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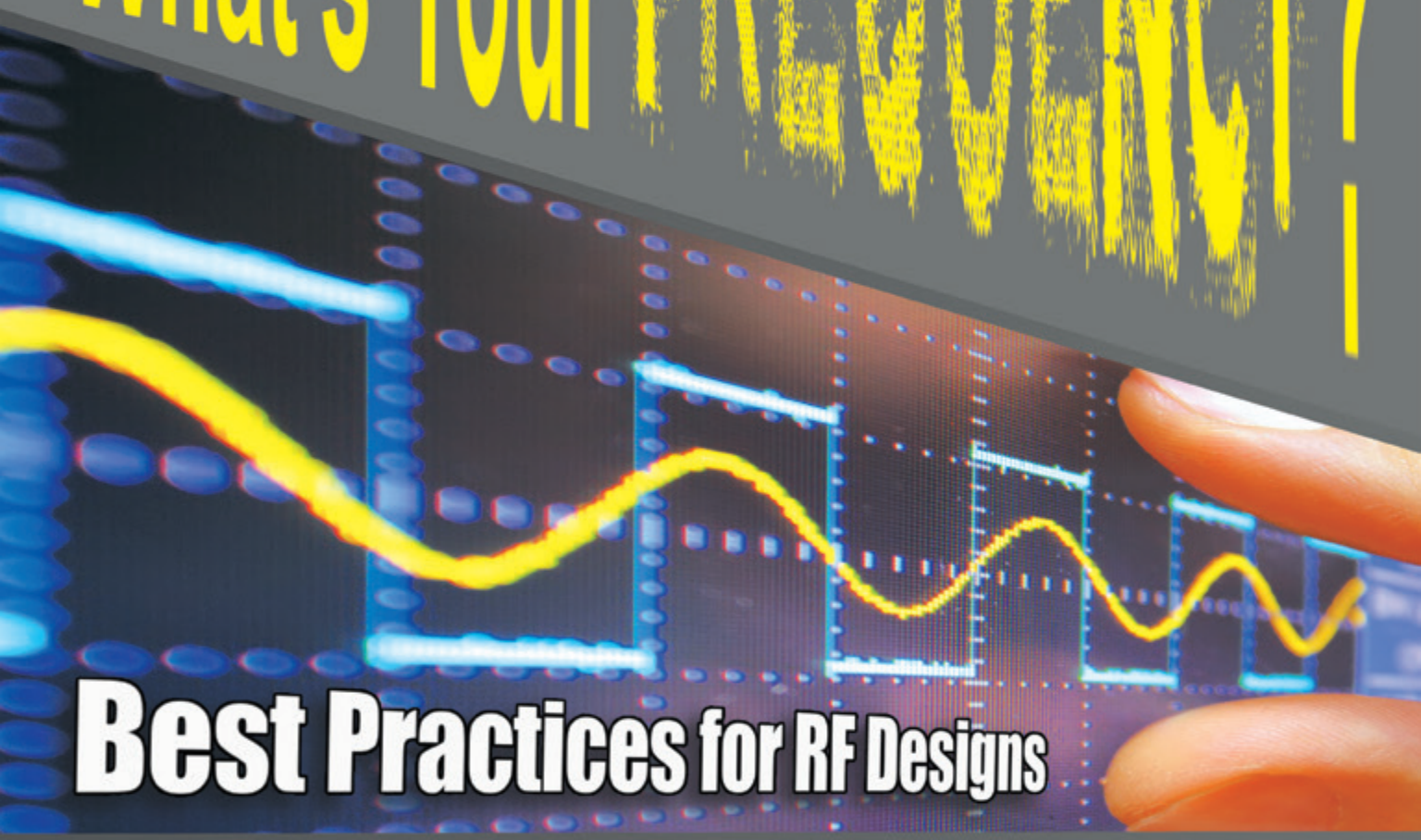

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~ **EMS** in **Colombia**: A Low-Cost Partner?

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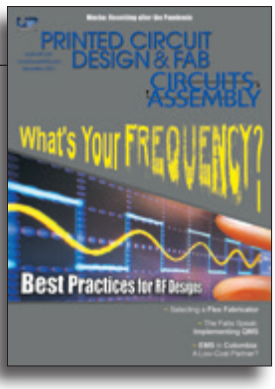

ON PCB CHAT (pcbchat.com)

PCB Chat

Soldering Materials and Selection
with PAUL SALERNO

HDG Users Group Update
with LARRY MARCANTI

DfX
with CHERYL TULKOFF and GREG CASWELL

INDUSTRY 4.0
with DAVE TRAIL

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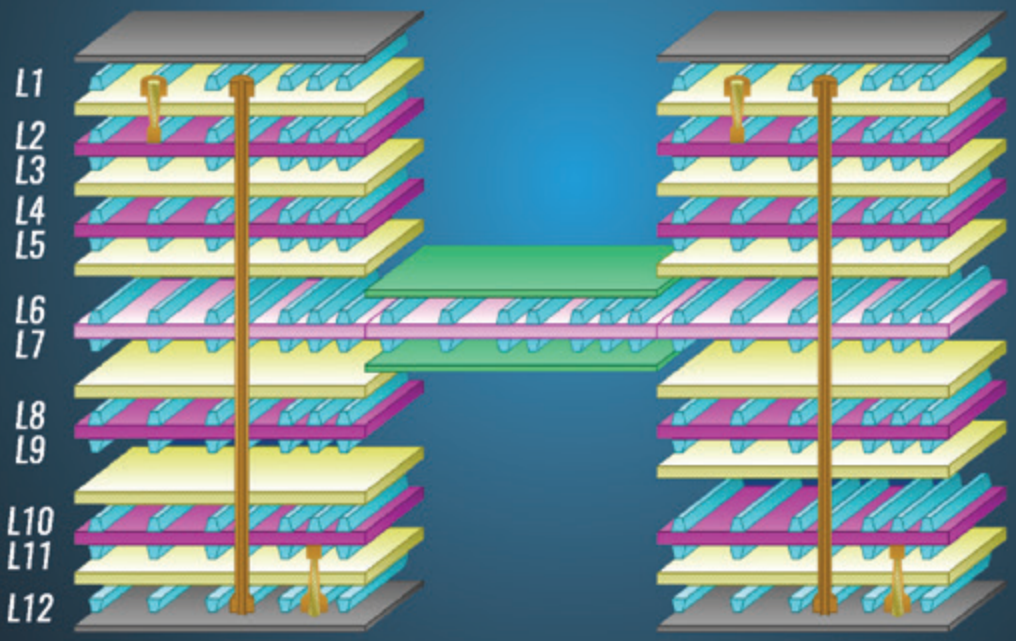

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MIKE BUETOW
EDITOR-IN-CHIEF

As the Chair Turns

TWENTY-ONE YEARS.

That's how long I've sat in this chair as an editor for this publication.

That's 21 years of writing editorials. Never missed an issue. Many times, I've written them on planes, heading to or from someplace afar. (I may work from home, but traveling from Boston to China, as I have done many, many times, still means ample commuting time.)

I wrote one on my honeymoon. I wrote one from the recovery room after my first child's birth. (With little else to do, I spent the time counting all the circuit boards in the equipment around me. Yes, I'm a nerd.)

There may even be a reader or two who was born about the same time I assumed this role in January 2000, first as editor in chief of PC FAB, to which my boss Pete Waddell then added PRINTED CIRCUIT DESIGN, and finally, in 2005, CIRCUITS ASSEMBLY. (Now I feel old. Thanks a lot.)

Soon, however, I will cede this spot to my longtime colleague, Chelsey Drysdale. And with our pending acquisition by the Printed Circuit Engineering Association, I will focus less on day to day writing and reporting.

Under Chelsey's guidance, we will introduce more content, some new contributors, and more closely tie our audio and video platforms with the publications such as this one. She will work with our editorial advisors to ensure we are focused on what matters to you. It's past time we have a fresh set of eyes and thinking.

That said, I will continue to be present in these pages, bringing news of the PCEA as the association works to advance the career of the professional electronics engineer.

Some of the things we will talk about include the design engineering training and certification program (PCEA is the certifying body for the Printed Circuit Engineering Professional curriculum, a new 40-hour training program developed by Mike Creeden, Rick Hartley, Susy Webb, Stephen Chavez and Gary Ferrari), the workshops and technical conferences (I should mention PCB East is coming up in the Boston suburbs in April), and other related programs that will help you, the reader, learn and understand more about the industry and your role in it, and prepare you for the next one.

I will continue to conduct interviews and produce podcasts, which can be found at PCBChat.com. We will revamp the website to make it more functional, faster and accessible, since so much of what you need can be found online in our archives and our e-learning platforms like Printed Circuit University.

The demographics of the printed circuit industry are bifurcated age-wise, with two big pockets of people younger than 35 and older than 50 and a dip in between, sort of like a binomial distribution. Content providers and training organizations, be they publications or associations or both, must reach those audiences by using the platforms *they* feel most comfortable with. As I witness firsthand with my kids, the demands for answers may be similar to mine, but the ways we get there are often very different.

Among our goals, we want to provide a network for electronics engineers to connect and mentor and learn. We want to make it as fast and simple as possible to get you what you need, when you need it.

In tackling this latest endeavor, we have the guidance and backing of a cadre of experts, truly the leaders in printed circuit engineering today. We consider ourselves incredibly fortunate.

Similarly, I have been beyond lucky all these years to work for – and with – leading editors like Carl Wesselmann, Ron Daniels and of course, Pete. They were true industry spokespersons, and it's a humbling experience to try to maintain their legacies. It's time to pass that awesome task to the next in line.

We wish you a healthy and happy holiday season. We do this for our readers and customers, and as always, are grateful for your support.

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PCDF People

Elmatica promoted **Robert Kurti** to chief information officer. He joined Elmatica in 2016 as IT manager, after supporting the US and NATO coalition forces for six years.

Nano Dimension named **Frank Silva** sales manager.

Siemens EDA named **Paul Lapointe** solution architect.

Taiyo America named **Bernhard Schmuki** technical sales engineer.

PCDF Briefs

AT&S is investing €500 million for a new R&D center for substrate and packaging solutions for the global semiconductor industry at its fabrication site in Leoben, Austria, up to 2025.

Harvard and **Washington University** engineers have developed a simple spatial light modulator made from gold electrodes covered by a thin film of electro-optical material that changes its optical properties in response to electric signals, a step toward more compact, high-speed and precise spatial light modulators that could be used in everything from imaging to virtual reality, quantum communications and sensing.

LG Innotek announced its Gumi (Korea) plant has obtained a Platinum level Zero Waste to Landfill (ZWTL) validation, a global resource recycling verification.

Nanya will invest $71 million to expand production of ABF substrates at its factory in Shulin.

Panasonic ordered the Zuken CR-8000 series for its imaging business unit sites.

Samsung Electronics has discontinued DDR2 memory and is on track to stop making DDR3 chips within the next two years, according to industry sources.

SnapEDA and **Ignion** collaborated to release CAD models for Ignion's entire antenna catalog.

The US executive order aimed at improving the nation's cyber security directs each federal agency, including each military department, to "develop a plan to implement zero-trust architecture." The same principles can be applied to secure embedded computing systems.

DuPont to Acquire Rogers in $5.2B All-Cash Deal

CHANDLER, AZ – DuPont has entered into a definitive merger agreement to acquire Rogers Corp. in an all-cash transaction that values Rogers at approximately $5.2 billion.

Rogers' shareholders will receive $277 in cash per share, representing a 33% premium over Rogers' closing share price on Nov. 1, and a 46% premium to the one-month volume-weighted average share price.

Rogers' board unanimously approved the agreement and recommends shareholders vote in favor of the transaction.

The transaction is expected to close in the second quarter of 2022, subject to customary closing conditions, including approval by Rogers' shareholders and receipt of regulatory approvals. Following closing, Rogers will be integrated into DuPont's Electronics & Industrial business unit.

"Rogers is a recognized global leader in advanced materials solutions, and this combination with DuPont will help accelerate our long-term growth in EV/HEV, ADAS and other key markets," said Bruce D. Hoechner, president and CEO, Rogers. "Our combination with DuPont, a proven leader in technology-based materials, provides resources and support to allow Rogers to scale for success. Rogers is a natural fit with DuPont, and this combination will create an exciting next chapter for Rogers' customers, employees and partners."

"Rogers is a results-driven organization with excellent technical expertise and deep customer relationships that align well with DuPont's leading innovation and applied material science capabilities," said Ed Breen, executive chairman and CEO, DuPont. "The combination of Rogers with our Electronics & Industrial business further strengthens our market-leading portfolio and ability to bring new solutions to exciting end-markets." (CD)

Ventec Finalizes Holders Asset Buy

LAMINGTON SPA, UK – Ventec International finalized an asset purchase agreement with Holders Technology on Oct. 21. The transaction completes Ventec's acquisition of a range of PCB assets owned by Holders Technology's German and UK operating subsidiaries.

Under the terms of the agreement, Ventec will integrate some of Holders Technology's specialist materials into its current portfolio of PCB base material solutions. The complementary product lines include entry and backing materials for drilling and routing applications, lamination accessories (release films) and copper foil for lamination applications. No financial terms were disclosed.

As of Oct. 1, Ventec officially took ownership of the fully tooled and equipped manufacturing site for backup and entry material in Kirchheimbolanden, Germany, with employees transferring to Ventec as part of the agreement.

"The acquisition forms an integral part of our global growth strategy," said Mark Goodwin, COO, Europe and Americas, Ventec. "5G, the Internet of Things, vehicle electrification and advanced LED applications are just some of the driving forces of the increasing demand for reliable, high-quality PCB base materials. With the acquisition of some of Holders Technology's specialist material solutions and expertise, we are even better positioned to implement our long-term growth strategy and to offer a one-stop shop for our diverse range of customers from industries such as automotive, industrial, medical and mil/aero." (CD)

Mitsubishi Materials, U-MAP to Develop AlN Ceramic PCB for Power Modules

TOKYO – Mitsubishi Materials is jointly developing an aluminum nitrite ceramic printed circuit board for power modules with U-MAP, a materials venture from

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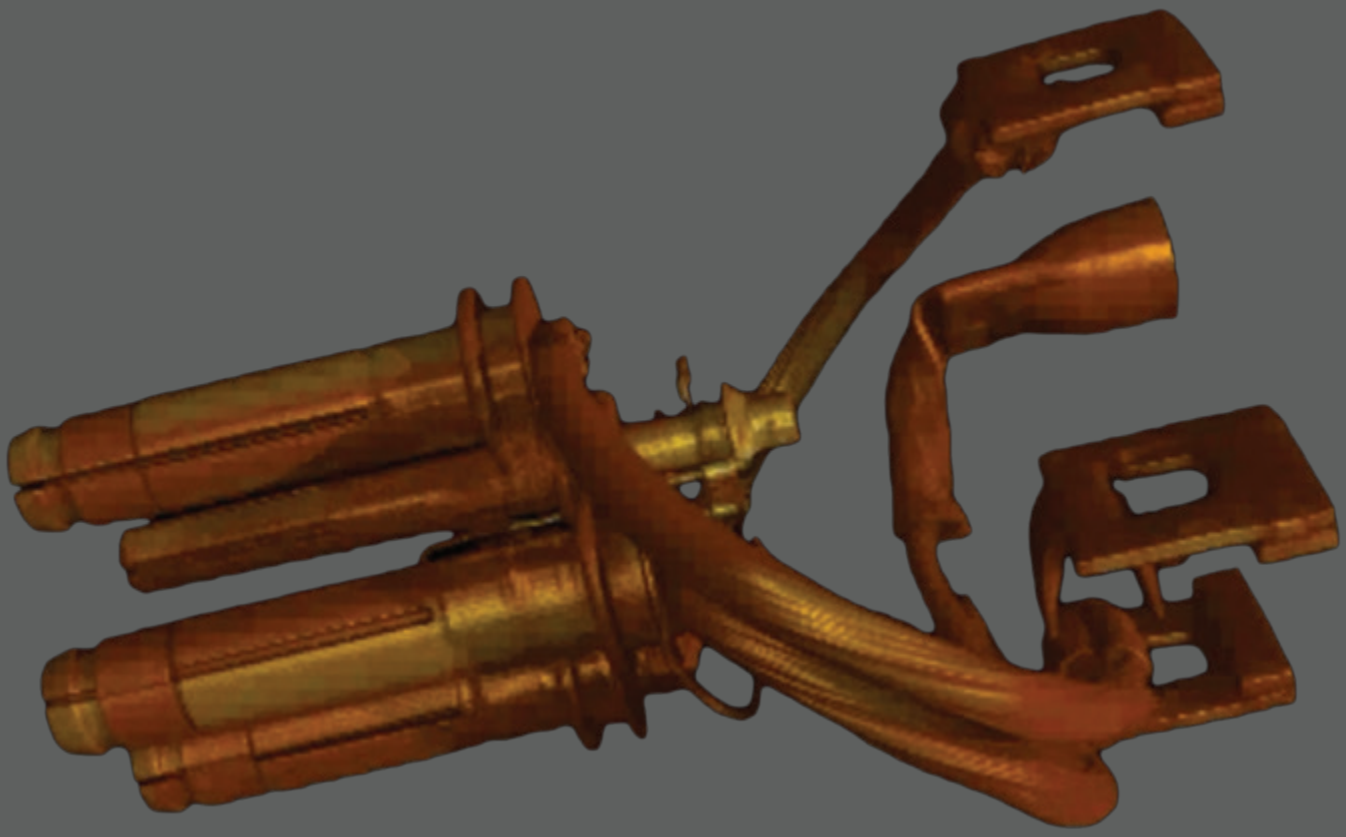

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CA People

Arch Systems named **Jon Gruett** senior sales consultant.

AIM Solder appointed **Jennifer Fijalkowski** as technical marketing engineer. She has a bachelor's in chemical engineering from the University of Rhode Island and is a certified Lean Six Sigma Green Belt.

MacDermid Alpha named **Steve Williamson** business director – East region.

PDR named **Jack Harris** as North American sales manager. He has with more than 35 years' experience as an independent representative and factory sales management executive.

Flex hired **Cameron Carr** as chief strategy officer. He spent the past decade at Microsoft, more recently as head of competitive strategy for the US.

Insituware announced **Charlie Kempner** as North American sales manager. He was previously a business development executive with Neo Tech and Rocket EMS, among other firms.

KIC hired **Wesley Ueoka** as R&D manager. He has a bachelor's from MIT with a focus on electrical engineering and computer science, and worked for Trex Enterprises for more than 18 years, most recently as director of software development. KIC also promoted **Gerardo Gallegos** to service manager Americas and Europe. He joined KIC in 2015 after 10 years at Jabil.

Koh Young America named **Joel Scutchfield** general manager of SMT business operations. He joined Koh Young seven years ago following more than 25 years in engineering and sales for TI, UTE, Panasonic and as owner of Process Solutions Associates.

Saki Corp. appointed **Daniel Laue** regional sales manager. He has 15 years' technical sales experience in electronics manufacturing in account management with a focus on inspection and measurement solutions.

SigmaTron named **James Reiman** chief financial officer. He has extensive experience in senior finance roles, manufacturing, international business and SEC reporting.

Nagoya University.

Until now, Mitsubishi has provided insulated PCBs with high reliability by joining different materials such as metal and ceramic. Meanwhile, U-MAP has discovered adding Thermalnite can provide AlN ceramic substrates with high thermal conductivity and high mechanical characteristics.

By combining these technologies, the firms aim to develop an AlN ceramic PCB, offering higher heat dissipation performance and reliability than the Si3N4 ceramic PCB.

The PCB is expected to aid in a more compact and higher-power-density power module. In addition, improvement of heat dissipation will allow other components and materials used for power modules to be smaller. (CD)

Cicor Adds to European Footprint with Axis Acquisition

BRONSCHHOFEN, SWITZERLAND – Cicor Group acquired 100% of the shares of Axis Electronics for an undisclosed sum.

With this acquisition, Cicor expands its European footprint into the UK. Cicor plans to integrate Axis into the global engineering and manufacturing network of the Electronic Solutions division.

Axis is a UK-based electronics manufacturer, focusing on the aerospace and defense sectors. Cicor will reportedly become a top-five EMS provider in aerospace and defense in Europe and will continue operations in Bedford, UK, retaining all 180 employees there.

The acquisition is expected to increase Cicor's sales approximately 15% on an annualized basis.

The closing of the transaction is expected in 2021 and is subject to customary closing conditions. (CD)

Nano Dimension Acquires Essemtec

SUNRISE, FL – Nano Dimension has signed and closed a definitive agreement to acquire Essemtec for $15.1 million in cash, with up to $9.7 million more to be paid over 14 months based on pre-agreed performance-based formulas.

Essemtec posted 2020 revenue of $17.2 million. Revenue for the eight months ended Aug. 31 was $15.4 million. Backlog as of Sept. 17 was approximately $6.9 million.

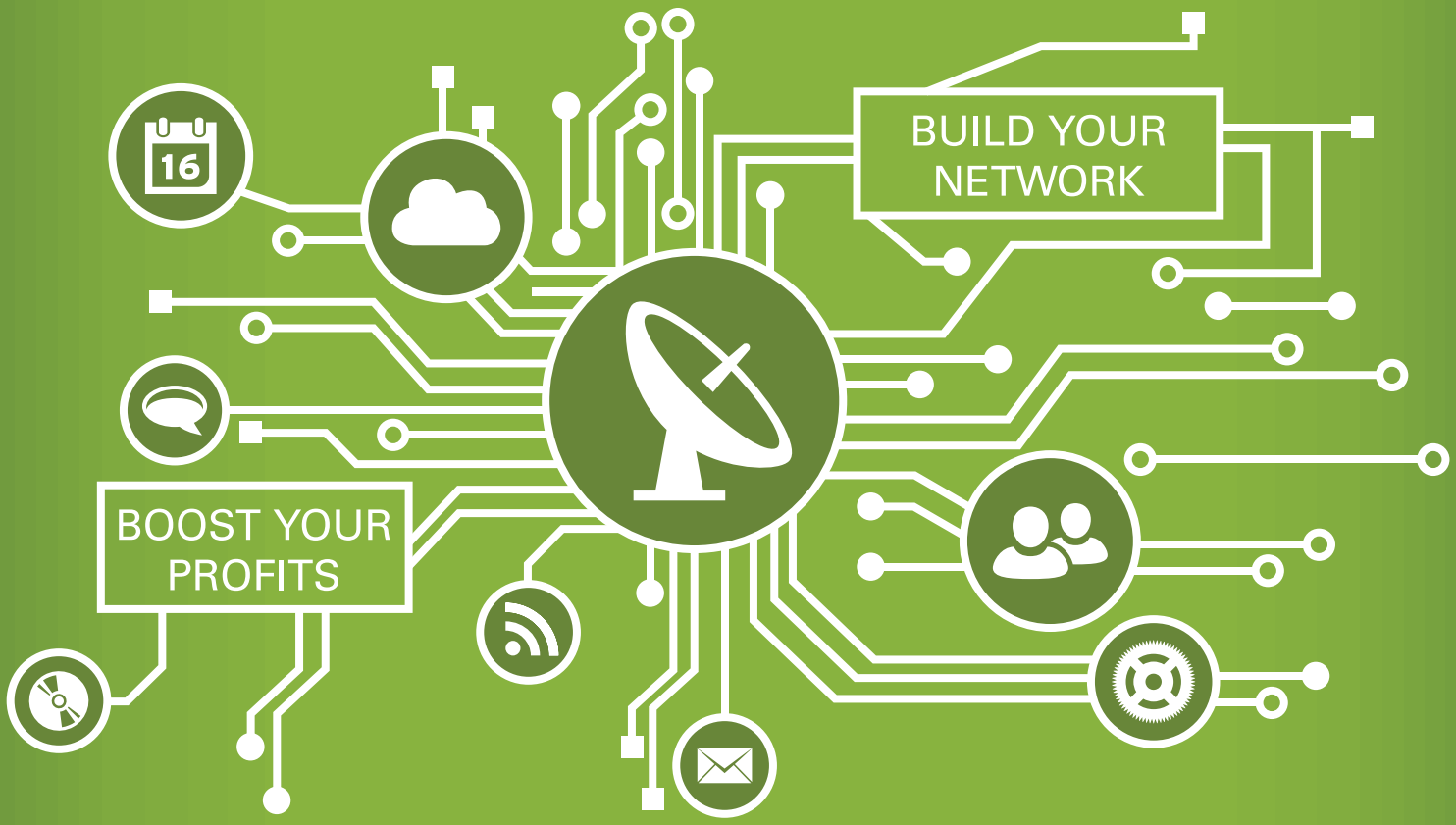
"It is an exciting combination of two technology leaders serving the PCB and wider electronic industry segments," said Franz-Xaver Strueby, CEO, Essemtec. "The combination of Nano Dimension's strength in the Americas with Essemtec's strong presence in Europe will enhance both product lines. Additionally, I believe the merger of the technologies will yield enormous influence and transformational momentum in the world of 3-D printed electronics and assembly."

Essemtec's staff and management remains intact, supported by Ziki Peled, COO of Nano Dimension.

"Essemtec's present products fit Nano Dimension's PCB and PCB assembly markets, as well as the original equipment manufacturers' verticals we serve," said Yoav Stern, chairman and CEO, Nano Dimension. "As such, we hope to leverage the distribution channels and go-to-market efforts of both organizations. Our mutual vision is to merge the technologies of our microelectronic 3-D fabrication machines for Hi-PEDs (high-performance electronic devices) with Essemtec's fuller suite of in-fabrication-process-equipment-assembly capabilities."

Separately, Nano Dimension named Greg Caldwell vice president of global marketing. Caldwell brings extensive experience in building and leading customer-centric marketing organizations in both the additive and traditional manufacturing

The *Circuits Assembly* *Directory of EMS Companies*



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CA Briefs

Apple added 100 more suppliers to its clean-energy pledge, bringing the total to 175.

Apple is looking to diversify its assemblers for the Mac series to include not only **Quanta Computer** and **Foxconn** but also a few China-based suppliers, according to reports.

Daburn Electronics, a manufacturer of wire, cable and electronic components, announced the acquisition of **EMSE,** a medical air and vacuum system design and manufacturing company.

Graco opened its South China Innovation Center in Dongguan City, focused on serving the electronics industry.

H2 Equity Partners will acquire distributor **Acal BFi** for total cash considerations of GBP 50 million.

Infestos has acquired 86% of the shares of **Neways.**

Intel, Samsung, and **TSMC** have threatened to pull the plug on US factory plans unless government subsidies are on the table.

LeeMAH Electronics installed an **ITW EAE** Electrovert VectraES wave soldering machine in Texas.

Naprotek has completed its acquisition of **SemiGen,** a privately held maker of RF/microwave components.

Omron is investing in **Techman Robot,** a manufacturer of collaborative robots in Taiwan and a subsidiary of **Quanta Computer.**

Precision Graphics will invest $5.1 million in a new EMS plant in Snow Hill, NC, with plans to hire 70 staff.

Russel Industries, parent of **Prima Electronic Services,** acquired North Wales-based **RAM Innovations.**

Safran Electronics & Defense opened a 4,580 sq. m. R&D center in France focused on developing high-integration electronics technologies.

Samsung plans to triple foundry chip production capacity by 2026.

Shenmao Technology began shipping lead-free solder paste used in production of low-earth orbit satellites to be launched by **SpaceX.**

The **United States Army** is pushing back the date when it plans to field augmented reality glasses from **Microsoft** but remains "fully committed" to the contract worth up to $21.9 billion.

Yamaha Motor Robotics SMT Section named **Micropak** distributor in Pakistan.

industries. He held various senior-level roles in marketing and sales at Microsoft, Sun Microsystems, Hewlett Packard, and Dell Technologies. Most recently, he was head of global marketing and sales enablement at Anark. (CD)

CIRCUITS ASSEMBLY Reopens SEA Registration

ATLANTA – CIRCUITS ASSEMBLY has reopened registration for its annual Service Excellence Awards (SEAs) for EMS providers and electronics assembly equipment, material, service, and software suppliers. The 2022 program returns to its original format after a focus group of past participants emphasized the value of the feedback they receive from their customers.

Now in its 30th 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.

"Datest offers testing, engineering, analytical, and other value-added services, all geared to speed, flexibility, and results," said Robert Boguski, president, Datest. "We need a mechanism for obtaining meaningful feedback from customers on a regular basis. We also share that feedback with our AS9100 auditor. The CIRCUITS ASSEMBLY Service Excellence Awards are ideal for capturing those honest reactions that make us a better company."

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; and value for the price. For the first time this year, participants will be rated on flexibility/ease of doing business.

Also in 2022 is a new award category: the overall best-in-show winner.

All customer responses and ratings are tabulated and provided in a confidential report to the participating company.

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 on the show floor at SMTA International on Nov. 2, 2022, at the Minneapolis Convention Center. Awards and reports will be distributed there. Participants will also receive their report as an Excel file after the show.

For more information, visit http://circuitsassembly.com/ca/editorial/service-excellence-award.html. To register, visit https://na.eventscloud.com/2022sea. (CD)

Scope Industries to Focus Solely on EMS

PERAK, MALAYSIA – Scope Industries will divest its oil palm plantation to focus solely on its electronics manufacturing services business, according to reports.


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Users Group progress
Cheryl Tulkoff
and Greg Caswell
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Scope is adding production capacity through the building of a fourth plant in Perak. The RM16 million ($3.8 million) plant will add 154,000 sq. ft. of EMS production space, for a total of 299,000 sq. ft. The plant is expected to be operational in July 2022.

Scope has recently expanded into completed electrical and electronics product assembly for customers in the US, South Korea and India. Products include smart speakers, air purifiers and payment terminals at gas stations. The company plans to add temperature controllers to its product list.

Inventec Appliances has brought in most of the company's major customers.

"The electronic segment is very wide, and it will continue to grow," said Jim Lee Min Huat, executive chairman. "If the retail side of the market keeps going up, then the supply of our consumer products will continue."

In the fiscal fourth quarter of 2021, Scope's manufacturing business had revenue of RM10.4 million ($2.5 million), an increase of 276% year-over-year. Profit after tax was RM1.3 million, compared to a loss after tax of RM822,000 in the fiscal fourth quarter of 2020. Year-to-date revenue was RM41.6 million ($10 mlllion) as of June 30, up 214% year-over-year. Profit after tax was RM5.6 million, compared to loss after tax of RM5.2 million for the fiscal year 2020. (CD)

Hanza Buys Helmut Beyers, Resumes Expansion in Germany

STOCKHOLM – Hanza Holding has acquired Helmut Beyers, an electronics manufacturer in Mönchengladbach, Germany, with approximately 150 employees.

The deal marks a restart for the EMS company's expansion in Germany, which was temporarily put on hold during the pandemic.

Hanza said it paid a price corresponding to the equity in the company, which according to preliminary financial statements amounts to EUR2.7 million ($3.14 million). An additional purchase price linked to an expected increase in sales from the current level for fiscal 2022 and 2023, up to a maximum of EUR2.5 million ($2.9 million). Transaction and integration costs are estimated to total approximately SEK10 million ($1.16 million), which are mainly expected to be charged to the fourth quarter of 2021.

Beyers has estimated sales of approximately EUR18 million ($20.9 million) in 2021, down approximately 10% from 2020 due to the pandemic. Profits have also been negatively affected, and the company currently operates at a zero margin.

Hanza has a production facility in Remscheid, Germany, which offers product development, final assembly and manufacturing of mechanics and electronics. The new production unit in Mönchengladbach is located about 7 miles from Remscheid and contributes both competence and capacity within electronics manufacturing.

"Our concept provides us with a good order intake in the Nordic markets, and we have continuously strengthened Hanza's other manufacturing clusters," says Erik Stenfors, CEO, Hanza. "During the pandemic, we have been waiting for the German market to reopen. Now we have reached the starting point for expansion in Germany, and we are adding a modern electronics factory in line with our cluster strategy."

Beyers' management will remain in their positions and continue to operate the factory.

"We have kept a close dialogue for some time and have also visited Hanza's cluster in Sweden, which has showed us the great benefits that exist with complete and local manufacturing," says Wolfgang Beyers, CEO and former main owner of Beyers. "Hanza's combination of focus on business logic and focus on employee welfare was ultimately the deciding factor. We look forward to contributing and becoming part of the Hanza Group." (MB)

GPV to Expand Manufacturing in Sri Lanka

NEGOMBO, SRI LANKA – GPV last month broke ground on a new manufacturing plant in Sri Lanka.

The site will add 11,300 sq. m. of production space to its current operations once completed in the first quarter of 2023.

The EMS company had paused the plan because of Covid-19.

"Our new factory will be a state-of-the art facility fitted for electronics manufacturing with room to grow, as well as room to develop cable harness manufacturing. Our many employees also look forward to the upgraded functionality," said Chandana Dissanayake, managing director, Sri Lanka.

"A strong presence on the Asian continent is important for us, as well as for our globally oriented customers," said GPV CEO Bo Lybæk. "GPV Electronics in Sri Lanka is fully certified within ISO 9001/14001/45001, and from here, we provide technology services, with special focus on our Swiss and German customers. The expansion in Sri Lanka is the first step in our master plan to expand and thereby also make room for our continued growth." (CD)

ECIA: 'Nov. Outlook Points to Strong Decline in Expectations'

ATLANTA – After showing a relatively stable, modest decline in overall sentiment between June and October, the November outlook in the latest results from ECIA's Electronic Component Sales Trend surveys points to a strong decline in expectations in the coming month.

While the average electronic component sales sentiment index declined by an average of three points per month in the prior four months, the average dropped over 12 points looking from October to November. The overall component index still shows a positive sentiment looking ahead. However, the outlook for November has now declined to 107.3 from its peak in March of 157.7. Looking at expectations from the perspective of the end-market average, the decline is more precipitous as it collapses from 118.1 in October to a 101.3 expectation for November. From the end-market perspective, the outlook for November monthly growth is essentially flat.

Distributors and manufacturer representatives report a more pessimistic outlook than manufacturers.

Analog ICs and discrete semiconductors show the most promising expectations for growth in November. Otherwise, the component subcategories have similar low-growth expectation looking ahead.

"Market growth appears to have moved to a new, lower phase of sentiment compared to the prior 15 months," said Dale Ford, chief analyst, ECIA.

STORAGE AT CAPACITY

Trends in the US electronics equipment market (shipments only)	% CHANGE JUL.	AUG.	SEP.	YTD%
Computers and electronics products	0.1	0.3	0.8	6.6
Computers	1.1	-1.4	-4.0	2.8
Storage devices	-3.7	-1.6	1.1	31.9
Other peripheral equipment	5.9	-1.7	3.2	5.4
Nondefense communications equipment	0.1	0.7	0.3	9.2
Defense communications equipment	0.0	-2.5	1.3	4.0
A/V equipment	10.3	-1.8	9.5	-1.6
Components[1]	2.0	1.0	3.2	6.3
Nondefense search and navigation equipment	0.9	-0.7	-0.2	2.8
Defense search and navigation equipment	1.1	-0.6	-0.8	2.8
Medical, measurement and control	-0.8	1.2	0.1	7.0

[r]Revised. *Preliminary. [1]Includes semiconductors. Seasonally adjusted.
Source: U.S. Department of Commerce Census Bureau, Nov. 3, 2021

US MANUFACTURING INDICES

	JUN.	JUL.	AUG.	SEP.	OCT.
PMI	60.6	59.5	59.9	61.1	60.8
New orders	66.0	64.9	66.7	66.7	59.8
Production	60.8	58.4	60.0	59.4	59.3
Inventories	51.1	48.9	54.2	55.6	57.0
Customer inventories	30.8	25.0	30.2	31.7	31.7
Backlogs	64.5	65.0	68.2	64.8	63.6

Source: Institute for Supply Management, Nov. 1, 2021

KEY COMPONENTS

	MAY	JUN.	JUL.	AUG.	SEP.
Semiconductor equipment billings[1]	53.1%	59.2%	49.8%	37.8%[r]	35.5%[p]
Semiconductors[2]	26.2%	29.2%	29.6%	30.0%[r]	27.6%[p]
PCBs[3] (North America)	1.11	1.15	1.29	1.48	1.25
Computers/electronic products[4]	5.24	5.26	5.27	5.26[r]	5.26[p]

Sources: [1]SEMI, [2]SIA (3-month moving average growth), [3]IPC, [4]Census Bureau, [p]preliminary, [r]revised

Hot Takes

- Two-thirds of **manufacturers were forced to raise prices** in 2021, and 71% expect to have to do so again in 2022. Shortages and supply chain and other issues have led manufacturers to increase costs by an average of 14.5% this year. Firms expect to raise prices another 7-8% next year. (IPC)
- **North American EMS shipments** in September were down 9.9% year-over-year and 0.8% sequentially. (IPC)
- **Global shipments of traditional PCs** (desktops, notebooks and workstations) reached 86.7 million units during the third quarter, up 3.9% year-over-year. (IDC)
- Contract prices of **NAND flash products** are expected to undergo a marginal drop of 0-5% sequentially in the fourth quarter as demand slows. (TrendForce)
- **Refined tin use** in 2020 decreased 1.6% to 361,900 tonnes, with a preliminary estimate of 7.2% expansion during 2021, attributed to recovery from the Covid-19 pandemic. (ITA)
- The **global flip chip** market is poised to grow by $5.6 billion during 2021-2025, progressing at a CAGR of 4.53%. (ResearchAndMarkets)
- The **global power electronics** market is expected to grow from $35.5 billion in 2020 to $48.3 billion by 2027, at a CAGR of 4.5%. (AllTheResearch)
- **Worldwide IT spending** is projected to total $4.5 trillion in 2022, an increase of 5.5% from 2021. (Gartner)
- **Smartphone shipments** fell 6.7% year-over-year to 331.2 million in the third quarter. (IDC)
- Taiwanese producers are still considering whether to expand capacity for **BT boards,** while ABF capacity is set to increase. (TPCA)
- **Worldwide sales of semiconductors** totaled $144.8 billion during the third quarter, an increase of 27.6% year-over-year. (SIA)
- After five quarters of growth driven by accelerated buying for remote work and learning, **global shipments of Chromebooks and tablets** recorded their first decline since the onset of the pandemic in 2020. (IDC)
- **The global PCB substrate value** for the first half of 2021 was approximately $6.37 billion, with manufacturers in Taiwan, Japan and South Korea accounting for almost 90% of the market. (TPCA)
- **The wearable technology products market** has doubled in annual revenue since 2015, to nearly $80 billion in 2020. (IDTechEx)
- Fifty-eight percent of organizations recently surveyed indicate their immediate focus is on increasing **supply chain visibility** to help create operational resilience. By the end of 2021, 60% of all manufacturing supply chains will have invested in the technology and business processes necessary for resiliency, resulting in productivity improvements of 25%. (IDC)

Planning is Always Challenging. This Year It May Be Worse.

A counterargument to cutting staff and inventory.

ONE OF THOSE rituals that takes place around this time is developing the business plan and related budgets for the new year. Deciphering the crystal ball, discerning optimism from reality in the sales forecast, determining budget capital investments and human resource needs, and so on, is always a complex task. The very unusual pandemic/post-pandemic world we are now in makes it even more so.

As we look to 2022, we see some unusual and especially onerous hurdles: a more strained supply chain, deteriorating consumer sentiment, increasing inflation, and segments of the economy still reeling from the worst days of the pandemic. While no single hurdle can be compensated for, the combination of threats can tempt the planner to take a conservative approach and decide it's time to hunker down.

But what does a conservative approach to planning and budgeting really mean? Typically, plans might include reducing inventory, cutting back capital spending and trimming staff (or hours worked by staff) to "right size" expenditures with the projected (feared?) lower levels of business. All are prudent steps that in normal times should be considered when an industry or the economy shows symptoms of fatigue. The problem is these are not normal times!

Reducing purchases to trim inventory levels works great when future business is questionable and if needed supply is readily available. It might be a very risky strategy to pursue, however, when the supply chain is stretched, and spot shortages of critical materials and components are reported almost everywhere. One could argue that, if anything, now is a prudent time to procure extra inventory as a hedge, especially if the global supply chain further deteriorates, causing more material shortages and price inflation. Having enough materials available to satisfy customers, but not too much inventory burning up critical working capital, is always a balancing act. The challenge is greater than ever to reconcile a measure of thriftiness in a slowing economic environment, while maintaining what is needed to service (read: retain) critical customers.

Investing in capital equipment is another area where traditional thinking might say to cut back to only what is essential or replacement items. Again, however, these unusual times possibly call for a different strategy. When uncertain about the future, the smart play has historically been to cut spending and not take on additional debt. Yet, when economic pundits agree the historically low interest rates most likely will not continue, and lead times for equipment are stretched about as far as the supply chain is, now *may* be the time to invest in capital equipment. Maybe the small ticket items could be pushed off, but for the big-ticket equipment that requires leases or bank financing, the savings over three to five years from today's low finance rates may well be the most prudent investment decision a company can make. Planning and budgeting for such investments more than ever require a sober look at backlogs, customer forecasts and resulting cash flow.

Budgeting staff may be the most difficult aspect of planning. In even the best of times, one can plan to hire, but it's another thing to find the talent. Finding good people can take a long time. Ditto for training and assimilating them into the organization. Long before Covid changed the business landscape, there were cries about a looming crisis that would impact all companies in every industry. That impending crisis is the replacement of a historically unprecedented number of retiring baby boomers with far fewer people in the pipeline of younger generations to fill those positions.

For those in manufacturing, the needs and lack of availability of qualified talent is well documented. Many companies have utilized creative means to attract and train the next generation. Regrettably, it is equally well documented that many young people do not like set hours or working every day and prefer far more personal flexibility at work than most manufacturing businesses can offer. During the pandemic, work from home and flexible work rules were employed to keep companies running and product being manufactured. A result of this is that many younger people prefer to work from home than go into an office. Rather than reducing workplace flexibility, it increased during the pandemic far more than anyone thought possible.

The pandemic accelerated one other trend: Many of the about-to-retire "baby boomers" chose to leave the workforce earlier than planned to avoid exposure to Covid-19 or assist in the care of family members.

In uncertain times, one of the most tempting plans of action is to reduce head count to the "right size" for anticipated level of business. Implementing such a strategy today might be devastating, however. Many industry companies have reported sizable staff reductions, citing business uncertainty and supply chain issues. Those companies that spent valuable resources to identify, hire and train talent, just to cut them, may be giving the competition the greatest gift possible:

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Tariffs Are Hurting the US Electronics Industry

Government-imposed inflation hurts the overall domestic market.

THE OFFICE OF the United States Trade Representative (USTR) is considering whether to reinstate Section 301 tariff exclusions that expired late last year on certain Chinese-origin products, including some printed circuit boards.

If granted, the exemption will pertain – as it did before – only to 2- and 4-layer rigid PCBs made of epoxy-glass. The tariff will continue to apply to single-sided and higher-layer counts, flex circuits, and other substrates such as aluminum or ceramic.

While 2- and 4-layer boards represent only a narrow portion of the PCBs manufactured in China, an exemption continuance will provide some relief to many OEM and EMS companies struggling with supply chain challenges.

The tariff aims to encourage "reshoring" by making domestic PCB manufacturing more appealing.

When Covid and all its associated supply chain issues came along, it emphasized just how much the PCB industry depends on China. But tariffs are essentially a punitive measure that interferes with PCB buyers' decisions about what is best for their operations and their customers. And in the end, who benefits?

It's *not* PCB buyers in the United States. It's not American consumers.

Even with a 25% tariff, PCBs built in China remain competitive against domestic pricing. And even if board buyers prefer to spend their money on American-built product, the domestic PCB industry lacks the manufacturing capacity to meet all the demand.

As a PCB broker who mainly procures boards from China, I have customers who have asked me to find domestic sources as a backup to secure their own supply chains. These customers understand they will have to pay a higher price for product manufactured in the US.

But from my experience, most domestic fabricators prefer small- to midrange-volume orders, and they are hesitant to even consider the mid-to-higher-volume business because of their own capacity issues.

What I've found is that many either decline to bid on these projects, or they suggest my customers use one of their offshore manufacturing partners. Many domestic PCB manufacturers offshore some of their production orders to meet customer demands.

You read that right: PCB buyers who would like to buy American are often forced to go offshore by domestic manufacturers themselves.

The protectionist tariff is intended to encourage board buyers to buy from American companies. Because domestic capacity is limited, however, the artificial demand created by the tariff encourages American PCB builders to raise their prices.

Essentially, for the far more numerous PCB buyers (and their customers, American consumers), tariffs just mean higher prices, whether the boards come from offshore or are manufactured domestically.

Another obstacle to bringing PCB manufacturing back to the US is that much of the high-tech PCB equipment required to increase domestic capacity is no longer manufactured here.

The US produces a limited amount of PCB laminate material, and most of the chemistry required for PCB manufacture is produced overseas. Even manufacturers who build PCBs on American shores are reliant on overseas sources.

To truly bring PCB manufacturing back, we would also have to bring back manufacturing in a variety of related industries.

The Trump administration and now the Biden administration have taken measures aimed at bringing manufacturing back to the US, but realistically, when will that happen? And how much longer will we ask domestic PCB buyers who must rely on China for product to pay a tax for boards they cannot get made in a reasonable amount of time in the US?

With all the supply chain issues of higher material costs and freight surcharges that domestic EMS and OEM companies are currently facing, continuing with this government-imposed inflation of PCB pricing hurts the overall domestic market.

Rising raw material and freight costs are hard to overcome, but I do know several OEMs who are considering "tariff engineering" by moving orders presently being built by US EMS firms to assemblers in either Canada, Mexico or Central America.

Tariffs fly in the face of a free market. Protectionist strategies won't solve the problems we face. The negative effects of the tariff will lead to more "nearshoring," and that's not good for American jobs.

History has shown that tariffs tend to increase domestic prices and raise costs to businesses and consumers. It is a double-edge sword that ends up usually cutting the wrong way. □

GREG PAPANDREW has more than 25 years' experience selling PCBs directly for various fabricators and as founder of a leading distributor. He is cofounder of Better Board Buying (boardbuying.com); greg@boardbuying.com.

Preparing for the Pivot

Be quick with customer forecast review meetings when orders slow.

I BELIEVE 2022 will be a pivotal year for most electronics manufacturing services (EMS) providers. Material lead-time and availability issues are slightly improving, and supply-chain executives are cautiously optimistic about a return to normal in mid-year as demand levels out and additional chip manufacturing capacity comes online. That said, a return to normal brings its own set of challenges, if past cycles of this nature are considered. It is particularly important for EMS program managers to start considering the issues likely to come with a mid-year pivot:

- Forecasts on some products may drop substantially. While component manufacturers, distributors and EMS companies typically have checks and balances to identify situations where customers have increased forecasts as a hedge against allocation, uncharacteristic demand spikes make those controls iffy at best. Most EMS companies have orders into 2022 and exceptionally high levels of inventory in-house. Any downward trend in forecasts should trigger a forecast review meeting with the customer to determine how rapidly orders and inventory levels need to be adjusted.
- Sourcing strategies will be reviewed. OEMs are reluctant to move to new suppliers when material constraints are this bad. That said, once the situation starts to normalize, customers who are unhappy or have decided to shorten their supply-chain pipeline will shop and move to other EMS providers. Most program managers know who their vulnerable customers are. This is the time to begin internally reviewing contractual inventory liability, notice and termination clauses to determine what protections are in place should a customer decide to leave on short notice. It is also the time to have internal discussions on options for building better relationships with vulnerable customers. Higher-level management meetings or corrective action plans that leverage an improving materials situation may be options that can help keep a dissatisfied customer.
- Engineering support activity requirements may increase. During 2021, many OEM product development teams focused on redesign to address existing product component availability issues rather than new product design. That will change in 2022. EMS companies whose business models provide close alignment with OEM engineering teams should review planned resource levels. Begin conversations with customers that postponed new products during 2021 to determine their 2022 plans.
- Demand spikes will continue in some markets. The automotive industry has cut production due to component availability issues. The drivers of demand in that market haven't gone away, so it is likely that industry will continue to see demand spikes once component availability improves and they work to make up lost revenue. Appliances have also been backlogged. That may be exacerbated if winter or spring weather events drive a higher replacement need. Government incentives for Made in America products, green energy investment or infrastructure replacement could also drive higher-than-historical demand. Strategic planning meetings should consider what a normal materials market and unplanned growth in customers with those industry dynamics would require in terms of additional production or support resources.
- Costs will continue to increase. Costs aren't likely to go down anytime soon. Are internal standard labor costs up to date? Are quoting model assumptions for freight and consumables not listed individually on the bill of materials correct? Now is a good time to adjust if that hasn't been done.
- Inventory liquidation may need to be done. While right now it is hard to imagine a world where excess inventory exists, considering that even brokers are running out of parts, it will eventually happen. Monitor inventory levels on parts that are at higher risk for becoming inactive should a market shift occur.

It is also time for program managers to review the things they can control:

- Are customers unhappy about issues outside of material availability? The material constraints have created a significant workload across most organizations. That means internal resource constraints may be causing customer disappointment that falls outside of material availability. Now is a good time to review accounts to determine if there are unaddressed, fixable service issues.
- Is another facility a better fit for your customer's needs? If customers are reviewing their sourcing strategy, are your company's facilities in alternate locations in the mix? Customers can become narrowly focused over time, making assumptions about their EMS provider that just consider the facility they are using and the services their current product requires. When the market begins to normalize, it is a good time to discuss overall company resources and customer evolving requirements to ensure that

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opportunities aren't missed due to incorrect customer assumptions about capabilities or location options.

- Are you adequately focused on cost reduction within your programs? You may not be able to control rising material, freight, utility or labor costs, but you can identify and eliminate internal inefficiencies that add cost. Can communications or reporting be improved? Is revenue delayed because items that are ready to ship don't get out of shipping on schedule? Are there opportunities to reduce redundant costs by moving work done at the OEM to your facility? Can shipping legs be eliminated by adding fulfillment or repair depots? This is a good time to review accounts for these types of opportunities.

The materials situation isn't fixed yet, and program team workloads will continue to be crazy for months. Program managers who find the time to plan for a mid-year pivot will likely have a better 2022 than those who don't. ▫

ROI, continued from pg. 16

available talented employees! The difficulty in today's economic environment is understanding the collateral damage making otherwise traditional human resource planning decisions may have on your business.

Be it inventory levels, capital investment spending or human resource needs, planning and budgeting in uncertain times is challenging. In today's unique vortex of supply chain disruptions and lack of available skilled labor, determining the best course of action may be more demanding than ever. This year think long and hard as you do your business planning and budgeting. ▫

Regarding the Use of Core Vias in a PCB Design

Buried and blind vias solve most HDI routing studies.

A POPULAR ANSWER to a high density interconnect (HDI) problem is to start with a simple printed circuit board and then proceed to add on layer after layer. This is known as a sequential lamination process. For the sake of balance, the layers are always added to the top and bottom in pairs. A notation we use describes the sequence.

A typical example is a board that starts with N number of layers in the initial pressing and has three additional lamination steps after that. Each additional pressing adds two layers: one above and one below the previous step. The shorthand for that type of construction is 3+N+3 or simply a 3N3 stack-up.

We could get more detailed and substitute the actual number of layers in the first pressing for the N and call it, for instance, a 3+4+3 board for an even 10 layers. The fact is the fabricator is more concerned about how many layers are added afterward than how many are used in the first step **(FIGURE 1).**

Three is not a random number. Fabricators that cater to the HDI market have the 3N3 board as their sweet spot. How does one tune a factory to build a specific stack-up? It's an equipment thing. Panels go through the etching and plating tanks with a short dwell, while the chemical processes do their thing. Drilling, especially mechanical drilling, is a little slower than some of the other batch processes such as screen printing.

Thus, for each plating line, there are four drills and one printer. In between those two processes are some of the most expensive pieces of equipment in the factory. Those items are the presses. Or, likely in the case of a smaller shop, the press. The press is the bottleneck. It is the main reason sequential buildup takes longer and costs more. Tour your local fabricator. The ratio of presses to drill stations is a tell of whether they focus on through-hole or high-density boards.

A shop with enough bandwidth through the presses can deliver on the 3N3 board, while keeping the other parts of the factory going at capacity. This level of technology is sufficient for most applications. Smartphones require a stack of microvias all the way through the board. This is a function of their chipset and the seriously tight packaging to make way for the battery. Their factory floor will reflect those needs.

The "core" of the matter. The "simple board" is complete, except for the lack of solder mask and silkscreen. The core is at least two layers but often more. We talk about core and prepreg materials, but this is a slightly different definition of core than that. Our core can be two layers, in which case there are overlapping definitions. We still call it a core, even when it consists of a core plus additional layers of prepreg. What eventually becomes the core via will start as a hole through a stack with multiple sheets of core material, if that is what the design requires. The core in this case is the product of whatever comes out of the first lamination cycle.

The materials for this initial building block can be woven glass for the completely rigid constructions or that plus polyimide for rigid/flex scenarios. In any case, the mechanically drilled holes in the core are filled with resin of the sort that makes up the space between the glass fibers in the dielectrics of the board. After filling, they are capped with copper, and the sequential lamination can begin.

Emphasizing that a core via starts as a through-hole via, the same process of plating up is required to deposit copper in the hole. This translates to using the larger minimum airgaps and line widths consistent with what is found on the outer layers versus typical innerlayer constraints.

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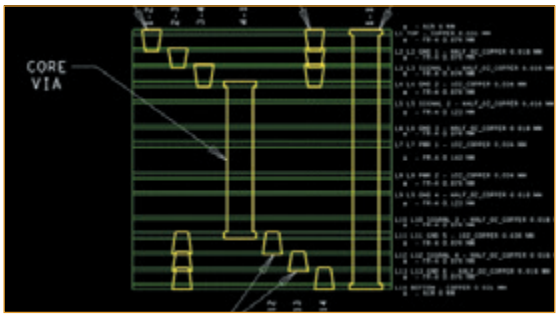

FIGURE 1. Copies of this 14-layer 3+N+3 board could be assimilated into a 42-layer board as an instance of what is possible with advanced stack-ups.

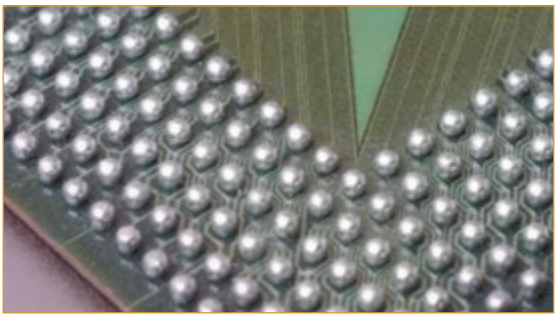

FIGURE 2. Increasing pin density drives the PCB to higher levels of technology. Sequential lamination boards are a mainstream answer in 2021.

Knowing thicker copper favors the wider geometries, it makes sense to dedicate these layers to power and ground nets that happen to also benefit from the thick copper and wide geometry. Naturally, the layers in between are the candidates for fine-line routing.

When the layer count gets hectic, multiple sub-boards are bound to be piled up such that core via spans are more like local elevators from a routing perspective. Grouping busses and associated power domains into dedicated sections will keep the cross-contamination down on these epic high-layer-count boards.

If the core is a multilayer stackup, it may be possible to create some microvias in the core section prior to adding the first additional pair of layers in the sequence **(FIGURE 3)**. Use a thin dielectric on the outer layers for the microvia to be manufacturable. You get a microvia that does not add a lamination cycle. That's like finding money!

If you like money, you should avoid trying to stack a microvia in the same location as the core via. That is one of the worst DfM transgressions. The exact distance between the core via and the adjacent microvia will vary. I'm guessing if you ask around, the preferred outcome is the two vias have a span between them equivalent to the airgap of differing nets. Normal via-to-via spacing for same-net spacing gives the fabricator a wide path to success.

That kind of thinking can run you out of options in some cases. Many chips are not built for lowkey circuit boards. Pushing it to the limit for same-net via spacing has the capture pads for the blind/buried and core vias tangent to each other, touching but not overlapping.

Be careful with overcommitting the transition layer. It will be busy with little snowman-shaped via pairs, so it's tempting to crowd them together. The real estate under a fine-pitch ball grid array (BGA) device can be precious. It may be wise to minimize their use under the device to those connections that pass through the board to a bypass cap or for some other compelling reason. Route away from the device on the layers that are accessible by way of the microvias, then make the jump with the bigger via where there is more room for them.

Stitching vias. Tending to the return paths involves many locations where there is a pattern of ground vias. The sooner you get to those details, the easier they are to implement. Wherever a trace goes through a transition, there should be a provision to tie the various reference planes together.

You may be called on to create a thermal path through the board. Think about leaving some dielectric material behind to maintain a level of impedance and structural integrity. Start with a concentration around the source but spread out as the vias are linked toward the other side of the board. I've never done it, but I don't see why you couldn't use a thermal paste via filler to increase the dissipation factor.

Lines of vias of any kind generate slots in the planes. Sometimes you're stuck and must do it. A little effort in those cases may be enough to break the slot into two smaller ones. The freedom of movement for the core via is better than that of the vias that are anchored to specific pins. Staggering the way they break out helps avoid magnetic coupling. A via is happy when it has a void of its own as it passes through a plane. Married couples, also known as differential pairs, are an exception, of course.

FIGURE 3. A 1N1+ stack-up with a core via from layers 2-5 and the "free" microvias from 2-3 and 4-5. Note the through-hole is technically for components rather than vias.

There you have it. Core vias are part of the foundation of a sequential buildup board. Their use implies one or more layers of buried and blind vias are in the mix. This is the mix that solves most HDI routing studies. Having one core via costs the same as having many, so, if you're already going that route, go ahead and live a little. ▫

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The course references general CAD tool practices and is vendor-agnostic. The instructor, Mike Creeden, CID+, has 44 years of industry experience as an educator, PCB designer, applications engineer and business owner. As Technical Director of Design Education at Insulectro, he helps OEMs and fabricators achieve design success for best material utilization. He has served as a Master Instructor for the CID+ IPC Designer Certification program, was a primary contributor to the CID+ curriculum, and founded San Diego PCB Design, a nationally recognized design service bureau.

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AS READERS OF this space may know, the Printed Circuit Engineering Association is acquiring the assets of UP Media Group. Once that happens, I'll become president of PCEA. Going forward, this column will focus on the ways PCEA is addressing issues of concern to our membership and the industry at large.

For the past year-plus, this column has been written by Kelly Dak, our erstwhile communications director, and Stephen Chavez, our chairman. In the next couple months, the PCEA is transitioning from an all-volunteer organization to one with a fulltime staff, which will allow the board of directors to focus on higher-level strategy. Steph's role, then will no longer be tied to monthly communications but rather leading the board in charting the goals and direction of the association. And filling the gaps is where I come in.

Think of the Printed Circuit Engineering Association as a "ground up" organization. We aim to advance the careers of professional engineers. We do this primarily through a peer-to-peer network where we offer training, technical knowledge, and career advice across the printed circuit engineering spectrum: design, fabrication, assembly, and test.

We have nearly 20 local chapters around the world (https://pce-a.org/chapters/) and are affiliated with multiple other trade associations, including SMTA and the European Institute of Printed Circuits (EIPC).

Those chapters engage in periodic meetings – in person and online – where they supplement their on-the-job training with tailored presentations from a host of industry experts. As a benefit of membership, PCEA is setting up a platform to make some of these presentations available on-demand. (More on that in a future issue.)

In the meantime, here's a sampling of the talks members have been treated to:

- Fundamentals of creating reliable PCBs
- How dielectric and conductor properties can affect high-speed PCB design performance
- PCB materials and their applications
- Designing for RF: tips & tricks from the PCB pros
- Next-gen line/space capability for PCB designs
- An overview of via fill
- Achieve optimal stack-up design considering process and electrical performance
- Microvias: Have you designed for reliability?
- How fabrication processes determine DfM guidelines
- The top 5 symbol and footprint mistakes that even professional engineers make
- Signal integrity effects of different PCB structures
- Artificial intelligence and machine learning basics and how they will affect PCB design
- Addressing the challenges of multi-board design
- Design and manufacturing developments to lower insertion loss and digital pair skew
- Rigid-flex PCB design
- Flex for 5G – why materials matter
- Model-based software design
- Modelado y simulacion de fuentes commutadas

No, your laptop isn't playing tricks on you. Those last two presentations are among those given at our chapters in Mexico, which are based in Monterrey and Nogales. Other chapters outside the US are in Toronto and the UK, and we are starting to affiliate with organizations in Australia and elsewhere.

At this point, you might be asking what all this costs. The answer is nothing. Individual membership in PCEA is free.

Some chapters have plans to resume live meetings. Others remain on the Web. Either way, PCEA meetings remain one of the most cost-effective ways to expand your professional network. Time and again, I hear from engineers that their opportunities for career advancement are limited, or their companies do not support outside training (or for that matter, inside training). While I believe that approach is short-sighted, after 30 years in the industry, I have found the most successful folks are the ones who focus less on talking about how things *should* be and more on carving out a solution that works for them.

PCEA meetings are exactly that solution.

If you are interested in presenting to one of our chapters, please let me know. ▫

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VR and AR Can Improve Lives as Well as Business Performance

Harnessing our technologies to assist humanity.

THERE IS A a technological solution for most things these days, and in this case virtual reality (VR) has been put forward to help new employees explore their working environment, find the locations of essential amenities, and experience lifelike introductions to the various activities and departments. The process can be completed quickly and efficiently, without the logistical challenges and delays that occur in the real world. It's also as cost-effective and easy to onboard a group as it is an individual, and can save section heads and other presenters from repeatedly taking time from their main duties to address the newcomers.

VR is not new, of course. What's happening is cases for using it in an ever-expanding variety of activities are becoming stronger as computing power and affordability increase. When a viable business case can be perceived, software application developers can get started, and a new market can begin – with all the new opportunities for technical and commercial development that come with it.

VR software geared toward corporate onboarding may be quite basic compared to what's happening at the leading edge of the technology right now. The drive to create increasingly immersive and more dynamic VR experiences is powered by human nature and is giving us innovations like VR suits, full-body wearables that capture motion in minute detail, as well as biometric information, and provide haptic sensations using transducers for force, vibration and ultrasound. Development has accelerated recently, and commercial products are now in the marketplace. Of course, we can expect equipment like this to enable exciting gameplay. However, there are other serious use cases in education, product design, and medical research, as well as training for diverse roles from sports people to surgeons, emergency first responders, and soldiers.

With internal climate control in a full body suit, all kinds of phenomena can be simulated, such as a cold wind, by combining temperature change and haptics. Adding electronic muscle and nerve stimulation, many other effects become possible. Further avenues for research include exoskeletons containing hydraulic and servo mechanisms that help accurately simulate walking and interacting with virtual objects.

These are great examples of the ways we tend to escalate our technologies. After a few development cycles, the grand new idea becomes the simple basic enabler for something far bigger and more complex, powered by technologies that are exponentially higher performing and more affordable than the preceding generations.

We can thank the Covid crisis for some recent developments in VR as the catalyst for online product showrooms and exhibitions that have been able to provide an authentic – although perhaps not 100% lifelike – visitor experience. These have enabled companies to overcome travel constraints to interact with customers, and to bring remote employees together to ensure progress against goals and maintain team cohesion.

VR's sister, augmented reality (AR), is arguably simpler and has more to offer immediately, particularly in industrial contexts. We saw Google Glass briefly enter the consumer world and disappear. It may return, depending on public acceptance and whether a truly useful application emerges. In industry, however, the properties of smart glass can make perfect sense, streamlining the delivery of essential information such as detailed instructions for assembly workers or maintenance crews: no looking for the book, no leafing through pages of instructions or navigating the on-screen menu. The information needed is served just in time, directly within the field of view, aided if necessary by visual cues such as color-coding and numbering. It's also easy to add AI to the mix, introducing the help of a virtual expert, or to connect to a remotely located human expert, leveraging the ultra-low latency of 5G to share the operator's field of view.

There have already been some powerful demonstrations showing what this technology has to offer. Smart eyewear that lets a ground crew at Singapore's Changi Airport view information about packages accelerates loading checks, reducing aircraft turnaround times. Apparently, loading can be 25% faster, cut from about one hour to 45 minutes. AR could also soon provide personalized assistance for travelers, presenting information such as walk times, directions, restaurants, and commercial offers via their mobiles.

You probably know by now my favorite focus is on harnessing our technologies to assist humanity and help more people enjoy longer, happier, safer lives. I'm excited to see how UNICEF is promoting AR and VR technologies through initiatives such as its innovation fund. The fund supports several VR companies seeking to make quality education accessible in countries and regions otherwise held back by connectivity constraints, and has also nurtured the VivoosVR virtual treatment tool. By delivering effective exposure therapy for people who otherwise struggle to get effective treatment, VivoosVR is helping restore mental health damaged by extremely traumatic events. I hope we will see exponential progress in these activities as we have in the more commercial aspects of AR and VR. □

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How to Select a Flex Circuit Supplier

All the pieces that add up to the right fit.

"I AM DEVELOPING a flexible circuit for my application and will soon be ready for prototypes, followed by production a few months later. A lot of flexible circuit suppliers are out there. How do I know if a vendor is reputable and will meet my needs?"

Many variables must be considered when picking a flexible circuit supplier. Do your homework and find a vendor that is a good fit for the project. It is advisable to also select a vendor that will support your program from prototype through production. Multiple vendors could build to the same Gerber files and overall specifications, but the end-product could have differences due to processing and material variations between suppliers. Switching fabricators midstream can introduce significant risk at a critical time between prototype and production. Following are the items I recommend learning about a vendor before making your sourcing decision:

Circuit application/performance class. This is more about the IPC performance class rather than specific application, but mil-aero, implantable medical devices, and so on generally are specified as IPC Class 3, while most everything else is Class 2. IPC Class 3 is the highest reliability and overall performance class and is usually specified when the product is used in a life-critical application. Class 3 product typically requires more stringent processing controls, QA, and documentation. Suppliers that primarily serve Class 3 users typically "stay in their lane" and build *all* products to Class 3 performance level regardless of the requirement.

Class 2 applications basically cover everything else, including medical diagnostic and surgical equipment, non-military handheld electronics (including cellphones), cameras, computers and other consumer electronics. Suppliers that primarily serve the commercial industry may shy away from Class 3 programs, which require additional controls and documentation the vendor might not support. But even if a Class 2 supplier crosses over and supports Class 3 product, don't expect Class 2 pricing! Class 3 circuits carry a premium regardless of where they are manufactured. As a general rule, US-based flex suppliers (meaning the actual manufacturing is performed in the US) support mainly Class 3, and Asia-based manufacturing operations support Class 2. My first questions to a potential supplier are what industries do they support, and what is the typical IPC class of their products?

Quantity and lead-time. How many parts are needed, and how fast are they needed? Very few suppliers support customers that need 25 pieces in a week or two *and* customers that need 10 million pieces a year. Many suppliers specialize in fabricating only small quantities and doing it very quickly (quickturn shops). Other suppliers are only interested in really large quantities (500,000 or more pieces per month). The rest fall somewhere in between. Most small-to-medium-volume fabricators also support prototype quantities but take longer than the quickturn shops. Finding a supplier that supports the quantities needed gives you a better chance of a good overall outcome. As mentioned, it is a good idea, if possible, to have your chosen supplier support both your prototype and production needs to reduce the chance of variations that could affect circuit board performance.

Price. Everyone wants the lowest possible price, but low-cost flex suppliers may lack in-depth engineering expertise to guide you during product development. A lot of "build-to-file" shops take a design and build it exactly as it is designed. Those shops typically do not ask about the application or the board function, which can help determine if the design could be improved, or if it will even function as it should. Flex suppliers with strong frontend engineering support are almost never the lowest cost but can help ensure anything built will work. Is it worth saving a few cents per circuit if it takes multiple builds to get something that performs as expected? Those additional spins to get a functioning design can significantly increase time to market.

Special requirements. If the flex design is exceptionally large (over ~24" in any dimension), or requires nonstandard materials, it may significantly limit the supplier base options. Large-format circuits present challenges ranging from raw material procurement to processing equipment limitations and overall handling. Suppliers that support these types of applications typically have custom processing equipment to overcome the limitations of standard PCB processing machinery. Flex designs that need to withstand very high temperatures require specialized high-temp materials that require lamination temperatures close to 300°C. This is well beyond what most suppliers' lamination equipment can support. While some vendors support these specialized requirements, the number is much smaller. Expect to pay a premium.

In the end, the issue is about finding a supplier that is the best fit and can support the needs you have. Weigh your potential supplier's frontend support, technical ability, cost, lead time, and quantity fit (in that order) to make the best decision. ❑

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Critical Success Factors for Implementing and Sustaining QUALITY MANAGEMENT SYSTEMS

Does sustained ISO 9001 and Lean Six Sigma deliver success?

by PATRICK VALENTINE, PH.D.

Sustaining quality management systems and continuous improvement strategies is critical for retaining a competitive advantage in the printed circuit board industry. Implementing and sustaining both ISO 9001 and Lean Six Sigma provides quality improvements, enhances organizational performance, creates efficiencies, increases market share, improves financial performance, and reduces product reliability risk. This quantitative correlational study evaluates critical success factors for implementing and sustaining ISO 9001 and Lean Six Sigma. Survey data were collected from the North American printed circuit board (PCB) industry. Canonical correlations were used for data analysis. A statistical correlation was found between critical success factors for implementing and sustaining ISO 9001 and Lean Six Sigma. Three canonical variates were extracted and interpreted.

Quality has become a key process indicator for manufacturing and service companies. Quality is a strategic priority for all modern businesses.[1] Improving and sustaining quality is a critical organizational strategy to retain customers in today's globally competitive environment. Quality management is used to proactively find solutions to current and future cost and risk problems.

The costs of poor quality include all costs incurred for not making or providing a perfect product or service the first time, including scrap, rework, repurchasing raw materials, labor, and inventory.[2] Companies operating at Three Sigma quality levels can spend about 25% of their annual sales remediating poor quality costs.[2,3] Other estimates put the costs of poor quality in the range of 25 to 40%.[4] Poor quality can destroy a company.

Unexpected product failures (poor reliability) significantly increase selling, general and administrative (SG&A) costs, leading to increases in inventories and fixed assets required to support operations. These indirect costs erode profitability more than the amount directly attributable to warranty claims processes. Product recalls negatively impact businesses financially and result in adverse publicity.

The printed circuit board is at the heart of most electronics worldwide. IPC defines three classifications of printed circuit boards, basing each class on tiered quality and reliability requirements: 1) general electronic products, 2) dedicated service electronic products, and 3) high-performance/harsh environment electronic products.[5] Class 3 requires on-demand performance, critical for electronic applications, especially within the aerospace and medical industries.

Globally, industry leaders realize the need for high-quality PCBs to maintain competitiveness and profitability.[6] Competitiveness in PCB manufacturing requires low production cost, high quality, and on-time delivery. ISO 9001 and Lean Six Sigma specifically address and target these manufacturing quality issues.

Quality Management Systems

The International Organization for Standardization (ISO) 9001 and Lean Six Sigma are proven quality management systems (QMS) that can reduce the cost of poor quality and increase productivity and profitability. Research shows implementing and sustaining ISO 9001 and Lean Six Sigma provides a synergistic improvement for organizations.[7] Both ISO 9001 and Lean Six Sigma can improve an organization's financial performance by enabling quality improvements. Implementing and sustaining quality management systems and continuous improvement strategies is critical for retaining a competitive advantage in the North American printed circuit board industry.

In this research, the researcher studied critical success factors for implementing and sustaining ISO 9001 and Lean Six Sigma by quality professionals in the North American PCB industry. The research question was, "Is there a correlation between critical success factors for implementing and sustaining ISO 9001 and Lean Six Sigma in the North American printed circuit board industry?"

Critical Success Factors

Numerous opinions of critical success factors (CSF) were uncovered during an in-depth literature review. Many scholars and researchers agree on 10 prominent critical success factors.[8,9] These critical success factors are woven throughout

peer-reviewed literature that spans decades. **FIGURE 1** lists the 10 prominent critical success factors developed from the literature review.

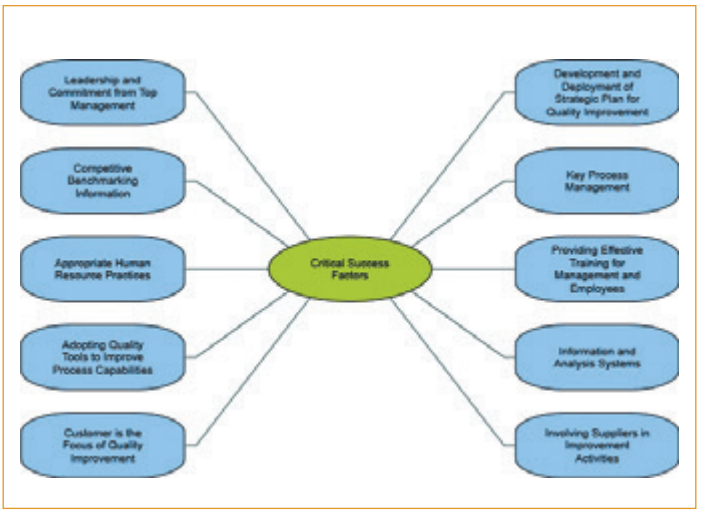

FIGURE 1. Critical success factors.

Leadership and commitment from top management. Senior management must demonstrate commitment by actively engaging in the implementation stage and be highly visible. Top management must articulate their commitment using communication to circumvent confusing intentions that can derail the quality management system initiative. Senior management commitment is critical for all QMS, independent of which change management method is employed. Senior management commitment needs to be constant over time and relates more to how an organization approaches change than the actual change method specifics. Senior leaders send encouraging signals, and influence, inspire, and motivate the organization to adopt the quality management system culture.

Competitive benchmarking information. Xerox coined the term benchmarking in 1979. Benchmarking is a systematic process of searching for best practices, innovative ideas, and decidedly effective operating procedures that can lead an organization to exceptional performance. Benchmarking includes process benchmarking, performance benchmarking, problem-solving benchmarking, and strategic benchmarking. Process benchmarking focuses on discrete work processes and operating systems (e.g., customer complaints, order fulfillment) to identify the most efficient operating practices from industry peers. Performance benchmarking allows organizations to assess their competitive positions through either product or service comparisons. Problem-solving benchmarking looks outside the problematic area or even outside of the organization to find solutions. Strategic benchmarking studies how companies compete.

Appropriate human resource practices. Organizational success is directly connected to proper human resource management. Good human resource management includes ethical treatment of workers and ensuring employee well-being. Human resource practices include employee recruitment, job duty training, employment security, career advancement paths, teamwork opportunities, performance-related pay, and excellent communication. Appropriate human resource management is a competitive advantage for organizations.

Adopting quality tools to improve process capabilities. If quality improvements are to occur, quality tools must be employed. Dozens of quality tools are utilized in quality management systems. Quality tools fall into one of five categories: 1) identifying causes of poor quality, 2) detailing and comprehending processes, 3) collecting and analyzing data, 4) generating improvement ideas, 5) and tracking continuous improvement projects. The goal of employing quality tools is to make informed decisions that improve quality and reliability.

Customer is the focus of quality improvement. Improving and sustaining quality is a critical organizational strategy to retain customers in today's globally competitive PCB industry. Business entities must strive for continuous quality improvements to satisfy customer needs. Customer relationships are developed and maintained by regular communication, interaction, and engagement. Communication is a contact sport that needs active participation early and often. Many managers do not have enough direct contact with their employees, suppliers or customers to adequately capture the voice of the customer.

Development and deployment of a strategic plan for quality improvement. A strategic plan is a document used to communicate the goals and needed actions within the organization. Strategic planning is envisioning a desired future state, translating this desire into goals and objectives, and setting a sequence of activities to achieve it. Strategic planning requires a disciplined approach from leaders and managers to define what an organization is, whom it serves, what it does, and how it will measure success. Strategic planning helps develop and refine critical customer attributes of fundamental business processes to ensure quality products and services.

Key process management. Process management is a structured approach to analyzing, continually monitoring, and improving processes that sustain an organization. Process management includes all methods, techniques and practices used by an organization to improve its process stewardship. Process management is intrinsically embedded in quality management systems such as Lean Six Sigma, ISO 9001 and TQM. Weak or neglected business process management may lead to reduced process performance.

Providing effective training for management and employees. Pertinent management and employee training improve long-term organizational performance. Actively engaging in practical training increases the financial returns of an organization. Cooperative and collaborative training instills in the

"IS THERE A CORRELATION BETWEEN CRITICAL SUCCESS FACTORS FOR IMPLEMENTING AND SUSTAINING ISO 9001 AND LEAN SIX SIGMA IN THE NORTH AMERICAN PRINTED CIRCUIT BOARD INDUSTRY?"

workforce the organization values them. Training managers and employees establish a shared vision of both short- and long-term quality goals. Training executives create a united vision, resulting in less resistance and increased sustainment of the deployed quality management system. Training improves morale, quality, customer satisfaction, financial performance, and long-term organizational success.

Information and analysis systems. All businesses need accurate and pertinent information and analysis systems. Business information and analysis provide vital metrics feedback on process efficiencies, cycle times, asset utilization, process yields, and quality. Accurate, actionable information can reduce waste, improve operational performance, ensure quality, and increase customer satisfaction.

Involving suppliers in improvement activities. The majority of the costs of manufactured goods are in the raw materials themselves. Costs of raw materials are typically 50% to 80% of the total cost of manufactured goods. Raw material suppliers must consistently deliver high-quality raw materials to manufacturers. Suppliers are an excellent resource for technical assistance in continuous improvement activities at the manufacturer's site. Suppliers assist with onsite visits, audits, joint training, and product and process support.

Methods and Materials

Survey. The instrument for this study was a mixed nominal-scale and interval-scale response survey on quality. The survey instrument consists of three sections: 1) quality management systems in use; 2) critical success factors for implementation; and 3) critical success factors for sustainment. The quality management systems consist of one question asking which systems are in use within the organization. The implementing section consists of one question asking the agreement of critical success factors for implementing QMS. The sustaining section consists of one question asking the agreement of critical success factors for sustaining QMS.

Participants were chosen based on their knowledge and experience of QMS within the North American PCB industry. Participants were either directors and managers of quality management systems or directors and managers of quality or process engineering. In some circumstances, an individual manages both the QMS and the process engineering department. These participants were highly qualified professionals familiar with their organization's QMS within the North American PCB industry.

Survey reliability, validity, and multicollinearity. Survey responses for both the implementation and sustainment questions were analyzed for reliability, validity and multicollinearity. Reliability was confirmed using Cronbach's alpha, and validity was confirmed using unrotated principal components factor analysis. Kaiser's MSA was used to determine if the distribution of values was adequate for conducting factor analysis. Multivariate normality of the data set distributions was tested using Bartlett's test of sphericity. Both Kaiser's MSA and Bartlett's test of sphericity confirm that factor analysis is appropriate for the pilot study. Multicollinearity was checked for and determined not to be present. The research instrument was determined to measure what it was intended to measure: critical success factors for implementing ISO 9001 and Lean Six Sigma.

Canonical correlation. Canonical correlation is a dimension reduction technique similar to principal components and factor analysis. Canonical correlation analysis relates two sets of variables together. In this research, the two sets of variables are critical success factors for implementation and critical success factors for sustainment. Canonical correlation analysis produces latent variables, which represent multiple variables from the actual data sets. These latent variables allow exploring linear relationships between the two variable sets, all measured on the same individual. Canonical correlation allows these explored relationships to be summarized into a few components. The researcher then interprets and names each component.

Results

The canonical variants summarized portions of the variation in the original two sets of variables. Relationships between the paired canonical variants were then determined through correlation analysis. **TABLE 1** summarizes these results with statistically significant canonical correlations in boldface.

There are 10 pairwise correlations. Eight of these correlations are statistically significant. Canonical correlations are always positive and range from 0 to 1. The correlation coefficients range from 0.14 to 0.93. The strengths of the correlations range from weak to strong. Only the first three canonical variates were retained for further analysis, accounting for 80.6% of the variance. Canonical variates 4 through 10 were pruned due to superfluous information.

Canonical loadings were calculated for all 10 canonical variates. Loadings ranged in values from -0.50 to 0.883. A minimum absolute value of 0.30 is needed for meaningful

loading and interpretation, with larger values preferred. **TABLE 2** displays the canonical variate loadings of the critical success factors for implementation and sustainment with meaningful absolute loadings above 0.45 in boldface.

Interpretation of canonical variate loadings. Canonical variate one (CV 1): critical success factor five (CSF 5) loads heavily on this variate. The loading value is 0.88. Critical success factor five (CSF 5) is the "customer is the focus of quality improvement." This canonical variate can be interpreted as customer quality focus.

Canonical variate two (CV 2): Critical success factors one through four and six through 10 (CSF 1-4, 6-10) load heavily on this variate. The loading values range from 0.46 to 0.74. These critical success factors are related to internal organizational quality infrastructure. This canonical variate can be interpreted as internal organizational quality leadership.

Canonical variate three (CV 3): Critical success factor two (CSF 2) loads heavily on this variate. The loading values range from 0.74 to 0.77. Critical success factor two (CSF 2) is "competitive benchmarking information." Benchmarking is a continuous improvement activity that searches for best practices and identifies the most efficient operating procedures. This canonical variate can be interpreted as continuous improvement.

Conclusion

The cost of poor quality and the need for high reliability are the catalysts driving quality management systems today. The costs of poor quality include all costs incurred for not making or providing a perfect product or service the first time. Poor quality can cost upwards of 40% of annual sales. Poor quality can destroy a company. Competitiveness in the printed circuit board manufacturing industry requires low production cost, high quality, and on-time delivery. ISO 9001 and Lean Six Sigma address and target these manufacturing quality issues. Implementing and sustaining both ISO 9001 and Lean Six Sigma can synergistically benefit an organization. In this research, the researcher addressed, "Is there a correlation between critical success factors for implementing and sustaining ISO 9001 and Lean Six Sigma in the North American printed circuit board industry?"

TABLE 1. Canonical Correlations of CSF for Implementation and Sustainment

Canonical Variate	Correlation	Eigenvalue	Wilks Statistic	F	Num *df*	Den *df*	*p*
CV 1	**0.93**	6.25	0.00	8.68	100.00	527.36	<0.001
CV 2	**0.89**	3.95	0.01	6.90	81.00	480.73	<0.001
CV 3	**0.84**	2.31	0.03	5.41	64.00	433.31	<0.001
CV 4	**0.77**	1.44	0.11	4.24	49.00	385.18	<0.001
CV 5	**0.64**	0.70	0.27	3.22	36.00	336.50	<0.001
CV 6	**0.57**	0.47	0.46	2.64	25.00	287.54	<0.001
CV 7	**0.37**	0.16	0.68	1.97	16.00	238.93	0.02
CV 8	**0.36**	0.15	0.80	2.11	9.00	192.42	0.03
CV 9	0.26	0.07	0.92	1.82	4.00	160.00	0.13
CV 10	0.14	0.02	0.98	1.73	1.00	81.00	0.19

Note: F = F value; Num *df* = numerator degrees of freedom; Den *df* = denominator degrees of freedom; *p* = probability.

TABLE 2. Canonical Loadings

	Implementation Canonical Loadings			Sustainment Canonical Loadings		
Variable	**CV 1**	**CV 2**	**CV 3**	**CV 1**	**CV 2**	**CV 3**
CSF 1 Leadership Commitment	-0.05	**0.52**	-0.09	-0.06	**0.50**	-0.05
CSF 2 Benchmarking	0.14	**0.46**	**0.77**	0.05	**0.50**	**0.74**
CSF 3 Human Resources	0.02	**0.69**	0.36	0.01	**0.73**	0.34
CSF 4 Quality Tools	-0.11	**0.62**	-0.06	-0.01	**0.66**	-0.10
CSF 5 Customer Focus	**0.88**	0.28	-0.13	**0.88**	0.32	-0.09
CSF 6 Strategic Plan	-0.12	**0.58**	-0.33	0.28	**0.66**	-0.21
CSF 7 Process Management	0.11	**0.73**	0.00	-0.04	**0.64**	-0.19
CSF 8 Training	-0.05	**0.74**	-0.10	-0.27	**0.73**	-0.21
CSF 9 Information Systems	-0.01	**0.55**	-0.18	0.02	**0.66**	-0.29
CSF 10 Involving Suppliers	0.26	**0.64**	0.03	0.41	**0.72**	-0.02

Three canonical variants were derived from each data set for implementation and sustainment of ISO 9001 and Lean Six Sigma. Addressing these three canonical variates may significantly improve implementing and sustaining ISO 9001 and Lean Six Sigma. The three canonical variates then become the framework and can be customized around site-specific needs and limitations. Relevant discussions centering on these three canonical variates include questions such as:

CV 1 customer quality focus. How does the customer define quality? Does the organization have the capability to measure key quality attributes? How will evolving customer quality requirements be determined? How will customer poor quality issues be addressed?

CV 2 internal organizational quality leadership. Does senior leadership realize the need for and support a quality culture? How will organizational quality buy-in be achieved? How will the quality infrastructure be deployed? How will remedial training and new concepts be adopted and disseminated throughout the organization?

CV 3 continuous improvement. Which continuous improvement protocols (e.g., DMAIC, PDCA, etc.) will the organization use? Which continuous improvement tools will the organization use? How will inter-department, cross-department, and industry best practices be determined and implemented? Is the entire value stream viewed in a holistic systems approach? How will innovation be incorporated into continuous improvement activities?

Correlation does not prove causation. Four conditions are required for making a causal claim: 1) correlation that is statistically significant, 2) time order of events makes logical sense, 3) theoretical mechanism makes sense, and 4) non-spuriousness; data and results are authentic and real.[10,11] Proving causation requires multivariate analysis where the dependent variable variance is examined in the presence of changes in the explanatory variables. An actual experimental quantitative design is necessary.[10,11]

This research suggests these three canonical variates are needed to successfully implement and sustain ISO 9001 and Lean Six Sigma in the North American printed circuit board industry. The recommendations of this research may have applicability to other QMS and industries. Evaluating and incorporating the three canonical variates may improve QMS implementation and sustainment. ▫

REFERENCES

1. J. Antony, "The Ten Commandments of Quality: A Performance Perspective," *International Journal of Productivity and Performance Management,* vol. 64, no. 5, 2015.
2. T. Pyzdek, and P. Keller, *The Handbook for Quality Management, 2nd Ed.,* McGraw-Hill, 2013.
3. K. Imler, *Get it Right: A Strategic Guide to Quality Systems,"* ASQ Press, 2006.
4. A. Buthmann, "Cost of Quality: Not Only Failure Costs," web post, retrieved from www.isixsigma.com/implementation/financial-analysis/cost-quality-not-only-failure-costs/, 2017.
5. IPC, "IPC-A-600J – Acceptability of Printed Boards," 2016.
6. Y., Lin, B. Yu, and S. Tsai, "High-Tech Manufacturing Enterprises' Competitive Strategies – The Case of Printed Circuit Board Manufacturing in Taiwan," *Advanced Materials Research,* vol. 945-949, 2014.
7. M. Carvalho, L. Ho, and S. Pinto, "The Six Sigma Program: An Empirical Study of Brazilian Companies," *Journal of Manufacturing Technology Management,* vol. 25, no. 5, 2014.
8. D. Montgomery, "Why Do Lean Six Sigma Projects Sometimes Fail?" *Quality and Reliability Engineering International,* no. 32, 2016.
9. E. Psomas, "The Underlying Factorial Structure and Significance of the Six Sigma Difficulties and Critical Success Factors," *The TQM Journal,* vol. 28, no. 4, 2016.
10. M. Brown and K. Hale, *Applied Research Methods in Public & Nonprofit Organizations,* Jossey-Bass, 2014.
11. "Canonical Correlation: A Supplement to Multivariate Data Analysis," *Multivariate Data Analysis,* Pearson Prentice Hall Publishing, 2013.

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From proper grounding to material selection, common best practices for optimal RF results. by ORLEN BATES

In our everyday lives, we are more connected than ever.

Your car keys wirelessly unlock your car when you get near it. Your phone connects to Air Pods while you listen to Spotify at the gym or stream the latest hit TV show. The smart home device in your living room streams podcasts, answers questions, and writes your shopping list on voice-activated command. All these daily activities have one thing in common: radio signals. Whether it be from device-to-device or through Wifi, the need for proper radio frequency (RF) sensitive circuits is ever-increasing.

Radio frequency design has a myriad of applications in the field. Some use cases are more critical, such as military or medical use, while others are for general public consumption. Regardless, in all cases it is imperative the design functions as promised without incident. Doing so will ensure a successful and reliable end-product that breeds a lasting impression with the consumer.

What are RF Waves?

First, a definition. Radio frequency (RF) refers to the rate of the oscillation of electromagnetic radio waves in the range of 3kHz to 300GHz, as well as the alternating currents carrying the radio signals. This frequency band is used for communications transmission and broadcasting. The term microwave is a reference to a class of waves. The microwave range is the spectrum of waves that Wifi operates within.

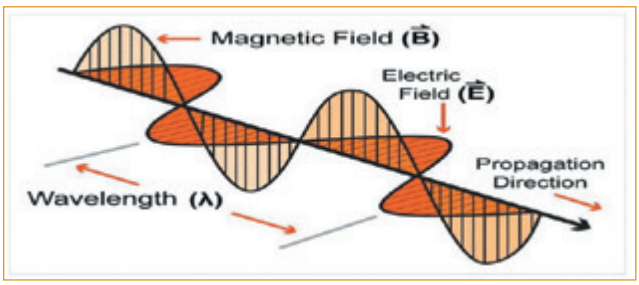

FIGURE 1. The electric and magnetic components of an electromagnetic wave represented as perpendicular sinusoids.

Knowing the basics of how RF works will help you understand what makes a good design and, ultimately, a superior end-product.

Wavelength is derived from the speed of light and frequency. FIGURE 1 points to the various key parts of an electromagnetic wave. The propagation direction is also the radiation length, and this radiation is measured in wavelengths. As a frame of reference, a WiFi signal is typically 12.5cm (2.4GHz) to 6cm (5GHz) and is shorter than that of a typical car stereo radio wave. (For example, the 97.9 WPXY radio station has a wavelength of 306cm.) Conversely, a WiFi signal is longer than the signals used for police radar guns, which are around 2.85cm (10.5GHz).

In this way, each of these signals has a unique area on the spectrum that is less likely to be interrupted by other signals. That said, an interruption can still occur if the signal output has signal leakage. This leakage refers to RF signal loss from the system when it is not properly contained. While every system has some loss, taking care to secure your signals within an RF circuit is imperative to avoid undesirable effects and ensure the loss incurred is within acceptable operating margins. Many factors are considered when designing an RF circuit. Everything from safety constraints to ultimate life-expectancy of the end-product will affect the way you design. These constraints guide the path the overall design project process will take.

Design Considerations

Health and safety requirements. The country you are designing in, or plan to sell your product in, will have specific requirements to follow. In some countries, these requirements may vary from state to state and province to province.

Environment conditions. The end-user classification of your product. The quality of the parts will differ depending on the performance class of the assembly. In RF, this often means the importance of the longevity and reliability of the product to the consumer. In the medical or military fields, for example,

the reliability of a working radio is incredibly high priority, whereas a car stereo for the general public may be less so.

Product lifecycle expectations. How long you expect the product to last without being redesigned. This decision is often made based on overall quality and cost expectations for your project, as well as projected future improvements or growth. Most major cellphone brands, for instance, redesign the phone every two to five years to revamp the product to modern standards.

PCB stackup and material usage. The selection and consideration of materials is highly important, as time, budget and quality constraints must be considered for your project. Lower quality materials mean a less expensive product, but it will not last as long before the signal deteriorates and the product is no longer usable to the consumer.

Stay Grounded

In addition to the general design considerations, it is crucial to ground your components properly for a PCB with radio signal capabilities.

Since the design is emitting signals per its function, it is incredibly sensitive to issues such as crosstalk and noise from components. Those competing emissions are destructive to the final signal quality. Further, the components necessary in an RF circuit generate heat, and grounding is a must to transfer this heat away from the central components. To do so, consider using an RF fence as a protection cover on the PCB design. A shield will help block radio electromagnetic radiation and reduce the coupling of radio waves and electromagnetic or electrostatic fields, protecting the PCB inside.

This concept is most famously exemplified through a Faraday Cage, where a conductive mesh structure can shield the person inside it from external electrical shocks, often emitted by a Tesla coil.

Instead, the electricity travels through the mesh and safely into the ground; hence the term grounding. When an RF fence (often a metal plate) is placed over the PCB, it reacts in a similar fashion to disperse harmful outside frequencies. It is common to have multiple plates over different sections of a design, shielding each part of the board from other signals in the same array, reducing the interference they would otherwise cause each other.

Ground Pins, Plating, and Copper Materials

Within the PCB itself, connect ground pins of RF components to the RF ground plane with vias. These connections should be as short as possible to limit interference. An ideal situation is to place a pin, then place a via directly in the pin, as it is the shortest possible route for the signal to travel to ground and will therefore produce a clean emission with no deterioration. If the board includes multilayer ground planes, provide many ground vias wherever the signal trace makes a transition from one side of the plane to the other.

Use gold plating for RF components created from etch. Gold does not tarnish or corrode, unlike silver and copper, and corrosion causes signal loss and overall degraded performance for RF circuits **(FIGURE 2)**. No copper islands should be near the RF circuitry, as they can act as unintentional receivers and emitters, causing many EMI issues. Additionally, fabricators will add copper thieving to prevent the board from warping during fabrication, and it is important to keep it away from the RF circuitry to prevent further EMI problems.

A high priority should be to ground both ends of the copper pours, and stitch as many vias wherever possible around the edge of the board to create a Faraday cage so signals can't radiate out of the board. Separate RF planes from all other planes in the design, and remove solder mask from the RF traces for a better and more repeatable transmission. Taking these precautions into consideration will prevent larger issues down the line.

Component Selection

Surface mount is better overall for a design with RF needs. The only vias that should be necessary in the design are for grounding, and surface mount has the best parts to make this happen. In case through-holes are required, backdrilling should be used with through-hole components and vias **(FIGURE 3)**. This will remove any unwanted "antennas," or stubs, on the vias and in the hole padstacks.

Multilayer PCBs permit a continuous ground under all traces in RF designs. Sealing the traces will create a ground on each side of the board to further protect it. When selecting materials, carefully consider your options. While less expensive, a standard FR-4 material may not meet your needs. The fiber weave in the material will affect the RF signal, so the material chosen must stay within the requirements pertain-

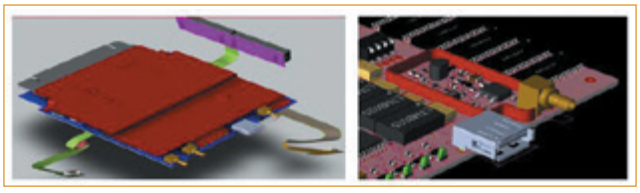

FIGURE 2. Use gold plating for RF components created from etch, and keep away copper islands.

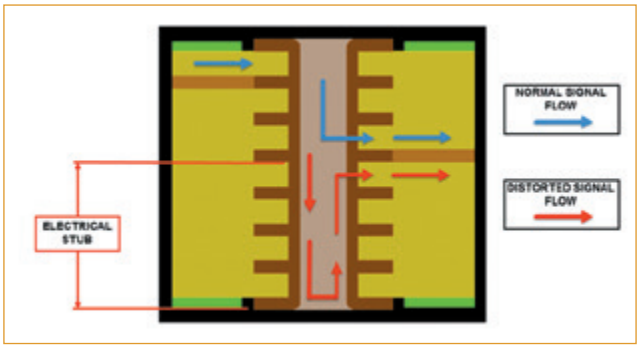

FIGURE 3. Backdrilling removes unwanted via stubs.

ing to the type of signal it is emitting **(FIGURE 4)**. Some CAD tools allow you to select different materials based on area. A high-end board material can be expensive but necessary for RF sections, and being able to leverage the material needed by exact location will allow you to benefit while keeping the overall cost down.

Vias, Routing and Simulation

Isolate vias for separate portions of a filter or matching network. Since vias are shielding, it is helpful to use the least number of vias possible in RF routing and max out the vias in the grounding. Properly routing and grounding the design is the top priority, so this step is crucial to design success.

Orienting a sensitive trace orthogonally rather than diagonally will work best in routing an RF design **(FIGURE 5)**. Use short traces between the crystal and RF device and find a design tool that will allow for pad-to-pad connections. Keep interconnect traces separated as much as possible and trace lengths to a minimum to avoid unwanted interference.

It is always a best practice to adhere to proper corner routing standards and use wire-wound inductors where possible. Additionally, avoid using printed-down circuit parts unless needed and be sure to place inductors, coils, and a planer isolated from each other. Copper is a conductor, so if the components are plated with copper, ground the area.

Once the board is designed, it is highly recommended to simulate the results. This is especially important if the RF components are printed down as part of the board, so any critical errors will be caught before the board is sent for manufacture.

Grounding is Everything

We can't say it enough: Ground your RF design.

Radio frequency inherently relies on electromagnetic radio signals to accurately reach a given destination. The confusion or misdirection of those signals will be the bane of the project's existence if not properly dialed in. Carefully consider RF implementation as you design because your choices will have a significant impact on the overall cost and complexity of the project. Pure and simple, understanding the effects of RF circuitry on your initial design is half the battle.

Knowing these fundamentals of RF design will prepare you for a request such as adding RF circuitry onto a digital design. It may seem unorthodox, as the two types of designs are polar opposites, and the components inherently do not work well together. However, it is a request all too common in the current age of fast-advancing technology where end-products are pushing the boundaries of circuit capabilities and connectivity. □

ORLEN BATES is field application engineer at EMA Design Automation (ema-eda.com). See his presentation on Designing for RF from the Orange County PCEA Chapter meeting at www.youtube.com/watch?v=EIW1Vp7etQk.

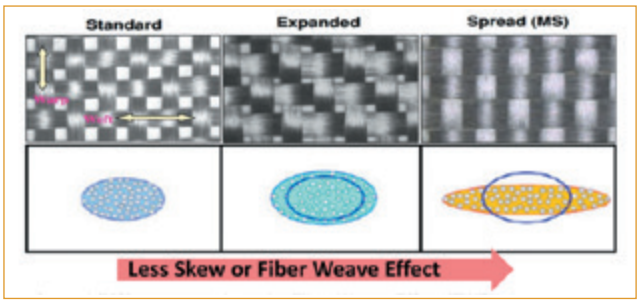

FIGURE 4. The laminate's fiber weave affects the RF signal.

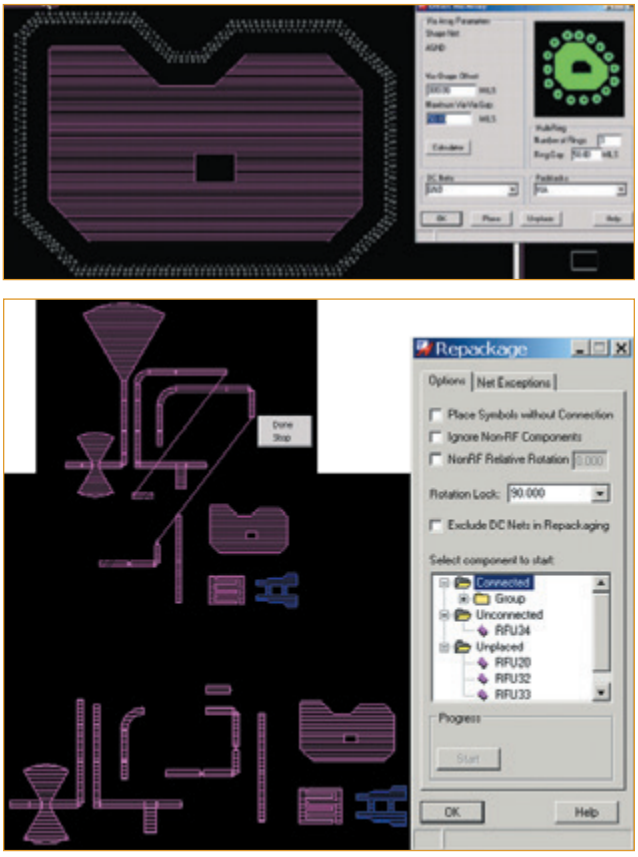

FIGURE 5. Orienting a sensitive trace orthogonally rather than diagonally works best for RF design.

Nearshoring EMS from LATIN AMERICA

An interview with Colombia's largest EMS company.

by MIKE BUETOW

Colombia is the 28th largest country by population and the 38th largest by nominal GDP. Residing as South America's connection into Central America, it is in the same time zone as the Eastern US during daylight saving time.

Invertronica was founded in early 2003 in Colombia and includes several companies involved in the design, prototyping and manufacturing of electronics products. Those companies include Tecrea, an electronics design and engineering unit; LosComponentes.com.co, a parts distributor, and Colcircuitos, the largest EMS company in Colombia. It can move fast: 24 hours from design to assembly.

Jorge Cardona, chief executive of Invertronica, describes the markets and manufacturing environment in Central America, and why Colombia is a nearshore possibility for US OEMs and EMS companies looking for low-cost partners.

FIGURE 1. invertronica Group includes three companies: Tecrea, LosComponentes.com, and ColCircuitos.

Mike Buetow: Let's start by talking about the business environment in Colombia. What end-markets are strong there?

Jorge Cardona: In Colombia today we have the automotive industry, which focuses on motorcycles. We produce around 800,000 to 1 million motorcycles a year, and we have some of the largest concrete companies in the world. The energy sector is very strong, and we have a lot of exports of energy to all the countries in the region. Recently, we [added] tourism as an industry that has been growing a lot.

[About] 10 years ago, we started to create an ecosystem to promote technology-based companies and startups, and now we are seeing a big evolution of that.

MB: Are many of those industries relying on domestic suppliers of hardware and circuit board-related products?

JC: They did the same as companies in the US. They started sending production for electronics and many other industries to China or Asia, and most of them have direct offices in Asia. But now we are seeing a comeback, a return of production coming back to Colombia. The electronics industry is not that strong; it does not represent any percentage of the total GDP because it's very small. We are fighting to get a piece of the market, convincing local OEMs to trust in our local capabilities. It is hard, but we are improving.

MB: Invertronica has customers in North America, includ-

ing the US. How long does it take to move product back and forth right now?

JC: For America, Colombia is considered a nearshore possibility. We are less than four hours by air to Florida or Texas. We have good logistics connections with Miami. What we can do is move the product faster. Obviously, our local labor prices are much different than the US cost, and even Mexico's. We have good capabilities, good manpower with a lot of knowledge, but still a pretty low price.

MB: For shipping product elsewhere in South America, is it typically done by truck, boat, train or plane?

JC: It depends, but if you analyze geographically, Colombia is in a strategic location. We are in the middle of Central America and South America, with an equivalent distance, so we can fly in five hours to Buenos Aires, Sao Paulo or New York. By air, we can reach the entire continent very quickly. For the near regions like Ecuador or Peru, some products can go by truck, but not to Chili, Brazil or Mexico because we have a lack of infrastructure.

MB: What are the national laws like when it comes to protecting business IP?

JC: From my perspective, there are two main factors here: We consider our culture a strong differentiator because we are respectful people, people with honor. We respect the intellectual property of customers. The other is we protect IP using legal terms of contracts and regulations, even if we don't have strong laws [like] in the US, which is number one in protecting intellectual property. We don't have all those structures to protect IP, so we rely on contracts, documents and our culture.

FIGURE 2. A Tecrea design engineer works on a layout.

MB: My understanding is Colombia is very competitive on labor rates. I've read the average is in the neighborhood of $1,200 to $1,500 US a month. Is that correct?

JC: For an operator, it is less. Our cost is around $900. An engineer starts at $1,500.

MB: What's the labor pool like? Is finding personnel an issue?

JC: We try to cooperate with some of the educational institutions to help them train people or prepare technicians who, in the future, will be operators. Additionally, as I mentioned, 10 years ago the technology-based companies started to grow at a faster pace. The institutions are producing more technical people, like developers. But even now we have [the need for] more or less 50,000 positions or engineers just among the local industries.

MB: Do you feel the domestic universities and colleges produce a sufficient number of capable engineers?

JC: They do produce good, quality engineers. However, they have to move faster. It is not only the institutions but also the culture of the millennials and the Y generation. Some of them don't want to study engineering anymore. That is a global movement. I don't know why. In general, we have good institutions that produce or prepare very good and talented resources.

MB: My understanding is Invertronica is the largest of the Colombian PCB assembly companies.

JB: Yes. In Colombia, to do only the circuit board is very tough compared with China because they have automated everything. However, in integration the situation is totally different because, no matter what, you need a combination of automated lines and operators, the hand labor, which is where we get the biggest competition and the biggest differentiator factors. We have around 100 people in our facility. We are by far the largest integrator in Colombia.

MB: What is the domestic electronics manufacturing environment like in general? Is it doing well right now, or have you been hit hard by Covid?

JC: Covid was very tough for the industry not because we got affected by it directly but because all our customers got impacted. They closed factories. They reduced end-demand. The entire market demand was reduced, and production was

impacted as well, so obviously 2020 was a tough year, even though we grew almost 60%. It has been very difficult times for us.

MB: I'm assuming your local competitors were affected as well. Did many close?

JC: One of them had to close, but the other ones are moving forward. From my perspective, a lot of startups are coming to market, and some are in an expansion state. Companies in IoT, the environment like the smart grid industries and renewables, and many others are creating hardware to support their solutions, so there are a lot of companies producing hardware here in Colombia to help with their international expansion.

FIGURE 3. The largest EMS in Colombia, ColCircuitos has six SMT lines.

MB: Invertronica has Tecrea, Loscomponents.com, and Colcircuitos, which is the largest EMS company in the country, and you can do bare board fabrication and component assembly.

JC: That's correct. We started in a garage doing PCBs a long time ago. After that, we start producing larger PCBs and doing assembly and growing the company. [Companies] develop skills, so we created an entire network that understands how to buy components very well. That's the reason why we created LosComponents, a company that today does e-commerce to sell components. Many customers requested local support: "I want to change this. I want to modify this functionality." If you try to manufacture in China, they only ask you to send the payment and files, and they deliver whatever you request. The difference with us is we understand customers don't know exactly the details of what is required in production. They need this kind of support. That's why we created the product development company Tecrea. That company is totally focused on product development, not only the electronics but also the case. We also support product certification in some cases, which is a good value to some customers.

MB: In the photos I've seen, your factory looks very nice. What can you tell us about the physical plant? Are all the companies in the same location?

JC: This building is six floors, and all the companies are located here, but we split it and decided the layouts according to industry best practices. The assembly lines, the PCB production … everything was designed according to regulations and standards, so our facility is enough for the market we have here. However, we are capable of growth, depending on demand.

We have six SMT lines and capacity for production. We consider ourselves a small-to-medium-sized PCB factory. We can produce 50,000 to 100,000 pieces a month locally, which is good for Latin America.

MB: You can do inspection and test there as well?

JC: Yes. For IPC Class 1 and 2, we have equipment. For Class 3, we don't have an x-ray machine, so we outsource that service. That's the only thing we outsource.

MB: What about specialty services like rework and repair?

JC: We don't do any maintenance. We only provide support or post-sales support and give warranties, depending on the production, but we don't have staff for maintenance, and we don't want to enter that particular market. We have partners for that.

MB: And you mentioned you have 100 employees. Is that across all three companies?

JC: Yes. Most of the employees are Tecrea or Colcircuitos. Engineering is not that big.

MB: Are you the only bare board fabricator in Colombia?

JC: We have a competitor that is five times our size. They can produce higher volumes [of bare boards] than we can. That only represents 10% of our business. We focus on integration.

MB: Would you do bare board fabrication for a company that you weren't actually doing assembly and integration for?

JC: We do have some of those customers. Depending on the specifications, we can produce the board and do the integration here, but sometimes requirements are very specific, and

we [purchase] the boards from Asian partners and perform the integration locally.

MB: What's the component situation been like there?

JC: Now you mentioned the toughest question! [laughs] Everybody is having a hard time with this. I don't know when we became so dependent on Asian producers of semiconductors. This is something the entire world is awakened to, but we are in exactly the situation as [the US]. Fortunately, we have good partners. Last year we signed a special agreement with Digi-Key, and through them we can work with vendors we never had contact with [before]. We have a very good supply chain of components; however, this is a nightmare. Many companies are affected by this situation. Even the new product designs we do, we are changing the entire architecture of the firmware we create. Let me go a bit deeper on this. Firmware is designed for specific hardware. However, when you change your mind, you can create drivers that can apply for one specific microprocessor, and then [you] can swap it to another one if you do the right thing in the firmware. So, we're trying to adapt the way we do the firmware to this new reality. In that way we can create products that are more flexible when they go to production.

FIGURE 4. Inspecting a PCBA at ColCircuitos.

FIGURE 5. ColCircuitos workers perform post-assembly touchup.

MB: Having design, fabrication and assembly all in one factory is hard to find these days. There's just not that many companies that do that in one place. That has to be a huge advantage in terms of being able to communicate back and forth because, no matter how digital we make our processes, there's nothing like being able to walk across the floor and talk to the person building the very thing you're designing. That has to be a huge advantage.

JC: It is. For both sides it is a win-win relationship. Some of the companies, no matter the size, want to create a product, or transform an analog product to digital. Usually, they hire an engineer and try to develop the circuit board electronics to do the objective. However, they don't have any notion of the production peculiarities. We integrate the entire view: not only the design but also the production considerations, the IP protection, the energy protection, the user interface … many other considerations that are required when you want to create a product for any specific market or application. And our design people are engineers. We have internal processes and have multidisciplinary meetings to evaluate the design, the production, the entire process, and that is a real advantage.

MB: As we mentioned, you draw customers from a range of countries geographically. Where are you most successful right now?

JC: Historically we have been focused on Colombian markets. I joined the company as a partner two years ago. One of my visions is to go international. I want to go to the US and Canada markets. I know at this moment there is a big movement of companies trying to bring back production. They are trying to relocate production to America or to someplace nearby. Mexico is taking advantage of this situation. I want to tell American companies they can rely on us because we are already near. We have quality, and they can produce 100% of their electronics manufacturing here with us, or even design products. ▫

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Isamu Akasaki, 92, Japanese physicist invented the first efficient blue LED and shared the 2014 Nobel Prize in physics.

Robert "Bobby" Baker, 60, Sanmina/SCI senior buyer.

Dan Bostan, hardware engineer for Cisco, Stoke, Allegro Networks, Atoga Systems, and Brightlink Networks.

Brian Brossart, 57, industrial engineer at Benchmark Electronics.

Richard Calvin, 59, former QA test engineer with Mentor Graphics.

Doris M. (Cyr) Carrier, 89, PCB inspector.

Henry Catalano, Jr., 78, circuit board designer for Parametrics.

Debi Coleman, 69, original Apple controller and CFO, and later CEO of Merix.

Eduardo (Ed) Gabriel da Silva, 84, design engineer for the first business computers at Burroughs Counting Machines, and later manager of PCB design team at Xerox.

Ethel Lee Hall Doyle, 76, retired electronics assembly supervisor for Hughes Network Systems.

Cynthia Ann Edwards, 78, retired circuit board technician.

Kim Marie (Williamson) Emerson, 59, worker for several circuit board companies, most recently CE Precision.

Richard Flanders, Jr., 73, ex circuit board technician, GenRad.

Charlotte Veronica Friedrichs, 76, Creation Technologies.

John Gammer, founder of JM Gammer Co., pioneer in rep businesses for electronics assembly.

Robert (Bob) Neal Gatlin, 79, retired Chrysler circuit board repair specialist.

Foster Gray, 90, longtime Texas Instruments engineer and standards guru.

Kerry Grimes, retired PCB materials distributor.

Shawn Haddy, 53, manufacturing manager at Unicircuit and other PCB fabricators.

Lana (Mihok) Hummel, 73, PCB designer and CAD specialist at Wink-O-Matic, Reliance Electric and Marconi Electronics.

Gregor Jost, 56, managing director, Balver-Zinn.

James Keil, 92, co-owned and operated PCB company.

Joseph La Liberte, 90, veteran of Sanders and other New England PCB shops.

Jeff Loewenhagen, 68, retired PCB fabricator.

Joan Long, 74, retired integrated circuit board technician at H-P.

William (Bill) Macartney III, 79, chairman of Indium Corp.

Mae Ann (Bremseth) Malinowski, 71, retired electronics assembler, Woodward.

Manny McMahon, 75, ex printed circuit board designer with CADstar.

Alice Mae Miller, 91, former circuit board assembler at H-P.

Frank J. Morawiecki Jr., 70, spent 36 years at EMD/Benchmark Electronics.

Hazel Blanch Norman, 99, worked in electronics assembly for Hill-Rom for 22 years.

Michael Rodriguez, director of operations, Express Manufacturing.

Donald Rumsfeld, 88, ex CEO of General Instruments.

Bhupender Saharan, cofounder and CEO, VVDN.

Tapan Kumar Sarkar, 72, Syracuse University engineering professor and former vice president of IEEE's Publication Services and Products Board.

Sir Clive Sinclair, 81, inventor who brought affordable personal computing to the masses.

Gregory Alan Voigts, 65, Foxconn director of product quality.

Pamela J. Waite, 68, circuit board assembler at C-COR.

David Wilson, 71, former PCB designer for Hamilton Standards.

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Industry 4.0 Takes on Solder Paste Replenishment

Automating paste application saves time and money.

INCREASING PRODUCTIVITY THROUGH process automation, software intelligence and multitasking capability are the foundation of Industry 4.0. Executing manufacturing tasks with exponentially more efficiency and precision ultimately drives cost lower and quality higher. This is proven across operations within numerous industries. As one of the critical sub-processes in SMT manufacturing, stencil printing is an area where substantive gains in quality and cost-efficiency can be made. Often overlooked is the smart factory approach to solder paste replenishment, though it is integral to a true closed-loop system.

Obviously, in order to print, material must be on the stencil in front of the blade. Currently, the predominant method for achieving this condition is manual application. A line operator physically scoops paste out of the jar and places material on the stencil. This seems like an appropriate use of operator resources, as they are positioned on the line anyway, but, in the "little and often" methodology for screen printing processing, this approach is counter to process stability, optimized throughput and cost-efficiency. Manual application of paste could be carried out more frequently to comply with "little and often," although that would require a machine stop, which may impact throughput and, therefore, cost. Conversely, the operator can apply a large volume of paste on the stencil to accommodate more prints, which may alleviate some of the throughput concern, but could have an adverse effect on process stability.

Balancing cost, stability and throughput – while minimizing operator assists and utilizing personnel resources for other tasks – can be achieved with newer-generation automated paste deposition technologies. These systems, many of which can now run for complete eight-hour shifts with no operator intervention, are another step toward Industry 4.0 screen printing capability. Manually applying paste requires the cover to be opened, which results in a machine stop. Instead, with an automatic paste dispenser, preprogrammed exact quantities of solder paste can be applied to the stencil while another process overhead – such as understencil cleaning – is taking place. This permits the printer to perform at its normal cycle time without impacting throughput. When the cartridge or jar for the automatic paste dispenser does require a changeover, more recent designs enable this to take place while the printer is in operation. Dual-access split machine covers facilitate partial opening of the printer cover for paste-dispenser-only access, while quick-release mechanisms and positioning simplicity facilitate the change.

Process and solder paste material stability are also optimized through an automated approach. When precise volumes of paste are placed in front of the blade at set intervals (instead of random and inconsistent volumes at unsystematic times), the likelihood of a tight, uniform result increases. In addition, material stability is maintained. With any automated material deposition system, paste is hermetically sealed within the standard cartridge/tube, or even if using a traditional jar of paste (which, incidentally, can also be used in an automatic dispensing tool). In either case, an on-board plunger helps maintain material stability and a sealed environment. With a manual pot system, one has to decide the fate of any material when a shift ends or production shuts down for the day. Honestly, I have seen some operators put material right back in the jar and into the fridge for use the next day. This is not ideal, especially in the world of miniaturization. With an automated system, there is no way to reuse material, and the risk of an unstable process declines dramatically.

Finally, there is the cost consideration. Clearly, an automated material system is more cost-effective for the reasons stated. Better throughput reduces overall operational cost and frees personnel resources for other tasks. When paste dispensers can run a full shift without changeover, all the better. Higher quality products and paste preservation through material stability also reduce expenditures over the long term. And while solder materials are not that expensive comparatively, reducing material waste adds to the bottom line.

Lights-out production, Industry 4.0 or closed-loop processing – whatever your preferred term – isn't just about keeping the line running at any cost. It is about ensuring cost-efficiency *and* the highest levels of quality; automatic control of material replenishment may seem like a simple, minor modification, but it's a major step in the right direction. ▫

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Dye and Pry, or Pull and Look

X-ray can't catch all failures.

THIS MONTH WE we look at solder joint separation from pads with dye and pry testing, which is of course intended, and in **FIGURE 1** shown as a perfectly good solder joint. (Well, until I covered it with dye and broke it, that is.)

During reflow training or process trials, simply prying a package off the board after soldering is a quick way to confirm successful reflow of area array parts, and the "dye" in dye and pry is not required. We use dye when evaluating joints after thermal exposure or, more likely, mechanical testing, or if there is a known failure not visible by x-ray.

In recent years, prying parts has lost favor to pulling parts from the board. For the majority of larger packages, however, prying with a wood chisel works fine for users with a little experience.

We have presented live process defect clinics at exhibitions all over the world. Many of our Defect of the Month videos are available online at youtube.com/user/mrbobwillis. Find out how you can share our new series of Defect of the Month videos to explain some of the dos and don'ts with your customers via CIRCUITS ASSEMBLY: https://bit.ly/3mfunlF. ▫

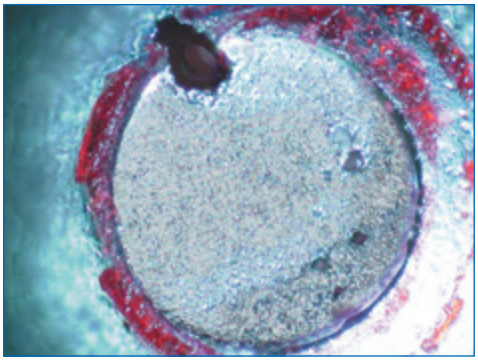


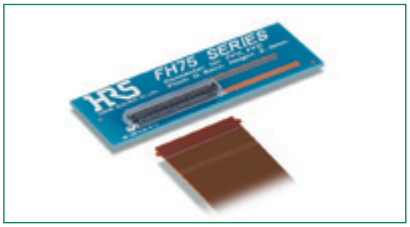
FIGURE 1. Pry testing a BGA.

BOB WILLIS
is a process engineering consultant; bob@bobwillis.co.uk. His column appears monthly.

STACKPOLE RMCA RESISTORS

RMCA series is AEC-qualified and has long-term reliability for automotive applications. Reportedly has exceptional test performance to all AEC tests, as well as an improved expected failure rate by a factor of 10 or more.

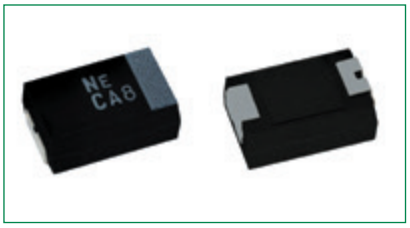
Stackpole Electronics
seielect.com



HIROSE FH75 FPC/FFC CONNECTOR

FH75 series automotive flexible printed circuit/flat flexible connector supports MIPI D-PHY specifications. Delivers high-speed data transmission up to 1.5Gbps. Has 0.5mm pitch and height of 2mm. Offers high contact reliability in severe environments and uses two-point contact design with two independent springs that provide wiping action to prevent contact failure from dust, dirt and other contaminants. Operating temp. is up to 125°C. Meets automotive requirements including resistance to shock and vibration, hydrogen and sulfur gasses, humidity and corrosion. Uses flip lock with FPC tab and housing side catches that offer retention force of 51.4N. Available in 40-position version that is halogen-free and RoHS-compliant.

Hirose
hirose.com/us



VISHAY VPOLYTAN T50 CAPACITORS

vPolyTan T50 surface-mount polymer tantalum molded chip capacitors are for high-temperature, high-humidity operating conditions. Offer high-temperature operation to +125°C and withstand temperature humidity bias testing of 85°C, 85% RH for 500 hr. For decoupling, smoothing, and filtering in harsh environments of industrial, military, aerospace, and edge computing applications.

Vishay
vishay.com

OTHERS OF NOTE

TORAY TORELINA FILM

Torelina bi-axially oriented polyphenylene sulfide film for 5G communications offers transparency, heat-resistance, flame-retardancy, and dielectric performance. Applications include transparent 5G antennas, flexible printed circuit boards, heater substrate materials, and other electronic components. Is opaque with yellow tinge of heat-resistant polymers. Haze of transparent polyphenylene sulfide film is comparable to polyethylene terephthalate film.

Toray
toray-eng.com

NANO DIMENSION DRAGONFLY IV 3-D PRINTER

DragonFly IV 3-D printer reportedly delivers improved accuracy of traces, spacing, vias, PCB product quality, and ability to design and produce 3-D Hi-PEDs in one-step production process. Supports HDI-level elements; 75µm traces; 100µm spacing; 150µm via; enhanced print quality, optimizing yield with predictable conductivity; thickness variation <5%.

Nano Dimension
nano-di.com

MURATA LQW43FT BROADBAND INDUCTORS

LQW43FT 1812 broadband inductors are for Bias-T circuits that support an inductance range of 10µH to 22µH and current of 700mA. Are for automotive applications such as vehicle-mounted power over coax systems used in SerDes interfaces. Comprised of three models, the series ensures high impedance. Low-frequency band up to 100MHz.

Murata
murata.com

VISHAY TECHNO CDMM CHIP DIVIDER

Techno CDMM high-voltage chip divider now comes in a ribbed molded package with compliant surface-mount leads. Designed to reduce component counts and improve TC tracking performance and ratio stability in automotive and industrial equipment. Delivers max. working voltage of 1500V in 4527 case size. Consists of two resistors integrated into one molded package.

Vishay
Vishay.com

HIROSE C.FL SERIES COAXIAL CONNECTOR

C.FL series coaxial connector measures 2mm x 2mm with 0.92mm mated height. Features low reflection characteristics up to 30GHz. Has low voltage standing wave ratios of 1.4 VSWR max.: DC to 15GHz; 1.5 VSWR max.: 15 to 20GHz; 1.6 VSWR max.: 20 to 30GHz. Offers self-alignment range of ±0.15mm in x and y directions. Tactile click communicates proper mating. For portable, consumer and IoT devices.

Hirose Electric
hirose.com/us

DUPONT ME102, ME604, ME614 THICK-FILM PASTE CONDUCTORS

ME102, ME604 and ME614 silver-bearing thick-film paste conductors for in-mold electronic devices have improved mechanical and electrical properties. ME102 is a highly conductive thick-film conductive paste for antenna, heater and RFID functions; ME604 is a general-purpose thick-film conductive paste with improved thermoformability and conductivity; ME614 is a thick-film conductive paste with added laser ablation property for fine-line applications. Applications include LiDAR systems for autonomous driving and touch steering wheels with transparent 3-D-shaped surfaces.

DuPont Microcircuit Materials
mcm.dupont.com

ITW EAE EDISON II ACT PRINTER

Edison II ACT (Automatic Changeover Technology) printer provides progressive stages toward full automation. Requires no additional skills to operate. Uses Edison printer and pairing cart designed to automate changeover of solder paste cartridges, support tooling, squeegees, and stencils.

ITW EAE
itweae.com

SAKI 3XIM110 AXI

3Xi-M110 inline 3D-AXI system comes with new software said to reduce cycle time up to 50%. Has x-ray imaging mode and optimized control and motor speed. Delivers high-speed 3-D volumetric inspection, maintaining inspection accuracy. Planar CT technology detects solder joint defects and microstructure abnormalities in high-density PCBs.

Saki
sakicorp.com/en

WELLER TOOLS WSW SOLDER WIRE

WSW Solder Wire is designed for hand and robotic soldering. Reduces tip consumption. Reduce splash feature increases direct user safety while keeping workbench clean. Reportedly has 100% continuous flux core, combined with pure metal melting; avoids rework and enables long-term durable solder joints without cracking. Comes in reel sizes of 100g, 250g and 500g.

Weller Tools
weller-tools.com

OTHERS OF NOTE

TRIO MOTION TECHNOLOGY SCARA ROBOTS

SCARA robots provide high-performance robot control, motion control, and machine automation from single controller. Designed for pick-and-place, assembly and dispensing. Four robots extend from 400mm arm range and 3kg max. load capacity to 700mm arm range and 6kg max. load capacity.

Trio Motion Technology
triomotion.uk

MYCRONIC MYPRO I SERIES 3-D AOI

MYPro I series 3-D AOI offers redesigned ergonomics, and new tools that reduce programming time by up to 30%. Builds on K series 3-D AOI. Newly designed UI has intuitive programming guidance and self-optimizing process control algorithms. Image recognition algorithm identifies component's characteristics and ML algorithm automatically locates a board's fiducials and a component's polarity.

Mycronic
mycronic.com

INSPECTIS BGA-006 OPTICAL INSPECTION

BGA-006 optical inspection unit provides side-view BGA inspection. Has high-power lighting and high-res 90° viewing angle. Offers 6mm x 0.8mm x 1.5mm footprint. Produces high-res images of low-clearance areas beneath BGAs, µBGAs, CSP, CGA and flip-chip packages with as low as 40µm standoff. Discovers micro-cracks, cold solder joints, whiskers, missing balls, scaling, excess flux and other soldering issues.

Inspectis
inspect-is.com

SCS PRECISIONCOAT VI

PrecisionCoat VI offers conformal coating and dispensing flexibility through range of valves and tools. Includes automatic quick change. Features five programmable axes, servo motor position control and up to eight tools for automated material applications.

Specialty Coating Systems
scsequip.com

BALVER ZINN REGI-007 VOC FLUX

REGI-007 VOC is an alcohol-based, no-clean flux with organic activation system. Is for soldering applications classified as ORL0 according to IPC J-STD-004 standards. Reportedly offers superior wetting performance with clear, dry and almost invisible residues.

Balver Zinn
balverzinn.com

EUTECT SRS SOLDERING MODULE

Sustained ring soldering module permits preassembled solder rings to be placed on and around THT pins, which are then melted by laser, piston or induction soldering, or IR emitters, hot air or thermodes. Fully automatic ring production device produces specific solder rings from solder wires, with or without flux core. Solder wires of different diameters can be bent with specific ring diameters.

Eutect
eutect.de

SEICA PILOT VX FLYING PROBE TESTER

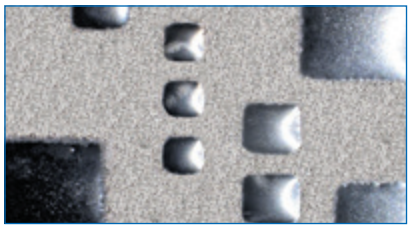
Pilot VX flying probe tester has 12 multi-function test heads. Can contact up to 44 points simultaneously. Collects and stores data regarding mechanical pressure applied by test probes on every point on board under test. Has positioning precision of +/-10µm; can probe 20µm pads, measure values such as 0.05pF capacitance or 100µΩ resistance.

Seica
seica.com

ANDA IPURE-1 FUME EXTRACTION SYSTEM

iPure-1 high-capacity fume extraction system is for high-capacity dispensing and conformal coating applications and adsorption of VOCs emitted during these processes. Fully programmable with automatic airflow sensing that self-adjusts to ensure continuous air filtration (typical operation 400cfm) with a max. operating capacity of 750cfm. Inflow and outflow air sensors.

Anda Technologies
anda.us



KYZEN MICRONOX MX2120 MULTI-METAL SAFE POWER MODULE CLEANER

Micronox MX2120 multi-metal safe power module cleaner is an aqueous, single-phase cleaner designed to remove tough flux residue from power modules that use nickel and most copper DBC as substrates. Reportedly provides outstanding cleaning performance and metal compatibility. Leaves great metal surface conditions for post-wire bond and EMC processes. Is designed to be effective in inline SIA cleaning systems. Is monitored and controlled.

Kyzen
kyzen.com

OTHERS OF NOTE

ELECTROLUBE UVCLX UV CURE COATING XTRA CONFORMAL COATING

UVCLX UV cure coating Xtra is solvent-free bio coating in which 75% of organic content is obtained from renewable sources. Applied via selective coating machine. Is touch-dry after short exposure to LED-365nm UV light. Full cure in less than 24 hr.

Electrolube
electrolube.com

EMIL OTTO EO-B-016 FLUX

EO-B-016 no-clean, alcohol-based flux is for selective soldering and is also suited for wave and manual soldering processes, for dip soldering and strand tinning. Application by all common methods except foaming. Solids content is 5% by weight. Has good soldering properties, especially in terms of penetration, wetting and cleanliness; good soldering results can be achieved on overaged or overlaid PCBs and components. Process window is wide, with high thermal stability and good process activity over long-time interval. PCBs are reportedly almost residue-free after soldering. Is based on alcohol with di-carboxylic acid activator complex and synthetic resin.

Emil Otto
emilotto.de

SAELIG NANORANGER NR-01 3.5-DIGIT DC AMMETER

NanoRanger NR-01 3.5-digit DC ammeter measures low currents. With automatic dynamic ranging (9 ranges across 8.5 decades), it measures currents from 1nA up to 800mA, with max. resolution of 10pA. Is factory calibrated. Current is measured with 12-bit ADC, which is oversampled and automatically averaged to produce 16-bit result. Samples are taken every 170µS.

Saelig
saelig.com

WELLER MG100S FUME EXTRACTION UNIT

Weller MG100s fume extraction unit is designed for hand soldering, heavy duty and general soldering, gluing, cleaning, filing and other fine dust applications. Purifies air at up to two workplaces simultaneously with H13 particle filter and wide-band gas filter. Features three speed settings and electronic filter control with filter alarm. Contains 6,7kg of potassium permanganate (KMnO4) granulated filter media. MEK, VOC and cleanroom applications can be accommodated with other optional filters.

Weller Tools
apextoolgroup.com

PVA DELTA 8

Delta 8 selective conformal coating machine now includes 5th axis motorized tilt, a motorized programmable tilt that can be configured to adjust to any angle between -45° to 45°. Permits greater part accessibility. Is for selective coating, potting, bead, and meter-mix dispensing applications. Robotic system repeatability of +/-25µm; servo-controlled optional four-axis motion featuring valve tilt and rotate; closed-loop process control throughout gantry system; multiple dispensing applications or materials in one cell; onboard PC for unlimited program storage; PathMaster programming environment.

PVA
pva.net

ELECTROLUBE GF600 THERMAL GAP FILLER

GF600 thermal gap filler provides thermal performance of 6.0W/m.K. Is designed to provide greater stability than traditional thermal interface materials. Bio-coating contains 75% bio-organic content from renewable sources and is eco-friendly. Is suitable for wide range of applications, including automotive and EV requirements.

Electrolube
electrolube.com

In Case You Missed It

This column provides abstracts from recent industry conferences and company white papers. Our goal is to provide an added opportunity for readers to keep abreast of technology and business trends.

3-D Printing

"Accelerated Discovery of 3D Printing Materials Using Data-Driven Multi-Objective Optimization"

Authors: Timothy Erps, *et al.*

Abstract: Additive manufacturing has become one of the forefront technologies in fabrication, enabling products impossible to manufacture before. Although many materials exist for additive manufacturing, most suffer from performance tradeoffs. Current materials are designed with inefficient human-driven intuition-based methods, leaving them short of optimal solutions. The authors propose a machine learning approach to accelerating the discovery of additive manufacturing materials with optimal trade-offs in mechanical performance. A multi-objective optimization algorithm automatically guides the experimental design by proposing how to mix primary formulations to create better performing materials. The algorithm is coupled with a semiautonomous fabrication platform to substantially reduce the number of performed experiments and overall time to solution. Without prior knowledge of the primary formulations, the proposed methodology autonomously uncovers 12 optimal formulations and enlarges the discovered performance space 288 times after only 30 experimental iterations. This methodology could be easily generalized to other material design systems and enable automated discovery. *(Science Advances,* vol. 7, no. 42, science.org/doi/10.1126/sciadv.abf7435)

Component Placement

"The Dissimilar Self-Alignment Characteristics of Smaller Passive Components in the Length and Width Directions"

Authors: Jingxi He, *et al.*

Abstract: As passive components' size gets smaller, quality rejects due to overhang and misalignment after reflow appear more frequently. This situation is partly because the pass-fail criterion is set based on the offset concerning the component dimensions. Therefore, understanding the self-alignment characteristics of electronic components becomes very critical for surface-mount assembly yield. This research investigates the dissimilarity of self-alignment in the length and width directions. *(Journal of Surface Mount Technology,* vol. 34, no. 2, https://journal.smta.org/index.php/smt/article/view/16)

Solder Joint Reliability

"The Effect of Electric-Thermal-Vibration Stress Coupling on the Reliability of Sn-Ag-Cu Solder Joints"

Authors: Xinlan Hu, *et al.*

Abstract: The damage of the package structure, caused by the multi-stress coupling of various environmental factors, can lead to the failure of the electronic device. Therefore, through the finite element method, the reliability analysis of three kinds of lead-free SnAg-Cu solders (SAC 105, SAC 305, SAC 405) in ball grid array (BGA) packaging was conducted under the conditions of thermoelectric coupling and random vibration, respectively. The results indicate that, according to the modified Coffin-Mason model, SAC 405 has the largest plastic strain range and the shortest fatigue lifetime under thermoelectric coupling. As a counterpart, SAC 105 has the smallest plastic strain range and the longest lifetime. However, under random vibration load, by addressing the Miner linear damage rule, the empirical formula of Manson high cycle fatigue and Steinberg's three band theory, the fatigue lifetime of SAC 405 is the longest, which is twice as much as SAC 105 and SAC 305. Furthermore, based on the linear damage superposition approach, the fatigue lifetime is predicted as SAC 305 < SAC 105 < SAC 405 under multi-stress coupling of electric, thermal and random vibration conditions. These results provide theoretical support for improving the application reliability of packaging in complex environments. *(Journal of Electronic Materials,* Nov. 10, 2021, https://link.springer.com/article/10.1007/s11664-021-09302-y)

Others of Note

Almost every study of heated traces or pads/components examines the thermal impact of the items on the top layer only, but it turns out there is a lot going on underneath the trace or pad that may have a major impact on other components. (www.edn.com/thermal-management-a-close-look-at-vertical-heat-flows-in-pcbs/)

University at Buffalo-led researchers will study how to make a new generation of high-temperature sensor electronics that bend and conform to different shapes. The NextFlex-grant funded project will focus on developing high-temperature flexible hybrid electronics, with substrates that are stretchable, conformable, and flexible. (www.buffalo.edu/news/releases/2021/11/004.html)

The wearables market has grown from $5 billion in 2015 to $32.6 billion in 2019 and is expected to grow at a compound annual growth rate of 15.9% from 2020 to 2027. Here are failure modes of wearable electronics. (www.ansys.com/resource-center/white-paper/ansys-failure-modes-of-wearable-electronics)

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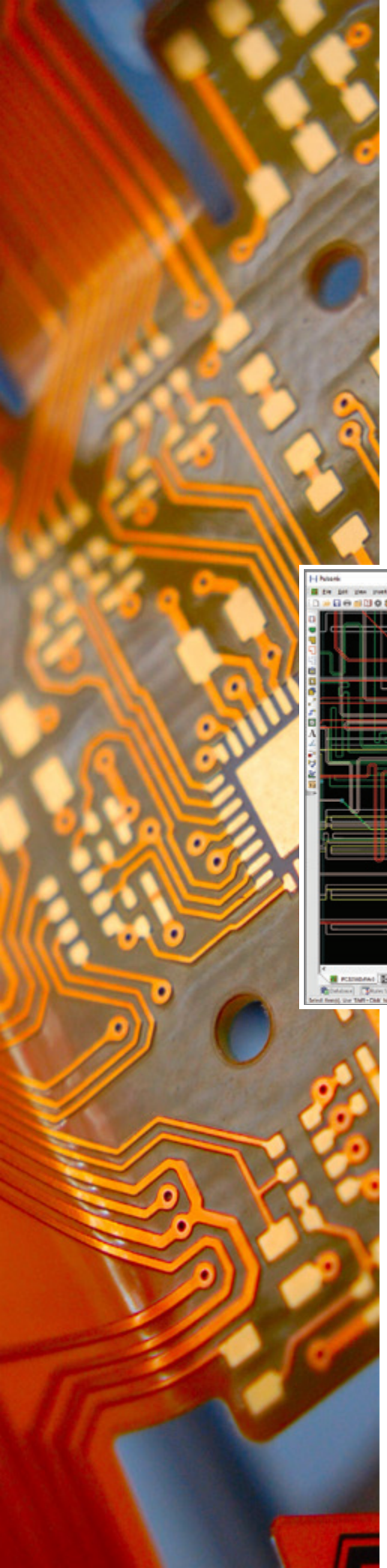
PCU

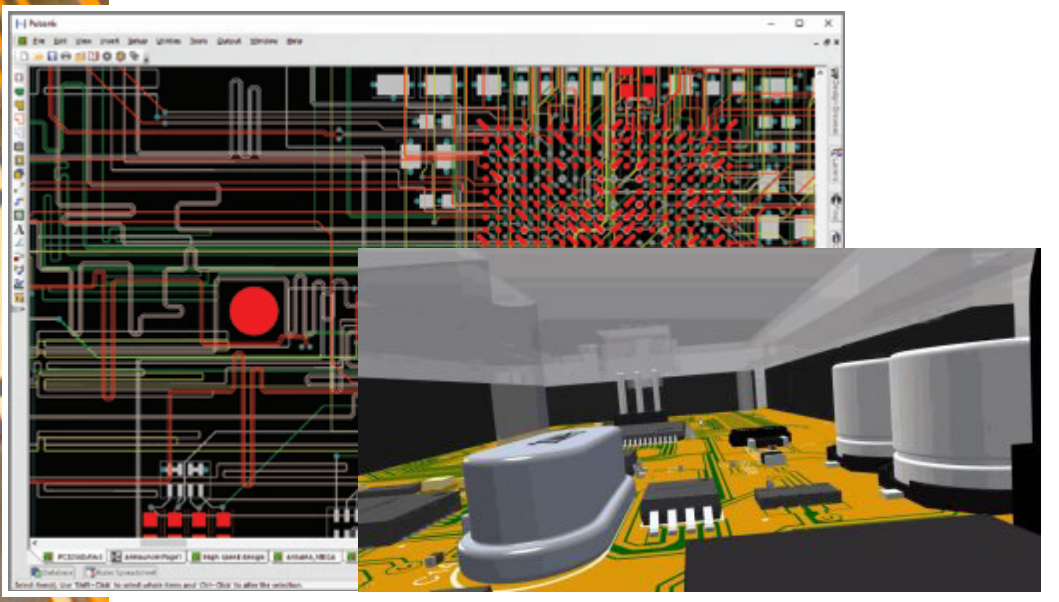


Pulsonix PCB Design Software

PCB design done right

New Version 11.0 Increases Speed up to 80%

Multi-threading and GPU processing in this new release create a gigantic leap in speed, dramatically reducing the time it takes to perform many PCB design operations, such as Design Rule Checking (DRC), Copper Pouring, and Gerber generation. That's PCB done right!



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