces its achievement as the second-place winner in the prestigious xTechInternational competition organized by the U.S. Army.

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

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

Prototron Circuits

America's Board Source

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

Manufacturing Isn't Linear; Stop Planning That Way

Article by Sylvain Perron
COGISCAN

In the last couple of years, exacerbated by the chaos of the COVID-19 pandemic, the uncomfortable reality is that many manufacturers are not well prepared to properly deal with and respond to last minute changes in the supply chain, worker availability, or major swings in customer demand. Many of you likely have a painful story or two about scrambling to address unexpected changes in the production plan and schedule over the last few years.

With the pandemic mostly in the rearview mirror, many organizations today are investing in solutions that will better equip them to handle any major disruption using tools that will provide both enhanced intelligence and agility. We can't control the future, nor any surprise disruptions to the global marketplace or supply chain, but we can look at our digital transformation strategy, and more specifically, digital visibility tools that help us better plan production.

Adapting to Last Minute Changes

Given the current challenges related to component allocation and extended supply-chain lead times, manufacturers today are regularly

Quick Solutions & *Fast* Quotes

Your Competitive Advantage

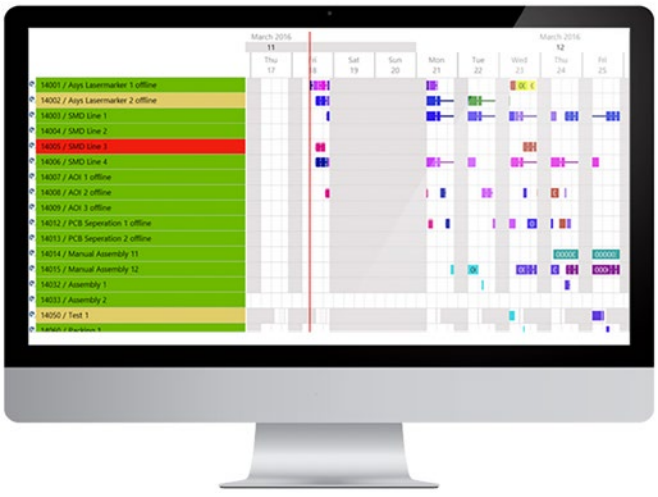
SUNSTONE CIRCUITS®

being forced to change production plans due to last minute changes in material availability. It's the sad truth that critical components often don't arrive on the required date for production, and planners are left scrambling to figure out how to re-align the production flow. Planners need to be equipped with a tool that appropriately evaluates the reality of materials so production orders can be easily and efficiently re-scheduled if a critical component doesn't show up when originally scheduled.

In many of these no-show material cases, planners need the flexibility to assess production options even without all required components, perhaps cutting the job in half based on available material and running that order through to the testing process, then holding those units at mechanical assembly until the rest of the order is ready to be built when the remaining material is in-house. The ability to identify and address risks beforehand ensures manufacturers can maintain continuity in operations and minimize the impact of no-show components.

Another complication many electronics manufacturers deal with regularly is when a top customer requests an urgent and hot order. These last-minute orders usually wreak havoc on production when they're plopped in unexpectedly. Planners need visibility on how to effectively squeeze in an urgent order and clearly evaluate available capacity and downstream effects on production. Simultaneously balancing multiple delivery requirements can be nightmarish, so the ability to easily visualize and choose the least painful option—for example, weighting profit margins more heavily with minimal impact to the overall production plan—is of the utmost importance in these hot order situations.

An advanced planning and scheduling (APS) platform helps manage these complicated material planning scenarios. Utilizing production optimization algorithms in the planning and scheduling process—including available resources, on-time delivery, current demand, and cost considerations—this tool simulates and plans the best factory-specific options for production scheduling, balancing many and often conflicting manufacturing priorities.



Screenshot from the gantt chart view within APS.

In today's environment, manufacturers require the ability to properly assess any impact on the originally planned schedule, evaluate the feasibility of potential adjustments, and then make informed decisions with minimal impact on both profitability and real-time operations.

Simplifying

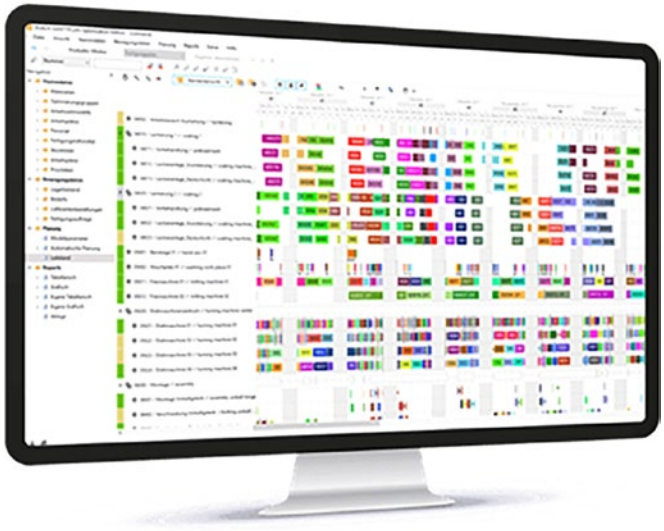
We're all feeling the pain of the global staffing crisis, whether it's something minor like the local coffee shop closing earlier than expected when you're desperate for an afternoon pick-me-up, or a positive COVID-19 employee infects all the staff assigned to the rework and repair department. It has disrupted our lives in one way or another.

Electronics manufacturing is a multifaceted production operation requiring a variety of resources beyond just machinery and materials. Availability of staff can have a dramatic impact on the production flow, and when a handful of operators call out simultaneously due to illness or otherwise, it can wreak havoc on the original production plan. Manufacturers need to be able to re-run scheduling sce-

narios if, and more likely when, staffing availability changes last minute. In the case of the GANTTPLAN APS system, worker resource gaps can be adjusted in real-time, so planners can act quickly to re-balance the schedule before actually hindering production.

Certain types of assemblies even require employees to have a specific credential to perform the required work. For example, an aerospace product may require a technician to have a specific IPC certification, so the manufacturer needs to put that technician's availability as priority when scheduling the work for that job. In GANTTPLAN APS, planners can look at all the variables involved in the assembly process, not just due date and resource constraints, and in the case of this aerospace example, would heavily weight the certified technician's availability to schedule and plan the process flow for production.

By leveraging simulations and balancing multiple weighted variables, systems such as GANTTPLAN APS help empower electronics manufacturers to make informed decisions, better plan and visualize production based on what's available at that moment, streamline operations, maximize profits, and achieve higher levels of productivity and competitiveness in this fast changing and ever-evolving industry. **SMT007**



Screenshot from the multi-resource planning view within APS.

Sylvain Perron is product manager of Technology Partnerships at Cogiscan.

Good News for U.S. National Security

By Chris Mitchell
Vice President, IPC Global Government Relations

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

Translation: It is now a tenet of U.S. policy that manufacturing more of the building blocks of modern electronics in the United States is essential to America's economic and national security.

Most people take our modern electronic wonders—from smartphones to medical monitors to air traffic control—for granted. We don't think about where these products come from, or what goes into making them.

But the supply chain crisis spawned by the COVID pandemic was a wake-up call. Suddenly, leaders of business and government realized we didn't have enough domestic capacity to supply all the semiconductor chips needed to power our economy.

That is why Congress last year enacted, and President Biden signed, the CHIPS and Science Act, which authorized the funding to implement the CHIPS Act of 2021 and expand U.S. output of semiconductor chips.

Now, leaders of business and government are beginning to realize that merely producing more chips is not enough. Semiconductors are modern wonders, but they are useless without PCBs and the rest of the electronics package. No one buys just chips; they buy components and systems that contain chips. Unfortunately, the United States is even more dependent on overseas suppliers for these components than they are for semiconductor chips.

Get more details in the Summer issue of *IPC Community.*

It All Starts With Sensors

Feature Article by Happy Holden
I-CONNECT007

Introduction

Sensor technology is at the heart of any manufacturing data collection, especially for the digital stream—it all starts with sensors—but there is so much more. Sensors need connections to instruments, and some actions need predictions; the process is sensing, connection, and predicting. Sensing assumes sensors. Connecting can be any intelligent device that provides a program or signal conditioning and then makes that data available to the rest of the organization. Predicting is the difficult step.

The Smart process needs to be implemented immediately. Time does not favor the procrastinator. Assign or hire an engineer who has the tools and creativity to make digitization work, let them gain the new training that may be required, and just do it.

Sensor Training Options

My background is chemical engineering, and we spent a lot of time learning about sensors, control systems, and chemical unit operations.

In my college days of the mid-1960s, basic industrial sensors included[1]:

- Electrical measurements
- Displacement and area measurements
- Pressure measurements
- Flow measures
- Measurement of temperature
- Thermal and transport properties
- Force, torque, and strain
- Motion and vibration
- Thermal and nuclear radiation measurements

MS2 can reduce your lead-free and leaded bar solder purchases by up to 80%

How much can you save?

Calculate your savings with just 3 easy inputs:

Choose your alloy

Production hours/day

Wave machines

Calculate your savings

PK METAL

+1 (323) 585-5058 www.pkaymetal.com

Later, in graduate school, I took a course titled "Instrumental Methods of Chemical Analysis."[2] This was a DIY course that required us to build 22 analytical devices and their electronics from a LEGO brick-like set of optical and mechanical components that snapped together. This course covered a wide variety of topics, including spectroscopy, chromatography, radiation absorption, and polarimetry, to name a few. I learned that sensor systems can lend themselves to DIY approaches.

Industrial Training

After college, I was recruited by Hewlett-Packard in Palo Alto, California, where I worked first in RF device substrate manufacturing and later in automation. As one of the world's largest instrument and test equipment manufacturers, HP had very large data acquisition devices: industrial DAQ and control units. These provided additional sensor training through practical industrial applications. Some resources I found helpful that are still available today are:

- Tektronix and Keysight publications (Figure 1)
- Tutorials from IPC and Institute of Circuit Technology
- Distance Learning: Massive Open Online Courses (MOOC) like Kahn Academy or Purdue Global

Sensor and chemical analysis are part of the "Automation & the Journey to the Smart Factory", a nine-hour webinar course offered for free by the UK Institute of Circuit Technology (ICT) organization.

Industrial Sensors and Transducers for Electronics

There are many industrial sensors present in PCB fabrication and component assembly on PCBs. Table 1 is only a partial list I have collected.

Table 1: Common sensors used in manufacturing today

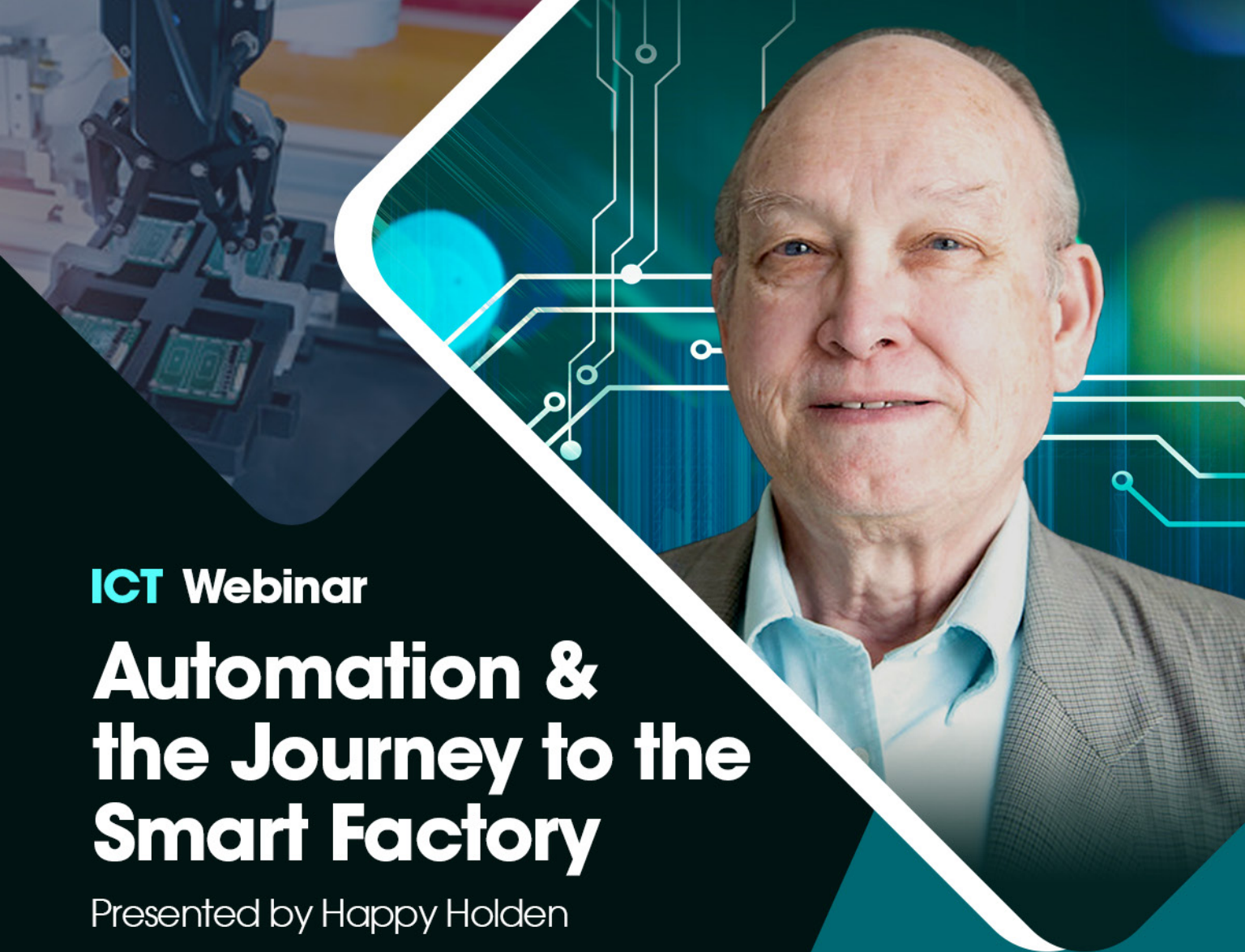
Accelerometer	Load cell	Proximity
Amp-hour	LVDT	RTD
Barcode	Mass flow meter	Specific gravity
Capacitance	Resistance	Speed
Count	ORP probe	Temperature
Employee #	pH probe	Thermocouple
Flow meter	Photocell	Thermistor
Inductance	Photoresistor	Time
IR Thermometer	Photovoltaic	Work order
Level Measurement	Pressure gauge	Weight
Electrochemical	Spectrometer	X-ray/Hall effect

These sensors can be found online but may not be suitable for all factory installations. They can be quite expensive, so I have looked for sensors and transducers that can be used in PCB processes and compiled a list in my book, Automation and Advanced Procedures in PCB Fabrication.[3] Sometimes, the best sensors come from fabricating them yourselves.

Figure 1: Vendor-supplied sensor and DAQ publications.

DIY Training

Sensors have been around since the Industrial Revolution and were the crucial tool that allowed us to make use of the steam engine. Now, there are so many electrical sensors.



ICT Webinar

Automation & the Journey to the Smart Factory

Presented by Happy Holden

Essential Skills

Industry 4.0

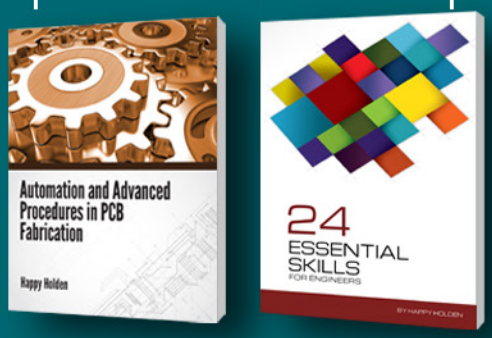
Please join us for eight 60-minute online sessions with industry icon Happy Holden. These sessions are open to all, including students.

To access these sessions, contact Bill Wilkie and provide your name, company and email address.

ACCESS WEBINAR SERIES

www.instct.org info@instct.org

BASED ON THESE BOOKS



DOWNLOAD FREE TODAY

Institute of Circuit Technology ICT Est. 1974

Though sensors, which are important for PCB fabrication and assembly, are harder to find, temperature sensing is by far the most common, followed by liquid level, and water conductivity. For chemical processes, Table 1 lists the most frequently used electrochemical sensors[6]. My favorite, though seldom used, is specific gravity. I favor it because most chemical processes in fabrication or assembly are aqueous. Changes in chemical concentrations can easily be detected by specific gravity changes and then measured with a hydrometer.

In my career, I have focused on four groups of sensors for analytic data[4,5]:

- Specific gravity
- Spectrometers: The LEGO spectrophotometer is quite easy to build
- Ampere-hour for plating: An AH totalizer component can cost less than $5
- Electrochemical sensors: Cyclic voltametric stripping for plating additives

Data Acquisition

The variety of data acquisition devices (DAQ) have increased significantly over the past 20 years. As seen in Figure 3, industrial devices for four analog channels start at a mere $85 and can range up to many thousands of dollars for six-digit multimeters that do 50K readings a second for many hundreds of channels. Multiple protocols are available for interconnection.

The popular programmable logic controllers (PLCs) also have analog and digital inputs and start at very reasonable prices, like I mentioned for the industrial devices.

For data analysis and signal conditioning, a personal computer can be used, though a microcomputer— such as the Raspberry Pi or Arduino—is much lower in cost and can be suitably protected for use in manufacturing (Figure 4).

The Raspberry Pi 4 is my personal choice because of its popularity, flexibility, operating system, connectivity (general purpose inputs

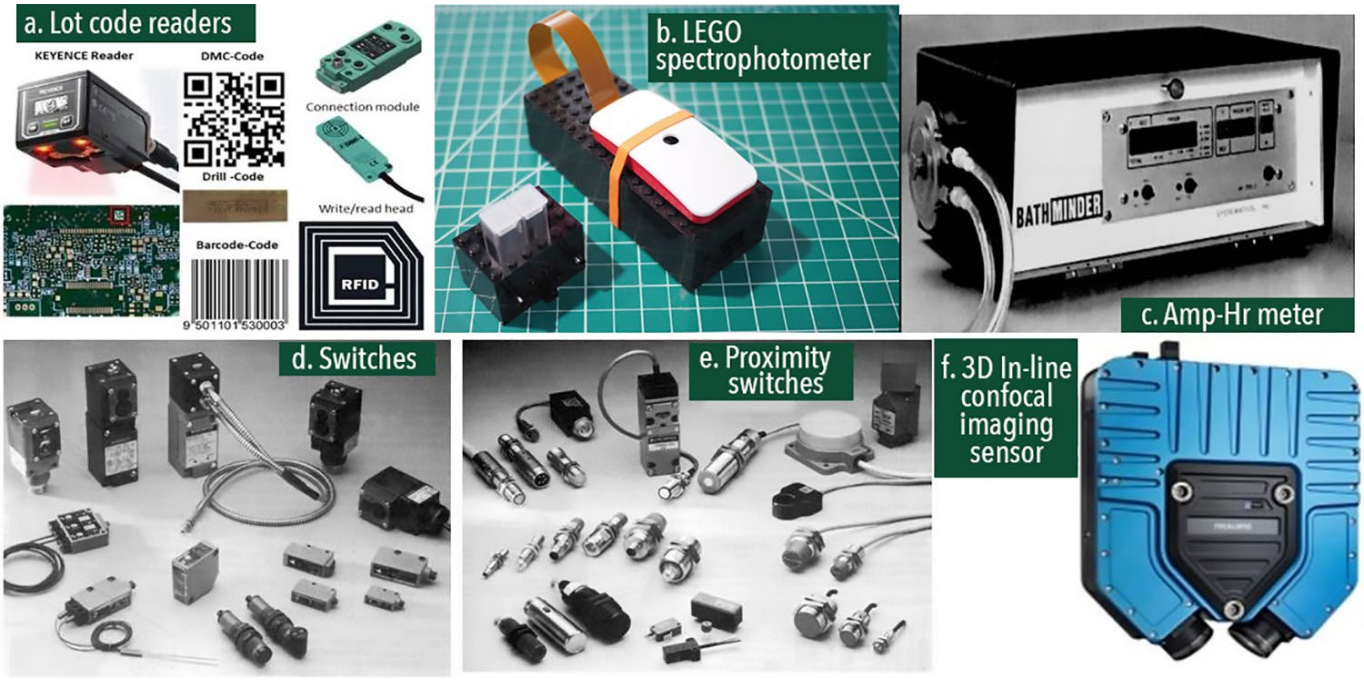


Figure 2: Sensors for electronics manufacturing: a) Lot code readers; b) The LEGO spectrophotometer; c) Ampere-hour meter; d) Various object sensors; e) Non-contact proximity sensors; f) In-line confocal microscopy serves as 3D measurement sensors for fine-line HDI geometries. (Source: LMI Tech[6])

Figure 3: Various data acquisition devices and their cost.

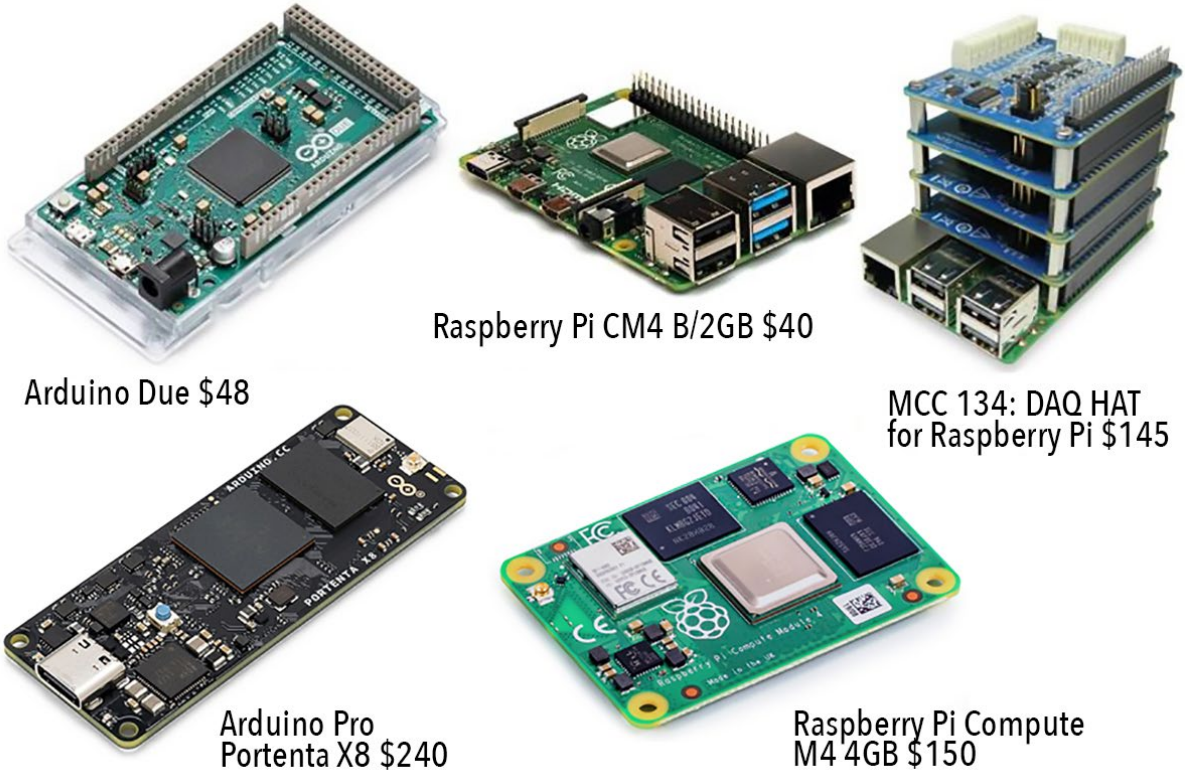


Figure 4: Microcomputers and controllers abound and are ideal for DAQ and data analysis/control/predictions.

and outputs), networking (USB, Wi-Fi, Ethernet), size, and low cost.

Challenges for Electronics Manufacturers

The challenge for using these technologies for digitization is in picking a suitable individual who has the proper background, then educating them in these specifics.

To learn programming languages, (Python and JavaScript) the easiest and fastest way is to use BBC's micro:bit computer. It was designed for seventh graders; it has the most complete

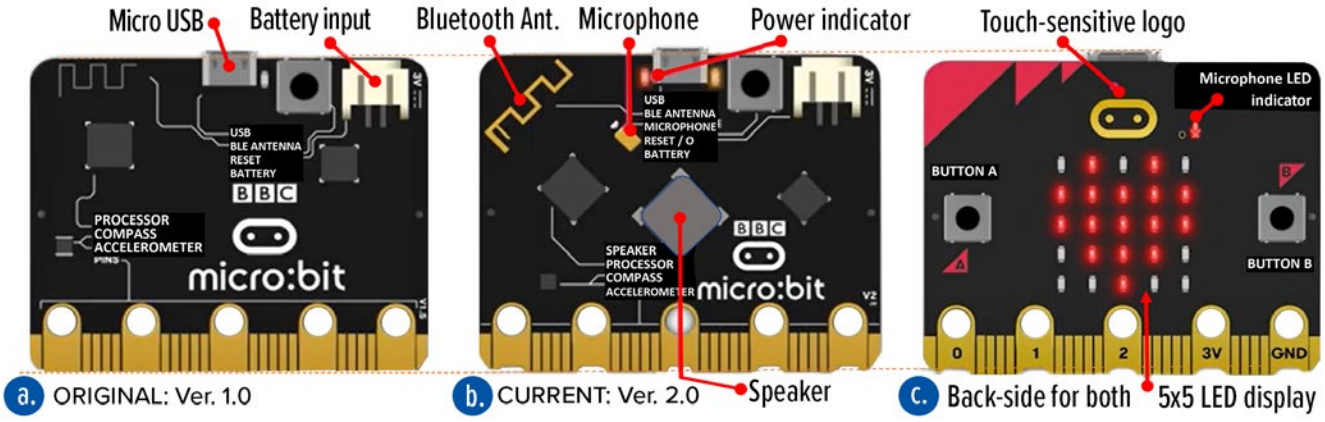


Figure 5: The BBC micro:bit programming training comes with many sensors and will teach you Microsoft MakeCode, Python, and JavaScript software.

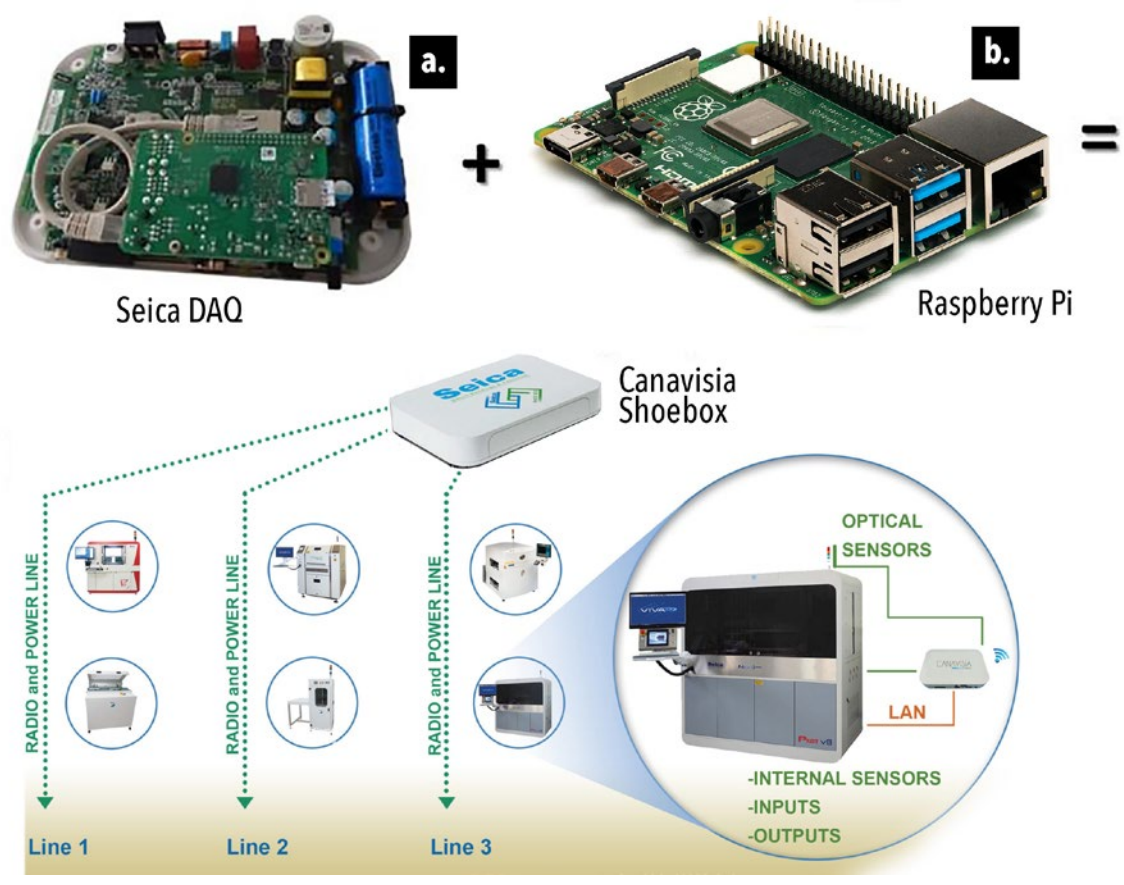


Figure 6: Seica's Shoebox uses the Raspberry Pi 4 with their own DAQ for wired or wireless sensor connectivity: a) Connected to its 40-pin GPIO; b) Enabling it to connect to older non-Industry 4.0 equipment for IPC-CFX or SEMI SECS-GEM connectivity.

tutorials with examples and quizzes[5] (Figure 5). The finished unit can be acquired from established EM equipment vendors, like Seica's Shoebox seen in Figure 6.

A more ambitious project would be a chemical control system for SAP plating using a spectrophotometer and Raspberry PI, or simply starting with a sensitive specific gravity controller attached to a DAQ and networked by a Raspberry Pi.

ALL EPISODES AVAILABLE

sustainability podcast

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

LISTEN NOW

Conclusion

If you have university trained engineers (or can recruit some) who can be assigned to these tasks, that's great, but it's not a necessity. A motivated PCB fab or EMS employee can learn these skills. What is needed is the focus and authorization to take this path:

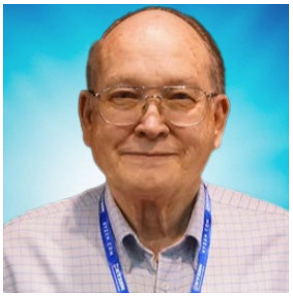
1. Delegating interested individuals to learn about sensors in your business.
2. Learning to use data acquisition and simple microcomputers like the Raspberry Pi or BBC Micro:bit.
3. Learning to program in Python or JavaScript using the BBC Micro:bit.
4. Start a first project, which can make a significant improvement in quality or productivity.
5. Conducting a Smart process audit of your manufacturing to look for additional high-value projects.
6. Training and upskilling additional employees with the skills you now have learned.
7. The journey to a Smart process will drive you forward. Remember to think big, start small, and prove the value so you scale fast. **SMT007**

References

1. *Experimental Methods for Engineers,* by J.P. Holman, 1966 (Eighth Edition, 2011).
2. *Instrumental Methods of Chemical Analysis,* Third Edition, by Galen W. Ewing, 1969.
3. *Automation and Advanced Procedures in PCB Fabrication,* by Happy Holden.
4. "Assembling the Public Lab Lego Spectrometer," Public Lab, Dec. 13, 2017.
5. "Happy's Tech Talk #20: Teaching Coding to Kids: The UK's Micro:bit Tool," *PCB007 Magazine,* June 2023.
6. Confocal Sensor Brochure from LMI Technologies, and IPC Auto Forum, IPC APEX EXPO 2019.

Resources

- "Happy's DIY Solution to Chemical Control," by Happy Holden, *PCB007 Magazine,* November 2020.
- "The Smart Factory: All the Bits and Bobs," by Happy Holden, *PCB007 Magazine,* February 2020.
- "Hardware and Software in Smart Factories," by Happy Holden, *PCB007 Magazine,* March 2019.
- Sensor Fundamentals, National Instruments Tutorial.
- *Engineers Guide to Accurate Sensor Measurements,* National Instruments Tutorial.
- Sensor videos and tutorials are available online from Electronics Tutorials and from IEEE.



Happy Holden has worked in printed circuit technology since 1970 with Hewlett-Packard, NanYa Westwood, Merix, Foxconn, and Gentex. He is currently a contributing technical editor with I-Connect007, and an I-Connect007 columnist. To read past columns or contact Holden, click here.

Save the Date!

Electronics Manufacturing Conference and Exposition

SMTA International 2023 MINNEAPOLIS

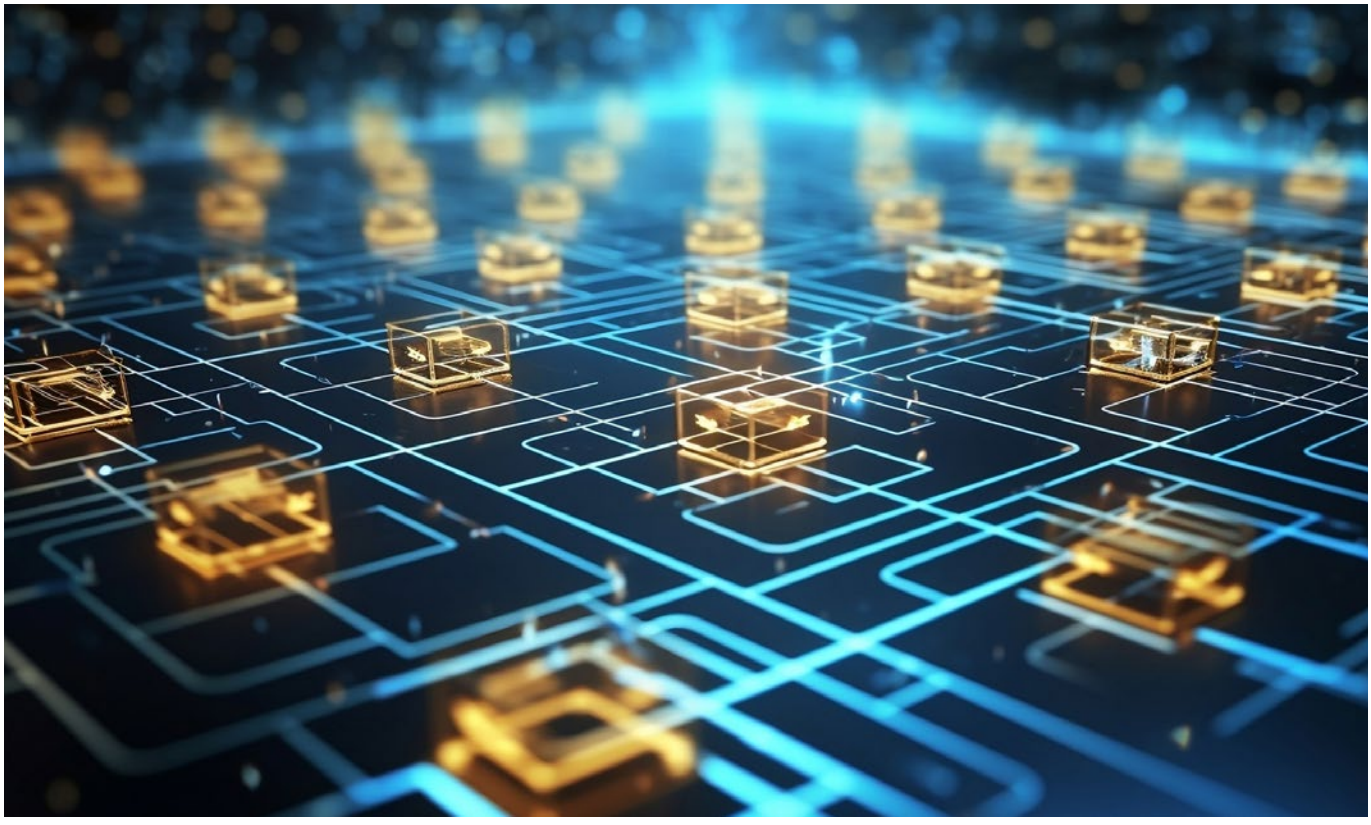
OCTOBER 9-12

Attend the Midwest's Largest
Electronics Manufacturing Event!

Conference: **Oct 9-12**
Exposition: **Oct 10-11**

To learn more visit
www.smtai.org

Cultivating Connections



The Challenge of Traceability Data: A Call for Action

Article by Dr. Eyal Weiss
CYBORD

Imagine the following scenario: You're working in the electronics manufacturing industry as an operations manager in charge of overseeing the assembly of cutting-edge devices. One day, you receive news that one of the series of products you've shipped to market has experienced a major malfunction, causing an uproar among customers. You frantically try to pinpoint the root cause only to lose yourself in the labyrinth of incomplete traceability data. The frustration mounts, leaving you grappling with the consequences of an ineffective traceability system. But what if there was a way to transform this experience into a seamless operation?

Traceability is the cornerstone of ensuring product quality, compliance, and customer trust, but traceability data as it exists today is not nearly as reliable as one might hope.

Enter individual material traceability, an upgraded approach to filling in data gaps, mitigating vulnerabilities, and eliminating potentially costly consequences.

The Challenge

Despite diligent efforts by manufacturers to implement robust traceability systems, three gaps persist between expectations and reality.

The first is a date code mismatch. In some cases, the traced date code—the code assigned

KOH YOUNG TECHNOLOGY

True3D Inspection Solutions for Advanced and Wafer Level Packaging

Today's complex electronics include more functionality and better performance in a smaller footprint, which increases board density, reduces component size, and introduces new manufacturing techniques. These aspects challenge typical inspection techniques, especially for ultra-thin solder or mirror-finish die. **We designed the Meister Series with our True3D™ measurement-based inspection system to reduce costs, increase yields, and maximize productivity. With the Meister series, users can master critical manufacturing challenges of advanced packages.**

kohyoungamerica.com

america@kohyoung.com

to a product indicating the year and week it was made—differs from the real date code.

The second is a production lot mismatch. These are cases in which the traced production lot—the number used to relay the batch of origin—does not reflect the real lot code. This disparity indicates the presence of multiple lots within a single traced lot, which suggests reel design variations may have been grouped and packaged together accidentally.

The third is a part number mismatch. A part number reflects an item's particular rating, voltage, speed, and many of its other qualities, and these parts need to be assembled with compatible ones. When a mix-up occurs and the wrong components get paired, the functionality of the end product is compromised. To make matters worse, it is very hard to detect this discrepancy during onsite testing.

These issues contaminate the supply chain with untraceable components, compromising product quality, risking regulatory non-compliance, and potentially triggering reputational or economic damage. Identifying these discrepancies is crucial for manufacturers to bolster traceability capabilities and improve overall supply chain transparency.

"With these tools, manufacturers can follow a three-step roadmap to address the shortcomings of current traceability practices.

AI and Big Data Close the Loop

Like any controlled parameter, traceability data requires a feedback loop for effective quality assurance. But within the electronics manufacturing industry, such a closed loop does not exist. Fortunately, recent advances in AI algorithms and big data analytics have provided manufacturers with the means to visually establish, automate, and verify all traceability data.

With these tools, manufacturers can follow a three-step roadmap to address the shortcomings of current traceability practices.

The first is to elevate traceability resolution from batch level to individual material level, in accordance with the soon-to-be enacted IPC-1782B, a standard that is strongly recommended for high-end and life-critical products like those in the automotive and medical spaces. With this upgrade, manufacturers can address batch incidents by checking for various defects at the component level with singular precision.

The second is to conduct AI-powered visual verification of all top markings on every board, which can even be accomplished without additional hardware. This allows for a finer resolution of verified information, enabling manufacturers to better distinguish between marking lots and documented supply chain lots. This heightened level of traceability provides a robust foundation for accurate data analysis and decision-making at any point in the lifecycle of any product.

The last step involves closing the loop with the previously mentioned feedback in as close to real time as possible. By integrating verified traceability data into the production line, manufacturers can effectively close the loop on data handover errors. To that end, typing errors, human errors, and systematic procedural errors can be identified and fixed promptly, ensuring an accurate data trail throughout the supply chain and production process.

Original equipment manufacturers (OEMs) who put these measures into action will see

improvements beyond just enriching traceability; they will also be able to assign quantifiable values to their operational efficiency, product quality, and to the capital they end up saving.

A Data Wake-up Call

Insufficient traceability doesn't just create headaches for OEMs; it affects everyone across the value chain, including suppliers, distributors, and especially consumers.

Manufacturers, regulators, and industry stakeholders cannot continue operating under the illusion that conventional traceability procedures meet the moment, especially when the devices in question are used in the automotive, medical, or defense industries where the potential consequences of complacency are far too dire.

Taking proactive steps to bolster traceability is the best way to protect the integrity of our most essential electronic devices and the people who depend on them. **SMT007**

Dr. Eyal Weiss is CTO and founder of Cybord.

Purdue Engineers Create Continuously Tunable Thermal Regulators

Battery safety and performance in electronic devices and systems like battery thermal management, space conditioning, vehicle thermal comfort and thermal energy storage can improve thanks to a continuously tunable thermal regulator created at Purdue University's College of Engineering.

Xiulin Ruan and Amy Marconnet have invented patent-pending, solid-state, continuously tunable thermal devices based on compressible graphene foam composites. The devices can dissipate heat, insulate against cold and function across a wide range of temperatures.

"As batteries and electronic devices get more powerful, managing heat becomes a more crucial issue," Ruan said. "We all know humans have a narrow range of temperature to live comfortably, and that is why we wear shirts in the summer to keep cool and coats in the winter to keep warm. Similarly, batteries and electronic devices have a narrow temperature range to function appropriately as well, and are even more 'picky' than humans."

Marconnet said, "Batteries perform poorly if they are too hot. As they heat up, chemical reactions occur that cause them to heat up even faster. This unstable reaction progression is called 'thermal runaway' and can even lead to fires and explosions. On the other hand, if the temperatures are too low, batteries suffer internal damage. It leads to poor performance like shorter driving ranges for electric vehicles and less cellphone usage time."

Conventional thermal switches, analogous to electrical switches that moderate current flow, tune a battery's heat dissipation pathways only by changing the conduction between on and off states. Ruan said the Purdue-invented thermal regulators improve upon this technology by changing the thickness of the material inside the regulators, which helps batteries continually adjust to different climates and seasons.

The commercially available compressible graphene foam Ruan and Marconnet use is built from nanoscopic particles of carbon deposited in a specific pattern with small voids of air in between.

(Source: Purdue University)

A Tale of Two Lawn Mowers

Maggie Benson's Journey

by Dr. 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.

Hal Lindsay really wanted to make this sale of two component placement machines to Benson Electronics. The selling price was $599,000 for the two Excel placement machines and he would get a generous commission when the deal went through. But he knew Benson Electronics had a close relationship with Professor Patty Coleman, and she had cost him a consulting job some years back. She used some highfalutin' mumbo jumbo calculations that unfairly convinced the customer not to retain his services. Well, he was prepared if she showed up. He knew the customer was looking for the lowest cost of ownership and he had the data to show that the Excel machines he wanted to sell were the best. To ensure he was prepared,

MES & INDUSTRY 4.0 INTERNATIONAL SUMMIT

Experience the future of smart manufacturing at the MES & Industry 4.0 International Summit. This transformative event brings together industry leaders, experts, and visionaries for two days of insightful discussions and cutting-edge technologies.

DAY 1
Inspiring presentations about how Digital Transformation impacts manufacturing. Join Jeff Winter as he explores the transformative power of Industry 4.0 in manufacturing. Alexander Hagenfeldt, from ASMPT, will share how software is revolutionizing factories for future success.

Engage in the panel discussions about artificial intelligence in manufacturing and how Virtualization, Digital Twins and Machine Learning are accelerating the spiral of innovation. Discover how MES and IIoT are building resilient and data-driven enterprises. Learn from renowned experts: Didier Chavet (Micron Technology), David Fried (Lam Research), and Michael Kaiser (B.Braun).

DAY 2
Continues with an interactive session led by Jan Snoeij from MOMI, delving into the vision and maturity assessment of Industry 4.0. Visit the **MES Expert Lab**, where the latest advancements in smart material management await. Immerse yourself in a virtual factory tour.

Connect with industry leaders, discover cutting-edge solutions, and stay ahead in the ever-evolving landscape.

Visit www.mesi40-summit.com to explore the full agenda and secure your spot at this transformative event.

Critical manufacturing
an ASMPT company

Critical Manufacturing, Leader in the Gartner Magic Quadrant, provides the most modern, flexible, and configurable manufacturing execution system (MES) available. As the host of the MES & Industry 4.0 International Summit, Critical Manufacturing brings their extensive expertise in MES and Industry 4.0, providing a platform for industry leaders to explore the transformative potential of smart manufacturing.

he even used ChatGPT to make sure he didn't miss any points. This time he was ready, even if that Ivory Tower Patty Coleman showed up.

Meanwhile back at Ivy University, Professor Patty was stressed. Her twin sons were now rising juniors in high school, so it was time for them to be preparing for college. Both were top students and stars on their high school golf team. All of Patty's many friends and relatives assumed the boys would go to Ivy U. However, there were two big problems:

First, it was possible they wouldn't be accepted to Ivy U; most people didn't know that the children of professors receive no preferential treatment regarding admission. This past year, Ivy U only accepted 10% of applicants. Many valedictorians, class presidents, and captains of sports teams didn't make it.

"This is another issue most folks don't understand: Professors get no special financial aid for their children.

Another issue was the cost. With all expenses added in, Ivy U and other top private schools cost almost $100,000 a year. This is another issue most folks don't understand: Professors get no special financial aid for their children. So, she and her husband Rob were facing the cost of $200,000 a year if their sons could even get into a top private school. Meanwhile, the best state schools were only $40,000 a year for tuition and other expenses.

Patty was startled into the moment by a knock at her office door. It was Paul LaCroix.

"Paul, come in," Patty said. "How was your meeting with Sue and Andy?"

"They were very helpful, Professor Coleman," Paul replied. "We discussed that the term 'cost of ownership' was really not that useful."

"Why is that?" Patty asked.

"Well, Professor Coleman," Paul continued, "they explained it by discussing the lawn mowing business example. They said it was something that Dr. Maggie Benson told them that all the leaders in Benson Electronics had to understand."

Patty chuckled. So, Maggie was now a PhD? In addition, Patty was pleased that the lawn mowing business example that she had taught Maggie and her peers received some traction.

"Can you explain it to me?" Patty asked, as Paul responded, "I think so," then explained: "Let's assume that a man has a lawn mowing business. His business is quite good, as he may have to turn away customers. He considers two professional lawn mowers. Number one costs $6,000 with a $1,000 a year repair plan. It uses $3,000 a year in fuel. Number two costs $10,000 with a $1,500 a year repair plan and it uses $4,000 a year in fuel. Assume both mowers are amortized over five years and, to simplify things, we will forget about interest as it is a second order cost.

"So, the cost of ownership for number one is $1,200 + $1,000 + $3,000 = $5,200. Whereas the cost of ownership of number two is $2,000 + $1,500 + $4,000 = $7,500. So clearly mower number one is better from a cost of ownership perspective, but..." Paul paused.

Patty couldn't help herself. She was bursting with excitement because she saw that Paul understood what many electronics executives didn't. However, she held back. "But what?" she asked.

"But it is meaningless," Paul responded.

"Why?" Patty asked.

"Because the man can make more money with mower number two since it can mow a lawn 30% faster," Paul responded. He has about $100,000 a year in business with mower num-

ber two, whereas with mower number one, he could only do about $70,000 per year."

"What if he only had $70,000 of business in a year?" Patty asked.

"Well, he would finish early and have more time to do other things," Paul said.

"So, sum it up?" Patty asked.

"I just don't see how 'cost of ownership' is a useful concept," Paul said. "I think something more like 'profitability potential' is more helpful. I plan to use this concept in my project to evaluate the component placement machines Benson Electronics wants to purchase."

Will Paul's use of profitability potential find the best component placement machines? How will Hal Lindsay react to Paul's analysis? Stay tuned to find out. **SMT007**

Dr. Ronald C. Lasky is an instructional professor of engineering for the Thayer School of Engineering at Dartmouth College, and senior technologist at Indium Corporation. To read past columns, click here.

Discovery May Lead to Terahertz Technology for Quantum Sensing

The manipulation of light waves at frequencies beyond human vision has enabled such technologies as cell phones and CT scans. Rice University researchers have a plan for leveraging a previously unused portion of the spectrum.

"There is a notable gap in mid- and far-infrared light, roughly the frequencies of 5-15 terahertz and wavelengths ranging from 20-60 micrometers, for which there are no good commercial products compared with higher optical frequencies and lower radio frequencies," said Rui Xu, a third-year doctoral student at Rice and lead author on an article published in Advanced Materials.

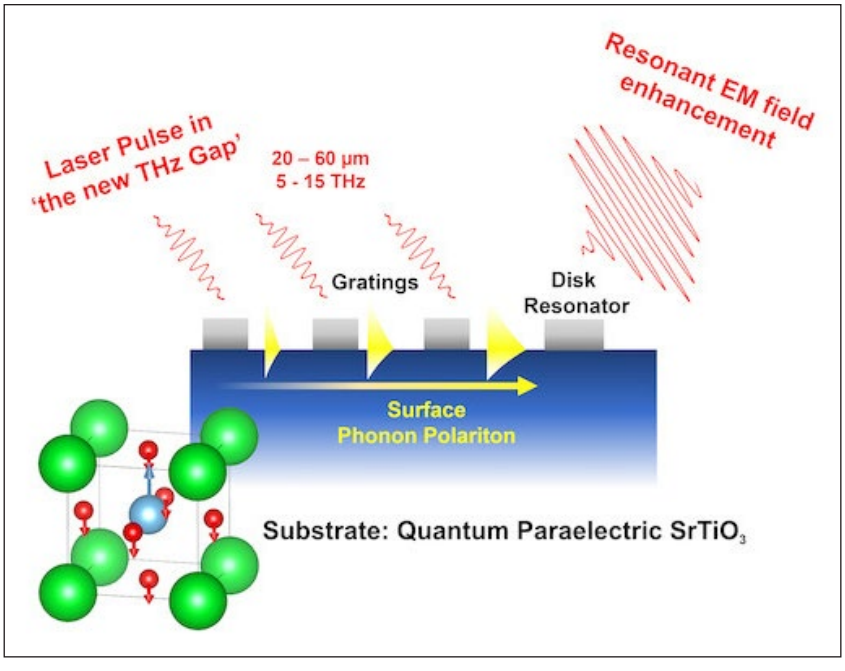
"Optical technologies in this frequency region—sometimes called 'the new terahertz gap' because it is far less accessible than the rest of the 0.3-30 terahertz 'gap'—could be very useful for studying and developing quantum materials for quantum electronics closer to room temperature, as well as sensing functional groups in biomolecules for medical diagnosis," Zhu said.

The challenge faced by researchers has been identifying proper materials to carry and process light in the "new terahertz gap." Such light strongly interacts with the atomic structures of most materials and is quickly absorbed by them. Zhu's group has turned the strong interaction to its advantage with strontium titanate, an oxide of strontium and titanium.

"Its atoms couple with terahertz light so strongly that they form new particles called phonon-polaritons, which are confined to the surface of the material and are not lost inside of it," Xu said.

Unlike other materials that support phonon-polaritons in higher frequencies and usually in a narrow range, strontium titanate works for the entire 5-15 terahertz gap because of a property called quantum paraelectricity. Its atoms exhibit large quantum fluctuations and vibrate randomly, thus capturing light effectively without being self-trapped by the captured light, even at zero degrees Kelvin.

(Source: Rice University)



The Vision: Virtual to Support Real Operations

Feature Article by Óscar Martins
CRITICAL MANUFACTURING

It's time to make the ideal of digital transformation a reality. Everyone seems to agree that is the path to manufacturing business success. Yet, not everyone knows how to proceed toward this digital future right now.

Hint: Combine the new Industry 4.0 technologies such as digital twin and augmented reality (AR) with up-to-date versions of proven software systems, particularly manufacturing execution systems (MES). Or better yet, find systems that inherently do that for you. Then create ways to ensure these digital and virtual systems reflect and fully support your physical and real operations.

There are many new technology approaches to consider in Industry 4.0. Here, we will focus mainly on two: digital twin and augmented reality (AR) and point to a third, digital thread, which is more an ideal data flow and approach that ties other technologies together.


We are dedicated
to excellence through
innovation,
technology
and most importantly,
service.
COMMERCIAL • MILITARY • MEDICAL • BAREBOARD
U.S.C.
U.S. CIRCUIT
www.uscircuit.com
ISO
9001 CERTIFIED
ITAR

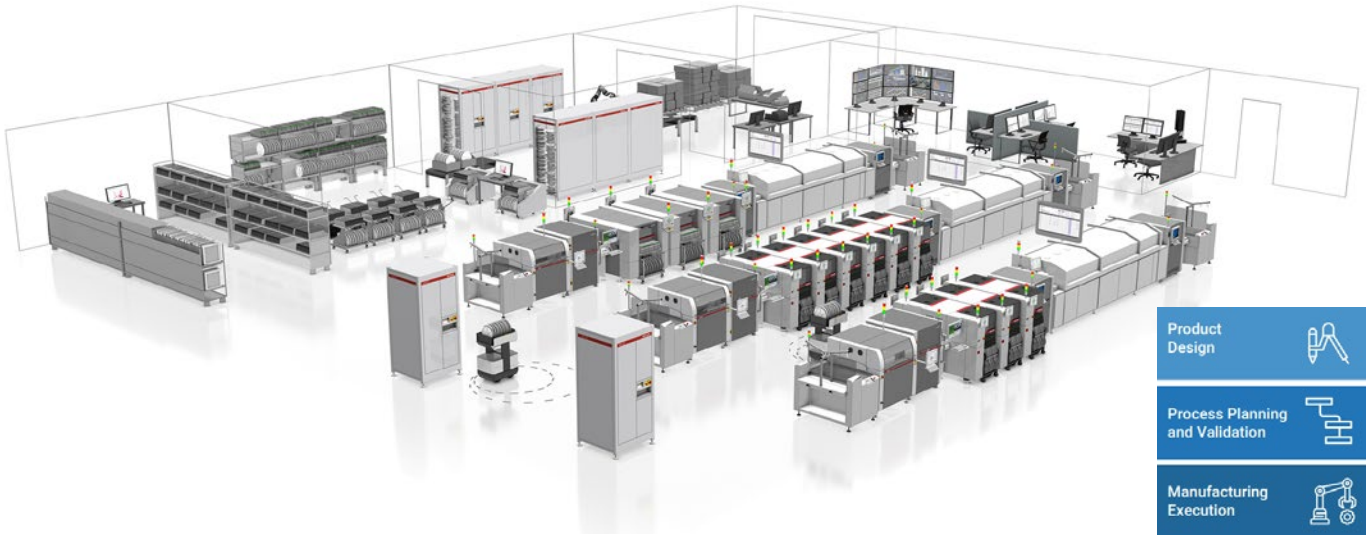


Figure 1: Digital twin is best known in product and process engineering, but there is also a digital twin of the actual manufacturing process as executed.

Digital twin is a digital replica of a physical entity. While common in product design, that is just one type of digital twin (Figure 1). In manufacturing, it's the set of models and data about a product, asset, production line, or plant that is continually updated through its lifecycle. Using Industrial Internet of Things (IIoT) data allows real-time updates to the virtual model based on what's happening in the real system.

Augmented reality (AR), as defined by MESA International, is: "Adding a virtual layer of contextual information at the right time and in the right place (e.g., through devices such as Google Glass). Augmented reality is expected to help plant floor workers perform a variety of non-repetitive tasks faster, such as assembly, picking, maintenance, and others." The virtuality-reality continuum is a way to understand the relationship between the virtual and real worlds (Figure 2). Notice that there are also various mixes of virtual and real, notably augmented reality.

It might help to think of these two as shown in Figure 3:

- Your plant is the real-world object
- The digital twin is its image in the mirror
- AR is a device to see the mirror at the same time as the real object

Digital thread, as defined by MESA International, is: "The collection of digital commu-

Figure 2: The reality-virtuality continuum includes not only real and virtual at each end, but also mixed reality. Mixed reality includes augmented reality (AR) where virtual elements are superimposed on a camera view of reality, and augmented reality, where views of reality are projected onto the virtual environment of a digital twin.

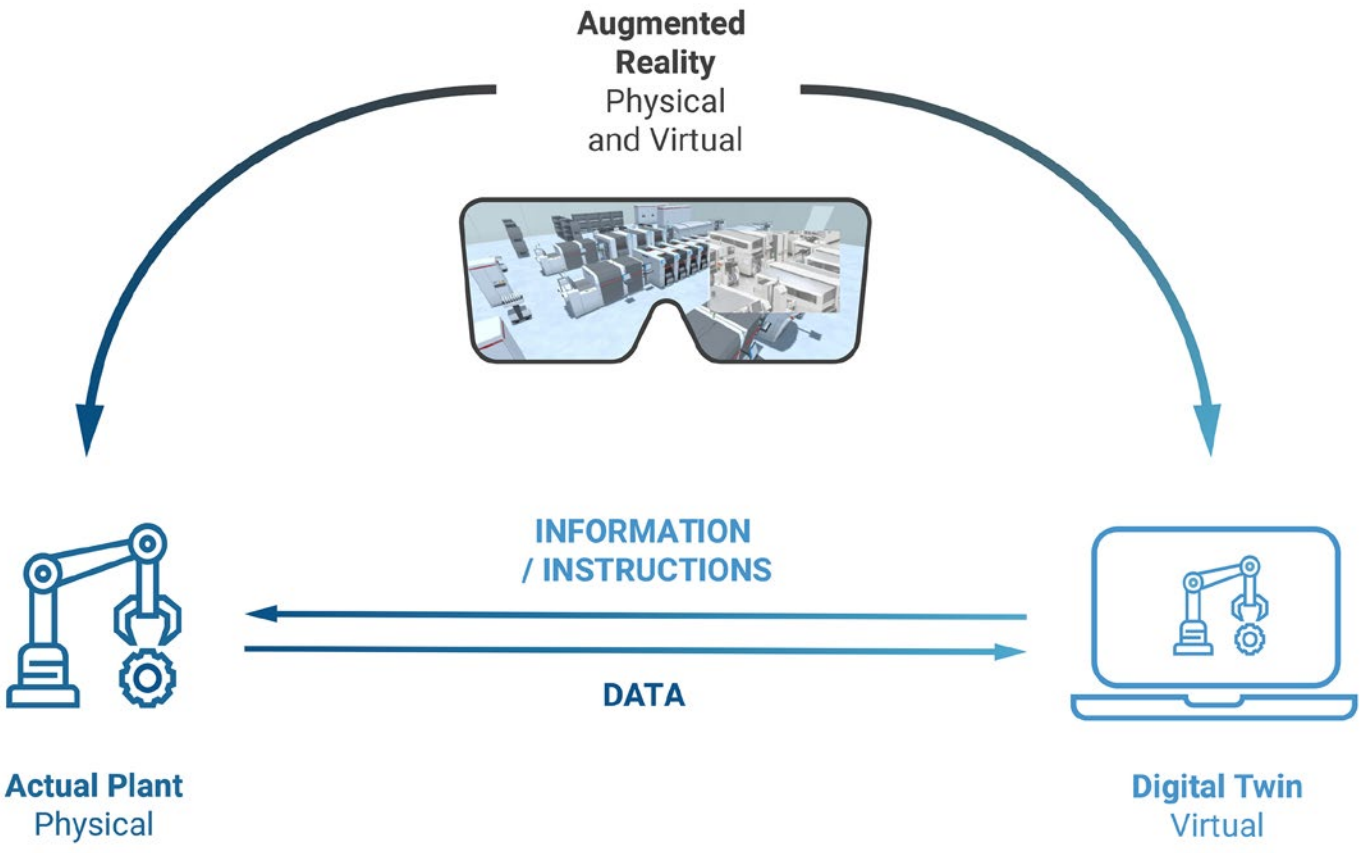


Figure 3: The manufacturing digital twin is the virtual model of the real-world plant. With information flowing back and forth between virtual and real, these are dynamic and synchronized. Augmented reality is the means by which relevant data from the plant digital twin is visible as an employee points a table, smartphone, or special goggles at a line, piece of equipment, product, carrier, etc., making both virtual and real visible simultaneously and in context.

nications that integrates and drives modern design, manufacturing and product support processes, and includes product and process definitions that start in design engineering and flow through multiple departments and suppliers in the product value chain. Emerging standards provide 3D geometric models enhanced with product manufacturing information that is semantically rich and machine-readable. There is a desire, however, for a bi-directional Digital Thread with component information flowing up the supply chain into higher-level assemblies and products."

Basically, digital thread is all the ongoing data flows that support both digital and physical aspects. This thread is part of the horizontal and vertical integration of Industry 4.0 between systems and disciplines.

Integrated Manufacturing Software Approach

This simplistic way of looking at it is not intended to mask the complexity and the real challenges of bringing together virtual and real. Just as a production operation is complex with many aspects, elements, and disciplines, there are also many elements of creating an effective virtual support system. There are many and varied technologies and processes that need to come together to move this beyond an ideal and into reality.

Despite this truth, there is one foundational solution: augmented MES. It is a plantwide software system that is Industry 4.0-ready. This modern style of MES builds on everything MES has always done. (See sidebar Manufacturing

Figure 4: Digital twin is inherently at the core of MES, as it models the production plant, equipment, processes and products. Modeling manufacturing is a crucial part of an MES implementation.

Execution System [MES] Defined.) In fact, MES originated to provide an integrated software system to better support the production operation. This moved companies away from point solutions for quality, materials and resource management, traceability, work instructions, and more. With all this in a single system, MES has been delivering in-context data for productivity, quality, and flexibility benefits for years.

So, what's new? The speed, complexity, requirements of production—and an array of new production technologies. To handle these, augmented MES needs many capabilities. Here we will review just those around digital twin and augmented reality.

The MES-based Digital Twin

Manufacturing digital twin and MES are deeply intertwined. That is because MES is the original digital twin of production. The mechanism by which MES supports production operations is through mapping manufacturing processes, both the physical and business processes. In this way, MES inherently always has had a model, or digital twin, at the core (Figure 4).

Key purposes of the MES digital twin have always included providing visibility into plant status or "actuals," plus to control and document activities. In addition, it's been a critical fuel for optimizing processes and understanding the path to continuous improvement.

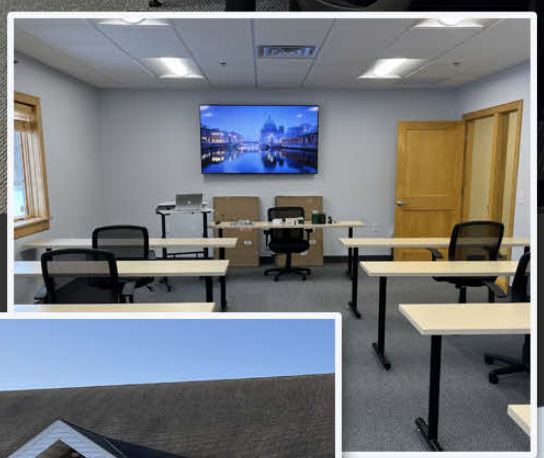
MES capabilities and how they feed and support digital twin of manufacturing include:

- Capturing and storing data in the context of this digital twin core model, making full synchronization of virtual and real worlds easy and inherent
- What's new is that the MES must efficiently process all the distributed incoming streams of data from new IIoT devices
- Comparing incoming data to plans and standards stored in the model, ensuring that error-proofing, alerts and alarms can go off
- What's new is that the MES must provide this type of capability, even if the data was originally captured by an IoT sensor anywhere in the world, not just from one plant

Today, the digital twin of a plant can be fully 3D and always reflect the status of each area, line, and piece of equipment (Figure 5). Using RFID tags and scanners allows frequent updates on where materials, containers, tools,

BLACKFOX
Premier Training & Certification

BLACKFOX'S NEW TRAINING CENTER
MINNESOTA FACILITY



Our 7th worldwide training center offers courses in:

- IPC J-STD-001
- IPC-A-610
- IPC/WHMA-A-620
- IPC-A-600
- Blackfox Customizable Soldering

Other courses available on request

For more information call 888.837.9959 or visit Blackfox.com
1000 County Road E West, Suite 120 Shoreview, MN 5512

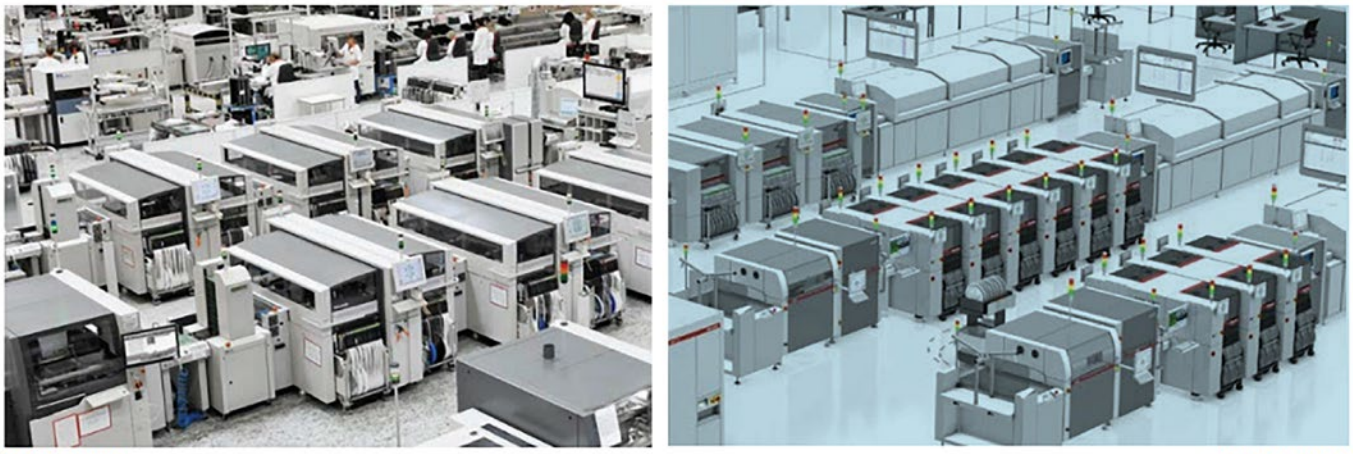


Figure 5: The digital twin of a plant can be fully 3D and always reflect the status of each area, line, and piece of equipment.

employees, and transport systems are at any time. Augmented MES can show that in the digital twin model, it is keeping coordinates for all elements updated. Even more exciting, new location-based services allow the model to include the many moving and dynamic portions of this model. These location-based services will allow a reading every few seconds, or even continuously. As these new location-based technologies become technically robust and affordable, the twins become more than 3D SCADA systems showing states and parameters; they come alive.

Yet, many MES products do not yet support these capabilities. Some that do parts of this make it very difficult to maintain and keep the digital twin synchronized with plant realities. Look for an MES that allows you to use existing blueprints and CAD models of equipment and location-based services. Ask about ways to quickly load data, position elements in the virtual space, and visualize results in ways that work for your employees.

MES Boosts AR

Augmenting reality with additional information is what MES has always done, but not with cool AR technology until recently. Basically, MES has provided guidance for operators and technicians through on-screen work instructions for many years. Now, whether you are using AR glasses, mobile phones, or tablets, the MES can deliver the critical overlay information employees need as they focus on their work.

The employee points an AR headset, tablet, or smartphone to the area in question. The AR technology reads identifiers such as bar codes or quick response (QR) codes on the container, products, and/or equipment. Based on the per-

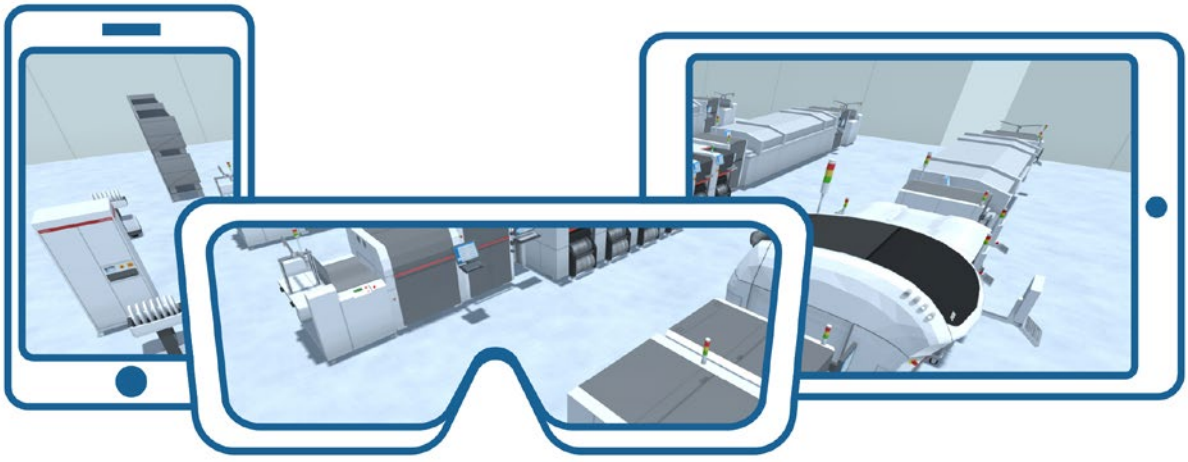


Figure 6: Rich AR information can be accessed through multiple types of devices, such as smartphones, tablets, and AR glasses or headsets, depending on the application.

son's role or task, they will see relevant information in an on-screen display (Figure 6). Over time, AR might also be triggered by proximity sensors, image recognition, location, and orientation of the camera, but bar codes and QR codes are the easy starting point.

What's special here is that as a part of MES, the system can instantly correlate that AR identifier to data in the MES. For products or lots, this MES data might be quantities, test results, work instructions, genealogy, or history record. For equipment or lines, it might show status, maintenance data such as mean time between failure (MTBF) and mean time to repair (MTTR), and performance information about equipment. All of the calendars, data, charts, widgets, etc., in the MES are available to set up in this way. The company can configure which pieces of data to display, in which order, in each situation.

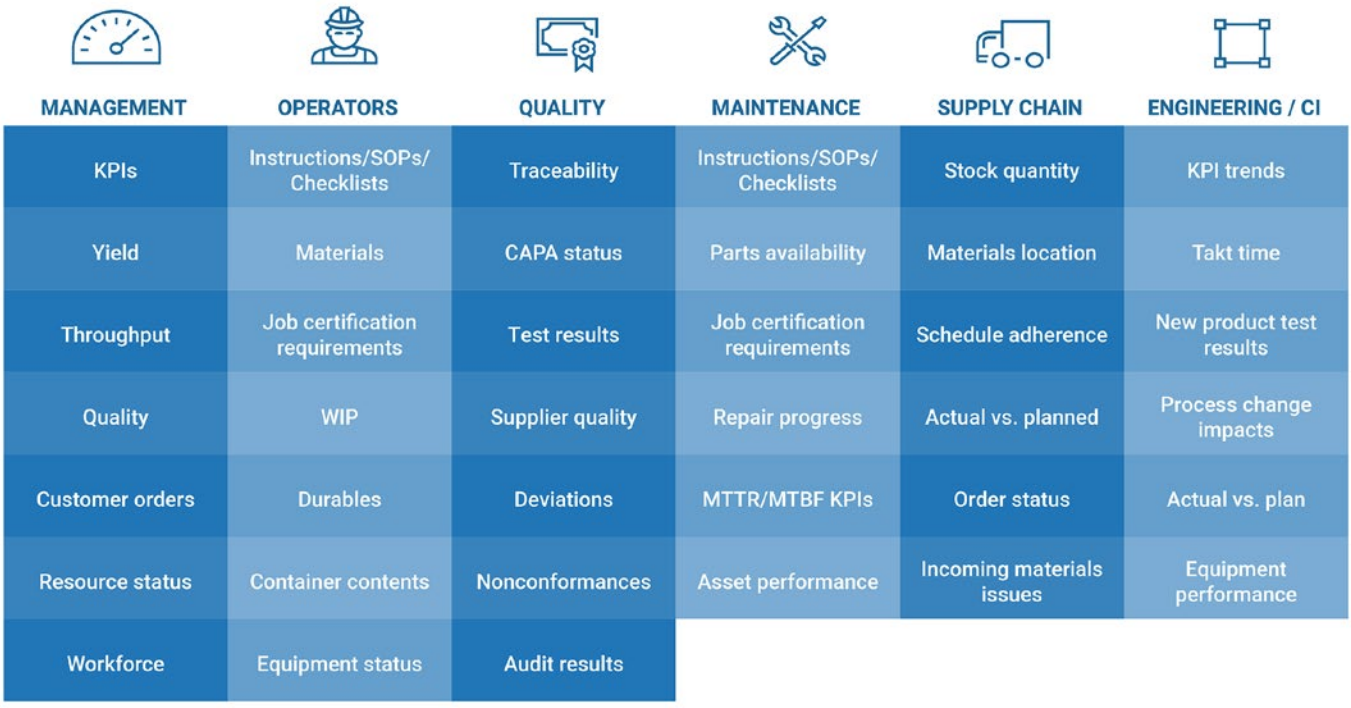
The digital twin portion of MES can be an even stronger foundation for AR. That model of the real world, kept up-to-date because it's inside the MES, delivers the virtual world that overlays what the AR camera sees. A broader, more up-to-date set of functions in MES, combined with IIoT data flowing in today, also enables a wide array of AR applications.

The use cases for AR are only limited by our imaginations. What do you want to see and know? Anything in MES or available through connection to the MES can be superimposed on a live camera shot of the real product, process, line, or facility area.

Every discipline in the plant is likely to have some things they might want to see in this way (Figure 7). Operations and maintenance can see SOPs, checklists, WIP and durables status, job certification needs, and KPIs on quality, timeliness, throughput, and availability. They could also gain interactive work process guidance to error-proof their activities, supporting new hires as well as those where mix is high or products changing. Everyone might benefit also from the ability to track materials per container—quantities, serial numbers, and more for picking, packing and also materials use.

Naturally, just because you can imagine it does not mean there is a business justification to use AR there. However, migrating portions of the MES user interface to mobile or AR devices seems inevitable. The new generation of workers expect it, and it can greatly reduce wasted movement back and forth to screens, as well as enhancing the accuracy of work.

Even further into the future, we see that interactions with digital twins via AR might be the one and only interaction mode with the systems on the shop floor. Combining AR with



MANAGEMENT	OPERATORS	QUALITY	MAINTENANCE	SUPPLY CHAIN	ENGINEERING / CI
KPIs	Instructions/SOPs/ Checklists	Traceability	Instructions/SOPs/ Checklists	Stock quantity	KPI trends
Yield	Materials	CAPA status	Parts availability	Materials location	Takt time
Throughput	Job certification requirements	Test results	Job certification requirements	Schedule adherence	New product test results
Quality	WIP	Supplier quality	Repair progress	Actual vs. planned	Process change impacts
Customer orders	Durables	Deviations	MTTR/MTBF KPIs	Order status	Actual vs. plan
Resource status	Container contents	Nonconformances	Asset performance	Incoming materials issues	Equipment performance
Workforce	Equipment status	Audit results			

Figure 7: There are applications for AR in every discipline in the plant. Examples of disciplines and uses. Your applications are limited only by the imagination of users once you have the right foundation.

speech recognition and bots, the standard software user interfaces (UIs) as we know them may cease to exist.

Make It Real With Augmented MES

So, we've laid out an ideal of a factory that uses IoT and AR to boost productivity and accelerate improvement. The great news: There are commercial MES products today that support these technologies. These modern software suites are designed from the ground up to support Industry 4.0 and the connected technologies involved. In this way, they are augmented MES.

Augmented MES can make this ideal real. MES contains a lot of information readily available to show as soon as the assets are identified in the model. Augmented MES can help you explore, build, and improve the manufacturing digital twin and use AR. MES is proven to deliver value almost immediately.

However, not every MES is ready to do that. Older versions almost certainly are not. Even many current systems do not have the breadth of applications nor the augmented capabilities to support Industry 4.0, IIoT, digital twin, and AR.

Those that do can become an important element in the digital thread. Putting operational data into context and making it available across enterprise and automation systems is what MES does best. With more and more distributed data coming in, this MES role is growing.

Beyond taking a few steps forward, companies that adopt an augmented MES will find they can move confidently. Augmented MES accelerates a company's progress toward Industry 4.0 dramatically and immediately.

There's no time like now to start. **SMT007**

Óscar Martins is an area manager for Electronics/SMT at Critical Manufacturing. This article is based on a white paper titled "Digital Twin and Augmented Reality: From Ideal to Real with MES," published in 2020.

IPC BUILD ELECTRONICS BETTER®

PCB DESIGN COURSES

DRIVE QUALITY AND INNOVATION

PCB Design for Manufacturability 9/12 to 9/28	**Introduction to PCB Design I** 10/10 to 11/16	**Introduction to PCB Design II** 10/9 to 11/29
Introdução a projeto de PCB II IN PORTUGUESE 9/25 to 11/20	**PCB Advanced Design Concepts** 10/9 to 11/29	**PCB Design for Military, Aerospace & Other Extreme Applications** 10/10 to 11/16

PCB Fab and Assembly Troubleshooting

- PCB Troubleshooting & Defect Analysis
  Led by Mike Carano — September 12 to October 5

NEW

- Troubleshooting & Defect Analysis for Electronics Assembly
  Led by Jim Hall & Phil Zarrow — September 19 to September 28

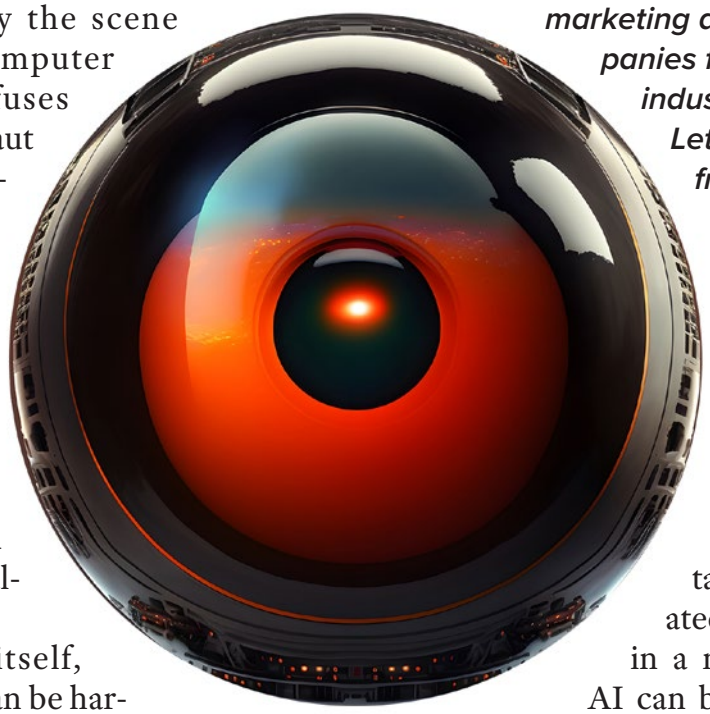
Learn more about our PCB Design Courses.

AI in the Electronics Manufacturing Space

The Knowledge Base

by Mike Konrad, SMTA

One of the latest acronyms to join the pop culture lexicon is artificial intelligence (AI). To many, AI brings the promise of revolutionary innovation into a near-limitless array of products and applications. To some, Stanley Kubrick's "2001: A Space Odyssey" comes to mind, particularly the scene where the ship's computer named HAL 9000 refuses an order from astronaut Dave to open the pod-bay doors. HAL states, "I'm sorry Dave, I'm afraid I can't do that." HAL followed a long line of Hollywood interpretations of artificial intelligence, frequently represented by nefarious, overzealous computers.



Like the internet itself, artificial intelligence can be harnessed for good and bad purposes. For this conversation, I'll leave the bad purposes in the scripts of Hollywood movies.

We've heard the term, but what is artificial intelligence? What are its potential applications within the electronics manufacturing industry? How is it being implemented? I invited Arif Virani, co-founder and COO of DarwinAI, to explain artificial intelligence and its current and potential applications within the electronics manufacturing space.

The term "AI" has been exploited by the marketing departments of companies from almost every industry around the world. Let's separate the wheat from the chaff. From a 30,000-foot perspective, what is artificial intelligence?

You're right, Mike. Artificial intelligence is clearly a buzzword. We think of it as the ability of machines to perform functions and tasks typically associated with humans, usually in a narrow domain. While AI can be applied broadly, the nature of the AI (e.g., expert systems, machine learning, generative AI), and the depth at which it was created, impact its usefulness.

For example, many AI packages are available to build visual inspection tools. However, getting these packages to work well in a pro-

NOW YOU CAN GET THE ESSENTIAL FACTS ABOUT TESTING YOUR HIGH-RELIABILITY BOARDS!!

Ensuring electrochemical reliability in circuit boards, where devices face potentially corrosive environmental conditions, is of paramount importance.

These **FREE** books provide essential insights into optimising PCB assembly process control and the vital practice of process validation, so that your manufacturing processes consistently yield products meeting the desired specifications and quality standards.

Elevate your manufacturing process to achieve unrivaled quality and reliability in the market.

Download your free copies now!

#THEPEOPLEWHOPROTECT

GEN3
PRECISION AS STANDARD

sales@gen3systems.com
+44 (0)12 5252 1500
www.gen3systems.com
www.objectiveevidence.org

Arif Virani

duction environment is difficult without extensive data, configuration, and deep technical know-how.

Let's get into our way-back machine for a moment. Technologies evolve over time and AI is no exception. Explain the evolution of artificial intelligence and how different generations of artificial intelligence have evolved over time.

Expert systems have been around since the late 1950s. A human programmer would code their expertise or that of a human expert into a system. It typically translates into logical statements (e.g., "if-then-else") representing specific rules in the decision-making process. However, it's hard for humans to explain their reasoning for a decision, which makes defining concrete rules extremely challenging. Furthermore, predicting every variation at the time of programming is impossible. As such, expert systems are inflexible and prone to error in real-world deployment, as they cannot handle the variations and uncertainty that can happen in practice.

Rather than hand-crafting rules as in expert systems, machine learning teaches a system how to do a task by "training" it on a large data set. The extensive rules are devised implicitly around the data. In some ways, it mimics human learning. When my daughter was a toddler, she learned what a dog was by seeing them in parks and books. When she went out with us, she could quickly point out dogs quite accurately, despite not being able to explain her rationale in expert detail. Generative AI is a form of artificial intelligence where systems create new content, such as written articles, dialogues, and imagery. Typically, generative AI is trained on past content and can generate new content based on prompts (e.g., "Generate a picture of a dog running in the field on a warm, sunny day").

Within the electronics manufacturing space specifically, how has AI been integrated into our industry?

Here are a few examples:

- **Automated Inspection:** Traditional AOIs based on expert systems have been effectively used for many years. They require significant programming up front and reprogramming whenever there are changes to products and components used, changes to the manufacturing environment and processes, etc. Machine learning not only leads to a big leap in the performance of finding defects in PCB assembly but significantly reduces and even eliminates programming time and frequency.
- **Design process:** To help address complex designs and a scarcity of skilled engineers, software companies are adding machine learning and generative AI capabilities to automate aspects of PCBA design to speed up design and improve the efficiency of the resulting PCBA design.
- **Predictive maintenance:** Analytics to predict when maintenance is needed for equipment, such as a reflow oven or a pick-and-place machine, to prevent it from breaking down.

- **Production analytics:** Many CMs and OEMs use tools to analyze production (throughput, asset utilization, line utilization) and understand causes of downtime, maximizing production yield while at the same time minimizing waste and human labor due to rework.

You come from the inspection side of the electronics manufacturing industry. How has the integration of artificial intelligence been implemented into inspection systems and what benefits have resulted from this integration?

AI—specifically machine learning—significantly reduces programming time for inspection systems while improving inspection performance. We've seen programming times for inspection of a new product reduced from hours to days in a traditional AOI (e.g., Expert System) to five to 10 minutes.

Inspection performance improved, especially for areas that are difficult to address through traditional computer vision, like through-hole components, wires, FOD, and visual cosmetic inspection.

> "Many defect types are challenging to inspect with traditional inspection systems.

When comparing inspection systems without AI to those with AI capabilities, has the integration of AI into inspection systems expanded their capabilities, and if so, what are the added capabilities?

Systems with machine learning-based AI capabilities are more adaptable, perform better on various inspection tasks, and can provide better end-to-end analytics. Machine learning-based AI systems are more adaptable than traditional AOIs. They maintain system performance as new products come into production and alternative parts are used. For example, because a machine learning system can generally learn the difference between components such as resistors and capacitors, it is better able to handle components from new suppliers without additional programming. Furthermore, it can learn to adapt and improve its performance over time as it sees more data.

Many defect types are challenging to inspect with traditional inspection systems. As a result, instead of using such systems, given the variability seen, humans often inspect foreign object debris and damage and cosmetic defects, such as scratches and dents. A machine learning-based system can handle such variability by learning the subtleties of these challenging defects directly from data. For example, machine learning-based systems can effectively distinguish between a scratch and a cleanable mark on a box build, which would be impossible to define the rules to accomplish reliably in practice.

Newer AI inspection systems often generate large amounts of meta-data—descriptive data about an inspection. Examples include the location of the inspection in the production line, component designators, the board serial number, when the defect happened, etc. The systems can ingest additional data from other places in production, such as ICT, reflow oven, and results from other inspection systems, and use AI to help narrow down why a defect is happening and how to fix it.

Many manufacturers are emphasizing process optimization as a method for becoming more competitive. How has artificial intelligence impacted optimization on a manufacturing floor?

In high-mix, low-volume manufacturing, fast setup and turnaround time are crucial to increase throughput for EMS companies. How-

ever, inspection equipment can often become a bottleneck at many inspection points, so having a highly adaptive system that can meet dynamic manufacturing environments is key.

Moreover, automating non-value-added labor can provide immediate value by reducing labor costs, increasing throughput, and ensuring higher or more consistent quality. By implementing these strategies, manufacturers can improve their overall efficiency and profitability.

How has machine learning, and generative AI specifically, impacted the manufacturing process?

Traditionally, machine learning requires large sets of real-world data for training. With generative AI, we can work with less in environments of limited production data; we can generate more "synthetic" data to teach and improve inspection capabilities quickly.

Many manufacturing processes are optimized and produce very few defects. Using generative AI, we create images of all types of variants of defects. These are then input into our ML training to improve inspection performance.

What are the most common misconceptions of artificial intelligence?

Newer artificial intelligence is much more difficult to operationalize than people think. While it's easy to get a simple proof of concept that will show the potential of AI, the path to production is fraught with challenges. For example, capturing images while accounting for variations in production facilities and manufacturing processes is not trivial. The adage, "garbage in, garbage out" is at play here as ML algorithms, despite their resilience, cannot function well with poor inputs.

From your perspective, where do you see the future of artificial intelligence?

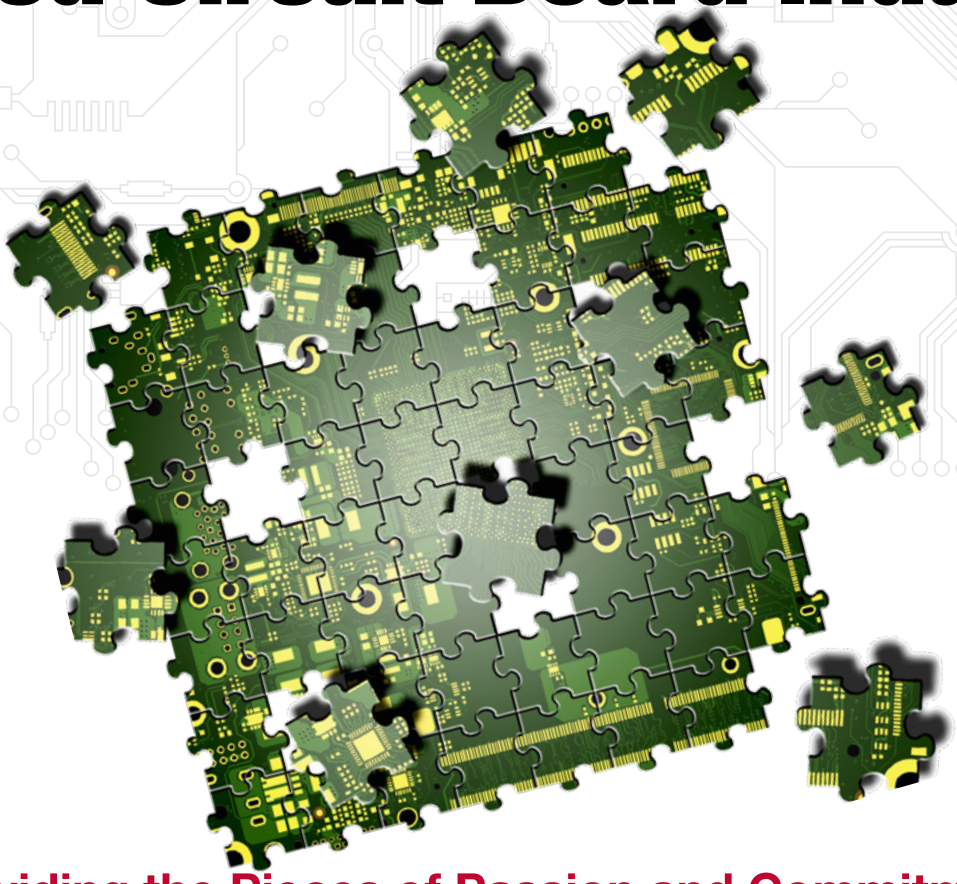
As an optimist, I have a positive outlook on the future and believe that AI-based systems will work alongside humans to improve production. Although some jobs may change and certain tasks will be automated, new job opportunities will be created.

In our industry, AI will help reduce inspection costs, making it possible to have inspection capabilities at every stage of production, and potentially identifying defects as soon as they occur. This early detection will prevent further problems in the production process. By automating certain inspection tasks, operators can manage more production lines or focus on other tasks, allowing companies to increase production faster and meet growing demands.

Thank you Arif.

Happy to help. **SMT007**

APCT Leading the Printed Circuit Board Industry



Providing the Pieces of Passion and Commitment to Support the Most Extensive Value Proposition in the Industry

Design | Fabrication | Assembly

- **Rigid Through-Hole**
  ~ Up to 40-Layers
- **Flex Applications**
  ~ Up to 6 Layers
- **Oversized Boards**
  ~ Up to 37” by 120”
- **Cavity Board Capability**
- **Buried Resistor Capability**
- **Introducing In-House Design**
  ~ HDI, RF, Rigid Flex
- **HDI; Blind/Buried/Stacked Vias**
  ~ Up to 8x Sequential Laminations
- **Rigid Flex Applications**
  ~ Book Binder Capability
- **Heavy Copper**
  ~ Up to 20 oz.
- **RF Technology Expertise**
- **Heat Sink Bonding Capability**
- **Introducing In-House Assembly**
  ~ For NPI & Quick-Turn

APCT
Passion | Commitment | Trust

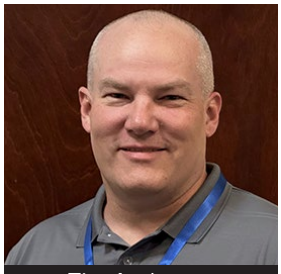
ADVANCED CIRCUITS
A Division of APCT

One Company | One Team

APCT.com | 4PCB.com

TOP TEN

EDITOR'S PICKS


Tim Anderson

Omron Discusses SPI, AI and More

At the recent SMTA Oregon Tech Forum and Expo, Tim Anderson, a senior account manager at Omron, shares his insights on SPI, the latest trends in the industry, and some solutions to consider. As he points out, the SPI, AOI, and AXI systems of today do far more than simply catch defects.

The Government Circuit: IPC Advancing Silicon-to-Systems With Government Leaders

Since the start of the year, IPC has been working with partners in the United States and Europe to find opportunities that put CHIPS Act legislation into effect in both regions. The EU's recent approval of an "Important Project of Common European Interest" represents a significant step toward bringing the silicon-to-systems value chain back to the region. In the U.S., we've been busy in Congress advocating for funds under the Defense Production Act to support the PCB sector and its designation as a national security interest.

It's a Team Effort: Final Episode in Sustainability Series Out Now

Available on I-007e and Spotify, Episode 6 of I-Connect007's podcast, On the Line with... features an interview with Siemens' Jonathan Fromm, product owner in predictive analytics, who introduces us to the "eight Rs" of sustainability. Fromm also draws parallels between the idea of thinking globally and the act of crafting holistic sustainability initiatives.

Standard of Excellence: Facing an Exciting Future

Trends today will determine the future, and things will change at such a rapid pace that the next 20 years will be nothing like the last 20 years. This is especially true when it comes to manufacturing. We already see the trends, ideas, and technologies we wouldn't have even dreamed of even 10 years ago. Personally speaking, I am constantly amazed at the high level of technology and automation we are bringing into our facility right now. Many of our new machines actually have artificial intelligence, where they learn as they work. They get smarter by doing what they should be doing.

Finding Sustainability in Additive Processes

When you think of sustainability, odds are that electronics isn't what comes to mind. The manufacturing process alone is riddled with processes that generate large amounts of waste and utilize volatile chemicals and compounds. Consumers dispose of their personal electronic devices, which, added to the waste from the manufacturing process, accumulates into quite a large sum.

Filling Critical Traceability Gaps With AI

Traceability means being able to track the origin of any given electrical component throughout the supply chain. For OEMs, this is no longer optional or "nice to have." Yet industrial traceability capacities are sorely lacking throughout industries. Today, the most widespread standard for traceability is "batch traceability," which aside from tracking the production lot, serial number, and exact board placement for components, fails to analyze the individual components themselves, thus jeopardizing the quality of the goods they compose.

EU Should Support Other Segments of the Electronics Industry That Complement Chips, New Report Says

Key segments of the European electronics manufacturing industry face significant challenges and require more support, considering their vital role in Europe's strategic autonomy and the "twin transitions" to a greener, more digital economy.

Benchmark Celebrates Grand Reopening Engineering, Manufacturing Facility in Almelo, Netherlands

Benchmark Electronics, Inc., a global provider of engineering, design, and manufacturing services, celebrated the grand reopening of its facility in Almelo, Netherlands, serving customers across the aerospace and defense, industrial, medical, and semiconductor capital equipment industries.

The Knowledge Base: Data Collection and Analysis

Ryan Gamble

Mike Konrad interviews Ryan Gamble, CEO and founder of Intraratio, about the collection and analysis of big data. What are the common misconceptions, does artificial intelligence play a role, and what are some of the biggest mistakes for assembly companies when it comes to big data collection?

DART Mission Leader Ed Reynolds to Keynote IPC High Reliability

Ed Reynolds, space exploration sector program manager at Johns Hopkins Applied Physics Laboratory (APL), will present his keynote address, "The DART Mission: Earth Strikes Back," at IPC's High Reliability Forum on October 17 in Linthicum (Baltimore), Maryland.

Career Opportunities

Find Industry-experienced Candidates at jobConnect007

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

In addition, your ad will:

- be featured in at least one of our newsletters
- appear on our jobConnect007.com board, which is promoted in every newsletter
- appear in our monthly Careers Guide, emailed to 26,000 potential candidates

Potential candidates can click on your ad and submit a resume directly to the email address you provide, or be directed to the URL of your choice.

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

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

+1 916.365.1727

I-Connect007
GOOD FOR THE INDUSTRY

smt007 pcb007 pcb design007

Career Opportunities

Technical Support Engineer

USA Region

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

Key Responsibilities:

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

Qualifications & Requirements:

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

apply now

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

Career Opportunities

THERMAL SYSTEMS

Sales Engineer SMT North Mexico

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

Responsibilities:

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

Qualifications:

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

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

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

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

apply now

TAIYO AMERICA

Europe Technical Sales Engineer

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

PRIMARY FUNCTION:

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

ESSENTIAL DUTIES:

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

QUALIFICATIONS / SKILLS:

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

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

apply now

Career Opportunities

BLACKFOX
Premier Training & Certification

IPC Instructor
Longmont, CO

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

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

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

Salary: Starting at $30 per hour depending on experience

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

Schedule: Monday thru Friday, 8–5

Experience: Electronics Manufacturing: 5+ years (Required)

License/Certification: IPC Certification–Preferred, Not Required

Willingness to travel: 25% (Required)

apply now

Prototron Circuits

Sales Representatives

Prototron Circuits, a market-leading, quick-turn PCB manufacturer located in Tucson, AZ, is looking for sales representatives for the Utah/Colorado, and Northern California territories. With 35+ years of experience, our PCB manufacturing capabilities reach far beyond that of your typical fabricator.

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

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

apply now

Career Opportunities

KYZEN
Where Science and Care Converge.

Regional Manager

West Region — Two Positions

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

DETAILS OF FUNCTION:

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

QUALIFICATIONS:

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

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

fernando_rueda@kyzen.com

apply now

EMA Design Automation®

Technical Marketing Engineer

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

Requirements:

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

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

Send Resumes to: resumes@ema-eda.com

apply now

Career Opportunities

pluritec®

MACHINES FOR PRINTED CIRCUIT BOARDS

Field Service Engineer

Location: West Coast, Midwest

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

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

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

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

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

Must be able to travel extensively.

apply now

KOH YOUNG AMERICA

Technical Service & Applications Engineer

Full-Time — Flexible Location

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

Responsibilities

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

Skills and Qualifications

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

Benefits

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

apply now

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

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 to build better boards faster. Our nationwide network provides many opportunities for a rewarding career within our company.

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

apply now

Career Opportunities

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

eptac

TRAIN. WORK SMARTER. SUCCEED.

Become a Certified IPC Master Instructor

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

Qualifications and skills

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

Benefits

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

apply now

Career Opportunities

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

CAD/CAM Engineer

Summary of Functions

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

Essential Duties and Responsibilities

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

Organizational Relationship

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

Qualifications

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

Physical Demands

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

apply now

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.

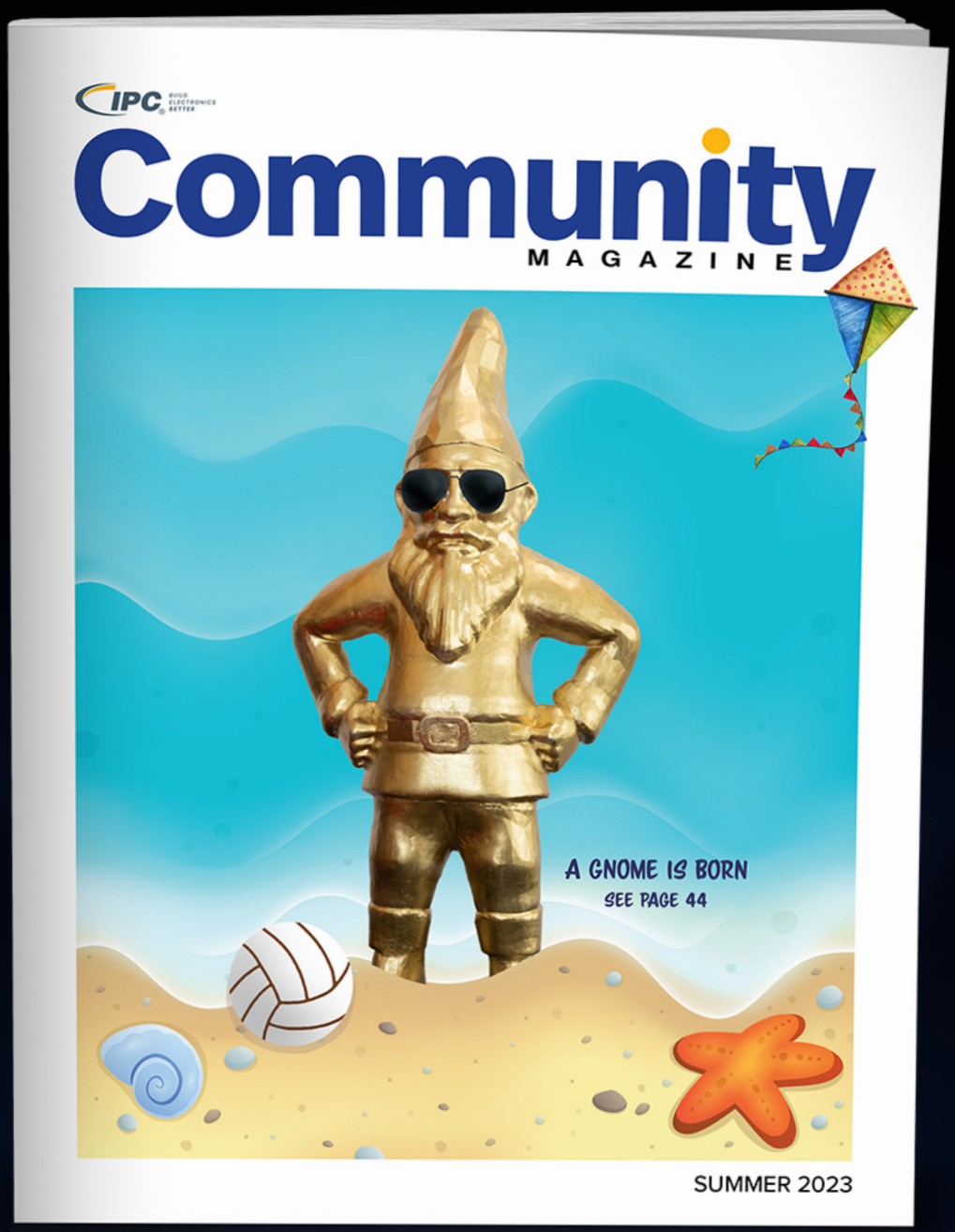
APCT currently has opportunities in Santa Clara, CA; Orange County, CA; Anaheim, CA; Wallingford, CT; and Austin, TX. Positions available range from manufacturing to quality control, sales, and finance.

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.

apply now

Summer issue available now!



LOOK INSIDE

IPC BUILD ELECTRONICS BETTER

Advertise!

ON DEMAND! Free 12-part Webinar Series

Smarter Manufacturing Enabled with Inspection Data

with expert Ivan Aduna

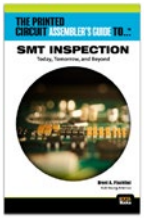
A smart factory is created from many parts, and inspection systems will play a critical role for process optimization in the next industrial revolution. Accurate, reliable 3D measurement-based data is essential, and a key element for a true smart factory. In this 12-part webinar series, viewers will learn about secure data collection, AI-powered solutions to manage and analyze data, and how to leverage the IPC CFX-QPL to succeed in the transformation to Industry 4.0.

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

NEW! *Process Control*

by Chris Hunt and Graham K. Naisbitt, Gen3

In this book, the authors examine the role of SEC test and how it is used in maintaining process control and support for objective evidence (OE.) Issues, including solution choices, solution sensitivities, and test duration are explored.



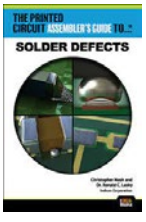
SMT Inspection: Today, Tomorrow, and Beyond

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.

The Companion Guide to... SMT Inspection: Today, Tomorrow, and Beyond

Advances in artificial intelligence have been limited exclusively to the human world until now, but there are far-reaching applications within the manufacturing sector, too. In this guide book, learn how equipment providers like Koh Young are enabling the Smart Factory of the Future by adopting AI to generate "knowledge" from "experience."



Solder Defects

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

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

NEW PODCAST! *On the Line with...*

...is available now on Spotify and coming soon on all major podcast platforms. In this podcast, we speak with industry experts to get the latest insights and perspectives on the most relevant topics in the electronics industry today. The first series of On the Line with... features conversations on sustainability.

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

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

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

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

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

TECHNICAL EDITOR: **PATTY GOLDMAN**

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

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

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

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

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

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

MAGAZINE LAYOUT: **RON MEOGROSSI**

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

CREATIVE TECHNOLOGIST: **BRYSON MATTIES**

COVER: **SHELLY STEIN AND BRYSON MATTIES**

COVER PHOTO: **NAWC, LT. CDR. JONATHAN 'DOS' BEATON, F-35 TEST PILOT**

SMT007 MAGAZINE

SMT007 MAGAZINE®
is published by IPC Publishing Group, Inc.,
3000 Lakeside Dr., Suite 105N, Bannockburn, IL 60015

August 2023, Volume 38, Number 8
SMT007 MAGAZINE is published monthly,
by IPC Publishing Group, Inc., dba I-Connect007.

ADVERTISER INDEX

Problems solved!

SUBSCRIBE NOW