Chavez: Optimization through FPGA/PCB Codesign
PCEA
Printed Circuit Engineering Association
PRINTED CIRCUIT DESIGN & FAB
pcdandf.com
circuitsassembly.com
March 2024
CIRCUITS ASSEMBLY
Getting Rugged
TESTING METHODS FOR ROBUST MATERIAL DEVELOPMENT
Visiting the World's Largest CAD Library
AI's Future Role in Manufacturing
Exploring Low-Temperature Solder Solutions

This issue of PRINTED CIRCUIT DESIGN & FAB/CIRCUITS ASSEMBLY is brought to you by:

Rigid PCB Manufacturing

Get your Custom PCBs exceptionally fast and perfectly tailored to your business needs with our complete dedication to quality and high performance.

Get a free quote

TOP 3 REASONS TO PARTNER WITH IMAGINEERING INC.

1. ADVANCED TECHNOLOGY WITH PRECISION AND SPEED
2. 35+ YEARS OF INDUSTRY EXPERTISE AND EXPERIENCE
3. FAST TURNAROUND WITHOUT COMPROMISING QUALITY

Some of the biggest brands in the world choose Imagineering for their printed circuit board fabrication and assembly

Whether you're looking for full turnkey services or PCB assembly that uses your parts, our PCB expertise gives you the highest quality printed circuit boards you need and the quick turnaround time you demand.

Get an online PCB quote in minutes:
www.pcbnet.com/quote/

www.pcbnet.com
sales@pcbnet.com
847-806-0003
imagineering, inc.

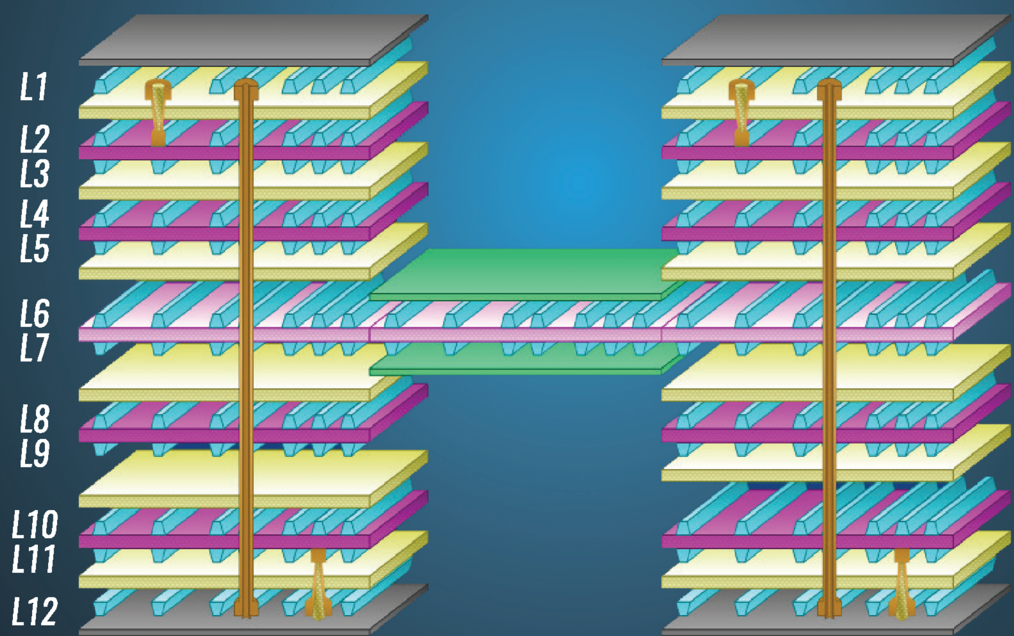
ITAR Registered AS9100D/ISO 9001:2015 SAM Registered
RoHS Compliant IPC Member

RUSHPCB

20 YEARS OF MANUFACTURING EXPERIENCE WITH BLIND AND BURIED VIAS, RIGID FLEX & FLEX PCB ELECTRONIC DESIGN, & QUICK TURN CIRCUIT BOARDS, ASSEMBLY & FULL TURNKEY

Multilayer PCB Stackup

12 Layer Flex Rigid, 0.030" Thick Rigid, 0.008" Thick Flex
Blind Via L1-L2 & L11-L12, 0.003" Hole, Resin Filled,
0.002"/0.002" Trace/Space, Controlled Impedance



Manufactured on August 2016

When you're in a rush call RUSH PCB

Affordable Pricing • Satisfaction Guarantee • Fast Response • Free Quote • Fast Shipping
HDI Boards • Stacked Micro Vias • 2 mil line & Space • Flex & Rigid Flex

Located in the Silicon Valley
PCB up to 12 Layers in 3 days
PCB Assembly Same Day Turn
Full Turnkey Service

Certified: ISO9001/ITAR/UL

www.rushpcb.com | Sales@rushpcb.com | 1 408 496 6013
Rush PCB Inc, 2149-20 O'Toole Ave, San Jose, CA 95131, U.S.A

MARCH 2024 • VOL. 41 • NO. 3

PRINTED CIRCUIT DESIGN & FAB CIRCUITS ASSEMBLY

FIRST PERSON

THE ROUTE
Renesas' acquisition of Altium brings questions.
Mike Buetow

MONEY MATTERS

ROI
Quality control includes people, too.
Peter Bigelow

TECH TALK

DESIGNER'S NOTEBOOK
Designing a producible board.
John Burkhert Jr.

DESIGN BEST PRACTICES
Integrating FPGA and PCB design.
Stephen Chavez

MATERIAL GAINS
Powering the world.
Alun Morgan

ROUGHLY SPEAKING
Engaging at the local level.
Geoffrey Hazelett

GETTING LEAN
Keep an eye on outside suppliers.
Allen Abell

SEEING IS BELIEVING
Be prepared to walk away.
Robert Boguski

TECHNICAL ABSTRACTS

DEPARTMENTS

AROUND THE WORLD

PCEA CURRENT EVENTS

MARKET WATCH

OFF THE SHELF

FEATURES

CAD LIBRARIES
Creating the Ultra Library
With more than 16 million components and 250,000 unique downloads per month, Ultra Librarian has built what it calls the biggest CAD library in the world. PCD&F visited the company's office in Alabama to find its secret to success.
by TYLER HANES

HARSH ENVIRONMENTS (COVER STORY)
Optimized Materials to Deliver Ruggedized Electronics
Automotive electrical systems require more robust hardware due to their unusual working conditions and environmental exposure. A discussion of material choices designed to combat temperature, vibration, heat and various aggressive environments, as well as a showcase of test methods used.
by LENORA CLARK, MARTIN BUNCE, PAUL SALERNO and SASKIA HOGAN

SOLDERING
Low-Temperature Solder: Challenges, Opportunities and Considerations
Low-temperature soldering can bring a host of benefits to electronics, but the lack of a standard solder alloy and the unique properties of emerging alloys require new fluxes and processes. Several factors are explored, including the limited availability of low-temperature alloys, the disadvantages of high-bismuth alloys and the impact of additive elements on alloy properties.
by TIMOTHY O'NEILL

EMERGING TECHNOLOGIES
Can Artificial Intelligence Solve Manufacturing Problems?
The growth of artificial intelligence brings a new set of questions about the role of automation in factories. Arch Systems cofounder and CEO Andrew Scheuermann offers his perspective on the emerging technology.
by MIKE BUETOW

ON PCB CHAT (PCBCHAT.COM)

ADVANCES IN AI DESIGN
with MATTHIAS WAGNER

BUILDING A SUSTAINABLE CAREER
with RICK COULSON

AI IN ELECTRONICS
with ANDREW SCHEUERMANN

US STRATEGY FOR SUPPLY CHAIN READINESS
with DAVID SCHILD

HAND SOLDERING AND REWORK BEST PRACTICES
with DEBBIE WADE

A Printed Circuit Engineering Association, Inc. publication. All rights reserved.

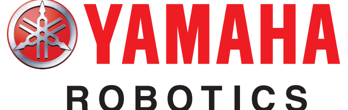
YAMAHA'S REVOLUTIONARY MOUNTER

SMT Innovation

ULTRA-HIGH EFFICIENCY, MODULAR MOUNTER

THE 1 STOP SMART SOLUTION

The ONLY Mounter you need for any SMT application



See us at APEX Booth #2820

The most adaptable surface mounter, providing unparalleled productivity and operational efficiency. The YRM20 is able to handle the most challenging applications with ease.

- 115,000 components per hour
- Single or Dual Beam, optional Dual Lane
- PCB sizes: L50×W50mm to L810×W510mm
- 25μ accuracy
- Superior component range eliminates the need for head changes, even for the most complex assemblies
- Exceptional component range from 0201mm to 55x100mm, up to 30mm tall
- Up to 128 unique components on a single machine
- No-Splice, Auto-Loading Feeders
- Exchangeable, Automatic Tray Stacker
- Real Time unique 2D barcode identification and vacuum monitoring.
- Complete Automatic Changeover
- Standard Onboard Nozzle Cleaning System

Contact **Yamaha Robotics** Today to learn more...

Visit **www.yamaha-usa-robotics.com**

PCEA
PO BOX 807
AMESBURY, MA 01913

PCEA BOARD OF DIRECTORS
Stephen Chavez, CHAIRMAN
Justin Fleming, SECRETARY
Gary Ferrari, CHAIRMAN EMERITUS

MEMBERS
Michael Buetow
Tomas Chester
Douglas Dixon
Richard Hartley
Scott McCurdy
Anaya Vardya
Susy Webb
Eriko Yamato

PCEA.NET

THE PRINTED CIRCUIT ENGINEERING ASSOCIATION, INC. BRANDS:

PUBLICATION
PCD&F/Circuits Assembly .... digital.pcea.net

WEBSITES
PCD&F .... pcdandf.com
Circuits Assembly .... circuitsassembly.com

NEWSLETTER
PCB Update .... pcbupdate.com

PODCASTS
PCB Chat .... pcbchat.com

EVENTS
PCB West .... pcbwest.com
PCB East .... pcbeast.com

EDUCATION
PCB2Day pcb2day.com
PCEA Training .... pceatraining.net
Printed Circuit University .... printedcircuituniversity.com

AWARDS PROGRAMS
Service Excellence Awards .... circuitsassembly.com
NPI Awards .... circuitsassembly.com
pcdandf.com

DATABASE
Directory of EMS Companies .... circuitsassembly.com

NPI
NEW PRODUCT INTRODUCTION AWARD

PCB WEST
Conference & Exhibition

The Circuits Assembly
Directory of EMS Companies

PRINTED CIRCUIT
DESIGN & FAB
CIRCUITS
ASSEMBLY

pcdandf.com
circuitsassembly.com

MANAGEMENT

PRESIDENT
Mike Buetow 617-327-4702 | mike@pcea.net

VICE PRESIDENT, SALES & MARKETING
Frances Stewart 770-361-7826 | frances@pcea.net

PCD&F/CIRCUITS ASSEMBLY EDITORIAL

MANAGING EDITOR
Tyler Hanes 205-258-0067 | tyler@pcea.net

COLUMNISTS AND ADVISORS

Peter Bigelow, Robert Boguski, John D. Borneman, John Burkhert, Jr., Stephen Chavez, Geoffrey Hazelett, Mark Finstad, Jake Kulp, Nick Koop, Alun Morgan, Susan Mucha, Greg Papandrew, Chrys Shea, Jan Vardaman, Gene Weiner

PRODUCTION

ART DIRECTOR & PRODUCTION
blueprint4MARKETING, Inc. | production@pcea.net
Nathan Hoeller | nathan@pcea.net

SALES

VICE PRESIDENT, SALES & MARKETING
Frances Stewart 770-361-7826 | frances@pcea.net

SENIOR SALES EXECUTIVE
Will Bruwer 404-313-1539 | will@pcea.net

REPRINTS

sales@pcea.net

EVENTS/TRADE SHOWS

EXHIBIT SALES
Frances Stewart 770-361-7826 | frances@pcea.net

TECHNICAL CONFERENCE
Mike Buetow 617-327-4702 | mike@pcea.net

EVENTS MANAGEMENT
Jacqueline Bress 404-955-7675 | jacqueline@pcea.net

SUBSCRIPTIONS

PRINTED CIRCUIT DESIGN & FAB/CIRCUITS ASSEMBLY is distributed without charge to qualified subscribers. To subscribe, visit pcdandf.com or circuitsassembly.com and click on Subscribe. For changes or cancellations to existing subscriptions: subscriptions@pcea.net

PRINTED CIRCUIT DESIGN & FAB/CIRCUITS ASSEMBLY is published monthly by Printed Circuit Engineering Association, Inc., PO Box 807 Amesbury, MA 01913. ISSN 1939-5442. GST 124513185/ Agreement #1419617.

© 2024, Printed Circuit Engineering Association, Inc. All rights reserved. Reproduction of material appearing in PRINTED CIRCUIT DESIGN & FAB/ CIRCUITS ASSEMBLY is forbidden without written permission.

Move *Beyond* the Fixture –

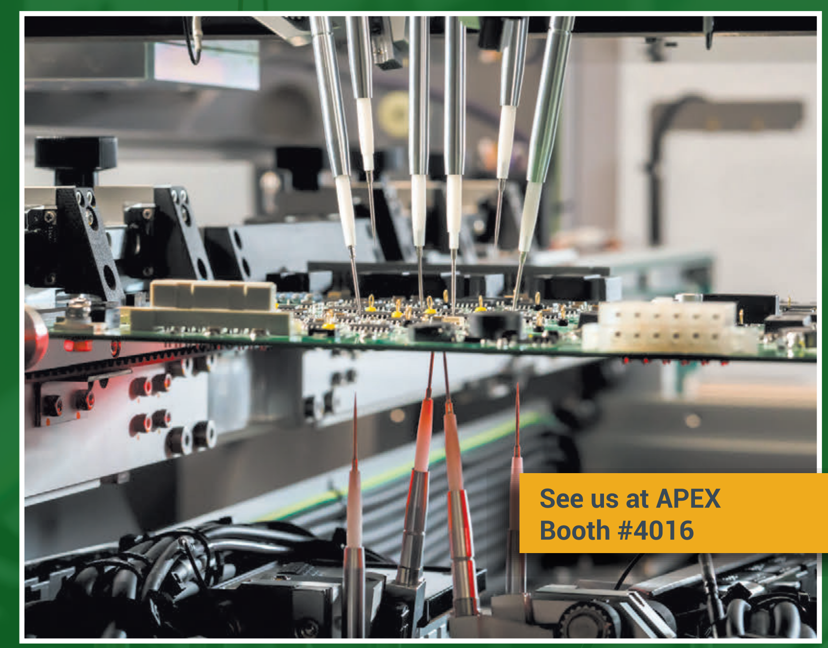
….To Greater Flexibility and Cost Savings with TAKAYA!

Eliminate slow, costly test fixturing for PCBAs with the automated flexibility of TAKAYA Flying Probe testing.

It's the best choice for high-mix assembly. No high costs and needless delays. ECOs? No problem - no new fixture is needed, just a simple programming change.

Plus, TAKAYA has the full path to complete flying probe test automation with 4.0 level line integration, communications, and near-zero operator assistance.

- Ultimate Flexibility for High Mix, Medium Volume Assembly
- No High-Cost Fixturing
- Fast ROI
- Single or Double-sided PCBAs
- Shipped from/serviced in the U.S. by TEXMAC USA.



See us at APEX Booth #4016

TAKAYA Advanced Flying Probe Systems

Find out more. Visit www.texmac.com/takaya today.

THE ROUTE

What's the Deal with the Altium Deal?

THE MASSES ARE atwitter over the recently announced Renesas acquisition of Altium, and for good reason. The $5.9 billion price tag is some real coin.

What's less clear to almost everyone outside the two companies, however, is the underlying strategy and how the merged entity will look going forward.

In announcing the acquisition, Renesas chief executive Hidetoshi Shibata called it "an important first step into our long-term future." But what is that future?

Obviously, Renesas is not going to take Altium private, for exclusive use by its own customers. The two firms do have many overlapping markets: IoT, consumer, automotive, among others. Renesas also plays in higher-end areas such as high-performance computing that Altium has not to our knowledge penetrated. If OEMs want one-stop shopping for a systems program, a combined Renesas-Altium starts to make some sense. But the latter lacks the chip package tool to complete the proverbial – and literal – circuit.

Renesas does plan to open Altium's signature 365 platform to "enable integration with third-party vendors across the ecosystem to execute all electronic design steps seamlessly on the cloud." This permeates the Apple-like shield Altium had in place that restricted outside developers from offering tools that could bolt-on to Altium 365 in ways that enhanced the user experience, perhaps even more efficiently than Altium could do itself.

Less clear, however, is why Altium is worth so much to Renesas. Yes, it likely has as large an

installed base as any major PCB CAD company. Its revenue, however, puts it behind Zuken in fourth overall, well behind Cadence and Siemens. Shibata highlighted Altium's growth rates and profitability. But neither its revenue nor its net income ($43 million in its last fiscal year) will move the needle for Renesas.

As for the price: Renesas will pay $5.9 billion in the all-cash transaction. That's a healthy premium relative to other significant deals in the industry over the past decade. I'm not of the mindset that every deal must pay off in direct financial ways, but given the price tag, on the surface I think this one will be a tough climb. Extrapolating Altium's net income, it would take 137 years to recoup the investment, and that's not counting the time value of money and so forth.

That said, big deals are nothing new to Renesas. Including the pending Altium check, it has spent some $22 billion on various chip and software companies over the past seven years.

How does this one rank with other high-profile ECAD M&As? Let's look at some measures:

Company	Prior 4Q Revenue at Acquisition	Acquisition Price	Stock Premium	Revenue Multiple
Cadence + Sigrity	$1.33B + $20M	$80M	NA	4x
Siemens + Mentor Graphics	€79.6B (US$88.4B) + $1.18B	$4.5B	21%	3.8x
Synopsys + Ansys	$6B +$2.1B	$35B	29%	16x
Renesas + Altium	$9.94B + A$263M (US$171.6M)	$5.9B	34%	22x

Cadence bought Sigrity in 2012 for what now seems like couch change: $80 million.

The Ansys acquisition announced last month reportedly will increase Synopsys' total addressable market by 50% to $28 billion. While Synopsys is strictly EDA, Ansys plays heavily in the automation space, with focus on large end-markets like automotive, aerospace and industrial. Semi makes up less than one-third of Ansys' revenue. (Asked on a conference call how the Altium deal would affect Renesas' TAM, the company demurred.)

Going back even further, Mentor paid $19 million – that's an "m" – to nab VeriBest and its autorouting technology from Intergraph in late 1999. That was less than one times revenue.

This all can be traced back to Siemens' 2017 acquisition of Mentor Graphics. Under duress after multiple hostile takeover attempts, including one by Cadence, Mentor was acquired by the German conglomerate at less than four times annual revenue. Synopsys is paying 16 times revenue for Altium; Renesas is paying more than 22 times revenue for Altium. How the CAD company's former shareholders must be wishing they were still on the block now!

Renesas hinted that Altium shouldn't be viewed in a vacuum but as part of a larger strategy. Will Zuken be next? At $250 million in revenues over the past four quarters, and a market cap of $630 million, it would likely be a far cheaper buy. And Zuken could add chip package and high-end PCB tools to the suite, while also bringing several major military and aerospace customers. Zuken has danced with others through the years. Might it someday find a new home with Renesas?

A 'smart' deal? Speaking of deals, the spotlight is on the synergy between the world's largest physical retailer and a Top 10 maker of smart TVs. Walmart, which already sells Vizio's smart flatscreens by the boatload, is expected to benefit by expanding its ad-targeting capabilities to connected television, per Axios and other analysts.

But I find it intriguing for other reasons: It is an audacious revamping of the OEM-distributor relationship.

Walmart is in fact the world's largest retailer, with annual revenues topping $635 billion. That's well above that of Amazon ($350 billion range in retail; much larger if services are included). The margin grows if we subtract the billions in revenue Bezos and Co. collect selling their internally sourced brands, such as Eero routers, Kindle e-readers, Fire tablets and TVs, and of course Alexa and Echo smart home devices. And that's just the electronics side of its vast private label businesses.

Walmart, of course, has its own private labels as well, but they tend to be in the home and sporting goods and automotive spaces. Electronics was an afterthought.

Vizio, however, adds a $1.7 billion electronics arm, complete with all the requisite supply chain demands, from design to parts procurement to manufacturing to logistics. How will this affect Vizio's sourcing strategy? Will Walmart overlay its procurement approach? Will

Vizio's competitors attempt to undercut their tie-up with Walmart by asserting that the new owners will give their own channels precious advantages on retail walls and shelves?

I'm not discounting the already robust Vizio supply chain practices, but there's a learning curve both organizations are about to experience: Vizio with a new corporate overlord, Walmart with an outside team whose operational methods are almost certainly different than its own. Who will bend, and how?

mike@pcea.net

@mikebuetow

P.S. Our condolences to the family of Tony Hilvers, a former executive at IPC who was the EMS industry's biggest cheerleader in the 1990s and 2000s, who passed away in January. Tony was instrumental in recruiting me to IPC in the 1990s, and he was a strong advocate for the recognition of EMS as a standalone industry in the media and the stock markets.

MIKE BUETOW is president of PCEA (pcea.net); mike@pcea.net.

As technology becomes more integrated with daily life, we're making semiconductor technology more reliable.

From preserving the highest levels of system purity to protecting critical process tools, our solutions deliver the performance semiconductor manufacturers need to power a smarter, safer, more connected future.

www.chemours.com/semiconductor

Experience tomorrow, today.

©2024 The Chemours Company. Chemours™ and the Chemours logo are trademarks of The Chemours Company.

Renesas to Buy Altium for $5.9B

TOKYO – Renesas Electronics will acquire Altium for A$9.1 billion (US$5.9 billion) in cash, subject to a number of conditions, the companies announced in mid-February. The deal has an enterprise value of A$8.8 billion ($5.7 billion).

The transaction has been unanimously approved by the boards of directors of both companies and is expected to close in the second half of 2024. Completion of the transaction is subject to approval by Altium shareholders, Australian court approval as well as regulatory approvals and other customary closing conditions.

Renesas plans to finance the transaction with bank loans and cash on hand and the transaction is not subject to any financing conditions. Altium will continue to be led by its CEO, Aram Mirkazemi, as a wholly owned subsidiary of Renesas.

The acquisition enables two industry leaders to join forces and establish an integrated and open electronics system design and lifecycle management platform that permits collaboration across component, subsystem and system-level design, the companies said in a press release. Renesas said the transaction aligns with its digitalization strategy and represents its first significant step in bringing enhanced user experience and innovation at the system level for electronics system designers.

Renesas and Altium aim to build an integrated and open electronics system design and lifecycle management platform that unifies these steps at a system level. The acquisition brings together Altium's cloud platform capabilities with Renesas' portfolio of embedded solutions, combining high-performance processors, analog, power and connectivity. The combination will also enable integration with third-party vendors across the ecosystem to execute all electronics design steps on the cloud. The electronics system design and lifecycle management platform will deliver integration and standardization of various electronics

design data and functions and enhanced component lifecycle management, while enabling seamless digital iteration of design processes to increase overall productivity.

"Development processes continue to evolve and accelerate," said Hidetoshi Shibata, CEO, Renesas. "Our vision is to make electronics design accessible to the broader market to allow more innovation through a cloud-based platform. [The] addition of Altium will enable us to deliver an integrated and open development platform, making it easier for businesses of all sizes and industries to build and scale their systems."

"I strongly believe that electronics is the single most critical industry to building a smart and sustainable world. Renesas's visionary leadership and commitment to making electronics accessible to all resonates strongly with Altium," said Aram Mirkazemi, CEO, Altium. "Having worked closely with Renesas as a partner for nearly two years, we are excited to be part of the Renesas team as we continue to successfully execute and grow."

Altium common stockholders will receive A$68.50 per share in cash, a premium of approximately 34% to the closing price of Altium common stock on Feb. 14 and a premium of approximately 39% to Altium's one-month volume-weighted average price from Jan. 15.

The all-cash transaction represents an equity value of approximately A$9.1 billion (approximately 887.9 billion yen at an exchange rate of 97 yen to A$1), and an enterprise value of approximately A$8.8 billion (approximately 859.3 billion yen at an exchange rate of 97 yen to A$1).

The transaction is immediately accretive to earnings without synergies; the combined company expects to achieve earnings impact from revenue and cost synergies after the completion of the transaction. Altium had US$263 million revenue, 36.5% EBITDA margin, and 77% recurring revenue in its fiscal year ended Jun. 30, 2023.

Altium was founded in 1985 in Australia as a PCB design tool provider. In June 2023, Renesas announced that it had standardized development of all PCB design on the Altium 365 cloud-based platform from Altium. Renesas has been working with Altium to publish all its products' ECAD libraries to the Altium Public Vault. With features such as manufacturer part search on Altium365, customers can choose Renesas parts directly from the Altium library.

Tata Gets Green Light for Wistron iPhone Unit Acquisition

MUMBAI, INDIA – Tata Group received approval from India's Competition Commission to acquire Wistron's Indian iPhone production unit, paving the way for Tata to become India's first homegrown iPhone maker.

Tata and Wistron agreed to the $125 million sale of Wistron's iPhone factory near Bengaluru in October after Wistron sought to diversify its business beyond iPhone manufacturing into areas such as servers. The company also sold its iPhone production business in China to a competitor in 2020.

Tata was in talks for more than a year to take over the plant as it seeks to forge closer ties with Apple. The deal also advances India's efforts to create local contenders to challenge China's dominance in electronics.

EOS/ESD Association Releases Technology Roadmap

ROME, NY – The EOS/ESD Association released its Technology Roadmap, which presents estimated threshold changes in electrostatic discharge (ESD) and the potential impact on ESD control practices through 2030.

In an effort to keep abreast of the evolving electronics industry, the document is updated annually by EOS/ESD Association.

The first section of the roadmap provides estimates of future electrostatic discharge (ESD) thresholds of semiconductor devices and the potential impact on ESD control practices. These levels are strongly technology- and design-dependent and need to be periodically revised in the context of advances in the electronics industry. The second section contains

information on device testing trends and characterization from the ESDA and ESDA/Joint Electron Device Engineering Council (Jedec) teams working on these methods. The roadmap also includes an outlook on important trends in the semiconductor industry looking toward 2030 and closes with a section on electronic design, an important contributor to reliable and robust ESD and latch-up design.

"EOS/ESD Association is the independent association with the technical expertise to provide the roadmap for research and development (R&D) as well as education in electrostatic discharge," said executive director Lisa Pimpinella. "As an association that combines representatives from all of the major semiconductor companies in the world, we are highlighting the criticality of research, development, education, and funding to ensure electrostatic discharge is recognized as the major thrust behind reliability."

Details of the roadmap can be found here.

UK-Based EC Electronics Acquires Liad Electronics

BASINGSTOKE, UK – EC Electronics has acquired Dutch EMS provider Liad Electronics, growing EC's presence in mainland Europe and expanding its manufacturing capacity.

Liad Electronics Breda specializes in printed circuit board assemblies, and the company's operations in the Netherlands will continue to be overseen by Rick Meesters, who will be reinvesting in the group and joining the board, said EC Electronics.

"We are very excited about Liad Electronics joining the EC Group and working with the incredibly experienced team there," said Phil Simmonds, CEO, EC Electronics. "Liad will now be the foundation for the next stage of our growth plans in mainland Europe and a key part of the future success of the group."

"The additional services offered by EC will allow us to significantly improve our position and provide extra support to existing relationships," said Meesters.

Lean Stream, Fuji, Koh Young Unite for Collaborative Workspace

ATLANTA – Lean Stream, Fuji America and Koh Young America have partnered to launch a collaborative workspace in Fremont, CA.

Recognizing the importance of skilled professionals in driving industry progress, the workspace will host comprehensive training programs to empower individuals with the knowledge and skills needed to navigate the evolving landscape of electronics manufacturing. Attendees will explore interconnected systems, artificial intelligence and data analytics that enhance decision-making and streamline production. The goal is to empower manufacturers to embrace Industry 4.0 standards, fostering a new era of efficiency and competitiveness.

"The grand opening event was not just a ribbon-cutting ceremony; it was celebration of collaboration, technology, and progress," said Joel Scutchfield, general manager of SMT operations, Koh Young. "As we unite our expertise, this innovative hub promises to be a game-changer, showcasing live demonstrations, immersive training sessions, and cutting-edge smart factory solutions for advancements in electronics manufacturing."

Lean Stream, Fuji America, and Koh Young each bring a wealth of experience and innovation to the table, and by pooling their resources, they aim to create a synergy that will elevate electronics manufacturing processes to new heights.

"The collaborative workspace will feature live demonstrations that offer a firsthand look at innovative technologies shaping the future of electronics manufacturing," said Tom Zabkiewicz, executive vice president, Fuji America. "From advanced assembly line solutions to precision machinery, attendees will witness the seamless integration of hardware and software designed to optimize efficiency and quality."

One of the key pillars of the collaborative workspace is its strategic proximity to customers. Nestled in the heart of the Bay Area, the facility is strategically located to be easily accessible to electronics manufacturers in the region.

“Being close to customers allows us to deliver solutions tuned to the specific requirements of area manufacturers,” said Lean Stream president Robert Jones. “The collaborative workspace becomes a responsive hub where industry players can actively take part in shaping the technologies and processes that will drive their businesses forward.”

The collaborative workspace’s proximity to customers enables real-time collaboration, allowing manufacturers to engage directly with experts, troubleshoot issues and explore tailored solutions, ensuring a rapid response to industry demands. Beyond business transactions, the collaborative workspace is also meant to foster an environment for building lasting relationships, the companies said.

“This collaborative workspace isn’t just a facility – it’s a hub for area manufacturers to stay at the forefront of industry trends,” Jones said. “By providing a space for networking, knowledge exchange, and collaboration, the workspace aims to create a vibrant community that propels the entire region into a leadership position in electronics manufacturing.”

Celestica Adding Capacity in Asia to Meet Higher Demand Needs

TORONTO – Celestica is expanding at electronics manufacturing sites in Thailand and Malaysia in anticipation of greater demand for hyperscale computing applications, the company said on a conference call in January.

Celestica is raising its capital expenditure budget from 1.6% of revenue – $125 million – to 1.75% to 2.25% of anticipated 2024 revenues, said Mandeep Chawla, CFO. The EMS firm expects to front-load the capex spend as it expands capacity in support of its customers’ AI/ML compute and HPS programs.

In Thailand, Celestica is adding more than 100,000 sq. ft. of capacity over multiple phases. Phase one will come online in the current quarter and phase two is expected to be completed in the first half of 2025. The expansion, Chawla said, is “partially funded by a co-investment with one of our hyperscale customers to facilitate demand for highly specialized data center products.”

The Malaysia operations are seeing a slightly smaller expansion, where some 80,000 square feet of capacity is being added for customers in its connective and cloud solutions (CCS) segment. That expansion is expected to come online in the first half of this year, Chawla said.

Tata, Pegatron in Talks for iPhone Assembly Partnership

BENGALURU, INDIA – Tata and Pegatron are reportedly in talks to form a partnership to run an iPhone assembly plant in the Indian state of Tamil Nadu.

Tata is building the plant – its second in India – in Hosur, and is in talks to partner with Pegatron to speed up its plans to start manufacturing, two sources told Reuters.

Pegatron would provide technical and engineering support at the plant, which is expected to have 20 iPhone assembly lines, the sources said, while Tata would hold a majority stake in the venture.

Tata's other iPhone assembly plant is in the state of Karnataka, which it took over from Wistron last year, and Pegatron operates another assembly plant in Tamil Nadu.

EMA, Hawk Ridge Systems Enter ECAD/MCAD Partnership

ROCHESTER, NY – EMA Design Automation and Hawk Ridge Systems have entered a strategic partnership to offer a full ECAD/MCAD design experience.

Through the partnership, Hawk Ridge Systems will now sell and distribute Cadence and EMA ECAD design solutions to their customers, including Cadence OrCAD X and Allegro X.

"As the ECAD and MCAD domains continue to converge, there is a great need to help customers manage the realities and requirements of a fully integrated design environment across the electrical and mechanical product development process," said Manny Marcano, President of EMA Design Automation. "Partnering with Hawk Ridge Systems brings two companies together with unmatched expertise in electrical and mechanical design to help customers confidently deliver successfully electromechanical products on the first pass."

"Our customers are looking for solutions to help them bridge the gap between MCAD and ECAD to operate more efficiently and effectively as they design their products," said Dale Ford, CEO, Hawk Ridge Systems. "This partnership with EMA allows us to instantly provide expert guidance and support to our customers for the electronics in their electromechanical EMA and Hawk Ridge Systems Reshape Engineering systems. We're excited to be working with EMA."

Epoch Expands EMS Operations, Moves to New HQ

SAN JOSE, CA – EMS company Epoch International announced the relocation of its US headquarters to a new larger facility here.

The move will permit its manufacturing subsidiary, Epoch Technologies, to double its production capacity augmented by its UL508 and ISO certification, and underscores its commitment to meeting growing demands with superior design, engineering, and manufacturing services in the North American market, the company said in a release.

The new facility's Foreign Trade Zone (FTZ) designation and its proximity to the San Jose International Airport also make it logistically convenient and accessible to its international supply chain, Epoch said.

NationGate Acquires Hesechan

Industries

KUALA LUMPUR – Malaysian EMS company NationGate Holdings announced the acquisition of Pengang-based Hesechan Industries for RM25 million ($5.2 million).

The acquisition, which includes four factories and an office block, comes as NationGate seeks to acquire additional manufacturing space to facilitate its business expansion, the company said.

"The acquisition represents a strategic investment for expansion, and is undertaken in line with NationGate and its subsidiaries' long-term plan to grow its business," NationGate said. "As the group intends to continue expanding its business, it envisages the requirements of additional manufacturing space to facilitate the expansion."

Kerafol, X2F Strike Thermal Solutions Partnership

LOVELAND, CO – Kerafol and X2F are partnering to develop thermal management solutions for electronic devices using Kerafol's thermally conductive materials and X2F's controlled-viscosity molding technologies.

The partnership aims to provide advanced thermal management solutions that meet the ever-increasing high-performance demands of the electronics industry, the companies said in a release.

Combining Kerafol's high-performance thermoplastic elastomeric materials with X2F's controlled- viscosity molding (CVM) technology delivers a higher-performance alternative to conformal coating, potting, and sealing of electronics, achieving superior environmental protection and heat dissipation while reducing processing times and manufacturing costs, the companies said.

The companies aim to create a strategic partnership to deliver advanced protection for

electronic devices, ensuring long-term reliability by safeguarding against contamination, vibration, shock, ESD, and thermal stresses, all in a streamlined, one-step process.

Kerafol's silicone-free Keramold materials are soft and flexible, highly electrically isolating, thermally conductive and can be molded into complex geometric shapes, making them ideal for overmolding electronics. Additionally, Keramold materials are easy to handle, process at room temperature and require no refrigeration, drying, pre-treatment or post cure.

The X2F CVM approach to overmolding electronics combines patented hardware, sensors, and software to control the viscosity of ultra-high-performance materials and optimize mold pressure. Heat is generated electrically for continuous temperature control, and a multi-step "pulse-pack" extrusion process is used to fill the mold. By continuously sensing mold cavity pressure and deploying its "pack-hold-and-repack" process, X2F builds to the best mold pressure for the application. As a result, X2F can mold ultra-high-performance materials and complex geometries that were previously considered unmoldable.

"Our Keramold thermoplastic elastomers flow extremely well on X2F's CVM equipment, wrapping the complex contours of components and PCBs. And because of its softness, when pressure is applied it conforms to surfaces unlike any other material in the industry, without damaging sensitive components," said Wolfgang Hoefer, Thermal Products Division manager at Kerafol.

"We are excited about this collaboration because it provides our customers a new approach for heat management in electronics that is far superior to conformal coating and potting in many applications," said X2F CEO Mike Slowik.

Icape Makes 2 Italian Acquisitions

FONTENAY-AUX-ROSES, FRANCE – Icape Group in February announced the acquisition of the operating assets of Italian PCB distributor PCS and design company Studio E2.

A PCB producer for more than 30 years, PCS switched to printed circuit board distribution in 2015, and has a portfolio of around 80 customers from the Lombardy industrial area, from all sectors. In 2022, PCS generated an annual net revenue of more than €700,000 ($754,000).

Studio E2 has more than 40 years of experience in project management applied to all sectors of civil and industrial electronics. The company, which consists of three engineers, provides more than 70 customers with a full range of services, from printed circuit design to mechanical and electronic engineering, as well as producing the documentation required at every stage of the product's life. Studio E2 recorded net annual revenue of more than €275,000 in 2022 ($296,000).

Through the acquisition of PCS, Icape expands its presence in Italy, and enhances purchasing and commercial synergies with its local subsidiary while benefiting from a high level of profitability, Icape said in a release.

The integration of Studio E2 completes the already extensive range of services provided by Icape to its customers, with the addition of printed circuit board design, giving the company proven expertise across the entire printed circuit board value chain, from design to delivery to the end customer, Icape said.

"Although modest compared with our previous acquisitions in Europe, these operations consolidate our strategic position in the PCB value chain while providing us with a new solid base in Lombardy, an Italian region renowned for its economic dynamism," said CEO Yann Duigou. "PCS has a customer base of eighty manufacturers representing all the sectors of activity that drive this industrial area. As with each of our acquisitions, we targeted the synergy potential between our two entities as a key selection criterion. Given this potential, our subsidiary Icape Italia should rapidly benefit from the experience brought in by PCS. The acquisition of Studio E2 will enable us to bring in new, high added-value expertise for our local and international customers. Moreover, by offering this additional PCB design activity, we are reaffirming the Icape Group's role as a key technological intermediary for its customers."

MacDermid Enthone Opens PCB Chemistry Lab in Japan

NAGOYA, JAPAN – MacDermid Enthone Industrial Solutions celebrated the opening of its new lab here on Feb. 1 with a ribbon cutting ceremony and customer event.

The event commenced with a ceremonial ribbon-cutting for the laboratory, hosted by local MacDermid Enthone representatives and global leaders. Matthew Cenzer, principal officer, US Consulate in Nagoya, was in attendance along with automotive customers from across Japan.

"The opening of our laboratory facility in Nagoya is an exciting new chapter for MacDermid Enthone and our partners," said Hui Hui Kiw, vice president of Asia, MacDermid Enthone. "Our local presence enables us to deliver superior customer support while bringing global capabilities to customers in Japan."

Throughout the day MacDermid Enthone industry experts delivered presentations on sustainable anti-corrosion solutions, their trivalent chromium portfolio, including evolve and evolve BOND, and electroless nickel technologies. Attendees were able to tour the Nagoya laboratory and learn about the global manufacturing, testing, and supply chain capabilities that MacDermid Enthone can bring to Japanese OEMs.

"It is a privilege to host this event in Nagoya and share a milestone in our history with local customers and colleagues," said Richard Lynch, senior global vice president, MacDermid Enthone. "Our commitment to future-focused innovation, coupled with Japan's focus on sustainability, is a partnership that will help drive the automotive industry forward. Thank you to all who joined us."

CIRCUITS ASSEMBLY Opens 2024 Service Excellence Awards

PEACHTREE CITY, GA – CIRCUITS ASSEMBLY has opened registration for its annual Service Excellence Awards (SEAs) for EMS providers and electronics assembly equipment, material, service, and software suppliers.

Now in its 32nd year, the SEAs honor companies for excelling in the critical area of customer service, permitting participants to benchmark customer service against their peers. It is the only industry awards program that uses direct customer feedback to determine best-in-class.

Customers are surveyed to determine their satisfaction with a participating company in various categories, including dependability/timely delivery; manufacturing quality; responsiveness to requests and changes; technology; value for the price; and flexibility/ease of doing business. For each EMS category, the overall best-in-show winner is selected.

All customer responses and ratings are tabulated and provided in a confidential report to the participating company. The deadline to enter is Mar. 25, 2024.

"We get customer scorecards all year long. We work hard to continuously improve. When we win the CIRCUITS ASSEMBLY Service Excellence Awards, it means we've done everything right," said Gary Larson, CEO, Electronic Systems Inc. (2023 Overall Winner, EMS Revenues $20 Million to $100 Million)

About the awards. The SEAs recognize four categories of EMS providers based on revenues (under $20 million; $20 million to $100 million; $101 million to $500 million, and over $500 million).

Equipment, material or software supplier awards will be presented in each of the following categories: component storage systems; automation and handling equipment; cleaning processing or materials; device programming equipment; dispensing; pick-and-place; repair and rework; screen printing; test and inspection; materials (solder, encapsulants and adhesives); soldering equipment; automation/manufacturing software (not ERP/MRP); and supply-chain/ERP/MRP software.

Non-manufacturing service providers will be honored in the following categories: test laboratories; recycling, cleaning or other non-manufacturing process providers; and design service bureaus. Reps or agents and/or distributors will also be honored.

CIRCUITS ASSEMBLY will honor winners in person at SMTA International in October

2024 at the Rosemont Convention Center in Rosemont, IL. Participants will receive their report as an Excel file after the show.

For more information, visit https://circuitsassembly.com/ca/editorial/service-excellence-award.html. To register, visit https://na.eventscloud.com/2024sea.

USCAR Announces Publication of 'Roadmap for Automotive Smart Manufacturing'

SOUTHFIELD, MI – The United States Council for Automotive Research LLC (USCAR) in February announced the publication of its "Roadmap for Automotive Smart Manufacturing" for standards-based openness and interoperability of platforms and applications to enable a more productive, competitive and resilient automotive manufacturing environment in the US.

The roadmap was developed by a working group of USCAR, whose members are Ford, GM and Stellantis, in collaboration with CESMII – The Smart Manufacturing Institute. The roadmap's scope includes strategies to improve interoperability of manufacturing systems and to break down digital silos of legacy platforms.

Smart manufacturing requires a high degree of automation and integration of systems on the shop floor to deliver optimal performance. These systems have evolved over decades in a highly proprietary, closed manner. The resulting landscape of incompatible machine communication creates costly delays and complexity in product launches for automotive companies. Interoperability and extensibility of these machines is imperative to ensure cost-efficient operation and viability.

The Roadmap focuses on three pivotal strategies essential for fostering a more productive and sustainable automotive manufacturing environment in the U.S. These strategies are:

- Collaborate via real-time, data-driven business orchestration of digital processes

within plants and across the value chain. Goal: flexible and agile processes and supply chains easily reconfigured for changing market demands.

- Enable innovation through application and data interoperability based on standardized, open interfaces that eliminate data silos, stovepipe architectures, and vendor lock-in. Goal: reduce complexity and improve efficiency and innovation agility.
- Develop a Smart Manufacturing Mindset aligning education, workforce development, and continuous improvement strategies to create data-driven cultures. Goal: organizational structures that align resources and people.

USCAR engaged CESMII – The Smart Manufacturing Institute – to aid in the development of the roadmap. CESMII has a total investment of $140 million from US Department of Energy funding and public/private partnership contributions.

"The 'Roadmap for Automotive Smart Manufacturing' is a strategic initiative to enable sustainable smart manufacturing for our USCAR Members and their suppliers," said Dr. Steven Przesmitzki, executive director, USCAR. "By working with CESMII, we are able to leverage not only their expertise, but relationships with their members, the US Department of Energy, and additional industry contacts to promote smart manufacturing as a critical enabler for advancing and improving US automotive manufacturing processes."

Plans are in the works for members of the roadmap's research team to present their findings as part of a workshop on Apr. 15 in Detroit. To be added to the notification list for this event, email manufacturing@uscar.org.

TTM Expanding VA Operations

STERLING, VA – TTM Technologies in February announced a $13.4 million expansion of its manufacturing plant in Virginia. The expansion involves the purchase of new equipment and a renovation of its plant, which will add 43 jobs to the 200 already located in Sterling, VA.

Loudoun County awarded TTM a Commercial Business Incentive Fund grant for the expansion project, and the company received a Virginia Jobs Investment Program grant from

the Virginia Economic Development Partnership.

"TTM Technologies' decision to go all in with Loudoun is a testament to the strength of our local economy and the quality of our workforce," said Koran Saines, supervisor, Loudon County. "This expansion will provide valuable job opportunities for Loudoun's skilled workers and further solidify the county's position as a leader in advanced manufacturing."

Headquartered in California, TTM also has facilities in Colorado, Connecticut, Missouri, New Hampshire, New York, North Carolina, Ohio, Oregon, Utah and Ontario, Canada. In November, the company announced plans for a new $130 million manufacturing facility in New York.

TT Electronics Opens Mexico Facility

MEXICALI, MEXICO – TT Electronics has expanded its North American operations with a new manufacturing facility here. The 75,000 sq. ft. facility is equipped with the latest technology and manufacturing capabilities to meet the increasing demand for electronics manufacturing solutions in the North America region, the company said.

The plant has capacity for 250 workers and is equipped with up to six automated SMT lines.

"We are thrilled to inaugurate our new manufacturing facility in Mexico, a testament to our dedication to meeting the evolving needs of our customers and expanding our global footprint," said Michael Leahan, chief operating officer, TT Electronics. "This strategic investment reinforces our commitment to deliver increased value, a world-class service and the capacity to enable our customer's growth."

AROUND THE WORLD BRIEFS

PCD&F

American Standard Circuits Sunstone signed a licensing agreement with **Precision Circuit Technologies**.

Amitron installed a **Wise** outer layer tin stripper and Wise innerlayer dry-film stripper.

Gold Circuit Electronics and **Shikoku Chemicals** joined the **High Density Packaging User Group.**

Rogers Corp. signed a lease on a factory in Monterrey, Mexico, for advanced busbar manufacturing and engineering services. The first phase of the new site is slated for completion in late 2024.

Schmid is collaborating with **Calumet Electronics** to build its advanced substrate factory in the US.

Ventec's VT-901 polyimide material is now qualified by ESA in **ACB Belgium's** manufacture of HDI PCBs.

CA

Active-PCB Solutions purchased a **Kolb** PSE LH7 cleaning system.

Altest purchased a **Viscom** 8011-III x-ray inspection system.

Anzer received a contract from **Ohio State University** for the RALPH (Research

Assignment Learner for the Prehospital Setting) project.

Apple reportedly told its primary suppliers, **Foxconn** and **Pegatron**, to halt their plans for more production lines for the iPhone XR.

Bharat Electronics received a contract worth Rs 2,282 crore ($274.5 million) from the Indian Navy to supply an electronic warfare suite for use on warships.

Bittele Electronics expanded its Markham, ON, assembly facility to improve inventory accuracy and streamline operations.

Detech named **Estanflux** exclusive representative of Prey AOI in Spain and Portugal and **Panatek** sales representative in Egypt, Saudi Arabia and the UAE.

Dixon Technologies selected **Blue Yonder** to digitally transform its supply planning capabilities.

Electri-Cord Manufacturing is updating its brand to ECM to reflect its global contract manufacturing and supply chain solutions.

Heraeus Electronics acquired the PriElex electronics inks business line from **Kayaku Advanced Materials**.

Honeywell will invest $84 million to expand its aerospace manufacturing facility in Olathe, KS.

Japan's trade ministry will offer up to 45 billion yen ($301 million) for research into cutting-edge semiconductor technology.

Jyoti CNC Automation expects sales to electronics manufacturing services customers to rise to 25% of its business next year, up from 12.5% in the third quarter of the current fiscal year.

Kübler named **Murray Percival Co.** sales representative for Arcadia in Michigan, Ohio, Indiana, Kentucky, Illinois, Wisconsin and Western Pennsylvania.

Kurtz Ersa partnered with **Comtree** to strengthen the availability of spare parts in Canada.

Malaysia plans to build a world-class electrical and electronics cluster.

NEOTech expanded its microelectronics manufacturing center.

Nortech Systems expanded its fiber optic technologies with the addition of Expanded Beam Xtreme.

Nvidia is building a new business unit focused on designing bespoke chips for cloud computing firms and others, including advanced AI processors.

Panasonic has begun a 3.54 hectares expansion project that will double capacity at its SMT machine factory in China's Suzhou Industrial Park.

Pegatron has announced plans to build a plant in Malaysia, bringing the total number of its manufacturing sites in Southeast Asia to four.

Raytheon received a $20 million contract to develop a next-generation multichip package for use in ground, maritime and airborne sensors.

Saki Corp. supplied inline optical inspection systems to **Smart Modular Technologies**.

IONA Tech named **TestEquity** authorized distributor of its ESD prevention equipment and accessories.

TT Electronics will lead design, manufacture and integration of electric cable harness assemblies for the UK's Challenger 3 prototype tank.

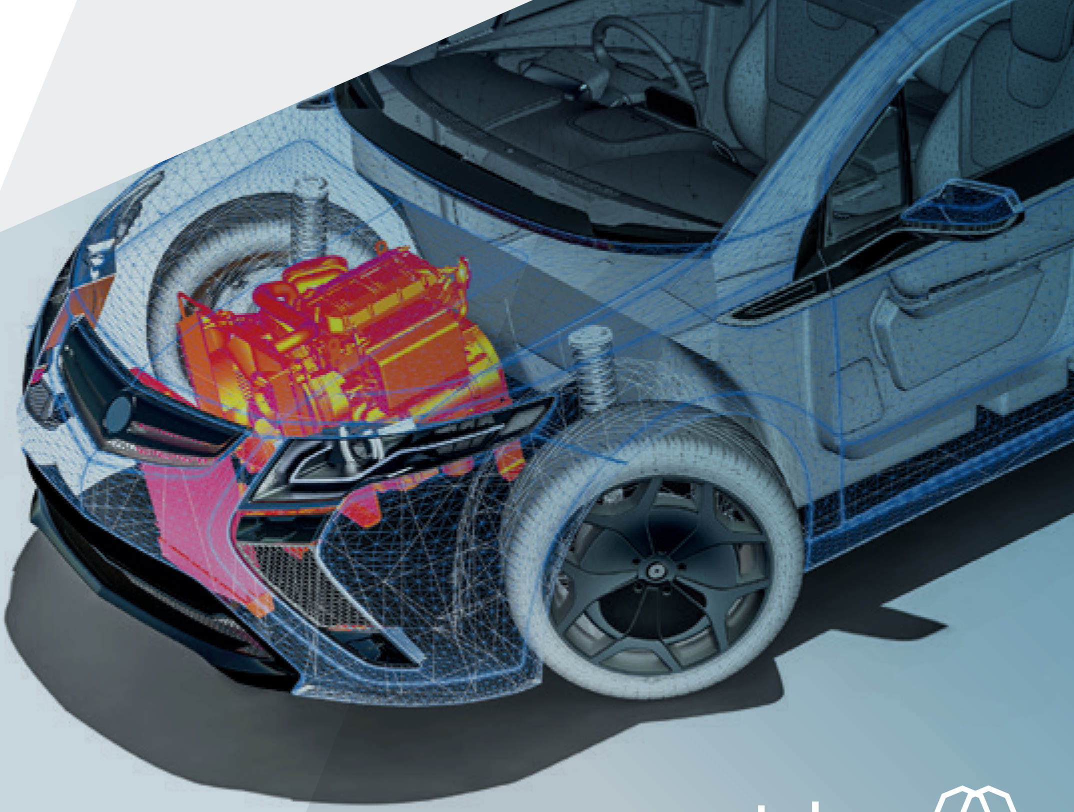
Variosystems opened a new subsidiary to serve the Asia Pacific market region.

Vega Industries named **Rocka Solutions** tool distributor.

autolam: Base-Material Solutions for Automotive Electronics

High-Performance Automotive Electronics begins with Innovative Materials

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



autolam

Wherever technology takes you, Ventec delivers

venteclaminates.com

PCDF

Keven Coates

AT&S named **Rafael Padilla** senior manager, business development.

Novium named **Keven Coates** senior electrical engineer.

CA

Bob Meyerson

Gene Agron

Jianli Guo

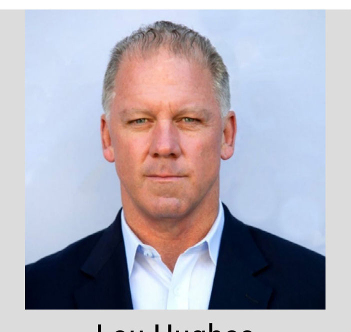
Dean Kavanagh

Todd Rountree

Olivier Clément

Don Dennison

Gustavo Jimenez



Lou Hughes

Angelo Panagopoulos

Hector Hernandez

Todd Foster

Amtech Electrocircuits named **Brenda Martin** business development executive.

Ark Electronics appointed **Bob Meyerson** president of sales & business development of North America, **Gene Agron** VP of sales for North America, and promoted **Jianli Guo** to VP of operations.

ATE Solutions appointed **Dean Kavanagh** managing director.

Austin American Technology appointed **Todd Rountree** chief executive.

Éolane Group named **Olivier Clément** chairman.

ESD Seating named **Don Dennison** representative in the Northeast US.

Hanwha Techwin appointed **Gustavo Jimenez** general manager for Mexico.

IMI CEO **Arthur Tan** will be stepping down as CEO in April, with **Lou Hughes** set to take the company’s reins.

Inovaxe named **Angelo Panagopoulos** director of business development.

JMA Wireless promoted **Mario Scalzo** to supervisor, process engineering.

Koh Young named **Hector Hernandez** regional sales manager for the regions of Baja, Sonora, Durango, Chihuahua and Jalisco, Mexico.

Kübler appointed **Todd Foster** of Foster Innovative Technology representative for

Arcadia in Washington, Oregon and Idaho.

If you want to be trusted, be reliable.

Your products.
A lifespan of reliability.

Fluid Dispensing | Plasma Treatment |
Conformal Coating | Selective Soldering

www.nordson.com/electronics

PCEA Announces UHDI Forum at PCB East

PEACHTREE CITY, GA – PCEA's first UHDI & Substrates: Design to Package Forum will be held on June 5, in conjunction with PCB East in Boxborough, MA.

UHDI, or ultra high-density interconnect, describes lines and spaces of less than 25 microns on a printed circuit board. Among the presentations are talks on standards, electrohydrodynamic (EHD) printing, direct imaging for less than 15 microns, a new mSAP process, a new replacement for ABF (Ajinomoto Build-Up Film), planning a new UHDI facility, and new materials for UHDI.

Each presentation will be 30 minutes. The program will close with a panel discussion.

The forum is chaired by Gene Weiner of Weiner International Associates. Peter Bigelow, president of FTG East, and Alun Morgan, technology ambassador of Ventec and president of the European Institute for the PCB Community (EIPC) are vice chairmen.

"Rapid technical progress and major dollar commitments are being made in the US and Europe to establish sustainable, secure sources of organic substrates and UHDI circuitry for advanced electronics packaging," said Weiner. "This forum is designed to present new design, process, material, and equipment capability information that delegates can immediately put to use."

"The industry has begun to recognize the need for – and challenges of – UHDI technology," added Mike Buetow, president of PCEA and conference chair of PCB East. "Gene Weiner and his colleagues have put together an outstanding program that will look at the state-of-the-art

and the requirements for implementation.”

PCEA Training Announces Spring PCB Design Classes

PEACHTREE CITY, GA – PCEA Training is offering two upcoming five-day training classes starting in April and June for printed circuit engineers, layout professionals, and other individuals currently serving in the design engineering industry or seeking to get into it. The classes include an optional certification exam recognized by the PCEA.

Upcoming class dates include:

- Class 1: April 5, 12, 19, 26, and May 3
- Class 2: June 14, 17, 21, 24, 28

These instructor-led classes cover the gamut of printed circuit design engineering, from layout, place and route to specifications and materials to manufacturing methods. Schematic capture, signal integrity and EMI/EMC are also part of the comprehensive program.

There are no prerequisite requirements to enroll. Upcoming classes will be held online. All courses are led by experienced instructors.

Registration fees include the 400-page handbook, Printed Circuit Engineering Professional, authored by Michael Creeden, Stephen Chavez, Rick Hartley, Susy Webb and Gary Ferrari.

For information about the instructors of the course and authors of the course material, visit pceatraining.net/instructors-authors.

For information about the course overview, class format, and materials to prepare in advance for the class, visit pceatraining.net/course-overview.

To apply, visit pceatraining.net/registration for the next available class or contact Mike Buetow at pceatraining@pcea.net for additional information.

PCEA CURRENT EVENTS CHAPTER NEWS

New England. The chapter plans a kickoff meeting on May 2, probably in the Andover (MA) area. Speakers include Gopu Achath of EMA Design Automation on supply chain-driven circuit design and Paul Yang of Jove PCB on embedded inductors. Contact Mike Buetow at mike@pcea.net for details.

San Diego. Stephen Chavez headlines our special chapter session taking place in conjunction with the Del Mar Electronics Show on Apr. 24. Chavez will speak on designing complex PCBs. For information, contact Luke Hausherr (luke.hausherr@freedomcad.com).

Silicon Valley. The next chapter meeting is Mar. 14 from 11:30 to 1:30 PST. The meeting topic is Design Essentials to Maintain Signal Integrity, presented by Amit Bahl of Sierra Circuits. The meeting will be held live at Levi's Stadium in Santa Clara. Contact Bob McCreight for more information; bob.mccreight@outlook.com.

Measure PCB Surface Finishes ENIG, EPIG, EPAG & ENEPIG

- XRF with Automated X-Y Table
  - Increased Throughput
  - Improved Reliability
- IPC 4552 B & IPC 4556

Measuring Made Easy®

www.fischer-technology.com | info@fischer-technology.com | 860.683.0781

Global Semiconductor Manufacturing Industry Poised for 2024 Recovery, SEMI Reports

MILPITAS, CA – The global semiconductor manufacturing industry recovery is taking hold with electronics and IC sales increasing in the final quarter of 2023 and more growth projected for 2024, SEMI announced in its fourth quarter 2023 publication of the Semiconductor Manufacturing Monitor (SMM) report.

In Q4 2023, electronics sales edged up 1% year-over-year (YoY), marking the first annual rise since the second half of 2022, and growth is projected to continue this quarter with a 3% YoY increase. At the same time, IC sales returned to growth with a 10% YoY jump in Q4 2023 as demand improved and inventories started to normalize. IC sales are forecast to strengthen in Q1 2024 with 18% YoY growth.

Capital expenditures and fab utilization rates are expected to see a mild recovery starting in Q1 2024 after significant declines in the second half of 2023.

In Q1, memory capex is projected to increase 9% quarter-on-quarter (QoQ) and 10% YoY, while non-memory capex is on track to climb 16% during the quarter but remain at lower levels than recorded in Q1 2023. Fab utilization rates saw a modest improvement from 66% in Q4 2023 to 70% in Q1 2024. Meanwhile, fab capacity grew 1.3% in Q4 and is projected to match those gains this quarter. Equipment billings in 2023 surpassed projections though growth is expected to be muted in the first half of 2024 mostly due to seasonality.

"The electronics and IC markets are recovering from a slump in 2023 with growth expected

this year," said Clark Tseng, senior director of market intelligence, SEMI. "Although fab utilization remains low at the moment, improvement as 2024 unfolds is anticipated."

"Semiconductor demand is well on its way in the recovery," said Boris Metodiev, director of market analysis at TechInsights, which assisted in the report. "While the overall IC market is growing this year, slowing automotive and industrial markets are hampering the analog expansion. AI will be a huge catalyst for leading-edge semiconductors as the technology proliferates from the cloud to the edge. At the same time, geopolitics is driving excess capacity at the trailing edge."

Ill Communication

Trends in the US electronics equipment market (shipments only)

	% CHANGE			
	OCT.	NOV.[r]	DEC.[p]	YTD
Computers and electronics products	-0.3	0.5	0.1	1.9
Computers	-1.8	4.9	5.0	13.7
Storage devices	-3.4	-2.4	1.0	12.7
Other peripheral equipment	-1.1	1.5	-5.2	19.4
Nondefense communications equipment	-0.5	0.2	-1.0	-2.1
Defense communications equipment	-2.0	-2.4	4.0	2.2
A/V equipment	-6.4	-0.6	-7.8	17.5
Components[1]	0.9	1.5	-2.5	2.7
Nondefense search and navigation equipment	0.0	0.6	0.0	1.1
Defense search and navigation equipment	-1.8	1.6	1.1	4.3
Electromedical, measurement and control	0.5	-0.1	2.3	1.5

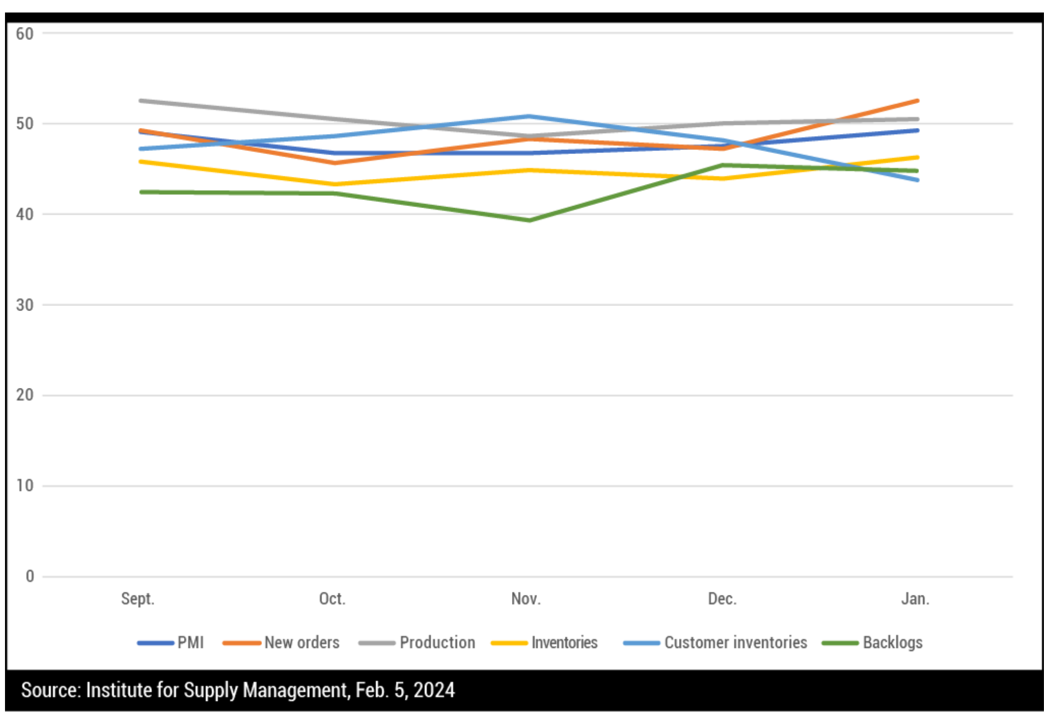
[r]Revised. [p]Preliminary. [1]Includes semiconductors. Seasonally adjusted.
Source: US Department of Commerce Census Bureau, Feb. 2, 2024

Key Components

	SEPT.	OCT.	NOV.	DEC.	JAN.
EMS book-to-bill[1,3]	1.27	1.23	1.23	1.20	1.20
Semiconductors[2,3]	-4.5%	-0.7%	5.3%	11.6%	TBA
PCB book-to-bill[1,3]	1.01	0.97	0.97	0.90	0.93
Component sales sentiment[4]	86.7%	88.8%	82.8%	77.8%	98.0%

Sources: [1]IPC (N. America), [2]SIA, [3]3-month moving average, [4]ECIA

US Manufacturing Indices



Source: Institute for Supply Management, Feb. 5, 2024

Hot Takes

Global **PCB output value** in 2023 will total $73.9 billion, a decline of 15.6% from 2022, but is expected to rebound in 2024 to total $78.2 billion. (Industrial Technology Research Institute)

Worldwide **tablet shipments** declined 17.4% year-over-year in the fourth quarter, totaling 36.8 million units. (IDC)

Demand for **low-loss materials for 5G** applications is expected to surpass $2.1 billion by 2034. (IDTechEx)

Global **semiconductor sales** totaled $526.8 billion in 2023, a decrease of 8.2% from the record 2022 total of $574.1 billion. (SIA)

North American **EMS shipments** in January were up 2.6% compared to the same month last year. Sequentially, shipments decreased 2.7%. Bookings fell 12% year-over-year and decreased 2.2% sequentially. (IPC)

Shipments of **AI PCs** – personal computers with specific system-on-a-chip (SoC)

capabilities designed to run generative AI tasks locally – grew from nearly 50 million units in 2024 to more than 167 million in 2027 and will represent nearly 60% of all PC shipments worldwide. (IDC)

Copper clad laminate, PCB and ABF substrate orders have increased with ChatGPT significantly boosting demand for AI servers. (DigiTimes)

Significant **semiconductor revenue growth** is expected in 2024 of 12%, followed by even stronger growth in 2025 of 21%. Moderated growth is anticipated in 2026 as the market enters a downcycle later that year. (TECHCET)

The world's **top five semiconductor equipment manufacturers**' latest financial reports signal a surge in demand for advanced manufacturing equipment and positive signs of industry recovery. (TrendForce)

Taiwan-based notebook ODMs, several of which experienced sequential shipment decreases in January, are expected to witness a pickup in March shipments. (DigiTimes)

North American **PCB shipments** fell 3.9% in January from a year ago, and fell 7.9% sequentially. Orders dropped 8.6% year-over-year and rose 11.1% from December. (IPC)

Worldwide silicon wafer shipments in 2023 decreased 14.3% to 12.6 billion square inches while wafer revenue contracted 10.9% to $12.3 billion over the same period. (SEMI)

DRAM demand bits remained low during the memory market winter, except for AI servers and automotive electronics, while generative AI applications like ChatGPT drove interest in high-speed memory technologies like DDR5 DRAM and HBM (High Bandwidth Memory), especially in data centers. (Yole)

Retail revenues for **US consumer technology** will grow 2.8% in 2024 to $512 billion, up $14 billion from 2023. (Consumer Technology Association)

The **defense electronics market** is projected to reach $213 billion by 2028, up from $167 billion in 2023, a CAGR of 5.1%. (Markets and Markets)

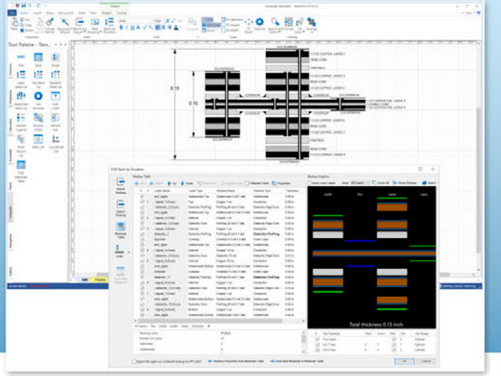
Support For Flex, Rigid Flex and Embedded Component Designs Now Available.

BluePrint-PCB®

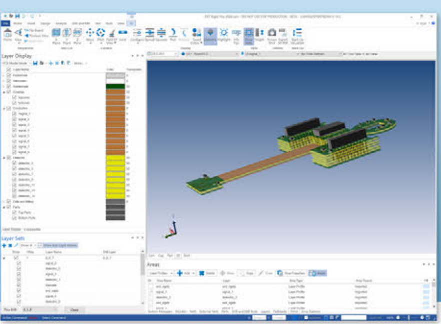
CAM350®

DownStream's CAM350 and BluePrint-PCB support importation and visualization of PCB designs containing Flex, Rigid Flex or Embedded components. Visualize designs in both 2D and 3D, and easily document complex Flex or Rigid- Flex Stack-Ups for submission to PCB Fabricators.

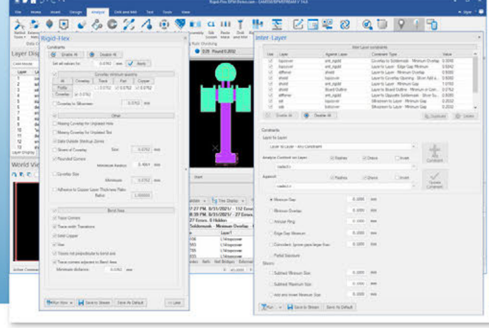
- **Import and Visualize Flex, Rigid-Flex and Embedded Component Designs**
- **3D Visualization to Validate PCB Construction and Component Assembly**
- **Manage Variable Stackup Zones for Rigid-Flex Designs**
- **Easily Create Custom Flex or Rigid-Flex Fabrication and Assembly Documentation**
- **Use DFM analysis to analyze a flex or rigid-flex design for potential fabrication or bend related defects**



Use Stack Up Visualizer and Blueprint's Rigid-Flex Stackup template to easily manage and document rigid-flex stackups.



A rigid-flex design in 3D. Shown with layers spread to improve visualization of the layer stackup.



Use Rigid-Flex and Inter-layer DFM analysis to analyze flex and rigid-flex designs.

For more information visit downstreamtech.com or call (508) 970-0670

©2023 DownStream Technologies, LLC. All rights reserved.

ROI

Small Parts, Big Trouble

Quality management systems will not work without engaged personnel.

IT WAS JUST a few bolts. What could possibly go wrong?

In industry, but especially in the electronics industry, nothing has changed more over the past several decades than the concept and implementation of quality management. In the early 1980s it was inspect, inspect and inspect again. In the late 1980s and through much of the 1990s, the concept of Total Quality Management, or TQM, became the rage. Manage the process and involve all the shop floor employees and stakeholders and better quality will result – requiring less inspection.

During the 1990s and continuing into the new millennium, TQM became overshadowed by Six Sigma. Applying Six Sigma, including certifying employees as green or black belts, enabled greatly improved quality. To be Six Sigma meant 3.4 (or less) defects per 1 million parts. Achieving this level was impressive for sure.

During the first decade of this millennium, things seemed to go full circle. While focused on achieving Six Sigma, customers began to require (read: demand) suppliers to perform first article inspections (FAIs) before shipping product. Over the years, many colleagues in the printed circuit board fabrication community have commented that the number of FAIs they do has grown exponentially and the requirement is binary: all or none – regardless of the complexity of part or end-application.

I know in my company I often comment that industry might make more money if we all

charge for the paper and give away the product! While that is an overstatement driven by frustration from filling out reams of paperwork, and seeing few customers actually following the basic AS9102 format and instead modifying it by adding what seems important to them, you cannot deny the process is time-consuming and costly.

All that said, in my experience even the best process management and most sophisticated statistical controls, all correctly applied and meticulously documented, all miss the two most common instances poor quality occurs.

One instance is when a manufacturing facility is operating with little work, it more often than not leads to quality suffering. Likewise, the other instance is when a plant is running overcapacity, with customers screaming to get product. In the rush to perform and under heavy pressure to deliver, quality usually suffers.

With too little work, people slow down and try to stretch what they are doing to fill time. Employees also begin to let their minds wander, so steps may be skipped, or may forget where they are in the process and believe they have completed a task thoroughly when in fact they have not.

With too much work, a different combination of events may occur, including excessive use of overtime, and borrowing people from different departments who are not familiar with a particular process that they have been asked to help with. And then there is the focus by all on just meeting shipments with often the implied message of "I don't want to hear about problems."

So, it was only a few bolts, what possibly could go wrong? Well in January, passengers on Alaska Airlines Flight 1282 found out, and in a hurry! "A few" bolts missing or improperly installed gave way and an emergency exit blew off the plane while flying at 16,000 ft. Now, a Boeing 737 Max must have close to two million bolts and screws, so the plane, statistically, still met Six Sigma. I can imagine how many trees were killed by Boeing and all the collective suppliers to produce the thousands, if not millions, of FAI reports. And assembly employees at Boeing are involved with quality circles, teams and reviews to assure product quality is achieved. So, all the evolution of quality management was well implemented in the assembly

of the 737 Max. And yet …

It appears that the most current and sophisticated quality management tools all failed in this situation. Why? I am sure the National Transportation Safety Board, along with scores of engineers at Boeing, will identify a root cause and will put appropriate protocols in place to prevent the problem from recurring. As the 737 Max has since experienced production delays and paused production, however, and that leads to customer demands to take delivery of planes they have ordered as soon as possible, the pressure mounts on management as well as production employees to work as fast as possible to make delivery, including running overcapacity to increase the number of planes shipped to meet demand and reduce backlog.

Quality can be measured in many ways. Statistics can be helpful, as can reasonable and effective documentation, but don't forget the human factor! When the regular cadence of a manufacturing facility is altered by either high demand or extremely low demand, quality may suffer. Those are the times when management cannot take quality systems for granted but needs to become more involved to keep employees engaged, focused and not so pressured that errors are made because of fatigue. Perhaps the message to share is: It was only a few parts. What could possibly go wrong?

PETER BIGELOW is president of FTG Circuits Haverhill; (imipcb.com); pbigelow@imipcb.com. His column appears monthly. He is vice chair of the UHDI & Substrates: Design to Package Forum, to be held on Jun. 5, 2024, in conjunction with PCB East in Boxborough, MA.

Lab-to-Fab 3D X-ray Inspection System:
iX7059 one

Our Highest Resolution Inspection System for Inline Applications

With an impressive resolution of 1 micron and consistently competitive cycle times, the iX7059 one is the ideal inspection system for your advanced assembly, power module and semiconductor production line.

- Resolution down to 1 µm for extremely accurate measurements
- Specifically taylored for semiconductor, power module and advanced assembly applications
- Ultra precise X-ray inspection in real 2D, 2.5D and 3D
- From RnD to inline inspection ("Lab-to-Fab")

To be shown at:

April 9 – 11 • Booth #2828

www.viscom.com

Designing for PCB Manufacturability

Making a board producible is entirely in your hands.

THE GOAL OF a good documentation package is that it is complete and coherent enough to proceed with the job without any explanations, waivers, errata or feedback of any kind. It doesn't always work that way, particularly when more than one vendor is involved. The fab drawing is more of a baseline from which they will all deviate to one degree or another. Even using the same vendor all the time is no guarantee that the DfM data come back immaculate.

The foundational aspect of PCB fabrication is a plausible phototool. That final imagery is derived from the artwork that you sent their way. What we know as global micro editing is where the phototool is crafted from the ECAD data. The artwork is more like a starting point.

Etch compensation – pre-distorting the artwork. The first item on the CAM operator's list is dealing with etch compensation. The traces and other geometry that appear on the board are what's left behind after the etch process. First, they must drill and plate the holes with copper. That's done prior to etching and adds a measure of copper to the entire panel. Only then do they mask off the circuit pattern that is not to be removed.

This means that the amount of copper to be etched away is a total of the beginning copper and whatever is added during via plating. You'll see that outer layers tend to have more copper than innerlayers. The exact amount of copper required in the barrel is often a technical question from the fabricator. Literally everything else flows from that number.

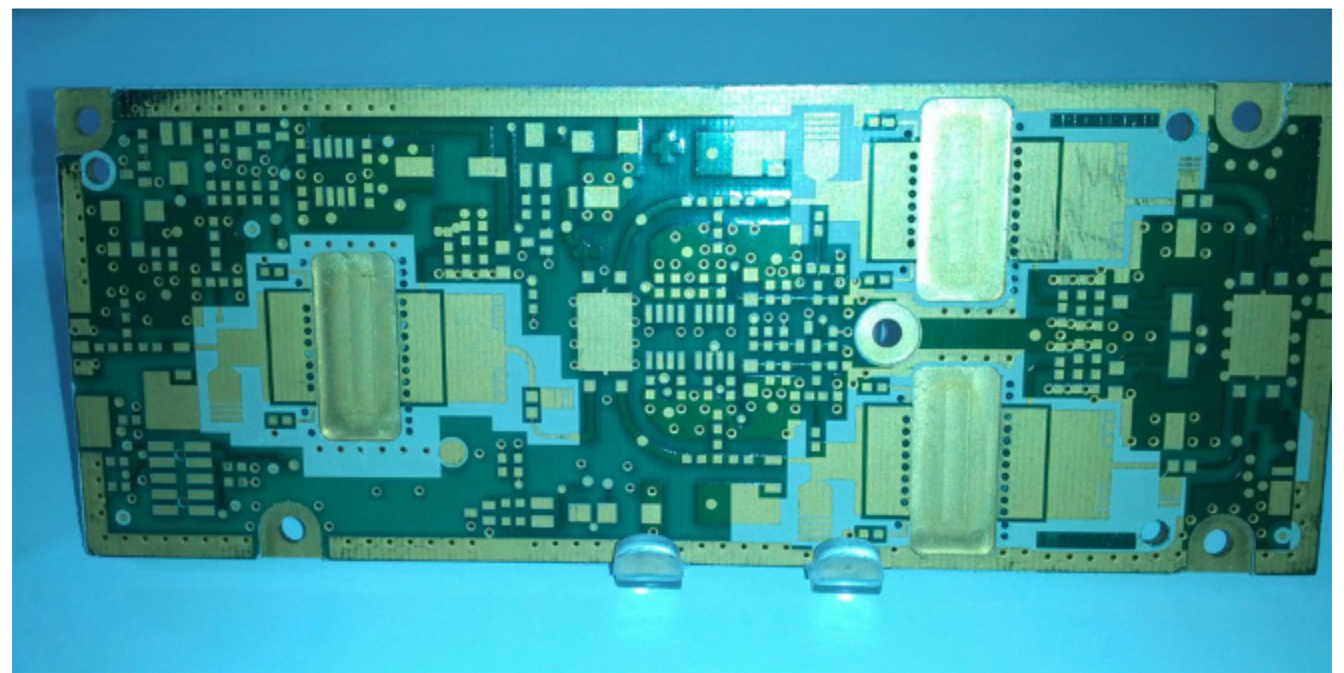


Figure 1. A showcase board that Sanmina had in its booth for years after it was produced. It's a heavy copper board with controlled depth slots and special patented vias along the slot edges. Five meetings came before tape-out on this radio board. (Image credit: Author)

Once the via plating deviation is approved, the fabricator can figure out how much to alter the photoresist so that the result comes out similar to what the artwork provided in the first place. The tendency is to make the tooling wider than the original to account for the profile of the trace as the chemistry forms the air gap. On balance, a narrow line is easier to etch than an equally narrow air gap.

Stackup tolerances: It's not a perfect world. The actual routing area on a board is slightly less than the board outline. The no-man's land permits random variation in the process. Every aspect of the board is ruled by some kind of tolerance. It's up to the designer to decide whether to believe the component data sheet of the fabricator's technology roadmap. You're likely the only one aware of some of these routine decisions.

The designer also must be a filter for requests that are out of touch with the fabrication limitations. It's true that the capture pads can be suppressed on layers where they do not connect. For Class 1 and 2 boards, the drill can cut a hole extending beyond the diameter of the "unused" pad. As much as 25% of the hole's diameter can wander outside the edge of the pad on any given layer and still meet IPC Class 2 specifications. Deleting those unconnected

pads does not mean that the clearance (anti-pad) can be reduced.

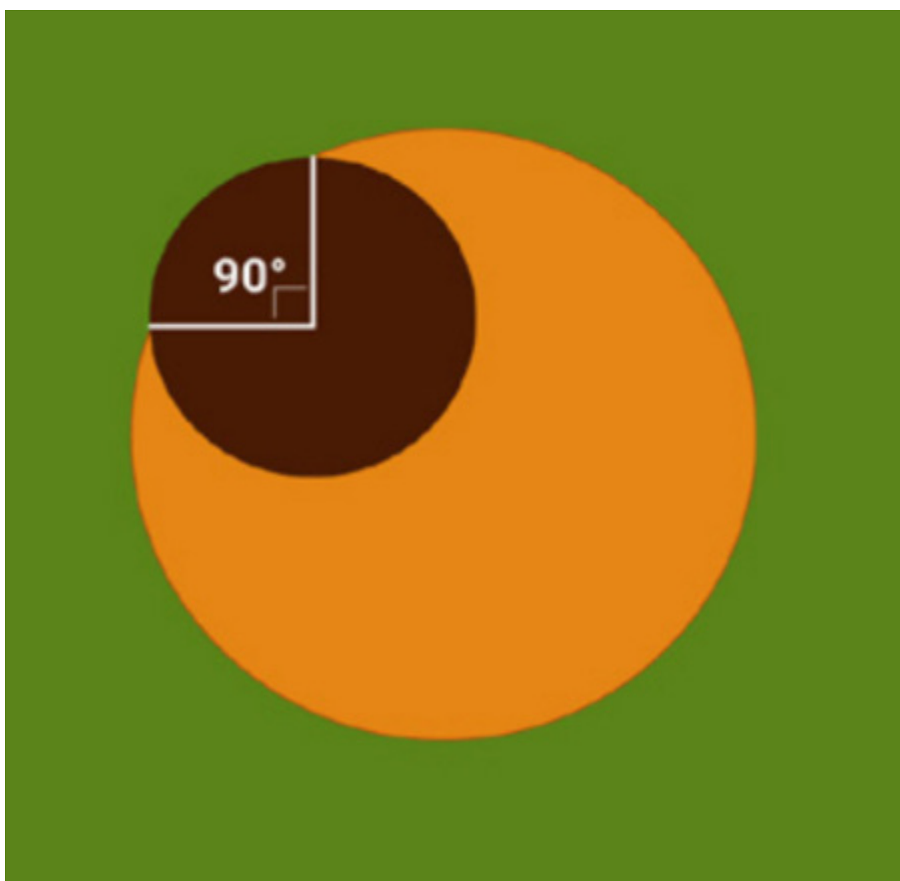


Figure 2. The brown circle indicates the maximum overlap of the hole and the edge of the capture pad for Class 2 boards. (Image credit: Sierra Circuits)

The case of sequentially stacking microvias to solve high-density interconnect (HDI) layouts is different in that all layers will usually plate up. Button plating is more likely to be found when creating flex circuits. The laser vias are ablated then plated one layer at a time in any case. The smaller via geometry only emphasizes the positional differences from layer to layer. Good thing lasers retain their edge and precision all day long.

The important metric becomes the aspect ratio of the via. The fabricator can make a deep and narrow hole with a laser, but can't plate it unless it's shallow. By shallow, take it to mean a hole that is wider than it is deep. Thin dielectrics are required to achieve the full potential of HDI technology. A byproduct of that is the calculated line width for controlled impedance gets narrower as the thinnest dielectric materials are implemented.

A larger annular ring is the No. 1 thing you can give your fabricator. One of the key differences between Class 2 and Class 3 boards is the allowance of the break-out of the drill on Class 2, while Class 3 maintains a complete annular ring. The whole process of piling one layer above the next gets easier as pad size increases relative to hole size. The drill pattern repeats with the same precision provided the bit is sharp.

The artwork also aligns over the entire stack with random misregistration. The repeatability of the tooling holes vs. the tooling pins governs the stackup uniformity. Every panel is unique in its imperfections. No matter the class, larger capture pads lead to more robust printed circuit boards.

It's harder to prevent things you can't see. Just like screen printing t-shirts, one color is easy whereas multiple colors (layers) increase the chances of misalignment. Thus, the solder mask openings benefit from expansion over the size of the copper pad, typically 50µm all around. The edge of the mask opening should then see another 75µm before any silkscreen is applied. Using a line width of zero for the silkscreen will make it harder to judge if the edge of the line avoids the edge of the mask opening.

Think of the layout as a digital twin of the fabricated board. Think of how small bits of a screen-printed t-shirt flake off in the wash. Avoid using a period or other tiny bits of punctuation. As silkscreen features get smaller, a circle becomes better than a cross as both become a little blob of ink at a certain point. Solder mask also has a minimum feature size before it becomes a sliver that will not adhere to the board.

Part of the DfM ethos is to keep prices down. In the bigger picture, cutting costs on a bare board only to have it fail in assembly, test or in the user's hands is sequentially worse. Size matters to most marketing teams; find the balance. Some boards may require laser printing, others may get away with no silkscreen at all.

The bare board is the foundation of the end-product. The product is only as good as the underlying printed circuit board. Making it producible is entirely in your hands. The penalty for failure can be severe in terms of the company's results. When someone asks for a feature that is not manufacturable, then it's up to you to speak for the fabricator. You're the advocate

for the board and that fits with the fact that it's your name at the top of the list in the title block. Own it.

JOHN BURKHERT JR. is a career PCB designer experienced in military, telecom, consumer hardware and, lately, the automotive industry. Originally, he was an RF specialist but is compelled to flip the bit now and then to fill the need for high-speed digital design. He enjoys playing bass and racing bikes when he's not writing about or performing PCB layout. His column is produced by Cadence Design Systems and runs monthly.

Affordable, Reliable Compliance

J-STD Storage of PCBs & MSD Components

DRY CABINET STORAGE

XDry humidity-controlled storage cabinets are self-contained, low-maintenance storage systems. There is no need for nitrogen or compressed air, just plug into the wall and they are ready to go! XDry storage cabinets satisfy standards such as IPC/JEDEC J-STD-033 and IPC/JEDEC J-STD-020. The cabinet environment can be maintained from ambient to 1% RH, providing constant & stable storage at precisely desired RH levels.

XDry cabinets are the ideal solution for printed circuit board and moisture-sensitive component storage.

HXD2-1106-01
Our largest heated dry cabinet

See us at APEX
Booth #2403

HXD1-703-02
Small footprint, but high capacity

XD1-302-02
Competitively Priced

Corporate Office
3407 County Road 427
Anna, Texas 75409 USA

Phone: 214.296.4868

www.XDry.com

sales@XDry.com

DESIGN **BEST PRACTICES**

FPGA/PCB Codesign

Optimizing multidomain integration in today's electronics.

THE INTEGRATION OF field-programmable gate arrays (FPGAs) and printed circuit boards (PCBs) has emerged as a transformative approach to electronics systems design, giving rise to a powerful synergy that enhances performance, flexibility and efficiency. FPGA/PCB codesign, the art of seamlessly combining the capabilities of FPGAs and PCBs, has become a cornerstone in the development of cutting-edge electronics systems. This month, we'll explore the significance of FPGA/PCB codesign, its principles, benefits and the role it plays in shaping the future of electronics.

Figure 1. FPGAs may be repurposed for different tasks and applications, leading to a more cost-effective overall system design.

Understanding FPGAs and PCBs. Before delving into the intricacies of FPGA/PCB codesign, it's essential to grasp the fundamental concepts of FPGAs and PCBs and how they work together.

FPGAs are semiconductor devices that offer a unique advantage in terms of reconfigurability. Unlike application-specific integrated circuits (ASICs), FPGAs can be programmed and reprogrammed to perform a wide range of tasks. This flexibility in regard to component physical packaging and capacity of logic makes FPGAs ideal for prototyping, rapid development and applications where adaptability is crucial.

On the other hand, PCBs are the backbone of electronics systems, providing a physical platform for connecting and supporting various electronic components. The type of material used along with the arrangement of the PCB stackup, signal traces, power/ground planes, vias and components on a circuit board determines the functionality and performance of the final product.

Principles of FPGA/PCB codesign. FPGA/PCB codesign is a holistic approach that involves seamlessly integrating FPGAs into the PCB design process. The primary objective is to optimize the interaction between the programmable logic of FPGAs and the physical layout of the PCB. A tightly integrated multidomain and multidiscipline collaboration between the FPGA engineer and PCB designer is the goal. This integration is achieved by considering the following key principles:

- **Communication and collaboration:** Effective communication and collaboration between the PCB designer and the FPGA engineer is paramount. The PCB designer focuses on the design layout to include the FPGA, while the FPGA engineer works on the embedded software that will run on the FPGA. This collaborative effort ensures that both aspects are optimized for performance and functionality.
- **System-level design:** Rather than treat the FPGA and PCB as separate entities,

adopt a system-level design approach. This involves considering the entire electronic system as a unified entity, addressing issues such as signal integrity, power distribution and thermal management at the system level.

- **Partitioning and mapping:** Enables optimization of FPGA pinouts so that connections are unraveled on the PCB. This reduces layer count/cost and improves performance. FPGA/PCB codesign involves partitioning the system functionality between the FPGA and PCB. Critical functions that benefit from the reconfigurability of FPGAs are implemented in the programmable logic, while other tasks are delegated to the fixed components on the PCB. This partitioning is crucial for achieving an optimal balance between flexibility and efficiency.

Benefits of FPGA/PCB codesign. Integration of FPGAs and PCBs offers a plethora of benefits that contribute to the overall improvement of electronics systems. Some key advantages include:

- **Performance optimization:** By leveraging the parallel processing capabilities of FPGAs, specific tasks can be offloaded from the main processor, significantly enhancing overall system performance. This is particularly beneficial for applications demanding high computational power, such as signal processing, image recognition and communication protocols.
- **Flexibility and adaptability:** FPGAs provide a level of flexibility unmatched by traditional fixed-function components. This adaptability enables quick iterations during the development phase and permits updates and modifications post-deployment, extending the lifespan of electronics systems.
- **Reduced time-to-market:** FPGA/PCB codesign facilitates a streamlined development process. The parallel development of hardware and software components permits faster prototyping and testing, ultimately reducing time-to-market. This agility is crucial in industries with rapidly changing requirements.
- **Cost-efficiency:** While FPGAs may have a higher upfront cost compared to fixed-function components, their versatility and reconfigurability often result in cost savings in the long run. The ability to repurpose FPGAs for different tasks and applications

can lead to a more cost-effective overall system design.

- **Enhanced system reliability:** Integration of FPGAs and PCBs enables the implementation of redundant features and fault-tolerant mechanisms. This contributes to increased system reliability, making it suitable for critical applications where downtime is not an option.

Challenges and considerations. While FPGA/PCB codesign offers numerous advantages, it also comes with challenges and considerations:

- **Complexity:** Integrating FPGAs into PCB design introduces additional complexity. Coordinating the hardware and software design processes requires careful planning and collaboration among specialized teams.
- **Power consumption:** FPGAs can be power-hungry devices, and optimizing power consumption is a critical consideration. Balancing performance requirements with power constraints is essential for efficient system design.
- **Cost of FPGAs:** FPGAs can be more expensive than traditional fixed-function components. Careful consideration must be given to the cost-benefit analysis to justify the use of FPGAs in a given application.
- **Security concerns:** The reconfigurability of FPGAs permits enhancing the security of a product by reconfiguring when a vulnerability is detected. Ensuring the integrity and authenticity of FPGA configurations is crucial, especially in applications where security is a primary concern.

FPGA/PCB codesign represents a paradigm shift in electronics system development, offering a potent combination of flexibility, performance, and efficiency. As technology continues to advance, the demand for sophisticated and adaptable electronics systems will only increase. The synergy between FPGAs and PCBs, when harnessed effectively through codesign principles, empowers engineers to push the boundaries of what is achievable in diverse industries ranging from communications to healthcare and aerospace. Embracing FPGA/PCB codesign is not just a technological choice; it is a strategic decision to stay at the forefront of innovation in the dynamic world of electronics.

STEPHEN CHAVEZ is a senior printed circuit engineer with three decades' experience. In his current role as a senior product marketing manager with Siemens EDA, his focus is on developing methodologies that assist customers in adopting a strategy for resilience and integrating the design-to-source Intelligence insights from Supplyframe into design for resilience. He is an IPC Certified Master Instructor Trainer (MIT) for PCB design, IPC CID+, and a Certified Printed Circuit Designer (CPCD). He is chairman of the Printed Circuit Engineering Association (PCEA); stephen.chavez@siemens.com.

Wednesday, June 5, 2024

Boxboro Regency Hotel & Conference Center, MA

HOT TOPICS

- Planning a New UHDI Facility
- New Materials for UHDI & Substrates
- Standards Updates for UHDI
- Making Surfaces Conductive for mSAP and SAP
- Ink-Jetting Conductive Inks
- New Build-up Films
- Direct Imaging of Sub 15µm Features

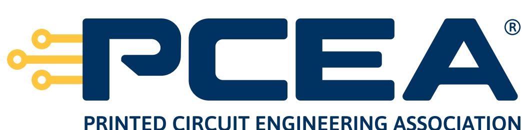
$295

- 9 Presentations
- Panel Discussion
- Lunch and Evening Reception
- Admittance to PCB East Exhibition

Forum chairman
Gene Weiner
(Weiner International Consulting)

Vice chairmen
Peter Bigelow
(FTG Circuits)
Alun Morgan
(Ventec and EIPC)

Brought to you by the PCEA and in conjunction with PCB East



pcbeast.com

Register by May 3rd and save $200!

Engineering *Tomorrow's* Electronics

REGISTER NOW!

CONFERENCE: June 4 - 7

EXHIBITION: Wednesday, June 5

Boxboro Regency Hotel & Conference Center, MA

HOT TOPICS

- Artificial Intelligence in Electronics
- Board Stackups
- Controlling Noise and EMI
- DDR5
- Design for Assembly
- Impedance Characterization
- Medical Wearable Device Compliance
- PCB Design
- SMT Equipment Validation
- Signal Integrity/Power Integrity
- Thermal Management

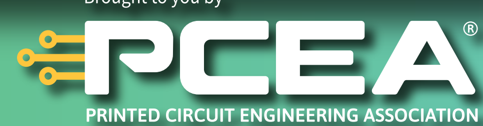
INDUSTRY EXPERTS

- Tomas Chester
- Rick Hartley
- Zachariah Peterson
- Susy Webb

FREE ONE-DAY EXHIBITION

- Leading industry vendors
- 7 free presentations + keynote
- Lunch on Exhibit Floor
- Reception sponsored by EMA Design Automation

Brought to you by



Engineering *Tomorrow's* Electronics

WHO'S EXHIBITING

Accurate Circuit Engineering
ACDi
All Flex Solutions
Allfavor Technology
AllSpice.io
Altair
Alternative Manufacturing Inc.
Amitron
APCT
Archer Circuits Company, Ltd.
ASC Sunstone Circuits
Bittele Electronics, Inc.
Cadence Design Systems
Cofactr
DownStream Technologies
Electronic Interconnect
Elsyca NV
EMA Design Automation
EMX US Inc.
Fine-Line Circuits Limited.
Fischer Technology Inc.
Freedom CAD Services, Inc.
GS Swiss PCB
Identco
Imagineering, Inc.
InfraTec infrared LLC
InstaDeep LTD
JBC Tools USA Inc.
Keysight Technologies
Millennium Circuits Limited
Newgrange Design
OKI Circuit Technology Co., Ltd.
PalPilot International Corp.
PCB Technologies USA
Polar Instruments, Inc.
Printed Circuit Board Association of American (PCBAA)
Printed Circuit Engineering Association (PCEA)
Quantic Ohmega / Ticer Technologies LLC
RBB
Screaming Circuits
Sourceability
Starteam Global
Summit Interconnect
Suntech Circuits Inc.
Surface Mount Technology Association (SMTA)
SVTronics, Inc.
Trilogy-Net Inc.
Trylene Inc.
Ventec International Group
Winonics
Winsource Electronics
XDry Corporation

PCBEAST.COM

Powering the IoT

Connecting the world will require a better energy solution.

THE EARLY STAGES of the IoT “hype curve” saw some wild predictions for the number of devices that would be deployed. They’re not looking so wild now, with 15 billion devices in 2020 and 29 billion expected by 2030. About 60% of these will be consumer devices, the remainder industrial, or IIoT, devices including smart meters and sensors for monitoring automation equipment, transportation infrastructures, and buildings like offices and factories.

Knowing that IPv6’s 128-bit address space would permit more than 100 IP addresses for each atom on the surface of the earth, we can see that the IoT could theoretically grow well beyond even the most ambitious predictions.

While we can solve many problems by adding more of these devices, we are creating another at the same time. Each one needs a source of energy to operate and the fact that many of them will be deployed in mobile or remote locations means a battery is the most obvious power source. Already, the US alone throws away about 3 billion batteries every year and our IoT habit could add many extra tons of hazardous waste. But there are some exciting alternatives.

None of the main battery technologies we use today is perfectly suited to IoT. Lead-acid batteries, although easily recycled and offering high performance thanks to low internal resistance, are large and heavy, typically unsuitable for use in tiny sensors. Alkaline batteries have a high self-discharge rate that limits their useful lifespan. And, while lithium-ion batteries offer greater energy density and longer lifetime, they are not easily recycled.

Arguably, waste is the greatest problem associated with using batteries to power IoT devices. Such massive deployments, and so geographically dispersed, means installing new batteries and recovering discharged units is simply impractical in most cases. Those chemicals and metals such as lithium will be left where they are deployed to decay into the environment. Even if we could recover the batteries, dealing with the waste properly will always be challenging.

Powering IoT devices from ambient energy sources can provide a perpetual supply that eliminates the replenishment and waste issues. There are issues here too, however. Photovoltaic cells have come a long way since the first solar-powered commercial wristwatches and calculators of the early 1970s. While their efficiency has increased and their cost has come down, integrating solar panels on small devices can be challenging and energy storage is needed to ensure continuity of supply in low light or poor weather conditions.

Alternatives like thermoelectric cells and kinetic generators that leverage electromagnetic induction also have shortcomings. Thermoelectric elements can generate relatively little power, while it's difficult to see kinetic generators being scaled down to a suitable size to power small IoT devices. Also, harvesting RF energy is known to provide enough energy to wake a small subsystem to retrieve and send back information stored in memory, such as authentication credentials or software version history. Again, relatively little energy is generated and a strong field is required, such as that from a reading device pointed directly at close range.

All of these are known to be effective in a suitable context and many applications are in action today. The search continues for a small, long-lasting, low/zero-waste energy source, however, to power the vast numbers of IoT devices we want to deploy in the future.

The FOXES project, by a consortium of European research institutions, has addressed some of the integration and storage issues associated with solar cells. Their Power Cube is a 3-D assembly that comprises a perovskite solar cell stacked on top of an energy-management circuit and multilayer thin-film capacitor for energy storage. With a surface area less than 1″ square, the research model can harvest about 260 millijoules per day, even in very low light conditions. To give an idea of how useful that is, the team says this is enough to power the

gas-sensing IoT node they're developing, which is intended to consume less than 50µW per readout.

On the other hand, research into microbe-derived energy could provide a great way to power smart farming. Northwestern University in the US has demonstrated a fuel cell that harvests energy from microbial action. This "dirt-powered" source is capable of operating small electrical loads such as moisture sensors and touch sensors – which could be used for monitoring animal movements – and is about the size of a paperback book.

While these concepts, theoretically, can supply energy forever, they may still be too big for the most size-constrained applications. Atomic batteries that harness energy from decaying radioactive isotopes could offer a solution. They can last several years or decades, depending on the materials used. The idea is over 100 years old, although the energy available has been considered impractically small. With the minuscule demands of today's tiny IoT sensors, perhaps it's time has come; a recent Chinese project demonstrated a 0.6″ x 0.6″ x 0.2″ cell capable of generating 100µW and lasting for 50 years. Alternatively, nuclear-waste batteries made with irradiated carbon recovered from nuclear reactors, encased inside synthetic diamond that absorbs the radiation to convert into usable electrical energy, can run for thousands of years. I like the circular aspect of this concept, reusing waste materials.

Right now, each of these potential solutions has its own associated problems. I have every faith that we can engineer our way to overcoming them. Some still need to be smaller, although we can now anticipate a singularity where a small enough source can handle a frugal enough load to allow a lifetime of battery-free, waste-free operation. It could pave the way for practical deployment of not tens of billions, but hundreds of trillions of IoT devices.

ALUN MORGAN is technology ambassador at Ventec International Group (ventec-group.com); alun.morgan@ventec-europe.com.

SAVE THE DATE!

Engineering *Tomorrow's* Electronics

CONFERENCE:
October 8 – 11

EXHIBITION:
Wednesday, October 9

Santa Clara Convention Center, CA

PCBWEST.COM

ROUGHLY **SPEAKING**

Getting Local

PCEA chapter meetings can be a great source of education and collaboration.

I AM EXCITED that my local PCEA chapter has gotten some traction and we are having regular meetings! After a couple years of false starts and hiccups, the Oregon/Pacific Northwest chapter got the spark and the ball rolling with members coming to connect and learn from each other. Which is exciting! I was able to reconnect with someone with whom I worked almost 20 years ago. He was attending from another country, but still views Portland as his "home area."

As our meeting progressed, we had a good educational segment and then an active discussion about topics to discuss next time. A question came up about a mechanical exchange format, and we just happened to have someone in the meeting who works for the company that manages that format! And if we didn't, I am sure we could have reached out to our separate networks of contacts to find an expert to talk with us about it. Meanwhile, additional topics of interest were shared, along with requests for recommendations on specific types of quality fabricators and assemblers. So add that to our list of people to invite and reach out to.

PCEA chapters meetings are great ways to network with other experts in the PCB industry and really dive into the core values of collaborating, educating and inspiring. With meetings that continue to embody these values, I know that we will all benefit.

PCB West and PCB East are great examples of crossroad events that bring together material suppliers, ECAD suppliers, fabricators, assemblers and designers to the same event to speak openly and work together on much larger, albeit less frequent, basis than your local chapter. I

lost count of the number of times I have turned to a designer and asked if they have talked with their fabricator, only to see them look dumbfounded that they hadn't, like they had thought it was illegal to do so. Sometimes multiple levels of separation exist between the fabricators and designers, these layers consisting of management, buyers, brokers, contract manufacturers, etc. Many times, designers and fabricators start a dialogue only after something has gone horribly wrong and the blame game has begun. Not a very welcoming environment if one is looking to ask about a new technology or how to do something unique! So environments where designers and fabricators can connect and collaborate are vital to advancing technologies, improving yields and reducing waste.

If your local chapter hasn't gotten off the ground yet, I encourage you to poke around. Organically getting a group together to talk about common interests and how to assist each other should be the target, so focus on finding compatible meeting times and schedule them in advance. For my local chapter, we seemed to get a lot more attendance when we shifted the meeting from after work to the lunch-time hour. Additionally, instead of focusing the meeting on the details of the organization, such as who would fill different titles or roles, we focused on providing value to our members. Collaborating, educating and inspiring each other to know more, be more and do more for each other and our industry.

If you can't tell, I am excited in a way that I was never excited about other industry meetings. We aren't necessarily bringing in world-renowned experts, although collectively we do know a few whom I am sure would be willing to talk with us for 20-30 minutes on a topic. Our focus is on bringing value to each other. As we all learn and have the opportunity to share our expertise and knowledge, our respective knowledge silos are opened and trust is built among ECAD, material suppliers, designers, fabricators and assemblers.

I have felt the excitement and connection possibilities at PCB West and PCB East. I hope my local chapter can continue to spark similar possibilities for those who don't have the opportunity to make it to those conferences. Likewise, I hope your local chapter is also engaging and expressing PCEA's core values to you. I want this to be an encouraging word for you, that we struggled in our local chapter for some time, but we finally found our footing.

To find your local chapter, visit pcea.net, or contact PCEA president Mike Buetow (mike@pcea.net) to learn how to start one. For more ideas about helping your local chapter, feel free to reach out to me at geoffrey@pcea.net.

GEOFFREY HAZELETT is a contributing editor to PCD&F/CIRCUITS ASSEMBLY. He is a technical sales specialist with more than 10 years' experience in software quality engineering and sales of signal integrity software. He has a bachelor's degree in electrical engineering; geoffrey@pcea.net.

CAD LIBRARIES

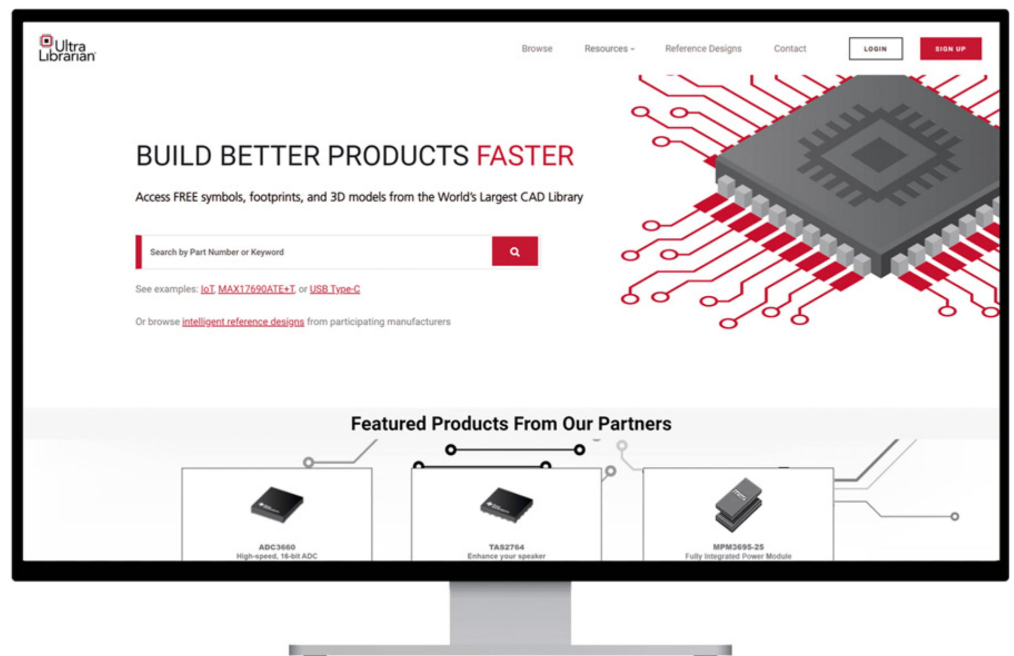
Creating the Ultra Library

Building and maintaining what's said to be the world's largest CAD database requires strong relationships.

by TYLER HANES

Keeping up with the increasing demand for new and specialized components is no easy task, but Ultra Librarian's team has proven up to the task – to the tune of more than 16 million components in its library and a quarter of a million unique downloads per month.

When we visited Ultra Librarian's office in Huntsville, AL, in early December, EMA Design Automation had just announced the library service's spinoff into a new ECAD-oriented company, Accelerated Designs, which was the original name of the company under its founder, Frank Frank, before it was acquired by EMA in 2016.



Ultra Librarian's parts database contains more than 16 million components.

Frank is still with the company today as chief architect, and oversees a team that specializes in the different aspects of maintaining its CAD library.

Ultra Librarian's employees add an average of around 35 parts per day to its library, but there are days in which the company builds hundreds of new parts, depending on the demand, Frank said.

UL has around 600 part templates that are used in the creation of new components, which significantly speeds the parts creation process as opposed to building each part from the ground up, he said.

Once built, components are stored in Ultra Librarian's database, which supports 25 different CAD tools, and the schematics and models of all parts are available for free download by users.

One of Ultra Librarian's advantages is its ability to build a "superset" of a part, which means compiling all the relevant information about a part that could be needed in any of the CAD tools, and then exporting only those data needed for a specific tool.

"Part of what that template does is it adds in data for, let's say PADS, that's special for PADS, but it doesn't have to add it into Altium because Altium can't use it," Frank said. "We've got a data structure that allows us to put together as much data as we can, so that when it comes out, it's as complete as it can be."

Part of the company's services is also its ability to add components and parts based on user demand. Ultra Librarian receives around 80 such requests per day – and usually fills them within 24 hours before reaching out to manufacturers to entice them to add the part to their library.

"We've got a pretty smooth process to get it to the manufacturer," Frank said.

Those manufacturers also have their own part libraries, and anyone looking up a part on Ultra Librarian's database can see if the part was built in-house by the UL staff or added by a manufacturer.

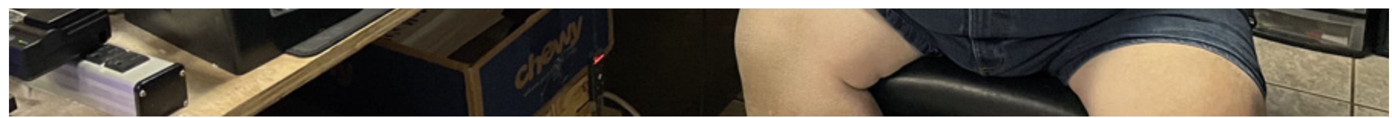
Ultra Librarian's data are stored in a vendor-neutral format, meaning that the company stores the relevant data from the many CAD tools it supports and prevents inconsistencies across the different CAD types. Most of its parts are also built using UL's desktop software, which also helps make sure components are consistent across the different tools. When appropriate, parts are built to the IPC-7351B standard, and symbols are built based on the ANSI Y32.2-1975 standard. The library also generates 3-D models, built to the STEP-file format, ISO 10303-21, of each part based on its footprint.

As EMA Design Automation is exclusive distributor of Cadence's OrCAD products in North America, the recent announcement of Ultra Librarian's spinoff into a CAD-agnostic company should permit it better to connect to other CAD users, Frank said.

"It will allow us to be viewed as more neutral," he said. "It will allow [EMA] to take some of the other products they have and sell them to more than just Cadence customers."

The key to Ultra Librarian's success has been its ability to maintain strong relations with manufacturers, and making sure those manufacturers' components are up to date in the library and available for users to find and use them.

"We have a good relationship with a lot of these people, and that's what makes everything work," he said. "The manufacturers definitely want their files spread out so people can design their parts with them."



Ultra Librarian chief architect Frank Frank credits the company's good relationships for its continued success.

AI-Based Modeling

To keep up with the increasing need for speed in developing CAD models, Ultra Librarian has developed an AI-driven engine that takes advantage of its experience in CAD modeling to drastically decrease the time needed for development.

The project started as a curiosity for Frank, who said he wanted to see if AI could be used to generate components, and has turned into a new service that will soon be available for users.

The model is designed to work by pulling information directly from datasheets provided by a manufacturer, which required training the AI tool to identify an order table, pin data and other needed information on its own.

The Ultra Librarian team has been training the AI model using the multitude of CAD models available in its database, and the tool has continued to improve its efficacy as it learns, Frank said.

"The goal is to take all the parts on the datasheets, rather than just the part that was requested, and take as much as that information as possible rather than us having to type or scrape it," he said.

After gathering that data, the AI tool is then able to build the part's footprint, with all its data, symbols and a 3-D model, for entry into the component database.

The company announced the AI modeling engine late last year, and previewed the technology for visitors at PCB West 2023.

Frank said the tool will soon be available as a free beta, and once it starts to hit its full

potential, it could cut the time needed for CAD modeling by as much as 20 to 30 times when compared to manually finding and inputting the data.

"I have a lot of confidence that we'll be able to get there," he said.

TYLER HANES is managing editor of PCDF/CIRCUITS ASSEMBLY; tyler@pcea.net.

ANNOUNCEMENT

PCE-EDU, the industry leading PCB designer and design engineer training and certification program, is now **PCEA Training!**

Developed by Mike Creeden, Steph Chavez, Gary Ferrari, Rick Hartley and Susy Webb, the 40-hour live curriculum includes a 400-page handbook containing information on everything from parts libraries to high-speed design.

pcea**training**.net

UPCOMING CLASSES:

April 5, 12, 19, 26 & May 3

June 14, 17, 21, 24 & 28

Optimized Materials to Deliver Ruggedized Electronics

A showcase of testing methods used in the development of robust materials.

by LENORA CLARK, MARTIN BUNCE, PAUL SALERNO and SASKIA HOGAN

Ruggedization means “to strengthen (something, such as a machine) for better resistance to wear, stress, and abuse.”[1] Automotive systems are built for aggressive environments and are categorized as ruggedized electronics. One usually thinks of an all-terrain vehicle navigating an uneven landscape in an extreme hot or extreme cold environment. The systems require more robust electronic hardware due to their unusual working conditions and environmental exposure.

Today’s automotive electronics, specifically those for advanced safety features, require ruggedization against traditional as well as additional self-inflicted abuse. The high level of processing required to execute “sense” and “respond” of multiple safety systems working in concert creates increased heat and increased mechanical strain leading to shorter characteristic life. Advanced IC substrate packages create challenges for the system as well. The need to combat these additional challenges requires specific ruggedization. This work will discuss material choices that were designed to combat temperature, vibration, heat, and various aggressive environments to offer extended system life.

The authors’ purpose is to showcase test methods used in the development of robust materials. The work will bring attention to automotive specifications such as IPC-6012DA[2] but will focus on the value of material specific testing to inform us on properties and enhancements on the path to system-level testing. Predicting the needs of many different

safety systems across the industry for a wide range of design criteria is impossible. The development work brings insight to the steps taken to create materials with wide operating windows that address a range of needs in the automotive space.

Materials for multiple levels of the electronics build are reviewed including printed circuit board (PCB) surface finish, solder paste alloys, assembly adhesives, and conformal coatings. Testing includes solder joint reliability, vibration exposure, surface insulation resistance, and exposure to condensing environments.

Two major trends are responsible for growth and performance changes in automotive electronics. They include the transition to an electric powertrain and the journey to autonomous vehicles. Both megatrends require more robust electronics. Electrification requires high-power electronics that can compensate for high temperatures. High-speed and high-processing power advanced safety also requires the ability to withstand temperature fluctuations and mechanical stresses connected to coefficient of thermal expansion (CTE) mismatch. Finally, consideration for aggressive environments including high temperature, dirt, dust, and even condensing environments has always been a necessity.

A widely used surface finish for high-reliability applications is electroless nickel/immersion gold (ENIG). End-users prefer this finish for extended shelf-life preassembly and its resistance to the environment in final application. Although known for its corrosion resistance, the chemical nature of plating gold on nickel requires corrosion to occur. It is an exchange reaction that happens when nickel is removed from the surface for gold to plate. A risk with this process is uncontrolled corrosion during plating that can lead to a defect called black pad or black line nickel. This shows itself only after assembly when a proper solder joint is not created, and the electrical connection can be compromised by a crack or complete fracture of that solder joint.

IPC-4552B defines cross-sectional analysis to understand corrosion of the nickel layer in advance of assembly.[3] It can save an assembler or end-user time and money by detecting a potential defect in advance of assembling expensive components. Our development team has used cross-section as well as gold stripping and scanning electron microscopy (SEM) analysis to characterize corrosion of the nickel in combination with gold plating. These methods help

determine which process and formulation adjustments can be made to achieve better resistance. Yet, all these methods focus on a spot location and do not always reveal the true performance of the finished PCB.

A more practical tool is ball shear testing. This solder joint reliability test can be executed faster and delivers tangible information on a larger scale when compared to cross-section or SEM. Analyzing shear force and the resultant failure mode delivers more realistic information about performance than a spot view of a corrosion spike.

For the evaluation of two ENIG processes, a test board containing an 84-count BGA design with solder mask-defined pads was used. The pad opening was 600µm. After ENIG plating, solder paste was printed, and solder spheres were placed using a small stencil on the ball grid array (BGA). After reflow, shear force was measured using a Xyztec Condor 70 tester at 0.35mm/sec. Parts were measured for shear force in Kg, then failure mode was analyzed optically. Only two failure modes resulted, die shear and die break. Die break **(Figure 1)**, the preferred failure mechanism, happens within the bulk solder. This indicates strong interface bonds. A die shear **(Figure 2)** failure mechanism indicates weak bond strength between the solder and pad finish.

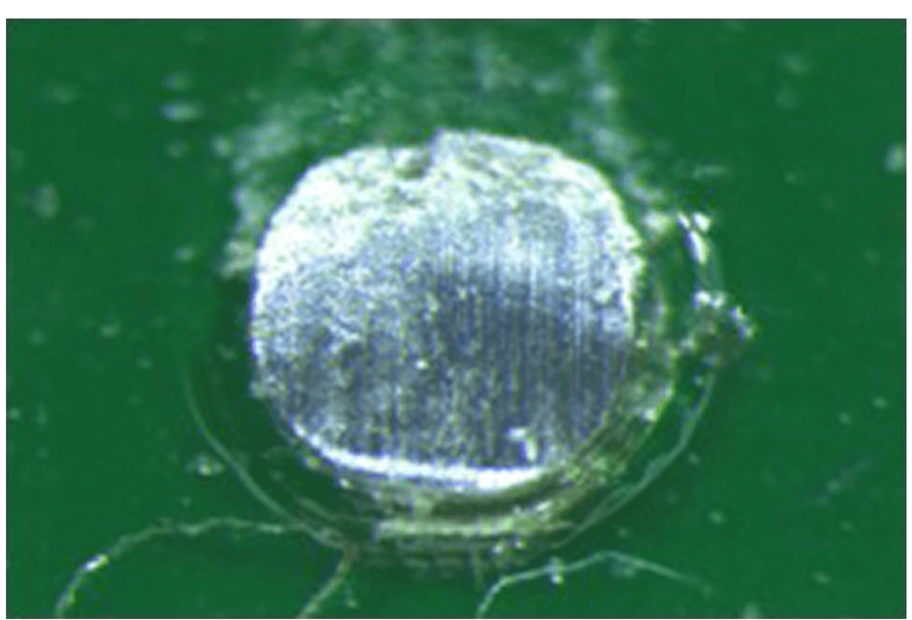


Figure 1. Die break is a failure which happens within the bulk solder.

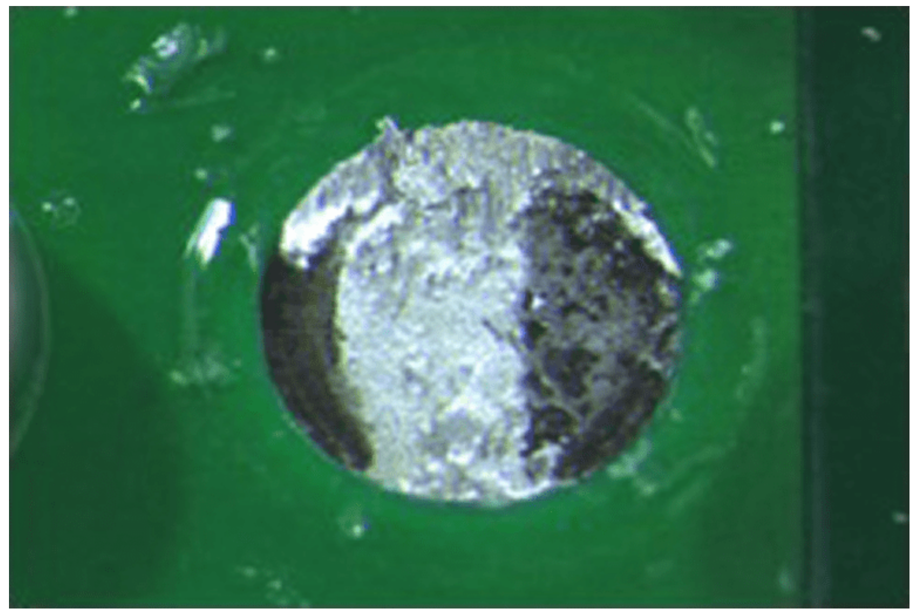


Figure 2. A die shear failure indicates weak bond strength between the solder and pad finish.

Two ENIG systems were tested to gain a deeper understanding of corrosion performance. A market-leading ENIG was tested against an optimized ENIG process. Both processes contain medium phosphorus electroless nickel plating systems. A textbook understanding of phosphorus ranges would put these systems between 5 and 9%. By optimizing the type and concentration of stabilizer in the electroless nickel bath, a process can deliver a more consistent phosphorus content throughout the bath life. This was the desire of the development team. By controlling the phosphorus content within a narrower window than convention, the bath would naturally eliminate swings in the corrosion created during plating. Eliminating swings in the phosphorus was expected to significantly reduce excessive corrosion and that result was in fact delivered.

Both ENIG systems passed the required shear force of 1.5Kg but the optimized ENIG process displayed a higher average force with lower standard deviation **(Figure 3)**. More importantly, the optimized ENIG only delivered die break failure modes **(Figure 4)**. No die shear failures were observed.

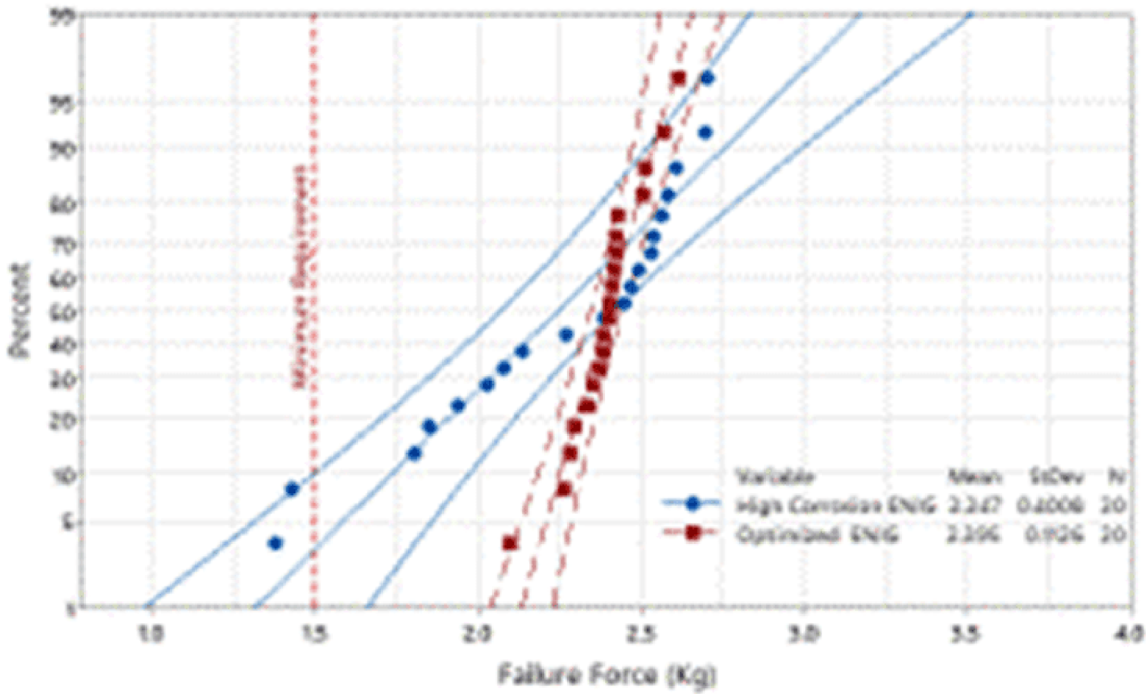


Figure 3. A Weibull plot of shear force in kilograms.

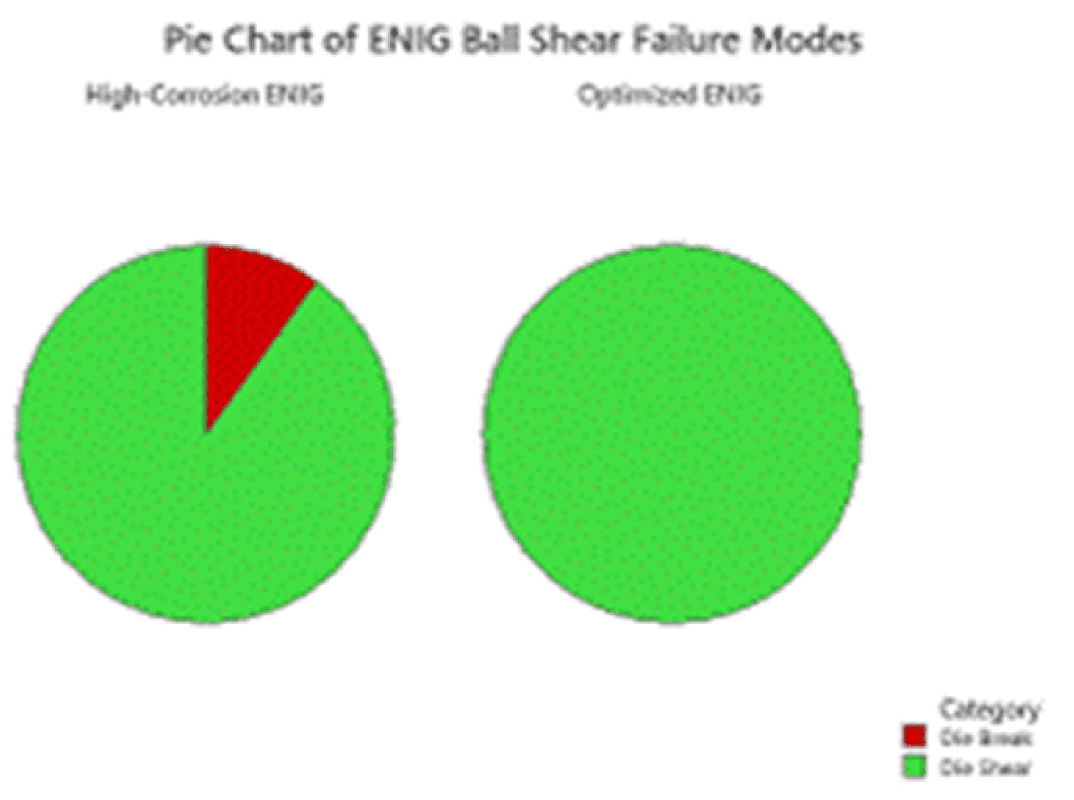


Figure 4. Ball shear failure modes.

A reliable surface finish is one of the first steps in delivering a successful system. The next in an electronics build is the solder joint reliability.

When evaluating solder paste alloys, mechanical resistance is an area of strong interest. In automotive applications, vibration resilience is important for system success. Most industry standards exist to test the full system but as a material supplier it is critical to test the paste alone in development on the path to understanding interactions in a system. The purpose of this experiment was to design a test regime suitable for differentiating the vibration performance of similar solder alloy formulations.

A 119mm^2 by 8mm-thick printed circuit board with 1oz. copper traces was designed for vibration testing. The thin, flexible, lightweight nature of the test vehicle permitted more movement during the test. All copper pads were solder mask-defined (SMD) to concentrate vibration stress at the solder meniscus/mask/board interface.

Three components were selected for analysis: PBGA256 dummies with 1mm pitch and SAC 305 spheres and two types of resistors, 1206 and 2010 **(Figure 5)**. PBGA256 were specifically selected for their relatively large body size, 17x17mm, to maximize potential deflection during vibration. Copper test points were added to isolate the failure site post-vibration. The 1206 resistors were added to deliver more typical board conditions where passives surround the BGA. This would permit a more comparable strain rate. They were also added to conduct shear testing. The 2010 resistors were used as visual indicators.[5]

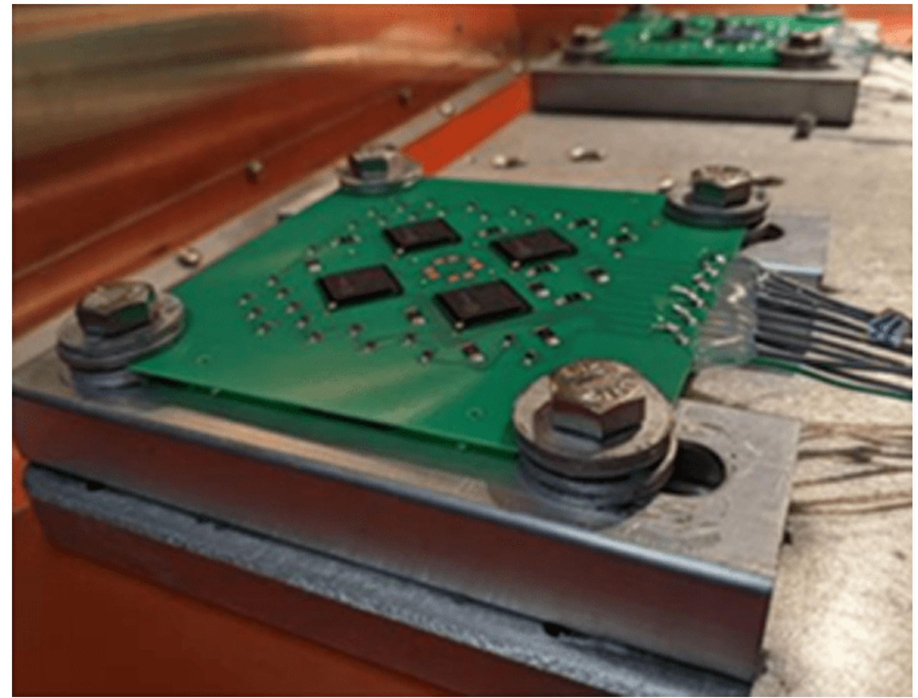


Figure 5. PBGA256 dummies with 1mm pitch and SAC 305 spheres and two types of resistors, 1206 and 2010, were used for analysis.

Paste was printed on the board with a 5-mil stencil and 500µm BGA apertures (40% area overprint). The final mixed solder joint is 2:3 paste to ball by volume. A no-clean flux was used for each of the three alloy pastes, and the boards were not cleaned before testing. The effect of flux residue on vibration resilience is assumed to be negligible.

Most vibration tests call for an electrodynamic shaker, but for this experiment a repetitive shock (RS) chamber was used. In a repetitive shock chamber, only the amplitude of vibration can be controlled, not its frequency profile. Most existing research and automotive standards use electrodynamic shakers, so any results taken from this experiment cannot be directly compared to the results of those tests. The random spectrum defined in ISO16750-3 was used as a target, it delivers a total of 18.4gRMS at frequencies ranging from 10Hz to 2kHz.[5]

The test was executed to compare three similar solder alloys; the traditional SAC alloy, Alloy A designed to achieve enhanced thermal cycle resistance, and Alloy B, a next-generation high-reliability alloy designed to improve mechanical performance. Alloy B is a SAC-based alloying solution with additions to improve strength and optimize microstructure to inhibit

crack propagation. Alloy B reflows at traditional SMT reflow profiles of approximately 245°C peak temperature.

This test also included the addition of a polymer reinforcement on the BGA packages. It was designed to understand the influence of an integrated solution and how that would affect system-level performance.

The Weibull plots indicate that Alloy B outperformed Alloy A and SAC 305 in vibration resilience **(Figure 6)**. By developing a solder paste focused test, fine differences in the solder alloys can be evaluated. The addition of the edge bond polymer reinforcement completely mitigated any failures, and we were unable to generate a Weibull plot for this condition.

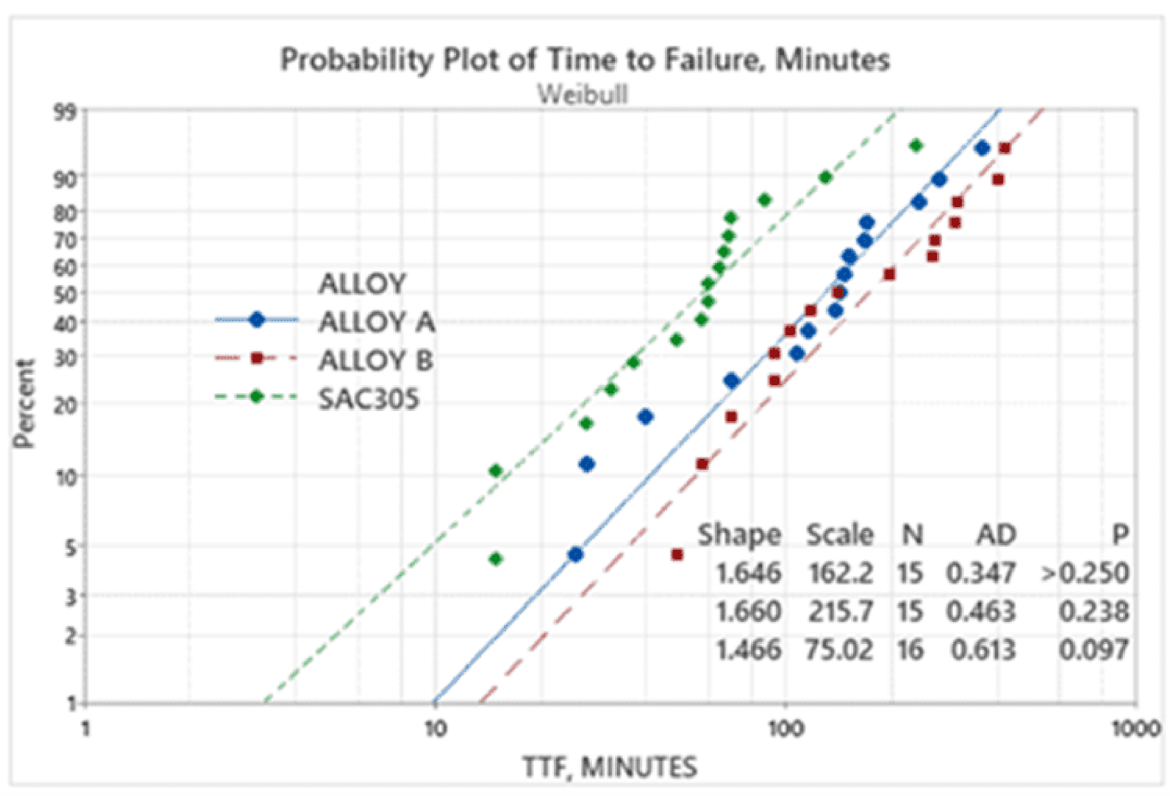


Figure 6. A Weibull plot of time to failure.

In the continuously changing landscape of advanced safety, automotive designers have quickly transitioned to advanced packages to achieve desired function. The use of BGA-style packages is changing the capabilities of vehicles today. They deliver huge advantages, but they are a significant concern for the industrialization teams at each automotive T1 and OEM. The use of enhanced reliability solder alloys has been widely adopted in the advanced safety

system space. As seen above, they improve vibration performance and a host of data support their resistance to thermal cycling.

Depending on package type, size, PCB layer count and build, in some instances a polymeric adhesive is the proper choice for a particular design. During temperature cycling the package moves differently than the circuit board, often flexing at the edges of the package. This is the result of a CTE mismatch. This puts more mechanical pressure on the outer solder spheres. It can result in fracturing of a sphere. To further support the package, a design may use a polymeric adhesive. Many designers resist use of an underfill because it is difficult to rework or has a negative impact on radio frequency properties. A great alternative is a corner or edge bond, which delivers structural rigidity without touching the solder spheres.[6] Pay attention to the potential chemical interactions of solder flux under the package and polymer adhesive. This is especially true for low-profile packages.

This particular test method offers further insight into interactions between the polymer adhesive and flux chemistry. In accordance with IPC J-STD-004A, B-24 comb patterns were printed with solder paste and reflowed in a BTU Pyramax 125N oven. Edge bond materials were printed over bare coupon as a control and over solder paste test coupons to deliver complete covering of the combs. Coupons were then cured in a convection oven as per the polymeric adhesive recommended procedure.

Coupons were conditioned during testing using an ESPEC temperature humidity chamber. To deliver more harsh conditions, the temperature was run at 85°C and 85%RH under a 50V bias. These conditions are normally more challenging for the edge bond materials. Surface insulation resistance (SIR) measurements were made using Gen3 AutoSIR or AutoSIR2 SIR dataloggers. To add complexity, the test was extended to 1000 hr., a significant increase over the IPC-J-STD-004A test of seven days, to represent typical automotive testing conditions and ensure any solder paste and polymer chemical interactions would be effectively evaluated. Also note, an internally developed test methodology was used to represent the environment of a low-standoff package.

Careful consideration should be made when selecting a polymer solution as an ineffective cure condition could lead to incompatibility with the solder paste flux chemistry, potentially

leading to electrochemical migration. Figures 7 and 8 show that the proper choice of materials will result in desired surface insulation resistance and no presence of dendritic growth.

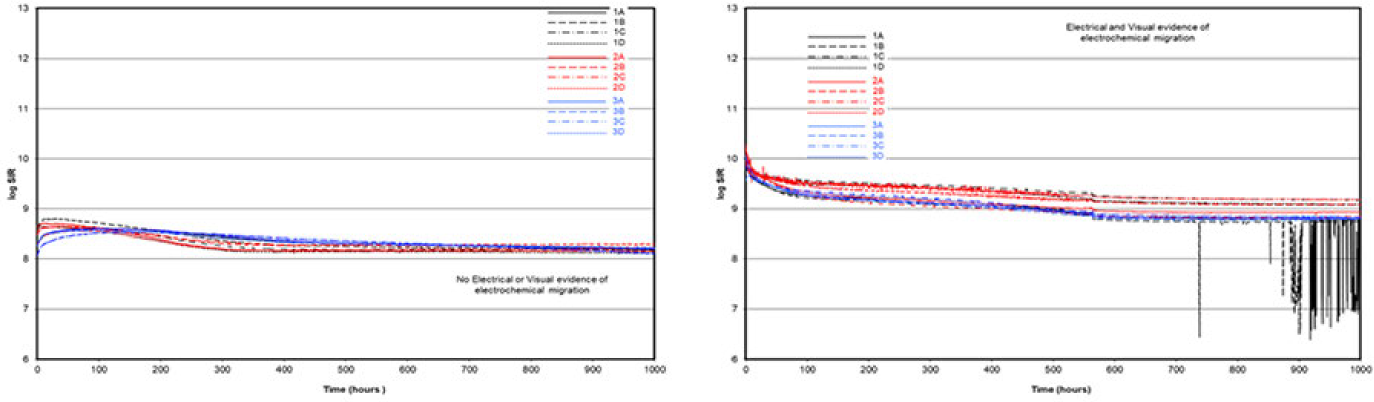


Figure 7. SIR data from testing.

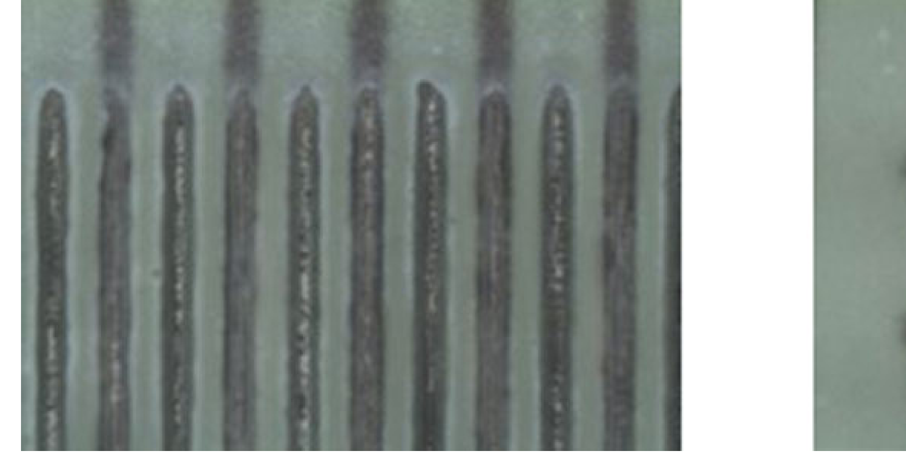


Figure 8. Optical observation of failure modes.

The review on ENIG and the solder paste alloys was designed to formulate improved materials. The above test informs on synergies or incompatibilities to educate assemblers on their process materials. It will save time and resources when trying to choose a polymeric material for advanced package assembly that works with an approved solder flux chemistry.

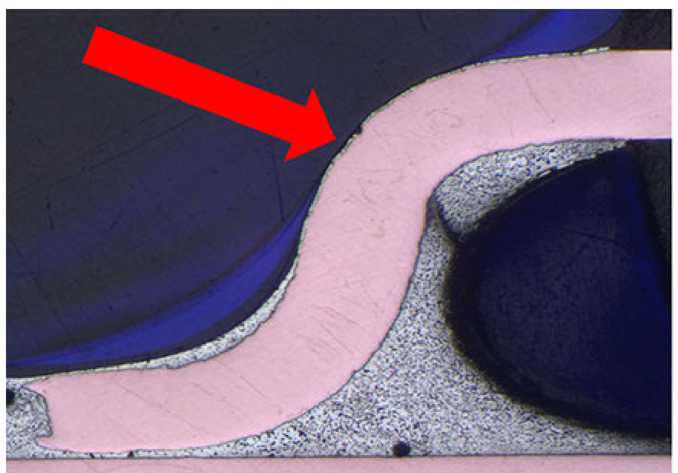
Finally, there are instances when the critical nature of electronics will not permit even the slightest chance of failure. In this instance, full protection of the assembled PCB from

condensation, particulate, and any foreign material may be required. In this instance a conformal coating would be used.

Most designers in any industry will tell you they do not use conformal coatings. Prismark Partners, however, estimates that conformal coatings was a $350 million market in 2021 and almost 50% of the segment is dedicated to the automotive industry.[7] This protective coating is designed to conform to the contours of the assembled board to deliver protection and extend product life.

In line with the previous test, high processing of advanced safety electronics for full autonomy generates exceptional amounts of heat. The possibility of localized condensation is a concern for many, especially under low profile packages. Also, these advanced processing packages need to deliver information quickly. They are fine-pitch components. A moisture barrier such as a conformal coat can prevent localized condensation from creating a pathway for electrochemical migration.

A well-known issue for conformal coatings called sharp edge coverage is its ability to cover device leads completely and reliably. Thin or missing coverage of solder joints and other metal surfaces make them susceptible to corrosion in a long-standing corrosive or condensing environment **(Figure 9)**. This issue was recently highlighted by the J-STD-001 Conformal Coating Material & Application Industry Assessment (5-22arr).



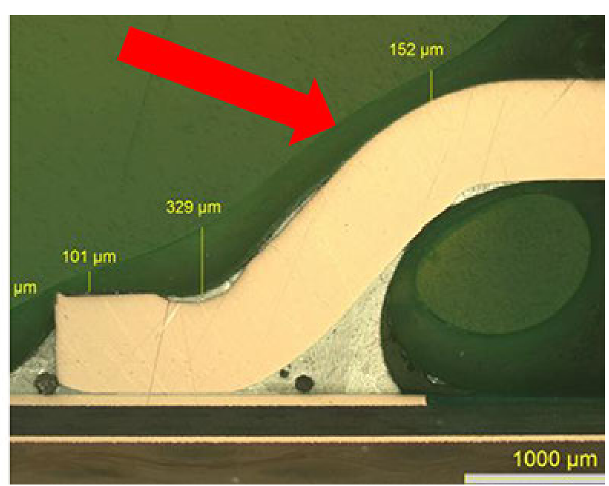
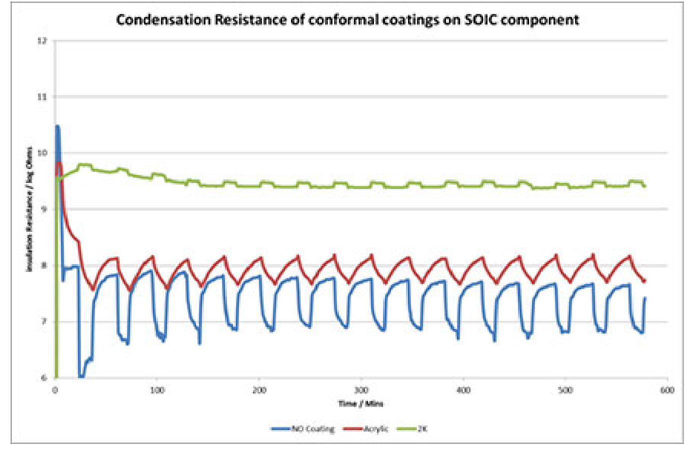


Figure 9. Sharp edge coverage (poor, left, and complete, right).

A new generation of 2K (two component) conformal coatings was developed to be applied thicker and to resist poor sharp edge coverage. It was designed to deliver greater moisture and thermal resistance than its acrylic counterparts which have limitations in the thickness they can achieve.

An internally designed test coupon for assessing conformal coating performance was used. It includes multiple package types; BGA, SOIC and a comb pattern. The boards were populated then coated with various test formulations. Solvent-based formulations were coated to a dry-film thickness of 50µm while the solvent-free material was coated to 30µm. All samples were cured at room temperature for seven days. To increase the intensity, this test ensures condensation representing a more aggressive test than humidity. It reveals performance information closer to immersion. Samples were tested using an AutoSIR2+ climatic chamber at 40°C (104°F)/93%RH under 50V bias for 10 hr. Parts were cooled to 36°C (97°F) and heated up to 40°C (104°F), using a 20 min. cycle time.

Optical analysis of the SOICs showed that the uncoated control and acrylic-coated parts revealed high variations in insulation **(Figure 10)**. Both the uncoated board and acrylic-coated board fell below the required resistance of $1×10^8Ω$. This was observed when the temperature dropped below the dew point and water droplets formed on the board. The 2K material displayed better condensation protection and kept a consistent resistance during the cycle testing. It was able to remain well above the required $1×10^8Ω$.



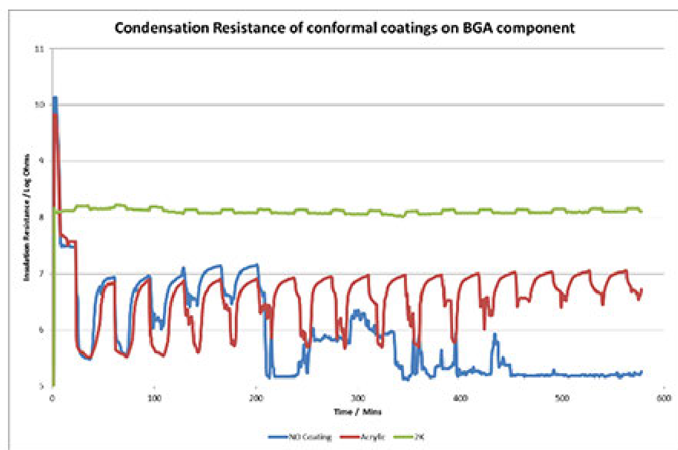


Figure 10. Insulation resistance charts.

Analysis of the BGA packages reveals a different scenario based on the package shape and low profile. During this intensity of testing, water can get under the BGA but will not dry or fully evaporate with time. That potential became clear and showed itself for the uncoated board. The moisture caused it to fail; resistance was completely lost. The acrylic coating resulted in improved protection but did not achieve the desired result.

This is a very harsh test for a solvent-based coating compared to traditional humidity testing. Again, the 2K material showed good protection above the required $1\times10^{8}\Omega$ with minimal changes during each cycle throughout the testing time.

Conclusions

The necessity to create more robust electronics specifically in the automotive space stems from the harsh working conditions of a vehicle, but present designs created for advanced safety and connectivity create an additional challenge caused by high processing. Careful consideration should be taken for all material inputs during the design phase to ensure system-level reliability is achieved for ruggedized electronic devices. Understanding performance criteria and design is critical for success. Chemical and material suppliers need to take a different view of reliability testing to qualify materials in their individual state. Learning from this testing informs us on formulation and process changes that will offer end users a wider operating window with improved performance.

In some instances, it is necessary to break from an industry standard for additional information or to find finer differences. By developing in this way, we not only deliver better products but can also make informed recommendations for specific builds.

It is important to seek enhanced materials in this ever-changing automotive segment.

Ed.: This article was originally published in the proceedings of the SMTA Electronics in Harsh Environments Conference 2023 and is republished here with permission of the authors.

REFERENCES

1. Merriam-Webster Dictionary.

2. IPC-6012DA, "Automotive Applications Addendum to IPC-6012D Qualification and Performance Specification for Rigid Printed Boards," December 2018.

3. IPC-4552, "Specification for Electroless Nickel/ Immersion Gold (ENIG) Plating for Printed Circuit Boards," August 2017.

4. JEDEC JESD22-B117B, "Solder Ball Shear," September 2020.

5. Fox, Kennedy, et. al., "Highly Accelerated Vibration Testing for the Evaluation of Solder Alloys in Automotive Applications." IPC Apex, January 2023.

6. Jimmy Shu, "Edge Bonding AS Viable Reinforcement for Solder Joints in High Reliability Applications," SMTA International, November 2021.

7. Prismark Partners LLC.

8. Thomas Koschmieder, Ph.D., "Board-Level Reliability Test Method and the Automotive Electronics Council," SMTA International Oct. 31-Nov. 2, 2022.

9. F. Kraemer, K. Meier and S. Wiese, "The Influence of Strain-Rate Dependent Solder Material Models on the Interconnection Stress of BGA Components in JEDEC Drop Test," 4th Electronic System-Integration Technology Conference, September 2012.

LENORA CLARK is director of Autonomous Driving and Safety at MacDermid Alpha Electronics Solutions (macdermidalpha.com); lenora.clark@macdermidalpha.com; **PAUL SALERNO** is director of SMT & Preforms Circuit Board Assembly; **MARTIN BUNCE** is director of Final Finishes Circuitry Solutions; and **SASKIA HOGAN** is global product manager of Conformal Coatings

Stay connected to top **PCB Leaders** with PCU

printedcircuituniversity.com

It's like having a second brain.

PRINTED CIRCUIT UNIVERSITY

Online courses and webinars for the printed circuit engineering community.

SOLDERING

Low-Temperature Solder: Challenges, Opportunities and Considerations

An exploration of the factors affecting the development and growth of low-temperature soldering.

by TIMOTHY O'NEILL

Low-temperature soldering (LTS) is a rapidly developing field with several potential benefits to the electronics industry. These benefits include reduced warping of components and substrates, lower energy consumption and reduced material costs. The lack of a standard solder alloy and the unique properties of emerging alloys, however, require development of new fluxes and processes for success.

Herein we explore current challenges and opportunities in low-temperature soldering, including the limited availability of low-temperature alloys, the disadvantages of high-bismuth alloys, the impact of additive elements on alloy properties, the need for new flux systems and the importance of seeking guidance from solder suppliers.

What is Low-Temperature Soldering?

No formal definition exists for "low-temperature" solder, but it generally refers to alloys with peak reflow temperatures lower than those of traditional SAC 305 and its variants. Whereas SAC 305 has a peak reflow temperature window of 230° to 255°C, these alloys typically have peak reflow requirements of 190°C or lower, with SnBi-based materials having peak reflow requirements of 170° to 190°C.

While there are currently no standard solder alloys for LTS, the most common ones contain bismuth. This is because other candidate elements that might contribute to lower melting points when alloyed with tin – such as cadmium, gallium and indium – are either toxic or significantly more expensive.

What are the Advantages and Applications of LTS?

A primary application of low-temperature soldering is in surface mount technology (SMT) for assembling electronics devices. One of the challenges of SMT is the risk of warping, which can occur when components are exposed to high temperatures during the soldering process. Low-temperature soldering can help mitigate this risk and improve the reliability of the interconnects.

A more complete list of low-temperature soldering benefits include:

- **Reduced warping:** Lower temperatures reduce component and substrate warping during assembly, which in turn reduces the risk of non-wet open (NWO) defects and improves product reliability.
- **Reduced material costs:** By using lower temperature solders, manufacturers can incorporate lower-cost plastics and other materials, reducing overall costs.
- **Enhanced design flexibility:** Low-temperature solders enable greater design flexibility, as thinner and smaller components can be used without the risk of warping during assembly.
- **Reduced environmental impact:** Low-temperature soldering results in reduced energy consumption and related environmental benefits, making it a more sustainable option.
- **Lower processing costs:** Low-temperature solders can be less expensive to process than high-temperature solders because they require less energy.

These potential benefits make low-temperature soldering a promising area for future

innovation and growth. Consumer and disposable applications are likely to be early adopters due to cost advantages. Other industries, however, will need to carefully consider the available options, the risk/reward equation and the resources required to develop a viable low-temperature assembly process.

What are Current Challenges in LTS?

Despite the potential benefits of low-temperature soldering, several challenges must be overcome to successfully implement these materials. Some of the key challenges include:

Limited availability and lack of a standard. Currently, few options are available for low-temperature solders, with SnBi alloys being the main option. SnBi alloys have several disadvantages compared to SAC-based materials, however, including poorer mechanical and thermal fatigue performance. This could limit their use in certain applications and industries.

Adding trace elements and additives can improve performance and is often done to meet the requirements of a particular application. But with so many input variables, constituent elements, additive elements, and their amount and effect on solder alloy performance, a single low-temperature alloy is unlikely to meet all or even most application requirements. As a result, a “standard” has yet to emerge for LTS.

Disadvantages of high-bismuth alloys. High-bismuth alloys exhibit brittleness, which can impact process capability and product reliability. Increasing the ratio of tin to bismuth can reduce brittleness, but increases the pasty range, making good soldering potentially difficult to achieve.

While additive elements, such as silver, copper, antimony and nickel, can improve the mechanical and thermal performance of bismuth alloys, these elements can also impact alloy ductility, melting temperature and processing characteristics. It can be challenging to strike a balance between alloy performance and manufacturability.

Need for new flux systems. The unique properties of bismuth-bearing alloys require the development of entirely new flux systems to ensure successful soldering. The effects of

surface finish, component tinning and other soldered surfaces on these flux systems are yet to be clearly defined. These challenges highlight the need for continued research and development.

Solder suppliers can provide valuable insights into the available options and help manufacturers choose the right solder alloy for their specific application.

Solder suppliers can also provide guidance on the development of a viable low-temperature assembly process, including selection of the right flux system, optimization of process parameters and identification of potential risks and challenges.

Working with a reputable solder supplier can also help manufacturers stay up to date on the latest developments in low-temperature soldering and take advantage of new innovations and advancements in the field. By staying ahead of the curve, manufacturers can remain competitive and ensure that their products are optimized for performance and reliability.

TIMOTHY O'NEILL is director of product management at AIM Solder (aimsolder.com); toneill@aimsolder.com

The 2024 IEEE 74th Electronic Components and Technology Conference

ECTC

May 28 -31 • Gaylord Rockies Resort & Convention Center, Denver, CO, USA

Don't Miss Out on the Industry's Premier Event!
The only event that encompasses the diverse world of integrated systems packaging.

350+ TECHNICAL PAPERS COVERING:

Advanced Packaging Design, Processes, Reliability, Modelling
Hybrid Bonding & Advanced Interconnect
Fan-Out Wafer Level & Panel Level
Additive Manufacturing
Optics and Photonics Packaging
Quantum and AI Systems
High-Density 3D & Substrates
Heterogeneous Integration
Chiplets
High-Power & Thermal Management
Flip Chip, Die Bond, Chip Scale
Flexible & Wearable
RF Components, Antennas
Harsh Environment Reliability and Automotive

HIGHLIGHTS

- 41 technical sessions with a total number of 350+ technical papers including:
  - 5 interactive sessions including one student session
- 9 special invited sessions
- 16 CEU-approved Professional Development Courses
- Multiple opportunities for networking
- Technology Corner Exhibits, showcasing industry-leading product and service companies from around the world
- Various sponsorship opportunities for your company's visibility
- ECTC Gala and evening receptions

Sponsored by

For more information visit www.ECTC.net

EMERGING TECHNOLOGIES

Can Artificial Intelligence Solve Manufacturing Problems?

Why Andrew Scheuermann thinks AI will be the assistant every engineer has needed.

by MIKE BUETOW

We in electronics design and manufacturing know automation is part and parcel of what we do, but while the landscape has changed, be it the transition from mechanical drawings to CAD tools with their autorouters or from manual and semiautomatic printers and placement machines to lights-out factories where cobots have replaced operators, the industry still has a long, long way to go.

To help with perspective on this emerging technology, we interviewed Andrew Scheuermann in February. Scheuermann, along with his business partner, Tim Burke, is cofounder and CEO of Arch Systems, a Silicon Valley-based developer of software tools that collect raw machine data and use predictive and analytics to calculate manufacturing key performance indicators or KPIs.

Scheuermann has published numerous scientific papers in the areas of semiconductors, electronics manufacturing, and renewable energy. He has a Ph.D. in materials science from Stanford and is also part of StartX, a startup accelerator for company founders who are affiliated with Stanford and that has invested over $200 million in various crump companies including 13 that are now valued at over $1 billion.

The interview, which took place on the PCB Chat podcast, is edited here for length and

clarity.

Mike Buetow: In practical terms, how do you respond when someone asks what AI means when it comes to manufacturing?

Andrew Scheuermann: Ah, the ultimate question. It's so hard to say what it is, because there is not a clear definition. AI in manufacturing is doing something in the factories that only humans could do before. The reality is that it's kind of this moving line, and manufacturing has always been this area where people have been pro-automation, pro-improvement, Lean manufacturing. Of course we're continually improving. We're not going to solve the problems of yesterday; we're going to solve the problems of tomorrow.

Arch Systems CEO Andrew Scheuermann says new language AIs can translate thought for thought.

I think it's hard to say "what's AI in manufacturing?" because it's actually a moving target. Being a little more specific, I think AI is using data and algorithms to guide people to improve manufacturing, and again, do it in a way that humans alone could not do it before.

MB: We find new technology innovations solving problems of today, but also sometimes presenting problems that were unforeseen and introducing ones that didn't exist. I want to keep that in the back of our minds as we proceed. But first, how would you describe the current status of implementation?

AS: I like to break things up in use cases in manufacturing and think about where is AI as it relates to vision systems, where is AI as it relates to KPIs like predictive maintenance, where is AI as it relates to quality.

For the last question we were talking about how it's a moving line. Let's take AI as it relates

to vision and inspection. That's a big area in manufacturing. There was a time when it's, "Oh, this computer can identify this is a red apple or this is a green apple," and it's like, "Oh my gosh! That's AI." The conversation today is when people try to figure out what's the state of implementation in computer vision. Is it rules-based, or is it AI-based? And what they mean by AI is not the rules that I currently understand, like "red and green" or "I detect which color it is and I just say it." That's super easy. Even: Is the chip here or is the chip not here? Well, that can be rules-based. "I know it's supposed to be exactly in this spot, and I don't see a chip; that's a rules base, that's not AI." But AI is really generating a new set of more complex rules.

For example, in computer vision, the state of implementation that I hear everybody talking about now is a use case like the prior rules-based computer vision. It was able to do a decent job of detecting issues, for example, on the PCBA line, and it would send the ones that it wasn't sure about to a review room where there's a human who's looking at the picture and going, "Yup, chip is missing. Oh no, actually chip is there. No fault found." And now it's, "OK, what if we don't need a human to do that step because the algorithm is more accurate?" It can detect even without being told exactly where a chip is. It can do unsupervised things. That's an example of where the state of implementation is. We know how to say if something's red or green. We know how to say if a chip is here or not here if we're expecting the position. But now we're starting to be able to take images of boards and things that change more often. We don't necessarily have the design data and kind of just detect anomalies like it's different from the last image that went through.

What about maintenance? Predictive maintenance is getting really exciting in a number of areas. Now that we can pull process data out of the machine. We can get all the error codes. We can get pressures, temperatures, current signals. We can take that data and stream it in a way that we were already doing an SPC tools for quality. We were already looking at a signal and saying, "The resistance is too high or too low on this board. You need to rework it." But now we can look at that same kind of flowing data from, say, the pick-and-place so the solder printer and the selective solder and other things and we can predict a maintenance problem by the parameter getting out of control. Again, that's kind of the state of the implementation using error codes and parameters and predicting that things are out of bounds. We like to think about things on a per use case basis and what is that leading edge of using data and algorithms to predict things and guide better actions in the factory – at Arch we call them

"intelligent actions" – that in the past could only be done by humans.

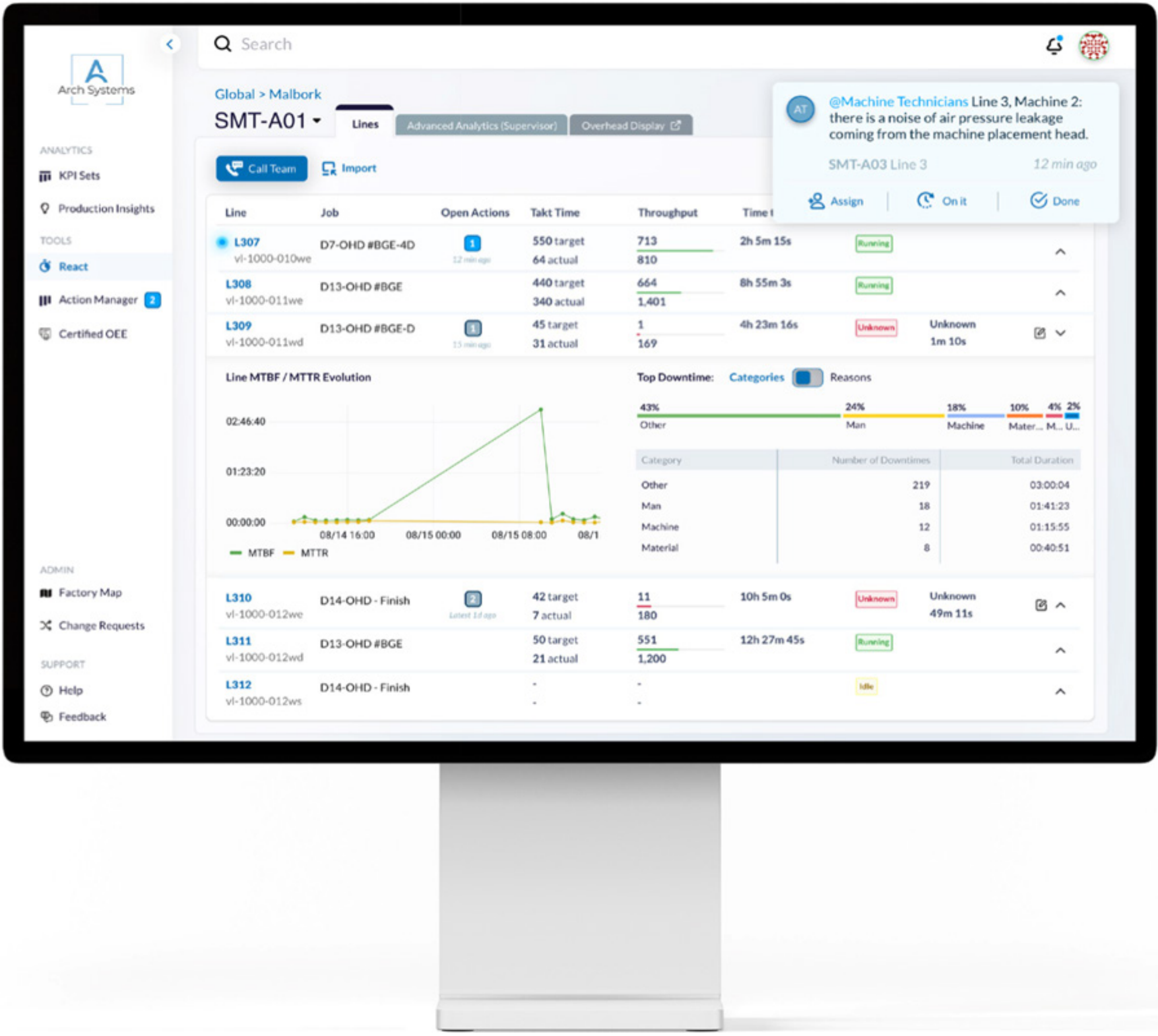
MB: What you've described sounds to me like a very linear, almost orderly process of implementation. I think one of the big questions on many engineers' minds is the issue of what I would call "impact versus replace." I want to stay away from the ethical questions of AI because that could be an interview in its own right and in any case, it's not something that those of us in the trenches of our industry will have much influence over. But my question is, should we view AI as "just another form of automation?"

AS: I would not. I look at it as something new. It is correct to say it is a *form* of automation. But I think "just" another form of automation is simplifying, because it often automates things that weren't necessarily being done that way before.

That's something we talk about at Arch. It's like, "Oh, right now the human picks up a part and it puts it here. Oh, now a robot can do that." Okay, that's automating a job that was being done before, but was I doing predictive maintenance before? Not necessarily; I didn't know when it was going to fail so I wasn't even doing that like could I have done that. Well, what if a human went and manually downloaded all the data or they could have every sensor machine has a log file or something somewhere? What if they had manually grabbed all of that, thrown it into a spreadsheet, crunched some math, and then by the time they did it, it's like, "Oh, the machine's already failed. I ran out of time to do my math." There are these complex problems that weren't actually being done before. We're automating what in your mind a person could have done but were they actually doing it? Yeah, maybe they didn't possibly have time to predict that.

Back to the computer vision example, that is a case where potentially there is a human being replaced and so people are calling that use case "automation," and that makes a little more sense because there's a person in the control room and [now] maybe there won't be a person in the control room. There used to be a person at the cashier register to check out your goods and there's not anymore. That makes sense to call it automation. But things like predictive maintenance, predictive quality … a lot of things that go in predictive analytics are adding new capabilities that we didn't have time to do as a human, even if it was theoretically

possible.



AI engines can process billions of manufacturing data points per day and reveal not just trends but offer predictive assistance.

MB: Neil Thompson, who is the director of the future tech research project at MIT's Computer Science and Artificial Intelligence Laboratory, has argued that it's not enough for AI systems to be good at tasks now performed by people, but the system must be good enough to justify the cost of installing it and redesigning the way the job is done. He says, "there are a lot of places where humans are a more cost-efficient way" to do that. Would you agree?

AS: Absolutely, yeah, I strongly agree. And I think that's kind of like a low bar for AI. Let's look for the little problem a human is doing and replace it, like the example I gave with predictive maintenance. Some of the stuff we like to do at Arch, it's not solving a problem

that doesn't exist, but it's solving a problem that does exist that people just don't have any idea how to solve, such as people aren't doing it because they can't possibly run to all these machines, grab the data, put it together, and have predicted this thing before the defect was already there or before the machine went down. That's extremely exciting.

Are there things that humans are still better at than machines? Absolutely. I'm a complete believer in that. I think that's one of the exciting things about some of the newest AI, like the large language models, ChatGPT, that everyone's been using. It really is good as a copilot and it's being built into tools like ours and others where it's directly pairing with people.

It's not like, hey, we're not even going to talk anymore. We don't have the AI talk for us. It's, no, we're going to talk *to* the AI to better understand the data. Because Arch was already pulling data from all these machines you didn't have time for into a predictive maintenance. But then you still had to go through our interface and find it or you had to know the right dashboard or you had to get training on that dashboard. What if now you can just talk to it and it takes you right to the dashboard or explains it for you? Everybody can have an assistant now. That's one of the really exciting parts of this most recent wave of AI and it has everything to do with amplifying people.

MB: For an engineer, a designer, an operator, what skills are needed now and for the next generation to fully realize the potential of AI?

AS: Back to that last thing I said, that AI is kind of becoming an assistant for everyone. In the past this was something that maybe only really rich people have. If you're just super rich, someone's doing your calendar and helping with your kids and helping run your business and getting your food, whatever it is. Now more and more with AI, each of us can have an assistant, so a factory engineer can have an assistant, a factory operator can have an assistant. The GM already had assistants, but they have even more assistants. So that's the first thing I would say when you think about what skills do you need.

How do you use an assistant? Well, it's actually a hard thing to do if you've never practiced it. I don't know how to delegate. I don't know how to share my work with someone who's healthy. I don't know how to ask the right question. So that "ask the right question" is called

prompting with the new language models, for example, and before language models it was, I need to know how to click on the right dashboard and even get the right data, so both knowing how to navigate through web browsers, how to Google search, how to do a basic Boolean argument and now how to prompt, which in in a way is even easier because you prompt an LLM [large language model] just like you talk, but there still is a bit of an art to it. There's a good way to prompt and a bad way to prompt. So those are the kinds of skills that are becoming even more important.

MB: It sounds like one of the skills that people will need may be precise communication skills, at least to start.

AS: Exactly. Precise communication skills. Imagine an operations manager and engineer and factory and version 1 of the person can't articulate the problem at all. The only technology they could use is a big red button that says, "Help me." And now the AI on the other side has to be as smart as possible. They click the button and I have no idea what's going on here. I can't see anything, can give no notes. No description. No pictures, just Help Me, and technology vendors like us, we want to build something that powerful so you could literally just do that. But if you think about the skilled side, what about the person who could precisely describe what's happening? So yeah, there's a bunch of data going on and they know how to grab this dashboard, that dashboard, because again, these AIs are always improving. They look at two pieces of information and they're like, "I think I have a problem at the printer and I saw this before here. Can you help me? What did we do last week when we had a problem with the printer?" And all of a sudden they're going to get way more out of that technology than the person that's just "Help me" and hits a button. So exactly, being able to describe your problem, know how to use your tools, and then kind of meet AI right at the interface.

MB: It sounds to me like AI really kind of replaces your Google search or what have you, because it's so much more comprehensive. Google can give you an answer to a question. AI can develop a whole strategy. Is that a fair way to put it?

AS: Yeah, I think that was said well.

MB: Let's look to the near future. Joseph Fuller is a professor at Harvard Business School where he studies the future of work. Fuller said that the latest AI innovations will have dramatic impacts in some areas related to our industry but not so much in others. Let me give you an example. He thinks generative AI is already so good at creating computer software that it will reduce the demand for human programmers. It's relatively easy to teach an AI how to write software; just feed it a lot of examples created by humans. But teaching an AI how to manufacture a complex object is far more difficult. What Fuller says is, "I can't unleash it on some database on the accuracy of manufacturing processes. There is no such data, so I have nothing to train it on." Given that, where do you think AI will be in electronics manufacturing three to five years from now?

AS: He says AI is extremely good at programming. I agree. It's amazingly good. I love programming with AI. I'll never program without AI myself. It upped my level overnight when I could talk to it. Back in school I studied material science, but I did some computer science too, and in the courses at Stanford, we would do peer programming because when you program with a peer you do everything better, so that kind of copilot like it is a perfect marriage with coding. So that part's exactly right.

His second comment – this isn't going to work in the factory because there's no data – well, I'm going to agree and disagree. I'll do the disagree first. There's a lot of data. Arch, we're still in the grand scheme of things a really small company. We process more than a billion data points today from 150 to 200-some factories of 10,000 simultaneously connected machines and systems that feed our systems all the time. There's a tremendous amount of data in manufacturing now. Where I agree with him is the nature of the data and manufacturing, it has to be split into these pieces because this is the data specific to how I make this, for instance, iPhone circuit board, and this is for this engine control unit, and this is for a missile, etc. All the different products that we're building are reasonably different and I think more different than just like another piece of code.

A lot of people have talked about how these language AIs can go all the way through high school and even a little bit into college and they can pass the SATs and they can pass all these standardized tests extremely well. They're good at general knowledge because there's so much

of that digitized out there on the internet, you feed it in and they can regurgitate it amazingly well and even build new creative combinations of existing knowledge. But if you go to manufacturing: Okay, how do I build this product that I have right now? How many copies of the data for that exact product exist out there? Nothing at all compared to the data to solve a vocabulary quiz, and so again, this is where I'm going to agree and disagree.

So I disagree that there is no data. There's a massive amount of data. But is there a ton of repeat data on exactly the same products and problems? No. What we have to do in manufacturing is combine these generic AIs that are being built with the specific data of each manufacturer's problem, which needs to be kept private and secure only to them, so they can combine these things in a controlled environment and then they can get the best use of AI combining general AI and their specific data for their problems.

MB: In SMT we look at outputs and variations of the product being built but this is really where Arch comes in. You can mine all sorts of data that in some cases manufacturers probably don't even know they have. For instance, I watched one of your YouTube clips and you talk about the motor voltage and movements of a given machine, even if it's a so-called dumb machine. It begs the question though, how are companies going to manage the data ocean without drowning and what specifically are you doing to help?

AS: [The YouTube video referred to] a sewing machine at Nike. We were able to take the current data out of it and turn it into a stitch model, which kind of makes sense but people were totally shocked: "Wait, this isn't a smart machine but you can say exactly where the stitches are."

If you were going to build a smart sewing machine, you'd have to do the same thing. You'd have to use the data, the current, the pedals, the everything, and create a model of how the stitches are going, and then once you had that stitch model we were able to predict a good pattern from a bad pattern by comparing to the expert sewers that do extremely well. There's a sewing machine called a Strobel that kind of sews to the side, so you can do the heel of a shoe. That's one of the hardest parts. It takes nine to 12 months to train someone to do it well. You can now immediately compare an expert sewer to a non-expert sewer and help

them see when they were doing a non-ideal pattern. That was just kind of one really cool example.

In SMT there's a lot of similar things. There's this tremendous amount of rich data in the pick-and-place machines. You know every kind of mispick that's happening on an exact track related to an exact material related to this head related to this camera. Same things on the printers and the AOIs and the ovens, and we've been able to correlate data across machines that people didn't necessarily expect in really cool ways.

There's parts of what we do at Arch that are just genuinely hard and the customer asks and we go, "Yeah, that's hard and even for us it takes time," but there's other parts where something's actually extremely easy and powerful that people thought was hard and this is one of them. You asked about the data ocean. Every single one of our customers is floored by how effectively we can grab all this manufacturing data and put it into a lake or an ocean at extremely low cost and sustainability. At the end of the day, you know all these files, all these data parameters and everything can be harnessed, they can be compressed way more than people think and it completely makes sense these days to put it into an ocean and then be able to use these advanced analytics to Google search through it; prompt AI to talk through it and correlate it with old school fantastic statistics as well and discover all the things inside that data when you finally unify it.

MB: You mentioned sustainability. Can you define what it means in this context?

AS: In that context I was talking about cost and business sustainability more than energy or carbon sustainability. But of course there's a link, like if you're spending a tremendous amount of data on server farms. They're extremely hungry from a CO_2 perspective, but business sustainability also means are you doing something that you're going to keep doing. So many times in the past companies invested in technology. It wasn't sustainable. They couldn't maintain it. Then they had to dump it and that investment went to zero, and this is one of the areas in decades past people built a data lake or a data ocean. It cost a tremendous amount of money; they didn't somehow magically create AI. AI didn't just emerge from the data. It wasn't that you just put it in the data lake and clicked your fingers and AI came out of it, so a lot of people lost money in the past doing this but that's where you have to understand

the difference between past lessons and the future, because technology is changing so fast. Today, it is possible to build a data lake, a data ocean at extremely low cost that is sustainable to manage. It is still true that AI doesn't just magically come out of the data once you put it in the same place, but it is extremely low cost to put it together that then allows you to do AI with it, and that AI is working very well.

MB: Who owns the data that you're mining? Obviously the manufacturer, your customer, is developing products and you're able to take all those zeros and ones together and make sense of it all, but in terms of what you do with that in the aggregate afterwards, improving your tool or improving the universe of your customers, so that things that have been learned are in the aggregate used to help, perhaps even their competitors. Where does that go and how should we think about that?

AS: Customers own their own data. Technology companies like ours are struggling with a deficit of trust because some of the past generation companies. The way our company works, and I think any company should work, is the customer owns the data. It's their data. We're a steward of it. We're trusted to manage it on their behalf.

Now the future of data ownership has complexities because sometimes our customers, which are the manufacturers, ask, "Do I own the data or does my customer or vendor own the data? I'm using an ASM or a Fuji pick-and-place machine: Is it their data or my data? I'm building a product for Cisco; does Cisco own the data, or do I own the data as a contract manufacturer?" I think there is an answer in every case, the originator of the data owns it and data sharing is how this thing works. You're able to share data. You're able to make copies of data that are anonymized aggregated. And people can provide value-added services. What's in the past is people would just soak up data. You don't even know what they're doing with it. You don't even know where it's gone. That's not how we do things. That's not how it should ever be done in manufacturing. What is the future is clear ownership of data and then sharing it with people who provide value to you. "I know why I'm giving you this data because you're predicting maintenance on my machines. I know I'm giving you this data because you're helping me predict my capacity and manage my throughput better. I'm so glad that you have a copy of all this data to do that."

MB: I think that gets to the heart of it. You have to think about it in terms of what the issue is and what the goal is, and if the goal is to be able to refine our processes so that we have the fewest number of deviations possible and we know exactly what's going on at the machine level and we achieve optimum levels of efficiency, which is always a moving target, then there has to be some level of that. You mentioned trust, but however you come by it, it has to exist in order for this whole process to work correctly. Would you agree?

AS: I would. Data is becoming one of these key means by which we're transacting value. A customer could work with us and say, "I will give you money, and you can use my data only for my thing but you are not allowed to make a copy of it. You're not allowed to improve anything Arch does." Okay, that's fine. Give us more money for that because you're only giving us money. Another customer says, "I will give you money and a right to make a copy of this data to improve your algorithms." Great. You can give us less money and the data.

That's how it works. It makes perfect sense. People can decide: Do they want to share data or not, but it typically makes sense, because when you share data you pay less money, and that's being clear about who owns data, being honest about it and valuing it, which wasn't always done in the past.

MB: This actually happened. I was driving home and I hit a red light at a traffic light and you know it happens every day to everybody. Light turns green. I drove about a hundred yards and lo and behold, another red. Now understand that this was about 10 o'clock at night. Mine was the only car in sight, and all I could think of is, if we can't get these basic sensors right, what does that say about the need for, or even the future of, AI?

We know that new technologies take a generation to take hold. So can we really expect AI to shrink that pace, or maybe AI will help itself shrink it? Or are we going to go through the natural curves of excitement, anxiety, learning, and rationalization that come with every new potential game-changing technology?

AS: It's a great example. That is just like downtime on a manufacturing line. The machine

went down again; who designed this thing? Well, people designed it and it has faults in it, and they ran out of time to look at all the data and perfectly orchestrate it. Humans in the government or wherever, they ran out of time to perfectly study a better way to synchronize lights because like in your example, you're like the product going down the SMT line and you're like, "Why am I stuck? This is so obvious!" But that's where AI comes in. Obviously I'm an optimist, but we have the data from the product's perspective. We have the data every single time the product is slowed down. It doesn't hit the golden cycle time. It hits a block and suddenly we see a traffic jam on the road and we have a new idea, we have a new insight to fix this problem.

Will there be other silly things? Absolutely. In the new language AIs, people call them hallucinations, where you ask it a question and it's just totally wrong. I'll give you a funny example of that with manufacturing. ChatGPT has all the data from just the general internet. There is some data related to manufacturing, so you can go to it and say, "I have error code 2213 or whatever it is on my placement machine or my SPI," and occasionally it knows the answer, because there is actually some public documentation of equipment, and it'll say, "Oh yeah, that error code means that you're out of materials and you should do this." But it has so much other data from random things that sometimes you'll ask it a question and it'll just tell you, "Oh yeah, you need to pour water on it." Just the completely wrong thing. It'll hallucinate in sometimes totally bizarre directions and it's totally ridiculous, which again is why these new AIs aren't a panacea. They don't solve everything. Manufacturing data, to the quote you gave earlier, it's big, but smaller in shape compared to all the world's books. We have to combine general AI with specific data to get the right results for manufacturers.

Being at the front lines of this stuff, I would share a sense of optimism and excitement. I really am extremely excited. Entrepreneurs tend to be optimistic people in general, but I think manufacturing is an industry that has lots of risks, and we have to think about things.

There are a lot of hard things happening in the world right now, like the change of globalization, regionalization. There's some good reasons for that and there's also wars and other things, so there's a lot to be afraid of and think about and try to improve in the world. I really am optimistic about AI. I think it's one of the bright parts of the world. I think it's incredibly powerful and it has way more chance to do good than harm, although there's both

and we need to guard it. Compared to the old internet, everything's out there. You don't even know what you'll find. This is like a guidance system. It's more like the GPS in your car as opposed to a giant stack of maps that you were given for the first time. I really think it has a great potential to do good and be harnessed in manufacturing and beyond.

MB: Electronics design and manufacturing has historically been in a labor crunch. I would argue that AI is needed badly right now to close that gap. Where does Arch fit into this at the user level?

AS: You're right. The statistics say there's more than a 100-million-person labor gap worldwide, more than one million in the US, and the National Association of Manufacturing says 53% of those, at least in the US, have one or two years of experience instead of 10. The question is, how can you use technologies like AI to suddenly give guidance and intelligent actions to people who only have a couple years' experience so they could suddenly level up, be upskilled as if they have five or 10?

I'll give a practical example of that. We talked before about machines that have error codes and it takes a ton of time and the manuals are kind of boring to read anyway. People tend to get practical experience after five to 10 years. They kind of know, in this plant these are the errors that tend to come up and here's what I do about them in my particular plant. That means a rework like this one, you can just keep the machine going. Whatever it is, well you can have an AI system that can read all these error codes, can understand when they matter and don't, and then you can work with the experts in the plant to build these into what we call playbooks. And our system is automatically watching all the machines, all the error conditions, and when they happen it serves it up now maybe to a junior person who's only just come to the factory with the expert's guidance attached to it, and so it's like they're being copiloted by the combination of the AI and the expert's written advice. That could allow them to say, "Oh, I can ignore this error code with confidence. Okay, this one, I need to do a recalibration procedure." They get right to the correct work instead of spinning their wheels. That's an example of what we call an intelligent action.

MB: In summary, an AI platform like that of Arch's can help users get up to speed quickly in their native language.

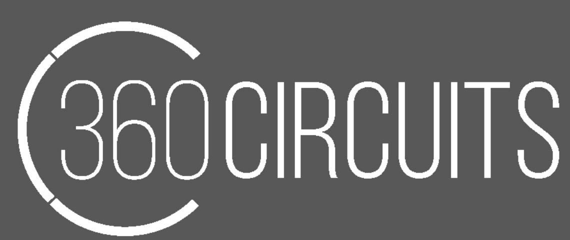
AS: That's a great point. Both in the native language of, "I'm a beginner. Make this easy for me," and in their native language of English, Spanish, Mandarin, Hebrew. The new language AIs are extremely powerful at translation. And that's something that we've already been using early on at Arch. Training materials, for example: We have tools where maybe we have a manufacturer who has sites in five or 10 countries just translate those immediately. It used to be that you need to do this in English and the translation tools really weren't that good. They are now so good that we do local language translations for all our materials and our interfaces. We have our shop floor interfaces translated into different languages, and what we're about to add are more of our summary analytics insights, also translated into local language.

MB: Because our industry is full of jargon, the translation in my experience was really the most difficult part. We go and present in other countries, and even when you have interpreters you know you've hit a head-scratching moment when you get "that look." And the difficulty when your entire platform is almost faceless is that you don't get that feedback in real time.

AS: That's exactly right. I'm so excited about this part because the tools like Arch's allow us to build these knowledge playbooks. The CEO of Flex, for example, Revathi Advaithi, says, "Excellence anywhere is excellence everywhere." For a contract manufacturer for example, they think, "I figured something out in this plant," whether it's Mexico, India, the US, Germany, and "I need to spread this excellence everywhere." And at the same time people are all speaking different languages.

The combination of having standardized normalized data and building normalized playbooks with these new language AIs that don't just translate word for word, they translate thought for thought, and they even put it in the right grammar, the right idioms, for that local language. It's really upping the ability to simultaneously do local understandability with global playbooks, global standardization.

MIKE BUETOW is president of the PCEA (pcea.net); mike@pcea.net. PCEA is hosting a free webinar on AI in Electronics featuring experts from several leaders in electronics design and manufacturing software on March 6 at 1 p.m. Eastern.

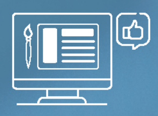


Full-Service
Marketing Agency

::: WITH A PASSION FOR ELECTRONICS :::

Top Services

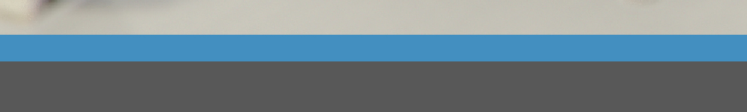
Graphic Design



Content Writing

Industry Consulting

Photorealistic Imagery, Animations and Interactive Media



www.360circuits.com

Lean and Quality within the Supply Chain

Outside suppliers can also affect a facility's quality levels.

USE OF LEAN manufacturing philosophy and Lean Six Sigma tools have contributed to SigmaTron International's quality and production teams achieving superior levels of quality, particularly within assembly operations. That said, even with outstanding process control, incoming material can impact achievement of Six Sigma quality levels. As a result, quality management needs to have a strategy for both ensuring supplier quality and identifying and correcting issues when that quality drops.

In this EMS provider's model, suppliers are asked to complete a self-audit and provide applicable document examples and a copy of a Development Manual, Control Plan, PFMEA, Internal and External PPM data, Quality Reliability and Test equipment list and other documentation, if required, as part of the qualification process. If the subsequent score indicates a need for improvement, the EMS provider assigns a supplier quality engineer (SQE) who works with the supplier's assigned stakeholders to meet the agreed-on improvement goal.

In cases where results of the self-audit or quality issues drive the need for additional scrutiny, a virtual or onsite audit may be conducted by the EMS provider. Audits for suppliers in North America are conducted by a US team and audits for suppliers in Asia are conducted by a team from the EMS provider's international purchasing office (IPO) in Taiwan.

While an OEM can rationalize its supply base to a select few and upgrade technology to

eliminate problem classes of parts via its design strategy, EMS providers must manage a larger supply base defined by their customers, which may include legacy technologies and suppliers whose performance requires improvement. EMS providers either need to put resources in place to address these situations or inform the customer that poor quality is the tradeoff for maintaining the problem supplier.

In this EMS provider's case, relays are an example of a chronic issue with a legacy, yet necessary technology. Relays are often the only mechanical device on a printed circuit assembly (PCBA). While design trends are eliminating relays in favor of solid-state components in most applications, mechanical relays remain a choice in situations where overcurrent could damage a solid-state part.

This EMS provider began working with its relay suppliers over a decade ago to improve quality. At that point, failure rates were running at 1000ppm predominantly due to debris getting into relays during the assembly process. A supplier development team worked with the relay suppliers to improve cleanliness in their factory assembly process. They also identified issues in the plastic injection molding process that were corrected by optimizing molds to reduce the need for secondary processing of parts following molding. Improvements to test and introduction of reliability testing for sample lots were also recommended. The result was that failure rates were reduced to 25ppm. That said, given that many of this EMS provider's customers require zero to 50ppm failure rates for finished products, a 25ppm supplier quality rate is still too high, and the supplier development process is continuing.

In other cases, supplier quality may trend negatively unexpectedly. Six Sigma tools such as the Eight Disciplines (8D) problem-solving methodology or the 5 Whys methodology can be helpful in determining root causes and corrective action.

The 8D methodology was originally developed by the US government in World War II. It was refined by Ford Motor Co. in the 1980s and grew in popularity. The 8Ds are:

- Discipline 1: Define and Describe the Problem
- Discipline 2: Form a Team to Plan a Corrective Action
- Discipline 3: Develop an Interim Containment Plan

- Discipline 4: Determine, Identify and Verify Root Causes and Escape Points
- Discipline 5: Choose and Verify Permanent Corrections for Problem/Non-Conformity
- Discipline 6: Implement and Validate Corrective Actions
- Discipline 7: Take Preventive Measures
- Discipline 8: Recognize the Team.

The 5 Whys methodology determines root causes by looking in detail at possible root causes. For example, if the root cause is identified as a design issue in a portion of the PCBA, the first why might identify the specific area of the PCBA causing the issue, the second why would look at the documentation that drove that design choice, the third why might identify errors in specification, the fourth why might identify what the revision should be and the fifth why might look at checks and balances that would have otherwise prevented the error from occurring. This would drive an action that addresses all elements identified in the 5 Whys process.

For example, in the case of an electronic membrane switch supplier, use of an 8D and 5 Whys approach resulted in the supplier changing its assembly process and improving its test process to enhance assembly process control and provide 100% testing of CTQ elements.

The results of this approach build better relationships with both suppliers and OEM customers because it creates an environment where quality issues are corrected through a collaborative process that quantitatively identifies what drove the issue to both the supplier and the customer. In this EMS provider's case, this approach has also positively impacted its scorecards with its major customers, delivering quality results from 0-49ppm across multiple high-volume programs.

ALLEN ABELL is corporate director of quality and compliance at SigmaTron International (sigmatronintl.com); allen.abell@sigmatronintl.com.

PCEA.NET/PCEA-MEMBERSHIP

Offering price points to meet every company's budget & needs!

The Price is Right?

Engineering ain't free – even if (when) would-be customers think it should be.

SMALL. SIZE DOESN'T matter.

Until it does.

Small companies and startups are often the worst: Junior Dictators consuming time in inverse proportion to the worth of their project. Much of that vaporized time has little relation to the technical specifics of the project in question.

As if they care.

Because the customer is always right (to monopolize everyone's time).

So the micromanager's ballet begins.

"I need it now." "We are line down." "How fast can you x-ray one board if we overnight it to you today?" "What happens if instead of one board, we send you four boards; how much and how fast?" "I'll write a requisition." "Parts are on the way: here is our tracking number. Please see if you can work this in, and get them done tomorrow, immediately upon arrival." "Please send us a completion date as soon as parts arrive (tracking number attached)." "Stop! Put the job on hold: our customer changed their mind." "Upon receipt, please return the board to us; take no further action beyond turning them around and returning them overnight." "Yes, your understanding is correct: do no further work on this project." "Our customer is making

up their mind whether to proceed and seeking alternative means to do so." "Cancel prior cancellation; please proceed: a PO will be issued shortly." "How fast can you do this?" "Can we move to the head of your x-ray queue?" "When can we have images?" "When can we pick our boards up?" "Can one of our engineers sit with your technician during the imaging session?" "Is there someone in your organization we can talk to directly who can expedite this process?"

Then they get our price.

"What do you mean? We've never paid that much before!" "This is outrageous!" "I'll need three signatures to approve this!" "Can you reduce the price to this level? That way we can avoid multiple time-wasting management signoffs." "The PO is delayed for signature. Can we simply use a credit card?" "Management will take a dim view of your minimum price. Can you take another look at it?" "Think Big Picture and Long Term."

As if we don't take a misanthropic view of their management.

Further, in the Big Picture and Long Term, we're dead. Meanwhile, life's short, bills come due, and one person's injustice is another's fair price.

"We've already sent our customer a quote, based on what we felt was a reasonable price. We are locked into that price. Can you reduce your price this one time to honor our quote? Going forward we'll build your minimums into our pricing, but to do so in this situation would be awkward." "We can't pay that amount." "We want to be partners."

Yes, you can pay that amount. And partnership is code for "do what I want." You can also sneak in the back door of your neighbor's cousin's twice-removed nephew's workplace, on his swing shift, around 10 p.m., dodging the security guards, and attempt to capture root cause in the unclaimed space of a 15-minute coffee break. Capitalism provides options. Good luck. Choose well.

Move on.

Medium. "We need a simple test jig, connecting our JTAG pod to the board on the bench. Nothing more. Cost matters. Speed to deployment matters." "How fast can you get us a

quote? Even if it's a swag, we want to have something in front of our customer Monday morning." So spoke the contract manufacturer, manufacturing urgency.

This, after they asked in July for an ICT program and fixtures for the subject board. We analyzed the data and told them 30% coverage was not a good fit for ICT. Undeterred, they asked for a quote anyway in August. Full speed ahead.

Then they got our price. Abrupt stop.

Curiously, they abandoned ICT, opting instead for flying probe with a benchtop boundary scan overlay. We obligingly submitted a second quote in September, this time for full flying probe and JTAG development, both from scratch.

Our second quote inspired epiphanies. Like the OEM customer's discovery of an existing JTAG pod at its facility. (Money saved!) And an existing JTAG program. (More money saved!) Sometimes the prospect of spending real money causes some to scour their attic. You never know what can be found when you look hard enough. They ask for another requote.

So a third request went out, for the aforementioned simple test jig. With program and JTAG hardware already bought and paid for, all that was needed was a basic box, providing a straightforward interface between pod and DUT, nothing more. Sheet metal and wires. All we needed was the wirelist and block diagram from the customer to proceed.

Two and a half months later, we received them. Seems they neglected a few things in the original requirement. The new documents described a new project: firmware loading, UART debug, adoption of an external transceiver to facilitate debug, functional tests. An integrated test fixture, combining the new features with the old, plus automation. All captured in a drawing (another new requirement), to be signed off by the OEM, in the person of a cantankerous, insufferably arrogant engineer, who had recently returned from a lengthy extraterrestrial sabbatical and inserted himself into the process after the third quote, outraged at the insufficient clairvoyance of our first, second and third quotes. Which, naturally, inspired a fourth quote.

And a fifth quote, after the drawing was rejected, point by feature-creeped point.

It's now February, month eight in our odyssey, with no baby to show for the intermingling. We haven't even started fixture fabrication. They make more changes to the drawing. We build in more money for our time. Engineering ain't free.

Inconsiderate meddling in peoples' time has no upper bound.

Simple indeed.

Quote six, bearing as much resemblance to the original concept as a paper plane to a 787, is submitted Feb. 2. Silence follows. And follows.

Two weeks later, we can't stand it any longer. What the hell is going on? Hit send.

"Sorry we haven't responded sooner, but we've had meetings. We decided to go in a different direction."

Complete silence.

Large. Doing business with them is a privilege, their websites proclaim. Helpfully, those same websites self-servingly trumpet adherence to the highest ethical standards (theirs).

One company is a market darling. Its stock price carries its own cachet. The horde of aspirants clamoring to supply it attests to this. The herd converges and creates its own demand. Suppliers want to bask in the glow.

Nevertheless, they approached little us, rather than the other way around. We have two things they want: skill and speed. Better than their own internal resources. If the price is right.

Another company is well-dispersed: manufacturing sites, operating divisions, responsible departments, complete accountability. Nobody talks to anybody, so nothing of consequence gets done in a timely way. On the other hand, reassuringly, their legal department will survive a thermonuclear first strike and a disaster readiness audit.

Once again, we offer fast solutions to problems made possible by their own system. Skill and

speed strike again.

A third is just big. And ponderous. And cautious. Even timid. Not unlike certain nations, and cultures, and home offices. Institutionally embodying the evolution of the disease it was established to treat. As if their mantra said this:

"What do we want?"

"Gradual change."

"When do we want it?"

"In due course."

Like an amoeba: It always gets where it's intending to go, given a decade or two to spare.

Why do business with these guys? The behemoths are Big Dictators: demanding – really imposing – the best price, delivery, quality (you know, like the 787-9). They want the paperwork filled out. They want their legal teams to review every NDA and contract (see you in six months). Their POs and payments originate from the Asian subcontinent. Manufacturing is in Mexico or Southeast Asia. R&D lurks in Florida. Responsibility is everywhere and nowhere.

The common threads: dispersion of authority and decision-making; enforcement of rules through ironclad control of documents. Semicolons matter when governed from 7000 miles. Bureaucratic little men (mostly men) rejecting W-9s in far-off places because we signed an older version. Or placing an invoice on hold because a lot charge doesn't match a unit price. And portals. Many portals. Like penance.

Why, as a small supplier, should we bother?

Because they are prisoners of their own systems. They still have deadlines, often the consequence of financial targets. Small suppliers like us can circumvent some of those systems. Recognizing these corporate shortcomings enables certain suppliers, like us, to act

from a position of strength. Time remains, after all, of the essence.

So the first company needs ICT development support for a product launch, and its current suppliers do not inspire confidence. In we come.

The second company jettisoned a previous supplier, whom they deemed insensitive and unresponsive. The universe of replacements in the ICT/boundary scan sphere with ITAR and AS9100 qualifications is a small one, so we got the email.

The third is a legacy customer. It's a long legacy: We haven't done any business with them in more than 10 years. But we remain the one supplier for test support of this product on their AVL. Pity.

Sometimes you just need to get stuff done and screw the restrictions. Enter us. We bear our burdens with dignity.

And price our services accordingly. As long as we're prepared to walk away. We are, and they don't.

Maybe we do stand a chance.

For the right price.

ROBERT BOGUSKI is president of Datest Corp. (datest.com); rboguski@datest.com. His column runs bimonthly.

pcbchat.com

Recent Chats:

- **Advances in AI Design**
  with MATTHIAS WAGNER
- **Building a Sustainable Career**
  with RICK COULSON
- **US Strategy for Supply Chain Readiness**
  with DAVID SCHILD
- **AI in Electronics**
  with ANDREW SCHEUERMANN
- **Hand Soldering and Rework Best Practices**
  with DEBBIE WADE

The PCB Podcast

KYOCERA AVX 9155-800 SERIES CONNECTORS

9155-800 series of vertical-mate, 2.0mm-pitch battery connector series now includes seven- and eight-position models. Features unique contact geometry that deflects cleanly when a module, mating connector or PCB is vertically pushed into position, enabling full vertical engagement in pluggable modules without the risk of contact damage. Also features forgiving sweeping beam contact design and anti-snag feature that protects contacts from damage during deflection, and when static as well. Includes gold-plated beryllium copper (BeCu) contacts said to deliver electrical and mechanical performance for more than 5,000 mating cycles and plastic locating bosses and SMT anchor tabs that maximize mechanical stability of the connector in high-shock and vibration environments. Is compatible with both signal and power circuits, and has flame-retardant (UL94 V-0) black, glass-filled Nylon 46 insulators, BeCu contacts with either 0.4μm or 0.8μm of selective gold-over-nickel plating and pure tin tails. Rated for 125VAC or DC equivalent; 1.5A or 2A, depending on number of positions (five to eight and two to four, respectively); and operating temperatures extending from -40° to +125°C.

Kyocera AVX

kyocera-avx.com

LITTELFUSE SM10 VARISTOR

SM10 series metal oxide varistor is designed to provide superior transient surge protection in automotive electronics, electric vehicles and various other applications. Is said to be the first surface-mounted MOV device compliant with the AEC-Q200 automotive standard, capable of withstanding high operating temperatures and offering ultra-high surge current handling in a compact package. Withstands temperatures up to 125°C and features repetitive surge capability handles up to 40 pulses of 6KV/3KA surges. Features dimensions of 15.7mm x 8.5mm x 14mm and a voltage rating of 130Vac to 625Vac.

Littelfuse

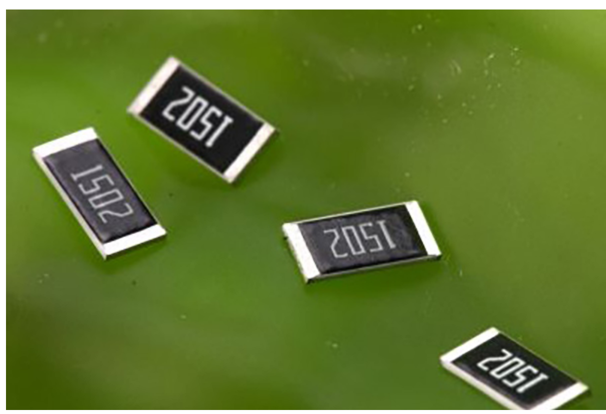
littelfuse.com

SAMTEC EDGE RATE SERIES CONNECTORS

Edge Rate ERF6 & ERM6 Series board-to-board connectors now include higher-density mated set half the width of previous designs and in a lower-profile 5mm mated height. Support 56Gbps PAM4 high-speed, rugged mezzanine applications for industrial, embedded vision, instrumentation and monitoring, drones, and robotics. Have two rows of pins while maintaining body width of 2.5mm. Body length is 11mm to 42.8mm with a 0.635mm centerline. Available positions for each row are 10, 20, 30, 40, 50 or 60. Permit 0.90mm of

nominal contact wipe for reliable connection. To ensure consistent alignment, polarizing features are molded into the connector body. Permit angular and linear misalignment.

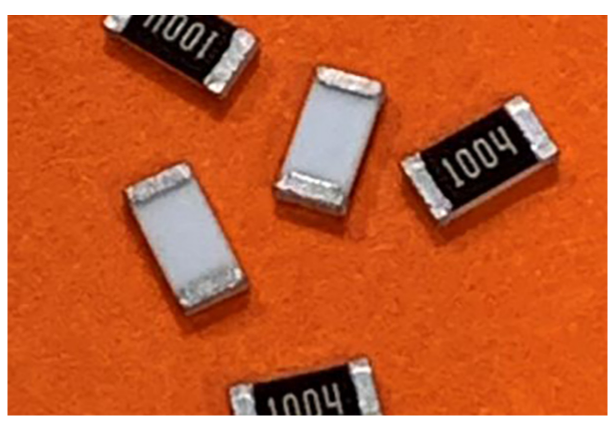
Samtec
samtec.com



STACKPOLE RMEA SERIES RESISTORS

RMEA series of automotive grade chip resistors are fully lead-free and AEC-Q200 qualified and anti-sulfur. Adhere to higher materials and process standards as well as 100% AOI to ensure performance and long-term reliability. Are for next-generation automotive electronics, industrial power and control applications, and electronics for measurement and metering.

Stackpole Electronics
seielect.com



STACKPOLE RNCU1206 RESISTOR

RNCU1206 provides tolerances as low as 0.1% and TCRs as low as 10ppm along with a 1W power. Is AEC-Q200 compliant with expected resistance shifts of less than 0.25% for many standard performance tests for stability and reliability, and is said to exhibit anti-sulfur characteristics while meeting the requirements of ASTM-B809.

Stackpole Electronics

seielect.com

UCAMCO UCAMX AND INTEGR8TOR V2023.12 CAM

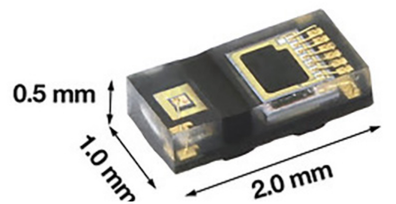
UcamX v2023.12 CAM software and Integr8tor v2023.12 pre-CAM software are now available, each offering additions to increase productivity.

UcamX's Coupon Assistant now modifies existing data without a complete rework, Drill Tool Manager can change the slot length and reduce manual handling, and Rout Manager's new accurate arc generation prevents rework.

Integr8tor includes improvements to QED extensions to include better via-in-pad detection and more, Gerber X3 input to turn Gerber component data into assembly information, and various improvements to performance and speed.

Ucamco

ucamco.com



VISHAY VCNL36828P PROXIMITY SENSOR

VCNL36828P compact proximity sensor combines a photodiode, ASIC, 16-bit ADC, and smart dual I²C slave address in a 2.0mm by 1.0mm by 0.5mm surface-mount package. Compared to previous-generation solutions, offers a 20% smaller package, 20% lower idle current of 5μA, and 40% higher sunlight cancellation up to 140klx. Features a range of 200mm and a typical rated supply voltage of 1.8V and is designed to deliver proximity detection while reducing power consumption to increase efficiency in space-constrained, battery-powered applications. Programmable interrupt function allows designers to specify high and low thresholds to reduce continuous communication with microcontroller, and uses intelligent cancellation to reduce crosstalk, while a smart persistence scheme ensures accurate sensing and a faster response time. VCSEL wavelength peaks at 940nm and has no visible "red-tail." RoHS-compliant, halogen-free, and Vishay Green.

Vishay Intertechnology

vishay.com

WÜRTH MEMS HUMIDITY SENSOR

MEMS (micro-electromechanical system) sensor measures with a precision of ±1.8% RH in the 20% to 80% relative humidity range. DFN (dual flat no-leads) package for SMT assembly measures 1.5 x 1.5 x 0.5mm, works with a current of 0.4μA and can be operated with a power supply between 1.08V and 3.6V. Is for distributed IoT sensor networks, such as those in smart farming applications. Dielectric polymer interacts with water molecules to adjust permeability of capacitor structure depending on relative humidity of surroundings, and includes temperature sensor. Uses integrated analog-digital converter to transmit momentary temperature as well as humidity information as 16-bit measurement data directly to conventional microcontrollers via I²C interface. Included heater with three selectable heating levels can be switched on temporarily as required, so sensor works effectively even

under demanding ambient conditions and measurement is not falsified by condensation.

Würth Elektronik

we-online.com

CA

APOLLO SEIKO SR-LYRA II ROBOT

SR-LYRA II soldering unit combines LYRA II soldering technology with a SCARA robot. Is engineered for high-speed, axially moving operations and is for inline applications designed for full automation. Integrates a lightweight robot and a compact controller to enhance robot mobility and simplify design of production lines. Features a virtual web-based teaching pendant, compatible with any operating system that can open a web browser, that provides a user-friendly interface for intuitive control and programming.

Apollo Seiko

apolloseiko.com

ASMPT SMT ANALYTICS SOFTWARE

SMT Analytics software runs stream analytics based on the latest data processing technologies to detect causes of trouble, highlights potential losses and points out potential improvements. Features a variety of dashboards for descriptive analyses based on user profiles and process structures, and clearly defined use cases help to monitor important KPIs, locate root causes of problems and present historical, real-time and reference data in a structured and correlated manner. Makes slowdowns and shortfalls visible through intelligent data correlation and detects and prevents immediate performance shortfalls while helping to optimize processes. Also analyzes downtimes resulting from malfunctions and provides detailed information on causes and durations. Third-party-system interaction coming.

ASMPT

asmpt.com

ECD EV12 THERMAL PROFILER

M.O.L.E. EV12 is a 12-channel soldering thermal profiling data logger. Delivers power and immediacy of touchscreen thermal profiling control. Addresses specific applications that require nine to 12 thermal measurements. Full-color touch display enables process calculation templates, profiles, and pass/fail results to be observed directly on the device. No PC download required for profile viewing. Has Bluetooth wireless connectivity, delivers higher sampling rates with greater accuracy, and supports multiple thermocouple types.

ECD

ecd.com

INEOS STYROLUTION ZYLAR EX350 MBS MATERIAL

Zylar EX350 MBS material possesses a balanced combination of stiffness and toughness, making it the ideal material of choice for carrier tapes in electronics component packaging. Enables the creation of deeper and more rigid pocket designs compared to using a GPPS/SBC blend, and is said to ensure component stability, a consistent and smooth peel-off strength performance and good transparency for the camera inspection.

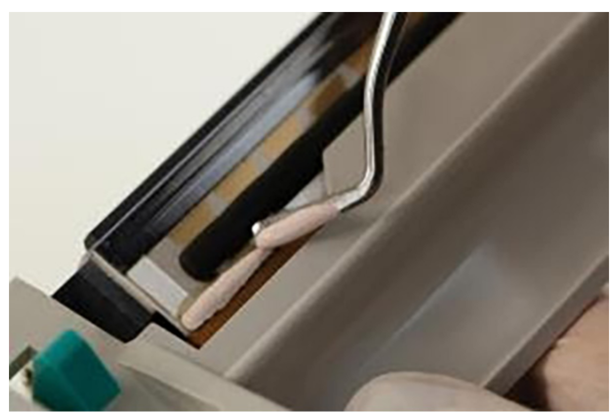
Ineos Styrolution

ineos-styrolution.com

INSPECTIS AHD SYSTEM PACKAGE

AHD System Package is a compact and lightweight analog high definition (AHD) video package for optical inspection and assembly. Features a compact AHD video microscope configurable with different optics for 1.3mm to 23mm field of view, (~300x to ~20x magnification on screen) and FHD resolution with low latency to provide a live view of the object during inspection. Is also equipped with a UNC 1/4"-20 standard camera mount for flexible custom mounting and is configurable with or without built-in lighting.

Inspectis

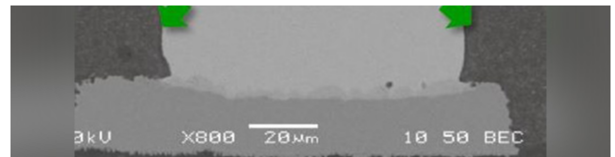


MASTER BOND SUPREME 11AOHTMED EPOXY

Supreme 11AOHTMed two component epoxy passes ISO 10993-5 testing for non-cytotoxicity and is recommended for bonding and sealing in medical device applications. Has a volume resistivity exceeding 10^{14}ohm-cm at 75°F and exhibits thermal conductivity of around 4 to 5BTU·in/ft²·hr·°F (0.58-0.72 W/m/K). Provides high bond strength properties with a lap shear strength of 3,200-3,400psi, a tensile strength of 7,000-8,000psi and a compressive strength of 20,000-22,000psi. Is designed to withstand thermal cycling and offers a wide service temperature range from -112° to +400°F (-80° to 204°C). Cures at room temperature in 24-36 hr., and faster with heat, in 1-2 hr. at 200°F. Is said to bond well to a wide variety of substrates including metals, ceramics, glass, rubbers and many plastics. Has a 1:1 mix ratio by weight, with mixed material being a thixotropic paste. Comes in double-barrel cartridges for gun kits, or in standard jars and cans ranging in size from ½ pint to gallon containers.

Master Bond

masterbond.com



SHENMAO SMF-D61 FLIP CHIP FLUX

SMF-D61 low-residue no-clean flip chip flux leaves minimal residue after reflow, ensuring clean and reliable solder joints. Is halogen-free and complies with RoHS, RoHS 2.0, and REACH standards. Is free from intentionally added halogens. Is designed for flip chip dipping applications. Offers wetting characteristics and solderability, facilitating precise and robust solder joints. Is fully compatible with underfills and EMC, eliminating cleaning of flux residue before proceeding with subsequent processes. Achieves flux residue levels as low as 5% after reflow, for performance and reliability.

Shenmao Technology

www.shenmao.com

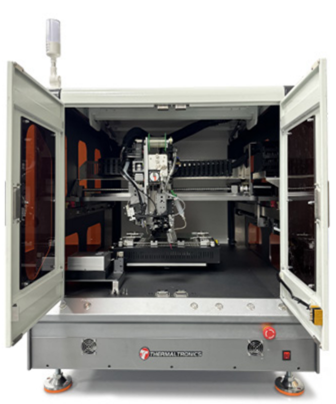
STENTECH BLUPRINT CVD SURFACE TREATMENT

BluPrint CVD (Chemical Vapor Deposited) surface treatment is a new method for depositing thin films of materials onto a substrate by introducing chemical precursors into a reactor chamber, where they react and deposit as a solid material on the surface. Offers consistently repeatable processing without variation, providing a virtually indestructible coating that remains resilient without degradation and ensures uniform printing, with the only variation being the area ratio, while each aperture remains identical. Eliminates need for frequent

replacements and ensures a longer lifespan for the stencil. Is applied at approximately 1000 times less thickness compared to current alternatives with a range of 3-5µm versus 3nm.

StenTech

stentech.com



THERMALTRONICS TMT-R9000S SOLDER ROBOT

TMT-R9000S solder robot is a compact and versatile benchtop unit catering to a wide range of applications in electronics manufacturing. Incorporates SMEMA Communication Ports, allowing seamless integration with Robotic Arm Systems. Features soldering area measuring 12" (308mm) x 12" (308mm) that accommodates a maximum PCB area of 17" (450mm) x 17" (450mm). Also features XYZ 3-D soldering and 3-D dispensing capabilities, and includes two input line voltage options, TMT-R9000PS-1 (100-110 VAC) and TMT-R9000PS-2 (220-240 VAC).

Thermaltronics USA

thermaltronics.com

WELLER ZEROSMOG SHIELD FUME EXTRACTION

ZeroSmog Shield Pro fume extraction system features EPA E10 filters for particulates and activated carbon for gases. Includes a quick and easy filter change process and continuous filter status checks to ensure filter is performing optimally at all times. Also features work zone identification with bright work lights to clearly indicate best extraction area for efficient filtration, stop and go functionality to seamlessly connect to various Weller soldering stations for automatic start and stop filtration, and an ESD-safe design.

Weller Tools
weller-tools.com

YAMAHA ROBOTICS YRI-V TYPEHS AOI

YRi-V TypeHS 3-D AOI includes a high-resolution 25MP camera, which is more than twice that of previous models, and the latest high-performance CPU and GPU applications. Is capable of high-definition inspection with resolutions of 7μm and 5μm approximately 1.6 times faster than previous models. Also includes a high-performance 3-D line laser which, combined with 3-D projector images using the phase shift method, reproduces shapes of specular and transparent components more accurately. Is said to provide greater accuracy in detection capability for 0201 (0.25mm x 0.125mm) ultra-small chips and specular-glossy

components.

Yamaha Robotics

yamaha-motor-robotics.de

YAMAHA ROBOTICS YRM10 SURFACE MOUNTER

YRM10 surface mounter is said to feature the world's fastest one-beam/one-head Class 1 mounting performance of 52,000cph. Developed as a successor to entry model YSM10, and maintains compact size while introducing new technologies such as high-speed general-purpose versatility head and vision systems. Includes 10 inline heads and scan camera that supports a wide range of components while maintaining high speed without need for head replacement and achieving mounting accuracy of ±35µm (Cpk ≥ 1.0). Supports 0201 (0.25 x 0.125mm) sized ultra-small chips to medium-sized or odd components, and includes sideview camera and optional coplanarity checker to detect components with a floating lead.

Yamaha Robotics

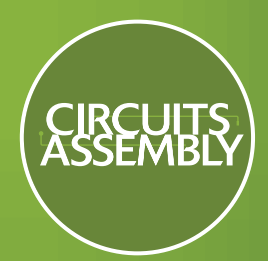
yamaha-motor-robotics.eu

The *Circuits Assembly* Directory of EMS Companies

BUILD YOUR NETWORK

BOOST YOUR PROFITS

- Build your EMS database
- 3,000+ facilities worldwide
- Sortable in Excel
- Unrestricted use
- Includes contact info, no. of lines, markets served and more!



circuitsassembly.com/dems

TECHNICAL **ABSTRACTS**

In Case You Missed It

EMI

"Advanced Characterization of a Hybrid Shielding Solution for Reducing Electromagnetic Interferences at Board Level"

Authors: Jorge Victoria, *et. al.*

Abstract: The development of new advanced functionalities, miniaturization, and the aim of obtaining optimized performance in electronic devices significantly impacts their electromagnetic compatibility (EMC). As electronic components become more densely packed on a printed circuit board (PCB), unintended coupling between components can cause electromagnetic interference (EMI). These requirements result in design restrictions that make using a board-level shield (BLS) essential in reducing intra-system EMI in PCB designs. This contribution focuses on studying and characterizing a BLS solution based on combining a noise suppression sheet (NSS) with an aluminum layer to reduce intra-system EMI coupling. This hybrid solution has the advantage of providing a shielding option that does not require any electronic redesign. It does not need a footprint or a ground connection as it can be affixed over the EMI source. The solution is expected to provide higher attenuation levels than using only an NSS by combining the absorbing properties of the magnetic material and the loss mechanism of the metal. To verify the effectiveness of the hybrid BLS proposed solution, the magnetic near-field emissions of an EMI source are analyzed in this study. The experimental measurements and simulated results demonstrate a significant increase (51.6dB at 1GHz) in the shielding effectiveness (SE) provided by the proposed solution compared to a conventional NSS. (*Electronics*, January 2024, https://doi.org/10.3390/electronics13030598)

Sn-Bi Alloys

"Investigating the Effects of Rapid Precipitation of Bi in Sn on the Shear Strength of BGA Sn-Bi Alloys"

Authors: Qichao Hao, *et. al.*

Abstract: The potential of SnBi alloys as low-temperature solders for electronics manufacturing has spurred significant research on their mechanical properties, both in the as-soldered condition and after aging. Previous studies have demonstrated that, because of the extreme temperature sensitivity of the solubility of Bi in Sn, the mechanical properties of SnBi solder alloys are very sensitive to their thermal history. While the properties of the bulk solder alloy are a factor in its performance as a solder joint, the reliability in service is also affected by joint geometry and the interaction of the solder alloy with the joint substrate. This work assesses the effect of thermal history on solder joints formed with representative SnBi alloy solder balls by measuring the performance in a standard ball shear test of a solder ball reflowed to solder mask-defined (SMD) copper pads with organic solderability preservative (OSP) or electroless nickel/immersion gold (ENIG) finishes. The solder ball/substrate combinations were tested within 10 min. of reflow and after room-temperature storage for up to 10 days to determine the effect of aging on their response to the ball shear test. The results show that the peak force and fracture mode of SnBi solder joints is influenced by the SnBi alloy composition, the substrate type, and the aging time. These observations provide new information on the capability of these alloys to deliver reliable service over a range of operating conditions. (*Journal of Electronic Materials,* Dec. 2023, https://doi.org/10.1007/s11664-023-10850-8)

Solder Reliability

"Temperature And Current Density Prediction in Solder Joints Using Artificial Neural Network Method"

Authors: Yang Liu, *et. al.*

Abstract: Due to the miniaturization of electronic devices, the increased current density through solder joints leads to the occurrence of electromigration failure, thereby reducing product reliability. This study proposes a finite element-artificial neural network method for the prediction of temperature and current density of solder joints, and provides reference information for evaluation of solder joint reliability. (*Soldering & Surface Mount Technology*, December 2023, https://doi.org/10.1108/SSMT-07-2023-0040)

Thermal Conductivity

"End-To-End Material Thermal Conductivity Prediction Through Machine Learning"

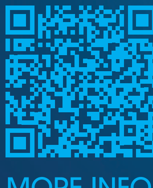
Authors: Yagyank Srivastava and Ankit Jain

Abstract: The authors investigated the accelerated prediction of the thermal conductivity of materials through end-to-end structure-based approaches employing machine learning methods. Due to the non-availability of high-quality thermal conductivity data, the authors first performed high-throughput calculations based on first principles and the Boltzmann transport equation for 225 materials, effectively more than doubling the size of the existing dataset. The authors assessed the performance of state-of-the-art machine learning models for thermal conductivity prediction on this expanded dataset and observed that all these models suffered from overfitting. To address this issue, the authors introduced a different graph-based neural network model, which demonstrated more consistent and regularized performance across all evaluated datasets. Nevertheless, the best mean absolute percentage error achieved on the test dataset remained in the range of 50–60%. This suggests that while these models are valuable for expediting material screening, their current accuracy is still limited. (*Journal of Applied Physics*, December 2023, https://doi.org/10.1063/5.0183513)

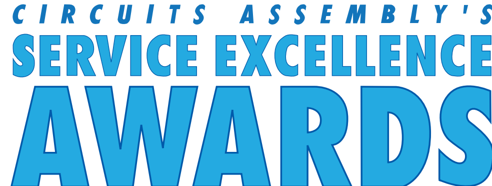
At ESI, our focus is on meeting and exceeding our customer's expectations every day.

Continuous improvement with a constant emphasis on the customer is how we achieve that, winning the Circuits Assembly's Service Excellence Awards means we've done everything right.

Amy Hoines, VP of Strategic Partnership
Electronic Systems Inc.
2023 Overall Winner, EMS Revenues $20M to $100M


MORE INFO

Do you compete for the
CIRCUITS ASSEMBLY'S
Service Excellence Award?



REGISTER TODAY

Deadline: March 25, 2024

CLICK HERE

TECHNICAL WEBINAR

TRANSLATING THE TECHNOLOGY

MARCH 13, 2024

11:00 AM - 12:00 PM (CT)

VIRTUAL MEETING

Just as a TV series cross-over event brings together characters from different shows to create unique storylines, this SMTA "Cross-Over" event brings together perspective from design, fabrication and assembly to tackle topics that impact the full process.

HIGH RELIABILITY APPLICATIONS

This interactive panel discussion will provide perspectives from PCB Design, PCB fabrication and PCB assembly with a panel discussion focused on the impact strong communication throughout the full process can have on project success.

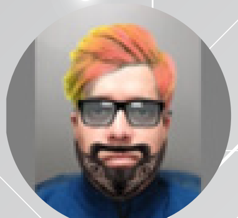
Humorous faux pas, lessons learned and success stories will be shared as this expert panel fields questions and imparts wisdom.

Mumtaz Bora
pSemi, A Murata Company

Steph Chavez
Siemens Industry Software

Mike Marshall
NCAB Group

Dave Neville
Infinity Robotics



Ata Syed
PFC Flexible Circuits

FREE for PCEA & SMTA members!

Use promo code **PCEAFREE** at registration
smta.org/event/translate24