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## ALTERNATIVES TO SOLDERING

# *NanoCopper-Based Solder-Free Electronic Assembly Material*

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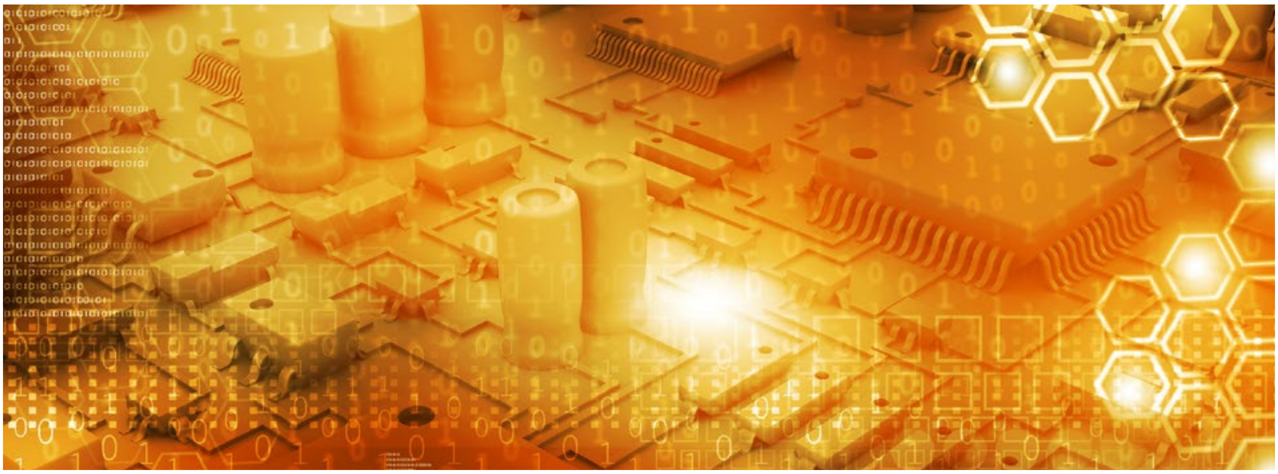
# October 2014 Featured Content

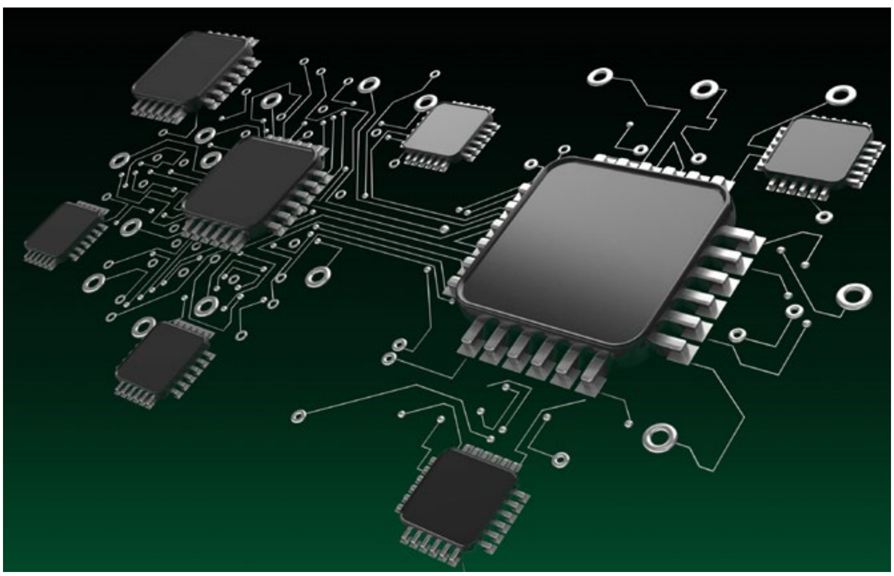
## ALTERNATIVES TO SOLDERING

Industry researchers have been predicting the elimination of solder for years. We're not there yet, but solderless assembly development is continuing apace. In this issue, A. A. Zinn, R. M. Stoltenberg, J. Beddow, and J. Chang of Lockheed Martin discuss a new nanocopper-based solder-free material that can replace tin-lead and lead-free solder. And Joe Fjelstad offers an update on solder alloy-free electronics (SAFE) processes.









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# New Young Voices Finding the Right Tune To Sing

**by Ray Rasmussen**
PUBLISHER, I-CONNECT007

The title of my column this month was provided by Joe Fjelstad. It came in the form of a comment at the top of an email he sent to me a few months back. I think it perfectly describes the theme of this column, as does the quote below from an article about the BotFactory:

"The guys at BotFactory hate to solder. Their eyes start gleaming when they talk about how future generations of their new desktop circuit fabrication platform, Squink, could bring to an end the days of soldering for engineering students and hackers. It's messy. It's hot. They never want to do it again."

I recently came across a quote on the topic of change from Bill Gates, which I believe is quite appropriate as we all try to figure out where this technology is going. Gates said, "We always overestimate the change that will occur in the next two years and underestimate the change that will occur in the next ten. Don't let yourself be lulled into inaction."

Futurist Ray Kurzweil says this: "If we look at the life cycle of technologies, we see an early period of over-enthusiasm, then a 'bust' when disillusionment sets in, followed by the real revolution."

The market hype associated with printed electronics and 3D manufacturing over the years has suggested that these technologies will be game-changers. The speed at which they're "changing the game," in reality, may lull some folks to sleep as they see PE and 3D more as fads as opposed to new ways of making circuits.

That brings to mind another Kurzweil quote: "Our intuition about the future is linear. But the reality of information technology is exponential, and that makes a profound difference. If I take 30 steps linearly, I get to 30. If I take 30 steps exponentially, I get to a billion."

The Gartner Chart in Figure 1 was pulled from this press release back in August.

In my June 2013 column, I posed the idea that the combination of 3D and PE technologies would create dramatic changes in the industry (more hype?). I suggested that the timing for this convergence (PE and 3D) and the PCB was somewhere in the future. But I don't believe that's the case anymore. Like the second half of Gates' quote on change and Kurzweil's on exponential change, we are likely underestimating what will occur over the next decade; things are changing exponentially.

For me, it's not what the guys at the Botfactory are doing, it's who is doing it. These aren't the industry experts, giant technology companies or huge EMS providers. It's the GenXers. They're by-passing the traditional industries entirely. They've gotten hold of cheap 3D printers along with the materials being developed for printed electronics and they're starting to build PCBs and assemblies. Sure, it is just rudimentary circuits now, but this will change. Think about it: They're


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**NEW YOUNG VOICES FINDING THE RIGHT TUNE TO SING** *continues*

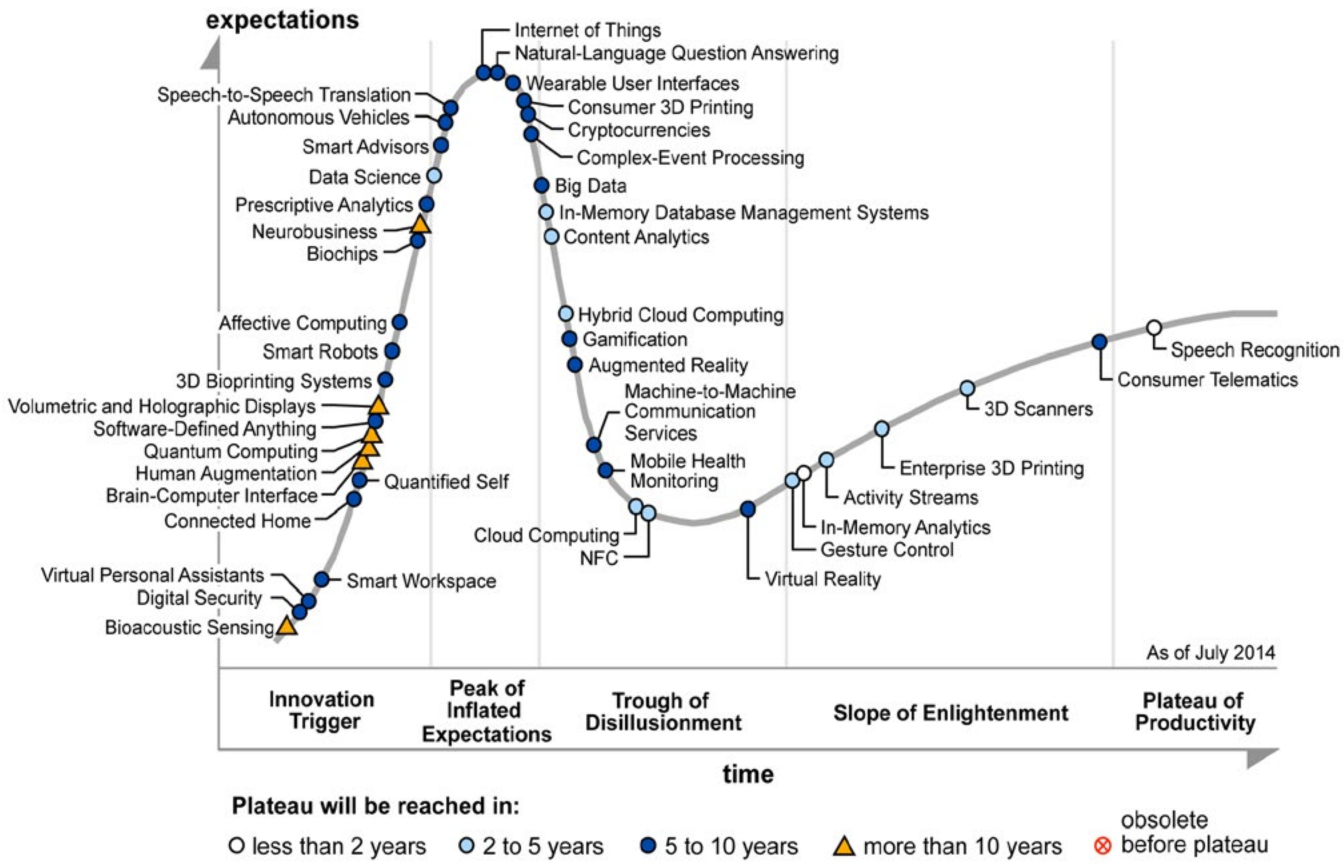



Figure 1: The Gartner Chart.

working to topple (they don't realize it, yet) an industry worth a couple hundred billion dollars. If they have some success, they're going to pique the interest of the VC community.

These new circuit makers are in a great position, too, because the large materials companies working to advance the potential of the PE market are doing all the heavy lifting. Those materials and technologies are opening the door for the creative minds fresh out of college. For a few thousand crowd-funding dollars, these next-generation technology entrepreneurs are working to create the systems to build multilayer PCBs and assemblies. There is no doubt they will succeed as the materials and systems they need are being developed at lightning pace by R&D labs from academia, industry and governments around the world, all striving to capture a share of this huge new market.

This stuff is happening all around us, right now. Some of it is making the news, which I've shared with you in this column in the past and more, today. To add more fuel to this revolution, I recently read that the U.S. government is buying 20,000 3D printers to give to high schools. I'm sure they're doing the same in Europe and Asia. Exponential change in underway.

I'm not freightened by all of this; I'm intrigued and excited. All of those young people we've been unable to attract into conventional PCBs and EMS are now coming. They're doing it in their own unique ways with their own timing. The timing is what we have to keep an eye on. The thing about exponential change is that it tends to blindside most of us. We hear the hype, don't see much happening, then, overnight, we're staring it, whatever it is, right in the face. That's where we are, today. We're exiting the hype cycle, mostly, and entering into a real, new phase of manufacturing based on 3D-PE.

Think of the possibilities. When an OEM can fabricate a PCB and assembly as needed, on the fly… Imagine the cost savings! It's an interesting scenario. But as these systems get dialed in, how do we stay relevant?

### Inherent Problems

Having just published another issue of *SMT Magazine* dedicated to Tin Whiskers, I, like most of you, am dumbfounded by the amount of energy and resources we invest to breathe additional life into these traditional systems. Lead-free has only magnified many of the problems related to traditional solders.

Another welcomed consequence of the addition of thousands of young minds to our industry is that they'll likely provide quick solutions to many of the problems plaguing the reliability of the systems we're building. These simpler (on the surface) systems will require better, lower cost materials. Again, this work is already being done by the globally-interested 3D and PE materials suppliers. Certainly, we can see the day when traditional structures and methods of attaching components will no longer be the norm. There are just too many problems. On the horizon we'll see new schemes to meld functionality into interconnection platforms. Will they be Occam-like or take some other form? Check out what the folks at PARC are doing with embedded components. It's mind blowing: PARC: 3D Printing Electronic Components Within Objects.

Based on what we're seeing, I don't believe the circuits of the future will be more of the same. If you're going to build thousands of PCBs and assemblies using these 3D-PE systems, they'll have to be built on a very reliable platform with the best materials. And with these fresh minds working on the problems, unhindered by 50 years of PCB or assembly experience, I predict they'll come up with some pretty elegant solutions. They aren't going to stick with something that's broken. That's what's really exciting. No legacy systems to deal with, just fresh thinking using cutting-edge equipment and materials.

### The Bigger Picture

The PCB industry generates $50–$60 billion in revenue today. The PE industry, by some estimates, could reach $300 billion in a decade or so. IDtechEx predicts a $77 billion PE industry by 2023 with only about 20% of that related to circuits. If that $300 million market size holds true it would mean PE circuits could represent about $60 billion. Now, some of that will be in new PE enabled products, but a portion will come from the PCB segment. And with the new capabilities of 3D combined with PE, along with advances in robotics and the trillion-dollar market forecast for the Internet of Things (IoT), new markets will emerge. Circuits will be everywhere and on everything. Many products won't have a PCB in the traditional sense, but circuits will most likely still connect things.

Here's a question that we should all ponder, going forward: Are we in the PCB fabrication and PCB assembly business, or are we in the circuit making and circuits' assembly business?

### Is it Our Industry?

I know some of you might feel like the industry is under attack from PE and now 3D printing, but I see it a bit differently. These technologies are coming whether we like it or not. And the fresh, young minds will invigorate and transform the industry into something new. Now, we can embrace the technologies along with the new entrants or fight them kicking and screaming to the end. I see a ton of opportunity for us all in the former and disaster and demise for us in the latter. I only know of a few PCB and EMS companies that are dabbling in 3D-PE technologies, but I'm sure there are more. I hope my passion for this topic is received as it is intended: to inform our readers as to what I see happening. I certainly welcome your comments. They can be published and shared with the rest of the industry or kept private. Just let me know. **SMT**

Ray Rasmussen is the publisher and chief editor for I-Connect007 Publications. He has worked in the industry since 1978 and is the former publisher and chief editor of *CircuiTree Magazine.* To read past columns, or to contact Rasmussen, click here.

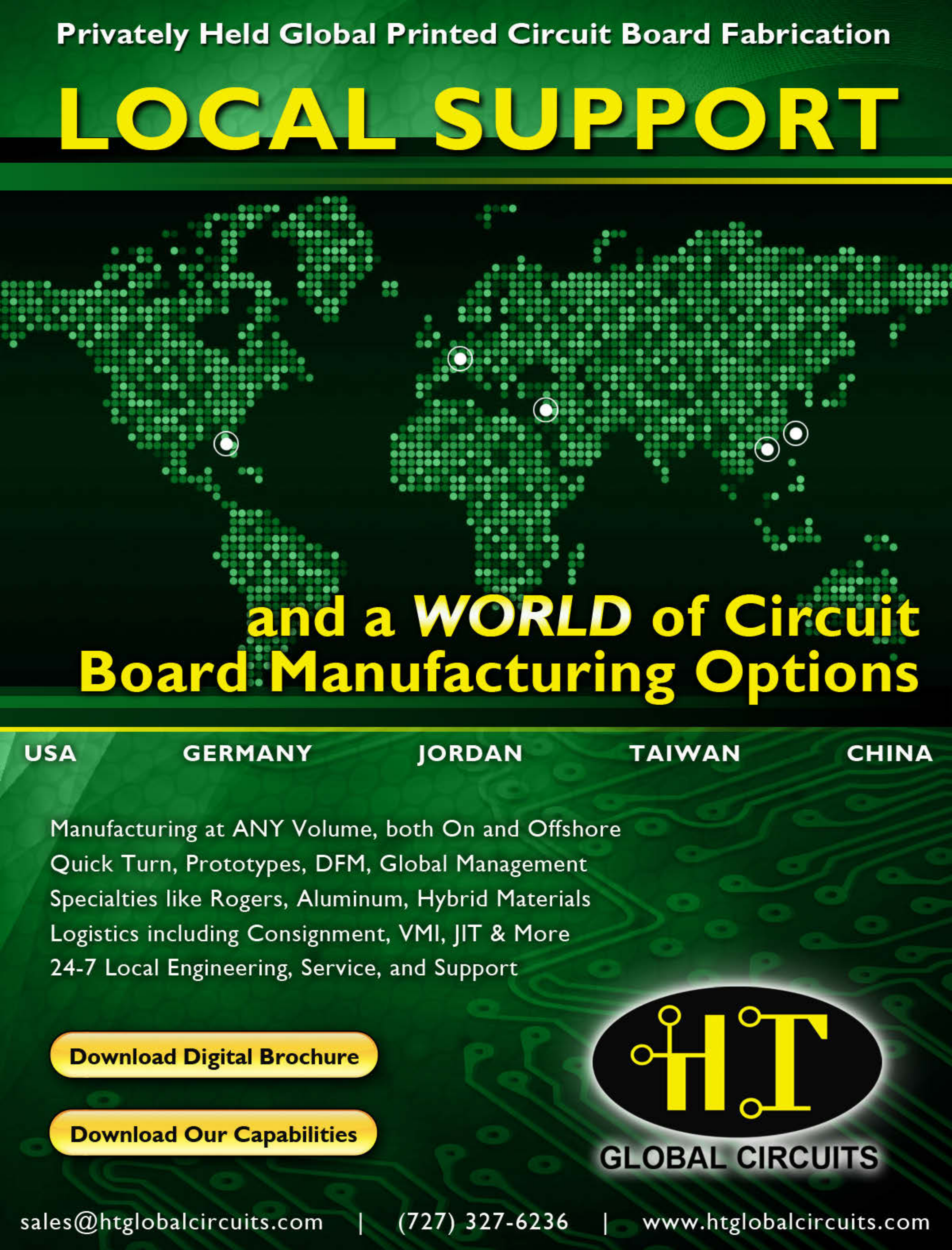
# NanoCopper-Based Solder-Free Electronic Assembly Material

**A. A. Zinn, R. M. Stoltenberg, J. Beddow, and J. Chang**
LOCKHEED MARTIN SPACE SYSTEMS COMPANY, ADVANCED TECHNOLOGY CENTER

*This article originally published in the proceedings of IPC APEX EXPO 2014.*

**Abstract**

The Advanced Technology Center of the Lockheed Martin Corporation has developed a nanotechnology enabled, copper-based electrical interconnect material that can be processed around 200°C. The readily scalable Cu nanoparticles synthesis process uses a low cost solution-phase chemical reduction approach. A pilot plant is fully operational producing one pound per batch of nanomaterial. We have demonstrated assembly of fully functional LED test boards using a copper-nanoparticle paste with a consistency similar to standard solder. Further improvements have led to the assembly of a small camera board with a 48-pad CMOS sensor QFN chip and a 26-pin through-hole connector. In addition, we have a fully functional nanocopper assembly line in place for process development using standard industrial off-the-shelf equipment. We are currently working with a commercial assembly house to dial-in the board assembly process. The fused material shows a tensile strength that is already in the range of space qualified solder. Once fully optimized, the nanocopper-based solder-like material (CuantumFuse™) is expected to produce joints and interconnects with up to 10x the electrical and thermal conductivity compared to tin-based solders currently in use and with a bond strength comparable or better than eutectic SnPb. Applications in space and commercial systems are currently under consideration.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### Introduction

In response to government legislation and regulation around the world regarding lead content in consumer electronics[1], electronics producers have quickly converted to lead-free tin/silver/copper (SAC) solder. In 1997, a comprehensive $11 million National Center for Manufacturing Science (NCMS) project was conducted by 11 private and public institutions to determine a suitable replacement for tin/lead solder (SnPb)[2]. After studying 70 candidate alloys, it was concluded that alloys near the eutectic SAC composition would be best suited for their applications. Additional studies and consortia (National Electronics Manufacturing Initiative, Center for Advanced Vehicle Electronics, INEMI, HDPUG, IDEALS, Pb-Free Electronics Risk Mitigation) perpetuate near eutectic SAC alloy as the most popular lead-free replacement out of the now more than 300 alloys in use. Its reliability has proven acceptable to the consumer electronics industry where short product life cycles and relatively benign operating environments are common. The primary difficulty of the SnAgCu system is its high melting point at 217°C, requiring processing temperature in excess of 250°C to ensure complete melting of the high melting phases Ag3Sn and Cu6Sn5 that could be present (Figure 1).

Such high temperatures can damage the polymeric materials used for components, staking, and boards, unless more expensive components and materials are used and limit the number of rework cycles[2]. Additionally, it brings new and reemerging failure modes in electronics, including tin whisker growth[3]. For defense and space applications, reemergence of this issue with SAC raises concerns regarding increased infant mortality, latent failures, and the need for complete requalification. Establishing new qualification procedures is made more onerous as the behavior of SAC alloys are still not fully characterized or understood. Additionally, the most common alloy system exhibits a number of known drawbacks, making it unreliable for long-term use in harsh environments with shock, vibration, heat or thermal cycling[4–8].

When alternatives to SnPb solder are consid-

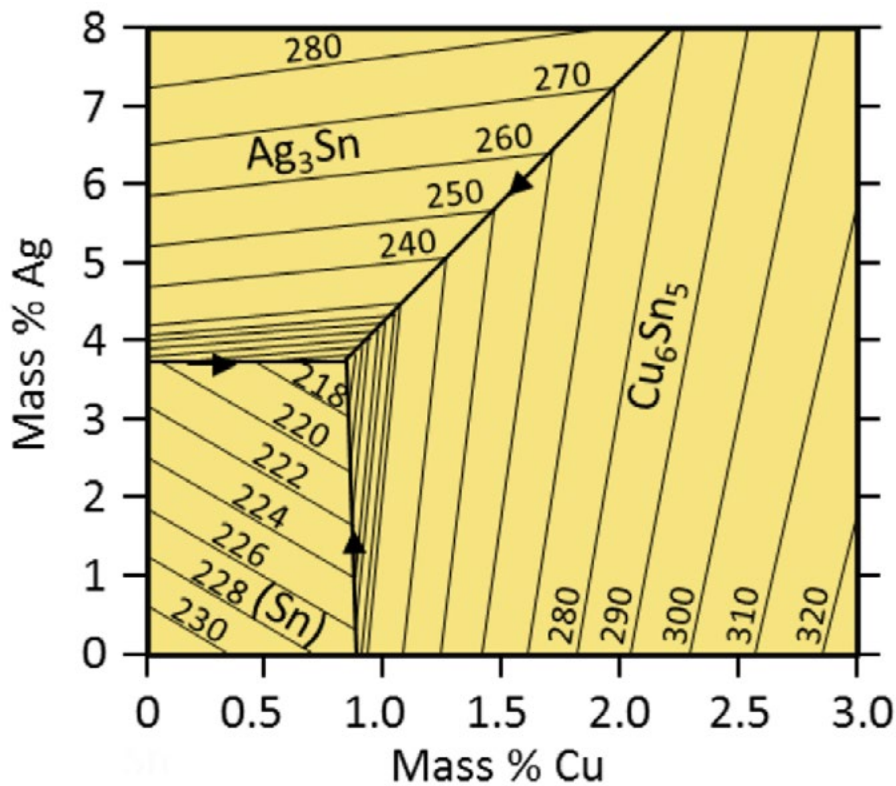


Figure 1: Phase diagram of the Sn-Ag-Cu system. Graph generated from NIST data.

ered, the first restriction on available materials is traditionally the melting point. The material must be processable at a temperature that will not compromise the electronic components or the substrate. Hence, low melting metals and alloys are the first candidates, while materials that are more cost effective like copper or aluminum or have excellent electrical and thermal properties such as gold, silver, copper, and aluminum are immediately passed over due to their high melting points. However, in this instance, nanotechnology allows access to more of the periodic table. It is well documented that as a metal particle size shrinks to the nanometer scale, the temperature at which these particles will join together drops significantly below the melting point of the bulk material[9]. It should be possible, then, to develop a pure copper solder by forming sufficiently small copper nanoparticles such that the melting point is reduced from the bulk value of 1084°C to a traditional electronics processing temperature around 200°C. Developing such a solder paste must address a number of requirements including:

1. Sufficiently small nanoparticle size
2. A reasonable size distribution
3. Reaction scalability
4. Low cost synthesis
5. Oxidation and growth resistance at ambient conditions
6. Robust particle fusion when subjected to elevated temperature.

This paper outlines the development of a novel nanocopper material—from synthesis to board level integration—as a solder-free electronic assembly material. Copper was chosen because it is already used throughout the electronics industry as a trace, interconnect, and pad material, minimizing compatibility issues. It is cheap (one-quarter the cost of tin; 1/100th the cost of silver, and 1/10,000th the of gold), abundant, and has 10x the electrical and thermal conductivity compared to commercial tin-based solder.

### Nanocopper Synthesis

Oxide-free copper nanoparticles with diameters in the 5–25 nm range were synthesized via solution chemistry (Figure 2). An inexpensive copper salt precursor is the basis of the reaction. The salt is dispersed in a suitable solvent, and subsequently reduced with sodium borohydride (NaBH4). The resulting copper atoms agglomerate into larger entities and are stabilized by the addition of surfactants to the reaction mixture. Quick cooling, after the reaction is complete, helps to arrest particle growth. The reaction output is then repeatedly washed to isolate the nanocopper particles and to remove side-products. Throughout the synthesis process, temperatures, color changes, solution viscosities, and times are monitored closely. None of the chemicals used in the synthesis are rare or prohibitively expensive.

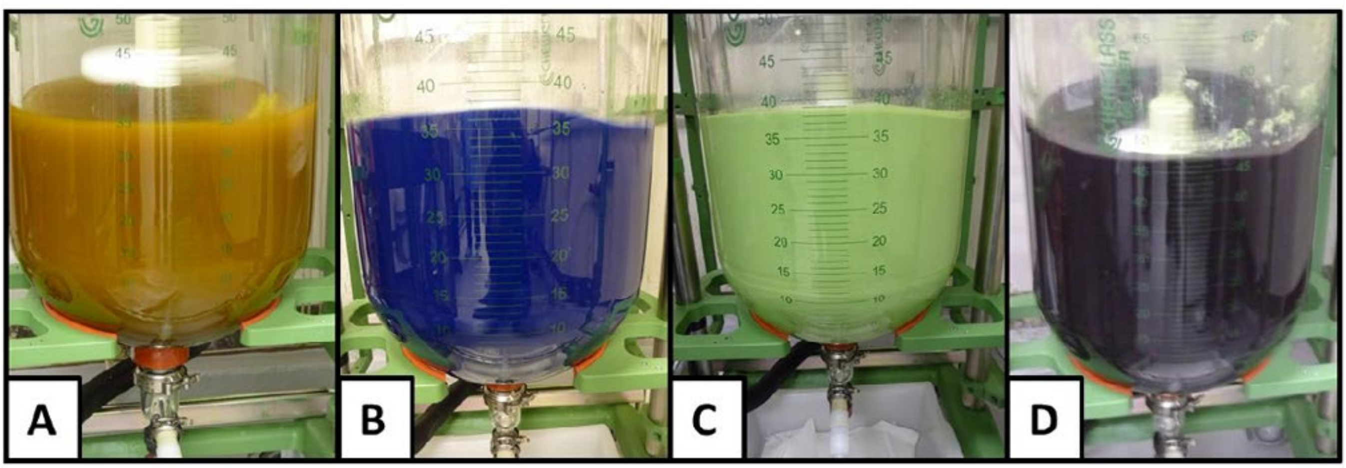


Figure 2: Reaction progression from a soluble copper salt (A-C) to reduction to copper nanoparticles (D).

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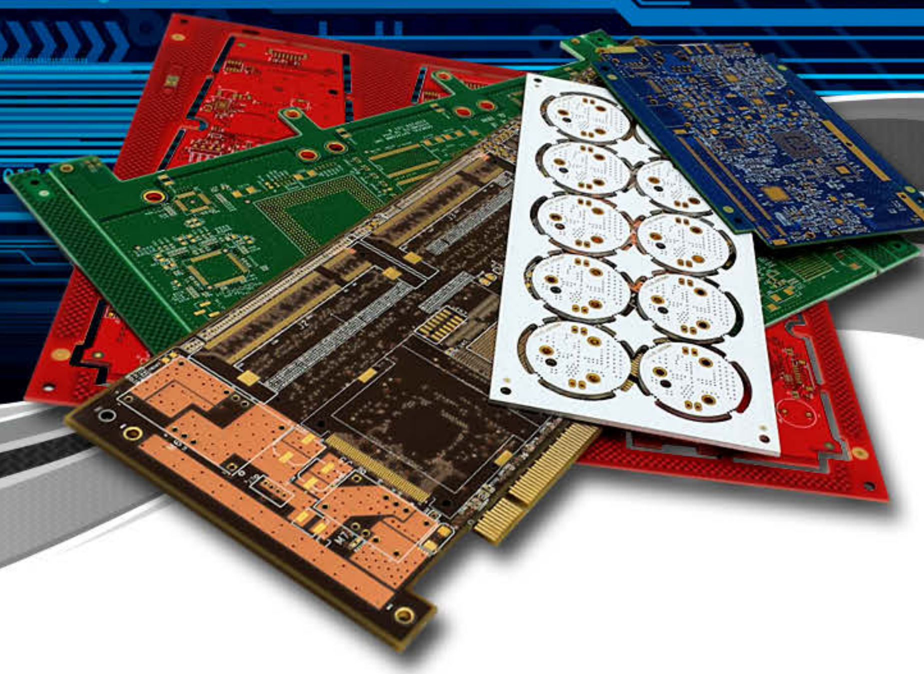

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**Scale-up**

A critical issue for nanomaterials manufacturing is scalability. The controlled fabrication of metal particles in the size range of interest has only been demonstrated previously with gold and silver after a decade of research. In solution-phase nanoparticle synthesis, there are two competing processes: nucleation and growth. Particle nucleation dominates the reaction in the beginning but then levels off over time, and particle growth takes over as the dominant process. However, nucleation does continue, providing a constant flux of very small particles. This leads to an increasing size distribution that is volume dependent. At a small scale (e.g., a few hundred milliliters) the two processes can be controlled quite well, allowing for a suitably narrow size distribution. However, with increasing volumes (e.g., thousands of gallons) controlling nucleation and growth can be more difficult, yielding a very broad size distribution.

This situation was overcome by designing a process that, for the first time, completely separates nucleation and growth without any nucleation additives. The concept works so well that all scale-up steps attempted to date have worked on the first try. This gives a strong indication that this process is fully scalable with little modification.

In order to demonstrate scalability, our facilities were upgraded with 5 L and 100 L chemical reactor systems (Figure 3). The 100 L reactor is now used routinely at the 80 L batch size to produce over 500 g of high quality material.

**Nanocopper Characterization**

As-synthesized nanocopper exhibits a number of bulk characteristics including color, luster, and consistency that can be used as an initial indicator of material quality. A high quality material is typically dense, exhibits a copper color with metallic luster, and has a paste-like consistency. A more fluffy, powder-like, dull, and brown-to-black appearance warns of an inferior product.

NanoCopper has also been characterized by a variety of microscopy and analytical techniques including scanning electron microscopy (SEM), energy dispersive spectroscopy (EDS), X-ray diffraction (XRD), thermogravi-

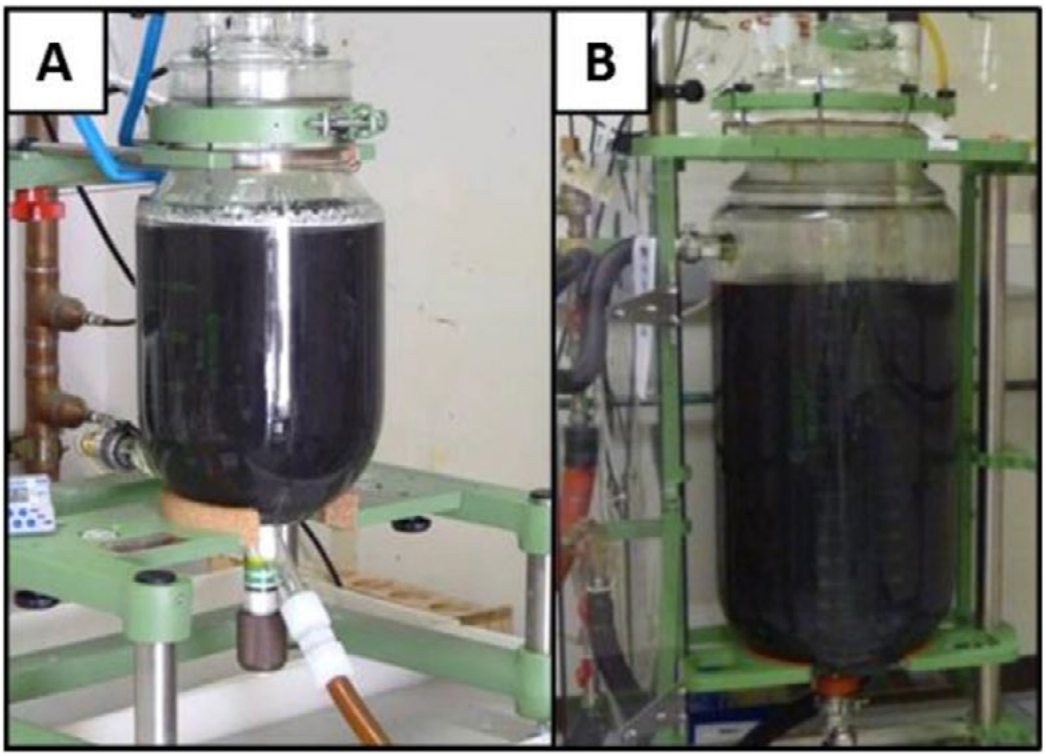


Figure 3: Nanocopper reaction at the 5 L scale (A) and 80 L scale (B).

metric analysis (TGA), and high-resolution transmission electron microscopy (HRTEM). The primary form of quality control consists of SEM and EDS. These techniques prove to be quick and low-cost while providing data that can be easily interpreted. For each reaction, a sample of the as-synthesized material and a fused sample (heated to 210°C with a nine-minute ramp and a four-minute soak under constant N2 flow) are subjected to SEM imaging and EDS analysis from which initial particle size, material purity and the fusion characteristics (necking, growth, porosity) can all be determined (Figure 4). High quality nanocopper material fuses into a continuous network with grains clearly exhibiting crystalline facets. Porosity can also be determined using a combination of ion-beam milling and SEM image analysis. Porosity of the fused material is an important metric in that it has a marked effect on the electrical, thermal, and mechanical properties of the final material.

HRTEM imaging revealed fringe patterns from which crystal structures and phases could be determined. Additionally, images were analyzed to confirm particle sizes and the arrangement of surfactant layers. Fused particles were examined to understand grain and grain boundary development.

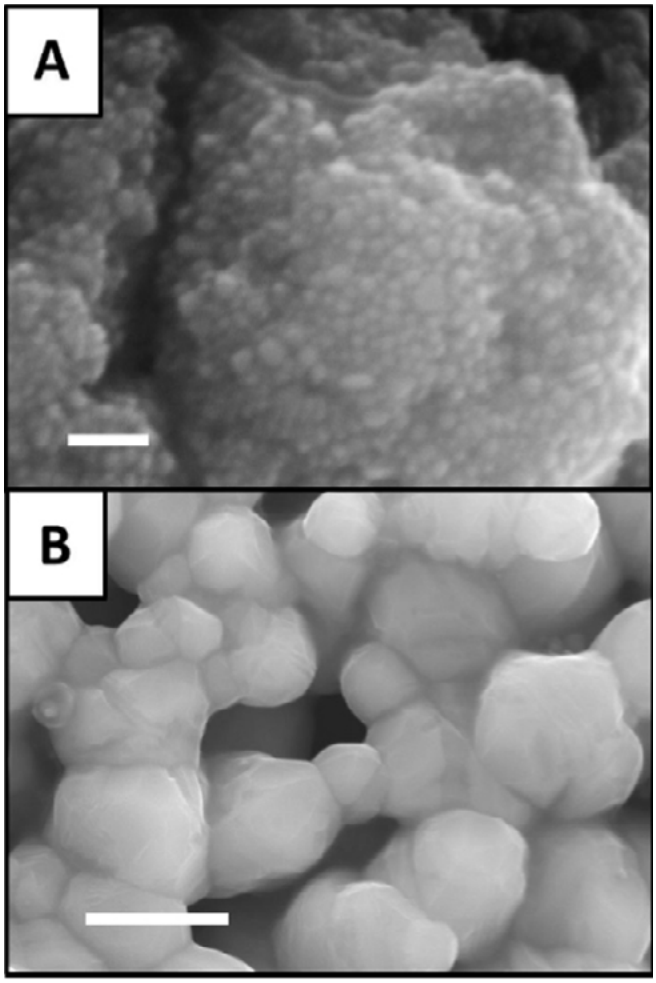


Figure 4: SEM micrographs of copper nanoparticles isolated from the synthesis (A) and material after fusing at 210°C for four minutes (B). The scale bars represent 100 nm and 500 nm for panels A and B, respectively.

### Nanocopper Mechanical and Thermal Properties

Before attempting to build electronic boards, a significant effort was undertaken to establish conditions that yielded high nanocopper bond strength. Specifically, the goal was to be comparable to eutectic Sn63Pb37 solder and other high temperature tin-lead solders qualified for use in space. Raw nanocopper material from synthesis was formulated into pastes with additives designed to improve suspension, dispersion, flow properties and fusion. The process for testing formulations was iterative and provided quantitative data on the tensile strength for each formulation. A non-standard tensile test had to be developed since the material does not lend itself to casting bulk dog-bone specimens of consistent quality as ASTM test procedures require.

Formulations were made by washing nanocopper powder several times with various chemicals, such as solvents, surfactants, and thickeners using a variety of methods, such as manual stirring, sonication, and homogenization. The viability of these formulations was quickly screened by performing a quick fusion test on Al substrates and making a qualitative measure of material strength and hardness. Promising formulations were further investigated through SEM and assembly of small LED boards to test electrical performance.

To quantify the tensile strength of a formulation, a unique tensile test specimen was developed. Tensile specimens consisted of two copper bars that were fused together with nano-

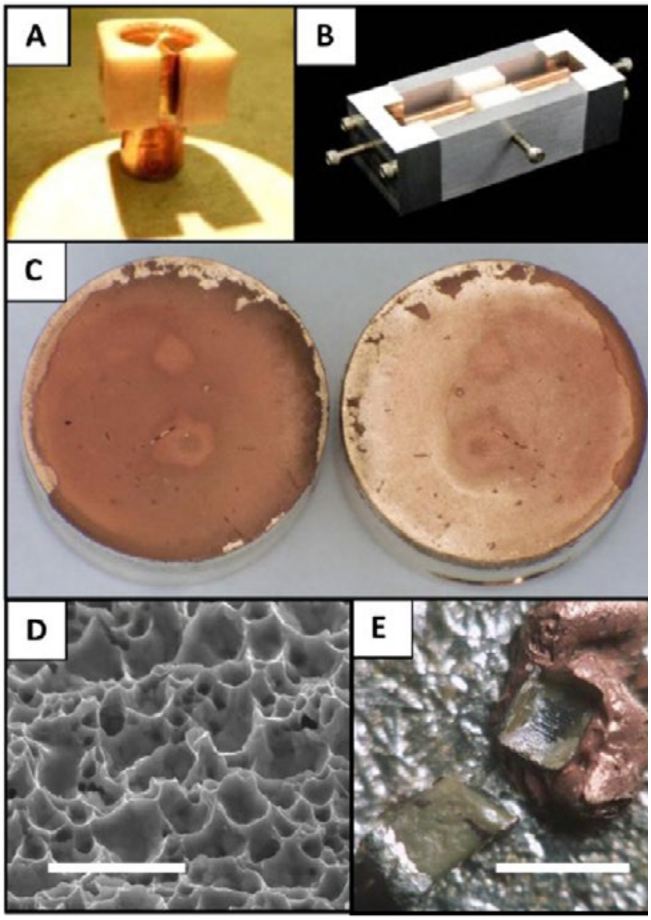


Figure 5: A–E: A) A single copper bar used for tensile testing is nested within a Teflon collar. B) A tensile specimen loaded in a fixture ready for fusion. C) Photograph of a fracture surface following tensile testing. D) SEM image of a fracture surface after tensile testing. The scale bar represents 5 μm. E) A surface mount resistor bonded to a Sn surface with nanocopper. The resistor failed in the ceramic rather than the nanocopper when stressed. The scale bar represents 1 mm.

copper. A metal fixture with a Teflon collar was used to align the copper bars and apply moderate pressure during the heating cycle (Figure 5A and B). The copper bars were weighed before and after fusion to determine the amount of nanocopper in each joint. Tensile tests were then completed using a tensile test machine, and the fracture surfaces (Figure 5C) were analyzed by SEM and EDS.

Many formulations were considered, created, tested, and down-selected. In total, 41 different sets of tensile tests were performed on nearly 350 tensile specimens. The maximum load held by a nanocopper joint was 1,155 lb or 7,683 psi for a 0.4375 inch diameter bar. Several sets achieved consistent bond strength above 4,400 psi which is the minimum tensile strength of the lowest strength SnPb-based solder alloys currently used for flight hardware assembly. To compare the results of this non-standard test to other materials, a number of baseline test specimens were generated using SnPb solders in place of nanocopper. These samples showed a tensile strength of 11,000 psi.

SEM imaging of the fracture surface of tested tensile specimens indicated that the above tensile strengths were achieved with less than 10% cohesive ductile failure. Extrapolation of this data suggests that just 20% cohesive ductile failure should produce joints with strengths equal to that of eutectic SnPb solder. The SEM images showed cup-cone features typical of ductile metal failure, which indicates nanoparticle fusion and formation of strong metallic bonds (Figure 5D). Fusion of nanocopper material to the bulk copper rod was also seen in many samples. This was an important finding as it showed that nanocopper exhibits sufficient activity to react with and bond to a thermodynamically stable bulk copper surface.

Thermal conductivity was tested according to ASTM D5470 yielding a value of 140 W/mK, 35% that of bulk copper, but three times that of SnPb (35–50 W/m*K depending on composition).

### Electronic Board Manufacture and Other Applications

A commercial camera board was chosen as the first demonstration build because the assembly required bonding of the most important electronic component types. Each board consisted of four surface mount resistors, 14 surface mount capacitors, three five-pin surface mount voltage regulators, four through-hole jumper connections, one 26-pin through hole connector, and one 48-contact pad QFN surface mount sensor chip. Additionally, successful camera board manufacture could be easily demonstrated via still and live image capture.

The camera board was procured as a kit from Digi-Key Corporation. The kit included software that provided a smooth interface between the camera and any Windows computer with a USB port. The specific hardware and software used were:

- Manufacturer: Aptina Imaging Corporation
- Camera board model: MT9V126
- Software name: DevWare
- Software Version: 4.1.9.27784

Nanocopper pastes were formulated using methods developed during tensile experiments and included additional steps to improve viscosity, minimize void generation during fusion and facilitate bonding to oxidized tin finishes. These formulations were screened for utility by fusing individual surface mount components to a small deposit of nanocopper on a pure tin surface. Some formulations proved so effective that the components broke within their ceramic bodies when subjected to stress (Figure 5E). Formulations have been developed for both manual assembly and automated assembly with stencil and pick-and-place equipment. Syringe application can dispense through needles up to G30 (150 µm inner diameter).

Various application procedures have been developed in the lab and piloted on a dedicated R&D production line for both SMT and PTH parts. In a typical fabrication procedure, nanocopper was applied in an automated fashion to the boards using a 4–6 mil stencil. Next, SMT parts were automatically placed using a production pick-and-place machine. Care was taken to minimize short circuits and to ensure wetting of the nanocopper to the pads. The sensor chip was the most complex component, and a number of paste application methods and paste formulations were developed for this step alone. Once all of the SMT components were in place (Figure 6A), PTH parts were added manually using a syringe to apply the nanocopper. A completely assembled board was then ramped through a heating cycle with a maximum temperature of approximately 200°C under constant flow of an inert gas. Drying procedures were developed to minimize cracking of the nanocopper and ensure integrity of the joints. After fusion, assembled components were protected with a standard urethane conformal coating cured at a maximum temperature of 100°C.

Each camera board was subjected to a suite of electrical tests at the component level, such as a production flying probe, and culminated in a final board-level evaluation by interfacing the board with the corresponding software. Fully functioning boards were able to display real-time images as shown in Figure 6B.

Beyond solder replacement, we have explored a number of other applications using nanocopper. Shown in Figure 7 are two flexible electronic devices about 10" long with embedded LEDs. The traces were formed by stencil printing nanocopper and the cured traces sealed-in using a standard \$89 laminator. The entire device functions under repeated flexing. Because the required fusion temperature is only 200°C, it is possible to interface with common

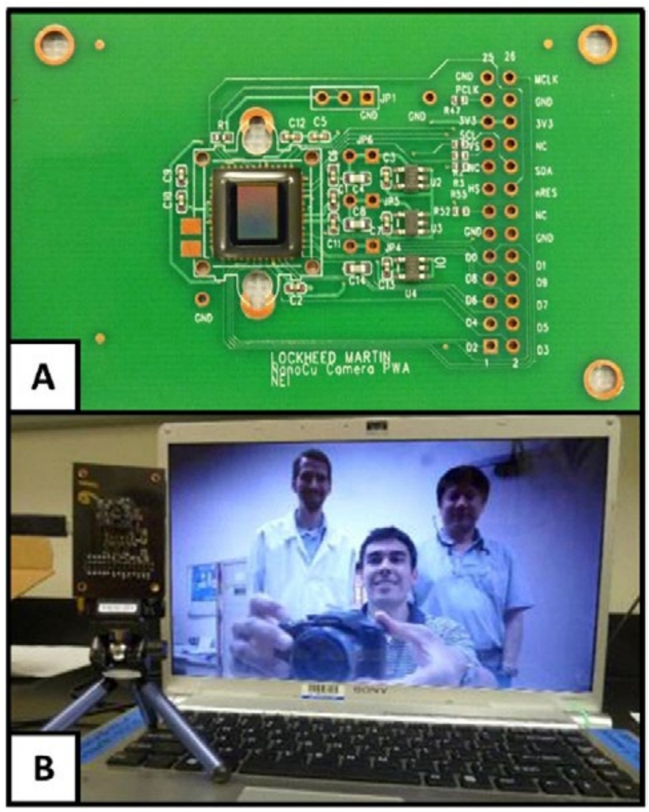


Figure 6: A) Photograph of a camera board populated with all surface mount components. B) Demonstration of fully functional camera board using only nanocopper.

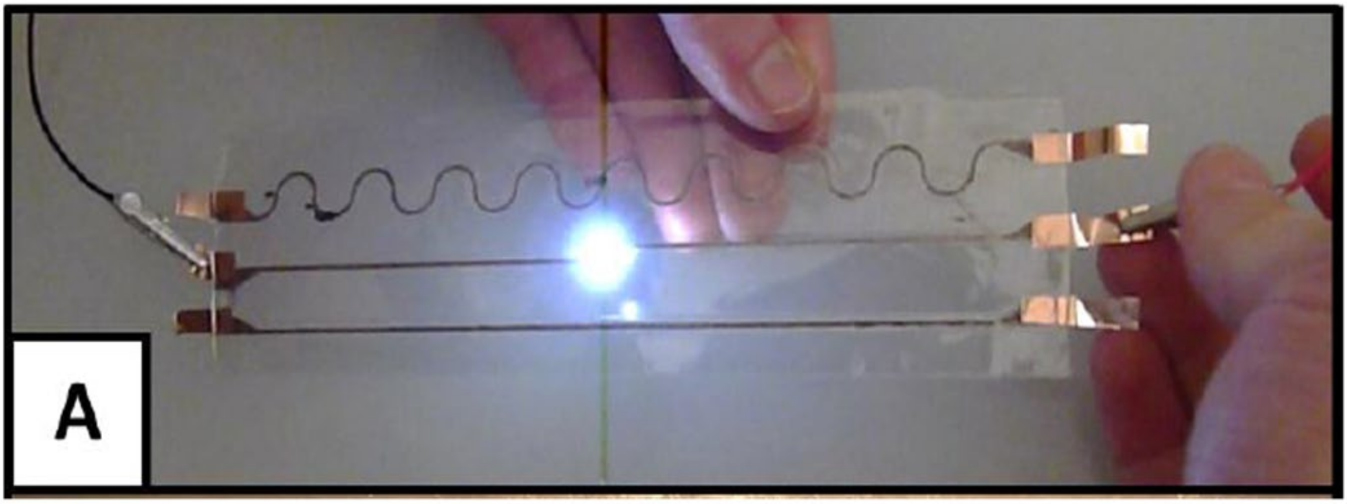


Figure 7: Photograph of flexible LED circuits with stencil printed nanocopper traces.

plastic substrates used for flexible electronics such as polyethylene terephthalate and polyimide.

## Conclusions

We have developed an all-copper electronic assembly material that can be processed at 200°C. Through improvements in nanocopper synthesis, paste formulation, and processing techniques, a fully functional camera board was successfully assembled using only nanocopper paste. Coupled with the proven scalability of our unique nanocopper synthesis process, this demonstration illustrates the utility and potential of nanocopper as a replacement for SnPb and Pb-free solders. The electrical conductivity of nanocopper is already 2–3 times higher than standard solder currently in use. Also, the tensile strength is approaching that of the best solders available. Nanocopper is still in the early development stages, yet improvements in strength, thermal conductivity, and electrical conductivity have been rapid. There is plenty of room for further improvement as the full materials properties potential of nanocopper have yet to be realized. We are aggressively pursuing further improvements in all areas of performance. The fact that this material already performs similar to or better than existing materials shows the exciting potential of nanocopper to be a robust alternative to the current library of lead-free solders. **SMT**

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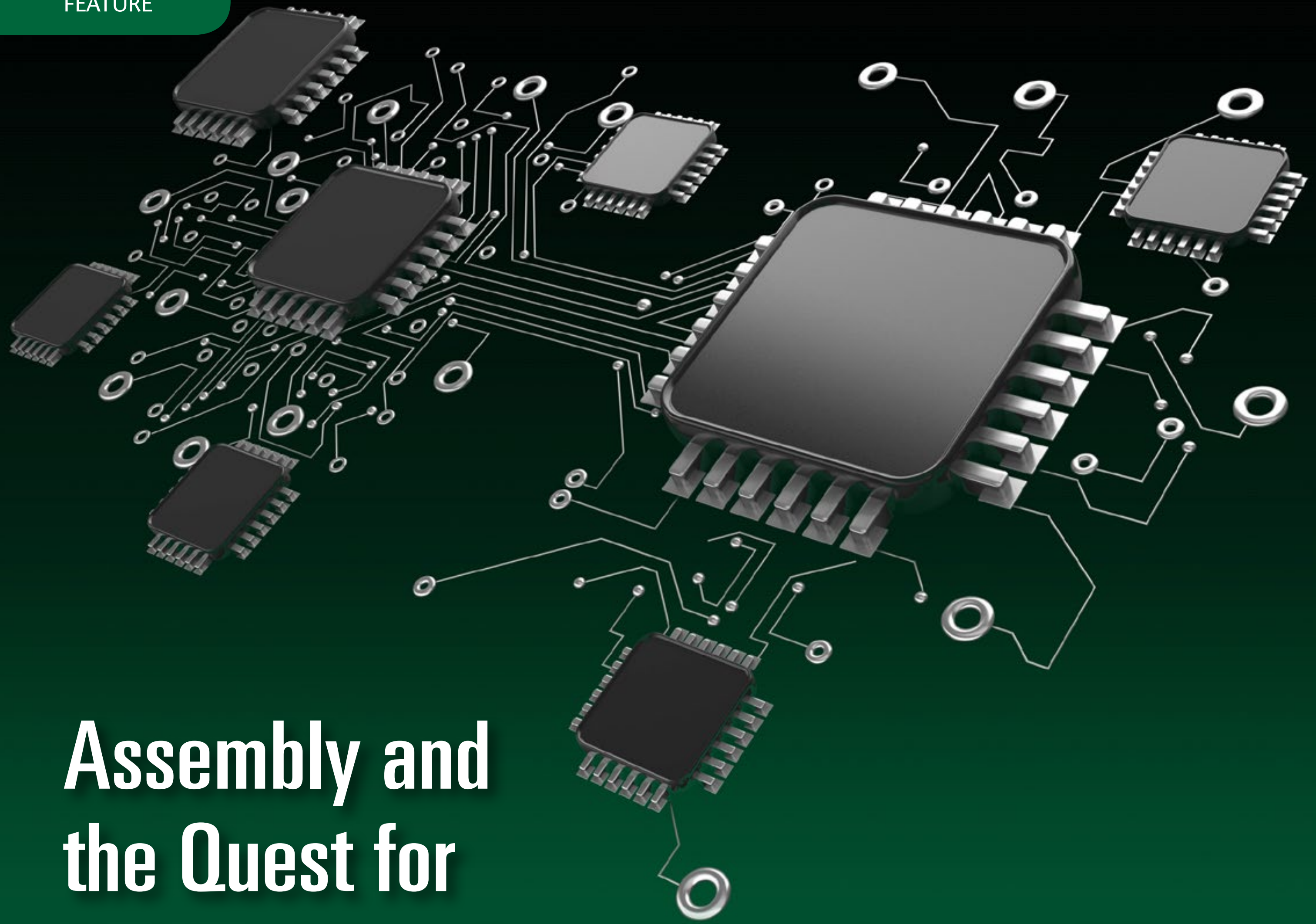

# Assembly and the Quest for Solder Alloy-Free Electronics (SAFE)

**by Joe Fjelstad**
VERDANT ELECTRONICS

As first brush, the title's suggestion that solder can be eliminated from the electronics assembly process may appear absurd. Everyone related in any way to electronics manufacturing industry knows that solder is the universally accepted way of connecting components to printed circuits in electronic assemblies. Thus, the fact that many seasoned and knowledgeable people in the electronics industry might scoff at the notion that solder can be eliminated comes both without surprise and a certain amount of resignation.

However, in reality, solderless interconnections are all around us. Many interconnections in electronic products, both permanent an intermittent, are made without the use of solder. Some noteworthy examples include press-fit interconnection of backplane connectors, separable interference interconnection between daughter cards and mother boards, wire wrap techniques to connect between component or connector pins, wire bonding used to interconnect chips to packages, resistance welding, and conductive adhesives. However, perhaps the most ubiquitous and yet least acknowledged form of solderless interconnections, are the trillions of electrolessly and electrolytically copper plated electrical and electronics interconnections made every year in printed circuits to make interconnections on multilayer circuits and more recently, for the circuits and interconnection of semiconductor chips.

The fundamental idea behind solderless assembly based on plating is simple enough. It is perhaps best illustrated by contrasting it with the

traditional approach to electronics assembly. In everyday assembly, electronic components are placed on and interconnected to circuit boards using a soldering process such as wave solder for most through-hole components or a reflow oven to melt solder paste, which affixes surface mount components. However, when solder is eliminated and copper is substituted, electronic assemblies are created by building up circuits on what can be best described as a component board. It eliminates a great number of steps from manufacturing, each step offering its own potential to yield a defect. The simple graphic that compares processing steps between the two approaches, which accompanies this article, bears quiet witness to the potential.

Such an approach is not without concern. One of the concerns that is commonly registered by those first hearing of this radical approach to manufacturing electronic assemblies is, "How do you rework and/or repair the assemblies?" This is a question that is perhaps best addressed by asking a counterpoint question: "Why must you rework or repair your assembly?" The answer to that latter question is, of course, because rework and repair are considered to be an inescapable part of the electronic manufacturing process. And, unfortunately, when using solder to make electronics assembly interconnections, that is a very true assumption. Anyone who knows anything about soldering, knows that, while it appears straight forward enough, it actually is a highly complex and multivariate process with many potential opportunities for failure. The list of things that can and do go wrong is a long one and one which has only become longer with the advent of lead-free. These were identified and enumerated in an earlier article which highlighted the many different types of faults and failures that are associated with the soldering process both at component and board level. Suffice it to say that solder is the number one cause of both defects and failure in electronic assemblies and unfortunately, the higher temperatures required for the most popular lead-free solders comprised of tin, silver and copper (the so-called SAC alloys) can both damage and degrade electronic components. (Electronics reliability experts have long known and warned that there is an inverse relationship between higher temperatures and electronic device reliability.) Thus, a good component is committed to assembly and after assembly it is defective and thus requires removal and replacement. Might it have survived its expected lifetime without high-temperature assembly? Who can say? On the other hand, does it really make sense to use the assembly process as a stress test to weed out possible defective parts?

***"Anyone who knows anything about soldering, knows that, while it appears straight forward enough, it actually is a highly complex and multivariate process with many potential opportunities for failure. The list of things that can and do go wrong is a long one and one which has only become longer with the advent of lead-free."***

Moreover, there is always the potential of seeing devices fail due to the explosive outgassing of moisture entrapped in the encapsulation, a phenomenon called "popcorning." It is left to the reader to consider how much loss is acceptable in their process but the argument from this side is that "acceptable losses" are actually unacceptable. Wouldn't it be better to build assemblies in a more robust and less damaging way? The long time lament of many production managers is: "Why is there never enough time to do something right but always enough time to do it over?" The simpler processing proposed in SAFE manufacturing should offer plenty of time savings to meet both the production schedule and desire for high assembly yield if one takes the time to do it right the first time.

Another concern registered by those considering for the first time assembly of electronics is the fact that some odd form-factor compo-

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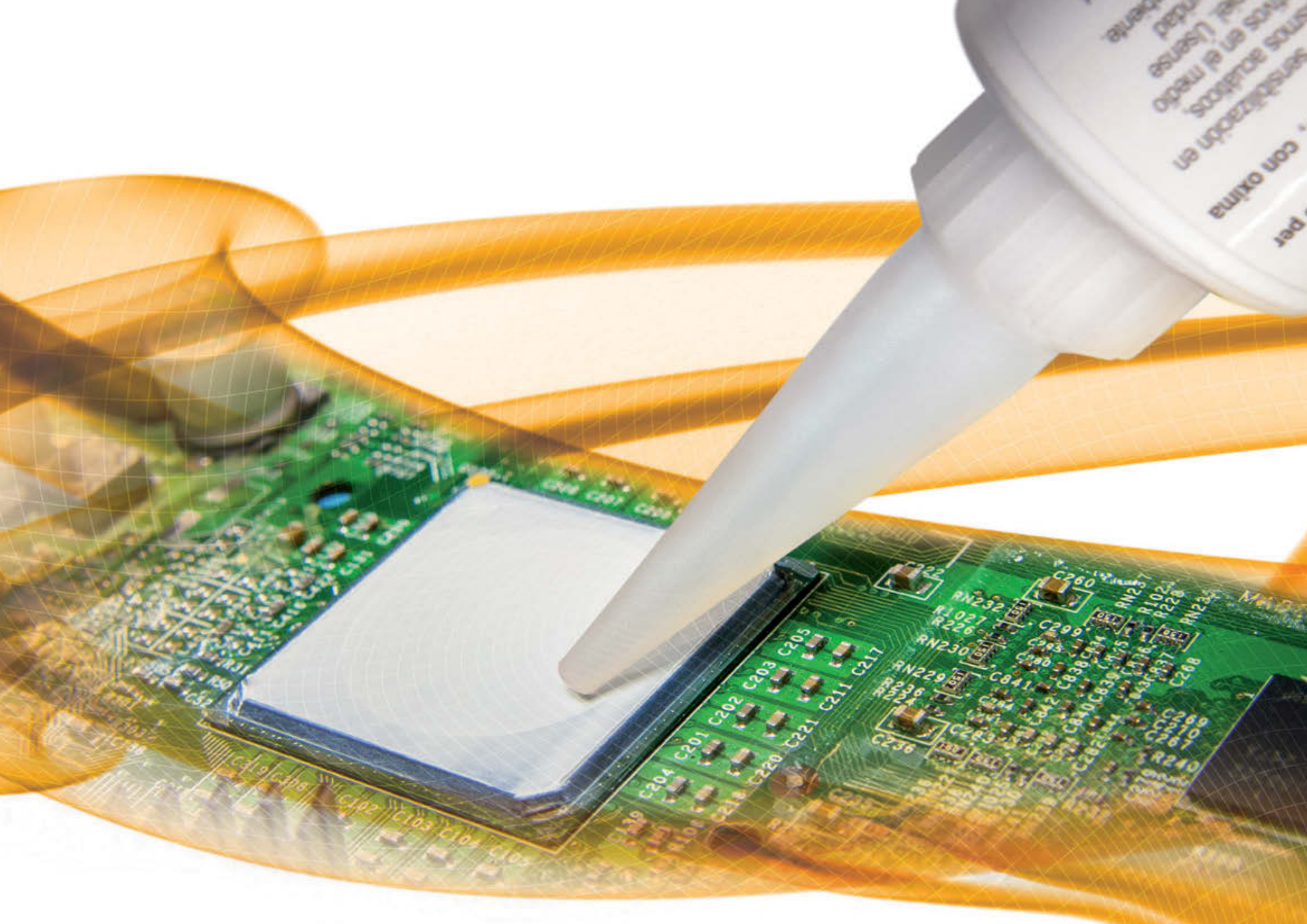
| Capital Equipment List for Traditional Manufacture *(Abbreviated List)* | Capital Equipment List for SAFE Assembly *(Abbreviated List)* |
|---|---|
| **PCB Fabrication** | Pick and Place Equipment |
| Shearing Equipment | Component Placement Inspection (Optical) |
| Drilling Equipment (Mechanical and Laser) | Shearing and Punching Equipment |
| Surface Preparation Equipment (Chemical and Mechanical) | Encapsulation Equipment |
| Metalization and Plating Equipment | Via Formation Technology (Laser or Photoimage) |
| Photoresist Application Equipment (Includes Solder Mask) | Surface Preparation Equipment (Chemical and Mechanical) |
| Photoimaging Equipment (Contact and Laser Direct Print) | Metalization and Plating Equipment |
| Image Development Equipment | Coating Equipment (for Photoimage Materials) |
| Lamination Equipment | Image Development Equipment |
| Routing Equipment | Routing/Depanelization Equipment |
| Cleaning Equipment | Cleaning Equipment |
| Testing Equipment (Electrical and X-ray) | Packaging Equipment |
| Packaging Equipment | |
| **PCB Assembly** | |
| Baking Ovens | |
| Solder Paste Application Equipment (Stencil Printer) | |
| Solder Paste Inspection Equipment (Optical or X-ray) | |
| Pick and Place Equipment | |
| Component Placement Inspection (Optical) | |
| Reflow System (Convection Ovens, Vapor Phase, Others) | |
| Specialty Cleaning Equipment | |
| Inspection and Test Equipment (Optical X-ray and Electrical) | |
| Solder Rework and Repair Equipment | |
| Depanelization Equipment | |
| Packaging Equipment | |

Figure 1.

nents appear to be ill-suited to assembly as prescribed in the graphic. A classic example is the large electrolytic capacitor. One response is to again ask a question: "Why do they have the form factor they do?" The answer appears to be, by and in large, that there were no particular restrictions when the early electronic devices were first being developed and thus they could be any shape that device designer chose. Could they be made to be more amenable to SAFE assembly? The answer is from the vantage point of this writer is unequivocally, YES.

Consider that new materials in the current nascent age of nanotechnology are coming on line at a prodigious rate. Super capacitors are poised to obviate some batteries and battery technology keeps on getting better on a regular basis. Moreover, with solderless assembly, the battery or capacitor can be made integral with the component carrier without worry because there is no high temperature soldering step to be concerned about. The stacking of chips and packages offers significant advantages.

It is easy to assume that if a component designer is unconstrained, they will (hopefully) come up with a highly effective design, but they may also just come up with a convenient design. If on the other hand, they are constrained and required to look at the problem/opportunity holistically, they are compelled (or should



be) to consider alternatives to the conventional approach. For example, who says that an electrolytic capacitor could not be flat or that a dry capacitor could not be developed that would provide the same or even better performance? As creative as our species is, we too often get channeled into thinking inside the box rather than outside it. Shakespeare warned his readers against such in Antony and Cleopatra, where he wrote: "Make not your thoughts your prison."

The key takeaway for the reader is that our assumptions need and deserve continuous evaluation in the light of the continuous change that surrounds us and our industry. With the surge of interest in recent years and months on embedding certain devices into PCBs to work in concert with soldered components on their surfaces, it would seem reasonable to anticipate that at some point, engineers will realize that they do not need solder. The cost savings could run to hundreds of billions of dollars annually and the reliability improvement potential should make for much better customer relations.

More discussion of this topic is planned for the future and questions, registration of concerns or desire for clarification on the topic are encouraged and invited.

Though the lists in Figure 1 are not exhaustive (many minor process steps are unaccounted for in both lists), they do provide a reasonable approximation of the difference in capital equipment requirements of traditional versus SAFE assembly. **SMT**

Verdant Electronics Founder and President Joseph (Joe) Fjelstad is a four-decade veteran of the electronics industry and an international authority and innovator in the field of electronic interconnection and packaging technologies. Fjelstad has more than 250 U.S. and international patents issued or pending and is the author of *Flexible Circuit Technology.*

## Video Interview

# Indium: New Associate Director, New Ideas

***by Real Time with... NEPCON South China***


Tony Teo, Indium's new associate director for sales and marketing responsible for the Asia-Pacific division, discusses Indium's future efforts in that region, as Indium celebrates its 38th anniversary.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# SMTonline Supplier/New Product News Highlights


**ZESTRON Americas Renews ITAR Registration**
ZESTRON is pleased to announce its renewal of the International Traffic in Arms Regulations (ITAR) registration with the U.S Department of State, Directorate of Defense Trade Controls.

**Yamaha Motor Acquires Hitachi High-tech SMD Business**
Yamaha Motor Co., Ltd. has concluded a contract to partially transfer assets related to the surface mounter business owned by Hitachi High-Technologies Corporation and Hitachi High-Tech Instruments Co., Ltd.

**Nordson Expands; Acquires Dima Group B.V.**
Nordson Corporation has acquired Dima Group B.V., a Netherlands based manufacturer of conformal coating, dispensing, and surface-mount technology equipment for the global electronics assembly market.

**HELLA Employs GOEPEL's X-ray Systems**
HELLA, one of the largest automotive suppliers for lighting technology and electronic products, uses X-ray systems of GOEPEL electronics for testing automotive electronics assemblies in production at three locations worldwide.

**ACE Unveils New KISS-101IL; Expands Features, Options**
The new KISS-101IL in-line selective soldering system is outfitted with expanded capabilities including standard features such as an automated two-point fiducial alignment and skew correction system, high-speed Z-axis, heated nitrogen system, a witness camera, and automated spray fluxing system.

**Panasonic: Koh Young Joins PanaCIM Tech Program**
Panasonic Factory Solutions Company of America has announced the certification of Koh Young Technology Inc. solutions and equipment through the PanaCIM Certified Technology Program. For 12 years, Koh Young has offered innovative solutions to electronics manufacturers around the world as a leader in 3D solder paste inspection (3D SPI) and 3D AOI equipment.

**Panasonic Introduces NPM-D3 to SMT Platform**
Panasonic Factory Solutions Company of America introduces the NPM-D3 to the award-winning, multi-functional NPM-series SMT platform.

**Nordson's Sales Up 14% to $459M in Q3**
"Our team continued to apply our model of innovative products, application expertise and global customer support across our diverse and growing end markets, resulting in organic growth in every segment and geography and all-time quarterly records in sales, operating profit and earnings per share," said Nordson President and CEO Michael F. Hilton.

**Crane Aerospace Invests in ACE Selective Soldering System**
The new KISS-102 selective soldering system has been installed at the Crane Aerospace & Electronics manufacturing facility located in Lynnwood, Washington, and is the second selective soldering machine Crane Aerospace has ordered from ACE-Production Technologies.

**Intertronics Adds New DYMAX Adhesives Selector Guide**
Intertronics has announced the availability of the new Industrial Adhesives Product Selector Guide from sales partner DYMAX. The guide features products for use with glass, plastic and metal, including a helpful table which clearly lays out product specification/chemistry and applications with possible substrates to enable easy comparison and quick selection of the optimal adhesive for any specific project.

**Nordson MARCH Intros FlexTRAK-S Plasma System**
The company extends its line of TRAK technology products with the FlexTRAK-S large-capacity plasma system for advanced semiconductor and electronic packaging. The 5.5-liter plasma chamber has a high-power RF generator and better vacuum conductance so it performs with the same consistent plasma treatment uniformity, efficiency, and short cycle times as the smaller version.

THE ESSENTIAL PIONEER'S SURVIVAL GUIDE

# Stop the SMT Conspiracy: Part 1

**by Michael Ford**
MENTOR GRAPHICS

I do feel bad about saying this, but when I take a tour of an SMT factory it sometimes feels to me like being in an episode of "The X-Files." I am not talking horror stories about glowing green men that emerge at night from X-ray machines, nor am I referring to slimy silver life forms that lurk at the bottom of wave solder machines. I would not even dream of mentioning deviant behaviour such as the use of AOI machines as photocopiers, production documentation systems to make wedding invitations, or even those people who use ICT fixtures as a strange form of acupuncture. Let's not go there.

I am actually talking about the weird, yet accepted, working practices that have sprung up across the shop floor, where people have conspired together to create or change operational practices for their own ends. These have then been in place for many years and seem to be unbreakable, even when these practices are actually limiting improvement and success of the business. The time has come, with pressure from the market, to break some of these bad


Figure 1: Weird, yet accepted practices have sprung up throughout SMT.

**STOP THE SMT CONSPIRACY: PART 1** *continues*

habits, to better use the fundamental resources and experience that exists in the manufacturing team, and to deliver the performance needed to take advantage of business opportunities.

A typical Mulder and Scully episode starts with something strange and mysterious. Similarly, here we are at the production site, dressed in white coats, puffy blue shoe covers, and peaked caps, looking as though we are about to perform an alien autopsy. An eerie green glow greets us as we open the door to production, which is what you might expect from light towers on top of the SMT machines; but, why are they shining green while the SMT machines are actually not producing? It's time we dig deeper and ask witnesses for their accounts.

> ***"A typical Mulder and Scully episode starts with something strange and mysterious. Similarly, here we are at the production site, dressed in white coats, puffy blue shoe covers, and peaked caps, looking as though we are about to perform an alien autopsy."***

Pointing out a line of machines, we are told that these are the very latest technology, the fastest, most accurate, and reliable models available, a significant investment intended to enable the company to satisfy the most demanding of customer needs. So, I ask the obvious question about why the machines are not running. The answer is simply that the machines are fully set up and ready to run, but the next assembly process is running slower than expected, such that too much stock has built up in between. So the line has to wait.

This surely was not a condition that was planned for. And it has been happening more frequently as customers try to streamline their stock-holding in between the factory and the final customers. It transpired that the current work order scheduled for this particular line, following the factory plan issued some weeks ago, had changed. A 20% reduction of the delivery rate was requested, over a four-week period.

The ability to provide this flexibility of output had been agreed upon by the factory and the customer as part of the deal negotiation. There was pride, as production managers had shown the customer their Lean assembly cell network, which could be tuned at short notice to provide the delivery rate that the customer needed. This had been a critical factor in the factory's ability to win orders from this customer. As the delivery rate changes, certain cells are assigned to different tasks, ensuring maximum flexibility and productivity. It is the Lean manufacturing model.

While showing the production area to the customer, at the last minute, the customer also requested a visit to the SMT area. Urgently, it was decided to adapt the light towers on the SMT machines to show green in all cases where the machines were ready, and not necessarily only when they were adding value actually making products. The customer's impression at a glance would be that the whole operation was Lean.

The reality, however, was quite different. The change in the green light qualification also had to be reflected in the charts and dashboards of productivity. The customer would see these too. When there was a good reason that the machines were not expected to work, the time was not included in the down-time reports. The resultant productivity levels looked very reasonable, nothing to cause concern from the customer.

Inevitably, however, as the recorded downtime was reduced, according to data in the reports, the uptime, that is the runtime of the machines, was correspondingly increased. Here was the conspiracy, one in which, to satisfy the appearance of the factory to a customer, the reporting system had been compromised. The concerned production members thought that this was an internal issue within the control of production, without any effect on productivity improvement programs because these projects record relative improvement, whatever the baseline may be. No matter how accurate or inaccurate the base data were, the real performance trend was not going to be affected. The goal as set out by business management with this customer had been achieved, with little sense of collateral damage.

The conspiracy seemed to have started from a higher management level. This needed to be proven. It is time to talk with the financial controllers to see how they were involved.

Our first impression is one of complacency. We mention how we were so impressed by the lengths that the factory had gone to satisfy the customer, especially where new market pressures demanded quick responses and delivery adjustments. The financial team shares with us that this is one "face" of Lean. In other areas, deliveries had failed to be met. Requests for increase in demand had failed, causing disappointment for the customer. These events had triggered newer and faster machines to be phased in, bringing with them a serious level of investment to be supported. Questions are now being asked at a corporate level, however, about why the return on the investment is so poor. Other factories in the group had achieved better cost and throughput performance without the need for increased investment. The financial team was at a loss to understand why this factory, with all the investment and Lean approach, is actually failing as a business insofar as these comparisons made with other sites.

It is apparent that the financial guys did not have all the information. The artificially increased machine runtime means that the calculation of machine performance, as measured in terms of placements per hour, is far lower than would be expected. The purchasing team confirmed this; they had actually approached the machine vendor to ask why the number of placements per hour was far less than expected, according to data collected, versus the machine specification.

The machine vendor, without visiting the site over a long period, had performed an analysis of the product data, the machine programs, and the optimisation of the line in terms of balance. Everything seemed to have been okay. The answer back from the machine vendor to the factory was that there must be some other cause of downtime affecting the results. Tension resulted between the machine vendor and the factory, as intense scrutiny of the reported downtime followed. Machine operators, production engineers, and even the supply-chain logistics operators were put under pressure. Because a real culprit could not be found in the data, confusion ensued as everyone started to blame everyone else. The conspiracy held because there was nothing recorded in the downtime analysis data that would indicate that the machines had been left intentionally idle.

> ***"Because a real culprit could not be found in the data, confusion ensued as everyone started to blame everyone else. The conspiracy held because there was nothing recorded in the downtime analysis data that would indicate that the machines had been left intentionally idle."***

The repercussions, however, went further. Based on the gross asset utilisation data, which again was simply measured throughout the corporation as the number of placements versus asset capability, the Lean factory, once held up as the company reference site, was now bottom of the corporate league. Distrust in management at the highest levels generated another round of intense analysis with little positive result and major internal collateral damage. The decision would be taken soon, that Lean is bad, it may satisfy the customer and bring business opportunity, but the cost of doing that business is unrealistic and cannot be sustained.

Here is the death of the Lean initiative, the origin of resistance that will not be quickly forgotten. The root cause was a simple decision, a conspiracy between people who had not considered the consequences outside of their own area. The right approach to solving the customer challenge, to bring Lean into SMT, was there, but had seemed impossible, or at least too much of a change to satisfy what seemed to be a simple problem.

Creating a Lean environment within a complex process area such as SMT may seem daunting. The efficiency, quality, and engineering resources are traditionally considered directly proportional to the amount of changes required in the production operation. It is said that there

**STOP THE SMT CONSPIRACY: PART 1** *continues*

is a finite limit on the capacity for change dictated by the way in which the SMT area operates, in terms of planning, process preparation, and material management. This does seem like a sign of another conspiracy, one in which change is resisted; the momentum of the past is being maintained.

A successful TV show always comes with a happy ending, however. It is always nice to play the hero. In our story, along comes the person who turns a progressive downward spiralling situation into a compelling need for a change, introducing a real Lean operation into SMT, not just a change in the wiring.

Fundamentally, the challenge is to keep the machines running all the time. Rather than setting many lines with the same throughput capabilities, create lines with different speeds, such that for any product, a line can be chosen to meet the requirement for that period. As customer demand increases or decreases, be prepared to move the product to other configurations.

The first resistance to overcome in doing this lies with planning. The assignment of work to different line configurations and the optimisation of the flow are easy; there are many generic scheduling tools available to do it, even including Excel. What is more difficult, however, is to understand how to group products according to feeder layouts to reduce change-over time, which can be the most significant cause of productivity loss. A lot more data about the bill of materials is required for this optimisation. This comes from the product model as managed by the engineering team who prepare the programs and necessary data for the processes that will make the product.

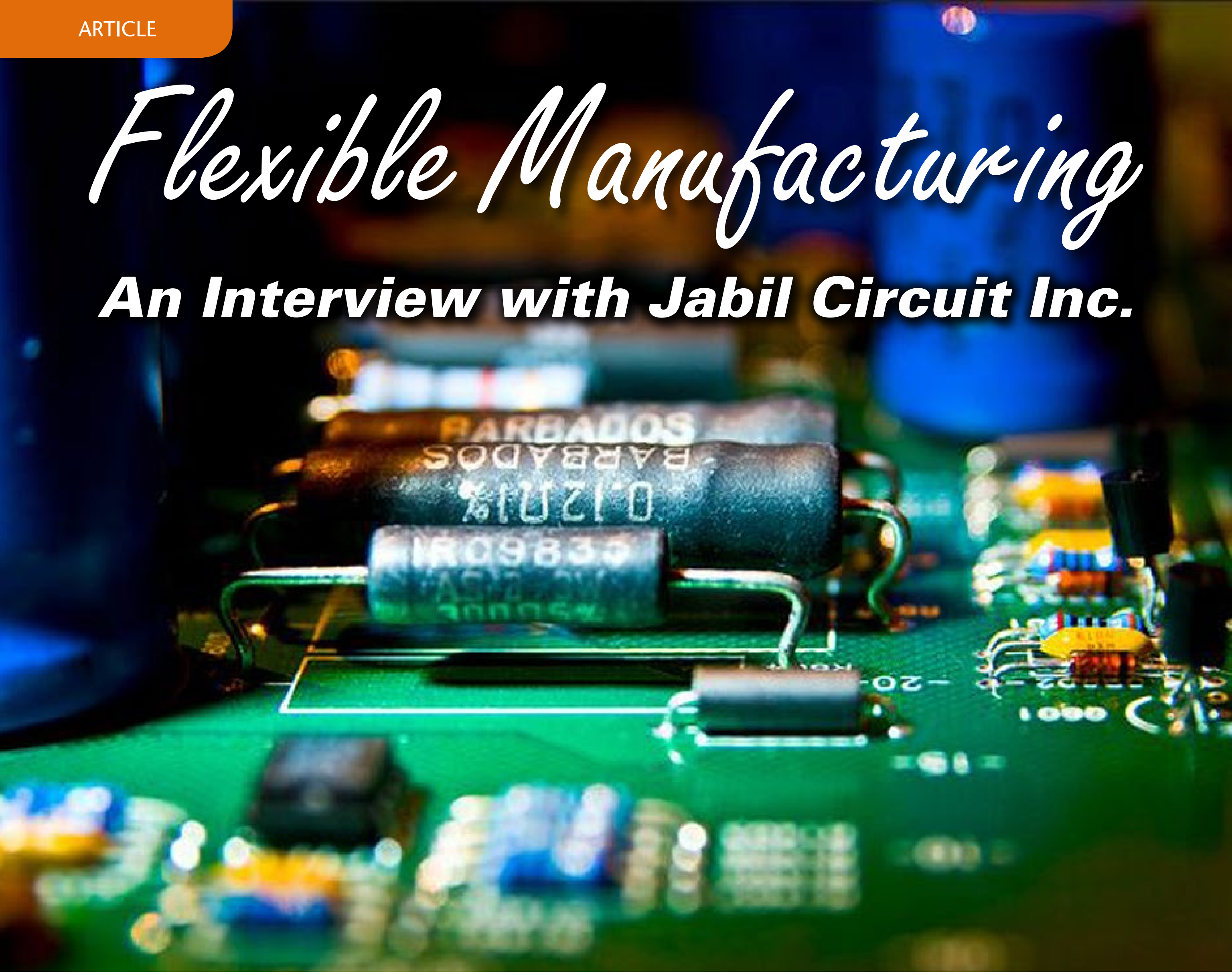
Traditionally, there is quite a gap between these two groups of people. A decision is often made by the engineering team about how best to optimise the commonality of materials before the actual work-orders, delivery times, and throughput rates are considered. This leaves the planning team with no real choices of which line configuration to use and hence, no control over the throughput. This gap needs to be eliminated so that the wider team can consider both the optimisation of work-order throughput to meet the customer demand, and at exactly the same time, the choice of the commonality of feeders based on the set of products to be made on any line. In this way, plans can be made and revised as necessary to respond to the actual need of the customer. This is a Lean practice.

The requirements for doing so are firstly to have an optimisation engine for SMT that can consider both aspects of optimisation simultaneously, not something that ERP, traditional MES, or a spreadsheet can do. There must also be close communication, through data, of the products as they are set up on each line configuration. The requirement is to have a process preparation system that can manage product and process data centrally and accurately, with automated processes to assign the data in the native formats needed by each of the machines in each of the lines. The automation of this leads to the products being portable, to be able to move from line to line without the need for down-time, as the programs and setup are generated, confirmed with the operation being simulated in software. The planning operation then sees multiple choices in where and when products can be made, such that the optimisation engine can successfully find the best plan, for work-order sequence and for common material setup. This Lean planning can meet the most immediate of demand changes, without the compromise of operational performance.

It is essential that legacy conspiracies, which exist, I am sure, in every factory today, are flushed out. It is not a matter of exposing a guilty party because there is no villain in this story. It is simply a set of circumstances that is common throughout the industry, which may have been reasonable in the past, but which now are crippling many operations. This is the compelling need for change, the compelling need to really create the Lean SMT manufacturing environment. It's time to stop the SMT conspiracies! **SMT**

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

ARTICLE



# Flexible Manufacturing

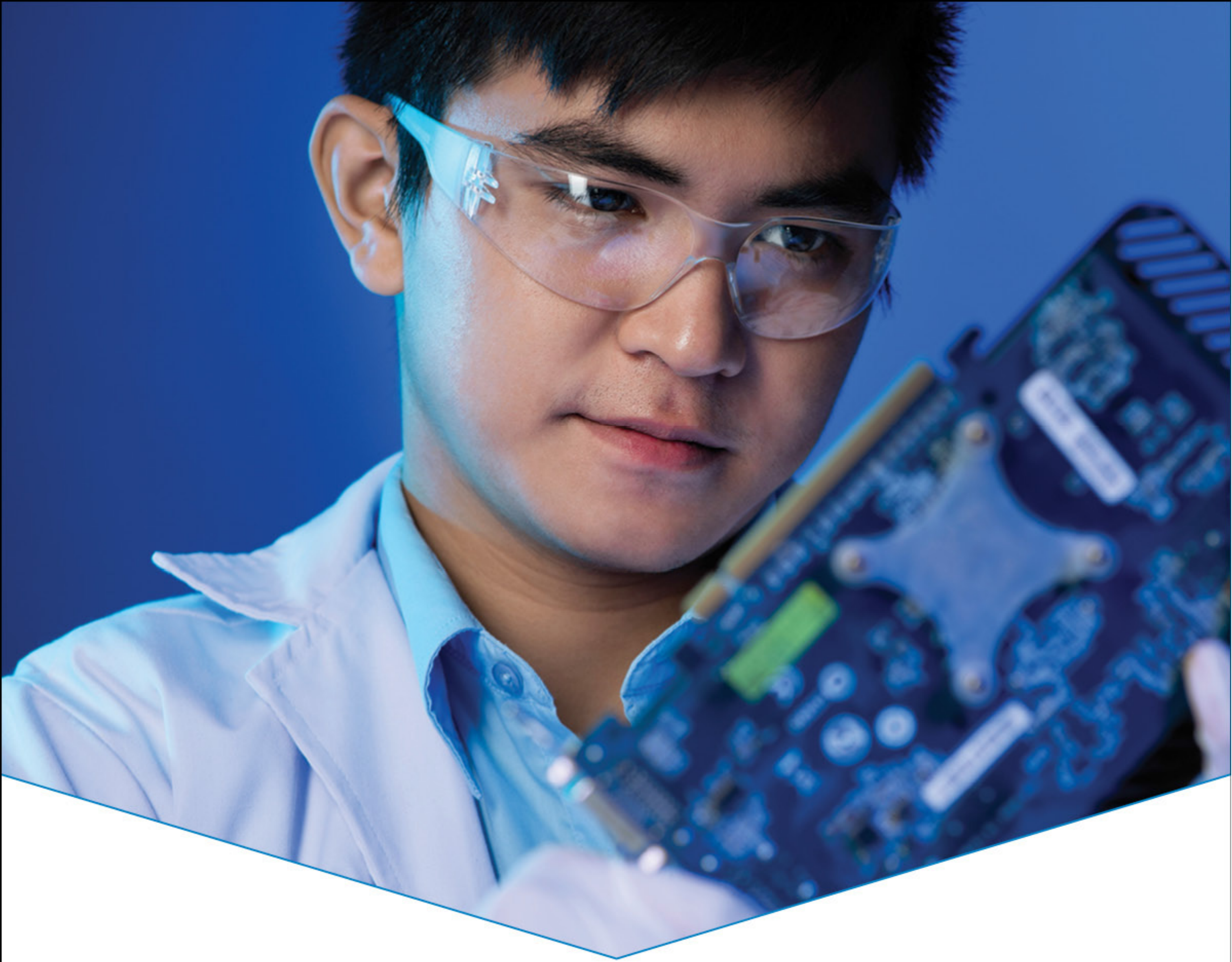
## An Interview with Jabil Circuit Inc.

**by Richard Ayes**
I-CONNECT007

John Dulchinos, Jabil Circuit's vice president of global automation, talks to I-Connect007 editor Richard Ayes about the electronics manufacturing landscape, the latest trends and developments, the EMS industry's need for manufacturing automation, and how the U.S. may become successful in its reshoring activities.

***Richard Ayes: What can you say about the current state of the electronics manufacturing industry, and what are the opportunities for growth?***

***John Dulchinos:*** Let me start by saying it is a great time to be in electronics. I think this is a period of unprecedented opportunity, largely driven by the fact that everything's getting smaller and smarter, and that it is so easy today to put electronics into devices that used to be passive. With miniaturization, battery technology getting better, with the low power electronics, wireless communications—all of these things are driving the opportunity to really go down into a new generation of devices. I am sure you've heard of the Internet of Things (IoT) as a catchphrase, but there is really truth in the fact that everything's going to be connected in the future. Given that, devices that used to be passive are going to be devices now that have some sort of active components in them.



So I think it is a tremendous opportunity for anybody who is in the electronics manufacturing industry to see continued, bright opportunities going forward.

***RA: From a manufacturing standpoint, what are the challenges being faced by companies?***

***JD:*** The challenges are not different per se; they just continue to be refined and they continue to extend the trend that's been going on for a number of years. One of the biggest challenges is the short product lifecycles—the rapid ramps. What we see today in certain segment of the electronics industry is the very short product lives. One-year, two-year product lives. What's a little bit different is the model now where the maximum volume happens during product launch, and then there's kind of a long-term decay from there.

It used to be the traditional product ramp where you have an exponential curve that starts low and builds up. Today, the way certain sectors of our business operate, the highest volume is day one, when you launch the product, and then over the next one to two years, it is a kind of steady decay for that product because it's matured.

So it's kind of almost a reverse curve. That puts tremendous stress on the infrastructure of the organization and the process development, the quality levels, and the yields.

***RA: Definitely there is always room for improvement when it comes to electronics manufacturing and assembly. From your perspective, how could the assembly process be improved?***

***JD:*** In terms of the circuit board assembly itself, I think we've done a great job as an industry over the past couple of decades to really build out a standardized set of tools, peripherals, meters and design rules, and toolsets that allow us to bring a new circuit board up in a very short amount of time, with a very high level of quality, and high degree of predictability. I think that's fantastic. That has not spilled over into the rest of the product design yet. One of the things we see over and over again is a gap between the product designers and the manufacturing/engineering people. Tolerance stack-ups are typically not buildable in the first versions of design we get. So you just kind of go through the math and say the yield is going to be this low because the tolerance just doesn't support it.

So, I think that's one of the areas where we can certainly integrate more the designers with the manufacturing/engineering people.

The second thing is that we are going through a period of high flux, or just high rate of change. For example, think about the way devices are being slotted together; it used to be a handful of pretty traditional ways—screw it together, snap-fit it together, glue it together. But today, especially as things become smaller, there's this theory of rapid rate of change going on, it's really glues—adhesives—that are becoming more preferred method to put things together.

These adhesives have certain strength characteristics, certain water-resistance characteristics, sometimes certain electrical conductivity characteristics, ability to disassemble/reassemble, and so every day we are seeing products with new adhesives with different characteristics that really go through a period of process development to get the formulation right, to produce in volume and in the quality and yield.

***RA: One of the things that help manufacturers cope with the high rate of change, as you mentioned, is automating the processes in their manufacturing lines. From your perspective, which processes in the electronics manufacturing can most easily be automated?***

***JD:*** Contract manufacturing is more challenging than a typical OEM in the sense that there is a broad diversity of products, a broad diversity of customers, and a real lack of certainty for the business. For instance, if I am an OEM making printers, I've got a pretty good understanding of my long-term roadmap, and I can make decisions based on that.

For contract manufacturers like Jabil, while we have great customer relationships that span decades, there is that level of uncertainty that at any point in time, the business can go away. The wide range of products that we produce creates a lot more diversity than a typical OEM will have to deal with.

So those baseline assumptions do make this a challenge for contract manufacturers to put automation in. It makes more difficult than it would for typical OEMs.

That's kind of a foundation. So, starting with that, you kind of like look at where the easiest, best opportunities for automation. And typically, what really make an automated system expensive and complex are product-specific tooling, feeders, and characteristics that really revolve around the geometry of the product.

If you work with that assumption, it typically means that that kind of generalized assembly is going to be further down the line in terms of what would make sense to automate. You have to back away and think where the easier opportunities are—things like machine loading and unloading are good applications for robots today. We've got a lot of robots installed at Jabil loading and unloading molding machines, and loading CNC tools. From an ROI standpoint, they typically ROI well because we take the expensive capital equipment like a molding machine, and then put in a robot, making it more productive, and bringing more consistency to the process, which improves the yield.

Another area where we can get a lot of value is in complex processes: polishing, painting, coating, grinding. These processes, where you do high-dexterity motions—and you need to do them consistently and fast—typically a robot can do a much better job of than a person can. What you end up with is not just labor savings, but the quality and the yield improvements that automation drives. Those are the great applications.

Then you work to the specific fastening tasks. Screw driving, for example, is a great application that a robot can do with a high degree of consistency. We can monitor the torque characteristics, therefore we can ensure that there's a bottoming out of the screw at the right torque level. The feedback of screw drivers tends to fatigue your arms, so it's hard to do that consistently manually over extended periods of time.

That's a very good application for robots. And then finally, things like point-to-point solder, high-precision test—again, they are difficult to do manually, and they require high levels of quality because of the precision and the process requirements. Mechanizing that with some levels of automation typically brings some improvements in terms of quality.

***RA: What about the risks and challenges when a decision has been finalized to automate certain assembly processes?***

***JD:*** One of the big challenges in terms of automation is automating processes that aren't mature. Anyone who's had an experience in automation knows that the best thing to do is to find a process, get it mature, and then apply automation to it. But what we're seeing today is that they're trying to automate processes that are relatively immature.

***RA: From a production standpoint, how does automation benefit the company?***

***JD:*** Clearly, when we put a piece of automation, we expect the quality and consistency and yield to improve. We have tremendous operators at Jabil that are doing the process manually. It brings a level of variability that, to some degree, is not completely controllable. But with such automation like robots, you can be sure that every robot is going to perform a task with the same level of precision and quality.

The second aspect, certainly in applications where you have a degree of precision required, the productivity out of a robot cell is higher than it is out of a manual station. The output we get per square foot factory space is higher. Certainly there's benefit from a labor standpoint, in terms of cost in labor.

Now, it's not easy to hire anymore. The younger generation doesn't want to work in factories; they want to go into white-collar jobs. The availability of labor, based on demographic trends, is going to force more and more into automation.

Those are the kind of near-term things that we are looking at. The longer term value proposition of automation and beyond those specific benefits is that because every automated station is a computer station. With sensing technology and capabilities we can build in an automated station, we will have a level of process control and monitoring that are difficult to get with manual stations. The real opportunity over the long term is leveraging the data side of automation to really improve the productivity and processes in our manufacturing.

***RA: Do you think automation in the manufacturing industry can bring back electronics manufacturing to the United States?***

***JD:*** I think there's no way for manufacturing to come back to the United States without automation. If you look at the cost of labor in the U.S. versus the cost of labor in China or Vietnam, it gets pretty obvious. Our largest factory in China has 60,000 people. Foxconn has got five or six times more. There's nowhere in the United States you can put up a factory like that.

Beyond the labor savings aspect of it, if we can do manufacturing processes that don't require that scale of labor, then we will be able to reshore. For me, I think the only way that we can have significant reshoring activity is by developing manufacturing processes that include a high degree of automation so that we can put factories in places in the United States where you can actually hire enough labor to support those tasks.

For the challenges, over the past three decades, there's really a lack of emphasis by all of the education institutions and organizations to really turn out high-caliber manufacturing employees in the United States. We used to have a tremendous tool and die capability; but over the last few decades, most of that capability is

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gone, and the remaining people are entering retirement age. So we really have to build that up to be able to produce a high level of quality in the US. Things like designing for assembly, designing for automated assembly—those kinds of courses used to be prevalent in institutions in the 1980s. As things went offshore, those kinds of courses have been eliminated. We have to rebuild our manufacturing infrastructure in addition to automation, to really start to bring a large segment of manufacturing base back to the United States.

***RA: Best practices that you can think of?***

***JD:*** Let me give you an example from an interesting perspective: leveraging new technology. We have a customer project that we're doing for a new wearable device that will be coming to the market this holiday season. The customer came to us in June, and said they really wanted it to be an automated process, they want us to design some automated stations for them, and they need the first one delivered in August, and the balance of the line delivered in September for them to meet their ramp.

Which is an aggressive target for automation: delivering solutions in eight weeks—it is a tall order. To add to the complexity, they said "Oh, by the way, we really won't have parts for you until before the day you are going to ship the first line," which makes it very difficult.

So what we did is take the latest CAD models and use 3D printers to print those parts. We can build the automation around it, and get very close to the final solution. We're doing that concurrently as the product was being finalized and stabilized. Therefore, when we get the final parts, we'll get very close to a solution that works as opposed to waiting to start the design until we got those parts.

I think that is an example of how new technologies like 3D printing are enabling us to do concurrent engineering to make solutions—which would not be possible three or four years ago without that kind of technology.

***RA: Do you think robotics will replace human workers in an assembly line?***

***JD:*** We don't look at it that way. To us, we look at process stations, and we evaluate the best way from a cost, quality, and flexibility standpoint to put that together. I don't personally see a future where we have a lights out automated factory; I look at a future where we have a high degree of interchangeability between people and robotics stations.

As far as I can see, I think that's the model. As we look at our business conditions, and the flexibility that we need to have for our customers and our shareholders, it's important for Jabil to have a flexible manufacturing model. Given that, we need a lot of interchangeability between manual stations and automated stations; what will make sense to automate in one production line, and what will make sense to have in another one, and vice versa. I don't see robots replacing people. I see some stations being automated, some stations being manual.

***RA: What are your thoughts on Industry 4.0?***

***JD:*** I think in concept, we all want the interconnected factory. The idea is that everything will be working on the same information backbone. At a conceptual level, I think it makes perfect sense. But whether Industry 4.0 is going to be the answer, I guess I can't say for sure yet. Conceptually, we all love that. Depending on the players who do it and getting the support will really be the key to how successful it will be.

***RA: What is your long term outlook for your industry?***

***JD:*** What we see certainly is miniaturization, but more integration. I think we are going to see more and more integration of electronics into devices, and processes that allow us to integrate those devices together without the classical printed circuit board.

I think the circuit board will start to merge closer and closer with the typical product itself to eliminate the cost and shrink packaging and so forth. Another trend we are seeing is more flexible devices; flex circuits, combination of flex circuits and rigid circuits. **SMT**

SMTA Surface Mount Technology Association

www.smta.org

# 2014-2015 Event Schedule

**October 14, 2014**
**Austin (CTEA) Expo and Tech Forum**
Norris Conference Center, Austin, TX

**October 15, 2014**
**Long Island Expo and Tech Forum**
Islandia Marriott, Long Island, NY

**October 16 & 23, 2014**
**Webtorial: Improving Mechanical, Electrical, and Thermal Reliability of Electronic Assemblies**
Instructor: Tim Jensen, Indium Corporation

**October 21, 2014**
**Connecticut Expo and Tech Forum**
Waterbury Marriott, Waterbury, CT

**October 23, 2014**
**Intermountain Expo and Tech Forum**
University of Utah, Salt Lake City, UT

**November 4 & 11, 2014**
**Webtorial: SMT and Through Hole Defect Analysis and Process Troubleshooting**
Instructor: S. Manian Ramkumar, Ph.D., Rochester Institute of Technology

**November 6, 2014**
**LA/Orange County Expo and Tech Forum**
Grand Event Center, Long Beach, CA

**November 11 - 13, 2014**
**International Wafer-Level Packaging Conference (IWLPC)**
DoubleTree by Hilton Hotel, San Jose, CA

**November 18 - 20, 2014**
**High-Reliability Cleaning and Conformal Coating Conference**
Chicago Marriott Schaumburg, Schaumburg, IL

**November 18 &25, 2014**
**Stencil Printing - A Practical Guide to Defect Prevention and Yield Improvement**
Instructor: Chrys Shea, Shea Engineering Services

**December 2 & 9, 2014**
**Webtorial: LED, BGA, and QFN Assembly and Inspection**
Instructors: Bill Cardoso and Glen Thomas, Creative Electron

**December 3 & 10, 2014**
**Webinar: IPC-A-610 and IPC J-STD-001 Moving From Rev. E to Rev. F**
Instructors: Norman Mier and James Barnhart, BEST Inc.

**December 4, 2014**
**Space Coast and Tampa Bay Expo & Tech Forum**
Park Inn by Radisson, Kissimmee, FL

**January 28, 2015**
**Rocky Mountain Expo & Tech Forum**
Mile High Stadium, Denver, CO

**February 3 - 5, 2015**
**Pan Pacific Microelectronics Symposium**
Kauai, Hawaii

**March 24, 2015**
**Dallas Expo & Tech Forum**
Plano Center, Plano, TX

**March 26, 2015**
**Houston Expo & Tech Forum**
Stafford Centre, Stafford, TX

**April 14 - 16, 2015**
**SEA Technical Conference on Electronics Assembly**
Eastin Hotel, Penang, Malaysia

**April 15, 2015**
**Atlanta Expo & Tech Forum**
Gwinnett Center, Duluth, GA

**May 19 - 21, 2015**
**ICSR – Int'l Conference on Soldering & Reliability**
Hilton Markham Suites, Toronto, Ontario

**June 4, 2015**
**Huntsville Expo & Tech Forum**
Von Braun Center, Huntsville, AL

**July 16, 2015**
**Ohio Valley Expo & Tech Forum**
DoubleTree Hotel, Independence, OH

**September 27 - October 1, 2015**
**SMTA International Conference & Exhibition**
Donald Stephens Convention Center, Rosemont, IL

**October 13 - 15, 2015**
**International Wafer-Level Packaging Conference (IWLPC)**
DoubleTree by Hilton Hotel, San Jose, CA

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# Mil/Aero007 News Highlights

### API Gets $3.6M in Microelectronics Module Orders

API Technologies Corporation has received a new, $3.6 million order for microelectronics modules to be used in a major commercial airplane platform. The orders are scheduled for delivery throughout 2015.

### U.S. DoC Releases Conflict Mineral Smelter List

The U.S. Department of Commerce has published a list of known conflict mineral processing facilities, as required under Section 1502(d)(3)(C) of the Dodd-Frank Wall Street Reform and Consumer Protection Act. The U.S. government recently acknowledged that it cannot determine which refiners and smelters around the world are financially fueling violence in the war-torn Congo region.

### Kingfield's New Facility Receives AS9100 Approval

Kingfield Electronics has announced expansion and successful transfer to the completely refurbished new facility at Kingfield House, Carrwood Road, Chesterfield, UK. The company has verified continued full approval to AS 9100, the Aerospace Quality Management System standard.

### Kitron Proves Capability; Earns EN9100:2009 Certification

Kitron AS is proud to announce its certification according to the EN9100:2009 aerospace industry quality standard. Kitron AS, based in Arendal, Norway, and a subsidiary of Kitron ASA, is one of the first electronics manufacturing service companies in Norway to be certified according to this standard.

### TRICOR Systems Achieves AS9100 Certification

TRICOR Systems Inc., a leading provider of EMS to the aerospace and defense, medical device, and industrial markets, announced that it had received their AS9100 Certificate of Registration issued by Perry Johnson Registrars, Inc.

### HANZA Inks Contract with Saab Dynamics

HANZA has signed a multi-year production contract with Saab Dynamics containing both mechanical and electronics. HANZA Holding AB, Sweden's leading commercial partner in manufacturing solutions, develops cooperation with defense firm Saab Dynamics through a multi-year agreement with a non-official order value.

### Aimtron Marks Opens Palatine, Illinois Facility

As Palatine Mayor Jim Schwantz cut the ceremonial blue ribbon, the assembled crowd of more than 150 guests and dignitaries erupted into applause. This ceremony marked the Grand Opening of Aimtron Corporation's brand new facility in Palatine, Illinois.

### Probe Releases Shareholder Update; Q2 Revenue Up

Probe Manufacturing, Inc., a global electronics design and manufacturing services company, is providing shareholders with an update on its operations to date and financial results for the three and six month period ending June 30, 2014.

### Rocket EMS Boosts Cleaning Capabilities

The company has installed three new cleaning systems from Aqua Klean Systems. Rocket EMS installed a Typhoon T-8 Chemistry Zero-Discharge Cleaner, T15 Water Soluble Cleaner, and DI Recirculating System.

### APDN: Preventing Counterfeits in High-risk FSGs

The Rapid Innovation Fund (RIF) project will develop a single authentication platform, APDN's "SigNature DNA" and complementary technologies, to identify authentic products and deter counterfeits from infiltrating six Department of Defense Federal Supply Groups.

# Counterfeit Electronic Parts Avoidance: Profitability or Catastrophe

**by Todd Kramer**
SECURE COMPONENTS LLC

## Introduction

The number of transistors in a dense integrated circuit doubles about every 18 months. Consequently, the critical technology that the Department of Defense (DoD) uses becomes obsolete around every two years, while many of their weapons systems will remain in use for more than two decades. As a result, there is a critical need to source obsolete or rare parts which are no longer sold via the authorized channel or produced by the original contract manufacturer.

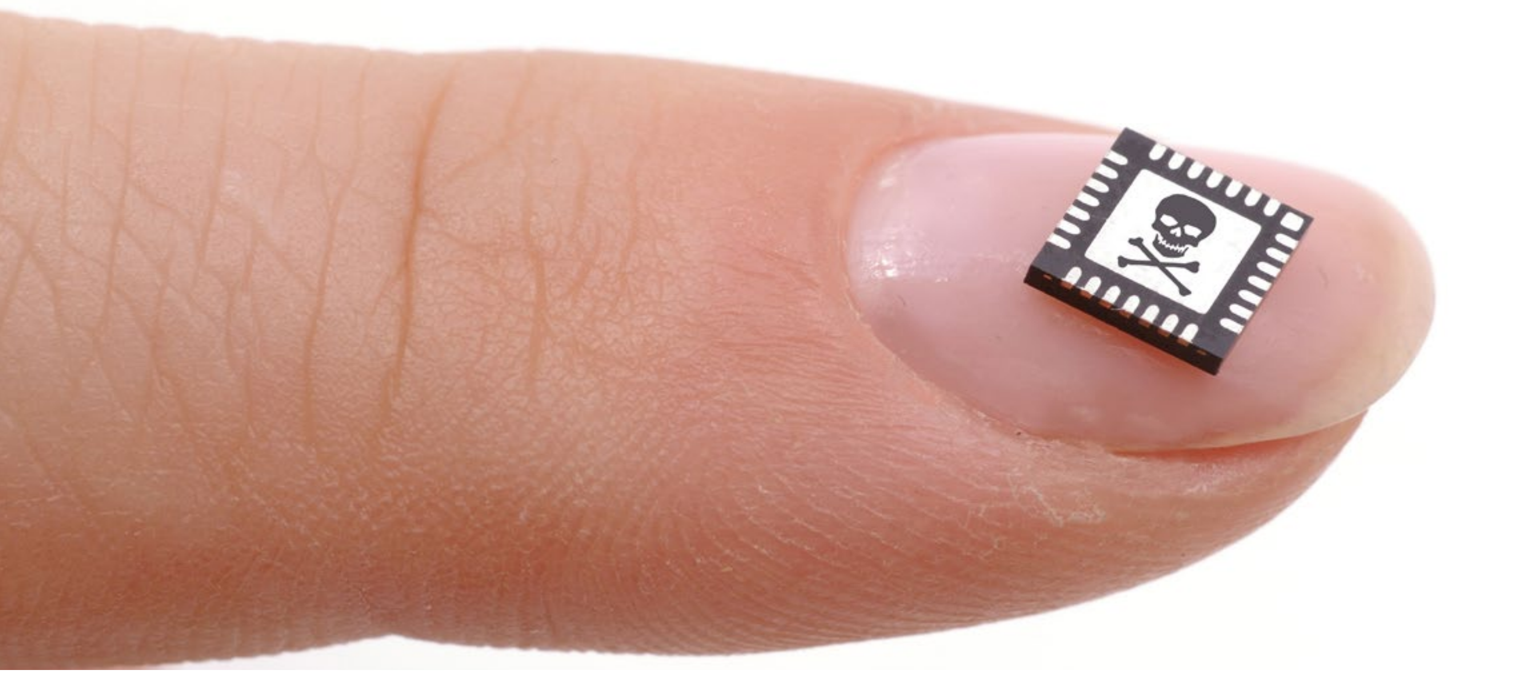
The potential for counterfeit parts infiltration into the defense supply chain is a real and present danger. Cost Accounting Standards (CAS)-bound contractors and subcontractors are required to have an avoidance and detection system in place to quarantine and report suspected counterfeit and obsolete electronic parts. In some cases, those without counterfeit avoidance strategies can be fined, jailed and even put out of business.

But that's just the tip of the iceberg. Sweeping changes in the way your business must handle the counterfeit parts threat are here and will soon affect every sector of the world-wide electronics market: government, commercial and consumer. Whether you survive and profit or fail and perish will largely depend on the decisions your business makes today to adapt to these new developments.

## A Cautionary Tale

John Doe, owner of XYZ Company, a New Jersey-based independent contract manufacturer, zipped his new Porsche 911 Turbo along I-95 over the George Washington Bridge and into New York City. He was on his way to an important celebration: His firm had just won a $35 million bid to supply electronic components to a prime DoD contractor, with the guarantee of larger deals in the future.

A lavish dinner had been planned honoring XYZ's seventh year of business—and 28 quar-



ters of consecutive growth! John's sales team was in for a big surprise: large bonus checks for everyone, and a special recognition award (the keys to the Porsche) for Mr. C., the China broker. Mr. C. had used his elite connections with a mainland supplier to sole-source deep-discount, out-of-production electronic parts, ensuring consistent markup prices for resale and a steady flow of quarterly profits for XYZ.

As John entered the hallway to the party he was handcuffed, read his rights and escorted out by federal agents. A military transport aircraft had recently crashed during a special operations mission in Iraq, killing all 20 servicemen aboard. A counterfeit part in the navigation system had been identified as the cause. XYZ Company was the source. John Doe was held responsible.

XYZ Company was blacklisted and forbidden from doing any future business with the federal government. The sales team was kicked off the supplier list and the business folded overnight. John Doe was staring down the double-barreled legal shotgun of civil and criminal liability, facing millions of dollars in fines and a several years in jail. His life was all but over.

### What Went Wrong?

XYZ Company hadn't done its due diligence, and relied on an unvetted, suspect, mainland Chinese supplier who said his firm was compliant to AS6081 standards for counterfeit avoidance and detection. No one bothered to check if the foreign enterprise was actually certified. It wasn't. The upshot: an un-vetted, untrustworthy supplier had slipped a counterfeit, mission-critical part into the defense supply chain and American soldiers died. Certification could have prevented it.

***No one bothered to check if the foreign enterprise was actually certified. It wasn't. The upshot: An un-vetted, untrustworthy supplier had slipped a counterfeit, mission-critical part into the defense supply chain and American soldiers died.***

Unfortunately, John and his sales team failed to notice that the market for electronic parts had undergone a profound sea change. A host of new developments and flow-downs impacting financial liability, personal injuries and property damage had arrived—indeed, were transforming the global market—and XYZ Company was left woefully unprepared.

With a bit of concerted effort, John Doe could have avoided failure and dramatically increased the chances of success for his sales team. A little bit of market awareness, common sense and cost-benefit analysis would have shown the price of education and certification to be very inexpensive compared to potential business losses from not investing in a robust counterfeit detection and avoidance plan.

You may be in the same position as John Doe and not even know it! Will your business have the foresight to make the right choices, before events overwhelm and overtake it?

Right now electronics firms are being caught off guard and many are forced out of business, but yours doesn't have to be. A few cost-effective steps can help your enterprise remain competitive, profitable and current with requisite counterfeit detection regulations (flow downs), even as businesses around you begin to fail.

### Why the Change?

Consider this. The defense industry itself requested the new, stringent requirements after a Senate Arms Services Committee investigation led by Committee Chairman Sen. Carl Levin (D-Michigan), and the ranking member Sen. John McCain (R-Arizona), discovered that more than 1 million counterfeit parts had infiltrated the defense supply chain, with the potential to wreak havoc through material destruction and loss of life. After the investigation, McCain and Levin offered an amendment to the FY 2012 National Defense Authorization Act to rectify vulnerabilities in the defense supply chain through robust counterfeit avoidance policies by the defense industry and DoD. A revised version of the amendment was included in a bill signed by

President Barack Obama and made its way into the 2012 NDAA (National Defense Authorization Act) under Section 818 entitled "Detection and Avoidance of Counterfeit Electronic Parts."

The fact is, the components found in these investigations are also the components frequently used in the medical, automotive, airline and other life critical applications. If this is an issue for the DoD, it can certainly impact a commercial operation. For obvious reasons, the U.S. military and the U.S. Congress are pushing the issue to protect the defense sector. There should be no doubt that, eventually, other industries will encounter circumstances that force a market change. It makes good business sense to proactively engage in the correct business practices that keep your company from being the fall guy in your industry.

Additionally, the new Federal Acquisition Regulation (FAR) states that the rules expressed in Section 818 have a wider scope and are not to be limited by part type or contractor classification. Hence, prime contractors are no longer legally immune from prosecution. If a prime contractor sells a counterfeit-infested component, it is now held liable along with participating contract manufacturers and suppliers.

To minimize potential damage, prime contractors like Raytheon have recently cut their list of approved suppliers from, in some cases, hundreds to generally less than five. Companies that have been removed from a prime contractor's approved vendor list are no longer permitted to do business and many have closed up shop overnight. Now, anyone who sells a compromised component is liable—up and down the defense supply chain—for a faulty board, circuit or damaged equipment caused by a counterfeit part.

In today's high-tech world of alternative media, where news can circle the globe in mere minutes, one's business reputation can be made or broken very quickly and must be diligently guarded from potentially damaging accusations of having sold counterfeits.

### New Flow-Down Requirements: All Aboard—the Future is Now!

Federal Acquisition Requirements are currently being proposed that would expand reporting requirements of non-conforming items for contractors and the federal government. This means that counterfeit parts may soon be considered non-conforming items, which would expand the need for quality assurance requirements and counterfeit avoidance measures on all items sold to the government. The proposals cover anti-counterfeit measures for businesses of any size: small, medium or large.

Initially, the rules will apply to government contractors, who will flow down the requirements, while many others could be subject to mandatory Government-Industry Data Exchange Program (GIDEP) regulations. Non-CAS covered and small businesses that participate in the defense supply chain are not excluded from the regulations. Commercial-off-the-shelf (COTS) products are also included because the definition of electronic parts now includes companies that sell products that contain electronic parts. Given the huge potential for product liability settlements, due to injury or death caused by counterfeits, businesses within the massive commercial and consumer electronics markets will be the next ones pressured to adapt to the new legalities.

Obviously, this portends a massive sea change in the global market for electronics, possibly equal in size and scope to the recent green revolution. Soon, virtually any business may be asked for proof of its counterfeit detection strategy and avoidance policy, whether an automaker, medical device manufacturer or even a software firm! In other words, a global transformation is taking place. You can be proactive and ahead of the new wave of convention and ride it to profitability, or you can be reactive and have it crash down on your head. Ignorance will have far-reaching consequences and will not be an acceptable excuse to save your business from potentially catastrophic consequences.

### Ensuring Survivability and Profitability: What You Can Do Today

Below are some of the concepts that my company felt were important to address for our long-term success. These points were part of the rationale for pursuing and accomplishing our goal of becoming the first company to become certified to the Defense Department's

AS6081 counterfeit avoidance standard for electronic components. Our philosophy adheres to the old adage "an ounce of prevention is worth a pound of cure," especially when handling such a virulent technological disease as counterfeiting.

**Here are some steps your business can take to mitigate the counterfeit electronic parts threat:**

1) Embrace change; don't fear it. "Adapt or die" has become the catch phrase for many industries in our rapidly changing, global market. Businesses that were proactive in their approach to the emerging green revolution in the 1990s, and had the vision to be out front with the new regulations and shift in social consciousness toward environmental responsibility, were in a better position to ride the wave of change to success and profitability. Indeed, the term "environmentally friendly" is now synonymous with good business ethics and best practices, much like Six Sigma and Total Quality Management became standard conventions a few years back.

2) Contract manufacturers and distributors should communicate with subject matter experts, and allow them to educate their sales team and quality/purchasing staff regarding returns, control of obsolete parts and traceability.

Contract manufacturers, working for commercial accounts whose main concern is keeping expenditures down to stay competitive, should consider the long-term costs of not investing in a counterfeit avoidance and detection system. A simple SWOT analysis (strengths, weaknesses, opportunities and threats) will confirm that potential short-term profits are never worth the long-term risk of losing one's business and reputation.

3) If you aren't doing anything different in your supply chain than you were three years ago, you are making a huge mistake regardless of the industry you serve. If you participate in the defense supply chain, become certified to AS6081 counterfeit avoidance and detection standards. However, there are several different levels of counterfeit mitigation depending on your electronic parts application, whether defense-related, commercial or consumer.

Many companies still allow their buyers to choose whom they are doing business with, instead of permitting their quality department to perform audits of potential business partners simply because it costs too much money. If your business is certified with a counterfeit avoidance plan already in place, it's a lot more attractive to commercial businesses, since you can save them the time and money of having to sending their auditors to do on-site inspections of your business. Remember that companies that are certified to international standards like SAE, AS9100, AS9120-A, or AS6081 are subject to third-party audits on an annual basis. These certifications require certified companies to comply and perform or risk catastrophic damage to their business. In addition, companies buying from companies certified to international standards benefit from third-party auditors performing quality audits that ensure an increase to the overall quality level for their supply chain, prove diligence and are no cost to them.

> *"If your business is certified with a counterfeit avoidance plan already in place, it's a lot more attractive to commercial businesses, since you can save them the time and money of having to send their auditors to do on-site inspections of your business."*

Instead, your business can focus on marketing to its customers that it has a certified procurement partner to source components—especially rare for out-of-production parts that must be procured from "other than authorized" supply sources.

4) Conduct ongoing training for your quality and sales teams, and maintain up-to-date

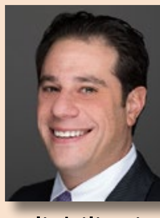
internal SOPs regarding your counterfeit avoidance plan.

5) Business convention is changing; therefore, be proactive not reactive. The number one excuse given by buyers for not adding new, conforming suppliers is that they've never had a counterfeit parts issue surface. This outdated approach is a sure sign of trouble. A smart company should not conduct business by allowing its suppliers to determine its fate. Companies must challenge their supply chains, and source for companies that adhere to a vigorous counterfeit avoidance plan, instead of coasting on past success coupled with a lot of luck. Gambling is unacceptable. A calculated risk, itself, is simply too risky. Only a guaranteed counterfeit avoidance and detection strategy is satisfactory.

## Conclusion

If your company buys electronic parts and components as part of its business, and you have not created a counterfeit avoidance plan, you are exposing your business to potential catastrophic consequences. The long-term benefits and potential profits far outweigh the short-term costs and risks involved in creating and adhering to a robust system.

Contract manufacturers should pay it forward now, do the work for their customers, and add value to their clients by partnering with certified companies, who themselves add value. This will create a virtuous business cycle, reduce the burden of risk to all parties involved and make your business more competitive in the long term. **SMT**



Todd Kramer is CEO of Secure Components LLC, an AS6081 & AS9120 certified independent distributor of electronic and mechanical components to the aerospace, defense, and high-reliability industries. To contact Kramer or to read past columns, click here.

# SMTonline Market News Highlights

### LED Industrial Lighting Market: CAGR of 29.64% by 2018

The need for energy-efficient lighting solutions is one of the key drivers in the market. Increased concern over the depletion of non-renewable sources of power and the need to minimize power consumption are driving the demand for LEDs in industrial facilities.

### Report: Smart Glass and Flexible Display Industry

The analysis shows that the total flexible display market is projected to reach the market revenue worth $3.89 billion by 2020. The value of smart glass market was worth $1581.4 million in 2013, and is expected to reach $5814 million by 2020, at an estimated CAGR of 20% from 2014–2020.

### Near-field Comms Market to Reach $20.01B by 2019

The global market for NFC, in terms of revenue, was valued at US $1.07 billion in 2012 and is estimated to grow at a CAGR of 43.7% during the forecast period from 2013–2019.

### China Leads 2013 Smartphone Market; 700M Users

With active smartphone users exceeding 700 million by the end of 2013, China has now become the largest smartphone market in the world. Demand for smartphones in China is expected to cross 400 million units in 2014 with more than half of the units being contributed by local vendors.

### $8 Billion Market for Wearable Electronics by 2018

The global wearable electronics market is expected to cross $8 billion in 2018, growing at a healthy CAGR of 17.7% from 2013–2018.

### European Semiconductor Sales Up 14.9% in July

Sales of semiconductors in July 2014 amounted to US $3.273 billion in Europe, an increase of 14.9% compared to the same month in 2013, the European Semiconductor Industry Association (ESIA) announced on the basis of the latest WSTS sales reports.

### Homeland Security Market to Reach $364B in 2020

Initiatives undertaken by various governments across the world are driving the market for homeland security products. Some of these government initiatives include Sisfron program undertaken by Brazil, TECS Mod program undertaken by the U.S., and Project Cytoon undertaken by South Africa, among others.

### Facial Recognition Market to Reach $6.50B in 2018

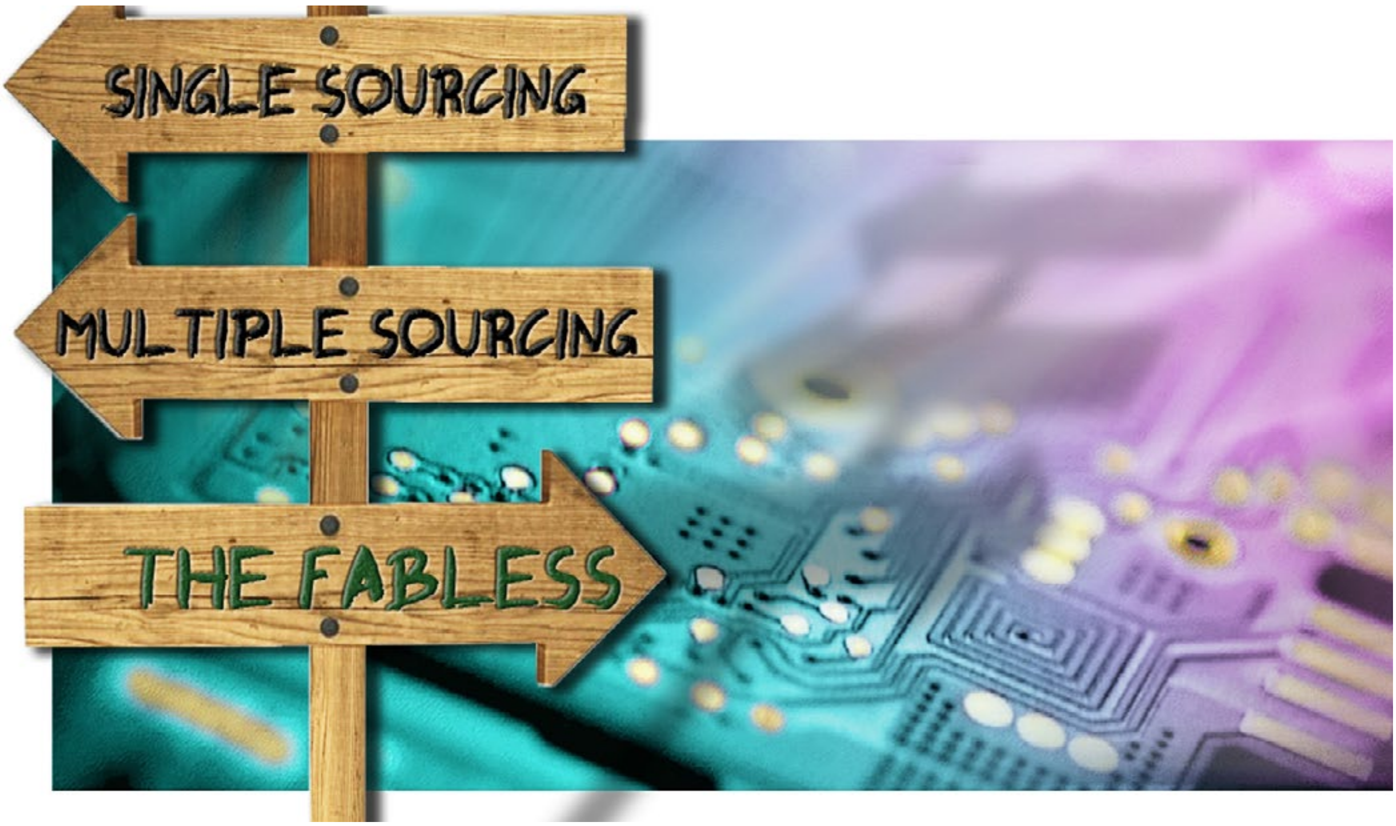
The global facial recognition market is estimated to grow from $1.92 billion in 2013 to $6.50 billion in 2018. This represents a CAGR of 27.7% from 2013–2018. In the current scenario, government and utilities are expected to be the largest adaptor for face recognition technology.

### 27% of U.S. Households Use a Connected Health Device

Research from Parks Associates shows more than 32 million U.S. consumers will actively track their personal health and fitness online or via mobile by 2016. If Apple's watch incorporates breakthrough wellness and fitness tracking functions and supports innovative partnerships with health industry incumbents, the market adoption could be much higher in the next few years.

### Solar PV Power in Japan; Market Outlook to 2025

The report provides an in-depth analysis on global renewable power market and global solar PV market with forecasts up to 2025. The report analyzes the power market scenario in Japan (includes conventional thermal, hydro, and renewable energy sources) and provides future outlook with forecasts up to 2025.




# Smart PCB Sourcing Concepts

**by Theo Langer**
CML

Whether you are an EMS or an OEM, defining the right sourcing policy for PCBs and components is an important strategic management task. Forward-looking decisions create results that help improve a company's competitiveness.

Consider a large EMS company that has a PCB purchasing volume in the order of half a billion USD. A holistic approach to draw on all available efficiency boosters in the company's sourcing environment (organizational set-up and purchasing efforts) will award the bottom line with single- or double-digit savings in the millions. It is worth pursuing a smart PCB sourcing concept.

### Classifying your PCB Purchasing Portfolio

Before defining a sourcing policy one has to know the DNA of the purchasing portfolio.

One way of analyzing it is to cluster it into two major groups—technology and volume requirements. There is also an additional option to classify into a third major group— business segment—for additional structure.

Recommended technology subcategories are: rigid boards, flexible/rigid-flex boards, heavy copper, HDI, and IMS requirements. The second group, the volume category, may be clustered as low, medium and high volume groups.

Having classified your portfolio, you need to find an efficient sourcing strategy, which ought to be implemented tactically by the procurement department.

### Purchasing Demand meets Market Supply Situation

The requirements of an often highly diversified PCB portfolio (technically and lot sizes necessities) traditionally meets a very different market reality on the supply side. PCB producers are often strong technically and commercially in mainly one particular PCB segment (e.g., low-layer rigid boards only, or high volumes only, or flexible boards and low volumes only). This will not cover a wide and diversified PCB portfolio.

# HIGH MELTING POINT SOLDERING COURSE (HMP)

## Soldering Series
## Blackfox "Employee Qualification"
## 8.0 Comprehensive Soldering Using HMP (High Melting Point)

**Course Description:**
This hands-on course is designed for those who have previous soldering experience and require an in-depth review of HMP soldering fundamentals, proper soldering methods, equipment care, ESD, safety and general requirement for soldering electronic assemblies.

There are many situations in electronics manufacturing where it is necessary to use high melting point solder. The act of implementing HMP solders will require soldering temperatures that are higher than standard Sn/Pb eutectic solders. Manufacturers soldering at high temperatures need to be aware of a few simple rules to prevent catastrophic component or board failures.

Each learner will gain the knowledge necessary to ensure quality skills and the latest acceptable workmanship requirements for all classes of products for soldering and reworking connections using HMP solders.

**What the Student receives:**

- A student soldering manual with step-by-step instructions
- Workmanship PCB with components for practical exam

**Course Objective:**
Upon successfully completing this learning activity, attendee will have received:

- Common Safety Rules for Hand Soldering
- ESD and PCB Handling
- Soldering iron and solder tip maintenance guidelines
- Methods for choosing the correct Tip-Temperature and Size
- HMP Solder and Flux chemistry and why they are used
- Create acceptable solder joints using HMP solder
- Cleaning the PCB
- Inspect work for conformance to the standards
- Rework Techniques

**Upon satisfactory completion of the written and practical exam, participants will receive Blackfox certification valid for 24 months.**

**Prerequisite:** Previous Soldering Skills
**Class Length:** 2 days

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Sure, there are producers around that offer multiple volumes and technologies from one source. However, one has to answer the question: Does this "Jack of all trades" situation always offer me the most reliable and competitive solution? If you believe the answer to this question is no, your sourcing policy tends to require a multiple sourcing strategy. If you believe the answer to this question is yes, your sourcing policy tends to require a single sourcing strategy.

Which sourcing strategy is the best and what are its strengths and weaknesses?

### Sourcing Options

For the most part, there are four different approaches to sourcing:

1. Sole sourcing: only one supplier in the supplier base (e.g., because of a patent)
2. Single sourcing: one single supplier is selected out of a choice of suppliers
3. Dual sourcing: two suppliers are selected
4. Multiple sourcing: multiple suppliers are selected

### Single Sourcing vs. Multiple Sourcing

Let's take a look at the pros and cons of the two most popular and classical approaches, before presenting a third, alternative approach.

#### *Single Sourcing*

Here, one single PCB manufacturer is chosen to provide the entire PCB portfolio.

There is one contract and one line of contact, which significantly reduces the effort in the day-to-day management of the outsourcing activities. Since there is only one contact window, continuous improvement programs can be run more efficiently. However, outsourcing to a single manufacturer does not diversify your risks, as you are putting many eggs in one basket.

Let us now compare two typical PCB manufacturer types available for this souring strategy, each with its own specific peculiarities.

#### 1. Medium-size PCB manufacturer

Medium size PCB manufacturers (annual turnover of $150-250 million) are usually armed with equipment that caters best for their core competence technology. If they are requested—due to a single sourcing approach—to produce various technologies that do not perfectly fit their core competencies, compromises must be made. Hence, a situation has to be managed that presents itself as follows:

- Boards for the "not-so-good-fitting" technologies are produced on less than sub-optimal production lines and quality restrictions are more often than not the trade-off
- Raw material costs may not be very competitive because the purchasing power for relatively small volumes of special materials remains limited
- Little to no stock keeping for "out of the ordinary" laminates will extend lead times
- Limited UL approvals for certain material combinations can send your project into a much unwanted waiting loop of around 3–5 months until approvals are granted

#### 2. Large size PCB manufacturer

Large PCB manufacturers (annual turnover of $0.8-2 billion or more) have sizable company overheads that will be reflected in the pricing. They lose flexibility and speed when demands for smaller lot sizes and fast lead times are to be covered. Because of their legal structure, decision-making tends to be relatively slow and can be perceived as being complicated.

Looking at only the two examples above, single sourcing has advantages but does come with a set of challenges to be considered before a strategic decision is made to go down this path. Deciding on this relatively inflexible strategy can pose problems when working in a highly dynamic and fast changing demand environment.

#### *Multiple Sourcing*

With multiple sourcing, you enter into several separate, parallel contracts with different suppliers to best cover the demand structure of your PCB portfolio. It is a rather flexible approach, although, you must spend considerably more time and resources to manage a broad range of suppliers (e.g., contractually, technically, quality-wise, claim-management wise).

Chances are that the quality of each of the PCB technologies sourced via multiple suppliers is higher. The reason is that the individual manufacturers are rather specialized in various technologies using tailored equipment leading to optimized results.

On the down side, however, duplicated responsibilities (managing multiple PCB suppliers) increase your management cost of this strategic approach noticeably. This multi-source management needs a very structured coordination in-house, since the multiple relationships across vendors tend to generate convoluted situations.

### General Sourcing Trends

Two major trends are obvious. Firstly, the focus on core competencies, and secondly the shift of value creation to suppliers, are the main tactics in supply chain management (SCM) of large multinationals. With this, outsourcing and a closer more collaborative relationship with suppliers becomes inevitable. Consequently, reducing the supplier base is the natural result in the industry overall and the PCB industry in particular.

The following examples in Table 1 will provide you with an idea of how large multinational companies (in all walks of life, not only in the field of electronics) position themselves on the question of supplier numbers.

Focusing collaboration on a narrowed down basket of suppliers drives the level of collaboration beyond just linking information systems. The final target is fully integrating business processes and organization structures across companies that comprise the full value chain. Today's SCM moves from pure execution (i.e., event-driven) to a more information and relationship intense focus. SCM is a vital core strategy and needs smart talents to shape it.

### The Third Way: Sourcing from a Large, Credible Fabless PCB Provider

From the above explanations we learn that single, as well as multiple sourcing have complementary advantages and challenges. Utilizing exclusively one or the other sourcing strategy will never benefit the customer with the combined advantages of the two models.

The consequential question must be: Is there an alternative sourcing option that cumulates the advantages and minimizes the disadvantages of the two strategies?

The answer is yes. The combined sourcing benefits can be harvested by sourcing from a fabless PCB provider.

### A Fabless PCB Provider: the Attributes

A credible fabless PCB provider owns everything that is needed to produce PCBs, but the factories. Instead of a factory, the provider has a portfolio of production partners. This portfolio is strategically developed and assembled over years. Ideally, it consists of partners with little overlap in the selected technology segments

| Premier Foods | Carillion | SIEMENS |
|---|---|---|
| At the end of 2010, the major South African staple foods producer cut supplier numbers by 11% over a single quarter as part of a bid to boost efficiency. | The construction giant decided in 2010 to drop four out of five suppliers from their books. The group has approximately 25,000 suppliers but reduced this figure to 5,000 to save $181 million a year in 2013. | 20% of its 113,000 suppliers are to be axed mid-term. Fewer suppliers mean not only improved efficiency and lower administrative costs, but also greater innovative strength. |

Table 1.

with best-in-class performance in the individual disciplines (Figure 1).

In contrast, look at the performance situation of one typical single PCB manufacturer (Figure 2).

Sourcing from a large credible fabless PCB provider helps you benefit from the combined advantages of both traditional sourcing strategies—single sourcing and multiple sourcing.

A credible fabless PCB provider is your single pivot point engaging multiple factories that are all tailored optimally for your required PCB technologies.

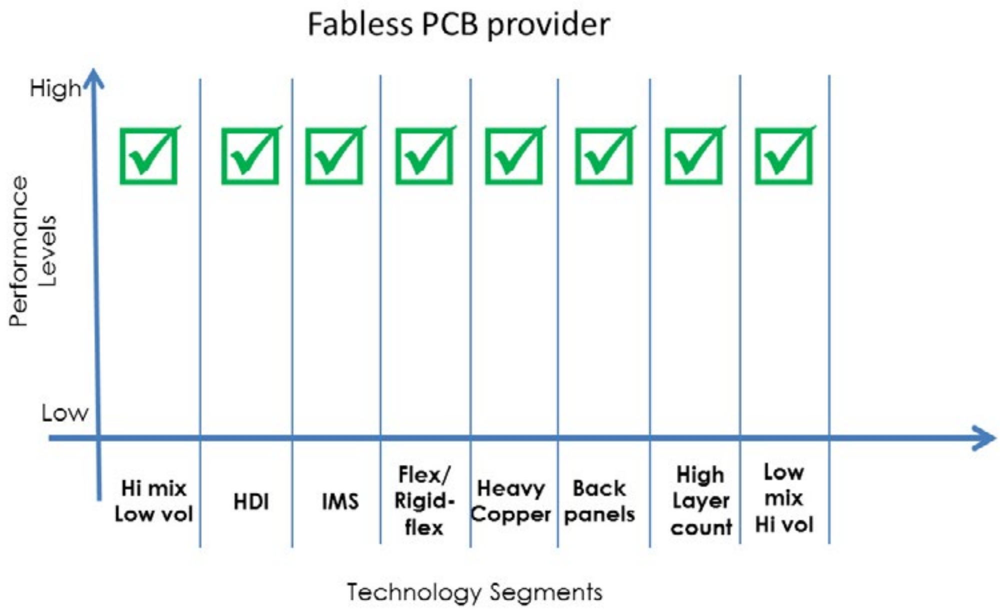



Figure 1.

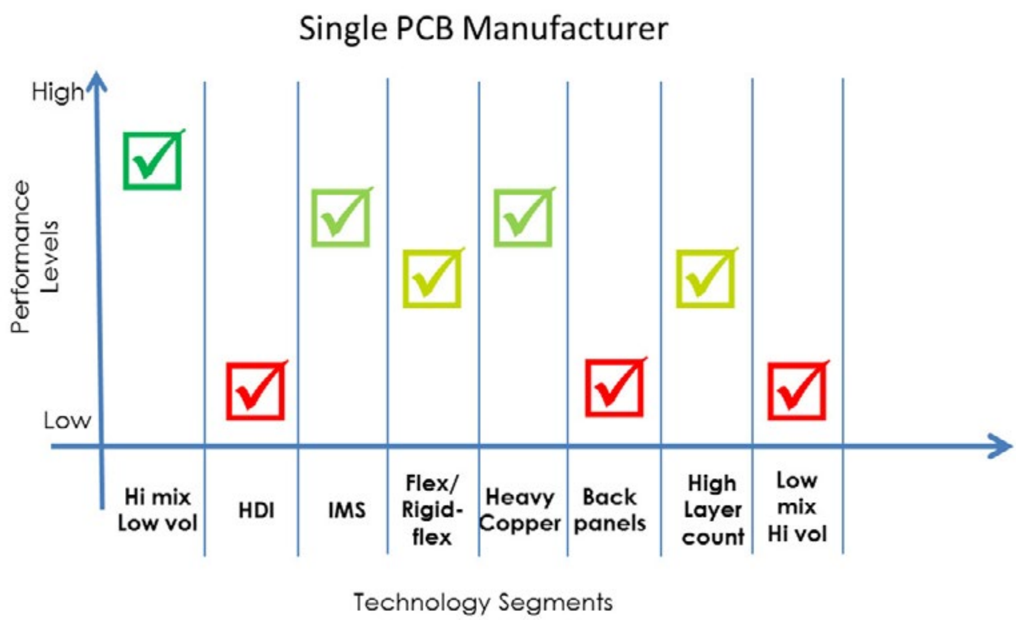
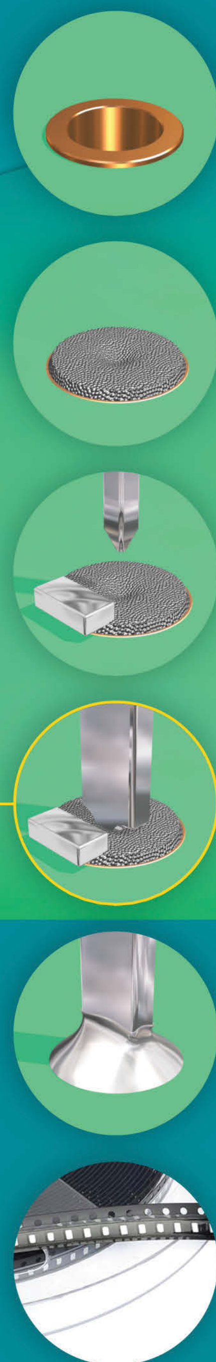



Figure 2.

# How do you achieve 100% hole fill on through-hole paste applications?

alpha® preforms

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If your company agrees with W. Edwards Deming's 14 points for management then following the approach of sourcing from a fabless PCB provider comes only as a natural result.

In the 1950s, Deming had major impact on the manufacturing and business world in Japan. Many of his 14 points are embedded in the concept and goals of sourcing through a credible fabless PCB provider.

Since a fabless PCB provider has everything necessary to produce PCBs but a factory, he will concentrate 100% on all supporting tasks with Deming's 14 points in mind.

Using a fabless PCB provider as your single point of purchase and project manager for all PCB supply related tasks (quality, logistics, factory audits, technology scout, even PCB education); you are able to turn a supplier relationship into a value creating long-term learning relationship.

The elimination of multiple and repetitive processes (e.g., scouting for suppliers, contract negotiations with each and every supplier, multiple supplier management, implementing standardized quality requirements across all suppliers) in your organization is another building block to keep your own SCM organizations lean and focused on core competencies.

Reduce internal processes and use bundled sourcing through a credible fabless PCB provider.

### Cost Consideration

The reactive PCB supply chain manager belongs to yesterday. Today, he proactively manages the strategic supply chain, or more precisely the total cost of ownership (TCO), as shown in Figure 3.

The analysis of customer requirements provides the basis for determining the cost drivers associated with purchasing the product and service. The supply chain manager has the right to expect product and services of the "right quality, from the right supplier, in the right quantity, at the right time, and at the right price." But what is the most and least important factor of all the expected "rights"?

A value stream mapping exercise comes to the rescue as it identifies the cost drivers to deliver product and services. Once identified what is most and least important, the SCM must work closely with the PCB provider to shape a TCO model for its individual case and eliminate non-value added activities. We need to understand that what is regarded as value-added can be different under various circumstances.

The author's publication "PCBs from Asia Traded by Western PCB Manufacturer" proves this. The customer, "PCB manufacturer," sourcing from a fabless PCB provider, can have a very different TCO model than, for example, an EMS supplier. The PCB manufacturer may not want the product qualification (e.g., climate chamber, temp cycling tests) to be done by the PCB provider. Since he is in a similar business as the fabless PCB provider, he might want to use his own test lab and does not require this service from the fabless PCB provider.

A successful supply chain manager knows how to find a trustworthy PCB supply partner who offers the most flexible solutions to meet the ever-changing customer requirements.

He understands the trend that it's not the big that eat the small, but it's the fast that eats the slow.

Cooperating with a fabless PCB provider who offers individualized solution can be a further benefit. Individually picking services that are important to have available locally (yellow part in Figure 4) vs. those services (lesser importance—faded part in Figure 4) that can be provided from offshore locations at a different price point, can help shape an individual TCO situation. It ranks services according to importance, keeping the one that are essential close to you.

The results: An individualized, lean, efficient and dynamic outsourcing solution.

### What's the Take-away?

The learning curve costs for your organization are minimized when you source through a fabless PCB provider. One of the fabless producer's added-value comes from being specialized in most efficiently managing a complementary pool of multiple PCB producers, because a fabless producer lives it and breathes it. It is his daily bread.

Engaging TCO models show that sourcing through a fabless PCB provider offers the high-

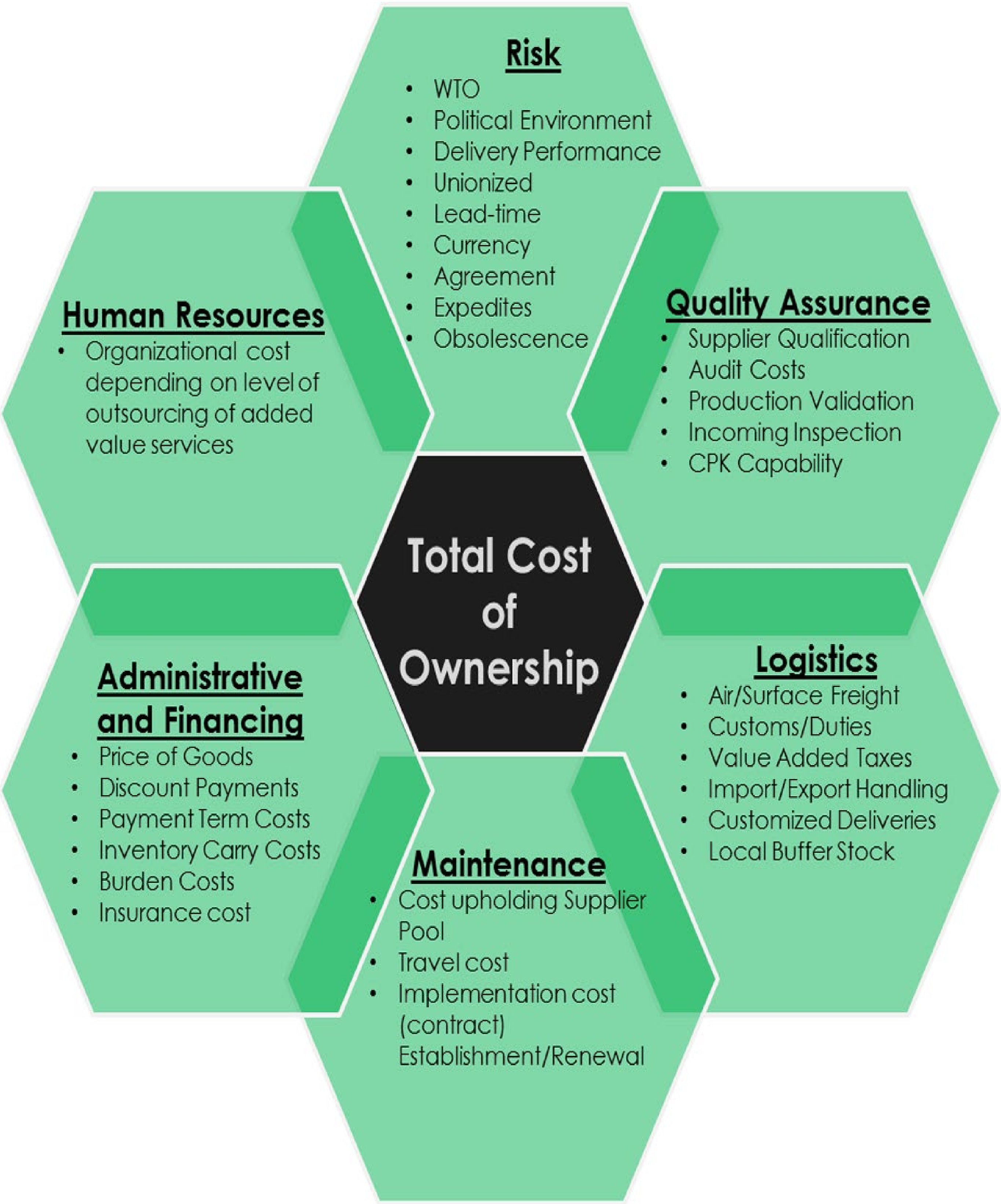


Figure 3: Total cost of ownership.

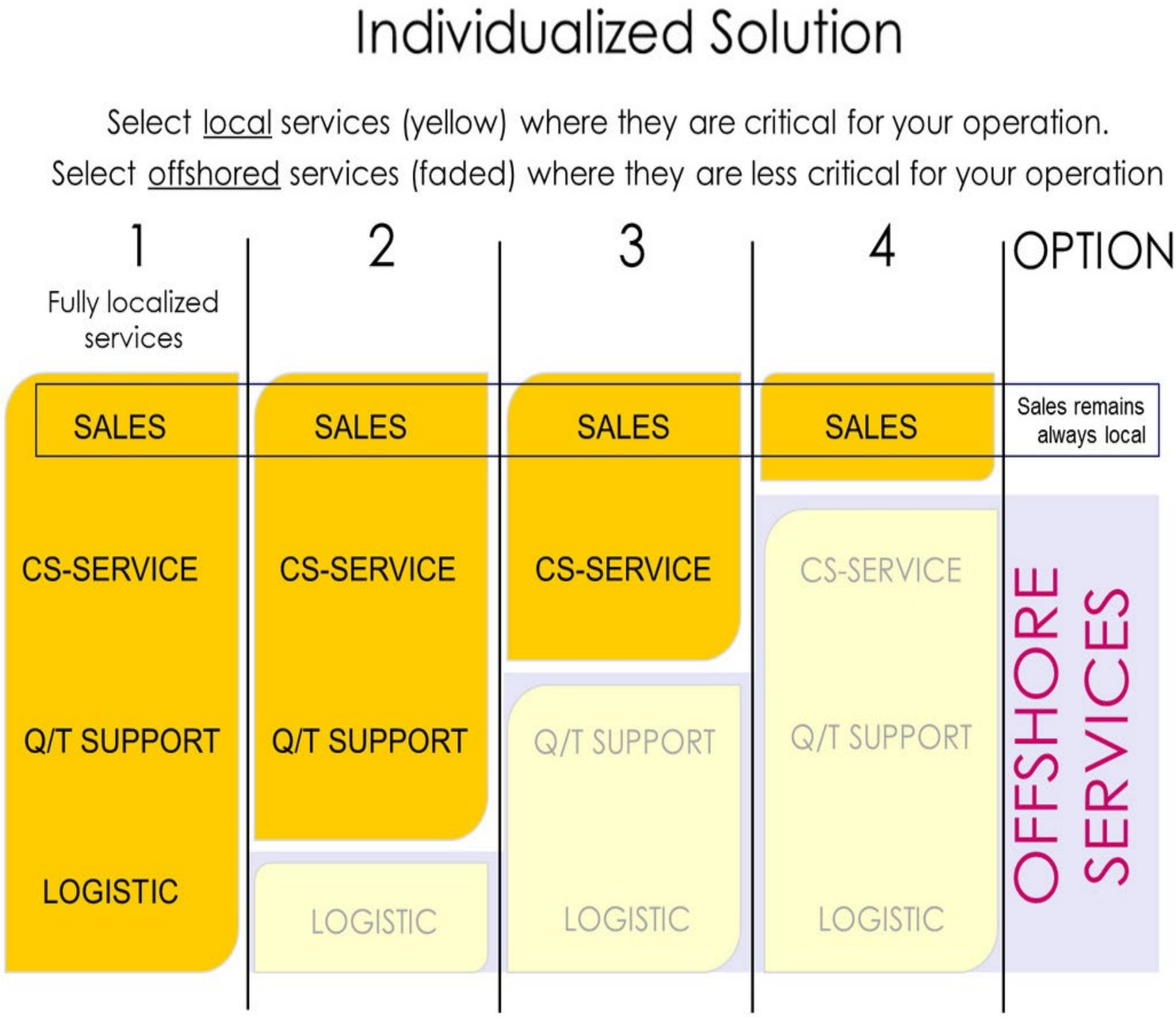


Figure 4: Individualized solution.

est flexibility with the lowest maintenance cost of possible outsourcing models. Forward looking SCM strategists are discovering their value. Proof lies in the positive turnover development of fabless companies. In the last five years, credible fabless PCB providers grew above market. In general, the growth was double digits.

During daily work with clients from around the world, it can be seen more and more that a single point of sales is preferred over multiple points of sales. The convenience factor for the SCM is the highest with this model. **SMT**

Theo Langer is VP of sales for Asia and worldwide sales coordinator of CML in Hong Kong and China.


# TOP TEN

# News Highlights from SMTonline this Month

## 1 Sparton's New Design Center Offers Tech Advancements

The innovation within the facility not only allows the company to continue to grow its skilled staff, but also its abilities to cater to more customers' needs. "The medical device world is constantly changing and this location enables us to stay ahead of the rapidly shifting technology," said President and CEO Cary Wood.

## 2 IPC Updates Electronics Assembly Standards

The documents have been updated to include technical advances in solder on plastic SMT components, new criteria for P-style and solder-charged Butt/I SMT terminations, a change to void criteria for BGAs, and enhancements to the language within the documents to provide ease of use and clarity.

## 3 Libra Industries Acquires Focus Manufacturing

Under the agreement, Libra Industries will benefit from Focus Manufacturing's metal fabrication capabilities, while Focus Manufacturing will continue operations under its own name. The companies will partner to provide world-class custom EMS and metal fabrication services. Combined, the organizations bring 54 years of experience in their respective industries.

## 4 IEC Reports Revenue Drop in Q3

"Our revenue for the quarter was lower than the same period last year. Overall, we've continued to have success adding new customers and adding new programs for existing customers, the majority of which we anticipate will be accretive to the company and will provide long-term value," says W. Barry Gilbert, chairman of the Board and CEO.

## 5 Standard for Solar Module Assemblies Debuts

IPC-8701, Final Acceptance Criteria Standard for PV Modules-Final Module Assembly, was written as a first step toward providing an infrastructure that will help companies increase volumes, hold costs down, and obtain common acceptance requirements between customers and manufacturers.

## 6 HANZA Presents 1H Results; Begins Acquisition Strategy

"Business-wise, it was a wait-quarter. Activity-wise, it was an intense quarter, with the listing on First North, the relocation of production and launch of a new product for manufacturing solutions. We are also pleased how our business model provides us new customers and contracts," said Erik Stenfors, CEO.

## 7 Key Tronic Completes Acquisition of CDR Manufacturing

Key Tronic Corporation has signed a definitive agreement and completed the acquisition of CDR Manufacturing, Inc. (dba Ayrshire Electronics) for $46.9 million in cash.

## 8 Sigmatron Disappointed with Q1 Fiscal 2015 Results

SigmaTron International, Inc., an EMS company, has reported revenues and earnings for the fiscal quarter ended July 31, 2014. Revenues decreased to $54.9 million in the first quarter of fiscal 2015 from $56.2 million for the same quarter in the prior year.

## 9 Natel EMS Embraces "Hands-free" Assembly Line

When it comes to producing intricate microelectronic assemblies, components manufacturer Natel Engineering Co. Inc. is saying goodbye to manual labor. The company has invested $1.7 million in developing, purchasing, and installing equipment for a "hands-free" assembly line, bringing the technology to the tiniest of parts: Integrated circuits.

## 10 Deswell Posts 19.7% Sales Drop in Fiscal 1Q 2015

Net sales for the first quarter ended June 30, 2014 were $8.9 million, a decrease of 19.7% compared to net sales of $11.1 million for the same quarter ended June 30, 2013.

# EVENTS

For the IPC's Calendar of Events, click here.

For the SMTA Calendar of Events, click here.

For the iNEMI Calendar, click here.

For a complete listing, check out *SMT Magazine's* full events calendar here.

**World Energy Engineering Congress (WEEC)**
October 1–3, 2014
Washington, DC, USA

**NEPCON Vietnam 2014**
October 9–11, 2014
Ho Chi Minh, Vietnam

**Austin CTEA Expo & Tech Forum**
October 14, 2014
Austin, Texas, USA

**Long Island SMTA Expo and Technical Forum**
October 15, 2014
Islandia, New York, USA

**Connecticut Expo & Tech Forum**
October 21, 2014
Waterbury, Connecticut, USA

**Intermountain (Utah) Expo & Tech Forum**
October 23, 2014
Salt Lake City, Utah, USA

**Industrial Automation Conference 2014**
October 23–24, 2014
London, UK

**LA/Orange County Expo & Tech Forum**
November 6, 2014
Long Beach, California, USA

**International Wafer-Level Packaging Conference**
November 11–13, 2014
San Jose, California, USA

**TSensors Summit 2014 – San Diego**
November 12–13, 2014
La Jolla, California, USA

**Wearable Sensors and Electronics 2014**
November 12–13, 2014
Santa Clara, California, USA

**ELECTRONICA 2014**
November 11–14, 2014
Messe Munchen, Germany

**Graphene LIVE! 2014**
November 19–20, 2014
Santa Clara, California, USA

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## Coming Soon to *SMT Magazine:*

*NOVEMBER:*
**Rework & Repair**

*DECEMBER:*
**Outlook for 2015**