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This Month's Feature Articles

Medical Electronics: Getting the Vitals

This month, *SMT Magazine* examines the medical market to learn what impact it has on the electronics industry and where it might be in five years. This issue also covers key trends driving medical electronics and the challenges and opportunities in the industry.

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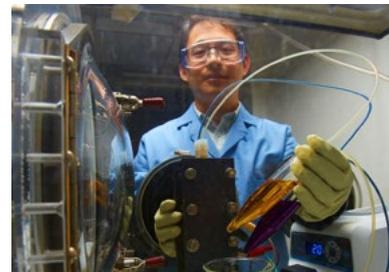


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Medical Electronics: Manufacturing Vitals

by Stephen Las Marias

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Welcome to the January 2016 issue of *SMT Magazine*. 2016! How time flies, right? I turn 35 this month, and one of my New Year's resolutions is to live a healthier lifestyle. After procrastinating about it for a long time, I've decided that this year will definitely be the year to restart my journey to fitness and healthy living.

This leads me to this month's focus of *SMT Magazine*: medical electronics. Two months ago, we were in Munich, Germany to cover productronica. Spanning seven halls of the Messe Munchen exhibition center, productronica 2015 was a really big event—and involved a lot of walking. Considering the amount of coverage we did at the show, I would say I lost a few pounds during the weeklong expo. It could have been a little more, but the weight I lost during the daytime was offset by the beer and really good German food at dinner. I also had a chance to look at my colleagues' Fitbit devices they were wearing, so I activated a smartphone app to track my footsteps during the event.

It's amazing how quickly people are get-

ting into the healthy lifestyle mindset with the help of such health and fitness tracker apps and devices. But from an electronics manufacturing standpoint, that is just a small piece of the medical electronics market.

With the rapidly growing aging population, rising healthcare costs and increasing health awareness, opportunities abound in consumer medical devices, diagnostics and patient monitoring, medical imaging, and medical instrumentation. Advances in semiconductor and sensor technologies, and integration of information technology have made these systems portable, low cost and more connected.

According to a report by market analyst MarketsandMarkets, the total value of medical electronics market is expected to reach \$56.5 billion by 2020, registering a CAGR of 5.5% from 2014–2020. Fueling this growth are increasing urbanization, the growing population, rising income levels and greater demand for personalized healthcare, MarketsandMarkets noted in the report. The continuous development of innovative electronic devices, low-cost medi-

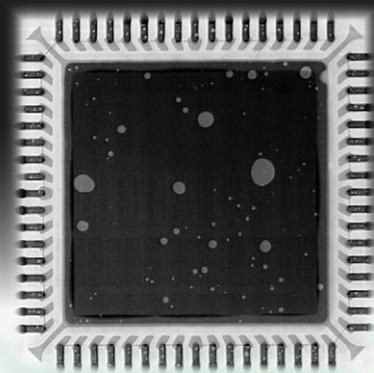


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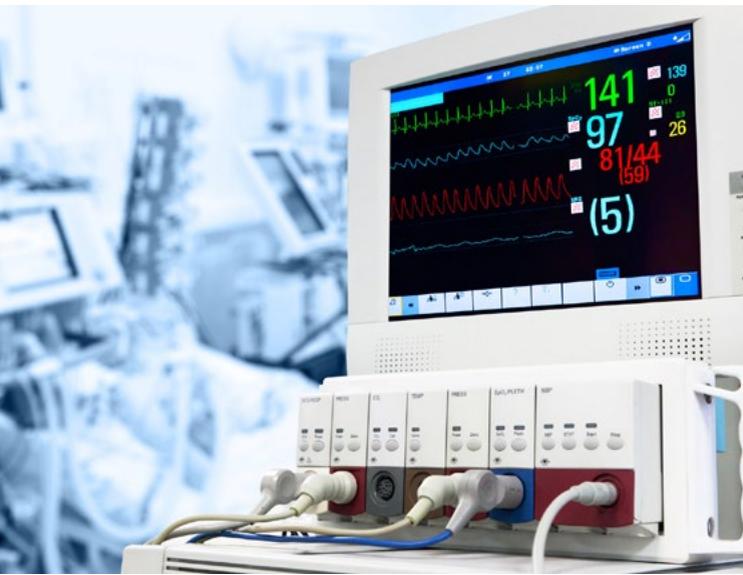
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MEDICAL ELECTRONICS: MANUFACTURING VITALS



cal facilities, and continuous support by various governments indicate heavy investment in R&D in healthcare and the medical electronics market in the coming years.

However, the medical electronics industry, and in particular, the manufacturing side of it, is not without its own set of challenges. For instance, the design of medical devices—including the complex manufacturing issues associated with the miniaturization trend, data security, power management, and lack of product differentiation—are key challenges when it comes to manufacturing medical electronics products. On top of it all are the strict regulatory requirements that manufacturers must adhere to and comply with.

This issue of *SMT Magazine* features articles and interviews that will help electronics manufacturers understand further the manufacturing challenges and opportunities in this growing sector. Here's what we're bringing you on the topic this month:

Kelvin Fernandez, a global product line manager at Nordson EFD, talks about the latest innovations in dispensing technologies when it comes to manufacturing medical devices.

Mo Ohady, general manager, and David Estes, engineer, at Digicom Electronics, write about what medical device companies need to consider when selecting a contract electronics manufacturer for their products, from track record and number of years in service, to types of

products being manufactured, age of the equipment in use, results from outside testing agencies, and more.

Frederick Blancas, senior division manager at Integrated Micro-Electronics Inc. (IMI), writes about the opportunities, trends and challenges in medical electronics manufacturing from the perspective of an EMS provider. He notes that while margin pressures, compliance costs and risks, supply chain instability, and new product introduction can be headaches, innovation helps medical manufacturers churn out more.

I interviewed Jay Wimer, executive vice president of the Valtronic Group, and president and CEO of Valtronic USA, about the impact of the medical market on electronics manufacturing, the challenges facing medical electronics manufacturers and technology providers, and how the trends happening in the medical electronics segment are driving innovation in electronics manufacturing.

Brian Morrison, director for Value Engineering & Technology at SMT Corp., discusses the manufacturing and supply chain challenges facing EMS providers when it comes to medical electronics, and the increasing need for risk management, design control and traceability.

As always, *SMT Magazine* would not be complete without technical articles discussing the latest developments in the PCB assembly, EMS and SMT industries. For this issue, Steve Fraser, VP of operations at Firstronic, writes about vapor phase (VP) reflow solder technology and why the technology is now coming of age. He also mentions several ways that VP reflow technology can save cost, and the benefits it offers electronics manufacturers.

Patty Goldman, editor of *The PCB Magazine*, interviews Tom Borke, founder of The Jefferson Project and the forthcoming Jefferson Institute of Technology, about his well-researched plan to bring manufacturing to engineering undergraduate students by bringing students to manufacturing, through a hands-on, real-world learning experience.

For his regular column this month, Michael Ford, senior marketing development manager with Mentor Graphics Corporation Valor division, shares how traceability can solve the problem of counterfeit materials. Ford says counter-

MEDICAL ELECTRONICS: MANUFACTURING VITALS

feit materials proliferate because of the complexity that lies between their detection and the ability to track back to the source—and that precise traceability of materials is an effective way to police and dissuade the majority of attempts.

Robert Voigt, VP of global sales at DDM Novastar Inc., picks up from where he left off in his last column about wave solder systems, and goes into detail about various board handling systems, including automated in-line, manual conveyor, and palletized carrier.

Last but not least, industry veteran Dr. Jennie S. Hwang, CEO of H-Technologies Group, offers her comprehensive annual look into the future. In her column this month, Hwang highlights market thrusts in the anticipated global economic landscape, and mega-technological trends, which include the highlights of macroeconomy outlook, China factor, oil dynamics,

cyber security, and grand challenges in technology and the path forward.

You can also check out our sister magazines, *The PCB Magazine* and *The PCBDesign Magazine*, to know more about the impact of medical electronics in the PCB design and fabrication industries, and the challenges and opportunities this segment presents to both.

We at *SMT Magazine* wish you a prosperous and healthy year ahead! **SMT**



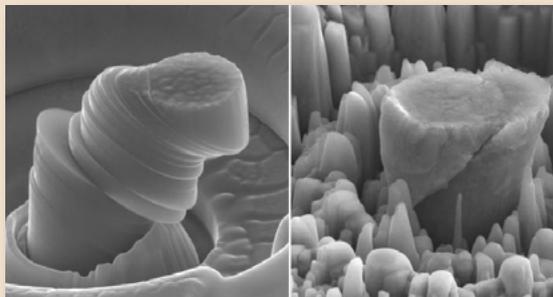
Stephen Las Marias is managing editor of *SMT Magazine*. He has been a technology editor for more than 12 years covering electronics, components, and industrial automation systems.

UCLA Researchers Create Exceptionally Strong and Lightweight New Metal

A team led by researchers from the UCLA Henry Samueli School of Engineering and Applied Science has created a super-strong, yet light structural metal with extremely high specific strength and modulus, or stiffness-to-weight ratio. The new metal is composed of magnesium infused with a dense and even dispersal of ceramic silicon carbide nanoparticles. It could be used to make lighter airplanes, spacecraft, and cars, helping to improve fuel efficiency, as well as in mobile electronics and biomedical devices.

The team found a new way to disperse and stabilize nanoparticles in molten metals. They also developed a scalable manufacturing method that could pave the way for more high-performance lightweight metals. The research was published recently in *Nature*.

"It's been proposed that nanoparticles could really enhance the strength of metals without damaging their plasticity, especially light metals like magne-



sium, but no groups have been able to disperse ceramic nanoparticles in molten metals until now," said Xiaochun Li, the principal investigator on the research and Raytheon Chair in Manufacturing Engineering at UCLA. "With an infusion of physics and materials processing, our method paves a new way to enhance the performance of many different kinds of metals by evenly infusing dense nanoparticles to enhance the performance of metals to meet energy and sustainability challenges in today's society."

Structural metals are load-bearing metals. Magnesium, at just two-thirds the density of aluminum, is the lightest structural metal. Silicon carbide is an ultra-hard ceramic commonly used in industrial cutting blades. The researchers' technique of infusing a large number of silicon carbide particles smaller than 100 nanometers into magnesium added significant strength, stiffness, plasticity and durability under high temperatures.

The researchers' new silicon carbide-infused magnesium demonstrated record levels of specific strength—how much weight a material can withstand before breaking—and specific. It also showed superior stability at high temperatures.

New Year Outlook: China's Five Year Plan

by **Dr. Jennie S. Hwang**
H-TECHNOLOGIES GROUP

Once again, it is time to look at the year ahead. This relished tradition puts me on the spot to think more intensely about the coming year. In this first column of the New Year, I usually take a long view on market thrusts in the anticipated global economic landscape, as well as mega-technological trends, which include: the highlights of macro-economy outlook, China factor, oil dynamics, cyber security, and grand challenges in technology and the path forward.

Reflecting on 2015, China was under an unusual light as the world watched its economic slowdown and other unprecedented and/or unexpected events unfold. Moreover, 2016 bears new milestones for China. Beijing will reveal a new Five-Year Plan (FYP) for 2016–2020, which is the very first FYP under the Xi Jinping administration. The yuan has also been added to the IMF's Special Drawing Rights (SDR) currency basket. Therefore, this time around I will use

this limited space to focus only on the China factor, specifically addressing the new FYP, notable events in 2015, anticipated key strategies, innovation as an emblem, and anticipated economic landscape.

China is not just a factor, but it's becoming a pivotal factor! As the world's second largest economy and the world's most populous country with huge upside potential, China plays an increasingly important role to the global economic growth, as well as to corporate business.

However, against the backdrop of slower growth, what is China's latest vision for its country?

Five-Year Plan (2016–2020)

Every five years, China's National People's Congress (NPC) approves a Five-Year Plan, which dictates China's economic and social policy. The FYP is a luminous blueprint for



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China's economic trajectory and serves as the holistic strategy behind it.

The country has been diligently and intensively working on its 13th FYP for national economic and social development, dubbed 13.5. This all-encompassing product is the result of comprehensive, disciplined, and systematic effort, serving not only as the guiding principle, but in fact the implementable practice. More importantly, the Plan is truly put into work.

“The phenomenal growth and reform during the last three decades demonstrably manifest the power of the Plan, although results may not always be straightforward and speed bumps have inevitably been encountered along the way.”

The phenomenal growth and reform during the last three decades demonstrably manifest the power of the Plan, although results may not always be straightforward and speed bumps have inevitably been encountered along the way.

In preparation for drafting the 13th FYP, the National Development and Reform Commission (NDRC) solicits applications from large corporations, industry associations, universities, research institutions, and international organizations to participate in the initial research phase. The previous FYP is evaluated for what worked and what still needs more work. Information, ideas, opinions and data are collected from all elements of society, including policy analysts, scientists, engineers, local governments, advisory bodies and the public. After the NPC approval, China's Central Government implements the Plan and passes it to local provincial and city governments for implementation.

Considering a slowing economy, the plan will build on the 12th FYP and will serve as a framework to advance key national reforms introduced under Xi Jinping's administration and to adjust China's economic growth model, in order to maintain stable growth. The goal of this first plan under the Xi administration is to promote China's transition to a consumption-driven, sustainable economy, and moderately prosperous society. The Plan emphasizes quality of economic growth instead of numerical GDP growth.

Beijing's broader strategic target—to double the size of China's economy and the people's average income from 2010 to 2020—is expected to be maintained. To meet the target, GDP growth is believed to need to be around a 6.5% average annually.

Notable Events in 2015

What notable events have occurred in 2015 which exerted substantive or psychological impact on the economy and the way to do business?

The stock market summer meltdown and the yuan's devaluation versus the dollar are the most prominent. The stock market meltdown was felt globally and the plunge created worldwide jitters. Its meltdown prompted Beijing's crackdown on financial irregularities. Yet, it should be noted that the stock market represents only a small portion of its capital funding and that it dropped after a huge jump (150%) before coming down (40%).

In an effort to put a floor under a slowdown, China's central bank has started a series of stimulus measures including cutting interest rates and reducing the reserve requirement for banks. It has also furthered a liberalizing path in its financial system and currency, albeit conservatively and cautiously. Its government also exercised other options by approving many infrastructure projects worth more than \$283 billion (WSJ, October 19, 2015). The massive stimulus program has caused its debt levels to climb.

China's goal to make the yuan a more global currency has gotten a boost by establishing the collaboration with the U.K. and the addition of the yuan to the IMF SDR currency bas-

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ket of reserve currencies (the decision was announced on November 30, 2015). A panel led by Michael Bloomberg was formed to bring the trading of China's currency to Wall Street—to build a framework for the trading and clearing of China's yuan in the U.S. The panel expressed that bringing trading and clearing services for the Chinese currency to the U.S. would lower costs for domestic companies buying goods and services from the Asian nation (WSJ, November 30, 2015).

The state-owned enterprises were going through an overhaul—separating transportation and services from other industries. Strategic industries will now enjoy preferential support and non-strategic companies will be more open to private and foreign investors. The share of state-owned enterprises in industrial output has continued to drop steadily.

Socially, a symbolically significant move was made as China decided to abandon its one-child policy and all Chinese couples will be allowed to have two children. The housing market problem persisted. Politically, a historic meeting between Xi Jinping and the leader of Taiwan, held in Singapore, was, to many, a surprise.

Another highly impactful initiative was that China stepped up its anticorruption drive, imposing a monumental shock on businesses. The consequence of that is much more acute and pervasive than what is obvious.

Anticipated Key Strategies

The details of the FYP will not be released until the National People's Congress approves it in March. Meanwhile, we must consider which sectors are likely to be favored over the next five years.

Environmental protection will be a priority. Controlling the emission of small particulate matters of 2.5 microns or less is a key remediating measure. The nation's Airborne Pollution Prevention and Control Action Plan—mandating reductions in coal use and emissions—has earmarked an estimated \$277 billion to target regions with the heaviest pollution. This is one of several policy efforts to limit coal's dominance in the economy and to encourage cleaner energy supplies.

Reportedly, an environmental tax is likely

to be imposed over the next few years to help cut carbon emissions in half by 2030. Heavy energy-consumption industries, the top emitters, will take a hit, and cleaner energy companies like solar panel and wind turbine makers are expected to benefit. Under this thrust, cleaner vehicle development and deployment, like electric cars, is expected to prosper. So deploying electric vehicles in China could be faster than the United States.

In addition, China will steer traditional manufacturing along an environmentally friendly path to establish a low-carbon production system and encourage businesses to upgrade technology. It is reported that the government plans to set up a Green Development Fund to promote clean industry and sustainable growth.

“Heavy energy-consumption industries, the top emitters, will take a hit, and cleaner energy companies like solar panel and wind turbine makers are expected to benefit. Under this thrust, cleaner vehicle development and deployment, like electric cars, is expected to prosper.”

Strategic industries, which are deemed a key element in delivering higher quality growth, will be strongly supported by the government. This cluster includes new energy, biotechnology, environmental protection, new generation information technology and the underlying foundation technologies (e.g., a new generation of advanced materials). Automobile electronics sectors are to thrive under the upcoming FYP. Education, health and infrastructure development, including charging stations for electric vehicles, are also in the plan.

NEW YEAR OUTLOOK: CHINA'S FIVE YEAR PLAN

Leveraging on the power of the Internet to boost the productivity of traditional sectors such as manufacturing and to garner smarter processes and better technology is another priority.

The government will continue its effort in modernizing its underdeveloped capital market. As committed, it will allow market forces to play a more important role in setting the yuan exchange rate in the 13th Five-Year Plan and continue reforms in its financial system. The inclusion of the yuan in the IMF reserved currencies, effective October 2016, reflects the recognition of China's place in global finance. But it imposes challenges in managing the yuan and in communicating with investors with

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“The government will continue its effort in modernizing its underdeveloped capital market. As committed, it will allow market forces to play a more important role in setting the yuan exchange rate in the 13th Five-Year Plan and continue reforms in its financial system.”

.....

clarity and transparency. Its central bank is expected to continue facing market pressure by allowing modest depreciation of the currency in the coming year. However, keeping the yuan's stability should be the number one priority. To achieve Beijing's goal to make the yuan a convertible and freely usable global currency, domestic pushback and significant challenges are in sight.

Innovation as an Emblem

Spurring innovation will need to be front and center to move China's economy up the value chain.

China has made heavy investments in R&D in recent years; China ranks number two globally in overall R&D spending (OECD 2014)—\$350B (2.1% GDP) vs. U.S. \$465B (2.8% GDP). Considering the spending growth rate, China's R&D spending is expected to surpass that of the U.S. by the early 2020s.

Heightened emphasis on innovation and technology is embedded throughout the Plan. The government intends to encourage innovation by supporting scientific research and corporate R&D and continue to encourage mass entrepreneurship through major scientific and technological projects. Building national laboratories in the hope that it will lead to new technology is also part of the plan. Over a million science and engineering graduates each year are helping to establish important beachheads in science- and engineering-based innovation.

Anticipated Economic Landscape

Contributing to approximately 38% of the global growth (2014) and more than 15% of the global GDP, China's stability and stabilizing growth will be essential to the world economy.

The inclusion as the third largest component of the IMF lending basket elevates the yuan's status, an uplift to China's economic leverage. In response, its central bank has announced to accelerate efforts to overhaul the country's financial system, further opening its market and keeping the yuan stable.

China's economy with double-digit growth rates as demonstrated in last two decades is the way of the past. However, even slowing down, China is expected to continue to grow at a pace that other major economies envy. A higher percentage does not necessarily translate into a more robust and stable economy. Maintaining the growth in the range of 6–7% (6.5% plus or minus 0.5%) over the next few years is a pragmatic target. In the event that the target lands below 6.5%, the fear factor may rule the market. The market could view it unfavorably, which would especially weigh on commodities.

To foreign companies, the new FYP bears a plethora of business implications. I see specific opportunities in individual areas and industry sectors. China continues to be the world's biggest consumer of semiconductor products, mo-

NEW YEAR OUTLOOK: CHINA'S FIVE YEAR PLAN

mobile devices, smart phones, LEDs, solar panels, medical devices, home appliances, and construction, among others. The demand of various industrial, consumer, medical, energy and information technology-related products and services will continue to increase, which will require new materials, advanced manufacturing infrastructure, as well as high performance electronics.

For Chinese companies, iconic branding is the dream to come true. Many have gained understanding on what it takes to globalize through the thoroughly planned strategy executed relentlessly over sustainable years. As more indigenous companies aspire to be a global brand, more global competition in all industry sectors intensifies.

As the concept map as well as the roadmap, the new FYP, again, will flex its muscle and exert its power in every sector of the industry.

China's president Xi expressed that China has been and will continue to be both "engine and stabilizer" for the world's economy. Between the United States and China, competition and cooperation is expected to co-exist. There will be many areas of competition and many areas of cooperation.

Upcoming Appearances

Dr. Hwang will present a lecture on "Preventing Manufacturing Defects and Product Failures" at IPC APEX EXPO on March 17, 2016, in Las Vegas. **SMT**



Dr. Hwang, an international businesswoman, speaker, and business and technology advisor, is a pioneer and long-standing contributor to SMT manufacturing since its inception, as well as to the lead-free electronics implementation. Among her many awards and honors, she is inducted to the WIT International Hall of Fame, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and IEM Corp., she is currently CEO of H-Technologies Group, providing business, technology and manufacturing solutions. She serves as Chairman of Assessment Board of DoD Army Research Laboratory, Commerce Department's Export Council, various national panels/committees, international leadership positions, and the board of Fortune 500 NYSE companies and civic and university boards. She is the author of 450+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. For further info, visit lennieHwang.com. To read past columns, [click here](#).

LCE Material to Pave Way for Advanced Sensors

Peter Palffy-Muhoray, PhD, associate director of the Glenn H. Brown Liquid Crystal Institute and professor of chemical physics in the College of Arts and Sciences at Kent State University, his graduate assistant, Andrii Varanytsia, and Kenji Urayama and Hama Nagai from the Kyoto Institute of Technology in Japan developed the first type of cholesteric liquid crystal elastomers (LCEs) with special properties that enable it to precisely emit laser light, without the use of mirrors, while being stretched.

"We can use the information learned as the basis for moving toward applications – such as remote sensors, which can be interrogated from a distance using optic fibers, and as precisely tunable light sources, which are very difficult to produce," Palffy-Muhoray said.

The liquid crystal acts as both the distributed cavity host and the active medium. Simple optical pumping of such a sample results in low-threshold, mirrorless lasing at the band edges. LCEs can change their shape when the orientational order of the constituents is changed – by changing the temperature, applying a field or introducing impurities.

Why Medtech Manufacturers Should Automate Fluid Dispensing Operations

by **Kelvin Fernandez**
NORDSON EFD

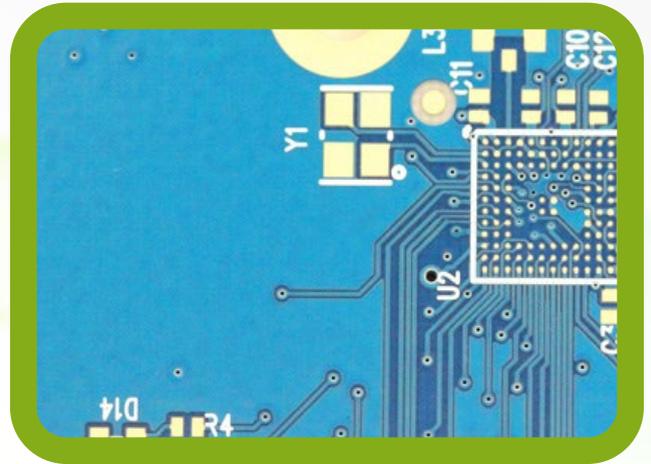
Researching, designing, developing, and manufacturing medical devices is an exact science. Consequently, fluids used to manufacture medical devices must be dispensed according to scientific principles—especially as devices shrink, parts are closer together, and substrates become more fragile and more prone to contamination. To address these challenges, medtech manufacturers are increasingly turning to the use of robotic dispensing technologies.

Used for bonding, gasketing, filling, lubricating, and sealing, the fluids used in medical device applications range from thick to thin. They can be two-part combinations, viscosity changing, or light curable. In addition, they can be dispensed in single or batch processes or in volume manufacturing operations using fully automated in-line systems. Whether they are used for R&D or prototyping purposes or in low-volume or high-volume production, fluids can be dispensed most precisely, reliably, and repeatedly using automated dispensing systems, enabling manufacturers to save materials, time, labor, and resources.

However, the transition from manual to automated fluid dispensing is more involved than simply deciding to automate. Determining what to automate is key. Thus, manufacturers considering the shift to automated dispensing should look closely at their entire process to ascertain whether automating a part of it will help them to improve safety, performance, product quality, reliability, or productivity.



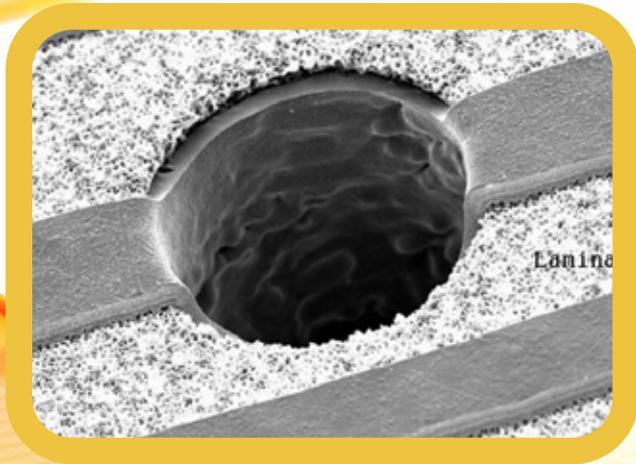
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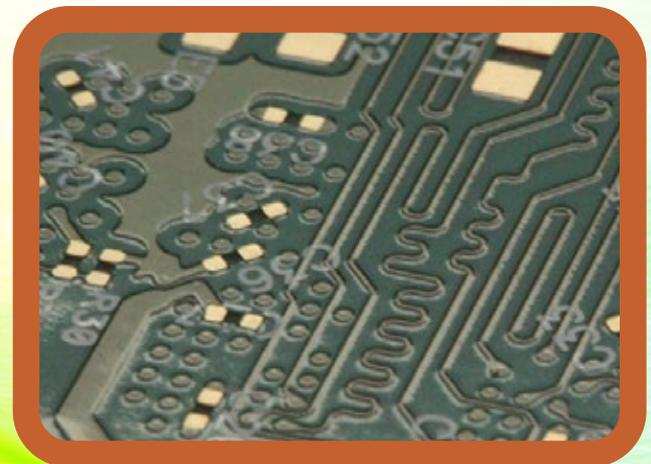


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WHY MEDTECH MANUFACTURERS SHOULD AUTOMATE FLUID DISPENSING OPERATIONS

Contact vs. Non-contact Dispensing

Two methods are commonly employed to dispense process fluids: contact dispensing, in which fluids are dispensed using a dispensing tip, and non-contact dispensing, in which fluids are commonly jetted. A manufacturer should choose one or the other depending on the viscosity and consistency of the fluid and the application requirements.

While contact dispensing produces much smaller deposit sizes than non-contact dispensing, the dispensing tip must be placed close enough to the part so that the fluid can make contact with the tip and part at the same time, as illustrated in Figure 1. In automated dispensing processes, this method is more time-con-

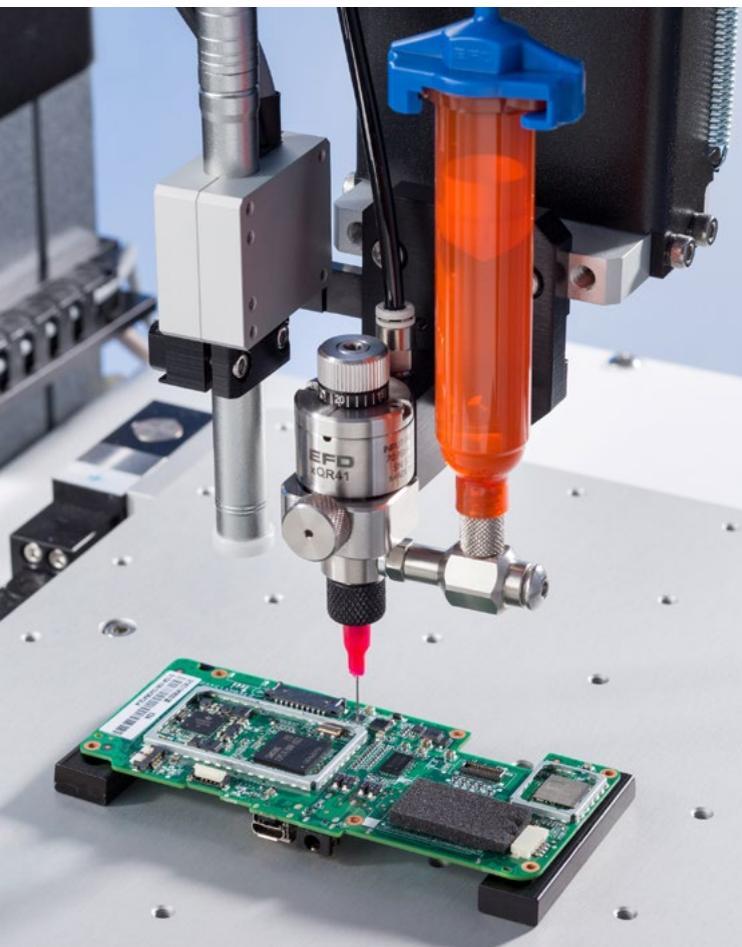


Figure 1: While contact dispensing produces much smaller deposit sizes than non-contact dispensing, the dispensing tip must be placed close enough to the part so that the fluid can make contact with the tip and part at the same time.

suming than the non-contact method because the tip must be lowered onto the dispensing area and retracted before it is moved to the next dispensing point.

In contrast, non-contact dispensing accelerates the process because the jetting action does not require automation to lower and raise the tip along the z-axis. Thus, the cycling of the jetting valve—which is usually piezoelectric—is performed at much faster speeds and higher cycle rates than tip dispensing can achieve, allowing for greater cycle time savings. An example of how a non-contact jetting valve dispenses fluid is shown in Figure 2.

In automated non-contact dispensing systems, some valves dispense fluids in volumes down to 0.2 nl with diameters as small as 50 μm . They can also handle fluids with water-like viscosities ranging from 1 to 5 cPs or thick pastes with viscosities up to 1,000,000 cPs at continuous dispense speeds up to 500 Hz. Precision automated dispensers are accurate systems which can deposit fluids at the desired location, including hard-to-reach places and device edges.

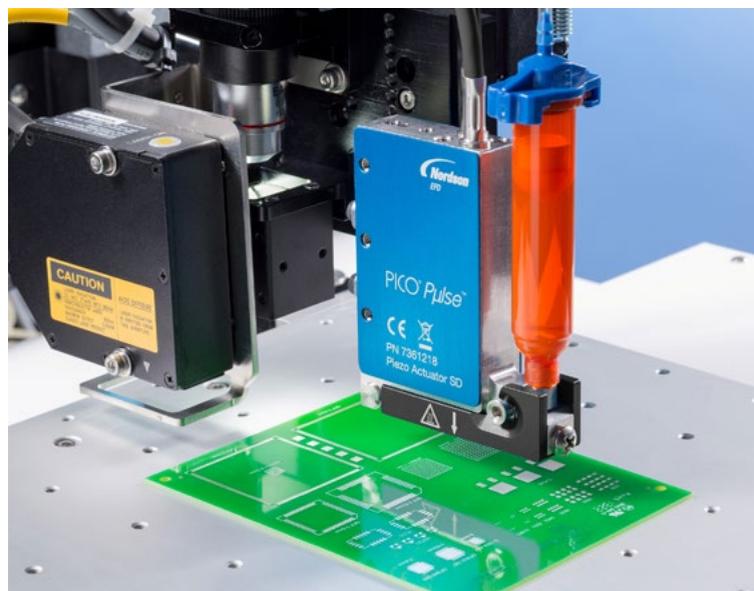


Figure 2: In noncontact dispensing, the cycling of the jetting valve—which is usually piezoelectric—is performed at much faster speeds and higher cycle rates than tip dispensing can achieve, allowing for greater cycle-time savings.

WHY MEDTECH MANUFACTURERS SHOULD AUTOMATE FLUID DISPENSING OPERATIONS

Automated Dispensing: Hardware and Software

The accuracy associated with dispensing fluids manually is highly dependent on the skill of the operator. In contrast, automated dispensing systems can be programmed to dispense dots, lines, circles, arcs, and compound arcs with accurate and repeatable tolerances. Such systems are usually designed to store multiple dispensing programs that can be retrieved as desired. The more advanced the system, the more accurately it dispenses fluids and performs complex dispensing patterns.

One such tool allows the user to move the dispensing head into the required position and program the coordinates. Another, more intricate option uses a vision-guided automated dispensing system that enables the robot to magnify the part to better position the dispensing head while providing an on-screen preview of the dispensing path. As shown in Figure 3, this functionality can enable the operator to view a magnified image of the part. The use of a vision system removes much of the guesswork from the process, minimizing programming times in complex dispensing applications.

Automated dispensing systems incorporating vision capability can often align programs to changes in part-to-part placement or fixture tolerance. They can also often integrate the vision system with embedded software to align the program to set fiducial points on a part, allowing the system to move the dispensing points and the path to accommodate placement changes from one part to another. In many instances, these systems can also provide optical confirmation that the workpiece is present to avoid dispensing fluid when a part is missing. More sophisticated vision-guided automated dispensing systems often utilize higher-level vision systems, more complex programming, and encoders in a closed-loop configuration, providing precise, accurate, and repeatable results in complex applications.

Because part positioning, irregular surfaces, thickness differences, and distortion can exceed dispensing tolerances, contact between the tip and the part is almost certain if the dispensing system cannot compensate for such variances. And depending on the complexity of the medical device, contact dispensing can damage fragile substrates. To manage these variances, some



Figure 3: A vision-guided automated dispensing system enables a robot to magnify a part to better position the dispensing head while providing an on-screen preview of the dispensing path.

WHY MEDTECH MANUFACTURERS SHOULD AUTOMATE FLUID DISPENSING OPERATIONS

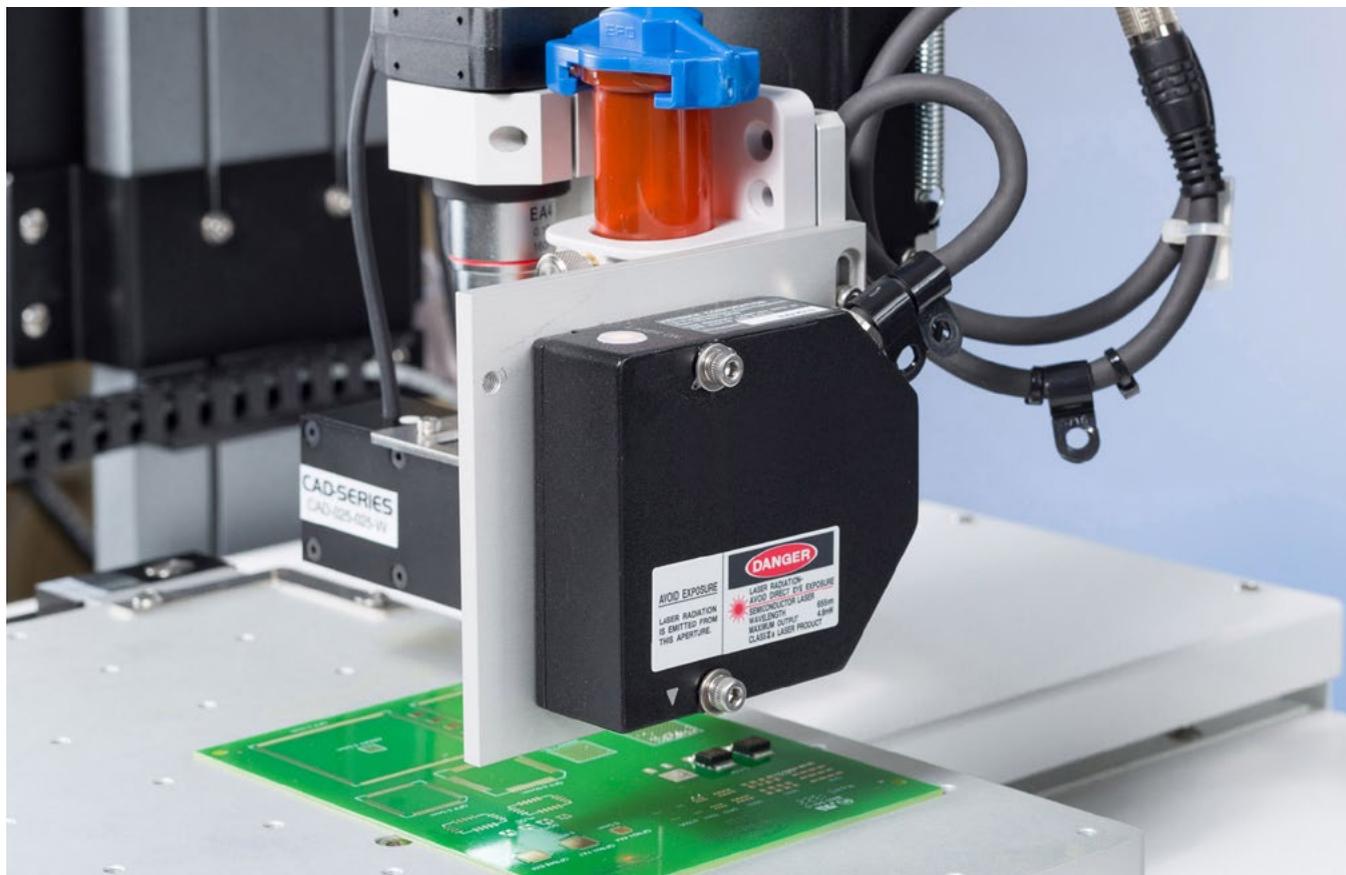


Figure 4: Some automated dispensing systems incorporate a laser noncontact height-sensing device to manage variances such as part positioning, irregular surfaces, thickness differences, and distortion.

automated dispensing systems incorporate a laser noncontact height-sensing device, as illustrated in Figure 4.

For example, because it is difficult to place probes onto the tightly spaced components on small PCBs, a laser can be used to measure height variations. By incorporating laser height-sensing capability into an automated dispensing system, the system can detect the distance between the part and the dispensing tip or valve.

The shape of the fluid deposit and its placement accuracy often depend on the positioning and the height of the dispensing tip in relation to the part. Laser height-sensing functionality enables operators to achieve proper placement and positioning so that they can maintain even deposit sizes for the entire length of a continuous pattern. Laser height-sensing capability also ensures that the needle will not touch the

substrate, reducing contamination and preventing damage to delicate parts.

Software can be the most differentiating part of an automated dispensing unit because it controls the system, enables system integration, provides the operator interface, and determines how easy or complicated the system is to operate. Intuitive and easy to use, today's software incorporates more process controls, programming capabilities, and closed-loop systems for process monitoring and on-the-fly feedback than ever. For example, a closed-loop system ensures that the dispenser is positioned where it needs to be. After being programmed into the system, the dispensing parameters allow the system to adjust continuously during the dispensing process.

The Right Robot for the Right Job

Automated dispensing systems come in a variety of configurations and platform sizes—

WHY MEDTECH MANUFACTURERS SHOULD AUTOMATE FLUID DISPENSING OPERATIONS

including stand-alone, tabletop, and integrated—to fit in-line with manufacturing cells. The appropriate size and configuration of the platform depends on the size of the part, the desired throughput, and the manufacturing process layout.

Manufacturers opting for stand-alone or tabletop dispensing systems should consider scalability. Because some systems can be configured with multiple dispensing heads, deploying a slightly larger platform can double the throughput. Manufacturers should also understand their application requirements in order to select the most appropriate system, especially because the medical device industry uses many specialized fluids.

As medical device dimensions shrink, manufacturers are shifting to the use of robotics to

perform a range of processing tasks, including fluid dispensing. Automated dispensing systems provide faster cycle times, higher throughputs, and better quality than manual systems, resulting in higher yields. To get the most out of an automated system, manufacturers should assess their processes, dispensing application requirements, challenges, resources, and near-future goals before attempting to incorporate automation into their production operations. **SMT**



Kelvin Fernandez is global product line manager at Nordson EFD. To reach him [click here](#).

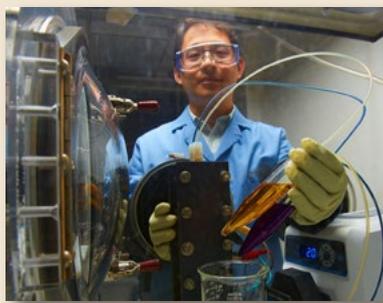
New Battery Technology Offers Lower-cost Energy Storage

Energy storage system owners could see significant savings from a new flow battery technology that is projected to cost 60% less than today's standard flow batteries.

Utilizing inexpensive organic molecules, the aqueous flow battery, described in a paper published in the journal *Advanced Energy Materials*, is expected to cost \$180 per kilowatt-hour once the technology is fully developed.

"Moving from transition metal elements to synthesized molecules is a significant advancement because it links battery costs to manufacturing rather than commodity metals pricing," said Imre Gyuk, energy storage program manager for the Department of Energy's Office of Electricity Delivery and Energy Reliability (OE), which funded this research.

"The battery's water-based liquid electrolytes are also designed to be a drop-in replacement for current flow battery systems," said PNNL materials scientist Wei Wang, one of the paper's corresponding authors. "Current



flow battery owners can keep their existing infrastructure, drain their more expensive electrolytes and replace them with PNNL's electrolytes."

Both flow and solid batteries, such as the lithium-ion batteries that power most electric vehicles and smartphones today, were invented in the 1970s. Carrying much more energy in a smaller space, lithium-ion batteries now make up about 70% of the world's working, grid-connected batteries, according to data from DOE-OE's Global Energy Storage Database. However, issues with performance, safety and lifespan can limit the technology's use for stationary energy storage.

Flow batteries, on the other hand, store their active chemicals separately until power is needed, greatly reducing safety concerns. Vanadium-based flow batteries have become more popular in recent years, especially after PNNL developed a new vanadium battery design in 2011 that increased storage capacity by 70%. While vanadium chemistries are expected to be the standard for some time, future flow battery cost reductions will require less expensive alternatives such as organics.

MilAero007 Highlights



Honeywell Paper Investigates Avionics Vibration Durability

Dr. Joseph Juarez, principal mechanical engineer with Honeywell International, discussed with I-Connect007's Andy Shaughnessy his SMTA paper, which addresses avionics vibration durability between tin-lead and lead-free solder, the years of testing he conducted, and some of the surprising findings of his research.

NEO Tech Expands Interconnect Business

NEO Tech has expanded its cable and harness manufacturing in Tijuana, Mexico to keep pace with significant interconnect business growth.

Congressman Chris Van Hollen Tours Zentech Manufacturing in Baltimore

Congressman Chris Van Hollen (D-MD-8) met with executives and employees of IPC member-company Zentech Manufacturing Inc. at the company's manufacturing facility in Baltimore, Maryland. The visit was part of IPC's "Meet the Policymakers" program, through which IPC government relations staff arrange opportunities for IPC member-companies to host elected officials at company locations.

U.S. Congressman Bob Dold Tours Creation Technologies in Chicago

U.S. Congressman Bob Dold (R-IL-10) met with executives and employees of IPC member-company Creation Technologies at the company's manufacturing facility in Chicago, Illinois. Coordinated by IPC, the visit is part of a nationwide effort to educate policymakers about legislative and regulatory issues that affect the electronics manufacturing industry.

Sypris Receives 2015 Supplier Excellence Award from Northrop Grumman

Sypris Electronics has received the 2015 Northrop Grumman Supplier Excellence Award for its manufacturing and related engineering support of the F-35 Joint Strike Fighter program.

Cirtronics Announces Lean Manufacturing Renaissance

New England-based Cirtronics is actively and purposefully engaged in a Lean Manufacturing Renaissance, including foundational training for new hires and renewal belt training for senior level staff.

Valtronic Strengthens X-ray Inspection Capability with Purchase of Nordson DAGE System

Valtronic purchased and is in the process of configuring an XD7500VR Jade FP X-ray system from Nordson DAGE on its production floor in Ohio. The system will be used for in-process inspection of BGA and wire bonded devices, as well as an analytical tool to verify, troubleshoot and improve Valtronic's internal processes.

Semi-Kinetics Earns ITAR Registration

Semi-Kinetics, a division of Gonzalez Production Systems, is proud to announce that they have obtained their International Traffic in Arms Regulations (ITAR) Registration. ITAR Registration means that Semi-Kinetics is able to fully support military and defense-related projects within the United States.

Qualitel Completes Factory Expansion

Qualitel recently completed the addition of 33,000 sq. ft. within its complex, increasing its size to over 70,000 sq. ft. Based in Everett, Washington, Qualitel provides a full range of contract electronics manufacturing services with the focus on high-mix, high-reliability product applications.

PartnerTech to Restructure Operations in Norway

PartnerTech's Norwegian subsidiary, PartnerTech AS, has announced plans to restructure the company's operations.

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Top 10 Factors

to Consider When Selecting a Medical EMS Company

by Mo Ohady and David Estes

DIGICOM ELECTRONICS

What makes for a successful contract electronics manufacturing relationship and what does a medical device company need to keep in mind and consider during the selection process? Once the decision has been made to use an electronics manufacturing services (EMS) company, selecting the right one involves several steps. Although most EMS companies perform the same basic services, every EMS company is different. You can tell when you walk into a place, examine the equipment and processes, and speak to the people.

Number 1: Prepare a List of Requirements

The initial basis for narrowing down your selection is to prepare a list of the basic requirements you expect an EMS provider to meet and detail specifically what you want the EMS to do—design, prototyping, material selection and purchasing, manufacturing, test, process validation, shipping and logistics, etc. Do you

need manual or automated processes, small quantities or volume manufacturing? Is the EMS able to offer the range of services that meet your needs?

Number 2: Certifications

Does the EMS provider have the appropriate quality certifications to manufacture the product? There is no room for error with medical devices. A basic requirement for the medical market is ISO 13485:2003, the medical device manufacturing certification. This certification states the requirements for a comprehensive management system for the design and manufacture of medical devices, ensures that medical devices meet customer and regulatory requirements, and establishes a commitment to quality. The FDA's Quality System Regulation 21 CFR (Code of Federal Regulations) 820 requires medical device manufacturers to perform a process validation when the process is not fully verified by a subsequent inspection or test. Process validation ensures that a process consistently produces a product that meets its specifications. It is an



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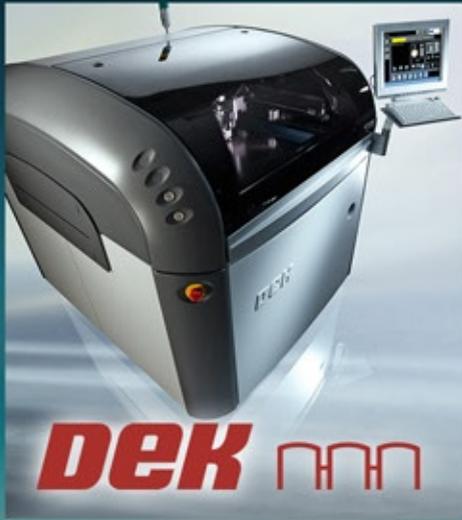


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Premium Products
for Assembly Materials

TOP 10 FACTORS TO CONSIDER WHEN SELECTING A MEDICAL EMS COMPANY

important component in the design, prototyping, and manufacturing process and one that, if done correctly, can save a considerable amount of time, money, and resources. By using an EMS provider that already has ISO 13485:2003 certification, regulatory bodies know that certain procedures and requirements will be met, so certification is less labor-intensive and approvals proceed more easily.

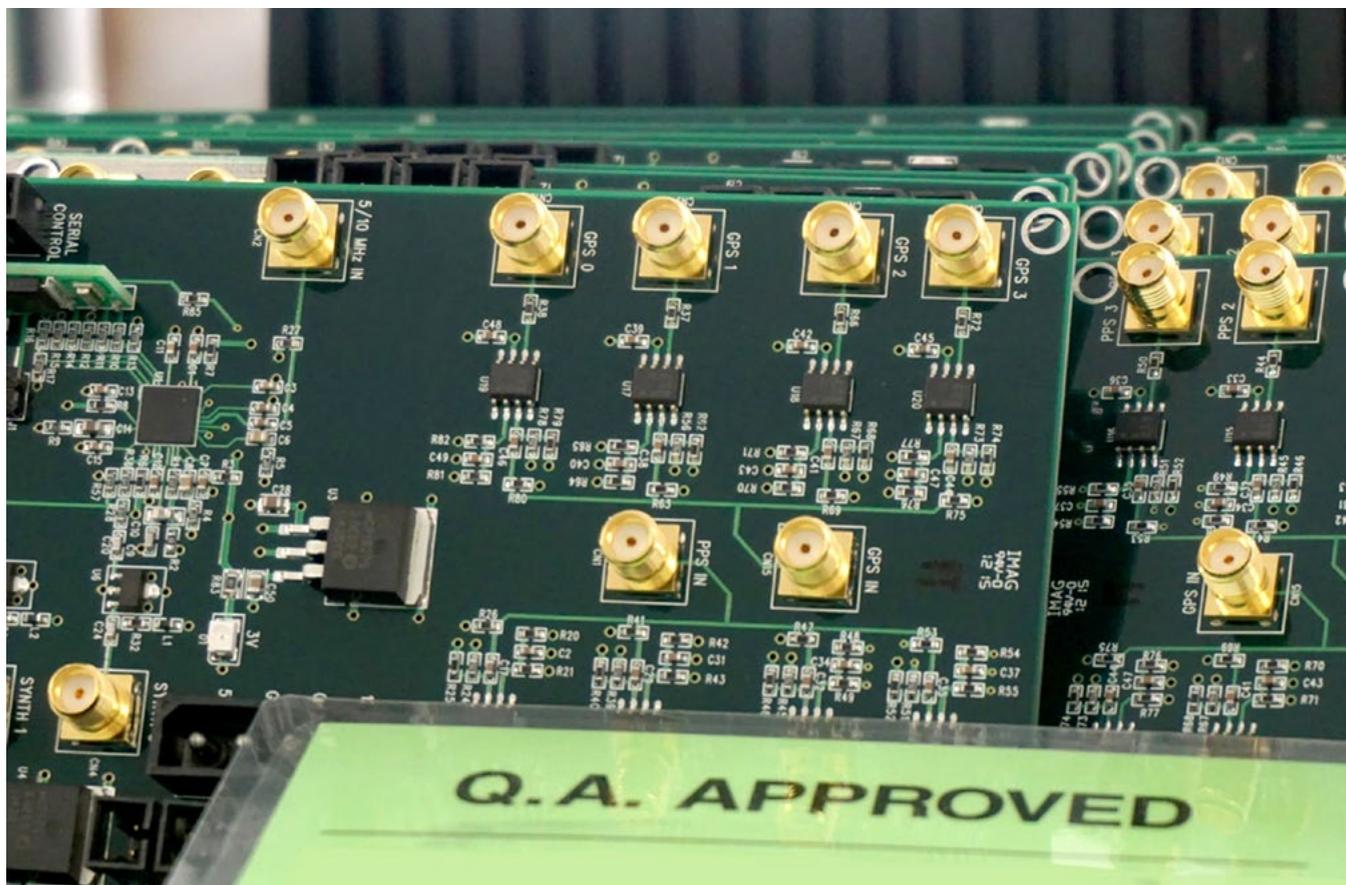
Number 3: Location

Check out where the EMS is located, where design and manufacturing are done, and make sure the size of the company is a good fit for your needs and products. Do you want the product manufactured close to where your company is located, close to where the product will need to be distributed, or are you manufacturing large volumes where cost is a major factor so a low-cost geography might be more beneficial? Considerations in choosing a location are the complexity of the device, process transfer, IP protection, shipping costs and time,

and the degree of involvement you will need throughout the process.

Number 4: Service and Support

One differentiator that is sometimes difficult to discern initially is the degree and type of service and support you will receive. No matter what company you select, make sure that they consider each job they do to be special. Find out who your point of contact will be, who will be managing and supervising the manufacture and work, who will ultimately be responsible if changes need to be made or problems arise, and how they deal with these problems. Is the person you deal with a high level engineer? How much actual engineering support and trouble-shooting will be done to make sure your design will be able to be manufactured accurately? The EMS should have the expertise to analyze your design for manufacturability and potential problems, evaluate the bill of materials, and optimize the manufacturing process to find ways to produce the prod-



TOP 10 FACTORS TO CONSIDER WHEN SELECTING A MEDICAL EMS COMPANY



uct more cost effectively. A lot of this has to do with forecasting.

Number 5: Inventory

Who controls and is responsible for the inventory and how much inventory will the EMS provider hold? A good one can analyze your bill of materials (BOM) and offer insight into potential issues before manufacturing begins. Sourcing hard-to-find components, obsolescence, and counterfeiting are all issues that an experienced EMS provider can advise a device manufacturer about. Open lines of communication and robust quality procedures will ensure that problems are prevented and a more reliable product will result.

Number 6: Processes and Procedures—Calculable Metrics

Review the processes and procedure for setting up the project. Look for a company that has tracking mechanisms in place. If something is defective or fails in the field, a tracking system will often help you determine where the failure occurred and what caused it, which batches might be defective, and what parts were used so that additional problems can be avoided. How

transparent is the operation? Each step of the assembly process should be noted electronically and sequenced in the order that it needs to take place. Inspection points should be set at every stage as first article checks ensure that the process flows error-free. In some plants, every operator has a unique identifier, providing complete traceability from when a job enters the EMS to the finished product.

Number 7: Quality, Inspection, and Testing

Quality is often the first thing mentioned in the rankings of what is wanted from an EMS company, but the degrees of quality provided can run the gamut. Examine the test procedures used. What types of inspection and tests are done and how are they performed? Inspection equipment has changed dramatically over the past few years so it is now better able to capture defects and help explain where they come from and how to prevent them. However, neither machines nor people are infallible, so for medical devices in particular, having some additional manual inspection procedures in place can provide an extra level of protection.

When in the manufacturing process are inspection and test performed? Make sure you se-

TOP 10 FACTORS TO CONSIDER WHEN SELECTING A MEDICAL EMS COMPANY

lect a company that takes inspection very seriously. Some EMS companies will do inspections at every station along the manufacturing process and every board is tested. Non-conforming parts are identified and errors marked for correction and captured for statistical process analysis for quality control purposes. What testing equipment and mechanisms are in place?

Number 8: Cleaning

Studies now show that a major cause of failures in the field is from printed circuit boards that are not completely clean. There is a gap in the market caused by new technologies that make it more difficult to ensure circuit board integrity. Today's chemistries in fluxes and solder, plus the extremely low board height of components, make cleaning more difficult. It is not enough to put the boards through a wash cycle. It takes a special combination of chemicals, temperature, wash cycles, and timing to get the boards thoroughly clean. Look for a company with customized and sophisticated cleaning and

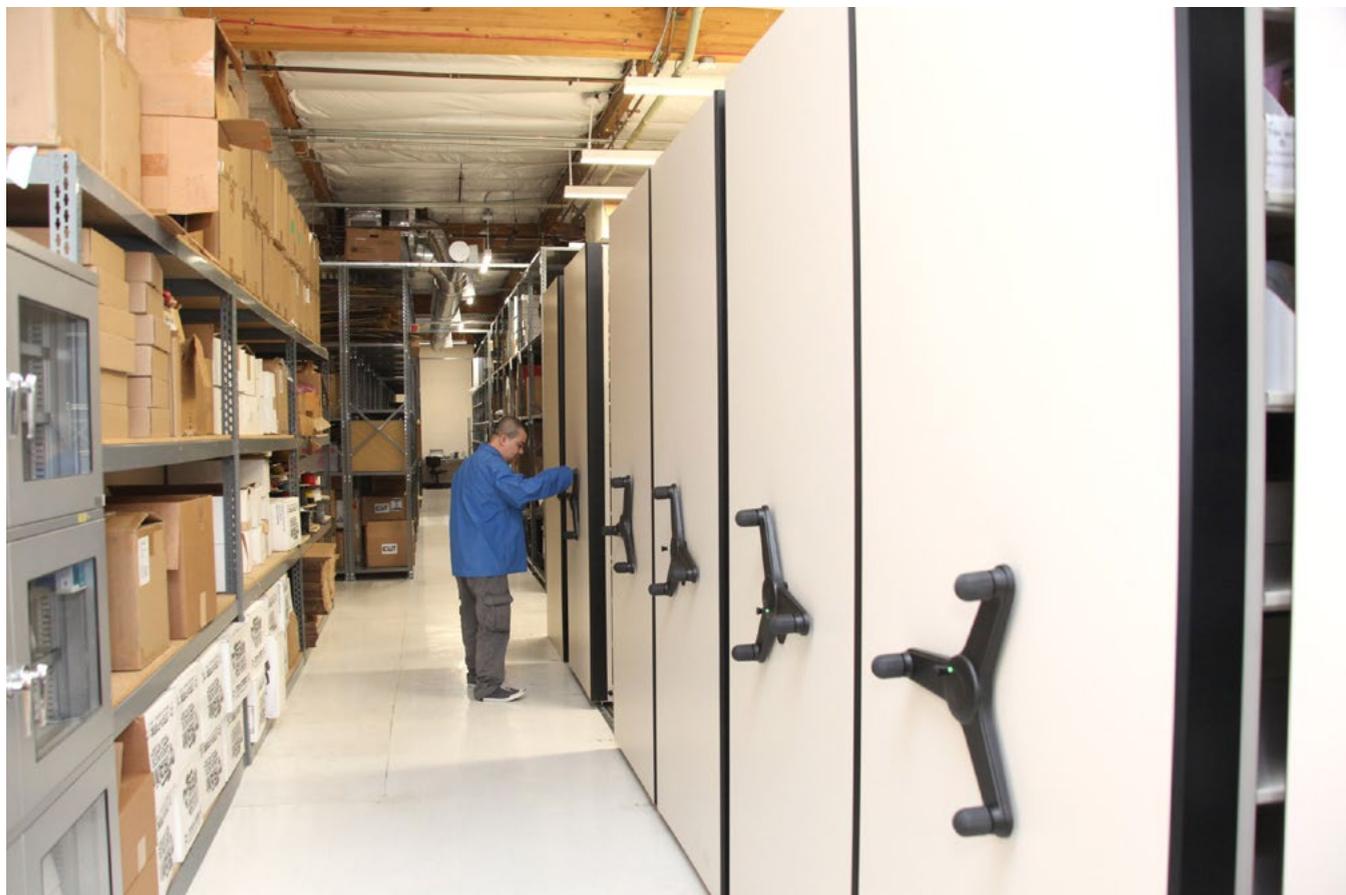
analysis techniques to ensure that even ultra-low levels of contaminants that are byproducts of the soldering process are removed to enhance the production of the delicate circuits.

Number 9: Concern for the Environment and Personnel

Is the company environmentally friendly? What attention is given to electrostatic discharge (ESD) protection and cleanliness? The floors should have ESD protection and the operators should all observe practices to ensure that ESD is not an issue. How are chemicals and wastes disposed? The EMS should comply with all local and government regulations.

Is it an ergonomic environment for the workers? How long have most of the workers been there? What is the company's history for accurate and on-time delivery? If the workers are happy and there is little worker turnover, there is more chance that your job will be completed accurately and on time.

An EMS provider is your partner and should



TOP 10 FACTORS TO CONSIDER WHEN SELECTING A MEDICAL EMS COMPANY

be on your side. He wants you to be successful. Visit the company. Talk to the people. Meet the person/team you'll be working with. Are the key personnel accessible? Does the culture of your company mesh with that of the EMS? Look at work that's been done. Make sure the company has a plan in place to clearly delineate the responsibilities of each party.

Number 10: Cost

Resist looking at costs alone. There is more than the initial cost. It may not be a bargain when issues come up and changes result in large cost increases, when items aren't delivered on time, or when you have to deal with after-sale issues from failures or poor quality. Making the wrong choice could damage or destroy your company's relationship with its customers, its reputation in the market, and even its standing in the financial community.

Conclusion

Look at the track record and metrics of the EMS company, such as years in service, types of

products being manufactured, business from repeat customers and referrals, on-time delivery, capacity, the types, capabilities, and age of the equipment in use, results from outside testing agencies, and quality awards. It's important to use due diligence in choosing an EMS company, but the rewards can be great. A properly functioning EMS brings decades of experience and knowledge to embrace and enhance the product you want to build in a time-efficient and cost-effective manner. **SMT**



Mo Ohady is the general manager at Digicom Electronics.



David Estes is an engineer with Digicom Electronics.

3D Nanobridges Formed Using Electron Beam Writing

Researchers have demonstrated a new process for rapidly fabricating complex three-dimensional nanostructures from a variety of materials, including metals. The new technique uses nanoelectrospray to provide a continuous supply of liquid precursor, which can include metal ions that are converted to high-purity metal by a focused electron beam.

The new process generates structures that would be impossible to make using gas-phase focused electron beam-induced deposition (FEBID) techniques, and allows fabrication at rates up to five orders of magnitude faster than the gas-phase technique. And because it uses standard liquid solvents, the new process could take advantage of a broad range of precursor materials. Multiple materials can also be deposited simultaneously.



"By allowing us to grow structures much faster with a broad range of precursors, this technique really opens up a whole new direction for making a hierarchy of complex three-dimensional structures with nanoscale resolution at the rate that is demanded for manufacturing scalability," said Andrei Fedorov, a professor in the George Woodruff School of Mechanical Engineering at the Georgia Institute of Technology. "This could provide a fundamental shift in the way this field will go."

The research team includes graduate student and first author Jeffrey Fisher, postdoctoral fellow Songkil Kim and senior research engineer Peter Kottke. The research was supported by the U.S. Department of Energy's Office of Science and reported in the journal *Nano Letters*. Applications for the rapid electron beam writing of topologically complex 3D nanostructures could include new types of electrode topologies for batteries and fuel cells, vertically-stacked electronic memory, substrates for controlling cell differentiation and tiny electrochemical conversion devices.

Electronics Industry News

Market Highlights



SMT Market to be Worth \$4.7B by 2020

The surface mount technology (SMT) market is expected to be worth \$4.73 billion by 2020 at an estimated CAGR of 9.84%, mainly driven by the increasing electronic manufacturing activity, rising demand miniaturization of components, and growth in consumer electronics, according to a new report by industry analyst MarketsandMarkets.

Frost & Sullivan: Five Big Technology Predictions into 2016

Frost & Sullivan's Audrey William, Head of ICT Research, Australia & New Zealand shares her insights for the five big technology predictions into 2016.

Smart Grid Data Analytics Market to Triple by 2022

According to a new market report published by Transparency Market Research "Smart Grid data Analytics Market - Global Industry Analysis, Size, Share, Growth, Trends and Forecast 2015 - 2022," the smart grid data analytics market was valued at US\$1.6 bn in 2014 and is estimated to reach US\$4.6 bn by 2022, expanding at a CAGR of 13.4% from 2015 to 2022.

Internet of Things Heralds New IT Services Opportunities in 2016

The Asia-Pacific data centre market is a state of flux with most service providers in the process of fine-tuning their strategies around data centres and cloud computing.

TrendForce Anticipates 4K TVs to Reach 23% Market Penetration in 2016

Global LCD TV shipments for 2015 will total 216 million sets, according to the latest estimation by WitsView, a division of TrendForce. This year's shipments will represent a slight annual decline, for the first time since the shipment slide in 2013.

Capacitive Fingerprint Sensors Technology Represent a Fast Growing Market

Fingerprint sensors using capacitive technology represent a fast growing market, especially in smartphones. The fingerprint sensor vendor IDEX

forecasts an increase of 360% of the number of fingerprint sensor units in mobile devices and of the fingerprint sensor market between 2014 and 2017.

Saturation of LED Market Will Drive Industry to Seek Profits in New Applications in 2016

Light-emitting diode (LED) manufacturers had an especially tough year in 2015. "Despite rising LED lighting market demand and the large scale replacement of traditional lighting products, the oversupply situation has caused the average LED sales prices (ASPs) to plunge 30% to 40% year on year," said Roger Chu, research director for LEDinside, a division of TrendForce. "Growing number of manufacturers have incurred heavy losses and exiting the market."

Silicon Shipment Levels Decline in Q3 2015

Worldwide silicon wafer area shipments decreased during the third quarter 2015 when compared to second quarter area shipments according to the SEMI Silicon Manufacturers Group (SMG) in its quarterly analysis of the silicon wafer industry.

Forrester Unveils 2016 Predictions For Business Leaders In Asia Pacific

CIOs, CMOs, and customer experience leaders will rally to achieve customer-obsessed growth by adopting human-centered design and data analytics to deliver exceptional experiences, according to Forrester Research, Inc., which today unveiled its 2016 predictions for Asia Pacific business leaders.

SSD Adoption by Notebooks May Hit 30% in 2016

Set against the previous quarter, the average contract price of mainstream PC-Client OEM SSDs has fallen by 10–11% in the fourth quarter, according to DRAMeXchange, a division of TrendForce.

Global Server Revenue Up 7.5% in Q3, While Shipments Rise 9.2%

In the third quarter of 2015, worldwide server shipments grew 9.2% from the third quarter of 2014, while vendor revenue increased 7.5% year over year.



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MEDICAL EMS: Opportunities Abound

by **Frederick Blancas**

INTEGRATED MICRO-ELECTRONICS INC. (IMI)

“Future State 2030,” a KPMG report, says that the number of people aged 65 and older will double to one billion globally by 2030. Today, this age group accounts for about 8% of the global population, but that will rise to 13% by 2030.

The emerging economies are home to over 80% of the world’s population—characterized by a rising middle-class population and a relatively young population compared to the developed economies. This means they drive global consumption of goods and services.

The above numbers present opportunities for medical device manufacturing.

New Venture Research predicted that the global medical product assembly value will reach US\$85.3 billion in 2019 from \$60.7 billion in 2014, a compounded annual growth rate (CAGR) of 7%. Medical diagnostics alone will reach \$43 billion by 2019 from \$27.7 billion in 2014, a CAGR of 9.2% (Table 1).

The total outsourced manufacturing value is expected at US\$21.8 billion in 2019—99% or US\$21.5 billion will be accounted for by electronics manufacturing service (EMS) providers. The medical EMS industry will likely be growing at 7.2% CAGR (Table 2).

I would like to think these forecasts for the medical product assembly are quite conservative considering that the megatrends mentioned at the beginning of this article bode well for the medical industry.

Margin pressures, compliance costs and risks, supply chain instability, and new product introduction headaches are some challenges in medical device manufacturing that probably hinder a more aggressive prognosis, but with innovation, medical manufacturers can churn out more.

Serving the Baby Boomers

The “baby boomers,” consisting of people born from 1946 to 1964, have become part of the aging population and are creating a high demand for healthcare and medical products. Ar-

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MEDICAL EMS: OPPORTUNITIES ABOUND

Worldwide Medical Product Assembly Market			
Product Application	2014 Revenue (\$M)	2019 Revenue (\$M)	CAGR (%)
Medical Diagnostics	27,724	43,029	9.2%
Therapeutic	12,558	16,056	5.0%
Monitoring and Surgical	20,429	26,259	5.1%
Total	60,711	85,344	7.0%

Source: New Venture Research, July 2015

Table 1.

Worldwide EMS in Medical Market			
Product Application	2014 Revenue (\$M)	2019 Revenue (\$M)	CAGR (%)
Medical Diagnostics	8,644	12,492	7.6%
Therapeutic	1,405	1,911	6.4%
Monitoring and Surgical	5,197	7,151	6.6%
Total	15,246	21,554	7.2%

Source: New Venture Research, July 2015

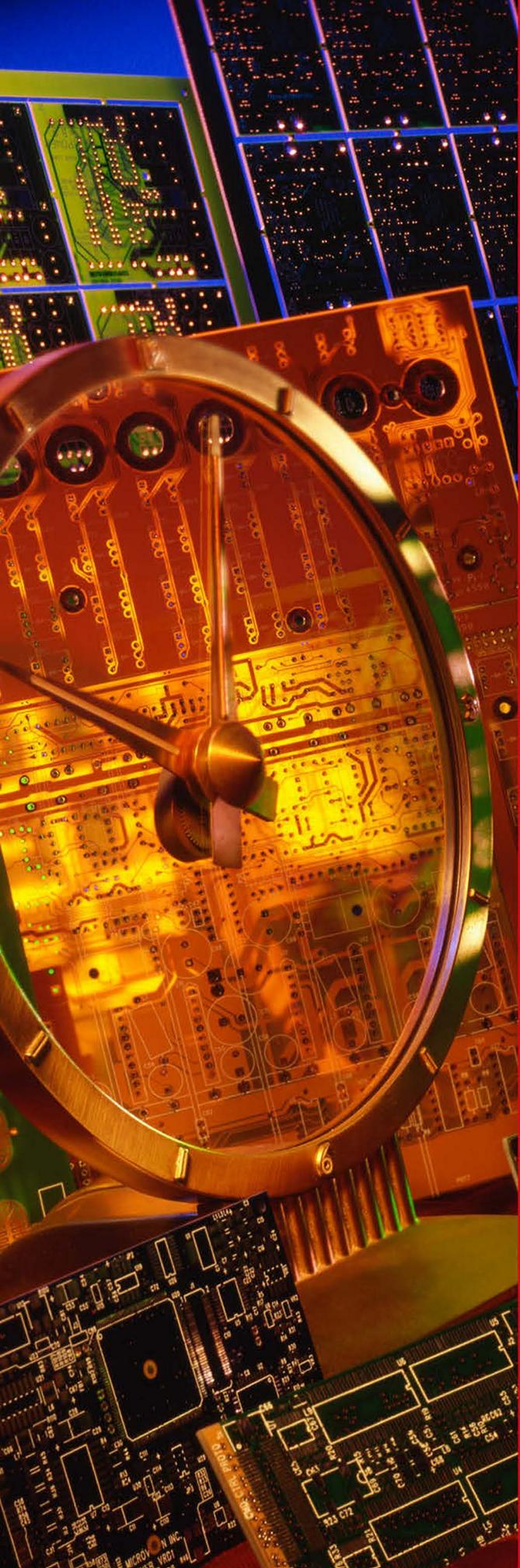
Table 2.

guably, because of their excesses in the past, the baby boomers are not necessarily healthy. They are likely to be obese, afflicted with diabetes, or have high blood pressure.

Seemingly because of their adventurous spirit, they are early adopters of new medical gadgets or technology. However, they demand

high-value low-cost solutions that promise improved health.

The baby boomers are requiring cost-effective, user-friendly, and less invasive medical devices that help them improve their health and live better. In response, medical device manufacturers innovate to bring solutions that



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MEDICAL EMS: OPPORTUNITIES ABOUND

are less expensive, easy to use, and effective in home settings.

According to Transparency Market Research, among the home healthcare device markets (therapeutic healthcare devices, diagnostics and monitoring healthcare devices, medical supplies, and mobility assist devices), the diagnostics and monitoring device sector registered the highest demand in the last couple of years due to the rising incidence of chronic diseases and increasing healthcare awareness. Market trends indicate that the therapeutic healthcare device sector will be the fastest growing segment between 2014 and 2020, with CAGR of over 10%.

The global home healthcare market, a US\$176.1 billion market in 2013, is growing to \$303.6 billion by 2020, an 8.1% CAGR until 2020.

“The development of less invasive monitoring and treatment methods for common diseases has improved patient mobility.”

The development of less invasive monitoring and treatment methods for common diseases has improved patient mobility. Through innovative at-home patient monitoring devices, the baby boomers don't need to do frequent trips to the hospital—less time on the road and less costs.

The continuous monitoring of patient data at home can happen without much effort. For example, implantable devices can monitor glucose levels without a patient having to puncture oneself with needles several times a day. The resulting data can be transmitted to a networked computer in the patient's home. Then the doctor can have real-time access to patient data through IoT. Timely access to patient data allows the doctor to make immediate decisions.

Integrated Micro-Electronics Inc. (IMI), a global EMS company that targets the medical sector, has collaborated with OEMs in the development or assembly of wearables for heart rate, hydration, and glucose monitoring for home care, hospital care, and sports applications.

Plexus, with 30 years of experience in the healthcare, life sciences and medical industries, is a key medical EMS player in home diagnostics and therapeutic healthcare device markets. Plexus was credited for the supply and design of Physio-Control's TrueCPR coaching device, a finalist for the Medical Design Excellence Awards. The TrueCPR is designed to optimize the quality and performance of manual CPR by providing feedback to rescuers in real time.

Cutting Edge Medical Devices

The article “Top 10 Cutting Edge Medical Devices” of internetmedicine.com states, “The world of innovative medical devices is fascinating in that it is the intersection of engineering and biomedical science. The intrigue of invention meets the life-saving, humanist potential of medicine. Social and scientific progress could be measured by the types of medical technologies we employ.”

For example, there's a contact lens that can disperse medicine doses. For baby boomers suffering from glaucoma, prolonged-delivery eye drops are cumbersome. A new type of contact lens is being tested that delivers the drug, intended to relieve ocular pressure, through a polymer film.

Advances in prosthetic limbs make life easier for amputees and senior citizens—from legs and hands controlled by the brain to artificial skin that can simulate the sense of touch by sending feedback signals to the brain.

A mind-controlled exoskeleton can help the disabled walk. This contraption, controlled by human thoughts and worn outside of the body, helps restore limb function in persons who could not stand or walk. There's an exoskeleton that fits around a person's hips and legs that is being developed by researchers in Germany and Korea. It comes with a cap (for the head), covered with electrodes that facilitate the connection between the person's brain and the machine.

MEDICAL EMS: OPPORTUNITIES ABOUND

There's also a biomedical vest that shows heart-related problem spots. The device employs 250 electrodes to detect extra heartbeats and other heart dysfunctions. It aids doctors pinpoint where heart problems are without the need for an invasive treatment.

IMI, through its Tustin, California advanced manufacturing engineering center, has developed for a medical OEM a camera pill that takes pictures as it travels through the intestines.

Capsule endoscopy helps the doctor evaluate the small intestine which cannot be reached by traditional upper endoscopy or by colonoscopy. Through capsule endoscopy, the search for a cause of bleeding from the small intestine becomes an easier and faster task. It may also be useful for detecting polyps, ulcers, and tumors of the small intestine.

Medical Care for the Masses

One of the concerns of governments as well as private institutions in emerging economies is the provision of high quality and low cost healthcare to a growing population, especially in the rural areas. Medical electronics manufacturers take the spotlight for addressing this concern through the development of innovative medical devices and equipment.

Surely there is pricing pressure on the device manufacturers, but this has to be viewed as a driver for innovation and differentiation. Resource-prudent innovations could be funded by government or NGO grants or by public-private partnerships. The governments of emerging economies are also expected to provide in-

centives and subsidies to device manufacturers.

Let's take a look at the case of India where heart disease is a leading cause of death. Accessibility and affordability of ECG testing has remained a challenge for many of its people. To overcome this challenge, GE Healthcare developed MAC 400 and MAC i—conceptualized, designed, and manufactured in India, and priced at a third of an imported ECG system.

GE Healthcare customized the product for better adoption in the Indian market. They created lightweight portable devices for use in remote areas. To deal with power outages, these devices are battery-operated. With the problem of shortage of healthcare professionals in India, GE Healthcare made these devices easy to operate. These innovations have been adopted in various countries across the world, including the U.S.

I hope EMS providers can work with OEMs like GE Healthcare to bring medical solutions to the masses, alleviating the dismal healthcare situation in many emerging economies. There's also no stopping the EMS providers from adopting an innovative business model that will allow them to produce and sell their own products and deliver high-reliability medical solutions within the parameters of sustainability. **SMT**



Frederick Blancas is a senior division manager at Integrated Micro-Electronics Inc. (IMI).

Fraunhofer Develops Flexible Biosensors on Metallized Film Substrates

Fraunhofer researchers have succeeded in taking a crucial step on the way to the production of small, light-weight and high capacity sensors suitable for use in applications such as wearable devices. The Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology

(FEP) has considerably advanced this development by providing metallized film substrates, while the Fraunhofer Institute for Silicon Technology (ISIT) developed a flexible electrochemical sensor. The sensor measures 8x10mm² and contains an array of electrodes for biological immunological tests.

The sensor's thickness is only approximately one tenth of a millimeter as it was produced entirely on a polymer film that had previously been coated at the Fraunhofer FEP. The fundamental principle for the production of flexible sensors is thin layers in the submicrometer range.



[AIM Solder Talks Innovations to Address Assembly, Reliability Issues](#)

David Suraski, executive vice president at AIM Solder's assembly materials division, sat down with us at productronica 2015 to discuss the latest industry trends and customer challenges facing the solder industry, and innovations that are helping customers address their issues.

[Alpha and The National Graphene Institute Sign Collaborative Partnership Agreement to Develop Graphene-Based Electronics Materials](#)

Alpha has announced a collaborative partnership with the National Graphene Institute at The University of Manchester to develop next generation graphene-based electronic materials for the electronics assembly and packaging, as well as for the energy and power market segments.

[Electrolube Discusses Conformal Coating Innovations](#)

At productronica 2015, SMT007 editor, Stephen Las Marias, interviewed Phil Kinner, technical director of Electrolube's Coatings Division, about the latest conformal coating challenges being faced by their customers, and how they are addressing these issues. He also talked about the trends driving product innovation strategies at Electrolube, and some of the new solutions they are offering the market.

[Saki America Wants to Dominate the Inspection Marketplace](#)

At SMTAI, I-Connect007's Andy Shaughnessy spoke with Quintin Armstrong, general manager for North American sales and service with Saki America. Quintin discussed Saki's 3D and X-ray inspection equipment and the company's expansion around the globe, as well as the inspection challenges his customers face every day.

[Rogers Signs Licensing Agreement with SBE for Capacitor Busbar Assemblies](#)

Rogers Corporation, a global leader in engineered materials solutions, announced today that it has signed an agreement to license technology that

will enhance the Company's capabilities in power distribution systems for electric and hybrid electric vehicles, renewable energy and industrial applications where efficiency, size and weight are critical factors.

[ALPHA MAXREL Alloy Improves Reliability in LED Chip-On-Board Assemblies](#)

Alpha has developed advanced alloys for improved thermal stability and reliability for high-temperature operation and higher thermal fatigue and vibration resistance, the first of which is known as the ALPHA MAXREL alloy.

[Camtek's Gryphon SL Wins The Annual Global Technology Award at productronica 2015](#)

Camtek Ltd's Gryphon SL one-stop-shop solder mask and legend deposition system has won in the environmentally-friendly product category of the 11th Annual Global Technology Awards at productronica 2015.

[Indium EZ-Pour Gallium Trichloride Simplifies Room Temperature Processes](#)

Indium Corp.'s EZ-Pour Gallium Trichloride (GaCl₃) simplifies the use of gallium trichloride by allowing the user to easily transfer the product from one container to another at room temperature.

[Quant 3D Introduces New, Faster Q300 3D Printer](#)

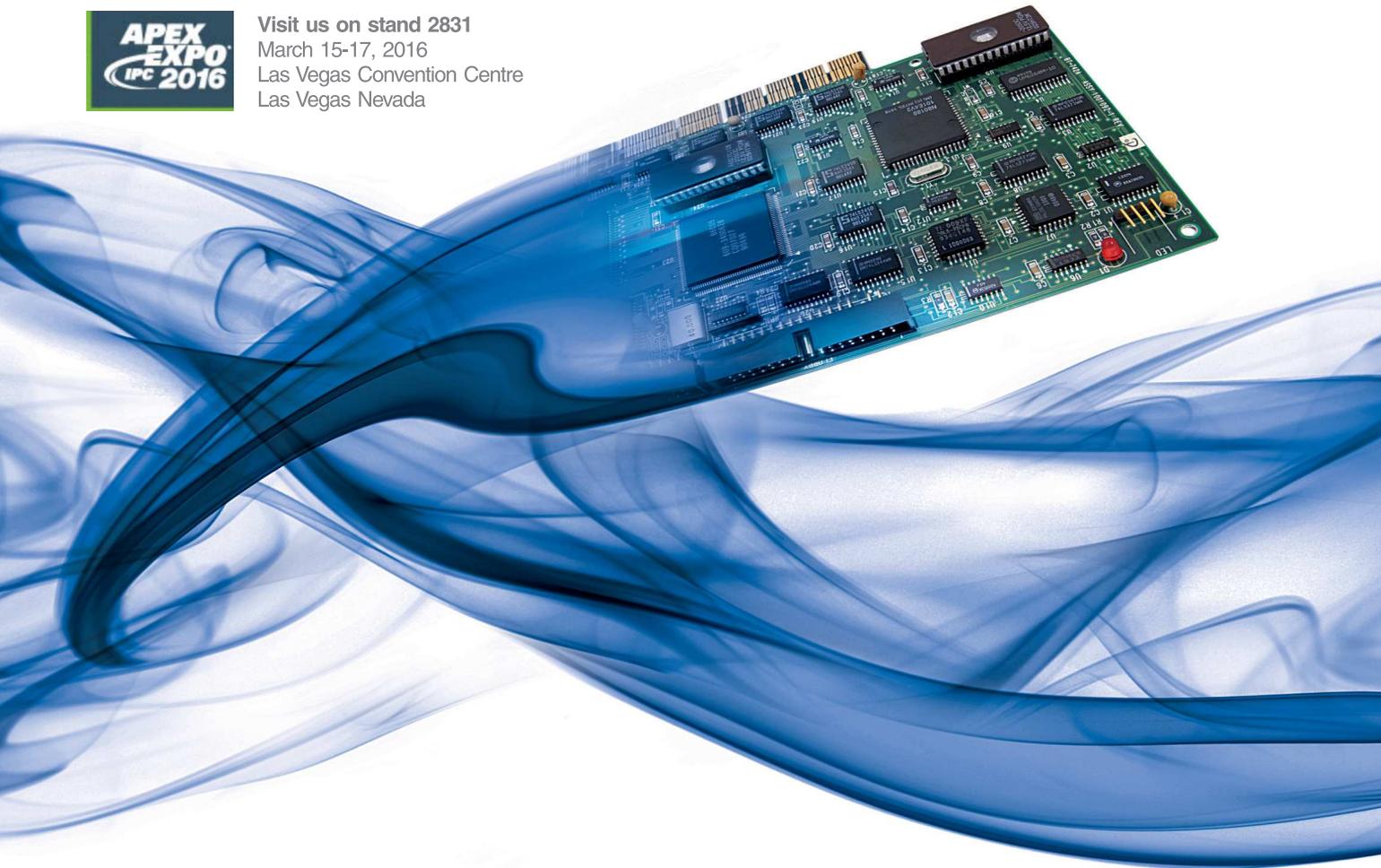
Quant 3D, a division of OK International, is pleased to introduce the new Q300 3D Printer, which offers improved printing speeds – 30% faster than the Q200.

[SolderStar Pushes Intelligent Manufacturing with SMARTLine](#)

With the latest evolution in Industry 4.0 standards and the requirement to implement intelligent manufacturing, SolderStar, a world leading specialist manufacturer in the design and development of thermal profiling equipment for the electronics industry, has introduced SMARTLine, an innovative data capture system.



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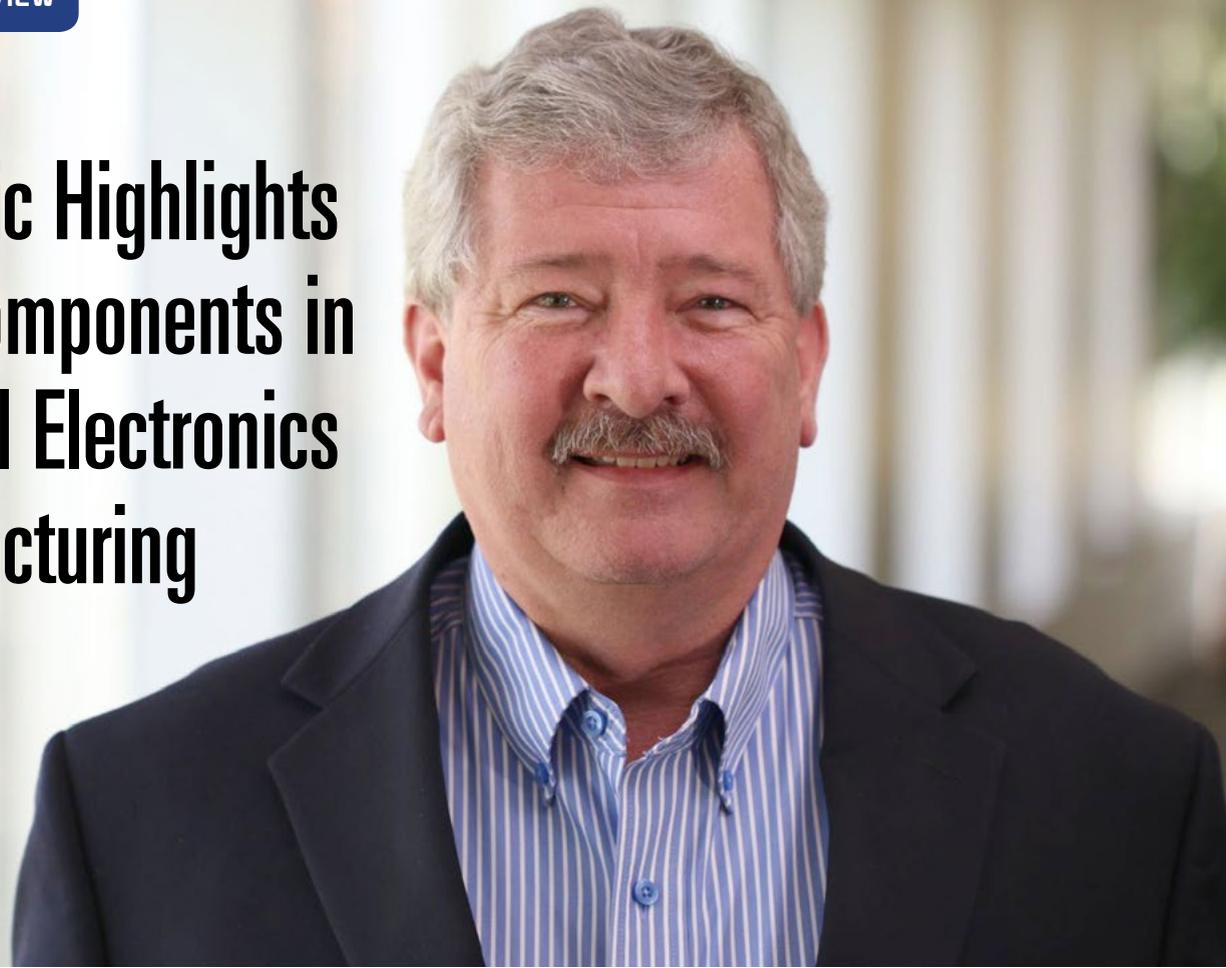
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Valtronic Highlights Vital Components in Medical Electronics Manufacturing



by **Stephen Las Marias**
I-CONNECT007

Headquartered in the Lake Geneva region, Switzerland, Valtronic is a contract manufacturer of miniaturized electronic products for medical devices. The company also has manufacturing facilities in Casablanca, Morocco, and in Cleveland, Ohio, in the United States.

Jay Wimer is the executive vice president of the Valtronic Group, and president and CEO of Valtronic USA. He also serves as director of the Advanced Electronics Technology Center in the United States. In an interview with I-Connect007, he discusses the impact of the medical market on the electronics manufacturing industry, the challenges facing medical electronics manufacturers and technology providers, and how the trends happening in the medical electronics segment are driving innovation in electronics manufacturing.

Stephen Las Marias: *How has the medical electronics industry evolved over the past decade, and what major changes have you witnessed?*

Jay Wimer: Ten years ago, OEMs were chasing lower costs in other countries for manufacturing. Most recently, we are finding OEMs willing to build/manufacture medical electronics in the United States due to lower total costs.

Las Marias: *How do you get to become an approved or qualified supplier or manufacturer for medical electronics?*

Wimer: By demonstrating your ability to fulfill a customer's need and provide solutions, as well as pass a customer quality audit.

Las Marias: *Overall, what can you say about the impact that the medical market has on the electronics manufacturing industry?*

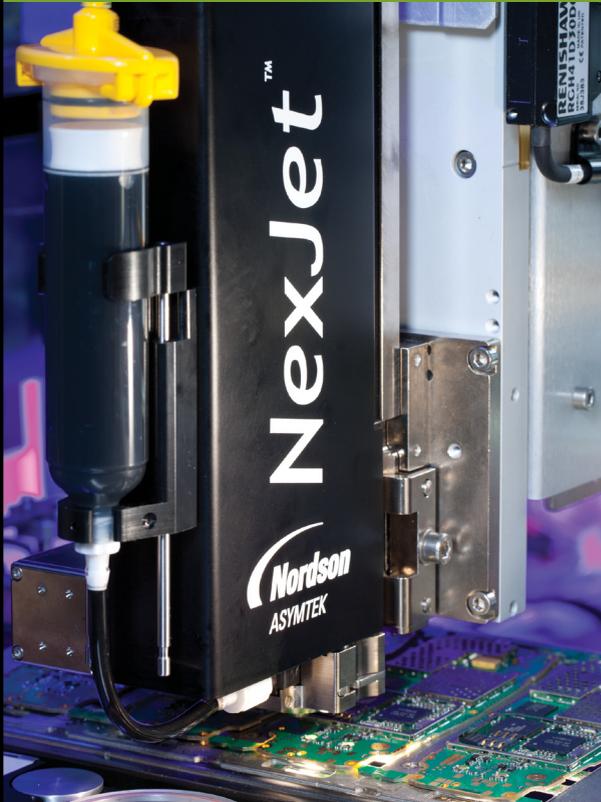
Wimer: The biggest impact that the medical market has had on the electronics manufacturing industry is quality systems due to the regulations of medical devices.

Las Marias: *Are there regulatory standards that you have to comply with?*

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Valtronic Highlights Vital Components in Medical Electronics Manufacturing

Wimer: CGMPs, Current Good Manufacturing Practices, which lead to ISO certifications 9001 and 13485.

Las Marias: *From your perspective, what are the biggest challenges when it comes to medical electronics manufacturing?*

Wimer: The major challenge we face today is cost, from an internal standpoint, and from a customer standpoint, it depends on what they are willing to pay for. ObamaCare's presence in the market has led to medical companies being more cost-conscious than ever.

“Our focus is to comply with regulatory bodies and find solutions for our customers' issues.”

Las Marias: *What about reliability, complexity and sophistication challenges, while meeting the regulatory requirements especially in the medical electronics sector? What strategies do you have in place to address these issues?*

Wimer: Our first strategy is to place subject matter experts in each area of our organization to meet regulatory requirements in our manufacturing practices. From a regulatory standpoint, we supply engineers in quality, manufacturing and project management. Our focus is to comply with regulatory bodies and find solutions for our customers' issues.

Las Marias: *What are the biggest requirements for your medical electronics customers?*

Wimer: Our requirements are specific to customers' needs for quality products with established compliance and the main driver of on-time de-

livery. We must comply with quality standards, and in every process, time is key from quote delivery to product delivery.

Las Marias: *What are the top opportunities in the medical electronics sectors? Which are growing markets?*

Wimer: From our standpoint, what we are seeing is an influx in products focused on neurostimulation. Biorobotics is a current trend that is continuously building on new innovations and technology. In addition, the Internet of Things is quite the topic today, bringing real-time data from the patient direct to the caregiver or doctor with the use of a medical device.

Las Marias: *What do you see as the biggest driver of medical electronics innovation?*

Wimer: The biggest driver of medical electronics innovation is cost constraints that drive the reduction of medical devices, the continued age increase in the millennial generation who are more apt to utilizing various technologies, the increase of biomedical graduate students and the simple fact that we have a need for medical electronics from a healthcare standpoint.

Las Marias: *How do you ensure the reliability of the components in your supply chain? Do you have traceability systems in place?*

Wimer: By utilizing DFMEA analysis and our supplier qualification requirements, we are able to ensure reliability. We also have an ERP system in place, which provides serialization and upward/downward traceability.

Las Marias: *Where do you see the medical electronics market headed in the next five years?*

Wimer: Medical electronics and devices will become more complex, smaller—depending on the package size—lighter, and faster, with greater functionality.

Las Marias: *Thank you very much, Jay.*

Wimer: Thank you. **SMT**

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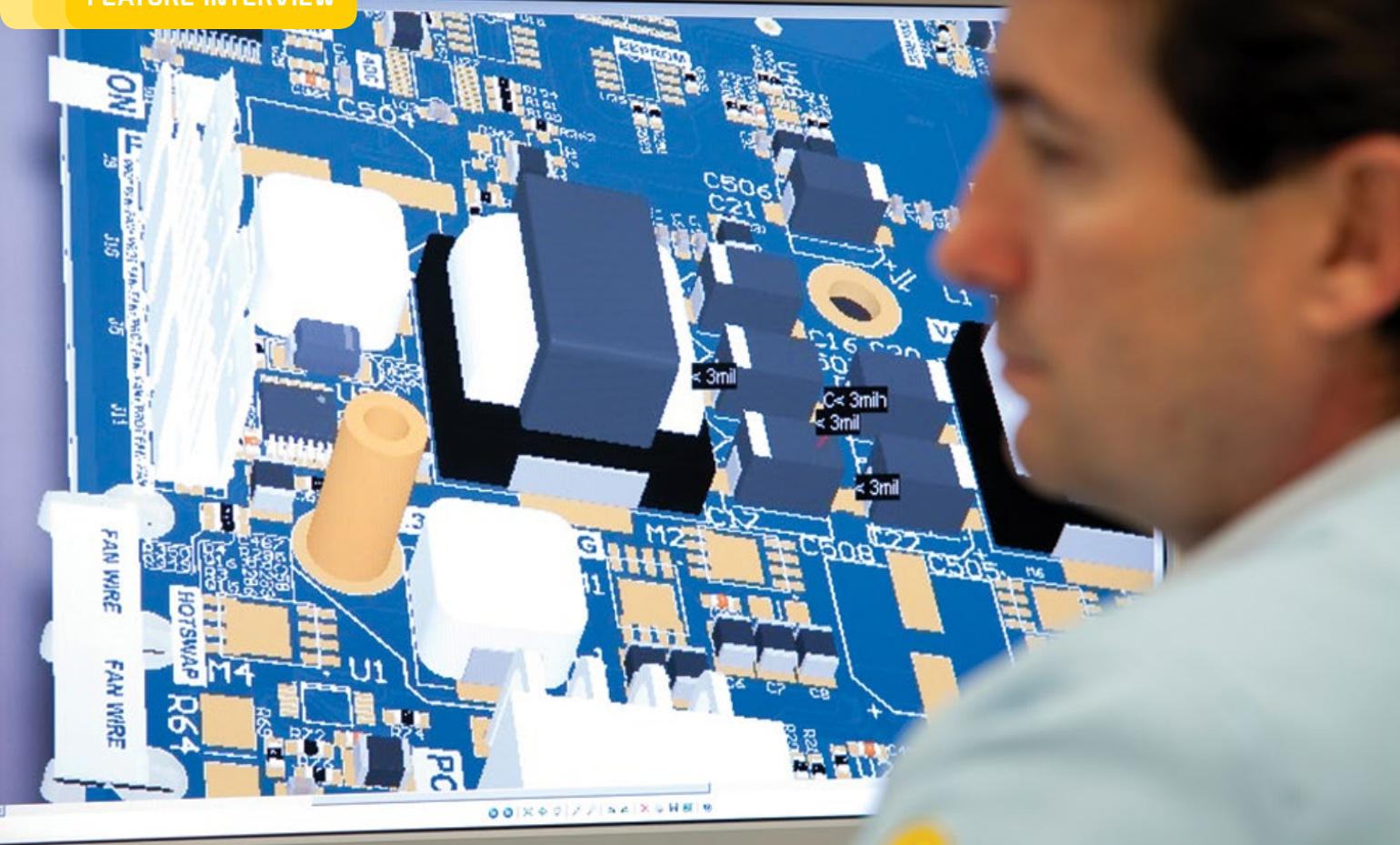
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MEDICAL ELECTRONICS: Risks and Opportunities for Electronics Manufacturers

by **Stephen Las Marias**
I-CONNECT007

Brian Morrison is the director for Value Engineering & Technology at SMT Corp. and has direct responsibility for process, test and development focusing on new customer and new product introduction. In an interview with I-Connect007, he discusses the manufacturing challenges facing electronics manufacturing service (EMS) providers when it comes to medical electronics, and the increasing need for risk management, design control and traceability.

Stephen Las Marias: *What can you say about the impact that the medical market has on the electronics manufacturing industry?*

Brian Morrison: The medical market for the electronic manufacturing services (EMS) industry is

a branch of electronics that deals with design, implementation and use of electrical devices and equipment for medical purposes such as research, examination, diagnosis, treatment, assistance and care.

We are seeing a number of portable and wearable medical electronic devices that are used both in a hospital and home environment. Conventional medical devices have evolved over time with the advent of handheld smart phone-sized systems, which are now becoming available for monitoring patients at home or in the field and can send data to a doctor in a connected environment.

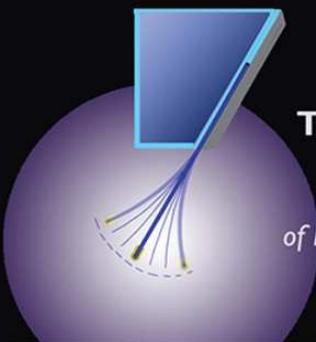
The medical market's drive for smaller, complex and advanced electronics has increased



Brian Morrison

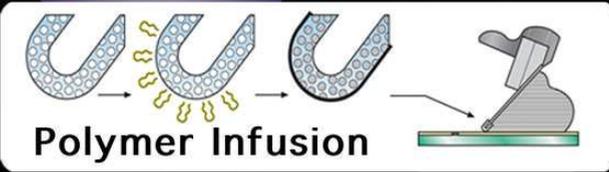
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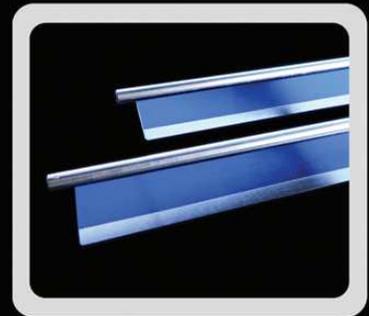


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MEDICAL ELECTRONICS: RISKS AND OPPORTUNITIES FOR ELECTRONICS MANUFACTURERS

the overall risk and opportunities for error for electronics manufacturers. As a result, requirements for risk management, design control and traceability has driven manufacturers to evolve from traditional new product introduction (NPI) practices, procedures and manufacturing methodologies typically employed in the electronics industry to meet the challenge.

Medical component level traceability has driven the need for enhancements to both business systems and manufacturing execution systems, including how we communicate and integrate production equipment to facilitate data sharing and collection. Improvements in data exchange standards and adoption from equipment and software providers have helped provide a more seamless traceability system and less reliance on paper driven data collection.

The criticality of risk assessment and controls requires the electronics industry to look at medical products with a more holistic approach to analyzing not just the assembly but also the design, components and processes. As a result, tighter collaboration between the designer and the manufacturer are required for success.

Similarly, control plans for highly complex products and assemblies require more capable and intelligent equipment and test strategies. Manufacturers have been focusing on more real-time feedback through integration and by implementing higher coverage test strategies through advanced test methods to provide a more complete end-to-end validation solution.

We have seen the electronics industry embrace the challenges presented by the medical market through a higher level of design collaboration than previously seen, better and more capable assembly tools and traceability capabilities and tighter closed loop controls. All in all, providing a more complete and robust risk management plan in step with advances in medical technology.

Las Marias: *How has the medical electronics industry evolved over the past five to 10 years, and what major changes have you witnessed?*

Morrison: Over the past number of years, we have seen a higher focus on wearables, nanotechnologies and an increased use of leading edge technologies which, for reliability reasons, were not commonly found in medical electronics.

This shift has placed requirements on manufacturers and designers alike to have a better understanding of the capabilities and limitations of both the design itself and the manufacturing process to ensure both the design and production are capable of achieving a reliable product.

Supplier collaboration has shifted from a best practice to a mandatory requirement and is a key differentiator for new OEMs seeking an EMS partner.

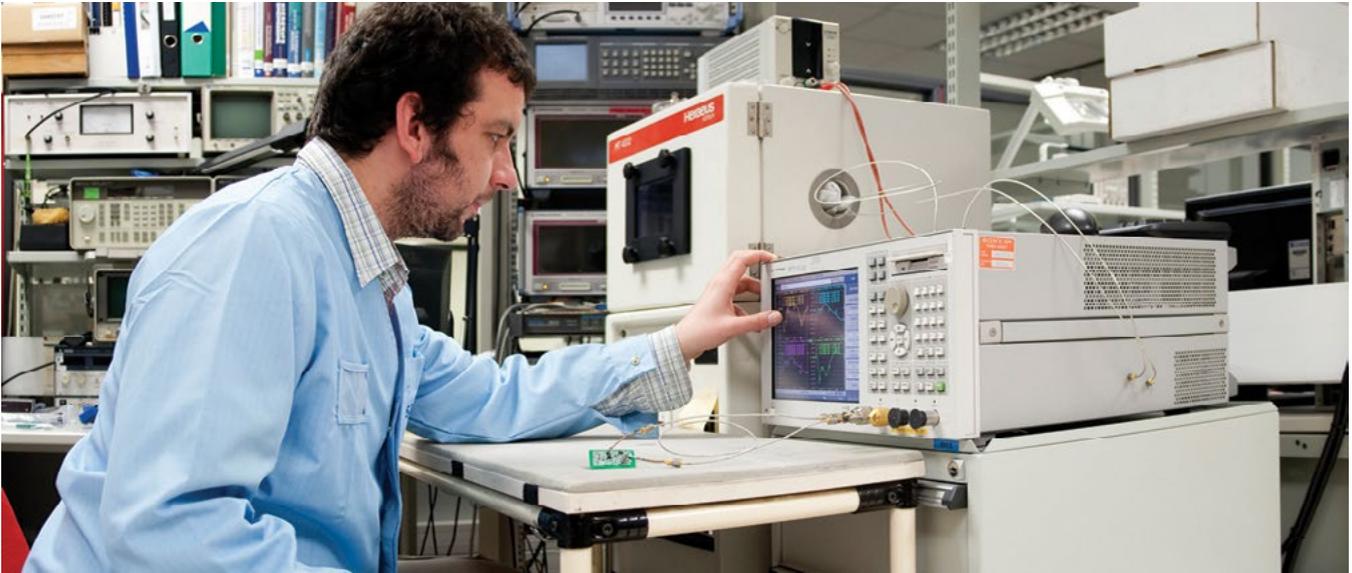
Las Marias: *From an EMS standpoint, what are the biggest challenges when it comes to medical electronics manufacturing?*

Morrison: The biggest challenge in medical electronics manufacturing is in the development of the risk management plan and the subsequent controls and traceability to support that plan. Commonly, the manufacturer is engaged after the design is complete and the EMS is tasked to develop control plans to address risk as a result of non-optimal component selection, assembly requirements and test strategy coverage gaps which can result in an overly complex and costly plan which may be avoidable.

In cases where critical components or aspects of the design are sub-contracted the EMS



MEDICAL ELECTRONICS: RISKS AND OPPORTUNITIES FOR ELECTRONICS MANUFACTURERS



inherits the risk associated with these components which further complicates the risk management plan.

A substantial portion of the risk has already been designed into the product before the EMS has seen the design and as a result the control plan may require additional test/inspection steps, which may have been avoidable if these risks were identified and addressed earlier in the development life cycle.

Las Marias: *How do you get to become an approved or qualified supplier or manufacturer for medical electronics?*

Morrison: Compliance with ISO 13485 is often seen as the first step to becoming an approved or qualified supplier or manufacturer for medical electronics. ISO 9001 is generally harmonized with ISO 13485, but the primary differences are as follows:

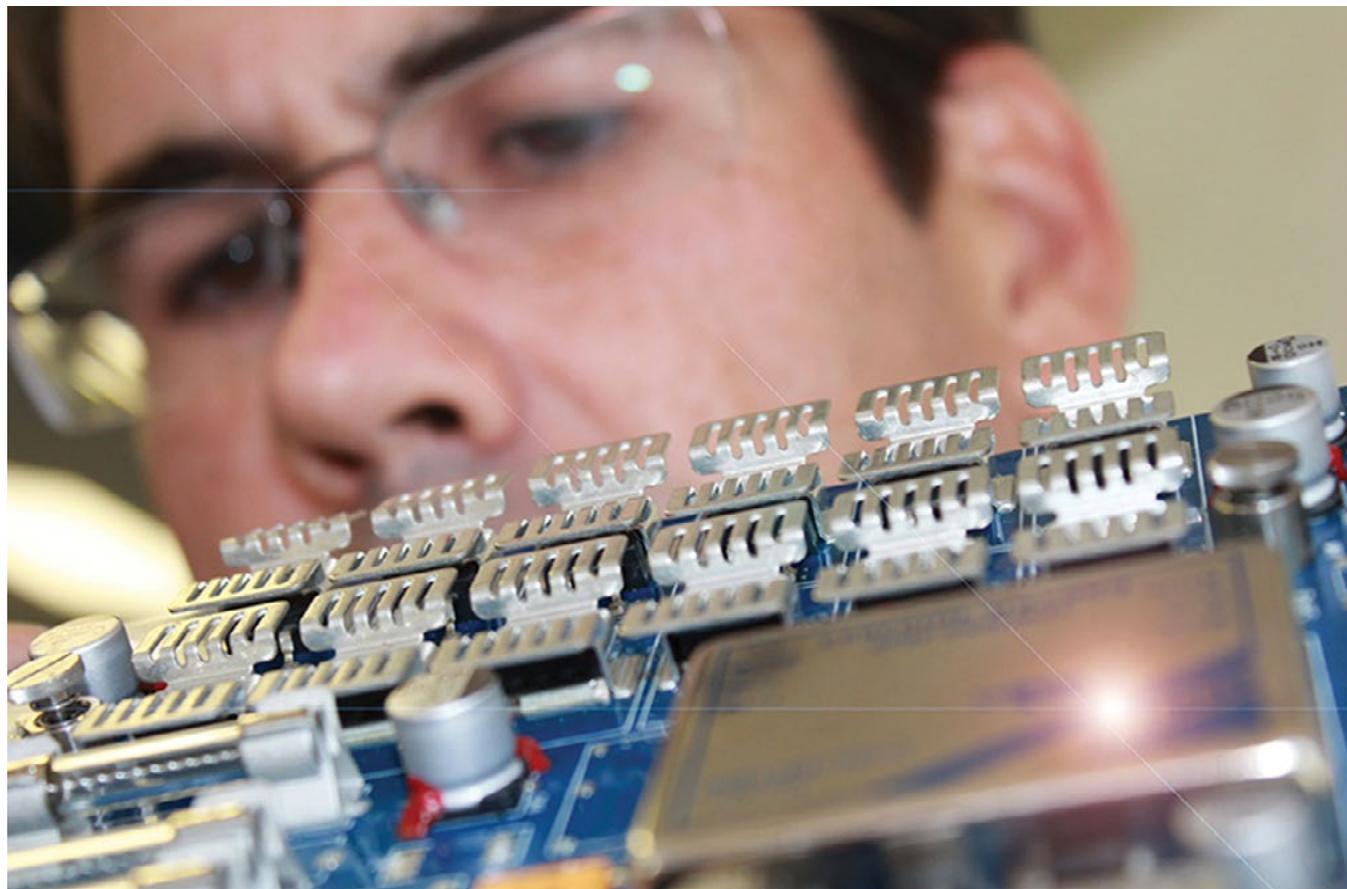
- Regulatory requirements are promoted as a management responsibility
- Demonstrated controls in the work environment must be in place to ensure product safety through employee training, manufacturing area policies and procedures, records including handling of material, product and tooling
- Specific processes and procedures with a focus on risk management activities and

design control activities during product process development, including risk management and control plans

- Specific requirements for inspection and traceability of components with an emphasis on critical components or aspects of the device including product serialization, label control and material lot control
- Specific requirements for documentation and validation of processes including equipment/tool qualification, operating qualification of process operating procedures and methodology and performance qualification demonstrating capability and expected result
- Specific requirements for verification of the effectiveness of corrective and preventive actions

Quality management systems were audited by third-party certification bodies with demonstrated medical product risk management activities and control plans including documented validation plans to support compliance with our processes and procedures. To support traceability, supplier procurement practices were updated to require lot codes from our suppliers, including full lot control from incoming through to shipment utilizing 21 CFR Part 820 certified serialization and manufacturing execution systems supporting integrated traceability records.

MEDICAL ELECTRONICS: RISKS AND OPPORTUNITIES FOR ELECTRONICS MANUFACTURERS



All employees were trained on the requirements and procedures, and internal audits performed to ensure organization compliance.

Las Marias: *Are there regulatory standards/compliance issues you have to comply with?*

Morrison: ISO 13485, Food and Drug Administration (FDA) 21 CFR Part 820 Quality System Regulation and Medical Device Directive 93/42/EEC (European Union) are the primary standards we comply with.

Las Marias: *Among the many challenges today when it comes to electronics products are reliability, complexity and sophistication, more so with the medical electronics market, while meeting the many regulatory requirements in the sector. Please give your comments here. What strategies do you have in place to address these challenges?*

Morrison: Medical electronic product is becoming increasingly complex due to the increasing

complexity of electronic circuits; power requirements; introduction of new component and material technologies; and the introduction of less robust components.

To meet these challenges, as an EMS partner to our customers, we collaboratively work with our customers to perform design reviews at key stages throughout the design cycle. This early supplier engagement provides critical feedback to address potential issues to ensure a successful new product introduction and high-quality, high-yielding, reliable and manufacturable product.

About 80% of the design cost and risk decisions are made during the first 20% of the development cycle. Strategies including DFX (Design for Excellence) and leveraging our technical services group to develop solutions and alternates have mutually benefited both our customers—by providing a higher quality product—and SMTC, in producing a more robust and repeatable manufacturing process.

MEDICAL ELECTRONICS: RISKS AND OPPORTUNITIES FOR ELECTRONICS MANUFACTURERS

Las Marias: *What are the biggest requirements for your medical electronics customers?*

Morrison: Regulatory standard compliance, traceability, controls and established risk management and quality management processes are paramount for our customers. To support this, we provide our customers with complete end-to-end risk management plans that are demonstrated through computer integrated manufacturing control from incoming through to shipment.

Our ability to produce a compliant medical product of high quality and reliability at the end of the day is why medical customers outsource, and this is where we exceed.

Las Marias: *What are the top opportunities in the medical electronics EMS sectors? What markets are growing the fastest?*

Morrison: We are seeing increased growth in home or remote diagnosis as well as health vital reporting and collection, and the ability for health professionals to effectively read, diagnose, and in some cases treat remotely, has introduced more wearable device and portable electronic device product introductions. With the increased need for connectivity including leveraging the Internet of Things (IoT), location has been less of a barrier for patient access including older technology advances such as wireless pacemakers.

We are also seeing electronics and advanced technologies increasingly being used to support DNA sequencing and new ways of disease detection/treatment, which is driving increasingly smaller electronics and denser devices and requires very small form factors to support this growing area.

Along with these areas, the use of new manufacturing techniques such as 3D printing (additive manufacturing), inclusive of metal printing and other nano-materials, has been a growing area especially for implants and related markets.

As an EMS provider, these areas are driving the need for more advanced and connected electronics and new opportunities to continue to grow our medical manufacturing sector.

Las Marias: *What do you see as the biggest driver of medical electronics innovation?*

Morrison: Advances in connectivity (IoT), manufacturing techniques (3D printing) and nanotechnology (materials and technology) are the biggest drivers in medical electronics innovation. These advances have opened new ways to communicate, interact and treat patients, which has been embraced by the medical industry, and as a result, we are seeing more and more electronic devices taking advantages of these innovations.

Las Marias: *Please highlight some of the best practices that help medical electronics customers select the appropriate contract manufacturer for their applications/products.*

Morrison: When selecting an EMS partner for their manufacturing needs, it is important to select a partner that complements the medical customer's core competences, market space, regional requirements and manufacturing needs. Picking a partner that is matched to the product characteristics and requirements should be taken into consideration, a higher complexity system with low volumes may be a different partner than a smaller, high volume runner.

Other considerations may include manufacturing and industrialization expertise; end-to-end service solutions that complement their product requirements; a collaborative partner that can provide value to the organization through value add services; and quality and regulatory expertise.

Las Marias: *How do you ensure the reliability of the components in your supply chain? Do you have traceability systems in place?*

Morrison: For reliability, we focus on critical components by narrowing the selection assessment to those of highest risk to the product:

- Sensitivity of the circuit to component performance
- Number of components within the circuit
- Output from the FMEA/FTA

MEDICAL ELECTRONICS: RISKS AND OPPORTUNITIES FOR ELECTRONICS MANUFACTURERS



- Past experiences/industry-wide experiences
- Complexity of the component

Critical components such as optoelectronics, low-volume or custom parts, memory devices, parts with mechanical movements (switches, relays, potentiostats, fans), surface-mount ceramic capacitors, electronic modules, power components, fuses, and electrolytic capacitors are considered high risk and involve increased scrutiny and audits to ensure supplier quality, reliability and performance.

All component selections and approvals are managed centrally through our product life cycle management (PLM) system to ensure only approved manufacturer lists (AML) can be procured and is fully integrated into MRP and traceable back to the originating PO. Procurement requirements include lot code issuances at the component level.

To support material traceability, we utilize lot control on all incoming parts and associate manufacturer lot codes to the lot control ID. As material progresses through production, ID are

scanned at point of use and associated to product consumption points to complete the product hierarchy. Complete product level traceability is maintained for a minimum of seven years from the date of product manufacture.

Las Marias: *Where do you see the medical electronics market headed in the next five years?*

Morrison: We believe the development of smarter wearable and portable medical devices will significantly increase over the next five years. Due to the advancement of smaller, faster and more intelligent microprocessors these devices are more portable, compact, lighter in weight and have reduced power consumption. Also the mobilization of medical devices will be a major driving factor for the healthcare industry as the use of medical devices has and will continue to boost the growth of this market and expand beyond hospitals to homecare environments.

Las Marias: *Thank you, Brian.*

Morrison: Thank you. **SMT**



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THE JEFFERSON PROJECT: Educating the Next Generation in Applied Manufacturing Sciences (Part 1)

by **Patty Goldman**

I-CONNECT007

The Founder of The Jefferson Project and the forthcoming Jefferson Institute of Technology, Tom Borkes, sat down with me at SMTAI and provided his well-researched plan to bring manufacturing to engineering undergraduate students by bringing students to manufacturing, through a hands-on, real world learning experience.

Patty Goldman: Tom, I understand you founded the Jefferson project, why don't you start by telling me what that's all about.

Tom Borkes: It's a very ambitious project. I wrote a paper years ago and coined the term 'concurrent education' because it became clear to me that there was this gap between academic preparation and industry need, that kept widening as the assembly technology got increasingly more complex. Obviously, schools are not able to respond to the needs of our industry in a timely fashion. I thought the only way to change that was to merge the two worlds – wrap

a school around a for-profit contract manufacturing business. That's what we're in the process of putting together now. Students will be studying and working for four years towards a bachelor's degree in applied design and manufacturing sciences and will have the opportunity to be educated in the real world for all four years. They will take all of the traditional courses needed for accreditation, but they will take them in the context of a for-profit, high tech, electronic product design and assembly business.

Goldman: Is the Jefferson Project a non-profit entity?

Borkes: The Jefferson Institute of Technology, the school part, will be a 501(c)(3) not-for-profit, but it's important from the students' preparation point of view that they receive their education in a real world, for-profit environment. One of the big problems, as anyone who's gone to school and then gone out to the real world knows, is the long learning curve that one has to go up to become fully productive. We're merging two environments that have been traditionally kept worlds apart.



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Goldman: *Are your goals, besides education, to get more and more people involved in this?*

Borkes: Yes. It turns out what we've done for the last five or six years really drills down into this issue about how to compete if you're in a high labor rate market. In other words, if you're in the United States you can pick up any newspaper and see the amount of manufacturing jobs that have been lost to low labor-rate markets. It bothered me to hear and see that happen. What I tried to do was study in detail what the actual facts were surrounding this exodus of manufacturing jobs. It turns out you find that there is another way to reduce labor costs, other than just finding sources of low labor rate workers - and that is by reducing labor content. You do that through automation.

Now, it sounds easy and obvious and I can give you examples. It is easy to pontificate about, but implementing is another story. In fact, the paper that I'm here to present this week addresses some important aspects of automation, because you find that it's not enough to simply buy hundreds of thousands of dollars of equipment like we see here on the show floor. If you don't have a workforce that can be successful in developing statistically capable processes and successful in maintaining those processes during a production run, you will fail. You will end up with a lot of products that have to be reworked. That rework consists of applying your high labor rate to troubleshooting, reworking, repairing, and then retesting a significant percentage of each product.

Goldman: *You've also screwed up your cycle time and everything else.*

Borkes: Absolutely. It occurred to me that we used to be very happy with 91% first pass in-circuit testing, but that when you think about it another way of saying this is nine out of every 100 things we build have defects. You can't do that and survive. Back in the '70s, and I talk about this in the paper, you could get away with that because there weren't those low labor rate sources where you could throw labor at the product.

Goldman: *People were more careless about improving because they didn't have to.*

Borkes: It started in the automobile business when Dr. Deming was shunned by Detroit and he ended up creating a manufacturing juggernaut in Japan.

Goldman: *Yes, I remember that.*

Borkes: Successful automation and overhead reduction are the high labor rate answers for the labor slices of the cost pie - but, there are more slices. Material cost disparity and the relative uncontrollable costs of the manufacturing "environment" are important cost contributors, as well. There are papers we have written on all of these that are available on our website. However, this paper and our discussion are on automation. There are a number of aspects that have to be addressed to do what I call 'exploit the automation.' What I mean is, use the automation in a way that results in instead of 90-91% yields, 99.5% and above. You have to have people with the educational background and experience to be able to take this very expensive, leading edge equipment and develop programs for it and make sure that the machine and equipment turns out products that have those very high assembly yields.

Goldman: *Yes, because they can also turn out a lot of bad stuff very fast.*

Borkes: That's right. Coming full circle now, we've come back to one of the prime motivational factors for the school: to create a world-class electronic product assembly workforce for high labor rate markets to successfully employ the automation. Automation is a great counterweight to low cost labor, but you have to, again, be able to exploit it in a way that results in high yields. To do that, you need a world-class workforce. That's one element of being successful at competing in a high labor rate market, to have a workforce that has the talent and the skill sets that allow that to be done. This workforce is not one to be purchased for a minimum wage labor rate. Unfortunately, this has been high labor rate management's traditional strategy to compete.

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Goldman: *In your paper do you discuss the courses?*

Borkes: No, that can be found at our website. This paper is very specific in its scope because one of the things you find out, especially if you're a contract manufacturer or an EMS company for example, is that you'll get a job to quote, and the product may not be designed for automation, so you're at a big disadvantage because you want to be competitive and win the job, but yet you know that the way this is designed you're not going to be able to be successful at automating it. The paper I'm presenting here at SMTAI specifically talks about designing for automation and an important tool that should be part of every high tech electronic product assembly's infrastructure.

Goldman: *Not just for manufacturability, but automated manufacturability.*

Borkes: Absolutely right. In the paper we do a case study that shows how, in very dramatic terms, we can do that. As long as you do it in the design phase you'll be successful in manufacturing. If you design it without that thought process in mind, you put the manufacturer in a very difficult position where no matter what they do they're not going to be able to successfully achieve those high yield rates.

Goldman: *Ideally the designer should be working with the manufacturer from the beginning.*

Borkes: That's always been the DFMA mentality. If you're an OEM that actually designs your own products you have a better shot, but even then it can be difficult. I do a lot of consulting work and my clients sometimes seem like they are three or four different companies because the departments are so self-contained, with the proverbial silo mentality. A lot of the time it seems they're competing against one another within the same company. That's one thing we do in the paper: describe a case study on automation design and coordination, and the dramatic effect that it can have on the overall labor cost.

The other part of the paper addresses automated process control. Years ago we started

to talk about the need for what we call proactive process control. It's one thing to design the product for automation, but when you get into a production run, there's going to be variation in your process. The robustness of the process (your process window) will determine how well that process will respond to the variation of the different independent variables as they change over time. In the paper we suggest that to achieve the yields needed to compete we have to go beyond what I have called proactive process control, where you don't wait for a process to go out of control before you stop the line and fix whatever is causing the problem. Proactive process control suggests that you want to constantly monitor the process in real time, and when the process parameters start to vary in a non-random way, you get an alert. A flag goes up and someone realizes, "I don't have any defects yet, but we're headed that way." There is what we call in statistical process control an "assignable cause" that has entered the process. That's proactive process control.

In the paper, what we're suggesting is that to achieve those 99.5% and above yield rates you have to go one step further. I call it "meta-

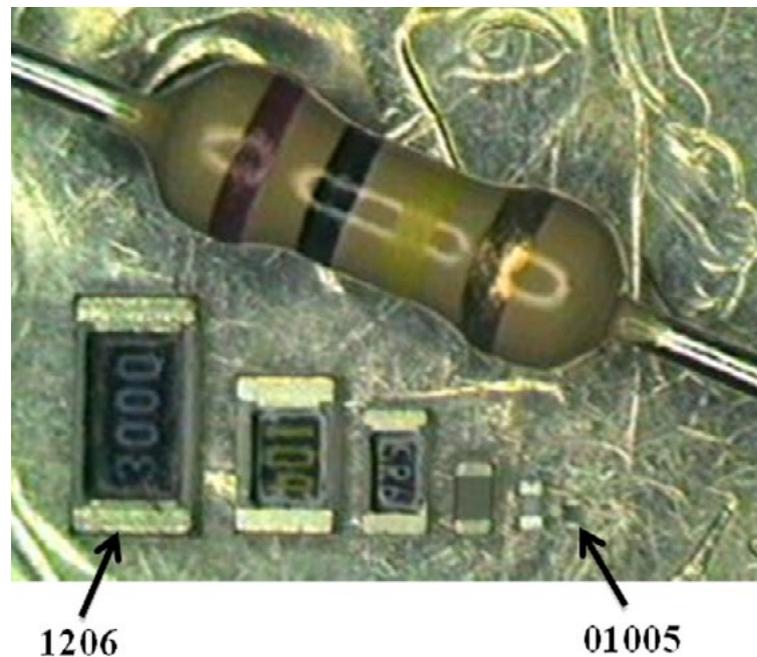


Figure 1: Passive SMT component family (with English designations) including their patriarch: the axial-leaded resistor (all on a Jefferson nickel).

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process control.” In meta-process control your assembly system will not only identify those areas that are of process control concern, but actually will self-correct automatically whatever the issue is. We use printing solder paste as an example. When you get a bare board that has

tiny pads on it for 01005 (English) components, you can’t even tell they’re components because they’re so small.

If, when you print paste on the board, the paste is offset from the pads, the system will recognize that offset and will actually change the placement programming. The pick and place machine that’s placing those components, instead of placing the component on the pads, will actually offset the component placement and put it fully in the paste. What we do in the paper is look at the difference in placing the component on the pads with the paste offset, or placing the component also offset with the offset paste to see which situation yields the best result.

Goldman: *In the meantime, if you’re still off the pad though, isn’t that a problem?*

Borkes: You’re still off the pad, but when the solder melts...

Goldman: *It’s enough to make it connect?*

Borkes: Yep, the results are striking in terms of the amount of defects you have when you have an offset of the solder paste and put the component on the pad where it was programmed to go, versus when you have an offset in the solder paste and a matching offset the component placement. As the paste melts, wets and pulls on to the pad, it brings the component along with it – right onto the pad.

Goldman: *How interesting!*

Borkes: We can’t afford for a human to monitor the printed paste and either reject, wipe the board and start over, or manually offset the component placement coordinates to match the paste shift. What meta-process control suggests is that the automation has the intelligence to be able to recognize the variation in paste printing and automatically make the adjustment to the pick and place component placement program to put the component entirely in the paste, rather than on the pad. That’s an infrastructural type of thing. In other words, you have to have that as part of your manufacturing

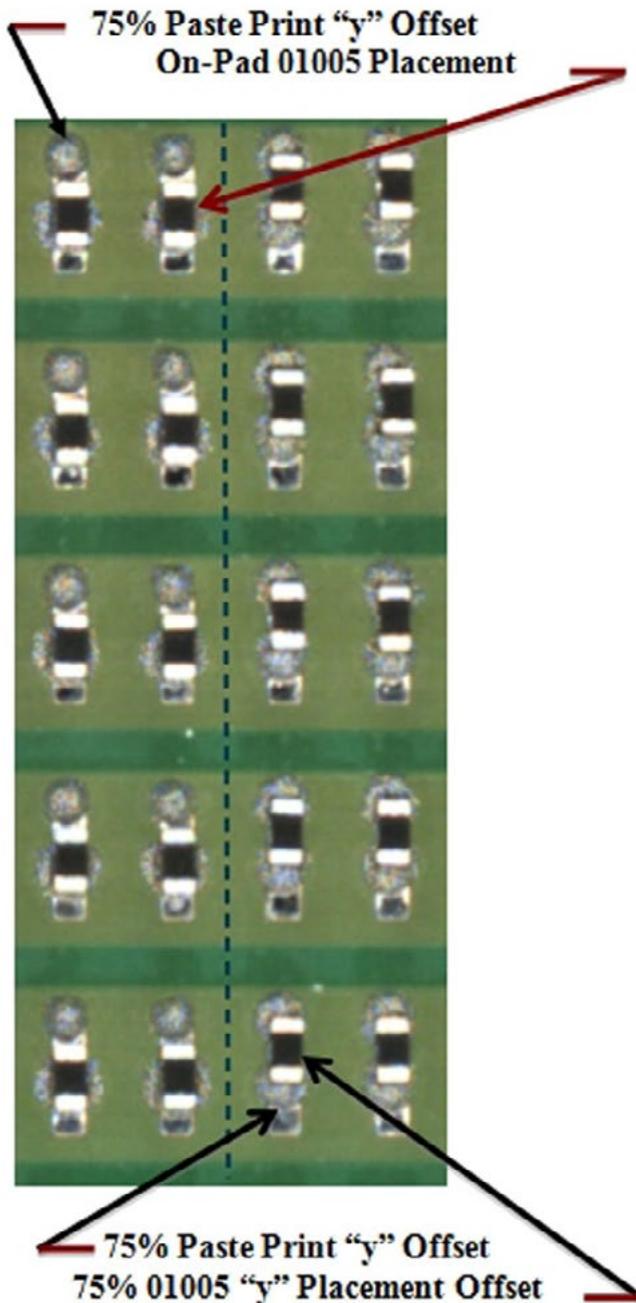


Figure 2: 75% paste offset with on-pad component (left), and 75% paste offset with matching 75% placement offset (right).

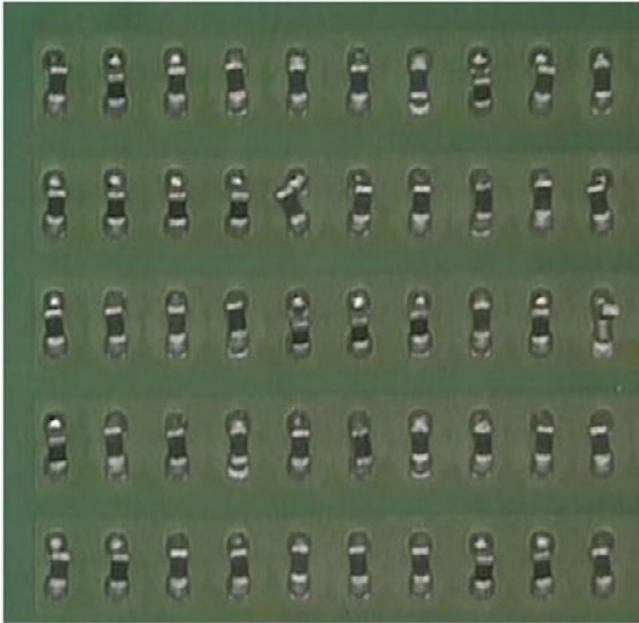


Figure 3: Post-reflow of on-pad component placement.

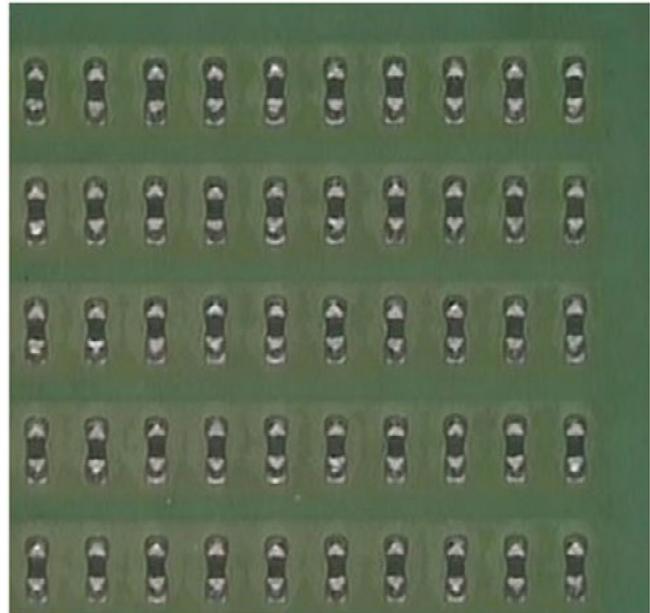


Figure 4: Post-reflow of on-paste component placement.

equipment infrastructure. That's not something you could just decide you want to do.

Again, the point is in order to exploit the automation you need more than just investing hundreds of thousands of dollars in leading-edge automation equipment. You have to have an infrastructure that allows you to make these kinds of process adjustments automatically, and you need to design the products for the automation so that you have a chance at these 99.5% plus yields. The other thing I should mention is why it is so important—what goes along with low yields, is the fact that you're going to have a lot of products that have to be troubleshot and then reworked and retested again with this expensive labor. But, here is the bonus. You're familiar with the in-circuit test, which is an electrical test that's done on the circuit board after it has been assembled. ICT checks to make sure the correct components are where they should be, that they are oriented correctly, that there are no opens or shorts, etc. – in other words, the board was assembled without assembly defects and the component values are generally within electrical tolerance. However, components are rarely out of tolerance these days. The problem is that if you are going to do a functional test

your customer doesn't care that you do an in-circuit test. Unfortunately what in-circuit tests have become, as AOI is becoming, is a way to separate the good boards we assemble from the bad boards, and that's a bad use of that tool. So, ICT in many cases compensate for poor process – and, we keep doing the test rather than try to identify and correct the root cause process issue.

Goldman: *You should be taking that information and using it right?*

Borkes: People rarely do that because they have the next job they have to move on to. What you want to do is obviate the need to do process issue troubleshooting by eliminating process defects. Then, you can go one step further. If you achieve 99.5% yields and above, and you're going to do a functional test on the board or the product anyway—which is a test that says the board or the product is producing the desired output—there is no value-added to an in-circuit test. If you only have one out of the 200 boards that have an assembly defect, it doesn't pay back to ICT all 200 boards. You're going to do a functional test on the 200 anyway and will identify the one defective board. And the func-

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tional test will verify that the board or product is shippable.

To do an in-circuit test on every board to find the one out of 200 that isn't built right doesn't pay back. If you can get the yields up, you're able to eliminate that whole process step, i.e., eliminate In-circuit test. Most people do ICT because they don't have the confidence in their process to result in the high yields that we need. All these things, again, point to reducing labor content as a strategy for competing against low labor rate markets. That's what the paper focuses on: two very specific things associated with automation that allows you to successfully compete in electronic product assembly in a high labor rate market.

Goldman: *Nice. After the paper, what's your next step?*

Borkes: Right now, we publish a quarterly newsletter which provides a progress report on the development of the school. I'm focused on the school, because without employees with the skill sets to do what we've talked about, buying the expensive state of the art equipment really doesn't get you very far. We've seen that. They have the same equipment in low labor rate markets like those that exist in the Pacific Rim, the difference is they can afford to have very low yields because every assembled board can go into a room with 200 people with soldering irons.

Goldman: *To fix things.*

Borkes: Yeah, we can't do that here. That strategy won't work. All of our efforts are really focused on trying to create an environment where we can reduce labor content to a very small amount and a very small piece of the cost pie. To give you an example, loaded labor in the United States that's through overhead, G&A, and profit, sells for about \$32 an hour. Basically, for a product that requires one hour of labor, I will quote you a price to assembly the product of \$32.00 + material costs. Labor in low labor rate areas like the Pacific Rim is more like \$6 to \$9 an hour. It's a big advantage. The point is if you can reduce your labor content you're mul-

tiplying that \$32 by a relatively small amount of labor hours.

Goldman: *Yes, and so it evens out.*

Borkes: That's the key, but the last part of the labor piece of this is recognizing that the person on the assembly floor who is operating the equipment or expending the direct labor doesn't earn \$32 an hour. They may get \$12 or \$13 an hour, which I've done the research on. That's about the average hourly pay for a person that does assembly work in a high labor rate manufacturing environment. Why do we charge \$32 an hour for someone that costs the company \$13 an hour? The answer is because we have to pay for all the indirect and overhead hours that load onto that \$13 an hour rate.

Goldman: *Yes, it balloons.*

Borkes: It balloons the labor rate to \$32 an hour or more. The other part of this, and the school will be a great demonstrator of this fact, is that we are suggesting reorganizing the way our companies are structured. We've evolved into this company organizational structure that groups employees together by virtue of their common skill sets. We have mechanical engineering departments, electrical engineering departments, manufacturing engineering departments, finance departments, procurement departments, etc. All those departments need managers, directors, and all the added costs associated with them. This structure is laden with indirect and overhead costs whose value is questionable.

Goldman: *All the overhead.*

Borkes: All the overhead that blows that labor rate up. Automation is one tool to compete with low labor rate areas, but the other challenge is to have a total rethinking about the way our companies are organized. For example, the Jefferson Electronic Manufacturing Center, which is the EMS that the school will use as their classroom, only has two groups: project teams and a leadership group. The leadership group consists of people that enable a product team to be successful. They provide the tools that the project

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team needs when working on the manufacturing floor. Instead of having mechanical engineers, electrical engineers, manufacturing engineers, or finance and procurement people, what the school will do is train the individuals to be multi-functional. You'll have a very small group of multi-trained people that do every facet of the product assembly operation – from procurement to final functional test, which is a big difference from the organizational hierarchy that we currently see.

“I've tried to demonstrate there is a lot involved and a lot of paradigms that have to be broken. It's a big ship to turn.”

And that leadership group actually is an enabling group working FOR the project team. Really, that's the essence. It's a very ambitious goal, but having studied this for a while you really come to the conclusion that there's no simple answer to this. On the other hand, there's no reason why we can't compete in a high labor rate market against low labor rates. I've tried to demonstrate there is a lot involved and a lot of paradigms that have to be broken. It's a big ship to turn.

So we do it a little at a time. We've got great support from a lot of people. A lot of these companies want the students to learn on their equipment, so they are willing to donate equipment to the school. I learned early on that I'm most successful at things that result in win-win situations. This is a win-win-win-win project.

Goldman: *And will students get paid for their work?*

Borkes: They get paid for working on the manufacturing floor. Plus, they get a real world, state-of-the-art education. Here's something very interesting: The more you look at this, the more

synergy you see emerging. The OPD (Original Product Designer) companies that the students, as part of the JEM Center, will be building products for as part of their education, will be prospective employers. In fact, there will be an option of a formal contract between the student and the company that will guarantee the student a job upon graduation. The companies are in great need of qualified employees, and who is better qualified than someone who has been building your products for you. The students win and the EMS client wins.

Goldman: *Exactly, and the students are making a real product.*

Borkes: As I say, what better training could a company have for their future manufacturing engineers than to have those engineers-in-training as students building their products?

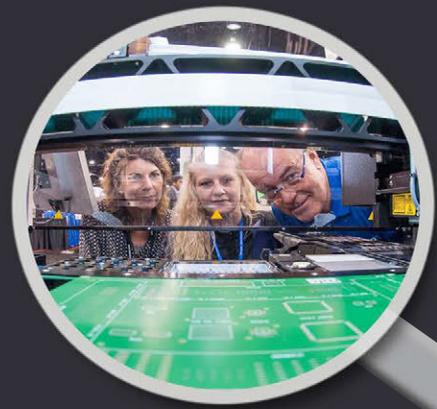
Goldman: *Who's paying the students?*

Borkes: The students are paid by the Jefferson Electronic Manufacturing (JEM) Center and are educated by the Jefferson Institute of Technology. There's this very positive linking up of interests. You have the equipment manufacturers' interest being served by students actually learning on their equipment, industry's interest accommodated by having their future employees educated in a relevant environment, and the students' interest addressed by receiving a valuable education that is a balance of “learning for learning AND learning for earning.”

One of the first papers I wrote concerning this subject was more than 20 years ago. This was after my first trip to China in 1981, before the government began to practice state capitalism.. They weren't doing any sizable manufacturing at the time, but it became clear when they did it was going to put a tremendous amount of pressure on our manufacturing because the government had control of their industries, and their labor rates were so much less than ours. This was the genesis of the strategy I called “Concurrent Education.” **SMT**

Editor's Note: Part 2 of this interview will be published in the February 2016 issue of SMT Magazine.

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Lost in the System: How Traceability can Solve the Problem of Counterfeit Materials

by **Michael Ford**

MENTOR GRAPHICS VALOR DIVISION

The word “counterfeit” encompasses a wide range of activities that are happening continuously in an “underground” SMT supply chain. The risks and potential effects resulting from the use of counterfeit materials can be huge, threatening human life, as well as the success of any company in the electronics industry. Word on the street is that the occurrence of counterfeit materials is growing rapidly, which means, at some point, a critical mass will be reached. The best managers and engineers among us must surely realize that now is the time to get proactive on this issue before a serious compelling event occurs. Let's play detective and investigate this dark side of manufacturing to try and find out what exactly can be done.

The classic plot of any detective story is the task of discovering the motive, means, and opportunity for the crime. In business, the motive

is focused on the financial aspects of materials supply. After all, materials generally are 80–90% of the cost of a finished product. As manufacturing costs decrease, the material costs become more significant. For example, shaving a cent or two off the cost of material in each product can be significant when scaled up to the level of materials used in high-volume consumer products. At the other end of the scale, many individual materials have a high enough value to be a target for counterfeiting even when used in lower volumes.

As well as the physical properties of the materials, test and qualification processes add value to a material, differentiating it from otherwise identical materials. In critical applications, materials that have not been through prescribed testing or have not been handled in an approved way are disqualified from use.



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LOST IN THE SYSTEM

Motivation

As a result of these pressures, the motivation to reduce material costs can encompass:

- **Vendor cloning:** There are many choices of materials manufacturers, and some have better quality or consistent products, which are also more expensive. The golden rule is to select the level of quality needed at the lowest price available. Substituting lower cost materials in volume, however, can make a considerable financial difference.

- **Test failures:** In testing materials during manufacture, some will inevitably fail. Electrical properties may fall outside of control parameters, or stress testing may reveal weaknesses. These failures create an opportunity for individual materials, groups of materials, or even a whole batch of materials to be scrapped or re-packaged as cheaper versions. This may not represent a huge cost to the original manufacturer, but the opportunity to make some extra money could be a significant motivation to anyone else involved in disposal or recycling.

- **Trial materials:** Materials made during the setting up of manufacturing processes, or samples generated, could also be intercepted in the disposal process and re-sold.

- **Dirty materials:** It is not only in the material manufacture and supply-chain process that counterfeit materials can be introduced. Spoilage generated during assembly production can also be inappropriately used. For example, materials that have been rejected by the SMT processes and discarded may be gathered up and recycled back into the machine at a later time. The handling of these materials outside of the supply-chain rules introduces risk of contamination from dirt and water. In many situations, refurbishing materials is acceptable, but in a situation where an acute shortage of materials happens at the end of a production run because of unexpectedly high spoilage can be a great motivator to simply pick up discarded materials and put them in a tray for re-use. These are also counterfeit because they deviate from the approved supply procedure.

- **“Garage” materials:** Some materials are made specifically with the intent to replace authorized materials. The classic situation is an entrepreneur who buys an out-dated manufacturing process that he sets up in a garage to churn out materials made with substandard raw materials, often without testing. The intent is simply to make the materials as cheaply as possible and then find a way to introduce them as genuine materials in the supply chain.

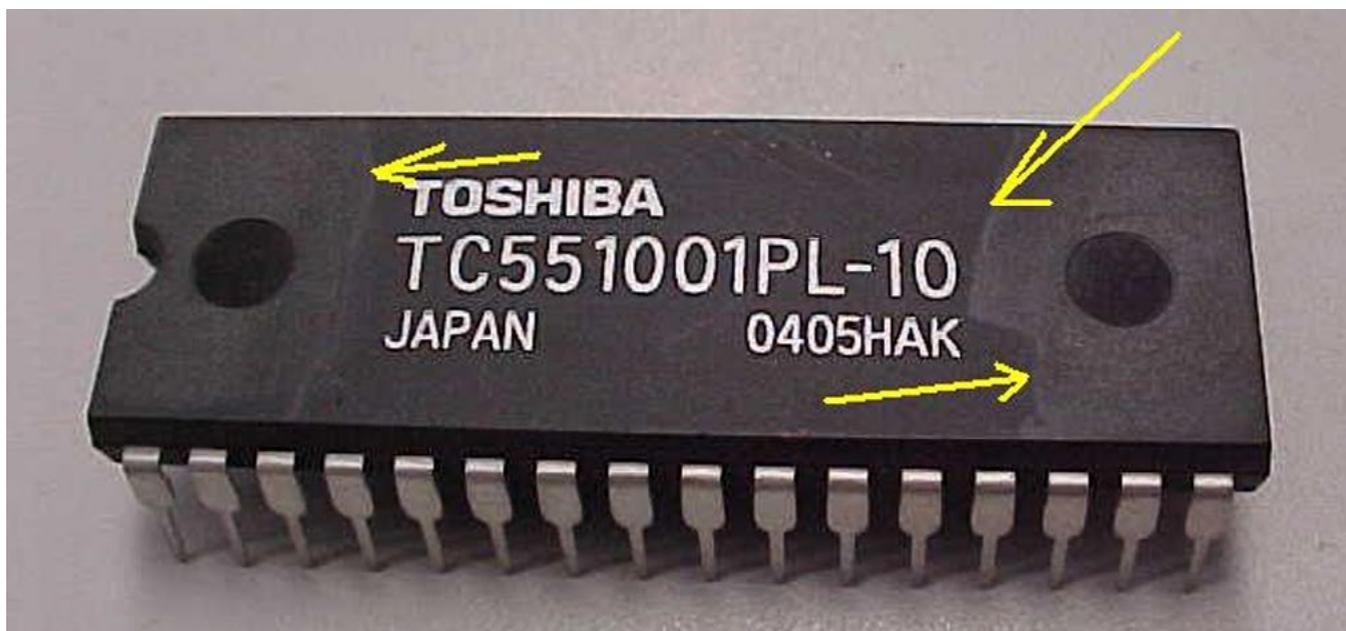


Figure 1: Evidence found of re-labeling an IC.

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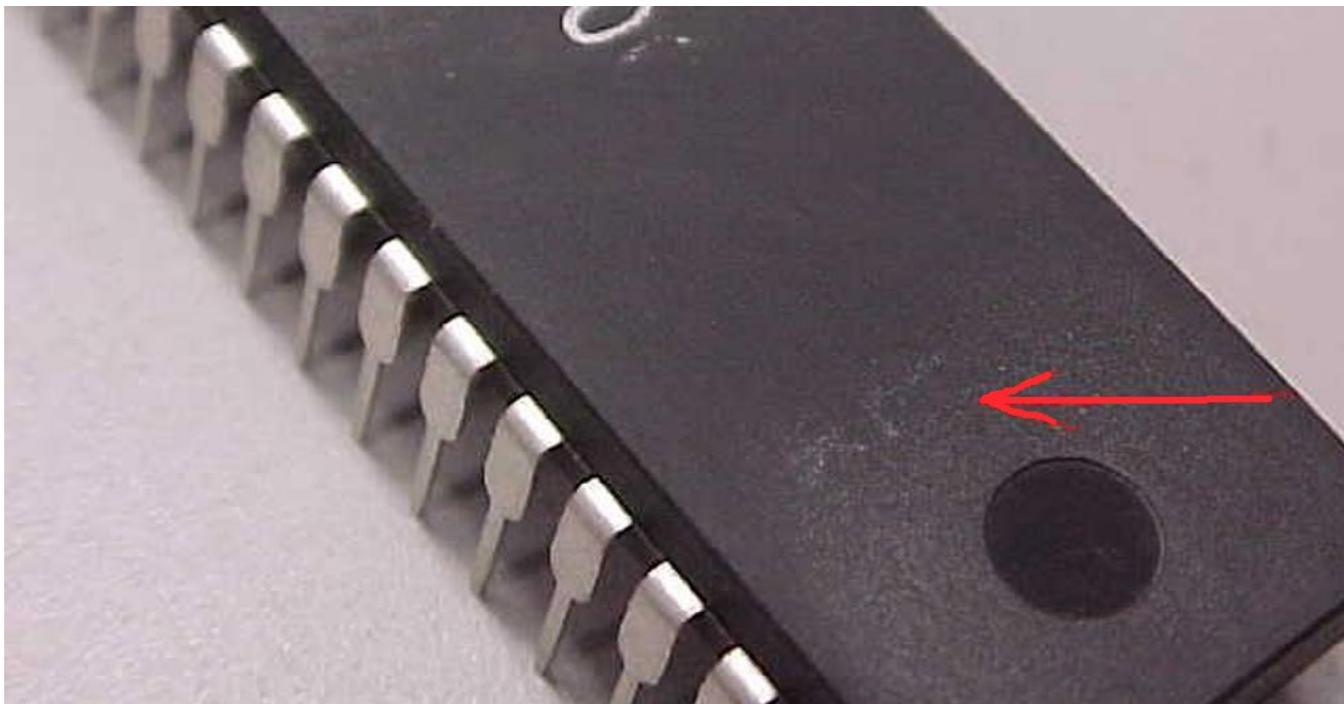


Figure 2: Scratching the surface reveals artifacts of previous markings.

• **Changing specifications:** As well as trying to reduce the cost of physical materials, logistics and contractual obligation costs can also be a motivation for counterfeiting. If a supplier finds that he is just a few materials short from fulfilling a delivery, he may be tempted to supplement the supply with materials that have similar electrical characteristics, but with wider tolerances, or have electrical characteristics that are close to the ones ordered. The penalty of not being able to fulfill a customer's order because of an incomplete supply is a significant motivator to cheat.

Means

Now that we identified reasons for motivation, the next issue to resolve is the means, that is, the method with which counterfeit materials are introduced into the supply chain. The means can be relatively simple in today's fast-paced electronics manufacturing industry. The counterfeit materials have to look like the originals. With recent technology advances, shaving or filing off the surface marking of an IC and replacing it with new markings, for example, can make an IC look like it's from a different manufacturer than the original.

As production machines are upgraded and replaced in factories, the older machines can be taken and reused to recreate or re-mark almost any material. The next step is to put the part into the correct supply form, on taping or in a tray, and package it up to look similar to the original. The final step is the labeling. Company logos can be downloaded from the Internet or simply scanned from genuine labels. Barcodes and formats of labels are easy to reproduce. The means and ability to create counterfeit materials is easier by an order of magnitude compared to just a few years ago, which is one of the reasons the occurrence of counterfeit-related issues has increased.

Opportunity

Lastly, opportunity is the easiest to identify. Materials are handled frequently between manufacturing and consumption. The many stages of logistics and processing offer multiple opportunities for the introduction of counterfeit materials into the system. The opportunity is supported by the lack of ability to detect counterfeits in a timely and traceable way. With the sheer volume of daily movement of electronic materials, by the time that issues related

LOST IN THE SYSTEM

to counterfeit materials are discovered, usually late in production as a quality issue, there is often no way to track back to when and where they were introduced.

This tracking problem has a historical element. In the early days of electronics manufacture, the quality of materials was relatively poor while volumes were ramping up with the popularity of electronic technology products. As a result, the quality of products in the market was low, and reputable manufacturers needed extensive incoming inspection regimes for many of the materials they used. The cost of this inspection was high, but the cost of market-quality issues was higher. However, neither of these high costs could be sustained as competition between electronics product manufacturers intensified. As a result, quality assurance was pushed upstream, and companies worked with their materials suppliers to manage quality and provide assurance of supply. Over time, material-related, market-quality issues were reduced, and with it the need for incoming inspection in the majority of cases.

But now because of the increase of counterfeit materials in the supply chain, the call is once more being made to set up incoming inspection regimes. What has been found so far is of real concern. While many batches of materials have no appreciable quality issue, some batches exhibit a failure rate that ranges from a few percent to as high as 10%. On further inspection, some discrepancies can be seen in the materials' appearance. Careful inspection of the materials for colors, fonts, lead geometries, package material and orientation, box materials, and labeling can reveal inconsistencies. In some cases, the counterfeit materials are hidden by mixing them in with genuine materials. In one case, a reel of SMT materials was found where approximately every seventh component on the reel was counterfeit. Reportedly, counterfeit materials are coming from both franchised and grey-market sources.

With this amount of counterfeit material, the industry will face a sudden, steady increase in production-quality and, potentially, market-quality issues or a significant increase in the cost of incoming material inspection. Today, however, with the increasing use of electronics

in safety-critical operations, such as automotive, medical, industrial, aerospace, and military equipment, the potential results of issues will certainly be far more serious than in the past. The industry will be forced to increase the inspection of more materials, inevitably raising costs. Rather than simply letting history repeat, we must take action now to change the supply-chain environment so that this proliferation of counterfeit materials does not continue.

Conclusion

After examining our detective scorecard, we can see that it's not practical to try to change the motivation. There will always be elements outside and around the supply chain that may be motivated to compromise standards. The means to enter counterfeits into the supply chain also practically cannot be controlled because of the many potential touch-points where logistics can be compromised.

The key issue that can be addressed, then, is the reduction of opportunity. Counterfeit materials proliferate because of the complexity that lies between their detection and the ability to track back to the source. If there was a high likelihood that the counterfeit could be tracked to the source and corrective action could be taken, the opportunities for successful counterfeiting would fall drastically. The traceability of materials spanning from the point of consumption all the way back to the original manufacturer can be an effective tool. If counterfeits can be detected and then traced back without doubt to a specific source, then either the source is the problem or has the responsibility to eliminate the problem. A few busts later, it will become clear that the introduction of counterfeits can no longer be lost in the system and that precise traceability of materials is an effective way to police and dissuade the majority of attempts. Only then will electronics manufacturing be able to return to a confident and cost-effective supply chain. **SMT**



Michael Ford is senior marketing development manager with Mentor Graphics Corporation Valor division. To read past columns, or to contact the author, [click here](#).



Figure 1: Firstronic has added two vapor phase reflow soldering systems to its Juarez, Mexico facility.

Vapor Phase Technology is a Viable Solution, but Carries a Learning Curve

by **Steve Fraser**
FIRSTRONIC

Talk to electronics manufacturers about vapor phase (VP) reflow solder technology and you'll find people who either love it or hate it. The reason for this diversity of opinion is due to fact that it is a technology that many people still do not fully understand. Yet, it is also a technology that has come of age in an era where its efficiency in reflowing densely packed printed circuit board assemblies is highly valued, since the vapor blanket immersion process ensures perfect wetting and void-free, high-quality solder joints.

Firstronic's electronics contract manufacturing operation in Juarez, Mexico has installed two VP reflow soldering systems over the last year. The facility also uses convection reflow soldering.

On the positive side of the equation, VP reflow soldering offers several advantages:

- Fewer process windows, which reduces changeover time
- Cleaner solder joints at lower temperatures
- More even heating for even large PCBAs

- Can eliminate need for wave solder or selective solder on mixed technology PCBAs
- Lower energy costs than convection reflow technology.

However, there can also be learning curve issues and tradeoffs:

- While the oven is in line and operates as a pass-through system, VP technology is still a batch process and the machine capacity must be sized to projected line volume
- The efficiency of the VP process can generate surprises in initial process development
- The fluid utilized in the process is a consumable which adds to cost.

An Excellent Solution for Lean Manufacturing

One of the big advantages in VP reflow soldering technology is that relatively few unique profiles are required. There is zero wait state between products and VP requires far fewer profiles than found in convection reflow soldering.



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VAPOR PHASE TECHNOLOGY IS A VIABLE SOLUTION, BUT CARRIES A LEARNING CURVE

Comparatively, convection reflow oven stabilization can add as much as 15 minutes to a changeover process.

That said, VP reflow is a batch process and throughput can't be changed. While that works well with the smaller lot size focus of Lean, the system can become a constraint if sized below the likely line volume. For example, Firstronic selected an IBL CX600 VP reflow soldering system when it added the technology in November 2014 because the facility was ramping production and a conservative approach seemed justified. The machine is sized for medium- to high-volume production environments, which typically would have no more than two SMT placement machines feeding the reflow process. When the second system was added in mid-2015, a higher volume CX800 system was selected because production volumes had grown faster than anticipated. SMT line configurations included three SMT placement machines and the smaller CX600 system was becoming a constraint. The larger system supports the three placement machine configuration with no throughput issues.

Significant Quality Advantages

VP reflow soldering involves immersing PCBAs in a vapor blanket. This contributes to even heating and the vapor penetrates under every component. From a quality standpoint,

this vapor blanket ensures perfect wetting and void-free, high quality solder joints. It also produces cleaner solder joints at lower temperatures (typically 240°C), eliminating the defect opportunities that can be caused by thermal shock during a convection reflow process that may reach 270°C.

The use of VP reflow soldering technology can result in immediate yield improvements over convection reflow processes. For example, this contractor's Mexico facility produces a PCBA which is also produced in China. The PCBA has microBGAs on both sides, including two microBGAs on the bottom side and seven microBGAs/BGAs on the top side. The largest BGA package has 266 balls. There is one chip scale package on each side of the PCBA. The 14-layer, high temperature FR4 OSP PCBA has 1809 components. In Mexico, VP reflow soldering is used, and convection reflow soldering is used in China. BGA opens/shorts are the number one issue in China, while the Mexico facility has experienced no solderability issues.

In another case, the facility is producing large PCBAs used in flat panel monitors. In convection reflow soldering a large PCBA can see as much as 90°C variance in temperature from one end of the PCBA to the other as it moves through various zones. If all parts are sitting in solder paste, this doesn't cause an issue; however, if balls aren't touching paste this thermal mismatch can cause parts to pitch slightly and form a gas boundary which causes an oxidized "pillow" to form. The end result is that parts touch but don't reflow. In VP reflow soldering the difference in temperature from one end of the PCBA to the other doesn't exceed 2°C, eliminating the potential for this issue to occur. In this particular project, the facility achieved yields of over 99% in the first three days of production ramp-



Figure 2: A vapor phase "blanket" provides even heating and the vapor penetrates under every component.

VAPOR PHASE TECHNOLOGY IS A VIABLE SOLUTION, BUT CARRIES A LEARNING CURVE

up and the project is running approximately 30,000 PCBAs per month.

There are some tradeoffs that can be easily dealt with once a team becomes familiar with the process and the technology. One technical challenge with VP reflow soldering is that the process can exacerbate 0402 and smaller device tombstoning. The solution is to incorporate a reverse home plate design for those pads on the stencil.

Another issue is the efficiency of the vapor blanket. In the 1970s and 1980s, when VP was still a common option, one of the negatives associated with VP technology was the fact that hybrid parts could be heat damaged. Sealed parts with open cavities could expand or explode. DC to DC or AC to DC converters (hybrid potted modules) would often fail. Today's technology minimizes those parts, but profile optimization is important because both sides of the PCBA go into reflow instantaneously.

A key selling point of the technology is that the process windows are broad enough that few unique profiles are needed. However, there can be a learning curve in developing the right profile because of the speed at which reflow begins. For example, the engineering team once ruined a profiler because the process was set at a level where the electronics inside the mole reflowed while taking measurements.

The Cost Savings Equation

VP reflow technology can save cost in several ways. First, it uses less energy than convection reflow soldering systems, in part because it doesn't radiate excess heat. It not only uses less energy, but the factory also requires less energy for cooling the air near the machine. For example in Mexico, where summer temperatures routinely exceed 100°F, VP is 40% an hour less expensive than use of a nine-zone convection reflow oven just in machine energy consumption alone. Add to that the fact that energy costs in Mexico are 1.5x higher than those in the United States and the additional savings associated with less radiant heat, and the concomitant load that places on air conditioning utilization, add up quickly.

One area that adds cost is the fluid used to generate the vapor blanket since it is a consum-

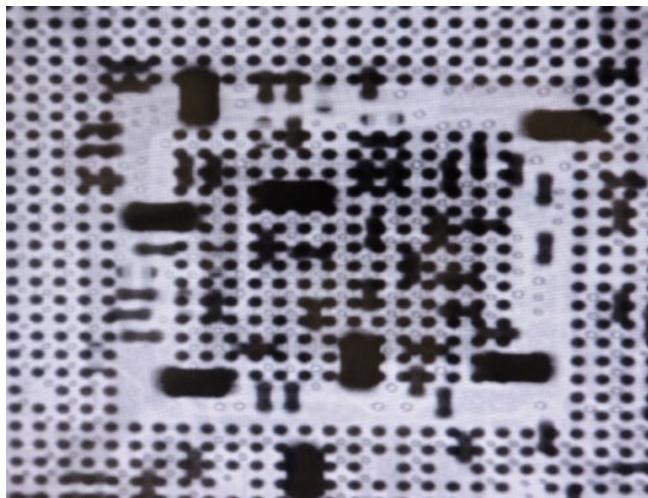


Figure 3: X-ray image showing consistent ball shape and solder wetting from vapor phase reflow.

able. However, the cost of the fluid is near or below the cost of nitrogen frequently used in convection reflow ovens.

One other area where VP reflow soldering technology can save money is on mixed technology PCBAs. When there are only a few through-hole parts, the PCBAs can often be completely soldered using pin-in-paste and VP technology. Depending on the product mix, this can eliminate or reduce the need for selective soldering systems or wave soldering machines. Additionally, while wave solder is typically a 3 Sigma process, SMT reflow is a 5 Sigma plus process, which means that the SMT process is much more repeatable and controllable in volume production.

VP reflow soldering technology has matured to the point where it can easily support higher volume production requirements. The challenge is properly sizing the machine to likely workloads and optimizing the necessary profiles. The end result is improved quality, better line flexibility and lower energy consumption. **SMT**



Steve Fraser is VP of operations at Firstronic. He can be reached at sfraser@firstronic.com.

Selecting a Wave Soldering System, Part 3

by Robert Voigt
DDM NOVASTAR

In the last column, we discussed the attributes of the various types of wave solder systems, the most common through-hole assembly system for small- to mid-volume operations. In this chapter, we will dive a little deeper and address board handling techniques.

For wave soldering, there are three common methods of running boards:

1. Automated in-line system
2. Manual conveyor system
3. Palletized carrier system

Automated In-line System

This arrangement is usually tied in to a total PC board assembly line, where the conveyor simply moves assembled boards from the assembly stage through the wave solder machine and on to cleaning, finishing and other secondary operations. There is no manual interference

at the solder machine; it's a totally hands-off operation from beginning to end.

Wave machines that run this way are usually very expensive and are used in high-volume repetitive operations. The Surface Mount Equipment Manufacturers Association (SME-MA) defines uniform specifications for in-line systems to assure that all the operations in an assembly environment transfer boards seamlessly from one machine to another, regardless of the manufacturer, machine model, etc.

- **Pros:** very efficient; reduces or virtually eliminates handling and manual labor
- **Cons:** very expensive; usually out of reach of low- to mid-volume contract assembly shops
- **Typical cost range:** often in excess of \$100,000



Figure 1: Finger conveyor.

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SELECTING A WAVE SOLDERING SYSTEM, PART 3

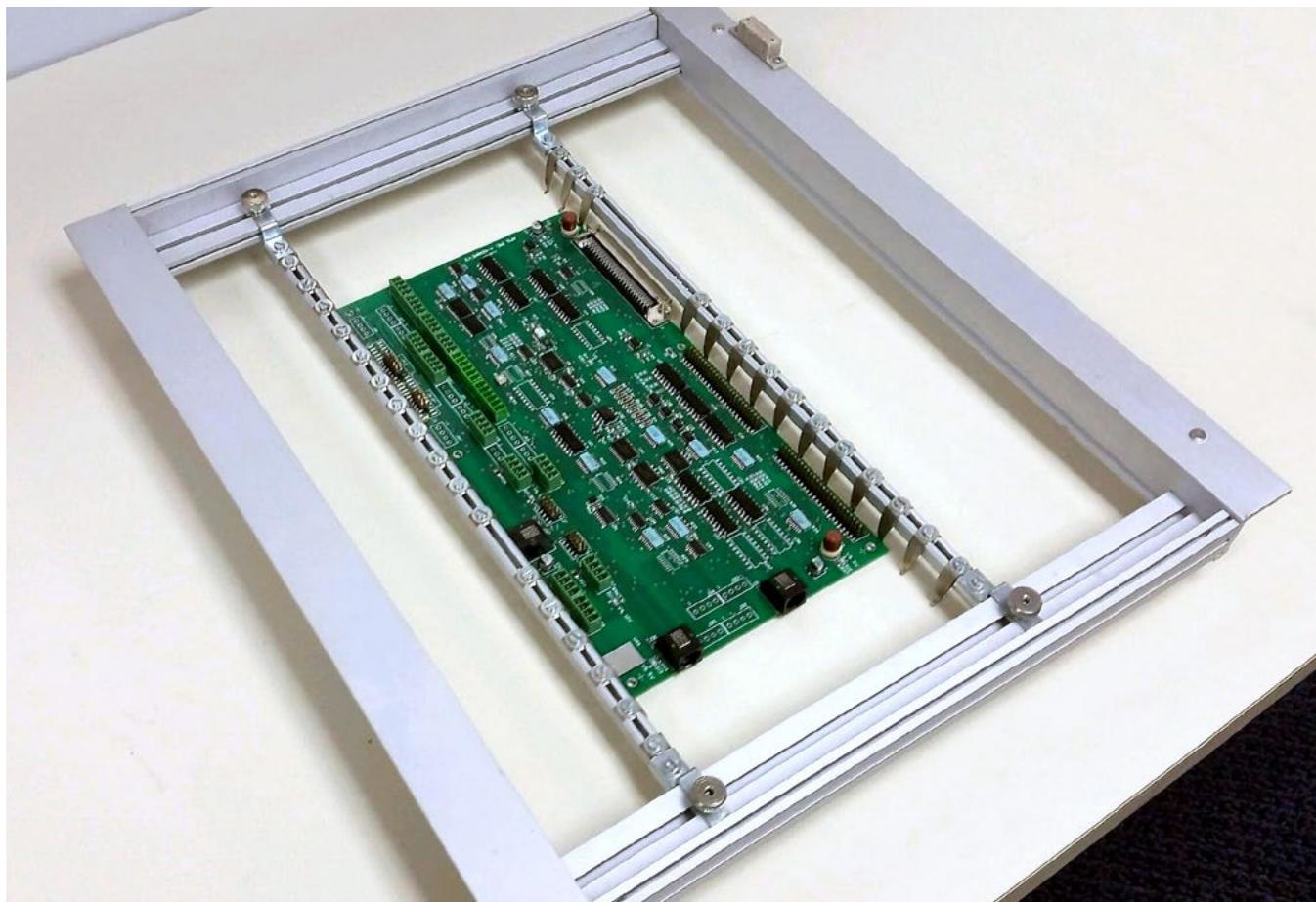


Figure 2: Universal pallet.

Conveyorized System

This system uses titanium fingers or clips to retain and position the boards as they move through the wave machine. Boards are loaded onto the conveyor by hand and removed by the operator on the other side.

- **Pros:** Considerably more affordable than a full in-line system. Less labor intensive than a palletized system (below)
- **Cons:** Odd shaped or thin boards can be difficult to run if they're only supported by edge clips or fingers; this is where the benefits of a palletized system appear
- **Typical cost range:** \$30,000–40,000

Palletized System

A palletized carrier is used to hold the circuit boards (which may include multiple boards) and the entire pallet is loaded onto the wave

solder machine. This is a batch process rather than an in-line system. The pallets are usually a fixed size according to the wave capacity (width and length).

- **Pros:** Good support for odd shaped boards or thin boards that could warp otherwise; can be customized to hold unusually shaped boards, or multiple boards; very easy to maintain pallets and fingers because everything can be done outside the machine; pallets don't rely on a set of fingers internal to the machine that would require shutting it down for maintenance
- **Cons:** Boards must be loaded manually into each pallet and then into the machine
- **Typical cost range:** \$12,000–30,000, but most high-end machines can use a pallet system

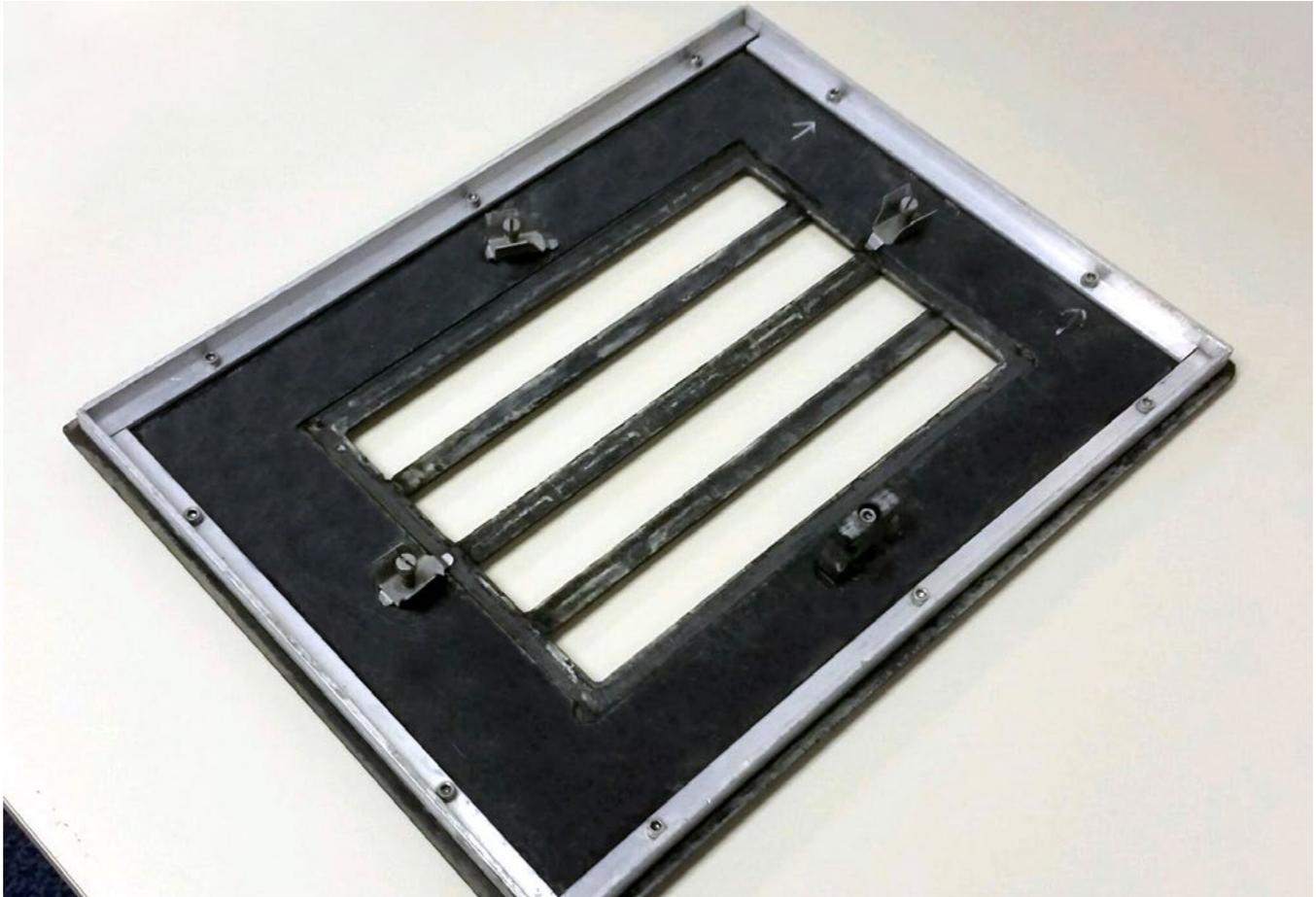


Figure 3: Custom board pallet—masks off areas that you do not want soldered.

Wave Solder Pallet Types

There are a number of companies that specialize in designing and manufacturing custom wave pallets. Following are some highlights on pallet features and design options. The wave solder machine vendor you choose should be able to guide you in the selection and use of a proper pallet device.

Through-hole technology remains the typical method for soldering connectors and many high power components such as transformers and regulators. This, in turn, has led to a style of mixed technology circuit boards with some or all of the following characteristics:

- Dense populations of components
- Boards with components on both sides
- Close pitch SMT or thermally sensitive components which would be damaged by a wave

- Through-hole connectors mounted close to previously installed SMDs

To wave solder these connections, a conformal selective wave solder carrier (CSWSC) is called for. This is a tooling pallet which has been designed to:

- Enclose all or nearly all solder-side SMT components
- Expose some or all pin through-hole (PTH) components
- Selectively allow solder to flow around the pins by creating the largest possible through apertures
- Mask thermally sensitive areas such as BGA lands
- Mask through holes and, if desired, ground plane areas and projections such as screws or rivets

SELECTING A WAVE SOLDERING SYSTEM, PART 3



Figure 4: Close-up of fingers or clips.

Key Elements of a Wave Solder Pallet:

- Wave solder pallets can mask ground planes, plated surfaces, mounting holes, and SMT components and expose only the desired PCB components to the wave
- Pallets can be customized with cost slides to quickly and easily hold down a row of components
- Pallets can include titanium corners to provide long life in high volume operations
- They can be designed to eliminate solder skipping and provide better connector support
- They can eliminate the time-consuming process of manually gluing SMT parts and masking through-hole parts
- They can improve solder flow in through-hole areas and reduce rework
- Custom fixtures can hold through-hole components and boards in alignment
- Built-in edge rails can be added to strengthen the pallet and protect the board from solder flooding

- Manufacturers can design custom fixtures to direct solder flow by shaping the solder side of the carrier to conform to the board

Check References

Remember to consult a variety of machine providers, talk to the manufacturers themselves if possible, and get references to contact before making a purchase. An important consideration for a complex machine such as a wave soldering system and its conveyor/pallet method is factory support, specifically training, software, upgrades and spare parts.

Next time: Wave machine options such as inerting, knife-edge cleaning, and more. **SMT**



Robert Voigt is VP of global sales at DDM Novastar Inc. To reach Voigt, [click here](#).

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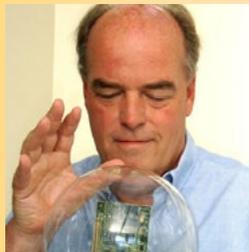
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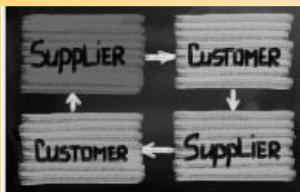
1 Printed Circuit Board Failures – Causes and Cures

PCBs can fail for a multitude of reasons. And the ability to detect and identify failures during assembly and final test is preferable to having to accept the consequences of field returns. This article details Bob Willis' recent webinar, which described failure mechanisms, demonstrated the use of standard test methods and tricks of the trade, and explained how to eliminate many of the common causes of PCB defects.



2 Sustainable Product Design & Supplier Material Disclosure

One of the biggest challenges for companies in addressing product sustainability initiatives is getting accurate and complete data from their supply chain. This article discusses how manufacturers can automate the process of gathering and managing supplier disclosure data to address current sustainability challenges, gain a competitive edge, and produce innovative and compliant products.



3 Standards Committee Updates at IPC

These standards committee reports from the 2015 Fall Standards Committee Meetings

have been compiled to help keep you up to date on IPC standards committee activities. This is the first in the series of reports.



4 SMTA Welcomes New Board Members

The SMTA is pleased to announce its election results for the Board of Directors:

Robert Kinyanjui, Ph.D., of John Deere Electronic Solutions Inc. was elected Treasurer, while Eileen Hibbler of TEK Products was elected VP Membership. Richard Coyle, Ph.D. from Alcatel-Lucent, and Tim Jensen of Indium Corp. were appointed to the Strategic Development Committee.



5 EMS Industry M&A Transactions Up in 3Q

There were 10 completed M&A transactions in the EMS industry in the third quarter of 2015, up from six transactions in the previous quarter, according to the latest EMS DealReader report by Lincoln International.



6 Saline Lectronics Installs a Flexible Assembly Flow Line

Saline Lectronics, Inc., a leading electronics contract manufacturer, recently installed a new assembly flow line. The line is setup in a systematic, unique configuration in order to provide a truly flexible lean system.



7 Mentor's Michael Ford on Lean for Surface Mount Processes

Michael Ford of Mentor Graphics Valor Division discusses with I-Connect007's Andy Shaughnessy his paper about lean systems in surface mount processes. He also talks about how the industry is now starting to look at Industry 4.0, and why the industry should stop focusing on the endless optimization processes, which are still important, but instead consider the optimization from the point of view of the product.



8 Tremol SMD Talks EMS Trends and Industry Outlook

At the recent productronica 2015 event in Munich, Germany, I interviewed Kiril Yanneff, CEO of Bulgaria-based EMS firm Tremol SMD about the electronics manufacturing landscape in east Europe and his outlook for the industry. He also spoke about the significance of automating production lines.



9 LACROIX Electronics, Top French Investor of the Year

At the FDI Awards Gala on 15 October in Warsaw LACROIX Electronics Poland was awarded the prize of Top French Investor of the Year. The prize was given by an independent jury consisting of 24 Commercial Counsellors from the Embassies supported by country specialists, Ambassadors and investment specialists.



10 New IPC Standards Gap Analysis Helps Your Bottom Line

How well do you know your manufacturing process? Are costly inconsistencies impacting your bottom line? IPC Standards Gap Analysis (SGA) is designed to enhance the financial success of IPC member companies.



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Coming Soon to *SMT Magazine:*

February: *What's New*

This issue will talk about the latest technology and process developments happening in the SMT, PCB assembly and EMS industries, and what to expect in the future.

March: *Strategies for Success*

This month, we will feature strategies for building the highest yield on the lowest cost possible to provide the greatest value to your customer.

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