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Outlook for 2015 and Beyond: A Supply Chain Perspective

By Yash Sutariya, page 22

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December 2014 Featured Content

OUTLOOK FOR 2015

It's almost 2015, and your company is making plans for the next year. We have the information you need! This month, our contributors gaze into their crystal balls and offer their outlook on the busy year ahead. Inside, you'll find predictions by industry prognosticators Yash Sutariya, Mulugeta Abtew, and Frederick Blancas, as well as a year-end wrap-up by Dr. Jennie Hwang.

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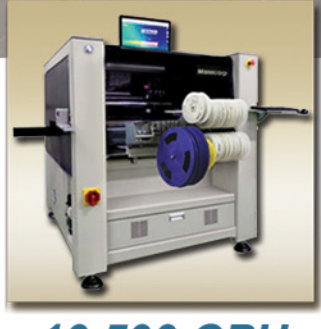

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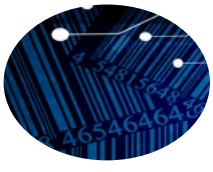

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THE WAY I SEE IT

Predictions

by Ray Rasmussen
PUBLISHER, I-CONNECT007

In October, the research firm Gartner issued a press release that made predictions for IT organizations. I wouldn't say I was surprised or shocked by the statements, but the implications of the forecasts intrigued me. When I first saw the release, I almost wanted to run it in the place of this column. Instead, I've pulled out a few of the more significant pieces and added my comments to each. The link to the press release appears below.

Before I go into the parts of their release I found most intriguing, I want to explain my role in all of this. I'm captivated by new, upcoming technologies and what's happening in emerging markets. There is an overwhelming amount of evidence that we are on the cusp of amazing change in technology, markets and even society. I see it as my job to share with you all the things I'm discovering. I certainly am no expert, but I see hundreds of news items and articles each week, which help me form a broad understanding of some of the changes coming our way. It's exciting to watch them evolve.

In our industry, the biggest problem I see is that most of the companies will likely be blindsided by what's coming. There's a lot to keep track of. You have to stay on top of all the latest technology, markets, regulations, etc., and still run your business successfully. Now, toss into that mix emerging technology, which could be game-changers for us all, and the continual emergence of competitors from around the globe and it's an almost impossible task to stay on top of everything.

As I was explaining recently to a top EMS exec, it's not the conventional technologies that are emerging in the traditional sense, providing incremental change (smaller, lighter, faster) that we have to pay attention to; it's the new technologies that have the capability to completely change everything that we must keep an eye on. And those game-changing technologies won't arrive in a politely linear fashion, allowing us to pick and choose which way we want to go. Instead, they will be disruptive and appear almost overnight, out of nowhere. Most of us will not see them coming. One day, the business model will change. If you're prepared, you can reap the benefits. And if not…

A couple of game-changers moving into our sectors are printed electronics and 3D printing. I have written about them extensively in this

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PREDICTIONS *continues*

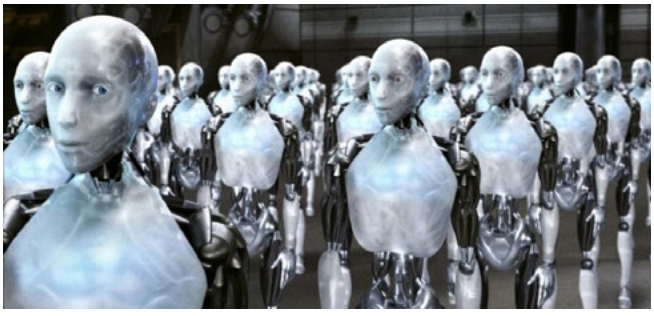
column and we have published dozens of technical articles on this subject in *The PCB Magazine* and *SMT Magazine*.

The way I see it, my job is to help you prepare for what's coming in these columns and in the news and articles we post to our sites and run in our digital magazines. If you're paying attention, at least somewhat, you will see the possibilities before most of your competitors do. There is real opportunity here for those companies led by managers who have their eyes open.

Here are snippets from the Gartner press release I mentioned earlier:

For some time now, there has been an ongoing shift in the roles machines play in our everyday lives," said Daryl Plummer, vice president, Distinguished Analyst and Gartner Fellow. "Compute-based machines are now being used to create an ever-expanding variety of experiences that extend human endeavors. Machines are taking on more human characteristics in order to affect a more personalized relationship with human beings and we find ourselves contemplating a near-term future of a world in which machines and humans are co-workers, and possibly even co-dependents.

How many of you have seen the movie "I, Robot" with Will Smith? Based on the famous collection of short stories by science fiction writer Isaac Asimov, it's a scary glimpse into our future. I'm sure most of you have heard of iRobot, the company building things like robotic vacuum cleaners, pool cleaners, robot-like video consoles for business and medical applications, and the remote systems used for the military to keep soldiers safe. Plummer's quote states the obvious, if you just look around. These same types of automated systems, devices and interactions (Siri? Watson?) are all around us now, and will explode into every conceivable market in the coming decade. The proliferation and integration of robotics and automation into our lives is growing at an exponential rate. That's why we have to keep our eyes open: in the short term, it means lots of new business; in the mid term, it means struggling to keep up with the technological changes. And in the long term, it's a new paradigm. The timespan between short term and mid term should give those who are paying attention time to react. From mid- to long term will be the time when most companies try to react to the sea-change, but it will likely be too late.



I, Robot, 20th Century Fox.

Here are a few interesting "near-term flag" pieces from the Gartner press release, followed by my thoughts on each:

• *By 2018, the total cost of ownership for business operations will be reduced by 30% through smart machines and industrialized services.*

The first prediction is already happening big-time in our industry. We see more and more robotics companies exhibiting at shows. However, I haven't run into companies offering "industrialized services," sort of EMS for EMS, I guess, yet.

• *By 2015, there will be more than 40 vendors with commercially available managed services offerings leveraging smart machines and industrialized services.*

Consumers' need to get faster, cheaper, better products and services in a mode that supports any time, any place and any channel is fueling the digital business revolution. Business processes and the entire value chain of business operations will shift from a labor-driven and technology-enabled paradigm to a digital-driven and human-enabled model. Smart machines will not replace humans as people still need to steer the ship and are critical to interpreting digital outcomes. Thus, smart machines will not replace labor; rather they will displace the complacency, inefficiency and add tremendous velocity to business operations. With consumers' preference to use Internet and mobile services to drive business efficiencies and optimize

time management, every industry is striving to improve the customer experience by simplifying, automating and making more intelligent end-to-end processes, minimizing manual interventions and allowing the consumer to self-serve.

By 2020, developed world life expectancy will increase by 0.5 years due to widespread adoption of wireless health monitoring technology.

So five years from now, we're all expected to live (slightly) longer, healthier lives. The pace of this improvement will accelerate for some time as science and technology work to extend the ability of our bodies to last longer. That's good news for just about everyone. The technologies described here are just a very small piece of what's going on.

• By 2017, costs for diabetic care are reduced by 10% through the use of smartphones.

Wearable monitors hold huge promise. Today, a simple wristband can collect heartbeat, temperature and a number of environmental factors. Wireless heart monitoring patches, smart shirts and sensors in accessories promise more accuracy, choice and comfort to wearers. Transmission through wireless is straightforward. Data can be correlated against large cloud-based information repositories for sanctioned actions and through social networks for anecdotal advice. Gartner expects data from remote monitoring devices to provide continued access from patients to medical practitioners.

By 2017, nearly 20% of durable goods e-tailers will use 3D printing (3DP) to create personalized product offerings.

This next quote provides some numbers backing up what most have seen coming for the last couple years. 3D will offer personalization, building off of a traditionally manufactured core, but every year, more and more of the core product will be customized until the entire product is built on demand directly by the seller. Some products lend themselves to 3D technology better than others, like a metal airplane parts where you only need a few each month. But that will change. Every year, more and more complex structures will fall to 3D printing. It will change everything.

• By 2015, more than 90% of durable goods e-tailers will actively seek external partnerships to support the new, "personalized" product business models.

3DP is already having a profound impact on enabling startups to reduce infrastructure costs, compared with existing traditional manufacturing processes. As consumers increasingly show an appetite to control more product features and capabilities, e-tailers are recognizing the business potential of moving from "configurable" products to "personalized" made-to-order products enabled by 3DP. Almost every single durable goods category will see a surge in 3DP-enabled personalization and manufacturers will develop capabilities for bringing the consumer closer to the design experience. The companies that set the strategy early will end up defining the space within their categories. This requires a corporate culture that is supportive of nonconformance products, new front office "concierge" business capabilities, and back office IT and operations skills. It will require a new agility that goes beyond rigid process automation, and may require entirely new business systems.

There's much more in this Gartner press release. And I do realize that these guys aren't always right but there's just too much happening out there to believe at least some, if not all of their prognostications. That can't be too far off the mark.

The day after that Gartner release was published, the company issued another one listing the top 10 technology trends. There you can read about IoT, 3D printing, smart machines and more.

We'll continue to do our best to bring you as much information as we can going forward to help you stay on top of this revolution in technology. **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.

SMT PROSPECTS & PERSPECTIVES

2014: Year-End Review

by Dr. Jennie S. Hwang
H-TECHNOLOGIES GROUP

For this year-end column, we will check on how my January 2014 column, New Year Outlook: What Can We Expect in 2014, actually panned out. As usual, I will go through the key sub-topics that directly or indirectly impact our industry in terms of macroeconomics, business environment, technology and global marketplace. It is comforting to say that my 2014 outlook was, by and large, on or close to target.

GLOBAL ECONOMIC OUTLOOK

From January 2014 Outlook:

"In 2014, the countries with the first and second largest economies, U.S. and China, respectively, are expected to show improved outlooks over 2013, while the third largest economy, Japan, launches bold new fiscal policies and economic stimuli.

With Japan holding the highest debt levels in the world (at 230% of GDP), Abenomics needs to show real progress; it will be a tricky maneuver. China and Japan both happen to have recently installed new leadership, which will exert new influences and economic policies. Across the Atlantic Ocean, progress has been made. The signposts indicate that the financial crisis is ending in the Eurozone. Countries such as Italy and Spain are exiting recession. However, the ECB is pondering the challenge and impact of the worryingly low inflation rate. The U.K. sees recovery gaining pace. The Bank of England believes the U.K. economy is recovering so quickly that it will likely consider raising interest rates in 2014[1].

However, a sound economy exists only if there is political and social stability. To that end, the standoff between China and Japan over territorial disputes could skew the global economies if it escalates to a dangerous stage. Such an escalation is unlikely, but not impossible. Eschewing any adverse complications calls for one of the most sensitive and intricate executions of the U.S. diplomacy and the foreign policies. Navigating between the two disputing countries takes more than the assessment of the current parameters and environments. It also needs both retrospective and prospective understanding of the two countries in relevant

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2014: YEAR-END REVIEW *continues*

economic, political and cultural terms, which are profoundly complex. Brinkmanship would not be an effective tactic. A gingerly and delicately executed treatment is in order.

The year 2014 appears to be an extension of another relatively low interest rate economy even with a modest interest rate increase, which is good for borrowing money to conduct business and corporate-finance activities. The 2013 U.S interest rate of 0.25% was at a historical low, far below the average (6%, with the all-time high of 20% in the 1980s), and the Eurozone was at 0.25%, also a record low, and U.K was at 0.50%.

In corporate America, a rising tide (stimulus and low interest rate) has raised all boats in the stock market. But many premier companies are taking a hard look at their business strategy and focusing on enhancing operating margin and profitability. It is an arduous and critical thinking process, but it has to be done in order to be competitive. This process includes where and how the cash-rich multinational corporations (collectively holding more than $1 trillion in cash) are going to invest—overseas or domestic; dividend increase or share buyback; operation expansion or mergers and acquisitions. The strategic outcome will impact the job market and the U.S. economy, as will government policies and tax reforms. At the date of this writing, December 1, 2013, the U.S. fiscal policy's holding pattern poses uncertainty and risks to the 2014 economy, and thus to corporate actions.

Judging from the Chinese government's decision not to pump funds into the economy and its implementation of new reform policies, the commodity prices, tightly linked with the supply and demand dynamics, are expected to stay flat or decline further. Another good sign is that U.S. manufacturing activity is in upward trajectory[2].

Going into 2014, the U.S. unemployment rate should see moderate improvement, hovering around 7%, but reaching the 6.5% milestone is perhaps a stretch, unless the new Fed Chair's emphasis on employment out of the central bank's dual mandate—maximum employment and stable prices—exerts "miracle" muscle on reducing unemployment. And the Eurozone continues to struggle with a double-digit high unemployment rate.

2014 is also the year that the U.S. Federal Reserve looks for clarity on growth in order to taper bond buying. In my view, the Fed should and perhaps would pare back the stimulus in the spring (if not in December 2013), at least moderately.

2014 is also the year that the U.S. Federal Reserve looks for clarity on growth in order to taper bond buying. In my view, the Fed should and perhaps would pare back the stimulus in the spring (if not in December 2013), at least moderately.

With increased underlying strength, the U.S. economy is expected to grow at a faster pace than 2013, barring political debacle in Washington. There is a good chance that the U.S. GDP may recover to 3% or better. Overall, for the first year since 2008, you don't have to be an optimist to see the glass as half full. And China's economy (as does its politics) continues to be a factor!"

What Happened in 2014:

Indeed, the U.S. economy improved in 2014. As of this writing, the U.S. GDP expanded at a seasonally adjusted rate of 3.50% in the third quarter over the previous quarter, according to the Bureau of Economic Analysis. It looks that 2014 will conclude with a GDP at 3.0% or better. With the improved economy and the controlled spending, the U.S. budget deficit has pushed down to 2.8% of GDP, the lowest level since 2008—a pleasing record!

The Federal Reserve ended its monthly bond-purchasing program and dropped a characterization of U.S. labor market slack as significant.

The U.S. unemployment rate reached below 6.0%, per the Labor Department, down to 5.8% as of November 7, 2014, which is better than I predicted. But whether the 5.8% accurately reflects the level of improvement is uncertain. This is due partially to the change in the labor participation rate as many unemployed may

have stayed out of the labor force, and some young people are staying in school for a longer period.

In other parts of the world, the Eurozone's recovery has been sluggish and Japan's Abenomics is still a work-in-progress, despite the stimulus programs. As expected, trouble spots with the standoff between China and Japan over territorial disputes in South China Sea did not blow up. Nonetheless, geopolitical risk has risen in 2014, especially with the resurgence of the Islamic State of Iraq and Syria (ISIS) and the escalating complexity of the Middle East politics vis-a-vis U.S. foreign policies.

Commodity prices, tightly linked with the supply and demand dynamics, have declined, also as predicted.

In corporate America, a rising tide (stimulus coupled with low interest rate) has raised all boats in market capitalization although stock prices have fluctuated far more than logic can justify. Companies that have not ridden the tide to take a hard look at their business strategy and to execute on enhancing operation efficiency and profitability are losing a precious opportunity. New evolving events toward the later part of the year (e.g., stronger dollar and lower oil prices) are expected to generate mixed forces in driving the corporate earnings in the fourth quarter.

For 2014, with lower energy prices and declining commodity prices, the impact of BRICS countries is largely supported by one country—as well said, for year 2014, the "brick" was China.

CHINA FACTOR

From January 2014 Outlook:

"China is gaining traction in global trade. The country has just hit another milestone as the use of the yuan (renminbi) in trade finance overtook the euro and the yen, although the yuan is still far behind the U.S. dollar. This is not to say that China's banking and financial systems are well established. However, this milestone indicates that foreign (non-Chinese) companies are getting more comfortable trading in yuan, in addition to garnering some pricing advantages.

It is crucial for China's new leadership to implement structural reforms in 2014. Within the context of "planned reform," the timing happens to be good from the standpoint of the state of the world economy.

With all three of its largest trading partners in a slow-growth mode, China has more a reason to gear up its consumption-oriented economy to spur long-term growth, sustainability and social stability. Its government increasingly recognizes the market role in economy in order to move to a sustainable path that will depend more on domestic demand and less on exports and government spending.

The country has just formed the National Development and Reform Commission to design and coordinate its reform. The new leading group's duties, apart from economic reforms, are to plan and carry out reform on modernizing China's "governance system" and "governance capability." The core issue of the reform is "to better handle the relationship between government and the market"[3]. With the formidable task in hand, the country's stability is the new leaders' number one "wants and needs." Consequently, the official growth target is not expected to be higher than 7%. However, take note that in practice, China has always exceeded its target in recent years. China's twelfth Five-Year Plan is the national master blueprint to achieve medium term economic and social objectives. The country must stay on its course to develop seven strategic priority industries: new energy (e.g., nuclear, solar, wind); energy conservation and environmental protection (e.g., energy reduction target); biotechnology (e.g., drugs, medical devices); new materials (e.g., high-end semiconductors, rare earth); new IT (e.g., broadband network); high-end equipment manufacturing (e.g., aerospace, telecom equipment); clean energy vehicles. China plans to provide financial and tax support to these industries over the next decade in hopes of making these sectors account for around 8% of China's GDP by 2015 and 15% by 2020. The broad-based goals to be achieved are: sustainable growth; moving up the value chain; reducing disparities; scientific innovation with R&D spending increase to 2.2% of GDP; environmental protection; energy efficiency; and domestic consumption.

2014: YEAR-END REVIEW *continues*

To foreign companies, these goals bear a plethora of business implications. I see specific opportunities in individual areas and industry sectors.

For Chinese companies, iconic branding is a dream come true. Many have gained understanding on what it takes to globalize through the thoroughly planned strategy executed relentlessly over sustainable years—Samsung and Singapore Airlines are two admirable models. As more indigenous companies aspire to be a global brand, more global competition in all industry sectors is in the works."

What Happened in 2014:

China's growth rate in 2014 was the slowest in five years, yet still above 7.2%. Their GDP target was around 7.5% and a figure slightly below this is acceptable to Beijing. It looks like it will finish the year with 7.2%, plus or minus 0.2%.

The country is moving from an investment to a consumption economy. A weaker yuan has flooded the financial system with cash, but it is expected to be transitory. China started working on the next Five-Year Plan (2016–2020)—specifically refining its original technologies and weeding out corruption.

Alibaba made history by listing its shares on the New York Stock Exchange and becoming the biggest IPO in history with a value of $25 billion. As one of the largest e-commerce companies in the world, the company is not a Chinese company any more, rather spreading its influence around the world by indeed becoming a global brand.

ELECTRONICS INDUSTRY—HARDWARE

From January 2014 Outlook:

"Five words cover the essence of electronics hardware: smart, mobility, connectivity, wearability and innovation. Technology never holds still. Technology advances will prop further mobility and connectivity in 2014. The growth and volume of electronics hardware will be driven by mobile devices, and high-reliability and high-performance electronics will propel new materials innovation. In semiconductor sector, Intel, the top captive semiconductor manufacturer since its inception, made an astounding announcement that the company will open up its fab factories to outside business, serving as foundries as well. The company will compete head-on with other giants, such as Samsung and Taiwan Semiconductor Manufacturing Company (TSMC). Its unprecedented strategy of giving up its long-standing captive status will change the dynamic of foundries business among the top players, and may spill over to the industry.

In manufacturing technology, 28 nm node has demonstrated high yield and low-cost manufacturing. Samsung and TSMC reportedly will use the 20 nm node technology to manufacture Apple chips in 2014. Additionally, the manufacturing prowess in 14 nm node will be unveiled by Intel. As the 20 nm is being established, 2014 is also the year to lay the ground work for developing 10 nm capability on 450 mm wafers. Building chips on 450 mm wafers in volume production is moving forward by both OEMs and foundry manufacturers. Establishing 450 mm wafers are a major technological move, so is to further shrink transistors below 20 nm. These plans and commitments will lead to further advances in the chip industry to deliver increased functionalities and reduced cost in electronic and optoelectronic products that serve abroad spectrum of industries. In the wafer fab equipment market, a year-over-year growth rate of more than 30% brings 2014 to the projected spending of $39.5 billion. In optoelectronics, new materials for LEDs, such as gallium nitride-on-silicon, is expected to see market penetration in 2014. As ICs move to 20 nm and below, a continuing effort to make the next levels of connections to reach the end-use products calls for new designs and new materials in the second level IC packages and the third level connection in PCBs.

In 2014, major new thrusts are not in sight for the second and third levels of inter-connections, yet activities are abundant that offer gradual technological advances, including optical inter-connections, embedded devices and printed electronics. The development in high-density packages, including 3D packages, system-in-package and BTC packages will continue. Overcoming the design and manufacturing

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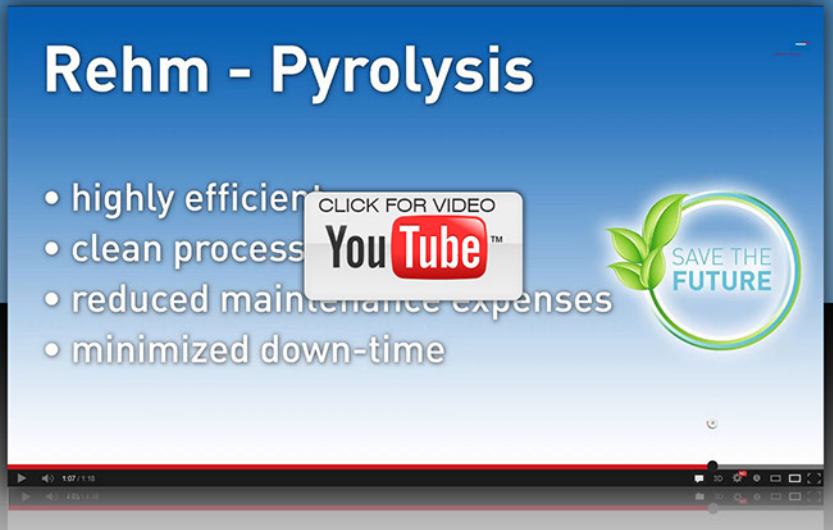

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2014: YEAR-END REVIEW *continues*

hurdles, the packages with 0.3 mm pitch BGA architecture will be entering into the mainstream. To maximize the yield and reduce cost, PCBs' thermal stability, under the high manufacturing temperature imposed by the assembly process, continues to be the most critical performance parameter. Although a PCB possessing a higher glass transition temperature (T_g) is readily available, T_g, per se, does not represent the PCB's heat tolerance ability. Other properties, such as mechanical properties, thermal decomposition temperature, thermal expansion over a temperature range, out-of-plane and in-plane thermal expansion and moisture absorption all contribute to the overall performance (i.e., internal structure integrity)."

What Happened in 2014:

On technological innovations, both "big ideas" and "incremental advances" have happened in 2014. Prominent among them are the plans of two leading companies. IBM announced that it pledged to spend $3 billion over five years on semiconductor research toward two major tasks—tackling technical obstacles to the miniaturization of circuitry on conventional silicon chips, and developing alternative materials and technology to keep boosting computing speed while consuming less energy. The latter includes replacing silicon with graphene—a thin film of pure carbon or structure called nanotubes. Other research includes neurosynaptic computing—a departure from the conventional computer designs that is expected to work more like a human brain and quantum computing. The ultimate goal is to overcome obstacles to shrink circuitry to seven nanometers.

In response to market demands, Intel is incorporating more advanced technology into tablets and smartphones. To pack more computing capability into a smaller space, a new manufacturing process that creates chips with circuitry measuring 14 nm is rapidly improving yields. Intel plans to advance two generations of chip production process, which are expected to reduce circuit dimensions to seven nanometers. Intel opened up its fab factories to outside business, serving as foundries. Panasonic, as one of Intel's customers, will make SoCs in a low-power flavor of Intel's 14 nm process technology.

In looking at electronic hardware, this year's story cannot be complete without mentioning the unprecedented and unparalleled performance of F-22.

F-22 made its combat debut in September 2014. The all-weather stealth tactical fighter jet developed for the U.S. Air Force offers air superiority, ground attack, electronic warfare and signal intelligence. A headline that ran in the Wall Street Journal, September 24, 2014: "F-22 Flies its First Combat Mission" excited and energized me immensely. The Pentagon's most advanced fighter plane made its combat debut in the U.S.-led strikes on Syria serving a crucial mission that depends on stealth. The fulfilment of this insurmountable (at least currently) technology is incumbent upon the advanced electronics and sensor technology. Our industry plays a crucial part in the technology and I have, in a tiny part, contributed to establishing one of the many electronic parts. Personally and professionally (perhaps with some bias), I view this as the technology of the decade that truly shows force and power—an epitome of the beauty and brain combo!

SOLAR VOLTAIC MARKET AND TECHNOLOGY

From January 2014 Outlook:

"The painstaking rebalancing, consolidation and shakeout are ending. All signposts indicate that 2014 is looking brighter throughout the solar industry and the "healthy" companies that have served the solar sector during the boom and bust times will win big and the sustainers will be handsomely rewarded. Companies that have a solid strategy and have thus survived the last two-year "massacre" have raised their shipment guidance.

Overall, 2014 will be a rebounding year, with the explanation below. In 2014, the global end-use market will be growing or stabilizing—U.S., China and the rest of Asia-Pacific will grow and Europe will be stabilizing. Japan's lucrative feed-in tariff scheme will accelerate its solar deployment. Solar global GW installation will

hit 45–55 GW level. In the U.S., more than 9.4 GW of cumulative solar electric capacity was installed in 2013. The Federal Energy Regulatory Commission (FERC) stated that solar is one of the fastest-growing sources of new energy in the United States. To spur new solar deployment nationwide, FERC issued a new order that allows solar projects that meet certain requirements to qualify for a "fast track" interconnection process, thus eliminating the need for costly and time-consuming studies. This new development will help reduce interconnection bottlenecks. China's Bureau of Energy proposed to increase solar power installations from the previous target of 10 GW to 12 GW in 2014. The prevalent view is that reaching 15 GW is likely. This time around, on top of the elevated installation target to help the industry, Beijing is accelerating its build-up of solar power plants, which will undoubtedly help the solar panel sector. This action is expected to rectify any residual imbalance that wrecked the industry for the last two years in an extraordinary way. Obviously, this action is good for "healthy" pure-solar players who survived the two-year downturn, such as Canadian Solar, Trina, Yingli, and First Solar, but not the "unhealthy" companies, who are goners.

In photovoltaic cell technology, while thick film and thin film are co-existing in the marketplace, the quantum dot technology is burgeoning in the laboratory prototype, which is poised to leapfrog the existing technologies. In the marketplace, thin film has lost market share during last two years due to the market turmoil and lack of scale.

Going forward, the advanced thin technology coincides well with the future growth of mobile devices. In terms of regional market, there will be a market re-distribution geographically. The solar PV market is shifting from Europe to Asia Pacific. However, not to ignore Europe; it remains overall a vast pool of end demand for solar energy, accounting for nearly a third of global demand at 10–12 GW in 2014. Europe will be stable in 2014 and will remain a key region for business."

Going forward, the advanced thin technology coincides well with the future growth of mobile devices. In terms of regional market, there will be a market re-distribution geographically.

What Happened in 2014:

After three years of overcapacity and declining profits, global PV end-market demand set new records in 2014, varying with regions and nations. This does not mean PV has become a challenge-free sector. In terms of installation, the top five market leaders are China, Japan, U.S.A., U.K. and Germany. Other countries, such as Turkey, India, and Thailand, also started showing increased activities.

Companies that steered through turbulent waters in recent years continue to reap economic dividends. Among the new or innovative business alliances, Canadian Solar has joined a growing field of Chinese solar panel makers entering the risky business of speculative development in China, with its launch of a new locally-based fund for solar power construction. This business venture demonstrates the restored confidence in solar industry.

Solar cell technology is also moving forward. The applications of quantum-dot films and the technology of low-temperature, solution-processed, quantum-dot photovoltaic cells have made progress. Although there is still a long way to go before quantum-dot solar cells are commercially viable, the advances made are encouraging.

From January 2014 Outlook:

"The industry's technology and manufacturing are expected to move ahead with incremental improvements. On conflict mineral disclosure requirements, 2014 will be the first filing year to comply with the Securities and Exchange Commission (SEC) rule. The rule requires supply chain due diligence and specialized reporting by companies that manufacture or are contracted to manufacture products that contain certain minerals originating from the Democratic Republic of the Congo and adjoining countries. Conflict mineral disclosure re-

2014: YEAR-END REVIEW *continues*

quirements include specific elements—tungsten, tantalum, tin, gold and their derivatives. Make a note that the category of derivatives is a tricky area.

In 2014, more electronics sectors including medical devices will join the world of lead-free electronics to comply with RoHS. Additionally, RoHS will be deployed to more countries. Introduction of new or modified lead-free solder alloy materials will continue through sound scientific (metallurgical) execution in an effort to improve the performance and reliability and to alleviate production and reliability issues of tin-copper and tin-copper-silver systems. On reliability, high-quality work has been conducted and abundant data generated. One challenging effort is not to make a conclusion when a conclusion is not ready to be made. Publications that deviate from this principle are not in short supply. Going forward, it is hoped that this necessary principle would be followed so that reliability means reliability.

Overall, environmentally friendly electronics is becoming a given. Corporations' environmental stewardship for global sustainability, driven by regulations or other causes, continues to be one of important corporate business policies in 2014.

The conflict mineral disclosure requirements are being met in due course by the requiring companies. Lead-free has made incremental improvements and lead-free electronics is expanding to more industry sectors including medical devices, which will be outlined in 2014 forecast column. And the global sustainability is robust and marching on."

What Happened in 2014:

During 2014, a further deployment of lead-free electronics to a wider array of electronic products was on track. The implementation of conflict mineral disclosure requirements is also on schedule.

Global sustainability is robust and marching on. Corporations' environmental stewardship for global sustainability in 2014 was on their business agenda. According to the Governance & Accountability Institute, many American companies have published their own sustainability report. In 2013, 72% of the S&P 500 index filed such reports, up from 53% in 2012 and 20% in 2011.

Reportedly, legislation in Europe will soon require companies to disclose their impact on the environment and society. European investors are used to challenging corporations' sustainability goals around environmental, social and governance strategies. The belief is that if a company has strong sustainability or a good corporate responsibility performance, then financially it will outperform.

Upcoming Appearances

Dr. Hwang will present a lecture on "Preventing Manufacturing Defects and Product Failures" at IPC APEX EXPO on February 22, 2015 in San Diego, California. **SMT**

Dr. Hwang, an international businesswoman and speaker, and business and technology advisor, is a pioneer and long-standing contributor to SMT manufacturing since its inception, as well as to the global lead-free electronics implementation. Among her many awards and honors, she is inducted to the International Hall of Fame—Women in Technology, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, and CEO of International Electronic Materials Corp., she is currently CEO of H-Technologies Group, providing business, technology and manufacturing solutions. She has served on the U.S. Commerce Department's Export Council, Chairman of Assessment Panel on DoD Army Research Laboratory, various national panels/committees, and the board of Fortune 500 NY SE companies and civic and university boards. She is the author of 400+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as the Harvard Business School Executive Program and Columbia University Corporate Governance Program. For further info, visit JennieHwang.com. To read past columns, click here.

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Outlook for 2015 and Beyond: A Supply Chain Perspective

by Yash Sutariya
ALPHA CIRCUIT CORPORATION,
SATURN ELECTRONICS CORPORATION

In "The Terminator" movie series, an artificial intelligence network known as Skynet wipes out most of mankind. It nearly succeeds in wiping out all mankind, but from the ashes emerges the Resistance. The Resistance is made up of survivors who, despite their weakened condition, have the will to survive and fight for existence.

This more or less describes the PCB fabrication industry over the past 15 years, except instead of Arnold Schwarzenegger and Skynet, we are trying to survive in the face of relentless competition from China and other emerging markets.

On our side, instead of someone cool like John Connor, our industry is unfortunately dominated by folks nearing or in their 60s, but at least they have the fight in them of Arthur Spooner, Jerry Stiller's character on "King of Queens." When you think about it, though, China isn't Skynet. Rather, what caused this drastic change was actually the free market system. In a free market, the prices for goods and services are set freely between sellers and consumers based on levels of supply and demand.

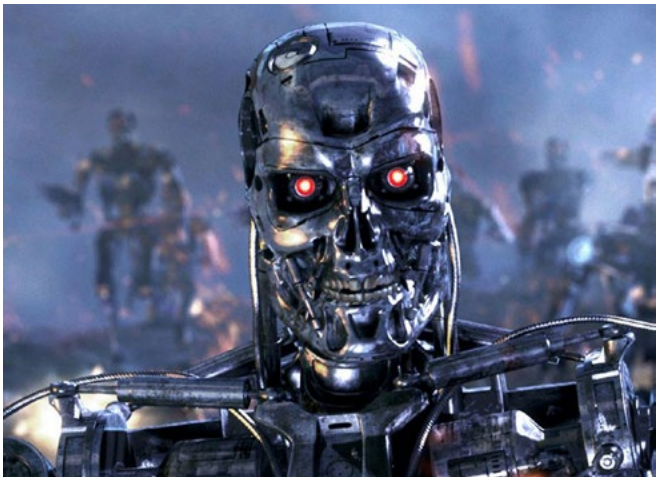

Figure 1: The Terminator.

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OUTLOOK FOR 2015 AND BEYOND: A SUPPLY CHAIN PERSPECTIVE *continues*

As Chinese manufacturers ramped up capacity from 2000–2002, they offered prices far below what domestic manufacturers could charge, resulting in a decimation of the North American PCB fabrication industry.

Events from 2000–2002 (the Downswing)

From a population of more than 700 PCB fabricators in 2000, we now number less than 300. More importantly, the North American PCB fabrication capacity has shrunk by closer to 70–80%, depending on whose estimates you go by. For certain technologies, the reduction in production capacity is even more drastic.

Events from 2002–2014 (the Upswing)

Once the dust settled, North American production plummeted from approximately $12.0 billion in 2000 to about $3.5–$4.0 billion in 2002. The remaining list of PCB fabricators ranked by size mimicked the much talked about income disparity between us and the "one percenters."

Events occurring since 2006 have resulted in the list becoming gradually more and more top-heavy as a result of considerable M&A activity:

2006

TTM acquires Tyco's PCB division: This is a situation where a high-volume, high-tech company acquires a high-tech and high-volume military operation. Note: Tyco's Stafford, Connecticut plant is the single largest supplier of military PCBs.

2009

TTM acquires Meadville: TTM doubles its size by purchasing Meadville, whose operations and ownership are based in China. Chinese ownership of TTM is now 45% of outstanding shares. DoD cites national security protection and requires firewalls to be set up between military and non-military operations as well as three seats on the board of directors.

2009

Viasystems acquires Merix: High-volume, overseas automotive producer acquires domestic high-volume, high-tech producer.

Ranking	Company	N.A. Sales ($ in millions)
1	TTM	$ 561
2	DDi (incl. Coretec)	$ 260
3	Viasystems (incl. Merix)	$ 148
4	EIT	$ 132
5	Sanmina-SCI	$ 125
6	Amphenol	$ 70
7	Advanced Circuits	$ 70
8	Multek	$ 48
9	Pioneer	$ 44
10	Harbor	$ 43
		$ 1,501
	Total Industry (est.)	$ 4,000
	Top 10 as % of Total	38%

Figure 2: Make sure all the eggs are in one basket.

2009

DDi acquires Coretec: Mixed-volume producer with advanced technologies and significant military gains high-volume mixed technologies with a small military presence.

By 2010, the top 10 PCB fabricators accounted for more than 25% of the entire market. Actually, it's even more if you consider that it's estimated that 25–30% of the remaining market value is comprised of PCBs produced overseas and resold by domestic fabricators.

Further exacerbating the revenue disparity, we have recently witnessed two mega-mergers that should result in a single entity producing up to 40% of North American production.

2012

Viasystems acquires DDi: Roll-up of mixed volumes and capabilities with primary North American presence.

2014

TTM acquires Viasystems: Creates one of largest PCB fabricators in the world. It also accounts for a large portion of U.S. military-certified PCB production facilities.

Based on published data, we can surmise that the combined entity's military revenue is approximately $370 million. The military mar-

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ket for PCBs is estimated to be about $1.05–$1.23 billion, with approximately one-third being sourced from overseas vendors, leaving about $670–$800 million produced domestically. Based on these industry estimates, we can surmise that the TTM/Viasystems combination now accounts for approximately 46–55% of that production basis.

For purposes of this discussion, we'll put aside obvious conflicts of national security and focus on the strictly commercial issue of supply chain security.

A simple financial analysis shows that there should be some concern for the long term. Both companies have posted losses in the previous 12 months' SEC filings, and now post a combined debtload of over $1.2 billion. (Of course, a refinancing of the Viasystems debt should reduce interest expense substantially from the current ~$44 million annual expense.) However, unless operations are modified to increase operating results substantially, this combination warrants monitoring from a supply chain security standpoint.

"The data can be cross-sectioned in another direction to look at capacity by capability. The majority of remaining PCB manufacturers are only capable of producing standard 2–6 layer technologies. Deep gaps now exist for simpler capabilities such as carbon printing and high-volume single- and double-sided boards."

Other Markets

At least the military users have numbers to go over. Domestic suppliers for the automotive and telecommunications markets rarely show up on the radar anymore. In fact, we are down to only three TS16949 Automotive Production-certified manufacturers in North America, with a combined capacity to produce perhaps only 5–10% of estimated North American usage, and that's with purging a good percentage of their current customer base.

The data can be cross-sectioned in another direction to look at capacity by capability. The majority of remaining PCB manufacturers are only capable of producing standard 2–6 layer technologies. Deep gaps now exist for simpler capabilities such as carbon printing and high-volume single- and double-sided boards. Volume capabilities are also limited for higher technologies that include blind/buried vias, RF/microwave, and higher layer-count PCBs. While volume production may not jibe with North American manufacturing, we do need to have backup for overseas production issues and surges in demand.

In a nutshell, while the data is more detailed regarding the supply to the military market, all end-users are now at a greater risk for supply chain disruption than ever before.

What can be Done?

I propose that the same free-market system that brought our industry down will help bring strength back to the industry. End-users are now more discerning about which companies can enter their supply chain, even to the point of performing financial analysis on the long-term health of each supplier.

This approach only calculates the safety of the existing supply chain. Some end-users may find that the existing supply chain participants collectively do not come close to offering enough capacity to insure some amount of safety. Taking another lesson from Skynet, the solution may lie back in time. In our case, we need to pull a term from the 1990s: strategic supplier development.

Strategic Supplier Development

My personal experience is from the automotive industry, but this practice has been used across almost all industries at some point or another. The premise is that in order to increase supply chain security and lower cost, you must increase supply. To do this, you need to grow your own supply chain given the current state of the industry. So, let's come up with a plan.

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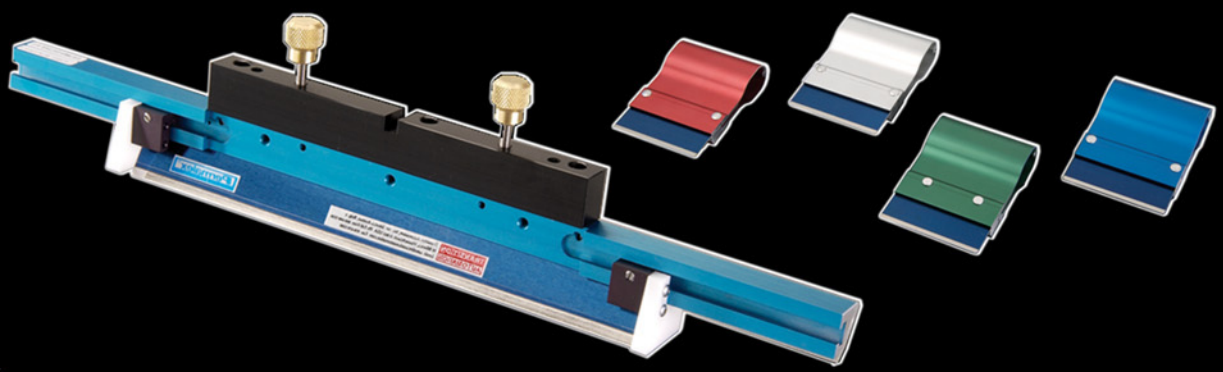

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OUTLOOK FOR 2015 AND BEYOND: A SUPPLY CHAIN PERSPECTIVE *continues*

Identify

It's one thing to identify potential suppliers when they are in abundance. It's another to identify a potential supplier that doesn't yet exist. The best place to start would be by filtering through your existing suppliers. Metrics such as defect rates, on-time deliveries, and feedback from purchasing and supply chain folks is a great start. Another is industry research. We often know much about our competitors, but little about members of our supply base's industry. Internet research will identify those potential suppliers that are taking steps to improve themselves and, as a result, are making the news.

Another idea is to see who is exhibiting at trade shows. Pre-show advertising and the robustness of associated websites means you don't even need to attend a show to know who is exhibiting.

And last, but not least, there are services geared towards helping the purchasing community identify potential PCB suppliers, such as The PCB List.

Educate

Larger suppliers and customers have open access to business improvement tools such as Kaizen, 6S, 6 Sigma, and Lean that can make them more efficient manufacturers. Other business tools for improved inventory turns, cash flow management, and business plan formulation are oft overlooked in small companies, but can add great benefits for the long term. Mentorship programs with the supply base can aid in this type of knowledge transfer. Once implemented at the supplier, these improvements can pay dividends indefinitely both to the supplier and yourself as the customer in the form of cost improvements and a more robust supply base.

Another area of concern for suppliers is obtaining certifications. These could include TS16949 (automotive), AS9100 (aerospace), Mil-Prf-31032 (military), and ISO14000 (environmental). Smaller suppliers often don't have the resources to read and interpret the standards from scratch. However, customers have often already earned these certifications and have training programs for their quality control personnel. These same training programs can help a supplier leap towards achieving higher-level certifications than the standard ISO9000.

"Larger suppliers and customers have open access to business improvement tools such as Kaizen, 6S, 6 Sigma, and Lean that can make them more efficient manufacturers. Other business tools for improved inventory turns, cash flow management, and business plan formulation are oft overlooked in small companies, but can add great benefits for the long term."

Support

Supplier development in many cases will require investment. This is typically a cart before the horse situation in which the supplier needs the added business in order to facilitate the investment, and the customer needs the supplier to make the investments in order to award additional business. There can be a compromise that could limit risk and open opportunity for both parties.

While it goes against the core of what has become the norm for purchasing, customers could help fund gradual investment programs in systems and capabilities via increased prices on goods currently purchased from those suppliers. Of course, this would have to be open book on both parties' sides wherein the increased profits are scheduled for discrete investments. The long-term understanding would be that the price increases would be scaled back over time as investments are completed.

Incentivize

At the onset of engaging in a supplier development program, it's critical to outline strict action items and goals on the part of the supplier. From the customer standpoint, you need to outline the incentives for the supplier in order to achieve those goals. Namely, long-term supply programs give suppliers the ability to create

long-term plans that would include re-investment, training, and technology/capability development. The lack of long-term visibility is the number one reason for the insufficient levels of reinvestment the PCB fabrication industry has had over the past 15 years. Giving them long-term visibility is the single most important gift a customer can give.

Sustain

We all know what happened when we pulled out of Iraq and Afghanistan too early: The mission failed. The same logic applies to supplier development. This is a multiyear effort that requires many more years of monitoring and plan tweaking. Quarterly business reviews are effective tools for helping achieving this. Metrics such as defect levels, delivery performance, and technology/capability achievements can be reviewed along with interim goals. Also, early warning systems can be developed to catch potential issues before they cause the train to come off the tracks.

Conclusion

Given the record corporate profits, potential political instability, and constant opportunities for supply chain disruption, now is the ideal and critical time for OEMs and Tier 1 suppliers to resurrect their strategic supplier development programs. These can be structured to utilize existing resources at the customer level to minimize cost, while maximizing the long-term benefit. You just have to focus on the long-term benefits rather than dwell on short-term cost impacts. **SMT**

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Yash Sutariya is president of Alpha Circuit Corporation. For more information, or to contact Sutariya, click here: ysutariya@alphacircuit.com.

THE ESSENTIAL PIONEER'S SURVIVAL GUIDE

The Future of SMT: Welcome to the 4th Dimension

by Michael Ford
MENTOR GRAPHICS

In the coming year, significant gains can be made through the understanding and acceptance of how market-delivery demand patterns are changing. Some entrepreneurs are already making serious money taking advantage of weaknesses in legacy distribution systems and traditional business shortcomings. A revolution in PCB-based electronics manufacturing is about to happen, driven by the same underlying principles behind the more general Industry 4.0 innovation currently discussed in Germany. This will act not only to drive a new wave of manufacturing competitiveness in the market, but will also bring home production traditionally regarded as being more cost-effective from countries with lower labor costs. The catalyst for these changes lies in the 4th dimension.

Time is generally regarded as being the 4th dimension. We are all time-travelers in a sense, travelling at roughly the same speed. Those who spend excessive hours flying around the globe may be slowing by an odd micro-second, but it is hardly significant; it seems only Superman gets the breaks.

If Superman actually existed, he could do worse than to start a new career in distribution. The manufacturing cost of goods made, for example in China, is a mere fraction of the price paid at retail. Taking out the costs of design, sales, marketing, and management overheads,

Figure 1: "The restrictive nature of SMT production has severely limited factory responsiveness to short term delivery demand changes. The time for a change is now."

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a very large part of the price per unit goes into the distribution of the product, from the door of the factory into the hands of the customer. In addition to cost, time to market is a key factor to consider, because products with the latest technology, many of which are being purchased like fashion items, command the highest opportunity for profit margin, but only for short times. The contribution of cost from distribution, including depreciation in the value of products through the long distribution process, has reached the tipping point as compared to base manufacturing costs, assuming company overhead, sales, and marketing costs remain the same.

This is the trigger for the need to look at the next step in manufacturing evolution. As airfreight costs are only going in one direction, and shipping by land or sea simply takes too long, it points us toward the old fundamental principle of "manufacturer close to the market"—reinvented.

It Was Acceptable in the '90s

In the 1990s, when many companies were considering the movement of serious amounts of manufacturing offshore to lower labor cost countries, many cost factors were considered but not all of them were considered seriously. The cost of transportation was raised, but was offset by the economy of scale associated with the size and volume of cargo ships coming out of places such as China, as well as the fact that products had to be shipped to various places in the world anyway. The cost of additional warehousing stages was also dismissed as insignificant. Assessment of risk found no significant change either because manufacturing was already dependent on raw materials coming from remote locations, so with a little due diligence and sufficient insurance, this issue also left the table. The cost to create manufacturing facilities offshore was then offset by the rapid growth in electronics manufacturing services (EMS) companies, who saw this as a massive growth potential, bringing the offshore opportunity to operations of all sizes. This seemed to be the end of the story, but recently however, two critical issues have emerged as being far more dominant than were once thought.

The True Costs of Offshore Manufacturing

SMT chip-based technologies continue to evolve, providing new functionality and faster services in smaller packages, and more power-friendly devices. All of these cause excitement in the market, triggering demand. The Apple iPhone 6 launch broke records for pre-orders on the first day, before anyone had even seen the phone itself, double the number previously for the iPhone 5. These sales are mostly for replacement devices, driven by the latest technology which has become fashionable, something that people like to show off.

Product availability is expected to meet the huge initial demand from customers. With the threat of rival products coming into the market from competitors, being just a few days or weeks earlier or later can have a huge effect on the period of profitability of a product. The time to market is therefore an extremely important issue. Design systems for electronic products have come a long way in recent years to ensure that modular design elements can be tweaked and re-used so that each new technology can be integrated far more rapidly into a new product. The market-leading PCB layout tools today offer the opportunity for layout designers to work concurrently on a design, reducing lead-time significantly. Material selection and manufacturing constraints are accounted for during the layout process in a way that is seamless to the layout designer. The completed PCB design is ready for fabrication and then on to assembly with a hugely reduced risk of re-spins and delays. The focus in the new product introduction (NPI) process now shifts to the factory and product distribution.

Products are traditionally dispatched from the factory into a series of distribution hubs and warehouses, until they end up in the storeroom of a local shop, whether commercial or retail, or as a key sub-assembly going into another product. This distribution chain has a critical effect on the time to market. Before sales of a new product can start, stock has to be built up throughout the whole distribution chain so as to ensure smooth supply and delivery to the point of sale ready for product launch, which takes time and investment. If the product is unavailable to a customer, a good salesman will

always offer an alternative, especially if a good deal is to be had, so sales opportunities for the intended product are lost.

With so many products in the distribution chain, there is a high risk of depreciation in the value of the products. Toward the end of life, or whenever a major new product comes into the market from a competitor, the value of all of the products in the distribution chain can collapse. There are many cases where products such as mobile handset units, because of the short lifespan of each model, have depreciated to the level where no profit could be made, or worse. Pressure has been to reduce the size of the distribution chain in recent years, reducing both the time that it takes to ship products to their final destinations and the stock levels at each stage. In the case of at least one key mobile handset manufacturer, a factory in China was purposefully located near an airport. The finished goods come off the production line and are almost immediately air-shipped to the end customers. The cost of air freight was more than justified by the avoidance of depreciation issues and other costs associated with the traditional distribution chain. This is no longer a one-off example, and it is no longer even under the control of the manufacturing company.

"In the case of at least one key mobile handset manufacturer, a factory in China was purposefully located near an airport. The finished goods come off the production line and are almost immediately air-shipped to the end customers. The cost of air freight was more than justified by the avoidance of depreciation issues and other costs associated with the traditional distribution chain."

Common consumer items, such as the latest designs of LED light bulbs, are now available through Internet shopping sites such as Amazon, eBay, or Alibaba, sourced directly from China at a fraction of the cost of those coming to the United Kingdom through a regular distribution chain. Entrepreneurs create small companies, each with some arrangement for sourcing local new and exciting technology, and more recently pretty much any other product that comes along. Even figuring in the cost of direct shipping by air for individual items will not raise the price close to the price otherwise sought in the United Kingdom. Shipping by land or sea makes direct purchase even cheaper, if the customer is prepared to wait.

Effects on the Factory

The reduction of the distribution chain is limited by having factories based in locations remote to the market that they serve, which forces companies to either accept the cost of direct shipment, or, face the consequences of the regular distribution system, with perhaps a reduced number of stages and a lower quantity of stock maintained at each. Whether the company is manufacturing its own products as an OEM, or as an EMS provider, the shorter the distribution chain from factory to the customer, the fewer the quantity of products acting as a buffer for short-term changes in customer demand. This in turn brings a higher risk and incidence to the factory in receiving sudden changes of delivery schedules.

The factory then has two choices. It can augment the dwindled distribution chain stock by holding greater quantities of products as finished goods on site, allowing factory schedules and operation styles to remain unchanged, but increasing the cost of stock including the effects of depreciation. The alternative is to create a factory operation that is more directly responsive to the changing delivery demand. This has to be implemented, however, without any reduction in capacity or productivity. It requires a whole new style of factory operation.

Bringing Manufacturing Home—The Theory

The enticement is that if the factory operation can be changed in this way, then a minimal distribution chain is required. Elimination

of the majority of the distribution cost can be done by moving the factory close to the target market. The critical issue is whether the reduced costs of distribution can exceed any increase in the cost of manufacturing. On-shore labor will be more expensive, but today, this is a diminishing factor of the overall product price with improvements in process automation.

Just a Couple of Problems

Any move to onshoring will not happen overnight, any more than the move offshore did. There are some key issues to deal with. The first is related to materials and key components. With the majority of manufacturing currently offshore, most of the very high-volume raw material sources are also offshore. It is possible to ship the raw materials in, and it may even be more cost-efficient as most raw materials are common to many products and assembly manufacturers, especially with the help of distributors. The change happens, however, once onshore raw materials manufacturers get back into gear. Many of these companies still exist, as some manufacturing never went over to lower cost areas, significantly suppliers to the safety critical areas of aerospace, military, some medical, and automotive.

The key question is whether there is a critical mass remaining to once again ramp up volume for regular electronics manufacturing. Another issue is how to change the manufacturing operation into one that is flexible enough to respond to potentially volatile changes in "local" customer delivery demand. This is where our 4th dimension advanced manufacturing control software comes in.

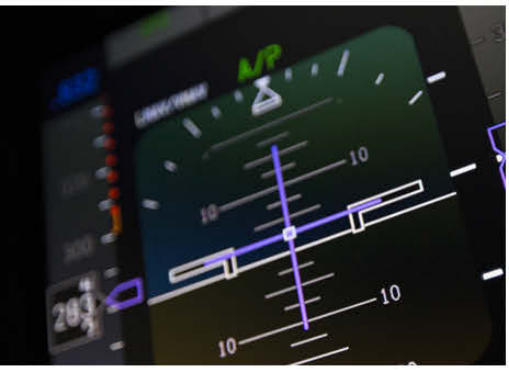
Manufacturing Software Challenges

The principle of an intelligent factory engine, such as that which the German "Industry 4.0" initiative defines, where products "self-route" to assembly stations, is an idea that certainly satisfies the end goal of short-term flexibility. It brings up the question of capacity and productivity, however, when comparing mass high-volume production to what is effectively just an automated "build to order." This is where the intelligence that governs the operation is critical. In the complex world of SMT, however, we know as a result of our direct experience that as flexibility increases, productivity declines. Even though SMT machines are already very flexible, there are certain intrinsic elements related to the hundreds or even thousands of instances of SMT materials that are needed to make each electronic product. Solutions to solve this issue, such as by putting more machines in line so as to have enough material feeder locations available to be able to produce any product at any time, has been tried already. The result was that for each product variant, very significant time is lost as each machine and line and optimization was severely compromised. This model cannot work because of the inevitable reduction of capacity and the decrease of productivity. To get a truly flexibility solution, we have to look beyond the machines and lines, toward planning.

"Even though SMT machines are already very flexible, there are certain intrinsic elements related to the hundreds or even thousands of instances of SMT materials that are needed to make each electronic product. Solutions to solve this issue, such as by putting more machines in line so as to have enough material feeder locations available to be able to produce any product at any time, has been tried already."

4-Dimensional SMT Optimization

With today's SMT planning tools, however, a chicken-and-egg situation exists because shop-floor planning tools cannot consider complex material grouping requirements of SMT for efficiency, and SMT-based tools cannot perform decisions related to the selection of products into groups according to shop-floor delivery needs. Both end up being separate steps, or categories, of optimization. Doing either step first places restrictions through assumptions handed-off to



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THE FUTURE OF SMT: WELCOME TO THE 4TH DIMENSION *continues*

the second. Were it possible, optimizing both steps in one would effectively create the flexibility needed for the factory, while retaining productivity as near to that of running high volume. A subtle change in the way that we approach planning optimization in the future will have a profound effect on the operation of the factory.

We need to look at each of the elements to understand the elements involved in the optimization of SMT production. From the SMT-machine-based tool perspective, traditional SMT optimization relates to the machine environment, making sure that the machines and lines are themselves fully optimized. At the base level, each SMT machine program is optimized to ensure that the machine is adding value for as much of the operating time as possible, without needless actions that slow performance. To put just this level of optimization into perspective, if every possible sequence of SMT placement path were considered by a super-computer, it would take years of processing to find the best sequence. SMT optimization algorithms in themselves can be software "works of art," designed to avoid having to consider every possible permutation.

On top of this optimization, however, the overall work for each PCB must usually be split between the different SMT machines and other processes in the line. Line optimization ensures that the best machines are used for each material, and, that the execution times between machines in the line will end up being the same, balanced; after all, the line is only as fast as the slowest process. Going up another level in the SMT level optimization, there is then the consideration of the line down-time that is needed to change material setups at the machine between one product and the next. This can represent more operational loss time than any other optimization factor in higher mix manufacturing. This optimization is achieved through the commonisation of materials feeder setup positions across a group of different products that will run sequentially. The machine-level software will create the setup based on a given list of products.

These elements of SMT optimization can together be thought of as the "three dimensions of SMT optimization," and are supported by the best SMT programming tools currently available, either from machine vendors directly where only one vendor of machines is used in a line, or by third-party multi-vendor solutions. The weakness of these tools and the inherent barrier for them to overcome is that the choice of products with which to make the common material setups is left as an open input, not considered for optimization, and is usually taken from the output of the shop-floor planning system.

> ***Ideally, there should be one system to optimize the shop-floor planning together with the SMT optimization—the 4th dimension of SMT shop-floor optimization. Even with the smartest of algorithms, however, optimization of all four dimensions of this problem simultaneously is nowhere near (yet) the scope of today's computing power, so what can we do?***

Unfortunately, the shop-floor planning system also has the same weakness in that it is not able to understand or consider the SMT optimization criteria. It can only optimize based on standard planning criteria, which includes delivery requirements, materials and other resource availability, asset performance, and current shop-floor progress. Ideally, there should be one system to optimize the shop-floor planning together with the SMT optimization—the 4th dimension of SMT shop-floor optimization. Even with the smartest of algorithms, however, optimization of all four dimensions of this problem simultaneously is nowhere near (yet) the scope of today's computing power, so what can we do?

The Responsive Factory of the Future

The solution to our planning conundrum is to turn the problem on its head. Instead of the serious compromise being made by first opti-

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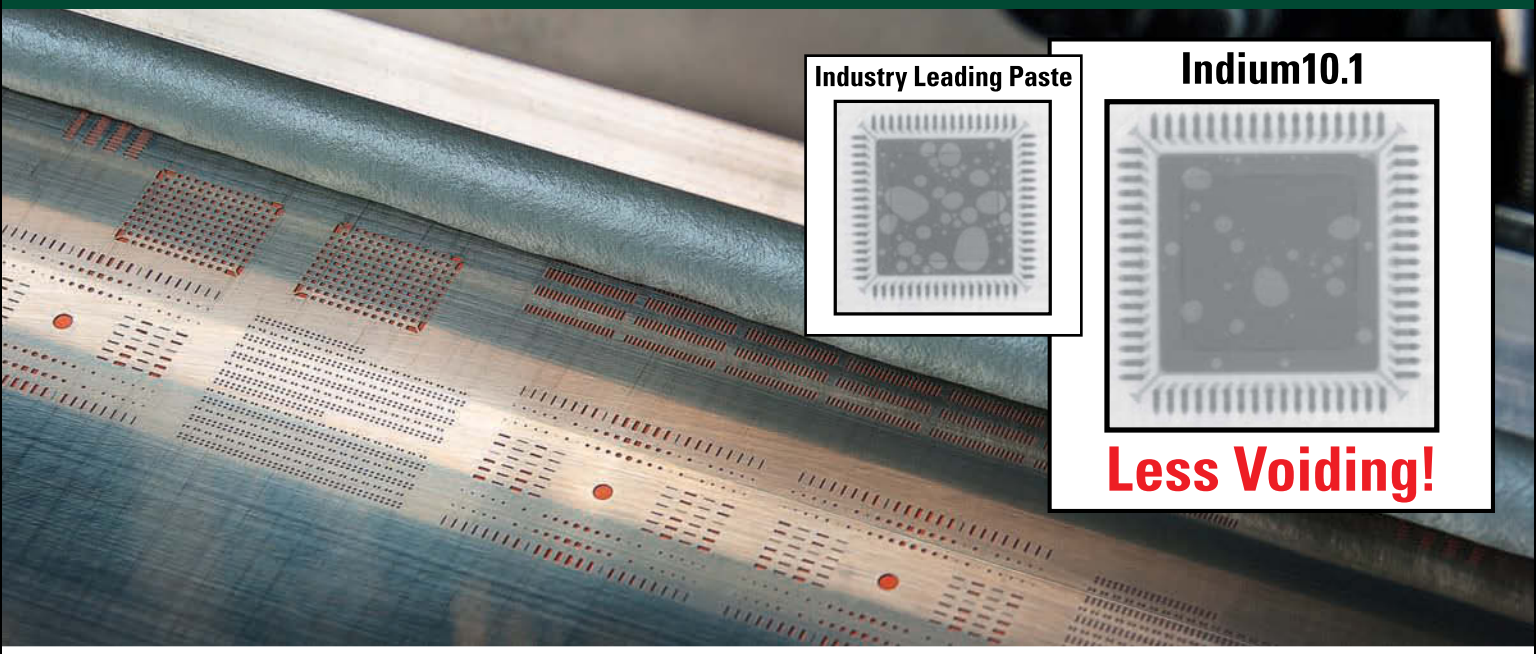

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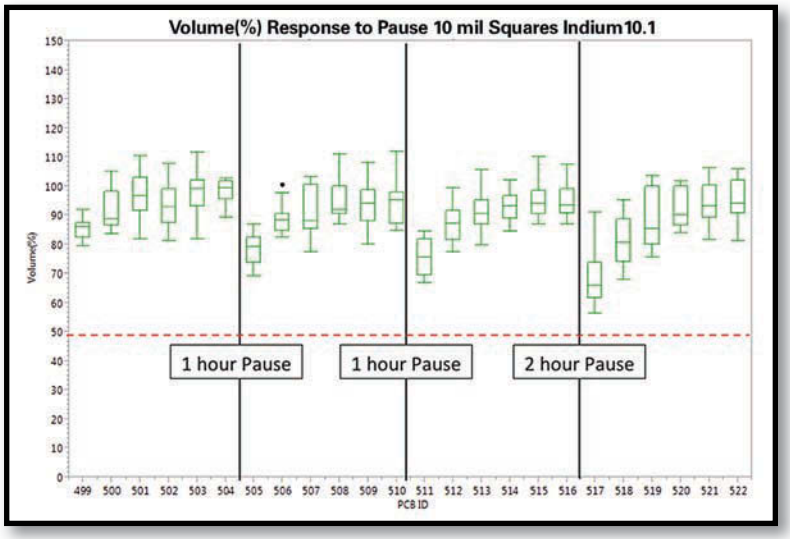

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mizing the three dimensions related to machine performance, and then thinking secondarily about delivery requirements, optimize the top three most significant dimensions first, leaving the relatively trivial SMT machine program as the second step.

This approach crucially allows the simultaneous optimization of the product mix for delivery and optimization of material grouping, qualified against the constraints and capabilities of the specific lines. The final optimization for the SMT machines can be performed with minimal risk of failure and high degree of expectation for machine sequence efficiency. In this way, the focus of the optimization as a whole is product delivery as it should be, but in this case of SMT, it is no longer hindered by assumptions and constraints made at the machine and line optimization stage.

"The ability to model and optimize the SMT factory based on customer needs is the solution to the trend in the market where the factory is now expected to be responsive to customer delivery demands, brought about by the many factors including the reduction or elimination of the distribution chain."

This type of specialist SMT shop-floor planning optimization software is now available, made possible by the access to key information about the operational status and progress of the shop-floor, materials availability, the engineering setup of each product, and the current customer delivery requirement. Having this information available electronically means that planning is not something that is done perhaps once every month or three months. Instead, it can be incrementally changing, a rolling plan repeated every day if necessary, bringing the flexibility to respond to changes in requirements almost immediately. Limitations in the availability, accuracy, and timeliness of data on the shop-floor have thwarted the creation of such live planning optimization technology in the past. It has led to the momentum of the machine-centric optimization model that actually does not make sense because it is rarely an optimization of the factory based on what the customer needs. This is the critical issue that now has been solved.

The New World Orders

You might be thinking that this seems like a fairly insignificant change, not really something grand enough to trigger a change in the way that the market works, even where companies choose to be located. Wrong! The ability to model and optimize the SMT factory based on customer needs is the solution to the trend in the market where the factory is now expected to be responsive to customer delivery demands, brought about by the many factors including the reduction or elimination of the distribution chain. Saving costs of distribution in a way that allows the factory to remain efficient exceeds in many cases the incremental costs of labor, comparing low- and high-cost locations. This is the key initial factor to allow manufacturing to come back on-shore, which could make manufacturing "sexy" again. With amazing strides in automation (the real robots are coming!), the streamlined flexible operation making fashionable electronics products based on latest technologies is an exciting place to be.

Whether existing OEM companies take this initiative, or once again creative and competitive EMS companies provide opportunity, or indeed like the Chinese entrepreneurs, the advantage is taken by new players coming into the market, we can start to establish a new paradigm of on-shore manufacturing. The whole industry could be reborn. Just as well if you think about it because there is already a great deal of labor around now that the distribution side of the industry has been waning rapidly. This is where it all comes together again. **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.

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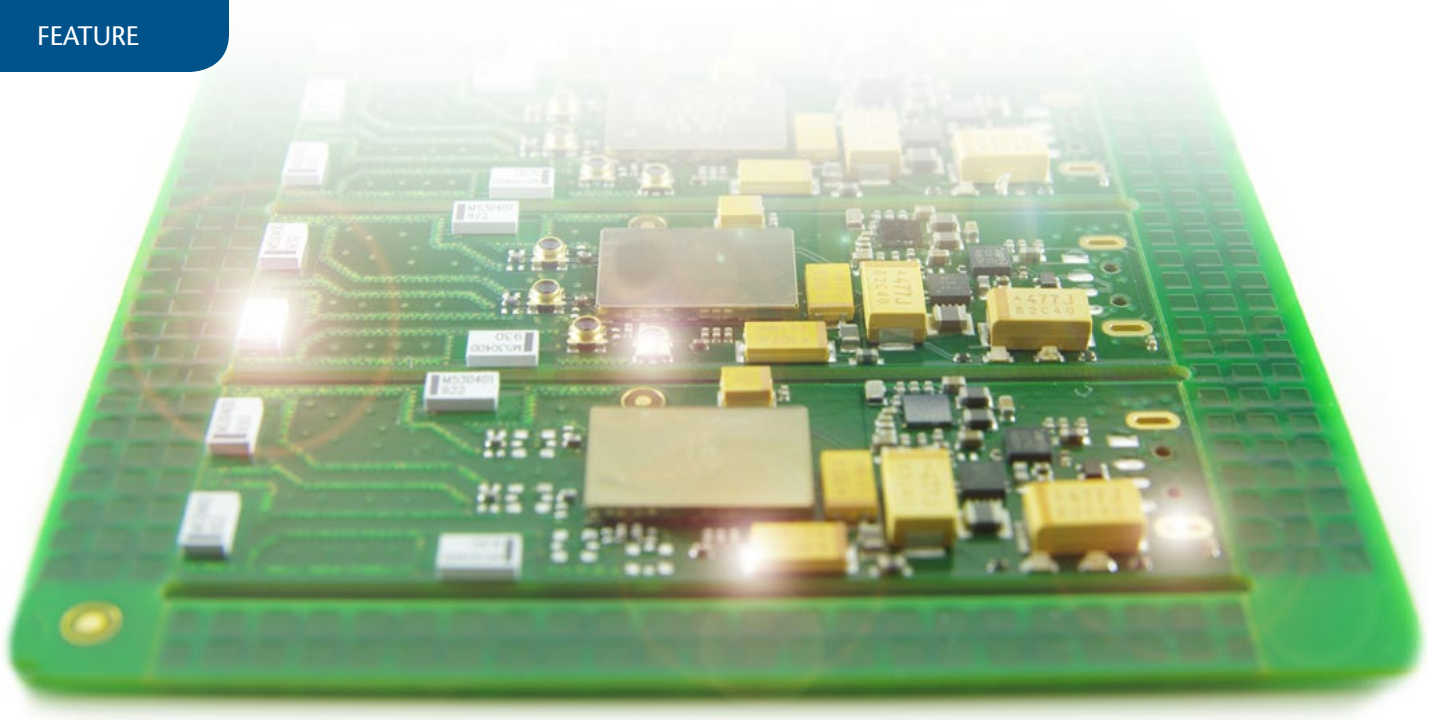

Surface Mount Technology Advancements in 2015

by Mulugeta Abtew
SANMINA

People take for granted that electronics development advances at a breathtaking pace—particularly in consumer electronics. But OEMs in telecommunications and mission-critical applications, such as medical and aerospace, are also demanding increased speed and new technology in the PCBs and PCBAs required for complex electronic equipment. Years ago, these advancements in technology would have been developed in many instances by major OEMs. But now, these OEMs have come to depend on EMS providers to make the necessary advances in core technologies and processes in order to deliver these innovations.

SMT is evolving as a result of new components coming into the market. In the early 1980s, a 64-pin ball grid array (BGA) was considered a high pin-count device. In 2014, BGA devices are in production with up to 3,700 terminations. Similarly, bottom-terminated components (BTC) evolved in the 1990s from having just a dozen pins to 200–300 pins today.

Meanwhile, pad pitch continues to shrink, going from between 1 mm and 1.5 mm several years ago to production pitches of 0.4 mm or less today. Pad pitch limitations are driven by various factors, namely PCB via pitch, via technology (e.g., stacked vias) and line pitch currently between 2.5 and 3 mils for most production PCBs. Another driver is speed, increasing

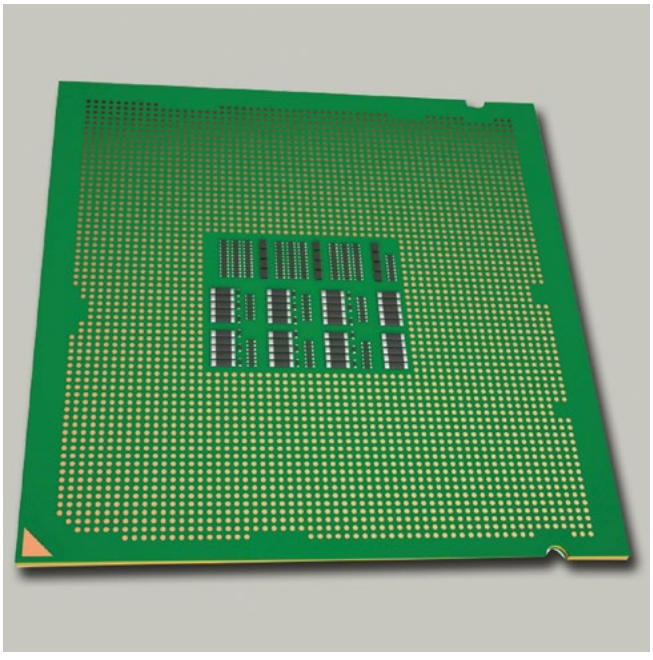

Figure 1: Typical high pin count PCB pad array.

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power and mixed signal integration with power and ground pins for different power domains. Also, PCB designers want passive components as close to a chip's power and ground pins as possible to improve decoupling. Finally, PCB technology is being driven to minimize chip-to-chip spacing in order to increase speed and signal integrity. Increasing performance at a lower cost drives demand for BTC. These designs with tighter chip and component spacing however, present challenges if rework is required.

Tier 1 OEMs have increasingly turned to vertically integrated EMS providers to develop the technologies needed to bring complex, high-performance products to market. Some of the key technology challenges OEMS and EMS providers are working to solve include: minimizing voids in BTCs; reducing the pitch between components while reserving sufficient space for rework; eliminating head-on-pillow defects in connections; and improving the robustness of PCBs used in high-temperature and/or corrosive industrial environments such as oil and gas exploration.

These issues continue to drive extraordinary advances in SMT processes as the number of terminations increase and pad pitch decreases. Here is a review of some SMT technology advances in 2014 and a look ahead to the challenges in 2015.

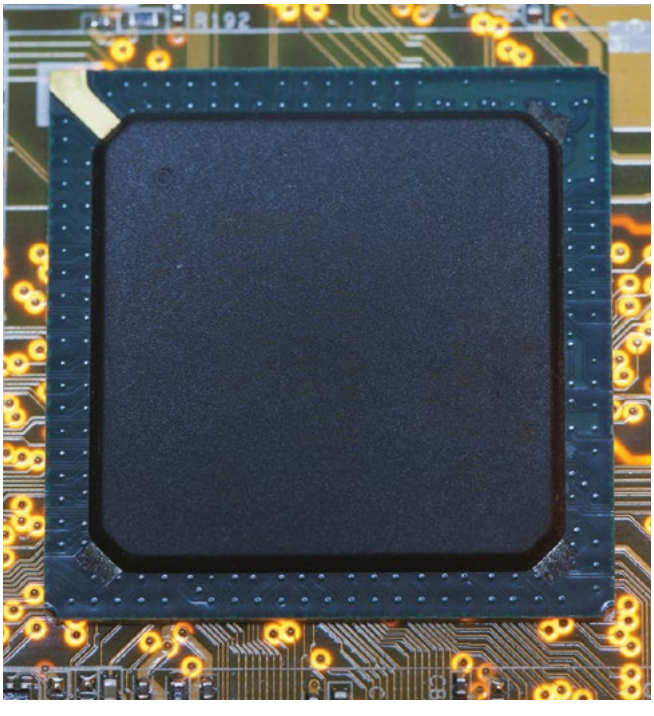

Figure 2: High pin count BGA device.

Challenge No. 1: Reducing Voiding In BTCs

PCBs with BTCs are increasingly common, as BTCs have the advantage of offering good performance—both in signal integrity and thermal performance—at a relatively low cost. However, increasing pin count and package size and reduced pitch on BTCs creates production challenges. The increased pin count allows more functionality, and manufacturing faces new challenges in producing reliable contacts with these large-surface-area devices.

The biggest challenge with BTC packages is thermal pad voiding. During the solder reflow process, chemicals or air can be trapped in the solder, creating voids that may impact thermal conductivity or solder joint reliability. Large voids can result in early product failures or long term reliability risks. Thermal pads present a unique challenge during reflow, as the pads are typically larger and connected to large copper areas within the PCB, and therefore taking longer to reflow than solder balls associated with signal pads.

As we enter 2015, stencil design techniques, soldering materials, new processes and design for manufacturability practices are continuing efforts being practiced and fine-tuned to minimize voiding, while vacuum reflow is also being investigated with promising results.

Challenge No. 2: Rework Challenges Rise as Component Spacing Decreases

OEMs are focused on functionality and performance. The use of decoupling capacitors for noise reduction leads to designs with more interconnects and smaller components with tighter component spacing. New designs, with more demanding signal integrity requirements can result in conflicts between layout requirements and what can be manufactured.

With the conflicts between design requirements and process capability, rework is becoming a challenge. For some high-performance

computing and telecommunications PCBAs we produce at Sanmina, for example, the cost of a single PCBA may be over $15,000. Therefore, it is imperative that the assembly is not damaged during rework. Furthermore, adequate spacing between components is also required to ensure that heat used for rework does not damage the solder joints of adjacent components, or the components themselves.

While IPC standards do not provide strict requirements for component spacing, and current SMT assembly processes can accommodate tight spacings, experience has shown that at least 200 mils of space should be left around large ball-grid arrays to allow for rework. OEMs are placing decoupling capacitors as close as 40 mils in order to optimize noise performance. EMS companies are working with equipment manufacturers to develop processes and rework tooling that make reliable, repeatable rework possible, without inducing secondary reflow or additional rework of adjacent components. Although current solutions exist for keep-out space values well below 200 mils, additional process development and tooling enhancements are necessary to achieve tighter component spacing.

Challenge No. 3: Chip Package Warpage

To minimize cost, ICs are often mounted in plastic packages. However, plastic is less stable for example than ceramic. When plastic packages are exposed to high temperatures during reflow, the package can warp: 2–10 mils or more, depending on the substrate, plastic material properties, package thickness and package size. A combination of package and PCB substrate dynamic warpage, along with PCB pad solderablity issues, variations in printed solder paste volume can result in solder defects between a device and the PCB. Two common defects are head-on-pillow (HOP), or non-wet open (NWO) type defects.

While NWO defects create solder joints with no electrical continuity, HOP defects can be intermittent and/or unreliable. Therefore, testing for HOP defects is a challenge and as such, time-consuming and resource-intensive screening processes are needed in order to prevent products with these defects from getting into the field.

The JEDEC specification for package warpage, revised in 2005 and republished in 2009, allows for a maximum of 8 mils of co-planarity at

Figure 3: BGA pad cross-section, showing good wetting.

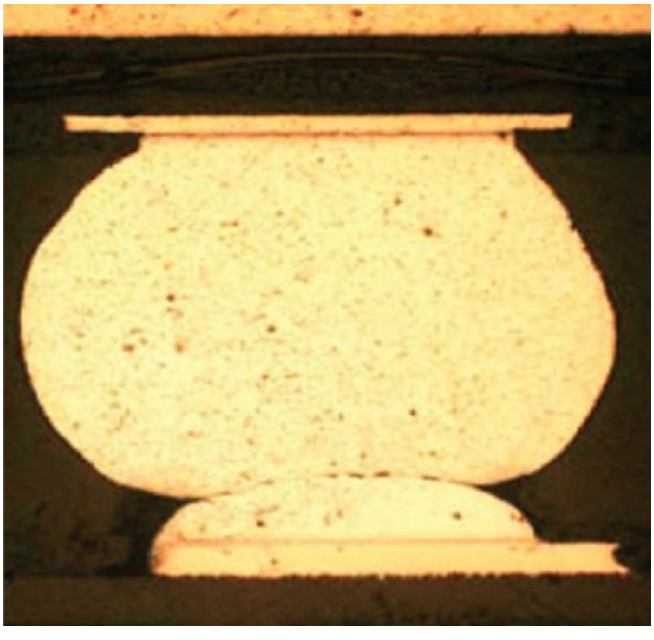

Figure 4: BGA pad cross-section, showing a typical head-on-pillow (HOP) defect.

room temperature. Component suppliers usually provide specifications for room temperature co-planarity, using either the seating plane or regression plane measurement method. As long as the value is under 8 mils, the co-planarity is deemed within specification.

Empirical data suggests that the JEDEC specification is no longer adequate. For high pin count packages with small pads and lower solder volumes, production data suggests that component warpage exceeding 3.5 mils can cause problems during reflow, with a high potential for HOP defects. Manufacturers of consumer devices may discard or recycle defective boards, but this is not an option for an advanced computing or communications PCBA costing over $10,000. Time-consuming and expensive 3D X-Ray testing is necessary with assemblies susceptible to HOP defects.

For high pin count packages with small pads and lower solder volumes, production data suggests that component warpage exceeding 3.5 mils can cause problems during reflow, with a high potential for HOP defects.

In 2015, EMS providers will continue to drive changes including advocating for improved plastic material compounds, along with working with JEDEC to tighten the standard warpage specification to closer to 3.5 mils for high pin count devices.

Challenge No. 4: Building PCBAs Robust Enough for Mission-Critical Industrial Environments

Industries such as oil and gas use electronic assemblies in very demanding environments. Drilling and exploration tools used two to three miles below the earth's surface can cost upwards of $2 million, and operate in environments up to 350°F. This equipment must continue to perform with precision, despite high temperatures and pressure, vibration, mechanical shock and corrosive environments (oil, mud, moisture, and chemicals).

PCBAs deployed in these environments require high-temperature solders that are not generally suited for current surface mount or automated pin through-hole manufacturing. Most of these PCBAs are still soldered manually. While high-Pb solders are excluded from the current RoHS legislation, there is an interest for alternative high temperature soldering materials, especially for environments up to 350°F. This research will continue in 2015, as OEMs and EMS companies work to develop better materials and processes.

Looking Ahead

SMT will continue to push the competing technical boundaries of signal integrity, miniaturization and increasing I/O counts. While devices with pad pitches in the range of 0.3 mils are already being assembled with automated surface mount equipment, this pad pitch cannot be commonly used for high pin count devices due to limitations in PCB technology (via escape) and package warp. Vacuum soldering, which eliminates voids, will likely become more mainstream. Vacuum-assisted reflow soldering (vapor phase or modular reflow, which involves adding a vacuum zone) equipment currently costs 1.2 to 1.3 times more than more conventional equipment.

As equipment prices drop, vacuum soldering is likely to become more common. Other challenges in 2015 are not unlike those the electronics industry has faced over the past 10 years, but solutions will continue to require more advanced process technology and equipment. The result will be new processes, PCB and PCBA technology that would have been viewed as unachievable just a few years ago. **SMT**

Mulugeta Abtew is VP of process technology development at Sanmina.

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EMS INDUSTRY: No Relaxing Now

by Frederick Blancas
INTEGRATED MICRO-ELECTRONICS INC

With technology and business environment always changing, the EMS industry has found itself in an ever-transitioning mode over the last several years. Certainly, the industry today isn't what it was five years ago, and the rate of change is likely to accelerate in the next five years or so.

The EMS industry is expected to grow from US$273.9 billion in 2013 to US$373 billion in 2018, a compounded annual growth rate (CAGR) of 6.4%, according to New Venture Research. This growth trajectory will be slightly faster than that of the worldwide electronics assembly valued at CAGR of 6.0% over the same period.

Given that the EMS industry accounts for only 22% of the worldwide electronics assembly per New Venture Research, it has ample room for an even faster growth depending on its ability to convince OEMs to outsource more than what they do now. The EMS providers' persuasive power lies in its ability to satisfy the demanding and changing requirements of OEMs.

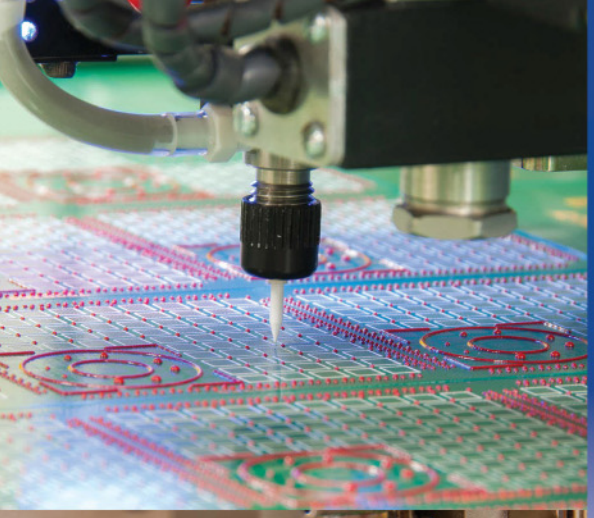
By the end of June 2014, the combined revenues of the nine largest EMS companies slightly declined year-on-year according to Walt Custer's quarterly report. Despite the reduction, Celestica, Jabil, Flextronics and Sanmina all managed to increase their gross margins in the same period from an average of 6.7% last year to 6.9%, indicating a shift of focus on margins based on Lincoln International Q2 2014 Report.

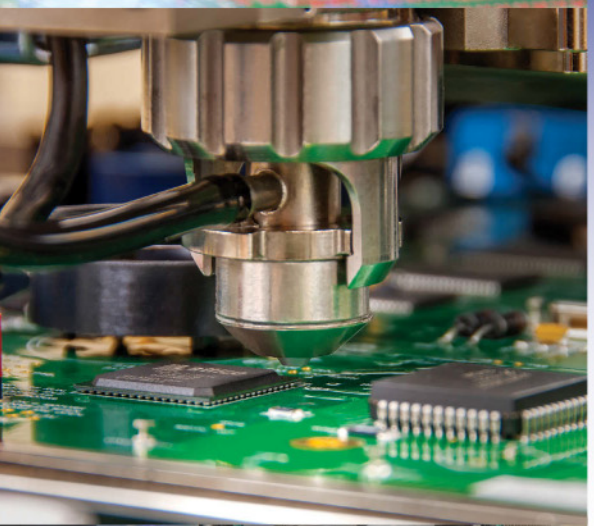
In terms of business model, EMS companies are veering away from the realm of pure-play EMS. They are creating more value for their OEM customers by expanding their solution offering, and in the process augmenting their revenues and margins.

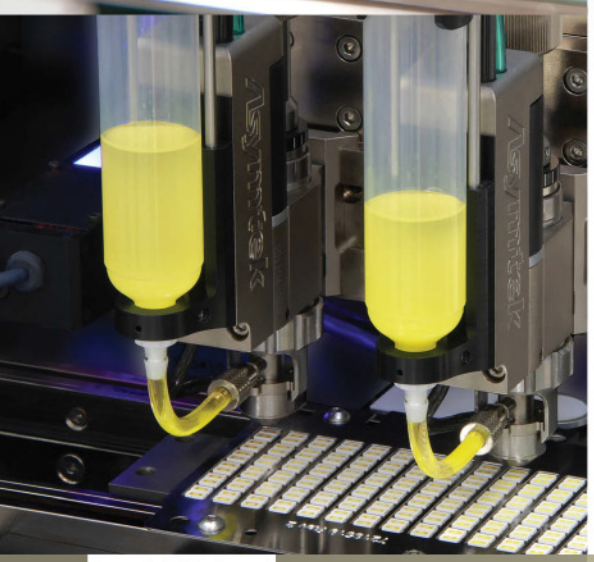
Arthur Tan, president and CEO of Philippines-headquartered EMS provider Integrated Micro-Electronics Inc. (IMI), said, "IMI is moving away from making only what we are good at toward leveraging our experience and expertise to venture into new growth areas."

Parsing "EMS," he added that the company is shifting away from the electronics and toward manufacturing and services.

Expanding services for Celestica, a Canada-based EMS provider, meant transforming itself







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EMS INDUSTRY: NO RELAXING NOW *continues*

into a company offering managed supply chain services that complement its contract manufacturing business. It delivers planning tools that integrate into the system, providing visibility through the supply chain with the right analytics. Foxconn, a Taiwanese EMS company, has its own retail outlets.

In manufacturing, Jabil has strengthened its plastic injection capability by acquiring Nypro Inc., a precision plastics manufacturer with strong presence in the disposable medical product market. This acquisition allows Jabil to expand into the healthcare and consumer packaging markets as well as reinforce its consumer electronics business.

Manufacturing movements have circled back from offshoring (or outsourcing) in the 1990s to the last decade's reshoring, in which multinationals retrieved some of their production intended for the American market. The emergent trend is next-shoring, whose two defining priorities are proximity to demand and proximity to innovation, particularly an innovative base of suppliers, according to the McKinsey Quarterly. In both developed and emerging markets, demand and innovation will be critical because next-shoring is less about moving manufacturing from one place to another than about adapting to, and preparing for, the changing nature of manufacturing everywhere.

Moreover, Tan has remarked that the capacity to rein in manufacturing technologies toward competitive advantage depends on talent. To do this, he said, it is crucial to have people "who understand your industry, your business, your specific environment, the technologies themselves and how to maximize these."

Plexus, a US-based EMS provider, recently opened a 265,000-square-foot facility in Guadalajara, Mexico, to beef up its manufacturing base for the North American market.

"In both developed and emerging markets, demand and innovation will be critical because next-shoring is less about moving manufacturing from one place to another than about adapting to, and preparing for, the changing nature of manufacturing everywhere."

EMS providers have also recently ventured into automating their back-end production lines to address rising labor costs worldwide as well as the increasingly stringent quality requirements of OEMs.

Michael Hansson, vice president for automation at IMI, said, "In the end, the value of automation boils down to decreasing costs and increasing revenue. If implemented judiciously, automation will increase throughput, improve quality, increase repeatability, and reduce labor-related costs."

To illustrate, IMI customized a robot for its plastic injection moulding line in Mexico to handle pin stamping, insertion, removal of finished parts, inspection, and sorting. Without this automation, it would have been impossible to attain the tight tolerance in the insertion process, high repeatability in the cycle time, and high uptime of the injection machine. After automating lines in its Mexico and Bulgaria plants, IMI will soon implement an automation strategy for its China factories.

Foxconn had led EMS automation in China manufacturing to increase efficiency and "hold the line" on wage increases through manufacturing efficiency improvements.

In terms of markets, in search of sustainable profitable growth, EMS companies have maintained a balancing act between high-volume programs especially in the 3Cs (computing, communications, and consumer electronics) and low-volume, high-mix programs usually found in the non-traditional markets of automotive, medical, industrial, and even aviation.

With technology permeating everyday life like never before, the medical electronics applications market represents another growth area worth around US$90 billion and is projected to grow close to 6 % per year driven by the demand for telehealth, wearables, and healthcare

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EMS INDUSTRY: NO RELAXING NOW *continues*

IT infrastructure, according to IHS iSuppli. ReportsnReports sees electronics reaching US$321 billion in 2018, with CAGRs in double-digits in major geographies, driven by semiconductor equipment, process control instrumentation, and automation systems.

Similarly, the Internet of Things (IoT) will usher in major technological breakthroughs and will increase the number of connected mobile devices per person from 1.8 in 2010 to above 6 in 2020, according to PwC International Ltd.

The possibilities for EMS companies seem limitless, which implies that this is not the time for EMS players to slacken. On the contrary: The need to augment capabilities refined for the production of high-reliability, enterprise-class products remains extremely critical. While benchmarking against peers remains good practice, EMS companies have historically transformed at different rates into diverse fields. Thus it is arguably more important for EMS companies to understand the needs of their respective OEM customers and the unserved markets, leverage their strengths and enhance capabilities, and creatively venture into new solutions that may or may not be within the EMS realm, keeping in mind that it has to create value for the customers and for itself. **SMT**

Frederick Blancas is senior division manager of strategic planning and marketing for Integrated Micro-Electronics Inc. (IMI).

Tiny, Sound-powered Chip Serves as Medical Device

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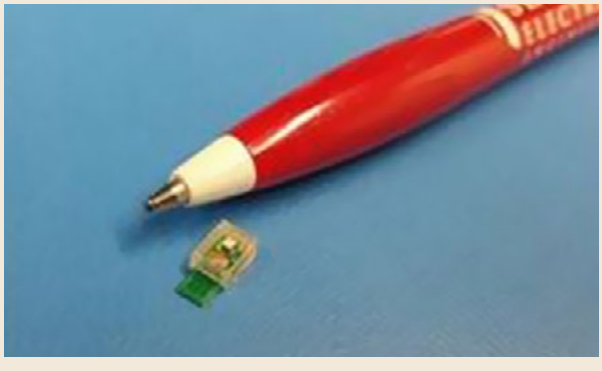
But so far engineers have been unable to make such devices small and useful enough. Providing electric power to medical implants has been one stumbling block. Using wires or batteries to deliver power tends to make implants too big, too clumsy--or both.

Now, Stanford engineers are developing a way to send power—safely and wirelessly—to "smart chips" programmed to perform medical tasks and report back the results.

Their approach involves beaming ultrasound at a tiny device inside the body designed to do three things: Convert the incoming sound waves into electricity; process and execute medical commands; and report the completed activity via a tiny built-in radio antenna.



"We think this will enable researchers to develop a new generation of tiny implants designed for a wide array of medical applications," said Amin Arbabian, an assistant professor of electrical engineering at Stanford.

Now Arbabian and his colleagues are collaborating with other researchers to develop sound-powered implants for a variety of medical applications.

The Stanford medical implant chip is powered by "piezoelectricity," a word that means electricity caused by pressure. Arbabian's team wants to test many other applications using this basic technology to wirelessly power small implants deep inside the body.

"Many biosensing and stimulation applications require small, deep medical implants," he said. "We believe our platform provides the recipe for building small devices that can be powered wirelessly and programmed to perform a wide array of tasks."

Mil/Aero007 News Highlights

Aerospace Business Drives Ducommun's Revenue Growth

"Ducommun's top line growth this quarter was driven by a 21% increase in our overall commercial aerospace revenue," said Anthony J. Reardon, chairman and CEO. "We continue to benefit from current platform build rates as well as higher content, reflecting increased customer demand for our structural and electronic solutions. The strength of our commercial aerospace operations has helped offset the impact of changes within certain military and space programs."

SCI Begins Production of Assemblies for Raytheon Missile

SCI Technology, Inc., a division of Sanmina Corporation and located in Huntsville, Alabama, has begun production of complex electronic assemblies for the Miniature Air Launched Decoy (MALD) and the GBU-53/B (SDB II) for Raytheon Missile Systems.

Kitron Nets Contract to Make Biometric ID Systems

Kitron ASA's subsidiary Kitron AB, in Jönköping, Sweden, has signed a three-year frame agreement with Speed Identity AB for production and related services for its biometric identification systems.

OSI Systems Bags $7M Sub-assemblies Award

OSI Systems, Inc. has received orders for approximately $7 million for electronic sub-assemblies from an OEM focused on providing advanced computing and storage solutions to the aerospace and defense industries.

Counterfeit Components the Focus of UK Master Class

Dr. Diganta Das of CALCE, University of Maryland will teach a full day Master Class, "Counterfeit Electronics Components: Avoidance and Detection," at the 24th MIRCE International Symposium in Exeter, England, December 4, 2014.

API's PA Facility Earns AS9100 Rev C Certification

API Technologies Corporation, a leading provider of high-performance RF/microwave, power, and security solutions for high-reliability applications, announced that its RF/Microwave facility in Philadelphia, Pennsylvania has achieved AS9100 Rev C Certification.

Plexus Neenah Design Center Earns AS9100

Plexus Corporation has achieved AS9100 certification for its Neenah Design Center, located in Neenah, Wisconsin. This is in addition to the AS9100 certification the company has already attained at many of its Manufacturing Solutions facilities in the Americas, European, and Asia-Pacific regions.

Defense Sector Drives Kitron's 10% Growth in Q3

The company reports that net profit amounted to NOK 4.8 million, an increase from 3.2 million. Operating cash flow was negative NOK 9.7 million, compared to negative NOK 33.9 million. Growth was observed in all market sectors except for offshore/marine. Growth was particularly strong in defence/aerospace and industry sectors.

Zollner Achieves EN 9100 Recertification

Zollner Elektronik AG has successfully achieved recertification of its aerospace quality management system under the International Organization for Standardization (ISO) EN 9100 standard.

ACD Completes Recertification Audit for AS9100C

With the recertification ACD is better equipped to serve the aviation, space and defense industries with a quality management system that has been accepted by the aerospace industry and that ensures compliance with risk management throughout the supply chain.

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Tracking Technological Change in the Internet Age

by Joe Fjelstad
VERDANT ELECTRONICS

The Internet is arguably one of the most important inventions in human history. It is, of course, dependent on myriad technologies that make it possible, and each of those technologies has technologies which are dependent upon others, and so on. The chain of dependence stretches back to the earliest humans, the invention of language, and the recording and storage of information. Those roots extend back deeply indeed.

Caves recently discovered in Indonesia feature images of animals recorded by our ancestors 40,000 years ago. We have a seemingly genetic need to share information for the benefit of our society from nuclear family, to clan, to tribe, to nation, to the world. We have even felt compelled to share information with the universe by means of the gold records aboard the Voyager spacecraft, which last year left our solar system and headed into interstellar space.

Through the Internet, information is now being promulgated and propagated at a prodigious rate. Renowned inventor and futurist Ray Kurzweil has studied the rate of growth of knowledge, and he has observed that human knowledge and technology have been increasing at an exponential rate since our ancestors recorded those first images on cave walls. This has led to his prediction of our achieving a technological singularity possibly as soon as the next two or three decades. This has both good and bad implications, which are not part of this commentary, but it suggests that technologies will enable machine intelligence that will exceed that of humans. While I am not disposed here to comment on the pros and cons of that not-too-distant future, the prospect does cause one to wonder if that as-yet unrealized intelligence is not currently driving humanity to assure its future realization.

That aside, we presently find ourselves awash in information (along with disinformation and misinformation) coming at us through our various electronic appliances, from computers to cell phones. Search engines provide us with means for finding information, but they do nothing to evaluate this information. The simple reality is that policing of information is not something free societies are overly enthusiastic about (even though there are clearly misguided and even dangerous websites littered throughout the internet). This brings us to this

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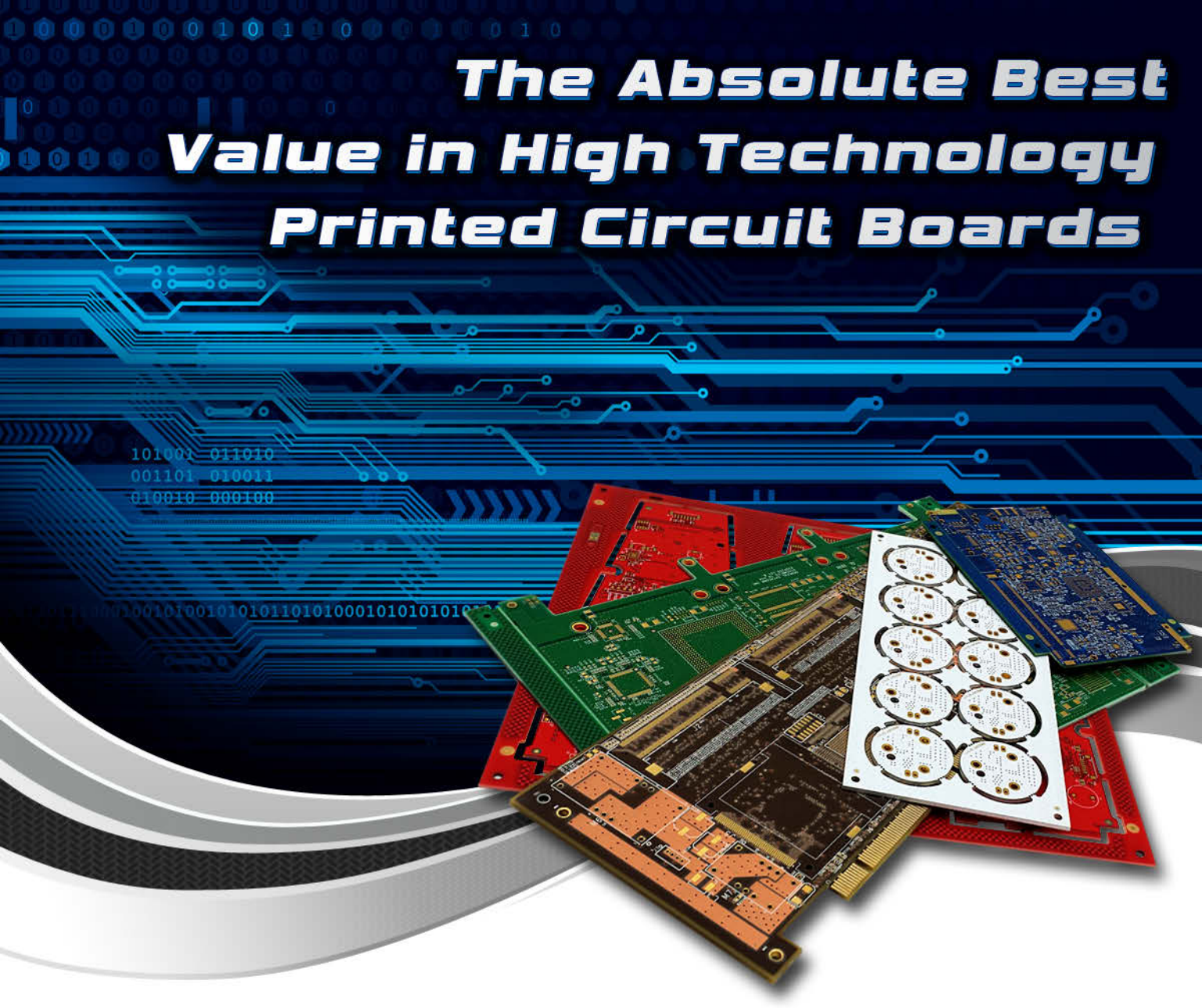

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topic: With so much technological change taking place on a daily, hourly and even minute-to-minute basis, how does one filter it? Spoiler alert: This author does not have the answer.

Finding What One Needs

Presently, the Internet is a marketer's playground, much like television advertising on steroids. Search engine providers, in spite of protestations to the contrary, are known to work on a "pay for placement" basis. That is, when you type in a keyword, you are as likely as not to see first on your hit list a link to an individual or entity that has paid to be there. The hit list may or may not be useful, so it is important to try to use as many key words and operators as possible to help filter your results. Given that there are billions of Web pages, one great way to control the results is to use Boolean logic and operators. Following are some common examples. The use of AND is a basic one. Obviously it is designed to assure that the search yields links that have both terms; however, improved search engines often assume AND is a number of different terms strung together. Similarly, OR will have a compounding effect by including both terms, but not necessarily in the same individual finds. AND NOT is used to exclude search results containing the specified word or phrase. For example, solder AND NOT lead-free would (should) produce results for solders that are not lead-free. NEAR will produce results where two words are found within 10 words of each other. This is useful in widening the net of results. To get more information, OR can help to make sure both wordings are found. That said, search engines will often default to results that they think the user wants, so one must be careful to make sure not to be misguided by a well-intended machine.

Punctuation marks are also used. For example, quotation marks around a term will focus the search on the exact term. For example, "lead free solder" will provide exactly that result and should ignore "lead-free solder." The asterisk (*) is a wildcard which can be used at the beginning or end of a term to pull in results that might be of value. Cent* will bring up a wide range of answers centipede, centimeter, centigrade, centennial, et cetera. Thus one needs to be a bit careful with its use. The tilde (~) helps one find other results by seeking out and providing synonyms of the search term. Finally putting a term in between parenthesis () helps to bound a search more tightly when different terms are required for example (solder AND NOT lead-free).

Once results are obtained, a good deal of sifting and sorting is inevitably going to be required. Fact checking is no less important in technology than it is in general news reporting.

> ***One way to increase one's field of view is to use the eyes of others. This is where the many daily or weekly newsletters can help. Editors of such information resources are always on the lookout for materials to help their readers get a leg up.***

Other Ways of Finding the "Good Stuff"

With the growing amount of information out there, it is now a huge challenge to try and keep up and find the information one needs. It is in one sense like searching the night sky for a specific star during a response to an air raid and a sky full of tracer rounds and in another sense like trying to see a flare in the sky on a bright cloudless sky. Given the hemispherical field of view and the limitations of one's individual scope of vision, unless one is looking in precisely the right direction at exactly the right moment, one is most likely going to miss the event.

One way to increase one's field of view is to use the eyes of others. This is where the many daily or weekly newsletters can help. Editors of such information resources are always on the lookout for materials to help their readers get a leg up. An individual newsletter might miss the one bit of news or information that really matters to one personally in their job, but it may be that the item was picked up by

another. Thus it is evident that more than one source is necessary.

There are many excellent science and technology newsletters available (I-Connect007 produces several) that one can subscribe to: dailies, weeklies, and monthlies; some offer late-breaking news alerts as well. It is doubtful that anyone can read everything but one can do a quick scan to see if anything pops and dig in if it seems appropriate. This is actually one of the great benefits of having a variety of sources, as it increases the potential of getting something unexpected. Moreover, if one subscribes not just to newsletters targeted on their own industry or interest, it is possible that some unexpected synergy can be found between elements of seemingly disparate disciplines as mechanics and metaphysics or physics and philosophy.

In summary, because of the rapid advance of technology and the internet we are now living in very interesting times. Curiously, one of the purported curses of the ancient Chinese was, "May you live in interesting times." The ancients, it suggests, were more interested in stasis than in change and interesting times were considered times of change and turmoil. Clearly as we approach the projected singularity things will get increasingly interesting. Obtaining and digesting knowledge about the march of technology, now being delivered in massive quantities on a daily basis through the internet, will be the key to our becoming masters of the future rather than its victims. **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.*

Enterprise Labeling: An Imperative for the Electronics Industry

by Joe Longo
LOFTWARE

The electronics industry is characterized by an ever-sprawling set of global supply chains, causing an increase in disparate labeling systems spread across the enterprise with an ever-increasing volume of duplicated label and redundant master data. This begs the question: How effective is labeling in the electronics industry today? Can labeling be more optimized for large corporations with thousands of printers around the world?

The challenges facing organizations dealing with global supply chains include the need to accomplish the following:

- Increase supply chain transparency for speedy product development
- Centralize and consolidate label printing from one location to thousands of remote printers worldwide
- Integrate labeling with business applications
- Reduce the number of label templates with automation
- Rapidly change labels as customer, geographical and regulatory requirements evolve
- Build "configure-to-order" solutions in high volumes
- Attain higher yields through fewer defects in labels
- Defend against higher costs by safeguarding against counterfeiting
- Reduce manufacturing costs and sustain or improve margins

That's more easily said than done. Why? Because among other things, and most obviously, the success of a collaborative and coordinated global supply chain depends upon operating reliably across borders, over distances, in many languages—and all must be in sync with differ-

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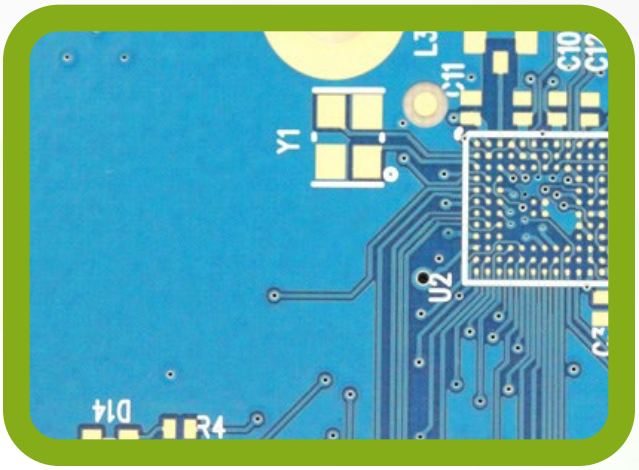

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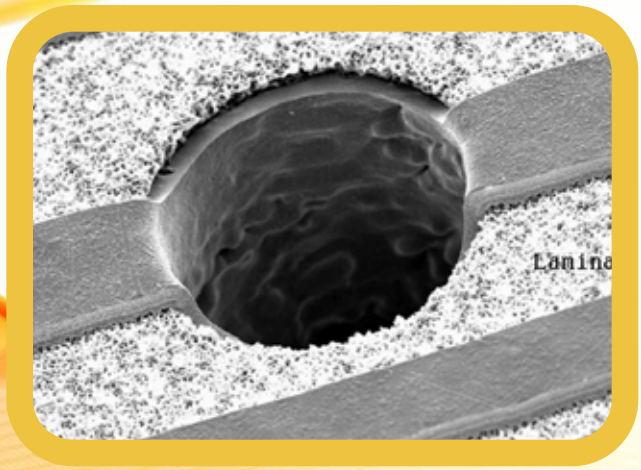

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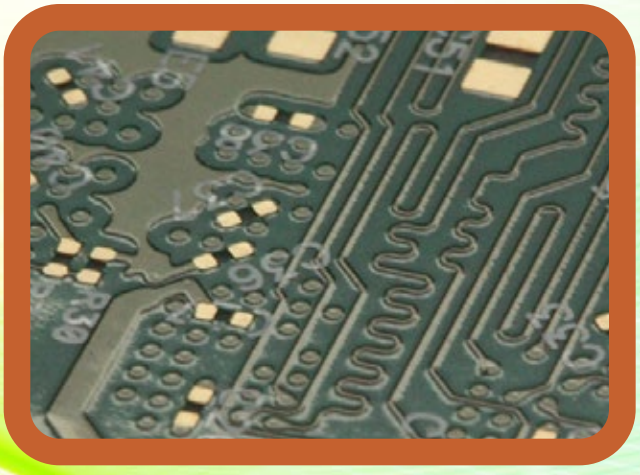

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ent time zones in compliance with a variety of different local, regional, and national regulatory requirements.

This discussion is targeted toward electronics industry supply chain and logistics professionals tasked with optimizing their company's partnerships to get more done, in more places, in less time, for the achievement of greater profitability and market share. It speaks to the many components that contribute to partnership optimization and solutions at hand through product labeling and data standards that can lead to supply chain transparency.

The basic concept is simple: If all stakeholders in the supply chain can speak the same language, figuratively speaking, then raw materials and finished products can come and go faster, more reliably, with less waste, and with fewer errors. All this can occur at lower costs for higher margin outcomes, increased customer responsiveness, and strong competitive advantage.

The basic concept is simple: If all stakeholders in the supply chain can speak the same language, figuratively speaking, then raw materials and finished products can come and go faster, more reliably, with less waste, and with fewer errors.

No Business as Usual in Electronics

Because the electronics industry continues to innovate, the task of meeting the new objective of supply chain transparency and integration is not merely a matter of engaging in the same, business-as-usual approach to raw materials sourcing, manufacturing, assembly, and shipment processes for a simplistic adaptation to a new supply chain model. For example, the adaptation has to happen in parallel with new trends in unit-level traceability by involving increasingly smaller components that defy conventional labeling processes. Adaptation has to occur while demands increase for faster line changeovers, faster component and assembly verification, and inspection. It all has to happen at a time when many electronics manufacturers are looking to emerging countries with fertile opportunities for low cost manufacturing potential through new or acquired facilities.

Against this backdrop, data and product marketing standards initiatives in the electronic industry cannot expect to gain traction until ongoing trends and developments can be supported. More well-known issues with a long-standing history of adding complexity to the industry need to be solved. In other words, the electronics industry doesn't just need something different, or something new, unless the solution takes away the burden of current processes and simultaneously delivers the opportunity to leverage the industry to the next level.

Costly, Risky, and Wasteful Limitations

If the common systems for product labeling were working flawlessly, there would be no demand for change. But even just a cursory review of all that electronics manufacturers must accomplish in labeling generates a profile of an approach that is unsustainable. Consider, for example, what manufacturers need to do simply to comply with their customers' labeling requirements as the industry continues to grow and expand product lines.

Customer labeling requirements often dictate the exact type and placement to be used on the product, box, carton, and pallet. It is not unusual for a major customer to demand exact specifications for label size, data titles, data field identifiers, as well as a dozen or more exacting guidelines for barcode symbologies. For example, one leading electronics buyer provides this guidance: "Barcodes should be within a character density range of 3.7 to 6.9 characters per inch, with a minimum element ration of 2.5:1 to 3.0:1… preferred." And every major customer's labeling directives can be different.

Customers today also want the manufacturers to exhibit faster, more reliable, more secure turnaround for the use of new label designs that evolve as products change. This comes at a time when products are changing faster than ever.

The industry is already coping with possibly the largest number of serial numbers and labeling configurations of any industry in the world.

Failure to meet customer labeling requirements, especially across multiple customers with differing standards, leads to shipping errors, higher freight costs, returns, repackaging expenses, late penalties, compliance issues—and worse—customer dissatisfaction. For an industry already undergoing increased pressure on prices and margins, these outcomes negatively exacerbate corporate growth and profitability objectives.

The above example is about outgoing finished product. But electronics manufacturers have an incoming raw materials labeling challenge—and opportunity. At the same time, the electronics manufacturer's business sustainability depends on meeting customer labeling guidelines. In many cases, the manufacturer is taking delivery of raw materials or components with labels that bear no compatibility or consistency with their labeling system. This means it takes time to determine what exactly has been delivered and from which provider. It means these materials or components have to be re-labeled or over-labeled with product label substitutes aligned with the manufacturer's system. This takes time and contributes to added expense.

The contemporary objective is to have raw materials providers label their products in ways that are consistent and compatible with the manufacturer's operations and labeling methodology. Unfortunately, "homegrown" patchwork systems and solutions that are not enterprise-driven, and do not provide integration capabilities with secure access to a provider of raw materials or components, cannot easily meet this objective, if at all.

Reliance on Compliance: Evolving Industry Standards

The variety of product labeling standards set forth, or under consideration, by organizations such as the Electronics Components Industry Association (ECIA), Electronics Components Association (ECA), Joint Electron Device Engineering Council (JDEC), Government Electronics and Information Technology Association (GEIA), now part of TechAmerica, Telecommunications Industry Association (TIA), and Consumer Electronics Association (CEA) present additional labeling challenges.

Among these are:

- CEA-556: Outer Shipping Container Bar Code Label Standard
- CEA-556C: Shipping and Receiving Transaction Bar Code Label Standard
- CEA-621A: Consumer Electronics Group Product and Packaging Bar Code Standard for Consumer Electronics
- CEA-706: Requirements for Using 2D Machine Readable Symbols for Marking and Identifying Electronic Components

Beyond these standards in electronics, global supply chain labeling demands to meet guidelines, standards, and regulations are increasing at a rapid pace in almost all industries. In the field of electronics, which crosses over with peripheral industries such as chemicals and consumer goods, evolving labeling standards and regulations, sooner than later, will require enterprise-wide labeling solutions in response to corporate concerns about risk mitigation and consumer safety.

Hewlett-Packard recently acknowledged it "maintains information on about 240 chemicals that could be in electronics parts but are not regulated, so it knows where the chemicals are being used in case they end up restricted by laws."

"With so many chemicals used in the manufacturing of electronics, and the increasing regulations in the chemical industry such as the Globally Harmonized System for Hazard Communication (GHS), electronics companies may have to address the associated challenges of labeling chemicals accurately. But all point to an unmistakable pattern: Globalization, environmental concerns, chemical substance monitoring and control, counterfeit prevention, industry regulations, customer responsiveness, best practices, supply chain transparency, data standards, and the need for commonly understood product labeling are all critical factors in the smooth operation of a reliable global supply chain."

This trend can be temporarily avoided or delayed, but inevitably the industry is facing a future where partners and consumers will demand to know more about a product's origins, contents, and whereabouts.

The following regulatory initiatives are admittedly environmentally focused. As such, what are the implications for quality enterprise barcodes tied to core applications? The point is this: The information required by these rules, directives, guidelines and regulations is not going to be managed at a desk using a notepad and a three-drawer manual filing cabinet system. Not, at least, for electronics manufacturers who hope to survive and thrive in this second decade of the 21st century.

Electronic data systems tied to product labeling solutions are going to capture, follow, measure, evaluate, track, and monitor the required information. For a long time to come, standards-based traditional and 2D barcodes will indisputably remain at the center of establishing and managing a product's identity and all of its various characteristics.

These directives, rules and regulations include:

The RoHS Regulation (Directive 2002/95/EC) and RoHS II: EU Member States shall ensure that new electrical and electronic equipment put on the market does not contain any of the six banned substances: lead, mercury, cadmium, hexavalent chromium, poly-brominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE), in quantities exceeding maximum concentration values.

The WEEE Directive: Together with the RoHS Directive, WEEE sets collection, recycling and recovery targets for all types of electrical goods.

The ErP Directive 2009/125/EC (Formerly EuP): This European directive establishes a framework under which manufacturers of energy-using products (EuP) will, at the design stage, be obliged to reduce the energy consumption and other negative environmental impacts that occur during the product's life cycle.

The Packaging Directive: This directive aims to harmonize national measures in order to prevent or reduce the impact of packaging and packaging waste on the environment. It contains provisions on the prevention of packaging waste, on the re-use of packaging and on the recovery and recycling of packaging waste.

The CE Mark: This is a mandatory conformance mark on many products placed on the market in Europe to ensure the product conforms to EC directives.

IPC-1752: This is an IPC materials declaration management standard for material declaration forms and electronic data exchange formats to facilitate electronic reporting for suppliers and customers along the electronics supply chain.

The Electronic Industry Code of Conduct: This is a set of best practices adopted and implemented by some of the world's major electronics and telecommunications brands and their suppliers to implement a single supply chain social responsibility code of conduct in the sector.

Green Supply Chain Management (GSCM): GSCM has been adopted as a proactive strategy by leading electronics industry companies, including Dell, HP, IBM, Motorola, Sony, Panasonic, NEC, Fujitsu, and Toshiba. It represents a proactive approach for improving the environmental performance of processes and products in accordance with the requirements of environmental regulations.

How Bad Can Bad Get?

The following should be cut and pasted, or cut and posted, at the end of every electronics manufacturing line, every warehouse, every distribution center, and even every executive suite. It is a list of the eight most common bad outcomes that can occur from labeling errors and derived from more than two decades of experience in manufacturing labeling mishaps:

1. Mislabeling and related data errors

The wrong label or a label with incorrect or incomplete data typically sidetracks the product, often in distribution centers, until the problem can be identified and corrected. Delivery deadlines can be missed, inventory carrying costs can soar, or worse, products that linger too long can become obsolete.

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2. Customer and regulatory fines

Label production delays due to non-compliance labels mean product shipment delays. With customers having agreements for timely delivery, delays often equate to monetary penalties. Labels in non-compliance with regulatory authorities can trigger recalls and fines as well. With the advent of emerging initiatives for global harmonization of product labeling, this is more important than ever.

3. Loss of business

Chronic label issues resulting in delayed shipments, customer fines, or the delivery of the wrong product can turn customers away to seek alternate sources of supply. "This negatively affects market share and margins, leads to loss of brand credibility, and increases customer dissatisfaction."

4. Label-related safety compliance

Beyond the regulatory implications of labeling-related safety compliance, failures in this area can dramatically impact a company's overall brand and reputation. In severe cases, many companies do not survive the reputational effects of a major product recall.

5. Inability to scale labeling operations in manufacturing, shipping and distribution centers

In today's electronics industry supply chain, speed and efficiency are two areas most manufacturers examine for value-added opportunities and improved economies of scale. When labeling inefficiencies such as improper load dividing or redundant relabeling slow everything down, or even bring operations to a halt, the bottom line suffers.

6. Label-related recall execution; track and traceability solutions

One of the reasons for the dreadful effect of a major product recall relates to how long it can take to identify and find the product and complete a recall cycle. Contemporary track and trace labeling solutions speed the process, thereby minimizing costs as well as the potential downside to a company's reputation in the marketplace.

7. Global readiness for evolving industry standards

Emerging product labeling standards, some mandated by governments, can mean the difference between market entry and exclusion. For companies working with supply chain, manufacturing, and distribution partners in these countries, compliance with regional standards can streamline the supply chain. The need to support language requirements and compliance variability based on each country's regulations is becoming more and more complex.

8. Inability to meet customer-specific labeling requirements

More than ever, customers are driving requirements for both label layout and data content for labeling. Both a baseline requirement and a point of differentiation against the competition, labeling is a critical factor when considering businesses' ability to quickly and seamlessly distribute their products from supplier to customer. If manufacturers lack responsiveness to these customer requirements, a loss in market share is a real possibility.

One Consequence of Organic Growth: IT Stress

On top of all this, many IT professionals in the electronics industry sector are apt to recognize the following profile characterizing the most common labeling technology challenges. For example, organizations often struggle with disparate labeling systems, accumulated over time to meet the needs of various divisions or functional areas. Some are standalone, purpose-driven or silo systems with no relevance or connection to enterprise data and business applications. For electronics manufacturing companies that have grown through mergers and acquisitions, multiple units may have varied labeling methodologies and technologies. Labels may be printed by these disparate systems for case, pallet, customer requirements, regulatory compliance, or other purposes, and may also have unique applications for each type of label. These companies lack an overarching process or global product identification solution that can consistently efficiently generate labels by product, customer, or country.

The situation is likely to become worse, because the industry continues to consolidate. Plus, acquired operations in emerging countries may bring with them their own labeling infrastructure, systems, and processes.

The absence of an enterprise-wide and centrally managed solution for products manufactured in disparate locations generates routine rework. Homegrown workarounds, numerous extract modes, and broadly fragmented labeling knowledge are often the result. This can lead to conflicting organizational behaviors, brand inconsistencies, mislabeling, and process failures with very costly implications.

There exists, however, a straightforward approach to solving these problems to meet the next generations of opportunity.

The Cure: An Enterprise-Centric Approach

1. Consolidation and Centralization

Electronics manufacturers with dispersed, departmental, standalone and multi-regional labeling systems face a daunting task of meeting enterprise-wide consistency and control if the decision is made to sustain these systems. Fixing redundancy of all these separate solutions over many departments and across all labeling geographies is a time-intensive initiative that, in the end, does nothing to resolve the underlying problems of a decentralized labeling approach. Consolidation around a centralized system, tied to enterprise applications and data, insures corporate-wide labeling consistencies, compliance, and security. Electronics manufacturing companies need the ability to easily and quickly manage label data, make label changes, comply with evolving standards, and flexibly support new labeling requirements. Allowing multiple locations and suppliers access to centralized data to seamlessly produce labels remotely is crucial to business continuity. Utilizing this centralized approach to label data allows businesses to scale globally and remotely, and drives label production from any of its sites.

> ***Electronics manufacturing companies need the ability to easily and quickly manage label data, make label changes, comply with evolving standards, and flexibly support new labeling requirements.***

2. Integration

Electronics products manufacturers today know they need—and they already have—systems for version control. This means many electronics manufacturers have systems in place for compliance and regulatory standards with approvals, workflow, revisions, and documented copies; and, they have the right people already in place who are familiar with these systems. With this in mind, it isn't practical to replicate data. Instead, it makes significantly greater sense to simply use the label data in these existing applications for the data to generate the labels, so the ability to connect and integrate to all key sources of label data is essential.

Business partners, too, need to leverage their own sources of label data, and extend labels and data to their partners. Through integration, an unprecedented level of flexibility to enable the use of corporate or partner data to create, manage, and print mission-critical barcode labels across the global supply chain becomes possible. In some enterprise solutions scenarios that include WYSIWYG design and browser-based capabilities, business users can even take ownership of the design process. This eliminates the need for IT at each print location to get involved or write code to handle new label creation and label changes, resulting in significant cost and time savings.

3. Automation Based on Business Rules

In addition to application integration, the forward-looking solution in electronics products manufacturing labeling looks to all major enterprise applications to drive label printing. To ensure an effective global supply chain strategy, customers must consider how labeling intersects with evolving contributors such as globalization of manufacturing, safety and quality

of products, shorter lead-times, lean business environments, and changing international market demands.

Widely installed enterprise applications from providers such as Oracle, SAP, and others, are considered "a single source of truth," and if these systems are leveraged to drive label printing and label data, then the error-prone practice of manual or redundant label data entry is eliminated. Enterprise labeling solutions include business rules logic that allows customers to automatically meet the rigors of global requirements such as regulations, languages, images, formats, and printers, and to manage variability across multiple industries and regions in one place. Automating these complex workflow processes frees up the organization to use precious labor hours more creatively and efficiently.

Summary

Once considered a mere tactical necessity, contemporary electronics industry product labeling solutions can have major strategic implications. As noted in this white paper, there are at least eight major negative corporate outcomes that can result from product labeling errors and inefficiencies. Averting these issues is no longer a matter of fixing one label at a time or refitting one product facility at a time with silo or purpose-driven systems. Labeling has become a core component of a manufacturer's strategic mission to create a smoothly operating global supply chain. The solution cannot be found in a patchwork of more systems, but in less and fewer disparities and incompatibilities. For a truly successful outcome, labeling must be integrated with core enterprise applications and data.

Electronics manufacturers of all sizes and scope can gain tremendous value from the intelligent three-step methodology of consolidation, integration, and automation of their labeling environment. Implementing enterprise-wide solutions that centralize global labeling and integrate with core applications and data bring into alliance the parallel goals of corporate growth and supply chain efficiency with labeling agility and accuracy. At a time when regulatory scrutiny and standards initiatives worldwide are on the rise; when customer demands are more specific and varied than ever before; and when a single source of truth is the most reliable repository of data, an enterprise labeling solution is an efficient, cost-saving, accurate, and flexible way to quickly meet the critical needs of today's global supply chain. **SMT**

Joe Longo is an electronics industry specialist with Loftware. He has been working with Loftware enterprise customers for over seven years. He can be reached at jlongo@loftware.com.

Future Lab-on-Chip Applications

Smart and portable medical equipment is essential for fast and easy point-of-care and point-of-use diagnostics. Lab-on-a-chip applications in hand-held devices can help to save time for laboratory medical analysis in emergency scenarios.

Fraunhofer FEP presents two different OLED-device concepts: one emitting in the near UV and another one in the green spectral range which both could be integrated to sensor applications.

These two exemplary OLED developments can be used for biomedical and biotechnical sensing in lab-on-chip applications. Furthermore, the scientists from Fraunhofer FEP combined a green top-emitting OLED with a thin-film optical filter and thin-film encapsulation so that a sample substance can be brought in proximity to the excitation source.

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SMTonline Market News Highlights

Global OE Market to Grow $75.82B in Coming Years

The organic electronics market is expected to grow from $16.45 billion in 2014 to $75.82 billion by 2020 at a CAGR of 29%. This growth is heralded by the growing display applications for organic electronics market. The lighting applications for this market are also expected to grow rapidly in the coming five years.

Top 20 Global Semiconductor Sales Ranking for 2014

The top 20 worldwide semiconductor (IC and O S D-optoelectronic, sensor, and discrete) sales ranking for 2014 includes eight suppliers headquartered in the U.S., three in Japan, three in Europe, three in Taiwan, two in South Korea, and one in Singapore, a relatively broad representation of geographic regions.

Smart Grid Infrastructure Gets $13.6B Investment from SEA

"Smart grid investment over the next decade will shift from North America and Europe to emerging market regions," said Ben Gardner, president of Northeast Group. "Southeast Asian countries are just beginning on the path of modernizing their electric infrastructure."

Industrial Internet Sensors to See $20.1B in Revenue

In a newly released report from NanoMarkets, the firm predicts the value of Internet-connected sensors for industrial applications is expected to grow to $20.1 billion by 2019. This report also identifies and quantifies where the opportunities are for makers of these sensors and provides eight-year forecasts for a variety of industrial sensor types.

Power Electronics Market Outlook Shows 9.6% CAGR

The Global Power Electronics Market 2014–2018 research report forecasts the industry to grow at 9.6% CAGR from 2013–2018. The Global Power Electronics market can be segmented into five end-user segments: commercial, industrial, consumer electronics, transportation, and others.

Wearable Technology to Continue Evolution

New research shows that wearable technology will evolve beyond its current ecosystem, which is very dependent on smartphone integration. New business models will develop that place wearable tech at the center of communications, applications, content, and commerce without the need for handheld devices of any type.

APAC to Retain Growth in Nanotech-enabled Printing

BCC Research reveals the global market for nanotechnology-enabled printing technology is expected to grow at a projected CAGR of 17.7% over the next five years to total $31.8 billion by 2018. The Asia-Pacific region is the largest buyer of printing technologies and will retain growth through the forecast period with 17.3% CAGR and reach revenues of $20.2 billion.

Bluetooth Low Energy Dominates Wearable Connectivity

"Wearables are about the quantified self, more than likely, communicated via Bluetooth to a smartphone to view the results and then possibly from there to a cloud-based service for aggregation and further analysis," states Nick Spencer, senior practice director, Mobile Devices at ABI Research.

Critical Innovation Stage to Drive Cloud Services Market

Public IT cloud services spending will reach $56.6 billion in 2014 and grow to more than $127 billion in 2018, according to a new forecast from International Data Corporation (IDC). Among the factors driving public IT cloud services growth is the adoption of "cloud first" strategies by both IT vendors expanding their offerings and IT buyers implementing new solutions.

3D Printing Materials Market to Grow Significantly

The 3D printing materials market is expected to grow significantly in the next few years, due to high demand for 3D printing technology in various industries such as electronics, consumer products, automotive, aerospace, and medical.

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THE SHORT SCOOP

Printing Two-Level PCBs in One Step with a 3D Electroform Stencil

by Rachel Miller-Short
PHOTO STENCIL LLC

The requirements for two-level PCBs with components on both levels have seen a recent increase. Stencil printing on both levels requires special stencil and squeegee blade designs. Recently, we participated in two experiments. The purpose was to determine if a 3D electroform stencil, in just one printing step, could be used to print a two-level board with cavities. The tests consisted of:

- Printing solder paste for .3µm µBGAs with pads on two levels (steps) of a flexible PCB separated by 7 mils (175µm).
- Printing flux and solder paste into a recessed area on a PCB for an embedded flip-chip with a cavity depth of 14 mils (350µm).

The printing tool used was a single thickness 4 mil (100µm) thick 3D electroform stencil with apertures consisting of 10 mil (250µm) circles. Printing was done in two modes: a step mode for the two levels and a reservoir mode for the recessed pocket. Although two-step stencils are commonly used for these applications, our tests used 3D electroform stencils for both print experiments.

In this Short Scoop, I will present the printing results obtained from the step print mode. Next month's Short Scoop will present the print test results from the reservoir print mode.

For the step print mode we used four different squeegee blades. We found that the squeegee blade was a significant factor in determining the printing quality and results.

Stencil, Board, and Squeegee Blade Set-Up

The step print test vehicle was a flex circuit having a 7 mil (175µm) thick stiffener attached to the back side of the circuit as a step-up. The front side of the flex circuit was flat with a .260 mm pitch flip-chip component and several µBGAs. The flex and stiffener surfaces were separated by the stiffener height. µBGA patterns printed on top of the stiffener were positioned at 25 mils (.64 mm), 50 mils (1.28 mm), and 100 mils (2.54 mm) from the step edge of the stencil. A shim was attached to the flex to simulate a flip-chip cavity embedded 14 mils (355µm) deep.

The task was to use a 3D electroform stencil to print on two surfaces of the backside of the flex at the same time. Solder bricks were printed on the .4 mm µBGA on the left side of the flex and on the surface of the stiffener.

Four different squeegee blades were used to print solder paste on the uneven surfaces: an 80 durometer rubber squeegee, a slit metal squeegee blade, a notched metal squeegee blade, and a straight metal squeegee blade. The printer was set with 2 kgm of pressure for a 12" blade at a speed of 25 mm/second. It was dry wiped after each print. A solder paste inspection system was used to measure the solder paste volume and solder paste volume deviation for the three sites on the lower level of the board and the three sites on top of the stiffener, for six sites total.

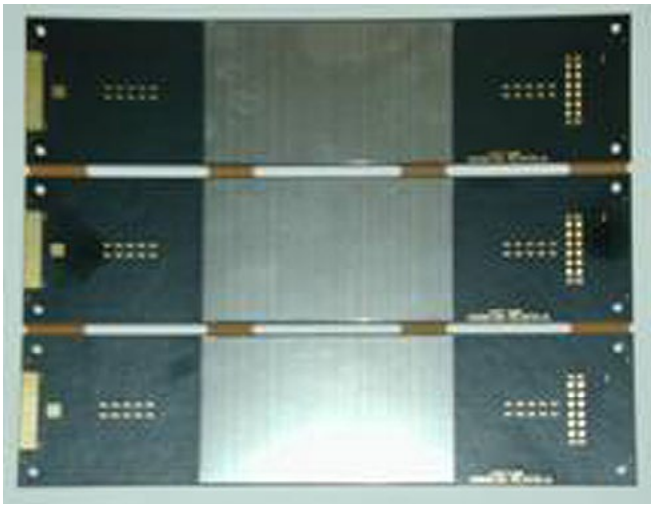

Figure 1: Backside of stencil.

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Figure 2: Paste residue on slit squeegee blade (left); notch squeegee blade (center); metal straight squeegee blade (right).

Print and Inspection Results

The slit blade was tried first. Excessive paste was left on top of the stencil. The pressure was increased to 4 kgm, but the increased pressure resulted in the slit portion on top of the raised area being bent back at a lower angle without improving the residue paste left on the surface.

For the notched and normal straight metal squeegee blades, 2 kgm of pressure was used. No excessive paste residue was left on the stencil in either case.

Results showed that for all the blades there was paste residue at the edge of the step-up portion edges. This was caused by a slight lip at the edge of the step. The data showed that the set of apertures located closest to the step edge (25 mils, 635µm) produced solder bricks with the largest paste volume deviation.

Table 1 shows the paste volume and paste volume standard deviation for the four blade types on one of the printed boards.

The "measures volume" is the measured volume divided by the aperture volume times 100% giving the % volume of paste transferred. Ten boards were run on the printer. The next five boards were run in the solder paste inspection machine for paste volume measurements. As seen in Table 1, the most consistent results are with the straight metal squeegee blade, which showed the lowest standard deviation.

Blade Type	% Paste Vol	% Paste Vol STD
SLIT:		
Loc 1	54	11
Loc 2	70	13
Loc 3	85	15
Loc 4	95	6
Loc 5	100	11
Loc 6	104	20
NOTCH:		
Loc 1	61	10
Loc 2	74	6
Loc 3	72	14
Loc 4	70	15
Loc 5	101	14
Loc 6	115	33
RUBBER:		
Loc 1	55	11
Loc 2	59	4
Loc 3	58	12
Loc 4	54	6
Loc 5	73	9
Loc 6	75	22
STRAIGHT METAL:		
Loc 1	73	7
Loc 2	71	6
Loc 3	72	6
Loc 4	77	6
Loc 5	82	9
Loc 6	98	15

Table 1: Standard Deviation for 4 Blade Types.

The paste height gets progressively higher for bricks closer to the step edge. Location 6, the one closest to the step edge, provided the highest paste volume and the largest standard deviation for all four blade types, with the notch blade showing the highest volume and standard deviation at that location.

A more complete picture of the edge effect in location 6 is obtained by analyzing the solder paste volume data for all five runs and all four squeegee blades. Figure 4 shows the solder paste volume for location 6 broken down into the eight columns of the 64 array pattern of the flex circuit pad sites. Column 8 is closest to the step edge. The paste volume increases from column 1 to column 8 as well as the deviation. Column 8 has more paste volume due to paste being left on the top side of the stencil. The metal and rubber blades provide a cleaner wipe near the edge leaving less paste on top. The paste volume data is split by print level:

- Notch blade was much better on the bottom level than the top level
- Slit blade had large deviations on both levels
- Rubber blade had low volume on both levels
- Straight blade gave best overall results

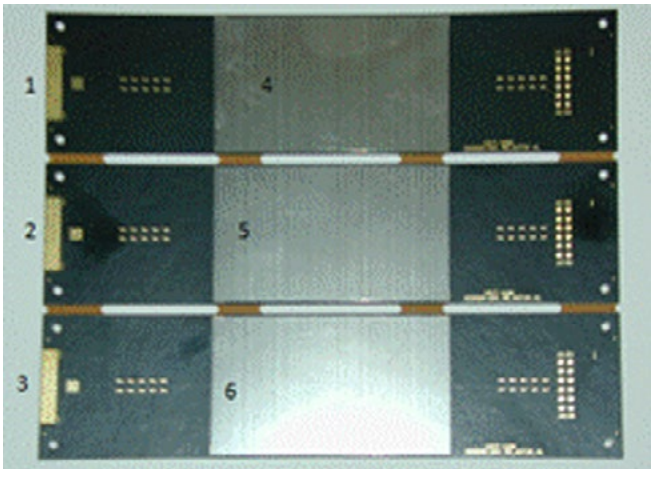

Figure 3: Six sites.

Conclusion

For two-level printing, printing with a 3D electroform single thickness stencil on two levels of a PCB is possible. However, the squeegee blade used in the printer makes a significant difference in the application of the solder paste and the results obtained. The solder paste volume is slightly higher on the top surface for all four blade types tested. The straight metal blade provided the lowest paste volume standard deviation of all the tested blades. Edge effect due to the raised edge near the step edge caused higher paste deviation near the step edge. **SMT**

Rachel Miller-Short is vice president of sales and marketing at Photo Stencil LLC. To read past columns or to contact the author, click here.

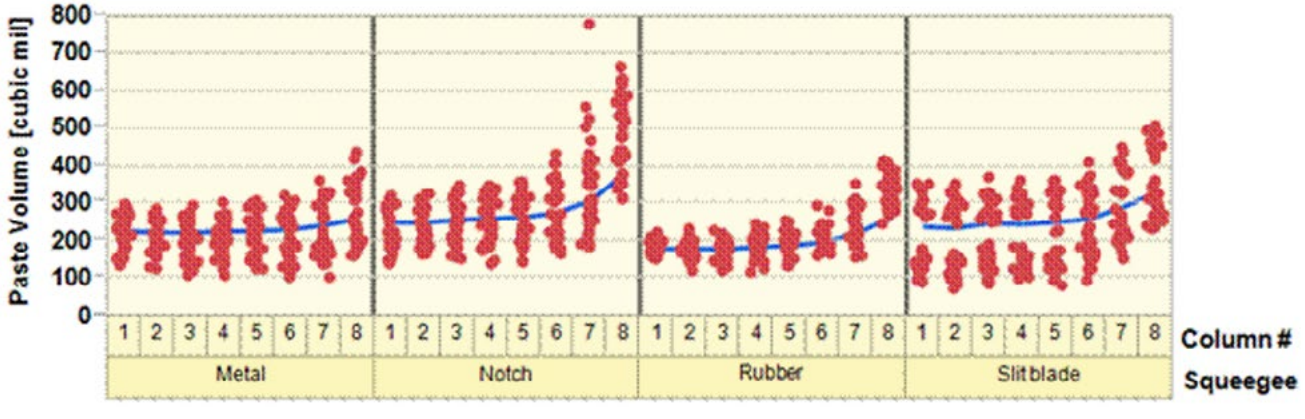

Figure 4: Solder paste volume shown by rows 1–8 of the FC array for location 6 (8 is closest to step-edge).

SMTonline Supplier/New Product News Highlights

Alpha EF-8800HF: Wave Soldering Process for Thick PCBs

Alpha has developed a solder flux, ALPHA EF-8800HF, to resolve assembly problems in the wave soldering process for thick, high-density PCBs.

Dymax Debuts SG-200 Super-Flow Spray Gun System

The company has introduced the new SG-200 Super-Flow Spray Gun System, designed for masking and coating applications where significantly higher flow rates are required. With achievable flow rates of 2.5 to 20 oz. per minute, the system helps operators maximize productivity in high-volume and large-part masking and coating applications.

Panasonic Factory Solutions Debuts Application Guide

"The expansion of our website continues to provide a resource to manufacturers and insight into the width and depth of solutions available from Panasonic Factory Solutions," said Faisal Pandit, President of Panasonic Factory Solutions Company of America.

ZESTRON EYE Celebrates a Successful First Year

ZESTRON, the globally leading provider of high-precision cleaning products, services, and training solutions for the electronics manufacturing industry, is pleased to announce its successful first year launch of its automatic concentration monitoring and controlling system.

DEK Strengthens Hi-Tech's Capabilities

In a move designed to raise efficiency and improve production capability, Hi-Tech Electronic Products and Manufacturing, Inc. has selected ASM Assembly Systems' DEK Horizon 01iX platform for its high-volume, high-mix manufacturing line.

Electrolube Launches New Coating, Resin Products in India

UVCL is the next generation of VOC-free conformal coatings that provides the ultimate protection in harsh environments, including high-humidity, corrosive, and chemical atmospheres. PE7500 is a clear amber, flexible encapsulation resin, which allows easy removal of cured material from broken or defective units, thanks to its "digoutable" properties.

Indium Expands Malaysia Technical Support

Indium Corporation's new Malaysia Tech Hub expands the company's physical presence to provide a convenient, regional center for the development of electronics assembly expertise and customer service. The areas of focus for the tech hub include PCB assembly materials, engineered solders and alloys, and semiconductor and advanced assembly materials.

Ellsworth Europe Offers Microcare's New TidyPen

Since it was first launched back in the nineties, The TidyPen has become one of the most popular products within the Microcare portfolio and is considered a "must have" time-saver for electronics manufacturers, repair shops, medical facilities, and more.

Panasonic: Heller Industries Joins PanaCIM Program

Panasonic Factory Solutions Company of America has announced the inclusion of Heller Industries' solutions and equipment in the PanaCIM Certified Technology Program.

Alpha Launches New Application Lab in Korea

The company has announced the addition of a new application lab in Korea. The lab will focus on trial or evaluation testing of products for new projects and supports Alpha's mission to provide superior technical support to their valued customers.

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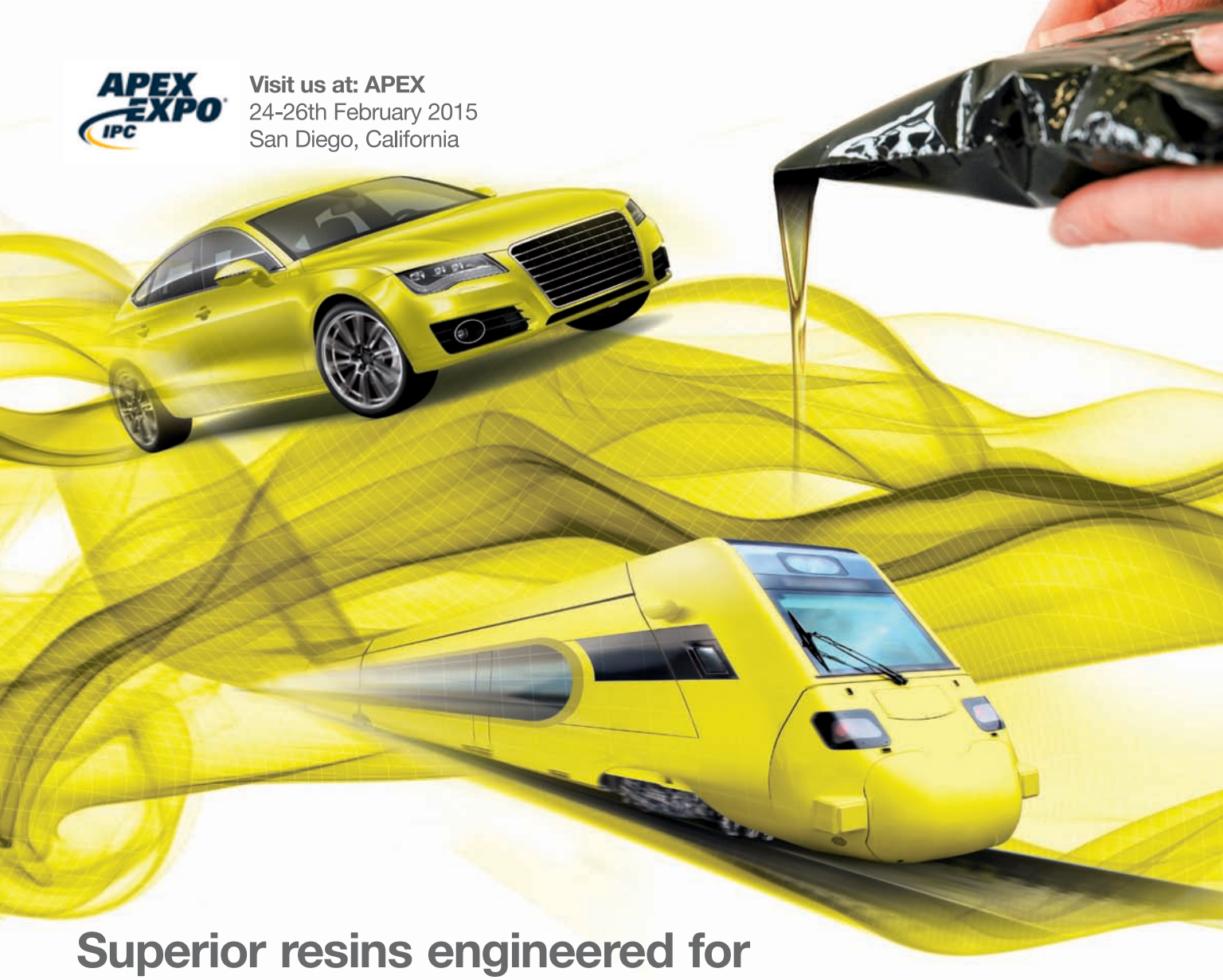

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KRAMER ON COUNTERFEITS

Bad Customers

by Todd Kramer
SECURE COMPONENTS LLC

Recent news reports of people maimed by shrapnel slicing through a car's interior has the public shocked, mainly because we all climb into the crosshairs of an airbag many times a day. The manufacturer's recall was limited to warmer climates in response to information linking higher temperatures and humidity as contributing factors. Just days before, an article surfaced about loaded missile racks falling from warplanes—victim of faulty attachment assemblies.

Both cases can be traced to substandard components either not meeting design specifications or not being evaluated thoroughly. The AS6081 Counterfeit Mitigation standard provides direction for the detection, mitigation and disposition of fraudulent and counterfeit components. It's this document that supplements the purchasing process while augmenting quality/reliability and safety requirement flow-down.

When cost and schedule are allowed to supersede quality and safety like a carrot on a stick, a mentality is nurtured that induces latent defects. Cheap parts are hard to resist, but it's these fakes that risk human life and critical systems. Electronic assemblies are seeing a much longer life than originally expected, such as those used in the B-52 bomber designed in the 1950s, or the growing number of vehicles that are older than 10 years on today's roads. The demand for pre-owned vehicles has not slowed as the economy sputters back to health, making the practice of driving cars longer a necessity. Maintaining these systems puts pressure on suppliers to find ever-diminishing supplies of replacement components, which produces opportunity for counterfeit parts. Fake, substandard components that have failed, shorted out, or are otherwise beyond their useful life, damaged or rejected by the manufacturer are inherently hazardous. Integrating them into circuits, subsystems or systems only increases the risk.

As parts become obsolete, finding a trusted source that meets OCM specification evolves

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Horatio Quinones, Ph.D.
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into a science. Secure Components, for example, partners with suppliers to locate hard-to-find parts, teams up with authorized test centers and amplifies customers' supply chain. Purchasing can become so focused on cutting cost it unknowingly introduces counterfeit components into the supply stream generating costs downstream erasing any initial savings.

Because these suppliers may have no experience satisfying AS6081 requirements, an in-house quality system is teamed with third-party test facilities to authenticate a part's pedigree. Depending on the customers' application and the suppliers' quote, which includes risk assessment, a well thought-out decision regarding the level of authenticity testing is required. All AS6081-invoked orders are processed using the minimum level, including: documentation and packaging inspection, external visual inspections, inspection for remarkings and resurfacing, X-ray inspection, lead finish evaluation and delid/decapsulate for internal analysis. Additional tests, when agreed to by the customer, may include environmental, scanning electron microscope, quantitative surface analysis, thermal testing, electrical testing, burn-in tests, hermeticity verification for fine and gross leaks, scanning acoustic microscopy, and more. Test programs are designed to test component functionality in accordance with OCM specs. There is a cost associated with this level of vigilance but authenticating a part to OEM specification generates greater customer satisfaction, system reliability and bigger market returns.

When organizations fail to recognize the benefit of counterfeit avoidance practices in favor of cheap substandard components, they are going against the prevailing trend. The DoD recognizes these gaps in the supply chain. To address them, AS6081 is intended to remove counterfeit opportunities. Failure to implement a counterfeit avoidance program is fast becoming a barrier to federal contracts. Business segments like the automobile industry also seek protection from the costly effects of fake parts. The Global Business Leaders Alliance Against Counterfeiting is one such organization to have major automobile manufacturers Daimler Chrysler and General Motors as members. Remember the air bags? A rigorous environmental test program would have unveiled this deficiency.

So what do you get with cut-rate components, or rather, what don't you get?

Evidence of supplier requirements: Flowing system requirements to purchasing contracts clearly communicates to the vendor what documentation must accompany all shipments. Insisting on this information, suppliers are reluctant to ship merchandise at the risk of incurring return shipping and restock fees.

Authentication: Counterfeiters are market-savvy and keep abreast of what components are obsolete, yet in demand of salvage parts. Applying a new coat of ink and freshening up company data on parts add to the illusion of OCM hardware, as does fake certification information printed from the Internet. Without traceability documentation, inspection and tests, performed by qualified test centers, you may be purchasing shorted circuits, or rejected and/or salvaged parts

Genuine savings: Fake components add costs in the form of rework, repair, maintenance time or off-duty periods. Factoring the expense associated with these activities exceed initially realized savings. The damage done to reliability predictions, maintainability and company brand are additional unexpected costs.

Counterfeit components are cheap! Many are reconditioned parts, even tested to a degree, and sold as new. It's hard to resist these seemingly cost-effective alternatives when cost is a primary driver, but the risk to personnel and systems is too great a gamble. A reliable system performing as marketed is vastly more valuable than any short-term savings from "yard sale" quotes or parts salvaged from a reject pile. **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.

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TOP TEN

News Highlights from SMTonline this Month

1 IPC Updates, Expands Electronics Assembly Standards

Two of the industry's most important electronics assembly standards, IPC J-STD-001, Requirements for Soldered Electrical and Electronic Assemblies and IPC-A-610, Acceptability of Electronic Assemblies, have been updated to include technical advances including solder on plastic packages, conformal coatings, and two new terminal types.

2 Flextronics Enters New Agreement with RocTool

Flextronics began using RocTool technologies in 2011. However, the new global license expands the agreement to include RocTool's latest injection molding processes for composites and plastic injection and innovations for consumer electronics, automotive, wearable applications, and a range of consumer products.

3 Sanmina Reports Overall Improvement in Q4, FY2014

"Solid execution coupled with stable demand from a majority of our market segments were the key drivers for overall improvement in our financial results. Revenue for the fourth quarter was up 5% sequentially and 12% over the fourth quarter last year," stated Jure Sola, chairman and CEO.

4 Key Tronic's Q1 Revenue Rises on Ayrshire Acquisition

"As previously announced, our revenue and earnings were impacted by the large revenue reduction by a certain customer, an unfavorable product mix, and unusually high operating costs in the first quarter," said Craig Gates, president and CEO.

5 Flextronics' Q2 Revenue Beats Expectations

"Our consistent execution continues to pay off with measured improvements across many areas of our business, including our operating margins, which improved for the sixth consecutive quarter," said Mike McNamara, CEO. "We are also pleased to have exceeded our revenue expectations in HRS and CTG in addition to posting $6.53 billion in sales."

6 Celestica CEO Craig Muhlhauser to Retire

Celestica Inc. announced that President and CEO Craig Muhlhauser has informed the Board of Directors of his intent to retire as an officer and director of the company by the end of 2015, beginning an orderly leadership transition over the next 12 months.

7 Kimball's EMS Business Spin-off Completed

"Today's announcement marks a significant achievement by countless employees of both companies," stated Bob Schneider, the new chairman and CEO. "Both companies are poised for growth and building success for customers, employees, and shareholders."

8 Benchmark Continues to Drive Profitable Growth

President and CEO Gayla J. Delly commented, "We are pleased with the solid performance of our teams during the third quarter as we have continued to support new program ramps and acquisition-integration activities."

9 IMI's EMS Biz Posts 18% Revenue Growth

Arthur Tan, IMI president and CEO, says, "Despite continued volatility in the global markets, IMI maintains a profitable growth as it is naturally hedged by the diversity of its markets served and locations in which it operates."

10 Neways Benefits from BuS Acquisition; Revenue Up 31%

Neways recorded turnover of EUR 89.9 million in the third quarter of 2014, an increase of 31% compared with EUR 68.4 million in the same period of last year. The increase was entirely due to the completed acquisition of BuS Group, which has been consolidated in Neways results as from July 1.

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.

J-STD-001 and IPC-A-610—Updates to Conformal Coating Section
December 1, 2014
Webinar

Seminar—Advances in AOI Technology
December 2, 2014
West Midlands, UK

International Printed Circuit & APEX South China Fair
December 3–5, 2014
Shenzhen, China

Space Coast and Tampa Bay Expo & Tech Forum
December 4, 2014
Kissimmee, Florida, USA

Counterfeit Electronics Components—Avoidance and Detection
December 4, 2014
Exeter, UK

SMTA Pan Pacific 2015
February 2–5, 2015
Hawaii, USA

MEDIX 2015
February 4–6, 2015
Osaka, Japan

IPC APEX Expo 2015
February 24–26, 2015
San Diego, California, USA

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Structural Electronics in Assembly