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DECEMBER 2013

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in 2014 p.20

How to Survive the
Teen Years p.26

Our Columnists Speak



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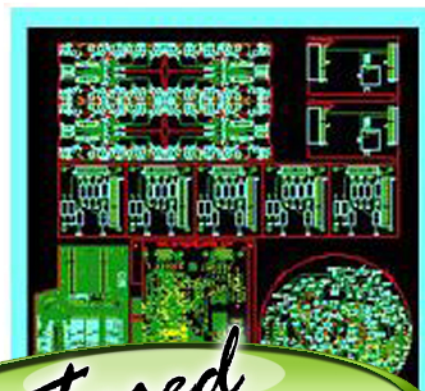
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December 2013 Featured Content

OUR COLUMNISTS SPEAK

This month, *SMT Magazine's* columnists went to their well of experience to both evaluate 2013, and take a look forward to the coming year, with an eye on trends, technologies, processes and equipment.

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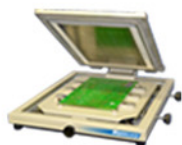
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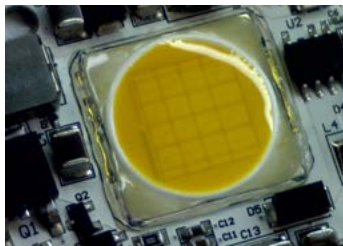
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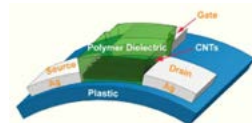


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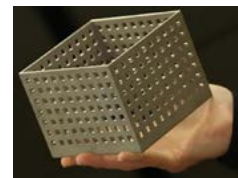


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THE WAY I SEE IT

The Wrap-Up

by Ray Rasmussen

PUBLISHER, I-CONNECT007

**Good Riddance**

Tying up 2013 into a nice, tight bow, tossing it over my shoulder and then dusting off my hands comes to mind when trying to wrap up the year. I didn't much like the year that was.

Politics seemed to take center stage for most of us as those we elected to keep us on track did nothing to improve the economy.

A few changes should be noted. On the PCB side of things, we lost Endicott Interconnect Technologies to bankruptcy and in August, Hitachi Via Mechanics sold to the Longreach Group. Hitachi has claimed the global top spot over the last decade, filling Chinese factories with their drilling equipment. The reliance on that low-margin sector, even though they sold

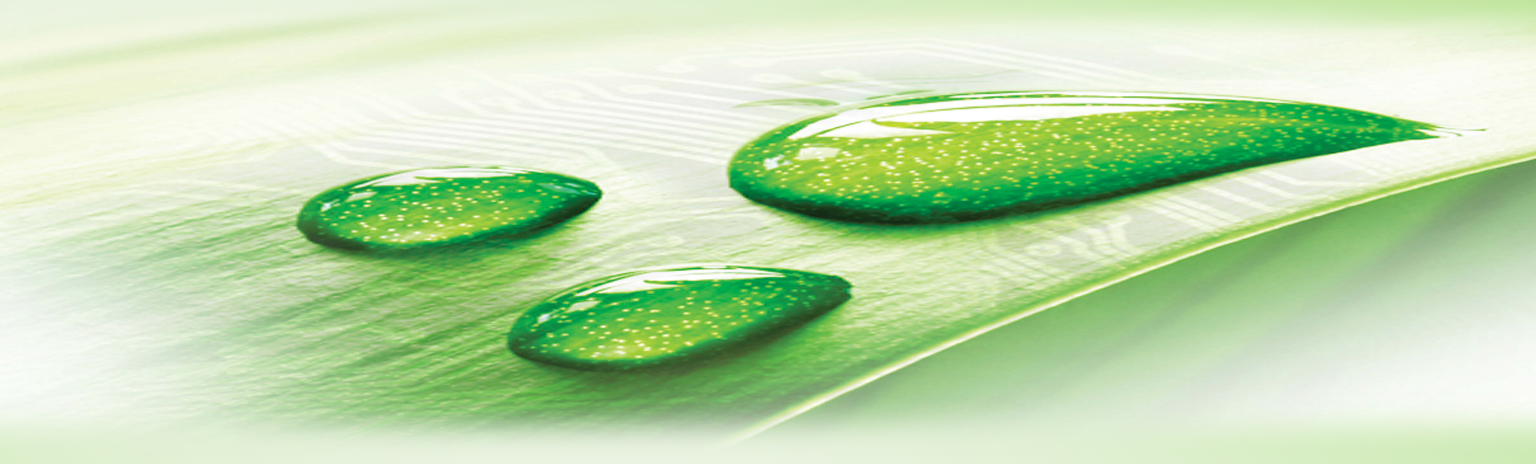
a ton of machines, may have cost them their business.

TTM COO Shane Whiteside left the company "to pursue other opportunities," and a few months later, his boss, Kent Alder retired. Those two built one of the world's largest PCB companies, but it makes you wonder. Their departures were so close together, it almost feels like they were jumping ship, although there aren't any indications that there's anything wrong with the company. The stock is doing fine. But it makes you think.

Other notable M&A activity includes Kyocera buying NEC Toppan Circuit Solutions; Graphic Plc buying Calflex; Elga Europe entering into a joint venture with Eternal Chemical;



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THE WRAP-UP *continues*

Eltek joining with Nistec, an Israeli EMS provider; R&D Circuits acquiring PCB design company Altanova; EPEC and Suncoast Digital joining forces (EPEC also purchased UPE back in January to enhance its extreme copper technology); China's Fastprint picked up eXception's PCB business; SMG and Global Circuits merged operations; Yash Sutariya's management team purchased Alpha Circuit Corp; Zutron acquired Teknoflex; and All Flex started off the year by acquiring Tri-C Design.

On the EMS side of things, CirTran finally got out of the EMS business and is now putting all of their focus on beverages. I have not spent time figuring out how and why they made the switch from electronics manufacturing to playboy energy drinks. Not a big loss, I guess. CTS also left the industry, selling its EMS capabilities to Benchmark Electronics so that they could focus on their sensors and components business. I guess focus is good. Hunter Technology acquired NBS's design assets; Natel bought EPIC Technologies while assembly equipment supplier Essemtec sold its operations to a private investor group. GE bought Imbera Electronics to advance its capabilities into advanced embedded electronics packaging. LTX-Credence bought Dover's Multitest and ECT, while Molex bought FCT Electronics, only to be acquired by Koch one month later.

Flextronics made a few acquisitions picking up RIWISA to strengthen its position in medical. They also picked up a couple of factories from Motorola Mobility (Google), one in Brazil and the other in China. Sparton bought Creonix to strengthen its mil/aero offerings and also picked up Aydin Displays. They bought Onyx at the end of 2012.

Jabil bought Nypro; OSI bought Briton EMS; Season Group acquired OEL; ENRI merged with Abotron; TPG and Goldman Sachs bought the rest of eXception; Probe bought Trident; JUKI and Sony merged their SMT equipment businesses.

Moving On

China's been sucking wind most of the year. Seems like things are improving but it's anybody's guess. China's official numbers are suspect at best.

Europe is finally coming out of recession, which is good, but it will take some time for things to get moving again.

In the U.S., we've had to deal with the repercussions of the budget sequestration (artificial slowing of the economy)

and the government shutdown by a few radicals (another artificial slowing of the economy). It's been painful. We need to pull out all the stops and allow the economy to grow at full speed. We can work on the structural stuff later, once we have full employment and tax revenues flowing in. We take two steps forward then one step back. It's crazy.

Market news is getting the most reader interest from our websites. Anything with market information seems to be of great importance these days. Leading

indicators from The Conference

Board captured the most attention. Those indicators have been climbing for most of 2013, which is a good thing, just not fast enough. All economists believe economic growth is being hindered by partisan politics in the U.S. Congress.

IPC continues to evolve and along with it, some more personnel changes. We've lost Susan Filz (conference coordinator) and Mary MacKinnon (APEX show sales). IPC has also added [PERM](#) into the stable of groups under its control. PERM is a group working to help high-reliability companies move to lead-free. Driven mostly by mil/aero suppliers, they're working hard on a solution for tin whiskers. They made some good, but rather expensive progress. As one gentleman from Raytheon said at the recent tin whiskers conference, they haven't seen any increase in failures due to whiskers, but he also acknowledged they are spending a ton of money to ensure that.

“As one gentleman from Raytheon said at the recent tin whiskers conference, they haven't seen any increase in failures due to whiskers, but he also acknowledged they are spending a ton of money to ensure that.”

IPC also broke bread with SMTA by co-locating their fall meeting in conjunction with the SMTAI show. It seemed to work well for both groups. Let's hope for more cooperation and, ultimately, the merger of these groups.

A bright spot for me in 2013 was the new [Viasystems factory in Anaheim](#). I liked that. It's good to see what may be a taste of things to come. Let's hope so.

Looking Ahead

What can we expect in 2014? I'm optimistic. It sure seems like the market is ready to roll if politics can stay out of the way. That's the only area of real concern I have. When you look at the raft of new technologies under development, conventional and alternative energy, printed electronics, 3D, new products based on exciting materials like graphene, the U.S. and Europe are in pretty good position to capture serious market share. Those innovations will translate into some type of electronics, which will drive our industry forward. The U.S. now has a pretty solid and reliable energy supply. Huge improvements to the energy infrastructure will keep energy prices relatively stable for years to come—a huge benefit for our manufacturers. This gives companies confidence that the costs of manufacturing will be fairly stable as they expand their businesses. Infrastructure and rule-of-law (IP protection), proximity to customers, and low levels of corruption are advantages we have over most of the developing world.

As a result, I think we'll see some surprising on-shoring initiatives in 2014 as companies make the move back to North America. China will continue to lose its luster. Things are beginning to come back into balance.

Another change we're starting to see and will continue to see expand in 2014 is the number of talented young people entering the industry. It has been a cry heard for years at industry events: Where are all the young people? How can we get them involved in the industry? Actually, these engineers, product designers, and entrepreneurs have discovered our industry because of printed electronics and 3D printing. They're going to rock our world. They don't have the mindset we all have.

They're going to develop the systems to build the electronics of the future, not based on what we know with traditional PCBs but on PE and 3D platforms. So for those of you who've been wondering where all the young people are, ask no more.

What will we see from the PE and 3D sectors in 2014? No big game changers, really. Just lots more low-cost prototyping systems. In a recent PCB assembly association survey, printed electronics scored highest as the area of greatest interest for its members. Just a couple years ago, PE was hardly on anyone's radar.

The link below is an example of the kinds of efforts being made by GenZ (get it, Z axis, third dimension) of circuit manufacturers.

[Circuit-printing startup reaches 30-day kick-starter fundraising goal in 5 hours](#)

And to help us get a glimpse of the kind of energy going into this, Oak Ridge National Lab is giving 35,000 3D printers to U.S. schools. Again, the concern about the lack of young people in our industry won't be an issue for long. It's just not going to be the industry we're used to. Read more about this initiative [here](#).

Tremendous opportunity awaits all those who grab it, and 2014 holds a lot of promise for our industry. You have to open your eyes, though, to see it. I'll leave you with a few famous quotes on the topic. **SMT**

The reason a lot of people do not recognize opportunity is because it usually goes around wearing overalls looking like hard work.

—Thomas A. Edison

A pessimist sees the difficulty in every opportunity; an optimist sees the opportunity in every difficulty.

—Winston Churchill



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](#).

2013: Year-End Review

by Dr. Jennie S. Hwang

CEO, H-TECHNOLOGIES GROUP

For this year-in-review column, we will check on whether my January 2013 column, [Outlook for the New Year](#), is on or off target. As usual, I will go through the key sub-topics that directly or indirectly impact our industry in terms of business environment, technology and global marketplace to see how my predictions actually panned out.

Global Economic Outlook

From January 2013:

The two largest economies, U.S. and China, are showing signs of improving in Q4 of 2012, which is expected to continue into 2013. In Eurozone, most alarming news has surfaced, although the solutions—economic, financial or political are to be concocted and implemented. Common mechanisms to ensure member countries following through on fiscal plans and an agreeable banking regulatory framework are yet to be formulated. The sense is that when any viable solution is in sight, it will be a great relief to the market...As the third largest economy, Japan... is expected to mildly contract from the 2012 level to below 2.0% GDP, due largely to its large export component and the continued strong yen currency...

...A pro-growth political resolution and economic policies in either U.S or Europe or both will brighten the global growth prospects and drive faster recovery; if failing to do so, the global economic outlook in 2013 will suffer... going into 2013, the U.S. unemployment rate will be slowly going down...

...If the belief that economic stimulus is justified when unemployment is above 6.5% and inflation is lower than 2% is put to work, we can also expect further stimulus by the U.S. central bank...

The world's major economies, overall, have been on the recovery path in 2013: Europe is emerging from recession, Japan started to grow and the U.S. private sector is enjoying handsome earnings as reflected in the upward stock market indices with about 20% increase. The U.S. stock market is further fuelled by the Fed's delay in tapering the bond buying program.

However, the U.S. economy may be "disturbed" by the public sector in government's spending cut, fiscal brinksmanship, government shutdown and the debt ceiling debate in Washington.

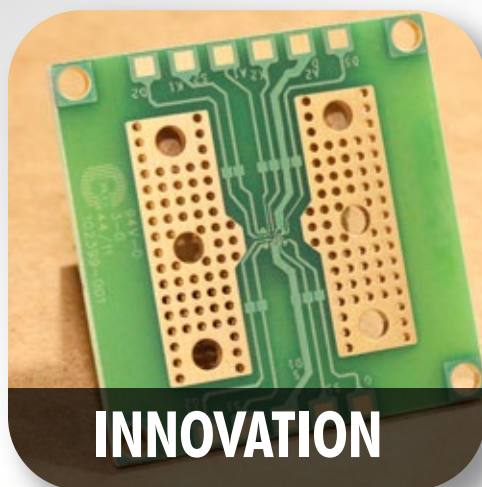
Japan's GDP, indeed, has grown to more than 1.5% under the aspiration of Abenomics (Prime Minister Abe's economic policies), which steers both domes-





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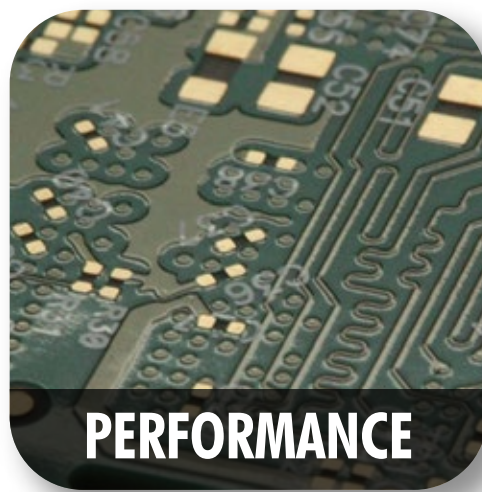
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2013: YEAR-END REVIEW *continues*

tic economic development and the intra-Asia influence. Europe, albeit fragile, is coming out of a recession, and seeing the light at the end of the tunnel. At the time of this writing (November 1, 2013), the political hurdles in the U.S. have delayed the report of economic data and may likely distort the economic indicators.

The U.S. unemployment rate has slowly decreased. As of October, the reported number is 7.2% vs. higher than 7.5% in 2012. The Eurozone still struggles with a high unemployment rate (more than 12%) compounded with the worryingly low inflation rate. Japan stays steady in unemployment rate at around 4%.

One bright spot is the stronger U.S. manufacturing activities (per the survey of Institute for Supply Management), which is in line with the corporate earnings report.

And the U.S. Federal Reserve did not taper the stimulus by reducing the bond-buying program in September as the Central Bank hinted in the early part of the year. And while in a holding pattern, its easy money program is intact and continuing.

From January 2013:

...In corporate America, where and how the cash-rich multinational corporations (collectively holding more than \$1 trillion in cash) are going to invest—overseas or domestically—dividend increase or share buyback will impact the job market and the U.S. economic outcome, pending government policies and tax reforms. The continued spending inertia by holding cash and taking a conservative stand appears to be the course of action.

Spending inertia was evident during the first three quarters of the year. This business position contributes to the sustaining higher unemployment rate.

From January 2013:

However, China, along with the U.S., will lead the way out of the global economic malaise. Asia

continues to be the high-growth region as the world's economic engine. And China will play a dominating role, enhancing the realization of the China factor by exerting its influence in both intra-Asia and outside the continent.

Overall, sign posts, hard indicators and soft inferences signal a mild economic growth over 2012, but not to expect an exciting 2013.

“One bright spot is the stronger U.S. manufacturing activities (per the survey of Institute for Supply Management), which is in line with the corporate earnings report.”

Yes, 2013 is going to end with moderate growth, but lower than desired. And the U.S and China have played influential roles in this economic recovery.

China Factor**From January 2013:**

Yes, there is the China Factor. The once-in-a-decade leadership change in China has occurred. The new seven-member Chinese leadership selected by their credentials and seniority was elected last November. One new characteristic is that this new leadership is the very first generation that has no involvement in 1949–1960s revolution. Would this transition of power steer different economic and political policies? My sense, in a nut shell, is that these new leaders will shape up the country's needs with the priorities on balancing the domestic consumption and the export, harmonizing the urban and rural society, containing inflation, and making more efforts to meet people's demands while exercising assertive foreign policies. With all three of its largest trading partners in either recession or a slow growth mode, China has more a reason to pump up its consumption-oriented economy to spur long-term growth and social stability. China's government may set its GDP target at 7% (lower than 7.5% in 2012). If so, it implies that the new government is willing to accept a slower growth economy by morphing into a consumption-oriented economy in lieu of investment. This strategy will serve as a stepping stone to a long-run wholesome economy on the world stage. Within a range of 6–8% GDP, a higher percentage does not necessarily translate into a more robust economy. Quality does count.

China, by and large, went through its leadership transition smoothly. The new leaders have already demonstrated new visions, signaling political and economic plans going forward. There have been some perturbances in its manufacturing activities during the course of the year. Nonetheless, China will conclude 2013 by exceeding its GDP goal of 7%, likely 7.4%, plus or minus 0.2%. 2013 was a transitional year for the country both politically and economically.

From January 2013:

The country's twelfth Five-Year Plan spearheaded by the State Council, the Ministry of Industry and Information Technology and the Ministry of Science and Technology of the People's Republic of China stipulates seven national strategic industries: energy-saving and environmental protection; alternative energy; alternative-fuel cars; high-end equipment manufacturing; biotechnology; new-generation information technology; and advanced materials. China indicated that it would provide financial and tax support to these industries over the next decade in hopes of making these sectors account for around eight percent of China's GDP by 2015 and 15% by 2020. Heightened emphasis on innovation and technology is embedded in the Plan. Also embedded in the country's economic roadmaps include building "smart" cities, low-carbon emission vehicles, information technology infrastructure and environment-friendly water and energy system. Its goal is to make non-fossil fuel account for more than 11 percent of primary energy consumption. The country has made enormous strides, yet much more remains to be done. The country is well aware of the need of building world class companies with leading global brands at the expense of heavily state-owned or controlled enterprises.

As China is or is becoming the world's biggest consumer of semiconductor products, mobile devices, smart phones, PCs, LEDs, solar panels, medical devices, home appliances, construction, etc., the

demand of various industrial, consumer, medical, energy and information technology-related products and services will escalate, requiring new materials, advanced manufacturing infrastructure, and high performance electronics.

Their strategic planning process through a series of economic and social initiatives is superbly effective and its ability to execute the plan is second to none. In 2013, China has started making an effort to reach its goals of the twelfth Five-Year Plan (2011–2015), addressing rising inequality and creating an environment for more sustainable growth by prioritizing more equitable wealth distribution, increased domestic consumption, and improved social infrastructure and social safety nets. To this end, some industries have experienced setbacks in the immediate term, (e.g., curtailing official banquets and related extravagant expenses have downsized the liqueur and associated industries).

In our industry, China has demonstrated that it is, or is becoming, the world's biggest consumer of semiconductor products, mobile devices, smart phones, computers, LEDs, solar panels, medical devices, home appliances, and other industrial and consumer products. According to China's Ministry of Industry and Information Technology (MIIT), China passed the 1 billion benchmark of total mobile phone subscribers. The country is now number one in the world in mobile subscriptions, although its penetration rate is lower than some of the developed countries.

According to China's Ministry of Industry and Information Technology (MIIT), China passed the 1 billion benchmark of total mobile phone subscribers.

Electronics Industry—Hardware

From January 2013:

Several major events are expected to propel the market. First, moving to the "smart" world will continue to drive electronic hardware in product innovation and in manufacturing efficiency, with the mobility and wireless being the primary thrusts. In the

2013: YEAR-END REVIEW *continues*

semiconductor sector, Intel as the top captive semiconductor manufacturer continues its commitment to capital expenditure to advance its manufacturing prowess. In parallel, the number one pure-play semiconductor foundry, Taiwan Semiconductor Manufacturing Company (TSMC), has set aside US\$10 billion for capital expenditure in 2013, making it the no.2 capital spender in the world semiconductor industry, after only Intel Corp. The majority of capital spending in manufacturing will occur in Taiwan, China and Korea. Technologically, efforts and commitments to scale-up wafer size and shrink down transistor circuitry will continue...The manufacturing plan of below 22-nanometer transistors processors are in the works by both OEMs and foundry houses using the legacy immersion lithography technology on 10 nm and 16 nm transistors...Migrating to 450 mm wafer is a major technological move, so is to further shrink transistors below 22 nm...As ICs move into below 22 nm, making the next levels of connections in order to reach the outside world calls for new designs and new materials in the second level IC packages and the third level connection in PCBs. No new forces are in sight for the second and third levels of inter-connections, yet activities are abundant to offer gradual technological advances including optical inter-connections, embedded passives and printed electronics. The development in high density packages, including 3-D packages, system-in-package and BTC packages will continue. PCB's thermal stability... continues to be the most critical performance parameter...Additionally, in new product introduction, the market seasonality has started to shift. Foundry manufacturers are expected to lift up the shipments of new designs from the third quarter to second quarter in order to provide OEMs a longer sale period, as driven by the market demand of smartphones and tablets. Indeed, the market has spoken.

"Smart" electronics is flourishing and moving to a higher level of wearability, connectivity and mobility. Smartwatch is one example. Several smartwatches are on the market already

(e.g., Samsung). Google is in the preparation of mass production. In 2013, OEM factory revenues of combined smartphones and tablets exceeded US\$350 billion.

The 450 mm wafer is a reality and its standardization is in progress. Transistors of 22-nanometer or lower are being manufactured. Newer PCB materials to possess improved properties were introduced. In 2013, 3-D packages and BTC components have been increasingly designed in the circuitry assembly.

Electronic Hardware Manufacturing

From January 2013:

What are the challenges ahead for the electronic hardware manufacturing sector? The broad answer is how to produce high quality reliable products at a competitive cost, in a competitive timeline while generating target operating margin and profits at any locale in the world. Specifically, attention goes to the following areas for OEMs or EMSs alike:

- Strategic alignment with core competency in niche areas
- Moving up in operating margin through niche services
- Time-to-market from design to end-use customers
- Manufacturing flexibility from design to production flow to supply chain agility
- Supply chain infrastructure and execution
- Inventory management and optimization
- Physical proximity to customers
- Partnership with customers
- Partnership between OEMs and EMSs
- Innovative capability
- Ability to foresee emerging technologies
- For OEM: out-source vs. in-source
- For EMS: off-shore vs. on-shore
- Tie in with advanced manufacturing

In the context of competitiveness in the global marketplace, advanced manufacturing will gain

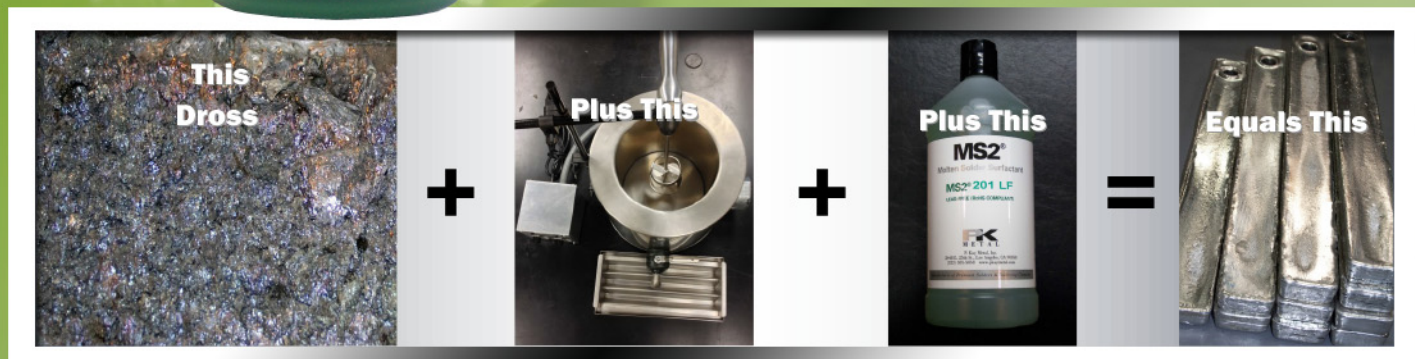
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2013: YEAR-END REVIEW *continues*

further momentum in 2013. I define advanced manufacturing as “manufacturing capability and leadership capacity to sustain, grow and excel in the global landscape to meet both anticipated and unpredictable challenges by leveraging technologies and business model.” This topic will be discussed in future columns.

Addressing inventory management is imperative to the success of manufacturing operation, and its optimization is paramount to the healthy balance sheet and cash flow. Companies must keep track and control of both days of inventory as well as the actual dollar value of inventory. Doing well in this area mitigates the mishap of production outpacing demand as well as eschews cash flow trap.

Going forward, the success of an EMS hinges on how well the EMS can make a strategic and technology partner with the OEMs to collaboratively tackle the end-market challenges by formulating strategic solutions. One reminder is that when assessing out-source vs. in-source by an OEM and when determining off-shore vs. on-shore by an EMS, the cost is not a sole variable in the equation, rather, the cost of ownership drives the business model.

During the course of the year, there have been “re-shoring” activities. In driving growth and profitability, the bullet point areas as listed in last January are as vital as ever to the electronics hardware manufacturing, regardless of on-shore or off-shore. Advanced manufacturing including 3-D manufacturing, “smart” artificial intelligence and leading robotic technologies is essential to present and future manufacturing.

Solar Photovoltaic Market and Technology

From January 2013:

Reality check has painstakingly set in. The re-balancing, consolidation and shakeout are expected to continue in 2013, however, with much less drama. Despite today's market turbulence, the bottom line is that the solar global GW installation will

increase although some countries (e.g., Japan, U.S., China, Canada, Australia) will make a high growth rate and those in Europe (e.g., Germany) remain in a stagnant growth mode in 2013. As the result of the fast decline of module prices, solar panel becomes more attractive. The Chinese National Development and Reform Commission (NDRC) has set a new domestic installation target to 21 GW by 2015 from its original 5GW by 2015. This quadrupling of the domestic installation target came after its already increased revision from 5GW to 15GW in May 2012. This upward revision of target will support prices and help absorb excess supply of panels... In technology, activities are

“**Advanced manufacturing including 3-D manufacturing, “smart” artificial intelligence and leading robotic technologies is essential to present and future manufacturing.**”

alive and well in advancing thin film efficiency and reliability. Thin film still has potential for the future. In 2013, thick film crystalline silicon technology remains prevalent in the marketplace... Again, a viable solar operation requires a business plan that is positioned to weather the industry's boom-and-bust cycle. It takes four core competencies to do business in the solar space: technology capability, manufacturing prowess, operational agility and strategic foresight. They are key to the future of a company, be it a cell and module maker or a materials and device supplier. And the sustained success requires these integrated forces to defy the impact of unwanted external conditions. After all, these requirements are not that different from running a viable business in other industry sectors.

In solar space, some market segments are in distress, while others are thriving. When taking all factors into consideration, the industry remains rewarding, perhaps one of few that have reachable, handsome growth prospects in the visible future. With a solid business model, hold your oar and get through this turbulent time. After going through the growing pains, the industry is expected to get stranger.

The solar industry is going through a quiet recuperating year, as it is emerging from a severe overcapacity debacle. Considering the depth of overcapacity, market geographical shift and political regulatory fluctuation, the industry has yet to reach an equilibrium state.

2013: YEAR-END REVIEW *continues*

The shakeout of manufacturers that do not have sound business plans and adequate capital is continuing. There will be more bankruptcies. The good news is that it is getting there, and the worst is over. Large manufacturers are regaining their value and returning to profit. And even better news is that China, as the largest market today, is curtailing any new capacity building, which is helping the price and profit landscape. And most importantly, the solar panel installation continues to grow in gigawatts (GW) and in geographic locales in the U.S. and across the globe. China and Japan are the top solar market this year, and U.S. has reached the milestone of 10 GW installed solar PV capacity. The global solar PV will exceed 40 GW installations by the end of this year.

The upfront cost has been a hurdle to installation. The industry has initiated various innovative approaches, which help the pace of installation. As one example, New York Light Energy (NYLE), while taking advantage of state and federal subsidies offered a “sunny zero-down solution” for customers who want to install Kyocera’s solar modules on their roofs with a return to buy electricity from NYLE at rates lower than typical grid utility charges. As a result, return on investment and savings are immediate. Kyocera also announced that 25 kilowatts (kW) of photovoltaic modules help power Chicago’s Midway Airport’s new environmentally friendly consolidated rental car facility. The PV system is on the roof of the quick-turn around (QTA) facility, where hundreds of rental cars are washed and refueled daily. The PV system supplies about 30 percent of the QTA’s power needs and provides a strong visual reminder of Midway Airport’s green initiatives (Source: Kyocera).

Environment-Friendly Lead-free Electronics and Regulatory-Complied Manufacturing

From January 2013:

The industry, technology and manufacturing are expected to move smoothly with incremental improvements. Introduction of new or modified lead-free solder alloy materials will continue. Medical electronics sector will join the world of lead-free electronics. 2013 will be the first calendar year that the Securities and Exchange Commission (SEC) rule

requires supply chain diligence and specialized reporting by companies that manufacture or contract to manufacture products that contain certain minerals originating from the Democratic Republic of the Congo and adjoining countries. And the first required report must be filed by May 31, 2014. This conflict mineral disclosure requirements include specific elements—tungsten, tantalum, tin, gold and their derivatives. Corporations’ environmental stewardship for global sustainability continues to be one of important corporate business policies in 2013.

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

Dr. Hwang will present “Preventing Manufacturing Defects and Product Failures” at IPC APEX EXPO, March 24, 2014, in Las Vegas.



Dr. Hwang, a pioneer and long-standing contributor to SMT manufacturing since its inception as well as to the lead-free development and implementation, has helped improve production yield and solved challenging reliability issues. Among her many awards and honors, she is inducted to the WIT International Hall of Fame, elected to the National Academy of Engineering, and named an R&D-Stars-to-Watch. Having held senior executive positions with Lockheed Martin Corp., Sherwin Williams Co., SCM Corp, IEM Corp., she is currently CEO of H-Technologies Group providing business, technology and manufacturing solutions. She has served on U.S. Commerce Department’s Export Council, various national panels/committees, and the board of Fortune 500 NYSE companies and civic and university boards. She is the author of 350+ publications and several textbooks, and an international speaker and author on trade, business, education, and social issues. Her formal education includes four academic degrees as well as Harvard Business School Executive Program and Columbia University Corporate Governance Program. Contact her at (216) 577-3284; e-mail: jennieHwang@aol.com. To read past columns, [click here](#).

A SHORT SCOOP

Why the Customer-Stencil Manufacturer Relationship Matters in 2014

by Rachel Short

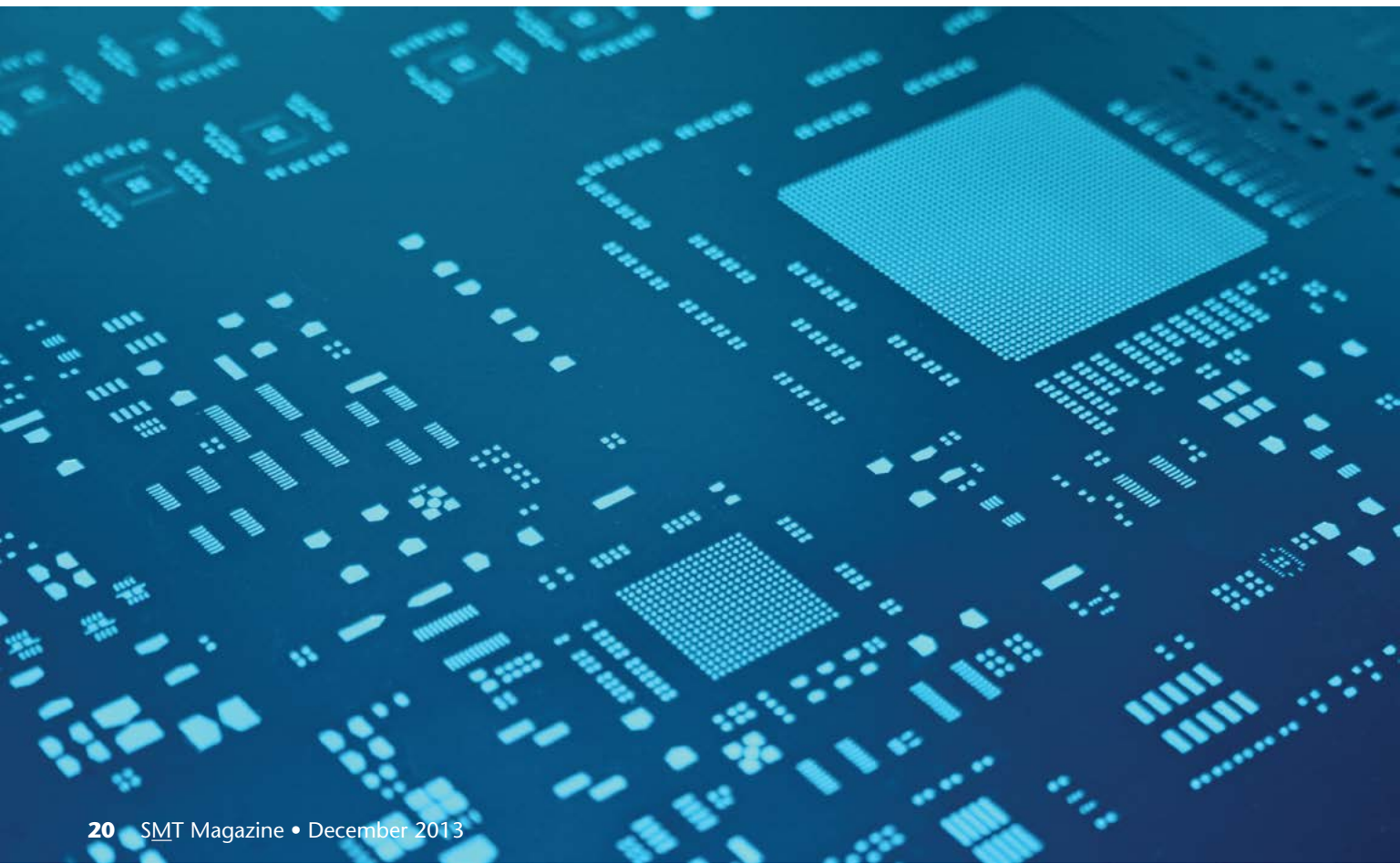
PHOTO STENCIL

When *SMT Magazine* editors asked their columnists to think ahead and discuss the technologies and changes that will lead the way in our field in 2014, my thoughts and predictions naturally turn to stencils.

The stencil market has certainly changed over the past few years, but the main change isn't with products and technologies—although there have been several innovations in products and their accompanying technologies. The big change is in the customer-stencil manufacturer relationship, requirements, and expectations. As recently as a few years ago, the majority of the relationship between a stencil manufacturer and the customer was purely focused on delivering the stencil. For many years, stencil

applications were relatively standard, boards were populated with standard components, and the types of conductive materials being printed didn't vary much. On the stencil side, there were basic laser cut stencils and high-end electroform stencils; but the wide selection of stencil types, materials used to manufacture stencils, and coatings used today didn't exist.

What I see as more acute now is the increasing requirement for stencil manufacturers to be more focused on customer support, technical and application support, technical aptitude, and equipment and manufacturing quality capabilities. The industry is driving suppliers to offer a wider than ever variety of solutions to fit current and future applications.



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WHY THE CUSTOMER-STENCIL MANUFACTURER RELATIONSHIP MATTERS IN 2014 *continues*

There are several reasons for this:

- Wider variation of components being mounted on less real estate
- The variety, types, and materials used to manufacture a stencil have changed
- Applications have become more complex
- Market demand has put more emphasis on quick-turn, time-to-market, and quality

Anyone dealing with PCBs knows that circuit boards are shrinking and becoming more complex. Components are smaller, the components on the same board can vary considerably in both size and height, and the components are spaced closer together. As components get smaller, it is difficult to print solder paste to satisfy the requirements of both very small components, such as 0.4mm and 0.3mm pitch CSPs, as well as normal SMT components. The large components require more solder paste volume for sufficient solder fillets after reflow. However, if the stencil normally used to print solder paste for SMT components is used for the small components, the apertures are so small that poor paste release may be encountered. The area ratio plays a large part in this dilemma. Once it's determined, it's critical to find the exact stencil to meet those parameters. This requires an extensive collaboration between the stencil manufacturer and the PCB manufacturer.

The need to satisfy more rigorous printing requirements due to finer pitch components

has led to a natural hierarchy of stencil technologies based on the application. The hierarchy advances through the technologies, starting with laser cut, and reaching to electroformed and electroformed NiEx stencils.

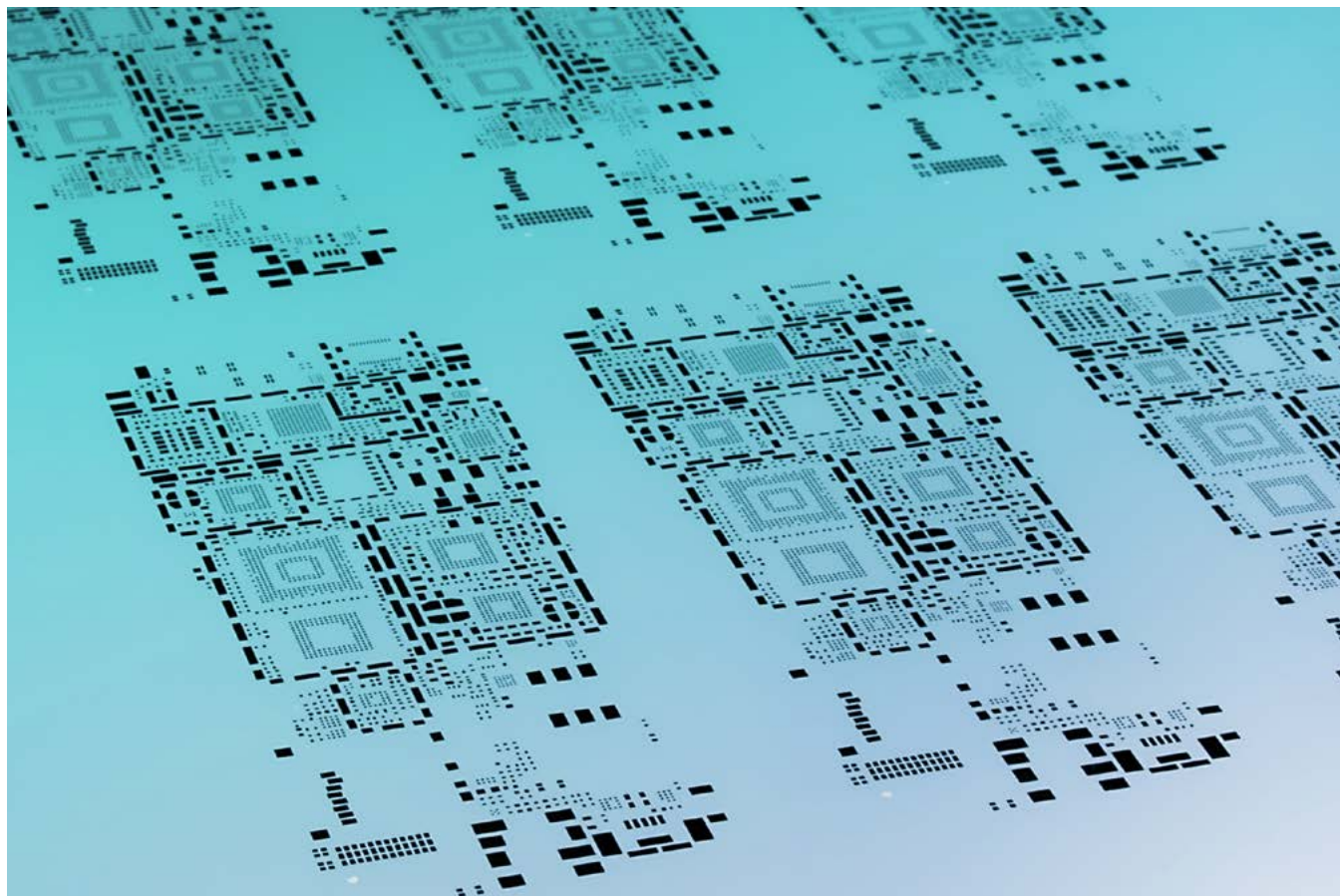
Laser cut are the most common stencils used today and are used for general solder paste printing. They are suitable for printing component pitches down to 20 mils. Electroformed stencils are made of nickel and are becoming more popular as pitches and components become smaller. They are used for active component pitches below 20 mils and for 0201 and 01005 chip components, and also for wafer bumping applications. Electroform stencils provide smooth aperture walls, promoting excellent paste transfer. NiEx electroform stencils are used for very fine pitch (less than .003) applications such as wafer bumping or flux printing. They have a higher Knoop Hardness than standard electroform stencils.

The stencils themselves are not always the whole solution. Coatings are now added post-production to the stencil manufacturing process. These coatings improve the fluxophobicity of the stencil underside and its apertures, improving underside cleaning performance and stencil-to-PCB gasketing, and results in better paste release, fewer defects from bridging and insufficient solder paste, and increased stencil capability for improved production efficiency, greater first pass yield, less time spent cleaning, and extended process capability.

Lead-time and quick-turn have probably become the most important parameters for a company when selecting a stencil provider, and that trend will most likely continue in 2014. PCB manufacturers are receiving intense pressure from their customers to shorten lead-times. Many customers end up using a less capable stencil because they don't have the additional lead-time to wait for the more appropriate stencil to be manufactured. However, this creates a conundrum because although quality has always been important, there is little room



WHY THE CUSTOMER-STENCIL MANUFACTURER RELATIONSHIP MATTERS IN 2014 *continues*



for error when components are close together or boards are complex.

An outgrowth of this situation is the Ni-Cut stencil, and my crystal ball tells me it will be the stencil of choice for 2014. This product solidly bridges the gap between a straight laser cut stencil and a full electroformed stencil. Basically, they are nickel blank stencils with laser cut apertures. Electroform blank foil material is used to obtain a highly capable core material that, when laser cut, achieves the smoothest cut from the fiber optic laser system. They are highly capable stencils that offer area ratios down to .47, which is a good solution for high density mixed components and for specialty and complex applications like .3 mm CSPs, BGAs, QFNs, resistor networks, and highly dense board patterns. They are far more capable than a straight low-end laser cut stencil, yet they can be turned around in the same lead-time including same day turnaround. Manufacturers get a high-end stencil for tough applications, but can still en-

joy short lead-times and quick turnaround at a reasonable price.

So for 2014, I see myself continuing to spend time in the R&D lab with application engineers, acting as a liaison between my customers and the process and manufacturing engineers, and participating in studies to determine the best stencil solutions for specific applications. I just presented the paper Print Performance Studies Comparing Electroform and Laser-cut Stencils at SMTA International in Fort Worth, Texas, which details the performance of 12 stencils in five categories. We are continuing to build on that research, which I will present at IPC APEX EXPO 2014 in Las Vegas. **SMT**



Rachel Short is vice president of sales and marketing at PhotoStencil LLC. To read past columns, or to contact Short, [click here](#).

Video Interview

Europe: High-Precision, High-Volume Market

by *Real Time with...
Productronica*



Roberta Foster-Smith, global marketing communications manager for Nordson, converses with SMTA's Ryan Flaherty about what's driving the changes in the conformal coating market here in Europe, as well as the need for high-precision, high-volume systems.



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Invisible Printed Electronics Using Carbon Nanotubes

Researchers at the UCLA incubator startup, Aneee Nanotechnologies, have demonstrated the first fully printed and invisible electronics using carbon nanotubes. Such a demonstration aims to propel the momentum in innovating invisible (transparent) displays used for Google goggles, invisible window displays, transparent smartphones, and wearable electronics.

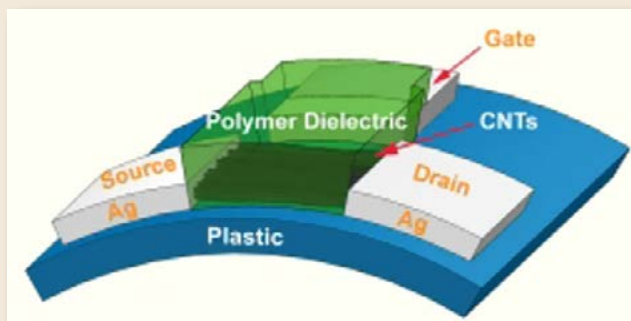
Research built the electronics made of thin film transistors (TFT) to be totally invisible to the naked eye by incorporating devices made solely using carbon nanotubes (CNT) materials that are inherently transparent. In addition to being printable, CNT materials operate at faster processing data speeds and CNT technology has the potential to lessen energy consumption and waste. Further-

more, these materials have outstanding mechanical, electrical, and thermal properties that make them an alluring material to electronic manufacturers.

"This is the first practical demonstration of carbon nanotube-based printed circuits for transparent applications," said Kos Galatsis, an associate adjunct professor of materials science at UCLA Engineering and a co-founder of Aneee. "We have demonstrated carbon nanotubes' viable candidacy as a competing technology alongside amorphous silicon and metal-oxide semiconductor solution as a low-cost and scalable option, but with more bells and whistles."

This distinct process utilizes an inkjet printing method that eliminates the need for expensive vacuum equipment and lends itself to scalable manufacturing and roll-to-roll printing. The team solved many material integration problems that enabled transistors to be fully printed using nano-based ink solutions.

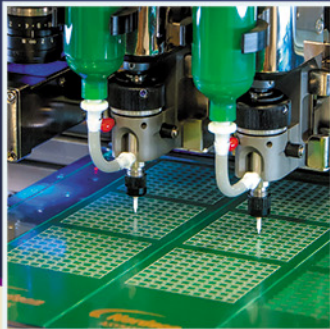
The new work is described in a paper published in the *Applied Physics Letters* journal, co-authored by Aneee scientists, Farzam Sajed and Christopher Rutherglen.



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THE ESSENTIAL PIONEER'S SURVIVAL GUIDE

How to Survive the Teen Years

by **Michael Ford**

MENTOR GRAPHICS CORP.

The year 2013 has been yet another year in which the whole world has been challenged by economic uncertainty. This really isn't news any more. For more than 10 years, many people have had to cope with financial challenges, one after another. The interesting aspect of the situation is how a steady state of austerity has evolved, with continued investment in electronics and technology by the people who "insert the coin"—you and me. Having survived the initial boom and bust in the early 2000s, people now make decisions and prioritisations in favour of technology, and in particular, electronics, bringing with it opportunity to the industry. Creating and delivering technology-based products is a challenge, as demand is there, but price remains extremely sensitive. We are in the midst of a "teenage" market: a market with little money, but heaps of expectation. Should electronics manufacturers be cautious and just try to survive until money flows more freely, or should they reach out for tools that bring positive differentiation? Yes, 2013 was certainly a teen year, and there are a few more to come.

Historically, in difficult economic conditions, economists point people in the direction of safe stocks, such as utilities. The thought process is that no matter what, there will always be a demand for the basic elements of society. But even these investments are not safe anymore, however, as environmental issues and maintenance concerns expose risks and uncertainty. In the teen years, then, what can we rely on? Is it electronics?

I would not be surprised if we look back on 2013 as the year when the perfect storm of a new generation of technology began. Finally, electronics technology is ready to solve our challenges and create opportunities. We already can see the signs all around us. Electronics is a key part of sustainable energy, from industrial-scale operations down to domestic solar instal-



BLACKFOX EXPANDS

Press Release

Blackfox Training Institute, LLC., headquartered in Longmont, Colorado, reports that it officially expands into three additional locations with new facilities.

November 2013:

Blackfox Training Institute reports that it officially expands its training and certification services to three additional locations with new facilities. In addition to the Blackfox headquarters located in Longmont, Colorado, **Blackfox now has new facilities in Tempe, Arizona, Guadalajara, Mexico, and Penang, Malaysia.** Each of these facilities offers the same IPC Certifications and Blackfox Skill-based Certifications as offered in Colorado. Additional locations are planned in the near future.

This expansion was essential in order to create a channel for delivering the IPC Quality Standards and skill-based training and certification to areas of high demand and reduce the travel costs for customers nearby. Each of the Blackfox Training Centers have resident Master IPC Trainers as well as Master IPC Trainers that travel the world delivering all of the training programs at their customers' facilities.

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HOW TO SURVIVE THE TEEN YEARS *continues*

lations. Instead of incandescent bulbs, we now have started to consume LED-based bulbs made on an SMT production line. New entertainment systems focus on energy savings, including the reduction of the cumulative waste of the stand-by mode.

Safety is another driver. Traffic signs and signals are now illuminated by LEDs as a part of smarter traffic control systems. Sales of security systems with cameras, detection, and recording systems have also been increasing.

The boost in electronics has been strongly felt at the high end of the market, such as medical devices. Technology progresses to find ways to add value and extend life in old age, much of it driven and delivered now through electronics of the finest quality and reliability. At the other end of the scale, there is also continued high demand for fashionable technology, the latest handsets and tablets, now with more choices of features. Demand for these products behaves like the fashion market rather than technology, with sharp spikes in early demand and a commercial lifecycle that is far less than the actual product is capable of delivering. The teenage attitude prevails. Prioritisations of want override need.

The continuing star in 2013 is automotive, which combines many of these key ingredients into one product. Efficiency of energy use through improved engine management systems, energy regeneration, optimisation systems, safety features designed to avoid accidents, communication between vehicles to warn of danger, as well as LED daytime running lights, is now compulsory in many countries. Optoelectronics are doing very well indeed. Security systems are expanding, with remote assistance, GPS, and satellite tracking, and now even cameras inside cars to record traffic incidents. Fashionable accessories are also present in automotive; connections for audio players,

hand-sets, tablets, video players are all on the increase. These are the hits of 2013, and they are the factors that serve to drive the demand for new products and technologies even within a world of economic caution.

Satisfaction of modern human wants and needs, through technology and fashion, keeps demand high, though perhaps more volatile. The issue then turns to supply. In these teen years, we cannot afford to simply throw money at manufacturing problems and expect any strong customer

demand to pay for it. Raw materials costs are increasing, fuelled by environmental issues, market speculation, and increasing transportation costs.

Ideally, we think that production needs to stay in the steady state, run by ERP, producing against a reliable sales forecast. This year has shown us that this is no longer an achievable reality. The evolution of customer demand brings with it a high volatility in the demand pattern, with significant short-term variance from one product or variation to the next. With Internet and electronic shopping now becoming dominant, sales of technology products from local stores is declining

and direct shipping from a central

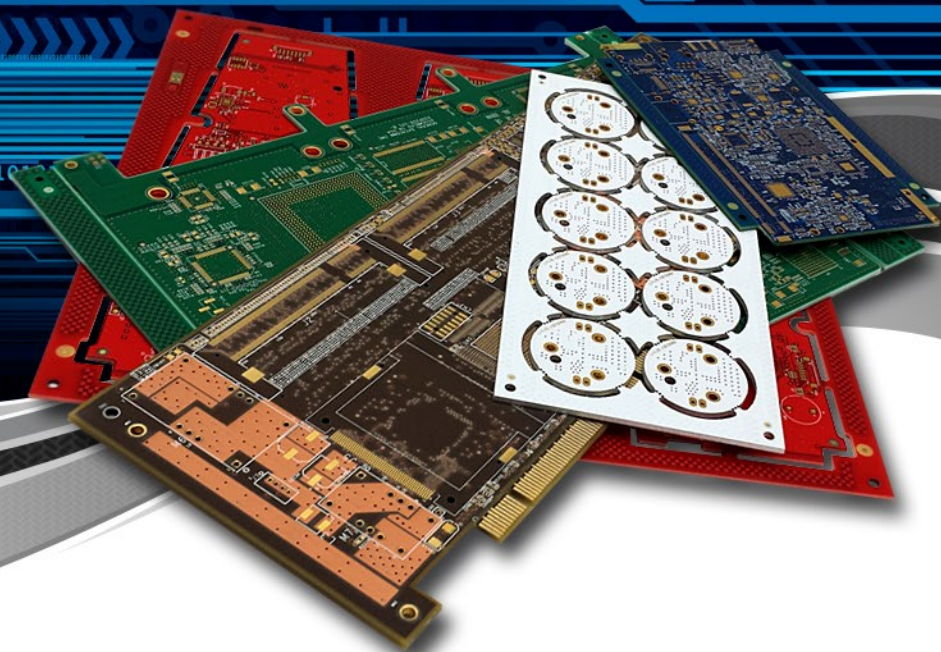
stock is taking over. The end-product distribution chain is all but gone, this vital piece of control that ERP used to create smooth orders to the factory.

In 2013, the factory saw a much more raw demand pattern, which it turns out is vital to the electronics business, ensuring that the depreciation of stock, especially at the frequent end of product life events, is reduced to a minimum. This variation in demand at the factory is the key challenge of the teen years. Although not a new issue in itself, the critical point has been reached now where factories need to provide a service that resembles "make to order,"

Ideally, we think that production needs to stay in the steady state, run by ERP, producing against a reliable sales forecast. This year has shown us that this is no longer an achievable reality. The evolution of customer demand brings with it a high volatility in the demand pattern, with significant short-term variance from one product or variation to the next.

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HOW TO SURVIVE THE TEEN YEARS *continues*

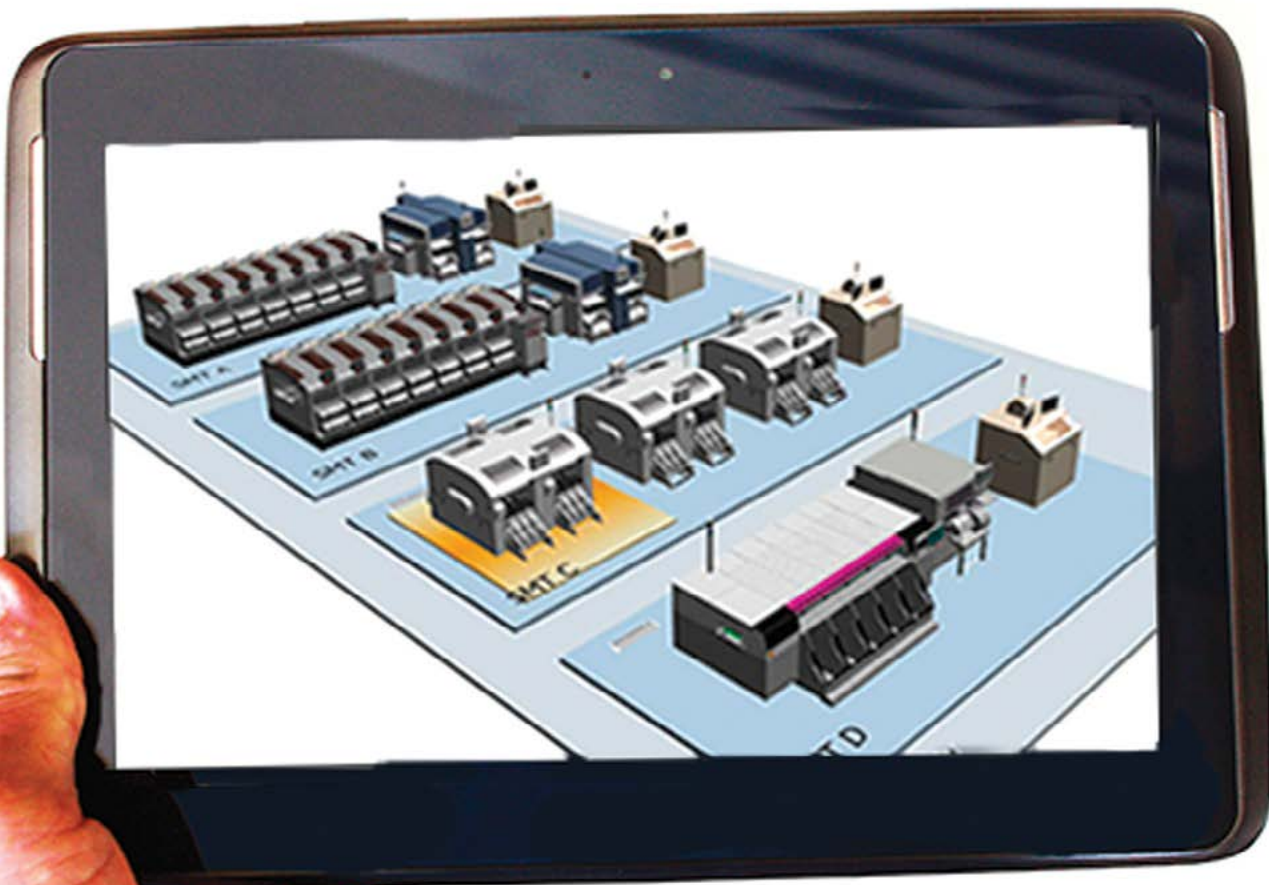
but combined with the economies of mass production. This is the key factor for future competitiveness.

Something of a revolution is happening, where manufacturing planning, execution, and material control are making a step change towards agility. This year has seen several examples of companies making the change, moving to mature software tools available in the market that can deliver on the need for agility. This makes them efficient and effective to supply today's market, as compared with those companies that choose to stick with the ways they have used for many years, focusing on reaction, fire-fighting, and even building to stock in the factory itself, in a desperate attempt to satisfy customer demand.

The key elements that have come together in 2013 to deliver agility are:

- **Lean NPI flow:** Ensuring that the representation of the product to be built is complete and detailed enough to avoid the need for data regeneration in production engineering. Cleaned of issues that would adversely affect the manufacturing, assembly, and test processes and using DFM tools, the designed product is represented in a format that contains all necessary information, such as ODB++. Process preparation time and effort for new product introduction is vastly reduced, allowing preparation over multiple operational configurations and offering wider choices to planning.

- **Production planning:** Frequent optimisation of the execution plan at a shop-floor level to maximise throughput and productivity across potentially thousands of products over all available lines, optimising work-order sequence and material feeder commonality simultaneously.



HOW TO SURVIVE THE TEEN YEARS *continues*

This enables rapid planning changes to meet sudden changes in demand, the essence of agility.

- **Lean supply-chain extension:** The total control of materials in a single system, not only across the various warehouses, but also covering managed shop-floor storage, material WIP, and the replacement of the MRP back-flush process with live consumption and spoilage information automatically obtained directly from processes. This ensures that planning decisions can be executed correctly with the knowledge that all needed materials will be physically available.

- **Lean just-in-time (JIT) materials logistics:** Ensuring that at any time, the only physical material commitment to the shop-floor is that which is actually in use. This allows the execution of rapid planning changes without additional physical material logistics overhead.

Although these software tools are available today in the market, we see a gradual adoption by assembly companies. Part of the reason is the resistance to change for many, knowing that small mistakes in a new operational flow can have significant quality or performance consequences. New systems and solutions are always regarded as carrying risk. Even companies like Apple and Microsoft have seen challenges in 2013 when making changes perhaps too radical for the market with their iOS7 and Windows 8 products receiving significant criticism. There is an important lesson here: too much change for the end-user is not always a good thing. For sure, integrated solutions in PCB manufacturing can deliver very high benefits and bring the level of agility needed, but these have to be built on firm principles and mature operations that deliver value to each point of use. This is quite a significant risk when introducing software that is completely new into the market with little, if any, track record behind it.

Industry 4.0

From 2013, looking forward into the rest of the teenage years, there is a project coming that is said to be able to revolutionise manufacturing: [Industry 4.0](#). The nice aspect of Industry 4.0 is that it is built on conventional concepts and technologies, but with elements working together in a way not commonly seen. The key element is the use of an RF-ID tag that carries

the specifications of what this product should be, which is used to route the individual product through processes that then add value according to the tag instruction. This is similar to the “lot follower” concept used in many areas today, including mixed production on automotive lines. It is a mechanism whereby products in the quantity demanded can simply be released whenever required into the factory “engine,” and after a certain period of time, appear as completed products at the end. For this to be achieved, of course, the factory must be prepared to make any product at any time. This could be quite a limitation for electronics production, especially SMT, in most cases. Even where this can be achieved, the resultant loss of performance due to lack of process optimisation must surely be a concern.

Industry 4.0 for electronics may take longer than other segments. Perhaps through specific product and process design for Industry 4.0, it can become a practical proposal. In the meantime, perhaps the better option is to continue to evolve our agile production environment, allowing production planning to provide continuous optimisation which would automatically create work-tasks in a similar way as material logistic tasks are created today in response to the pull signal from the machines to supply materials just-in-time to the shop-floor. We could be quite close to this being almost a reality within the teen years.

2013 then, is the year that electronics manufacturing, in terms of ERP and physical factory performance, began to be seriously affected by market trends for flexibility and agility. In a somewhat conservative industry, tools available in 2013 should last at least until the end of the teen years, when perhaps we will see the Industry 4.0 revolution come to fruition in electronics. It is going to be an interesting ride, fuelled by the knowledge that electronics, above pretty much all else, continues to see a strong and sustainable demand. **SMT**



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

SMTonline Market News Highlights



Global Smartphone Market Up 38.8% in Q3

The worldwide smartphone market grew 38.8% year over year in the third quarter of 2013 (3Q13), according to the International Data Corporation (IDC) Worldwide Quarterly Mobile Phone Tracker.

3D Printing Market to Reach \$8.41 Billion by 2020

According to a new market research report, the 3D printing market is expected to grow at a CAGR of 23% from 2013 to 2020, and reach \$8.41 billion in 2020. The upcoming expiration of patents with respect to selective laser sintering (SLS) is also believed to provide a further impetus to the growth of the market.

Survey Reveals Technology Investment Predictions

"CFOs continue to seek out technology which allows them to improve business performance and increase employee productivity," said Jay Cary, VP, Digital, Global Corporate Payments at American Express.

Are Nanomaterials the Next Big Thing in Electronics?

Senior electronics executives attending IPC's recent Management Meetings and Technology Market Research Conference in Chicago were treated to a positive and intriguing look into the future of the materials market.

Global Brands Need to Rethink Strategy as Asian Markets Remain Critical

According to Profit or lose, a new report released by EY today, succeeding in emerging Asia is paramount, with the region set to generate 38% of the sector's growth by 2017 and account for 25% of the CP market, up from 15% in 2007.

Global Expansion Techniques for Chinese Smartphone Makers

As Apple launches its 5C iPhone to compete in the Chinese market, Chinese companies are looking to the West to grow their businesses. However suc-

cessful in their domestic market, Chinese firms should carefully consider their global expansion strategies.

Apple and Samsung Lead in Overall Satisfaction Performance

"It's very interesting to see that satisfaction performance differs by smartphone brand across Tier 1 carriers," said Kirk Parsons, senior director of telecommunications services, J.D. Power. "This indicates that carrier services and how these carriers position specific features and services on their devices influence the experience customers have with their smartphone device."

Graphene Electronics Market to See 55% Growth

According to a new market research report "Graphene Electronics Market: Materials (PV, Electronics); Devices (Supercapacitors, Transistors, Spintronics, Sensors, ICs and Chips, Lenses); Products (Computing, Consumer, Memory, Display); Developments (Nanotubes and Ribbons, Fullerenes) (2013 - 2023)," the total graphene technology market is expected to grow at an estimated CAGR of 55.54% from 2013 to 2023 which includes in-depth segmentation of material, products and devices.

Global RFID Market to Reach \$7.88 Billion in 2013

According to a new RFID sector survey by IDTechEx Research, the RFID market will increase from \$6.98 billion in 2012 to \$7.88 billion, and will reach \$23.4 billion in 2020. This includes tags, readers and software/services for RFID cards, labels, fobs and all other form factors for both passive and active RFID.

Consumer Electronics Spending to Grow 2.6% this Holiday Season

The Consumer Electronics Association (CEA)® predicts consumer electronics spending will rise 2.6% this holiday season, down from 4% growth in 2012, according to CEA's 2013 holiday outlook released today at CEA's Industry Forum in Los Angeles.

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All-Inclusive Devices Driving Change

by Sjef van Gastel

ASSEMBLÉON NETHERLANDS B.V., VELDHOVEN

The increasing popularity of handheld electronic devices like smartphones and tablet PCs stems from the convergence of entertainment, information and communication functions into a single “all-inclusive” housing with touch screen control. The miniaturization and integration of these devices is leading to a fundamental change in the manufacturing process.

In the early days, mobile phones used only discrete electronic components. As a result, the component count of a relatively simple mobile phone went up to around 600–800 components inside a housing around twice the size of current mobile phones. Increased functionality and greater miniaturization, with phones becoming smaller and thinner, has forced mobile phone makers to reduce the number of components.

Solutions have come from integrating functions (special-function ICs), smaller passives,

smaller component interspacings and ultimately embedding components in first- and second-level interconnect substrates (Figures 1 to 3).

Dedicated special-function ICs include power management, RF, memory, navigation and UI control. These ICs integrate a number of dies/flip chips (FC) and passive components. Typical package styles are (FC)BGA, QFN/DFN and WLCSP. Since these ICs are dedicated to a specific function, they can be characterized as system-in-a-package (SiP).

SiP modules usually are manufactured in “sheetlets” consisting of multiple-unit substrate strips, with each strip typically containing from 60 to 400 SiP (BGA) modules. Figures 4 and 5 show a typical sheetlet substrate with multiple SiP packages. The integration steps, SiP manufacturing and component embedding, are migrating SMT from PCB assembly towards both substrate manufacturing (embedded compo-

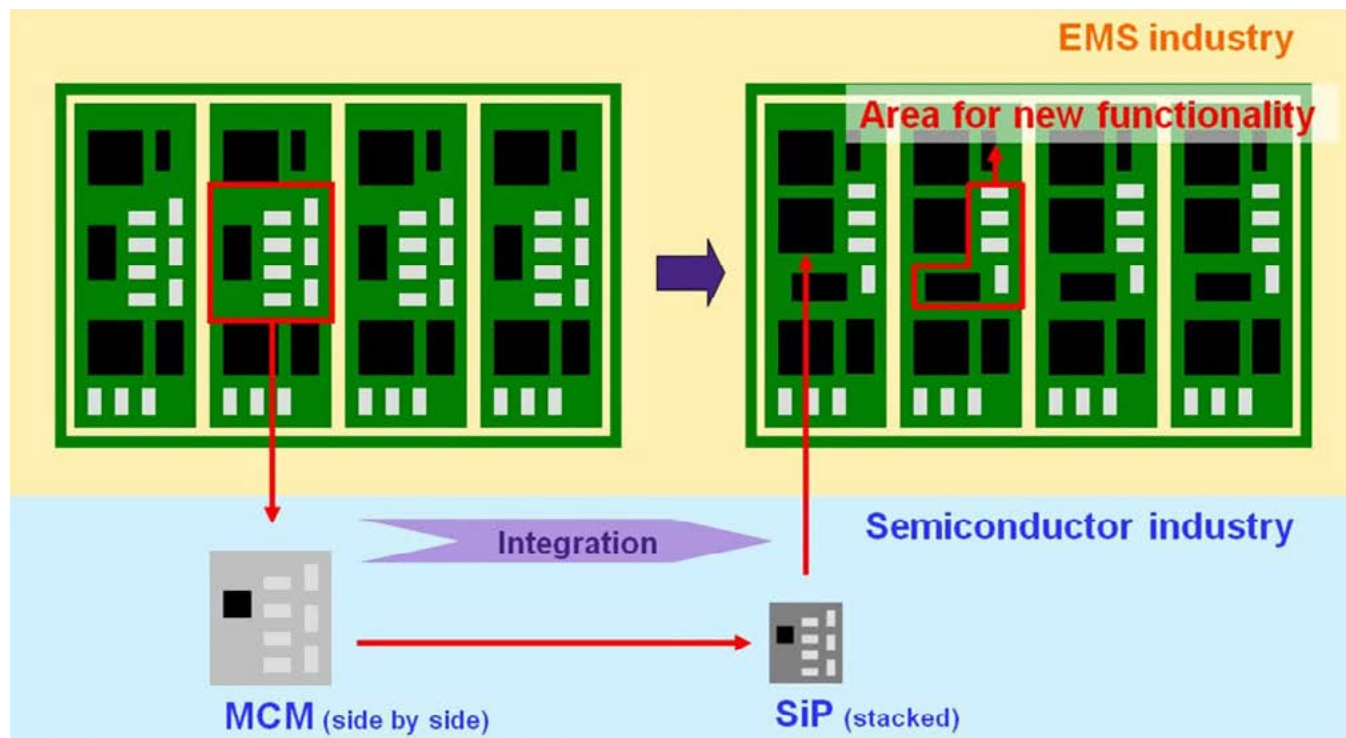


Figure 1: Discrete components are moving towards functional modules as a first miniaturization step.

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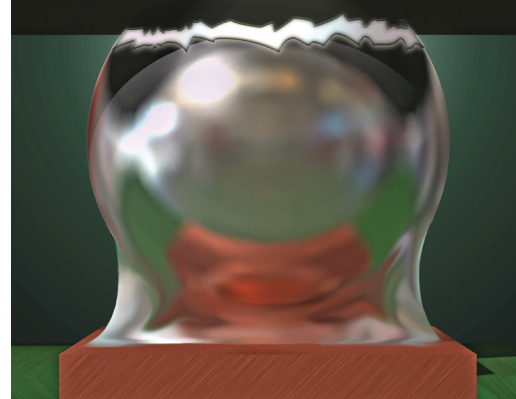
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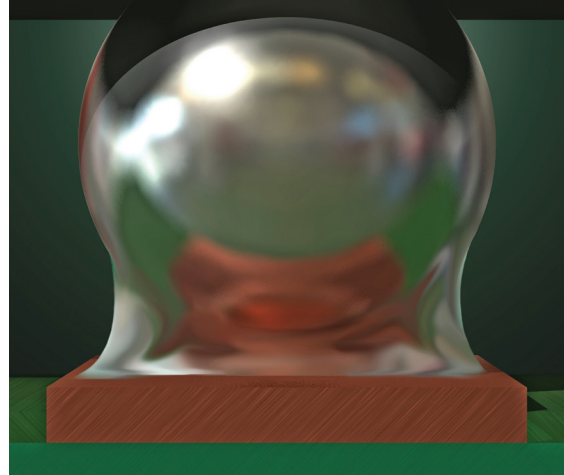
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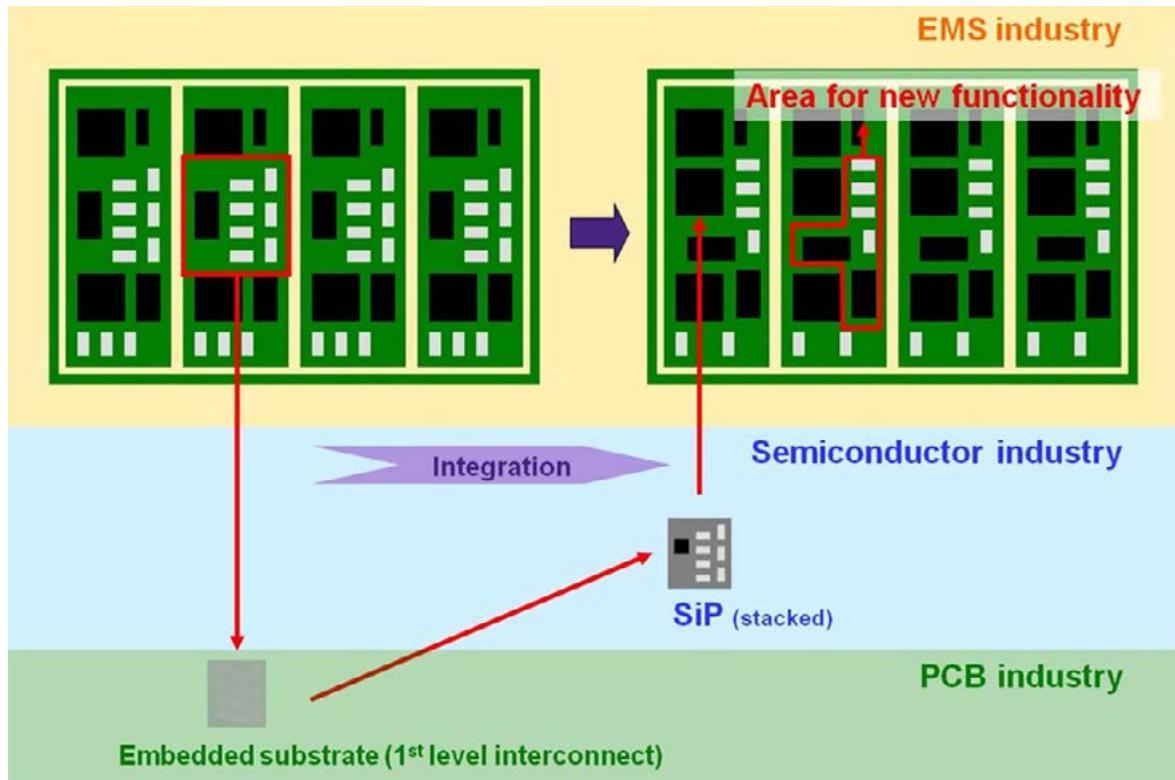
ALL-INCLUSIVE DEVICES DRIVING CHANGE *continues*

Figure 2: Embedding components into first-level interconnects is the next miniaturization step.

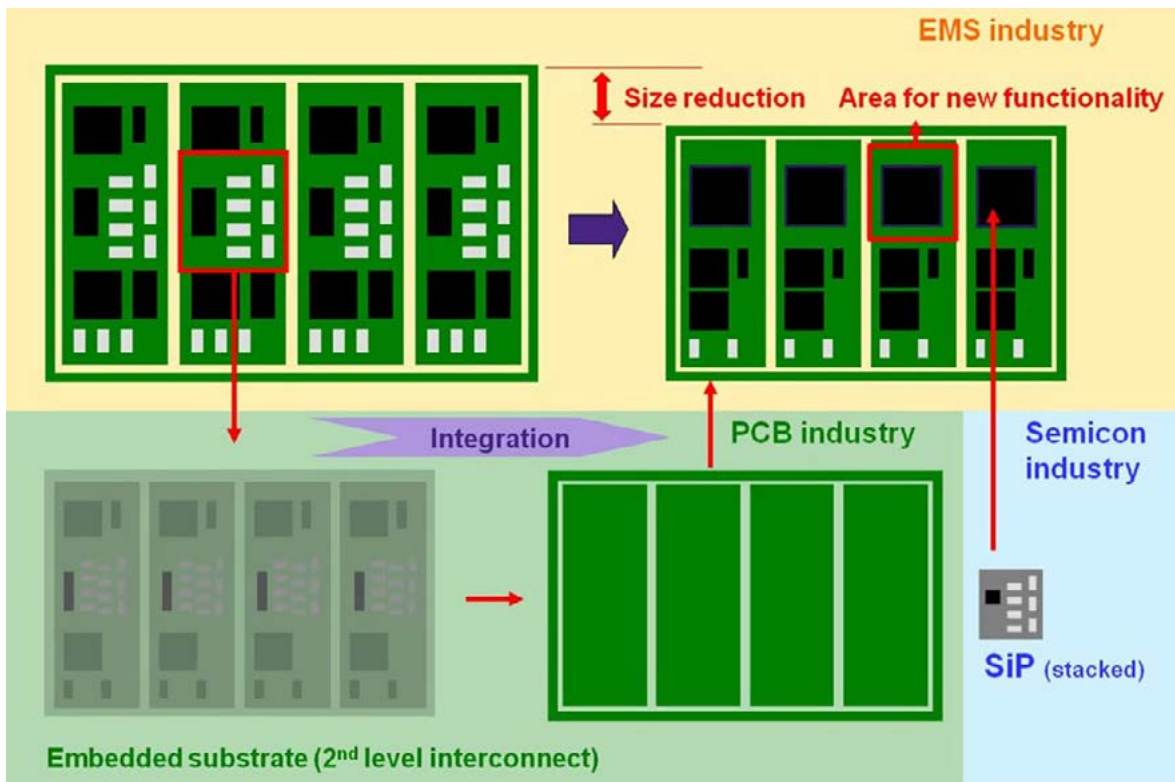


Figure 3: Second-level interconnects brings further miniaturization and integration.

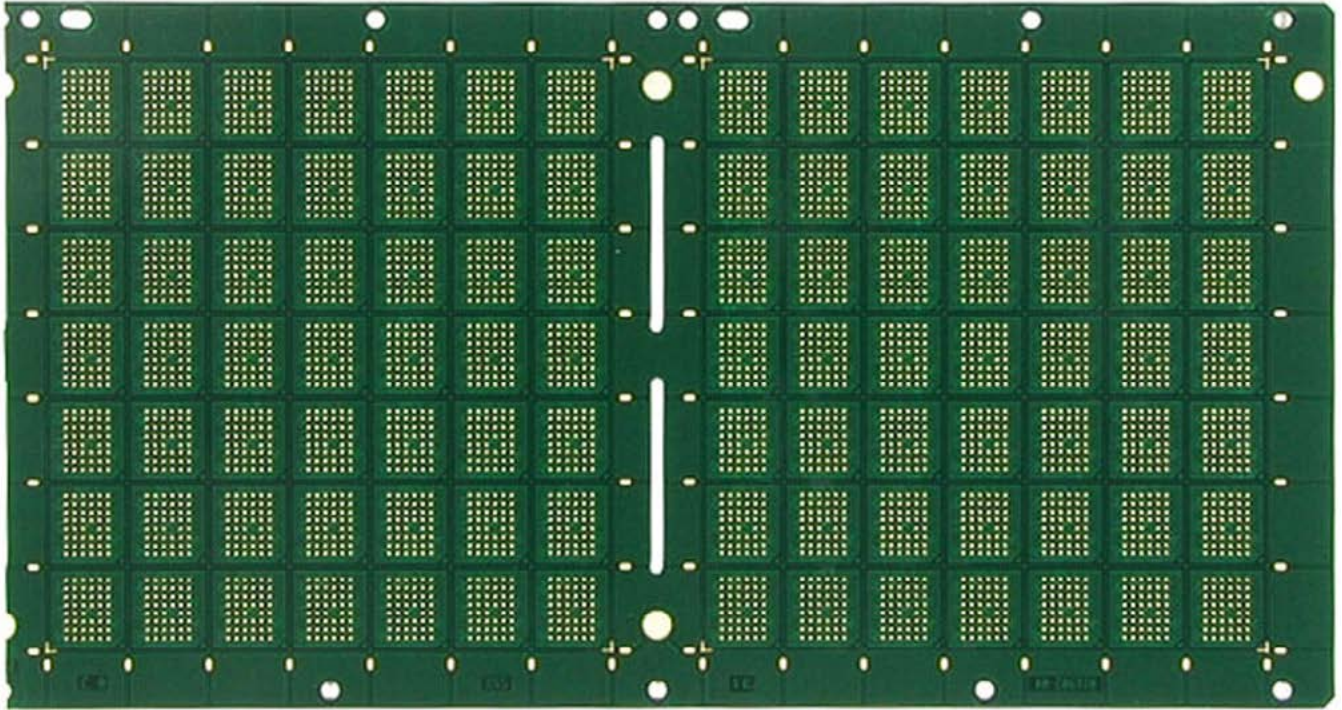


Figure 4: Typical substrate layout for SiP (BGA) module manufacturing.

nents) and semiconductor backend manufacturing. As a result, new technologies will be introduced into these supply chains. This will bring the SMD equipment industry both threats, such as a decrease in the number of components in a handheld device, and opportunities, such as SMDs being placed inside SiP packages.

Moving Away From Conventional Backend Assembly

Traditionally, backend assembly of semiconductor packages has been executed by the integrated device manufacturer (IDM) and the outsourced semiconductor assembly and test (OSAT) companies. An IDM is a semiconductor company that designs, manufactures, and sells ICs. An OSAT offers package assembly and test services for semiconductor companies without wafer manufacturing capability. These companies have traditionally organized production in flow lines with specialized equipment (one production process step per machine), usually in a cleanroom. Since a cleanroom area is very expensive, manufacturers have favored equipment with a high throughput per footprint.

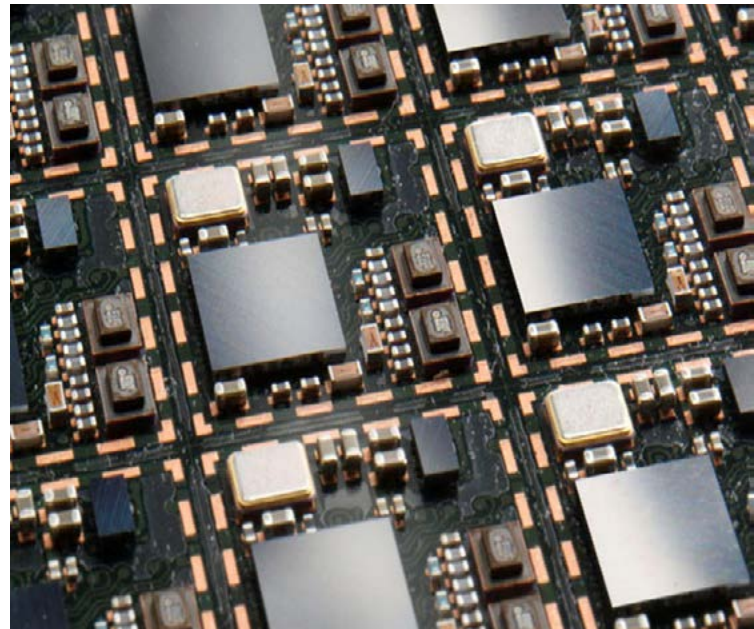


Figure 5: SiP (BGA) manufacturing in sheetlets.

A new type of pick-and-place machine has recently been introduced for integrated FC/die and SMD assembly. This hybrid machine

ALL-INCLUSIVE DEVICES DRIVING CHANGE *continues*

(Figure 6) allows die attach/flip-chip placement and SMD assembly in the same, modular, machine. The advantages of this hybrid machine can be best understood by looking more closely at the characteristics of SiP assembly.

Every SiP (BGA) package typically contains one to three dies (FC or DA) and two to 30 passives (R/C). In a conventional backend assembly line, all process steps are executed sequentially in separate machines. Any assembly process changes (for instance from flip chip to die attach) will immediately influence line throughput, since different assembly processes have different process times. In a hybrid backend assembly line all process steps are executed in parallel, so variations in process times are balanced.

With a conventional backend assembly line, variations in component count immediately lead to unbalance in workload, and

the related cycle times across the various machines. With a hybrid backend assembly line, this workload unbalance is solved by simply adding or removing process modules, e.g., dispensing/dipping modules, FC/DA assembly modules, and SMD placement modules. And seasonal influences can be much more easily handled by just adding extra assembly modules. The big advantage is that production floor space remains the same. With conventional backend assembly flowlines, seasonal variations demand more floor space, and more costly cleanroom area.

"I Want it all and I Want it Now"

As the British band Queen once sang, "I want it all and I want it now." That's certainly true of handheld electronic devices like tablets and smartphones. Their popularity depends on three main characteristics:



Figure 6: Inside a hybrid backend module assembly machine.

ALL-INCLUSIVE DEVICES DRIVING CHANGE *continues*

- Integrating entertainment (gaming, music, movies), information (Internet, PC, navigation, camera) and communication (mobile phone, social networks, messaging)
- Ease of use
- Form factor

With ongoing miniaturization and integration increasing the demand for specialized IC packages, all-inclusive manufacturing requirements are best met by the parallel assembly of hybrid backend manufacturing. **SMT**



Sjef van Gastel is manager for advanced development at Assembleon Netherlands B.V., where he combines his experience as systems architect and machine designer to explore technical and business opportunities from emerging technologies. To read past columns, or to contact van Gastel, [click here](#).

Graphene Grown on Silver

Growing graphene on a single-crystal silver substrate could lead to better optical devices and could allow graphene to interface with other 2D materials.

"Silver is a widely used material to enhance optical properties," says study co-author Mark Hersam, professor of materials science and engineering at Northwestern University.

"More recently, graphene has emerged as a promising platform for optical technologies. With our recent development of a method for growing graphene on silver, we can now exploit the best attributes of both graphene and silver at the same time."

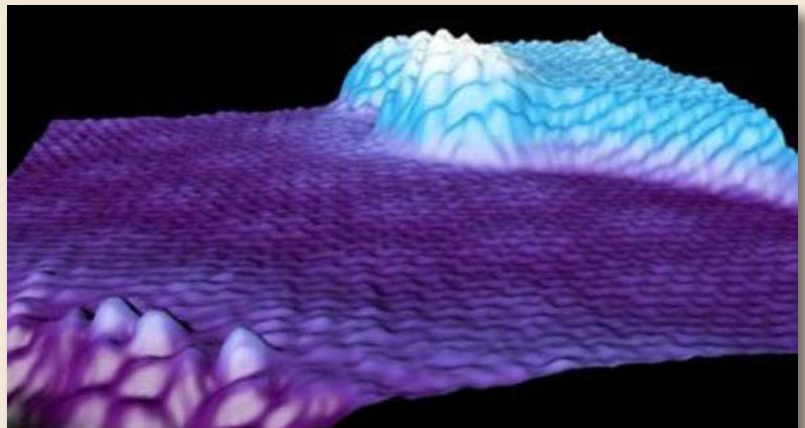
While graphene is conventionally grown on a metal surface by catalytically decomposing hydrocarbons at elevated temperatures, this method is ineffective for silver substrates because the substrates are chemically inert and have a relatively low melting point.

Using a graphite carbon source, the researchers were able to grow graphene by depositing atomic carbon, rather than a carbon-based molecular precursor, onto the substrate. The growth circumvented the need for a chemically active surface and allowed the researchers to realize graphene growth at lower temperatures.

"Graphene growth and transfer to a variety of substrates has allowed graphene to transform countless scientific fields," says Brian Kiraly, a Northwestern graduate student in materials science and engineering who worked on the research with Hersam and Nathan Guisinger, a staff scientist at Argonne National Laboratory.

"However, conventional techniques lead to contamination issues and are not compatible with the ultra-clean vacuum environments required for the growth of the latest 2D materials. By growing graphene directly on silver under vacuum, we provide an atomically pristine surface for advanced graphene-based technologies."

The researchers also found the graphene they grew was electronically decoupled from the underlying silver substrate, allowing the intrinsic properties of graphene to be studied and exploited directly on the growth substrate; this characteristic has not been previously observed with graphene grown on other metals.



Mil/Aero007

News Highlights



OSI Systems Enjoys Record-breaking Q1 2014 Revenue

Deepak Chopra, chairman and CEO, stated, "We are happy to report that our first quarter performance resulted in record-breaking revenue and profit, and provided an outstanding start for our fiscal year...we achieved 14% sales growth leading to our 17th straight quarter of record YoY non-GAAP earnings."

Ducommun LaBarge Reports Sales Drop in Q3

The company's DLT segment reported net sales for the third quarter of \$103.5 million compared to \$107.4 million in the third quarter of 2012. The YoY decline reflects a 24.7% decrease in non-A&D revenue, partially offset by an 8.9% increase in defense electronics and commercial aerospace revenue.

Sypris' EMS Segment Posts Revenue of \$9.6M in Q3

Revenue for the Electronics Group was \$9.6 million in the third quarter of 2013 compared to \$7.7 million for the second quarter of 2013 and \$13.6 million in the third quarter of last year, reflecting a number of factors including budgetary and funding uncertainties within the U.S. Department of Defense.

Difficult Defense Business Triggers Orbit's Consolidation

Orbit International Corporation will consolidate the operations of its Quakertown, Pennsylvania-based Tulip Development Laboratory (TDL) subsidiary, part of its Electronics Group, into its Hauppauge, New York facility.

Nortech Reports 7% Sales Increase in Q3

Nortech Systems Incorporated has reported net sales of \$27.4 million for the third quarter ended September 30, 2013, a 7% increase over the third quarter of 2012, when sales were \$25.5 million. Operating income for the third quarter of 2013 was \$376,000, a 14% increase over the third quarter of 2012.

Kitron's Revenue Drops in Q3, But Order Intake Strengthens

Kitron ASA reports that a strong order intake during the quarter has increased the backlog to last year's level. A decline in revenues led to lower profitability compared to last year. Negative cash flow development is due to build up of inventories.

Plexus Posts Fiscal Q4 Revenue of \$568 Million

Dean Foate, chairman, president, and CEO, commented, "Fiscal fourth quarter revenues were \$568 million, above the midpoint of our guidance range, but down modestly from the prior quarter. Diluted EPS was \$0.71, above the high-end of our revised guidance range, as a consequence of operating margin performance at the higher-end of our expectations and the benefit of discrete tax items."

Benchmark's Q3 Results Meet Expectations

"We are pleased with the results for the quarter with revenues and earnings in line with our expectations," said President and CEO Gayla J. Delly. "In the third quarter, we experienced revenue growth in three of our five industries that we serve and expect growth in all industry sectors next quarter."

API Nets Follow-on Order to Provide Microwave Products

API Technologies Corporation, a trusted provider of RF/microwave, microelectronics, and security solutions for critical and high-reliability applications, has won a \$2.2 million follow-on order to provide microwave products to a Fortune 100 defense prime contractor for use in a major U.S. Army counterfire radar program.

PIRANHA, Davtron Sign Service Agreement

PIRANHA EMS Inc., an EMS provider, has signed a service agreement with Davtron, Inc., a leading provider of digital avionics. PIRANHA will provide Davtron with a range of services, from layout through rapid prototype to assembly and final integration service solutions at their San Jose, California facility to support Davtron, Inc. as the company continues to design new products and scales to meet demand.

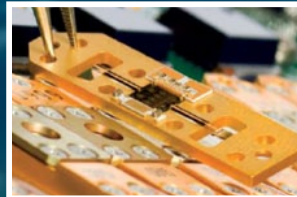
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State-of-the-art Equipment = Priceless

by **Karla Osorno**
EE TECHNOLOGIES

Looking ahead to 2014, reflection and goal setting are key activities for leading organizations. We can learn from prior successes and failures, take action and affect future results. In this five-part series, I'll explore key areas of development that make significant differences when it comes to achieving state-of-the-art status: people, equipment, building, culture, and systems.

Last month, I explained how people are the "secret sauce" for state-of-the-art companies who build state-of-the-art products. However, the value of state-of-the-art equipment cannot be ignored. This month, I'll address key questions to ask about equipment and the related solutions, and illuminate the role equipment plays in achieving state-of-the-art status. But first, consider this:

- Surface mount technology (SMT) line = \$500,000
- SMT oven = \$100,000
- Automated inspection system (AOI) = \$100,000
- Quality PCBs built with state-of-the-art equipment = Priceless

What equipment do we need?

It is not news that electronics manufacturing today is a complex and detailed process. As technology changes, parts become smaller; designs, more intricate; cost models are less; and product turn cycles become shorter. As a result, much of the manufacturing operations have become automated and highly technical equipment is required for the majority of electronics manufacturing.



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"Lead-free Paste Characterization (Wetting & Voiding) Versus Reliability" by Jörg Trodler and Hans-Jürgen Albrecht

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- Provides higher yields and less rework
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- SolderPro Series SF64 flux for Rework
- SolderPro Series W640SAC wire for Rework and Special Applications

The SolderPro Series F64* family is formulated with a special activator mixture that ensures good wetting to partially oxidized nickel surfaces, providing higher yields and less rework than competitive products.

Wetting on nickel plate in air



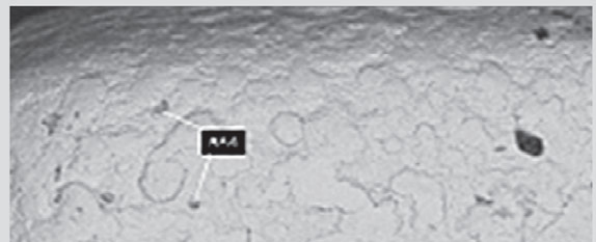
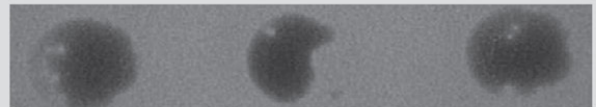
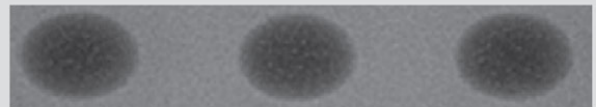
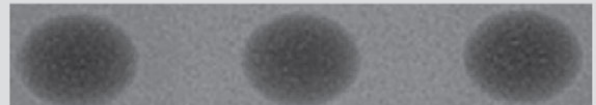
Excellent wetting
F640 powder type 3

Excellent wetting
F640 powder type 4

Competitor wetting on nickel plate in air

Poor wetting, fail

Example of a chip component with an imperfect Sn surface finish – darkspots are exposed nickel



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STATE-OF-THE-ART EQUIPMENT = PRICELESS *continues*

Equipment must allow you to achieve your business mission and it must be supported by your operations. Wise leaders purchase well with risk/reward considerations. Each company will have different specific equipment needs based on industry standards and customer requirements. But all companies must evaluate equipment initially and ongoing to remain competitive.

When startup occurs, companies should conduct due diligence to understand what is required to compete. Research includes evaluating competitors, trends, processes, regulatory issues, labor issues and available equipment options. Experienced experts hired initially or recruited in early stages provide significant insight and direction.

Equipment is sometimes acquired with a purchase or merger, and must be evaluated to ensure functionality that is appropriate for the existing business needs. If the company is a startup, then all equipment requirements will need to be determined and evaluated.

Mistakes at this stage of the game carry significant costs. Most equipment is a large capital investment and cannot be undone. Electronics contract manufacturers need SMT equipment including printers, pick and place machines, ovens, AOIs, and board washers—a minimum price tag of \$1 million—to start. Other inspection equipment inline or free standing may also be necessary. Selective solder machines and X-ray machines are additional options, and the list goes on.

Ongoing equipment needs should be evaluated annually and when new lines of business or new clients are taken on. With increased business through existing or new customers in the same business lines, a company may add additional pieces of the same equipment. Or sometimes new technology necessitates changes in equipment. Equipment may become non-functioning or outdated, requiring replacement. Favorable tax or other economic conditions may

trigger capital equipment evaluations and purchases, too. Finally, customers may request special operations that require specialized equipment.



When startup occurs, companies should conduct due diligence to understand what is required to compete. Research includes evaluating competitors, trends, processes, regulatory issues, labor issues and available equipment options.



Another equipment need consideration regards efficiencies in maintenance and training. Choose the same manufacturer and even model when purchasing multiple pieces of the same type of equipment. This results in a shorter learning curve for employee training. Maintenance on similar machines is also more efficient when the equipment is from the same manufacturer, allowing for tools, processes and knowledge sharing.

Alignment between equipment on different lines simplifies things for the operator.

When transitions are seamless, productivity is greater. Software compatibility is a huge consideration when assessing equipment to acquire.

Determining equipment needs in each of these areas is required to achieve state-of-the-art status.

How do we get the equipment we need?

From your needs assessment, come up with a priority list and capital budget for your equipment. Capital equipment return-on-investment (ROI) analysis is a helpful way to evaluate and stay within your company budget. The calculation for return on investment is:

$$\text{Return on investment} = \frac{\text{gain from investment}}{\text{cost of investment}}$$

When all qualitative variables are equal, the higher the ROI means the more value the machine has for the company. Use this calculation to help create a detailed capital budget. From this budget, you will start to evaluate each machine.

For each machine required, make a short list of your top priorities for that machine. For example, priorities for a pick and place machine

STATE-OF-THE-ART EQUIPMENT = PRICELESS *continues*

would include part placements, board size, component sizes, and machine footprint, to name a few. Use this to compare machine manufacturers across the board. This, however, will take time.

Establishing a team of internal experts to evaluate equipment is a good idea. Choose someone in your organization to lead this effort and do the advanced legwork. Then the team can engage in the review and decision process.

Strong EMS providers choose to keep equipment state-of-the-art. Since the primary equipment used in electronics contract manufacturing is surface mount lines, selecting the best manufacturer for pick and place machines, ovens, and printers, among others, is the way to go. One size does not fit all in the selection process. With strategic selections of equipment manufacturers, EMS providers see significant improvement in training, maintenance, and overall throughput.

Ultimately, you will work with capital equipment companies or possibly one or more capital equipment manufacturer representatives. EMS providers understand the complexities and choose to partner with capital equipment companies that also understand the business needs. Often manufacturer reps have experience and insight that saves time and money.

Trade shows are a great way to see equipment options, meet the players, and evaluate a lot of equipment in a short period of time. Regularly attend shows and stay abreast of technology trends so you are prepared when the need arises. Onsite visits and presentations are other options for interviewing manufacturers and assessing equipment.

In addition to internal training you provide for your teams, equipment manufacturers provide factory training for employees' maintenance recommendations. It is critical to follow factory recommendations and perform proactive maintenance. By tracking all maintenance

and repairs, operators can perform predictive maintenance and minimize or eliminate machine down time. This positively impacts ROI for that machine.

Consider the total acquisition cost of equipment and not just the purchase price. Training, installation, down time, and other costs of acquisition must be included to make the best decision. Now you have the information to acquire your equipment, install it and begin using it to achieve your business purpose.

How do we optimize equipment usage?

Part of continually evaluating equipment to assess value for the organization is to analyze and improve equipment usage and optimization. Most specialized equipment will also have software with optimization features. Reporting and analytics must be understood and used to tweak settings and processes. Do not overlook this or the cost of your equipment,

otherwise your ROI and your customer satisfaction will be impacted negatively.

Do not learn by trial and error. Instead strive to use every feature on your equipment as it was intended and avoid "customizing" to "the way you have always done it." Use new features as an opportunity to improve upon existing processes.

In addition to equipment, another way to stay ahead of the competition is by utilizing the newest software, support and tools. Often,

simply utilizing new peripheral tools will delay large capital expenditures. ROIs can be used to analyze these options too.

EMS providers work with vendors who are up to date on the latest technology. Vendors keep the EMS provider apprised of the latest options while the EMS provider keeps its focus on the core business of manufacturing for OEM customers.

Floor layout makes a difference in throughput and waste reduction. Take time on the front end to choose optimal floor layout. Do not

“
**Do not learn by trial
and error. Instead strive
to use every feature
on your equipment as
it was intended and
avoid "customizing" to
"the way you have
always done it."**
”

STATE-OF-THE-ART EQUIPMENT = PRICELESS *continues*

hesitate considering changing the floor layout when the long term benefits outweigh initial change costs.

Equipment location matters too. Strong EMS providers continually evaluate customer requirements and make sure the equipment is in the right location and working optimally to get product out to customers. This means equipment is sometimes relocated from one facility to another, for instance, from the United States to Mexico or Mexico to the United States. The relocation costs can be high on the front end but service to the customer and overall efficiencies and costs reductions drive these equipment moves.

Investing in equipment continues after the initial acquisition. Practical application is using analysis and action to optimize equipment utilization.

Who wins?

Everyone wins when a company strives to have state-of-the-art equipment, especially the

customer! And we know that when the customer wins, shareholders, employees and vendors win too. To ensure equipment is a win at the beginning, middle, and end of the process, companies should analyze the right metrics to consistently evaluate performance. Then leaders can make decisions based on these metrics.

Technology and automation can make or break a company in our industry. Finish 2013 strong and take action today to make 2014 even better by evaluating and taking smart steps to have state-of-the-art equipment. Next month, I'll address the importance of having a state-of-the-art building. **SMT**



Karla Osorno is business development officer for EE Technologies, Inc., an EMS provider delivering complete engineering and manufacturing services with locations in Nevada and Mexico. To read past columns or to contact Osorno, [click here](#).

Video Interview**Aqueous Cleans up With Batch Cleaning Process**

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SMTAI



For years, batch cleaning was the butt of jokes. But environmental and budgetary concerns have led to batch eclipsing the in-line cleaning process. Aqueous CEO Mike Konrad explains how the batch cleaning equipment they sold in 2012 saved millions of gallons of water, and he discusses the company's popular cleaning workshops.



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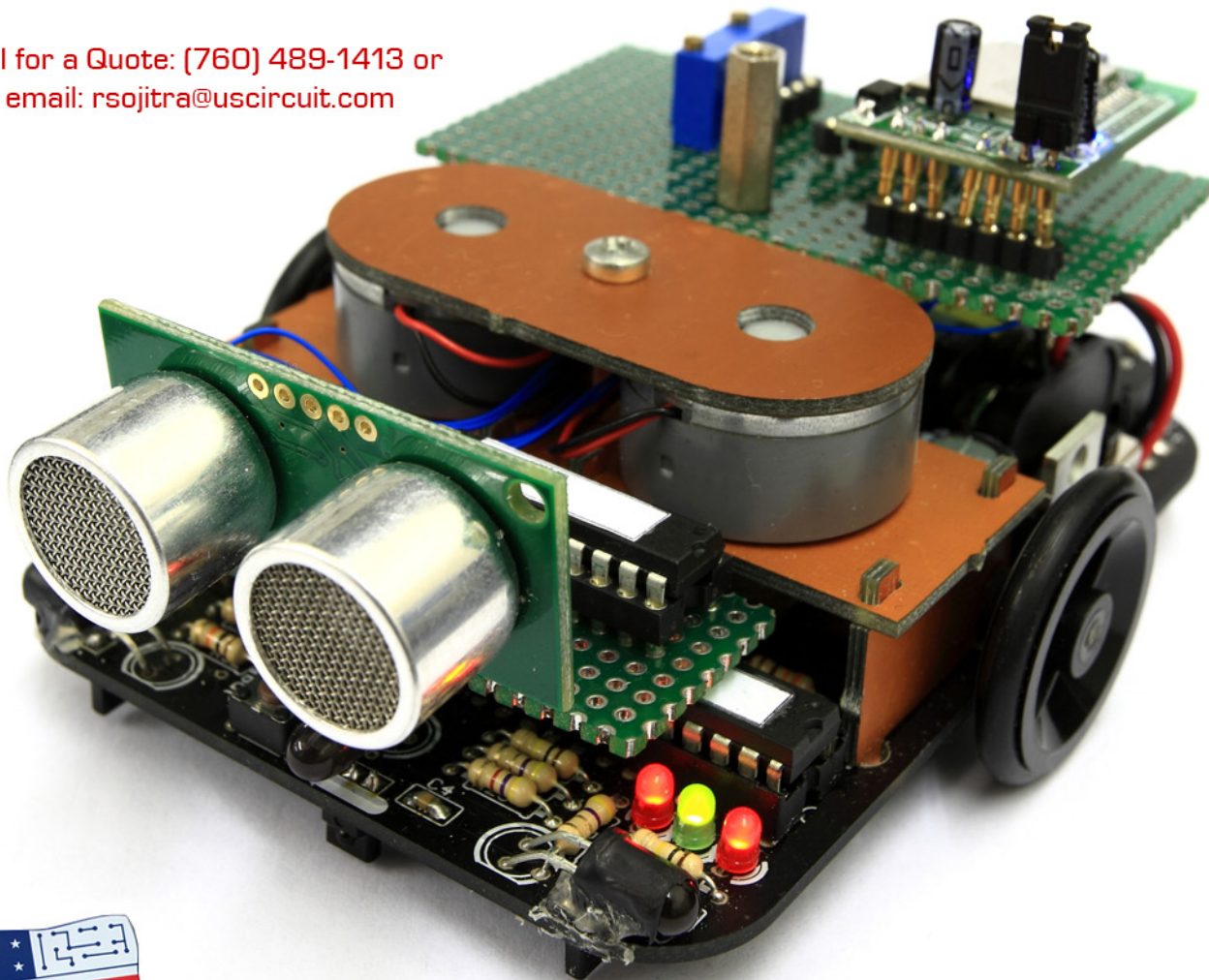


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SMTonline Supplier/New Product News Highlights



Electronic Systems Adds Fuji AIMEX SMT Equipment

Electronic Systems, Inc. is pleased to announce that it has purchased two new Fuji AIMEX surface-mount placement machines. The Fuji AIMEX placement machines provide superior quality and flexibility for today's demanding electronic manufacturing services market.

Dymax Intros Ultra Light-Weld 9309-SC Adhesive

Dymax Corporation has introduced Ultra Light-Weld 9309-SC, an adhesive that cures upon exposure to UV/visible light and is designed for rapid ruggedization of circuit board components. It provides rapid bonding to lead frame, PCB, silicon, and ceramic, and its tack-free surface allows for quicker handling and minimization of surface contamination. 9309-SC is compatible with both needle and jet dispensing systems and is highly thixotropic, minimizing movement after dispense.

Indium's Line of Solder Products Ensure Supply Chain Reliability

Indium Corporation continues to expand its existing line of solder products to provide customers with a consistent and reliable supply of soldering materials, thereby allowing customers to consolidate sources, reduce cost, and increase reliability.

Henkel Unveils New Transparent Conductive Inks

The Electronics Group of Henkel has developed a suite of clear conductive inks that provide superior flexibility, printability, and conductivity for multiple applications including industrial touch screens, electroluminescent (EL) lighting, solar cell manufacturing, and micro-scale LED lighting, among others.

Cemtrex's Acquisition of ROB Group Strengthens Growth Plan

The ROB Group, consisting of four distinct operating companies, serves the electronics and cabling needs of some of the largest companies in the world in the medical, automation, industrial, and renewable energy industries. With annual turnover

of Euro 42.1 million in fiscal 2011, the company also has a production facility in Romania.

Pettit Joins AccuSpec Electronics Management Team

The company announced the addition of Tracie Pettit as manager, supplier management. "Tracie's addition to the team underscores our commitment to strategic optimization of our global supply chain for continuous flexibility, value, and success," noted President and CEO Tim Morrissey.

Arrow Electronics Acquires Computerlinks

Arrow Electronics Inc. has completed its acquisition of Computerlinks, a value-added distributor with a comprehensive offering of IT solutions from many of the world's leading technology suppliers.

Panasonic Factory Solutions Appoints SMT Inc. as Sales Rep

Panasonic Factory Solutions Company of America announces the appointment of SMT Inc. as a sales representative of Panasonic electronics assembly solutions in Northern California and Northwest Nevada. "We are delighted to partner with Panasonic as we help our customers compete with lower-cost regions and deliver exceptional yields for complex assemblies," said Michael Milosevic, president, SMT Inc.

Manncorp Helps Customers Achieve Significant Savings

Manncorp is providing free consultation for customers who want to learn how to realize significant savings (of up to 35% or even more depending on their corporate tax bracket), by capitalizing on Section 179's depreciation allowance before the end of 2013.

Electrolube Secures ISO 14001 and OHSAS 18001

The global electro-chemicals manufacturer Electrolube is pleased to announce it has been awarded the ISO 14001 for its Environmental Management System (EMS) and OHSAS 18001 for Occupational Health and Safety, two of the world's most recognized standards from the BSI.



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solutions

Contact
lubricants

Water and solvent
based cleaning

Conformal
coatings

Maintenance
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EMS Discovers Mature IC Technologies

by **Zulki Khan**

NEXLOGIC TECHNOLOGIES INC.

Did you know there are some really new, up-to-the-moment PCB technologies nesting on the doorstep of PCB assemblers? In fact, some of these technologies are very mature, but they're new to PCB assemblers.

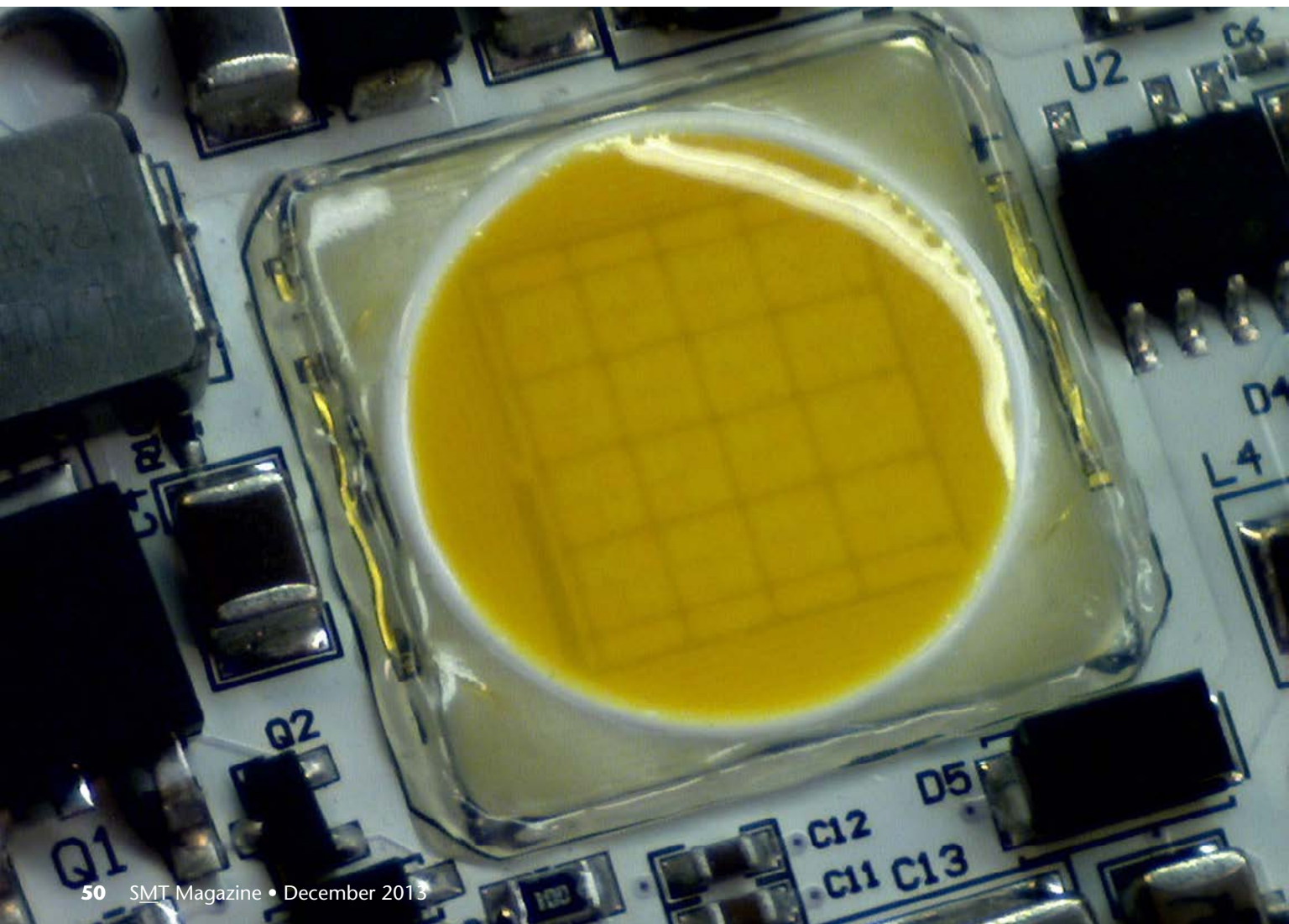
For the past year or so, we've been talking about package-on-package (PoP) and 0.4 to 0.3 mm pitch BGAs as new technologies, and certainly a lot of OEMs are using them in their advanced products; others are quickly coming on board. But I'm not talking about those.

The ones I'm talking about are some more recent ones that EMS companies have recent-

ly discovered, while PCB technology has been evolving at such a rapid pace.

The technologies coming to our attention are the following:

- Wire bonding
- Ribbon bonding
- Die bonding
- Extraordinarily fine-pitch 0.25 mm pitch BGAs
- Buried resistance/buried capacitance
- Chip on board or CoB (Figure 1)



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EMS DISCOVERS MATURE IC TECHNOLOGIES *continues*

Some of these technologies have been around for some time, especially in the semiconductor world—like wire bonding and chip on board—but they haven't come calling on our neighborhoods until now. Obviously, OEM customers designing in these newer technologies are going to their contract manufacturer (CM) and EMS provider partners to understand what kinds of solutions they offer to effectively handle them.

I can tell you unequivocally that effectively dealing with these technologies will be challenging, simply due to the fact they're rapidly evolving, and the EMS industry is not quite ready for them. They're coming so fast that no IPC standards for them exist; there are no defined processes and no major R&D studies, partially because there is no available and reliable data that can be used as a reference guide to determine how to design and assemble these packages. Worse yet, the capital equipment resources for implementing them are not yet available.

However, it's not just all of the above that's required. Equally important is having the right and proactive mindset as a CM or EMS provider and the ability to provide supporting capabilities. That includes having the vision to perceive what is changing and what's new on the market and the foresight to anticipate the newer technologies before they hit the market so that you are not caught flat-footed. Based on their experiences in this industry, CMs and EMS providers need to envision solutions to new PCB technologies, and be ready to serve customers when they do arrive.

Newer PCB Technologies

Up to now, most CMs and EMS providers have applied conventional SMT assembly procedures and soldering techniques to mount packaged components onto the PCB. However, these days, with both packaging and boards dramatically shrinking, OEMs are calling for wire bonding and its variants to attach a die, package, or substrate to the PCB.

Wire bonding has historically been associated with integrated circuit (IC) and component manufacturing and is used to attach a chip to the leads of the package housing that chip. Signals coming from a chip through those tiny wires are then spread to the leads and subse-

quently onto the PCB and to the outside world, as semiconductor people like to say.

As cited previously, there are variants to wire bonding. There is thermal compression, ultrasonic wedge, and a combination of the two, called thermal sonic. Each has different characteristics, which pose various issues and concerns that can have adverse effects on the overall reliability of the final board. So the CM or EMS provider has to decide on the wiring technology best suited to a given board application. For example, let's take ultrasonic wedge bonding. Determination must be made on wire thickness, chemical composition, diameter, and along with diameter, determination must be made as to the frequency for bonding purposes and power.

Regardless of the type of wiring used, each has its pros and cons. One type might be better for attaching a flip chip to a PCB. But chip-on-board attach might prove more robust and more effective using yet another wiring version. In some cases, aluminum wires are better; other times, gold wire is more suitable, or ribbon wire or die bonding for a given PCB application depending on different temperature ranges and other variables.

Meanwhile, there's that extraordinarily microscopic-size 0.25 mm pitch BGA to deal with. The latest flux type 5.5 is currently working fine for 0.35 and 0.30 mm pitch BGAs. At this point, there's some doubt if it will be effective for 0.25 mm, but flux type 6.0 will probably be the one to use in this case. However, it's not in production yet. Savvy CMs and EMS providers who have overcome the 0.35 and 0.3 mm pitch challenges should be in a good position to resolve this one at 0.25 mm pitch. This means closer study and experimentation are needed in this instance.

The same pretty much holds true for buried resistance and capacitance. The CM and EMS provider must draw from previous know-how to deal with this emerging technology. Shrinking board sizes and smaller packaging are triggering the need to eliminate traditionally packaged resistors and capacitors and surrender that valuable real estate to other critical circuitry. Resistance and capacitance are then embedded into the circuitry between a PCB's layers. They

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EMS DISCOVERS MATURE IC TECHNOLOGIES *continues*

can be embedded between buried and blind vias, or between other aspects of a PCB, reducing the number of components to be placed on the surface of PCB.

There are different techniques for implementing embedded resistance and capacitance. However, not everybody can do it. It requires considerable high-level knowledge of the physical characteristics of different materials, pre-pregs being used, thermal, mechanical and electrical characteristics, temperature of coefficient characteristics, and so on.

Like wire bonding, chip-on-board (CoB) has been around for a while. But it's taken on a new assignment on the PCB. Previously, CoB was treated as a discrete device attached on a PCB after assembly. Now, with the increasing use of LEDs in so many industries, CoB and surface mount (SM) devices along with the LED are merged together and being combined on a PCB. Today, technologies and base materials can handle that level of heat dissipation and deal with a CoB sharing the same PCB real estate with the rest of the SMT components.

How do we deal with them?

Dealing with these newer PCB technologies doesn't mean ignoring and setting aside other OEM customers and the conventional design and assembly methods used for those types of PCBs. Close attention continues to be given to those OEMs. However, that same close attention—and maybe a bit more—must also be provided to customers bringing in those newer PCB technologies. More so than ever before, it's a time when you work closely together as a team with your OEM customer to jointly develop and put in place the necessary processes, from smooth design to fabrication and assembly.

OEM customers know what they want and need. But in cases like this with the newer technologies, they simply don't have the knowledge or process details, or the understanding of the equipment that's required. That's why working in tandem with them is so crucial.

What this boils down to is this: The CM or EMS provider must take leadership simply because the burden falls on their shoulders. This is where the savvy CM or EMS provider dips down deep into its vast experience base to

pull together various past projects, link some promising ones, create experiments, and subsequently formulate the right solutions to deal with these new PCB technologies. In short, it's what's called pulling together all the "tribal knowledge" gained over the years with a variety of OEM customers.

The Right Mindset

As I said, the right and proactive mindset is the critical linchpin to deal with these technologies. In large part, this means making smart decisions based on your future outlook for effectively serving your customers. For instance, when buying new equipment you're not only factoring in the current customer needs, but you're also casting a broader net, so to speak, to include those long-term customer needs, as you anticipate how this industry and the technology are evolving. Or when you're buying the latest and greatest pick-and-place equipment, make sure it's capable of doing 0.1005-type passive devices. But you also want to get assurances it's capable of doing 0.25 and 0.20 mm pitch devices, as well as providing a solution for a modular format to handle future generations of package-on-package or PoP technologies.

The right and proactive mindset also includes training your design and assembly personnel regularly. In short, up-to-date training is critical to keep your people ahead of the technology. For example, PCB designers should take such latest IPC courses to be certified as CID or CID+ or even CID Master Trainer. As far as PCB assembly, floor personnel, both technicians and engineers, should have IPC training classes as part of their ongoing professional development.

The questions for the OEM to ponder are how does CM and EMS provider management look at emerging technologies? What's their mindset? And how proactive are they? **SMT**



Zulki Khan is the founder and president of NexLogic Technologies, Inc. To read past columns, or to contact the author, [click here](#).



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Understanding SMT Under Stencil Wiper Rolls

by **Dennis O'Brien, M.D.**
SWIFTMODE GROUP

SUMMARY: *Fine-pitch applications and small apertures are the norm now and the performance of stencil cleaning rolls is more critical than ever.*

Introduction

This article provides solder paste stencil printing engineers and purchasing professionals of stencil cleaning products a clear understanding of the different types of stencil cleaning paper/fabrics that are currently available. As fine-pitch applications and small apertures have become the norm, the performance of stencil cleaning rolls is more critical than ever.

Main Products in the Market

- Cellulose/polyester paper
- Cellulose/polyester hydro-entangled non woven
- Rayon (viscose)/polyester paper/fabric
- Rayon (viscose)/polyester resin bonded
- 100% polypropylene non-woven

Thicknesses of these products vary from 40 grams per m² to 65 grams per m².

Manufacturing Process and Environmental Impact

All cellulose products start with the same process, reacting the cellulose with sodium hydroxide (NaOH), which is a very strong alkali (corrosive). This alkali cellulose is then reacted with methyl chloride, chloroacetic acid, ethylene oxide, and/or propylene oxide depending on the type of cellulose ether product to be made. These chemicals are all classified as hazardous air pollutants by the U.S. Environmental Protection Agency.

Rayon (viscose) starts the same as cellulose and then the alkali cellulose is allowed to age before it is reacted with carbon disulphide (CS₂), a highly toxic substance and also classified as a hazardous pollutant. Typically, only 50% of the carbon disulphide can be recovered, leaving 50% into the environment. Extrusion and then immersion in a bath of sulphuric acid (H₂SO₄) generates hydrogen sulphide gas (H₂S), also classified as a hazardous air pollutant. Rayon is a particularly “dirty” product to make and has been associated with deforestation in developing countries.

Polyester is made by reacting ethylene glycol with terephthalic acid, which uses a lot of



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UNDERSTANDING SMT UNDER STENCIL WIPER ROLLS *continues*

energy and water. Polyester is not very reactive after polymerization, but the chemicals used in the process are highly reactive and toxic, with some being carcinogenic, so workers must be well protected. Traces of these chemicals remain in the polyester as it is not possible to polymerise 100%.

Polypropylene uses less energy than any of the above with a lower carbon footprint than any other fibre resins. The water used in the cooling process is closed cycle so the water does not go into the environment. According to [PlasticsEurope](#), Association of Plastics Manufacturers' environmental product declaration (EPD), polypropylene has a low impact on the environment, with no toxic waste or emissions, and no fluorocarbons or halogens. It is easy to recycle up to 50 times without reduction in its properties. Polypropylene has a high calorific value providing high energy for the amount of CO₂ emitted when burned.

Cellulose products need to be bleached. In a developing country, the process most likely uses chlorine gas or chlorine dioxide, unlike developed countries in Europe, and the U.S., who use an eco-friendly alternative like peroxide. Independent testing for chlorides has clearly shown that:

Cellulose/polyester paper contains (source, China):

- Chlorides: 11 µg per gram
- Sulphates: 87.5 µg per gram
- 18.7 times that of PP

Rayon (viscose)/polyester paper/fabric contains (source, possibly India):

- Chlorides: 4.56 µg per gram
- 7.77 times that of PP

Polypropylene non-woven fabric contains^[1]:

- Chlorides: 0.587 µg per gram

Once again, 100% polypropylene non-woven fabric comes out on top, with the lowest chloride content because bleaching is not part of the process. Polypropylene non-woven has the lowest environmental impact of any of the products covered in this paper. This surely has to be a serious consideration for any user with an active environmental policy that demonstrates real commitment to use products with low environmental impact.

The Effect of Construction on Cleaning Performance

Cellulose/Polyester Paper

The fibres have one dominant linear direction due to the process of manufacture, and the surface is smooth.

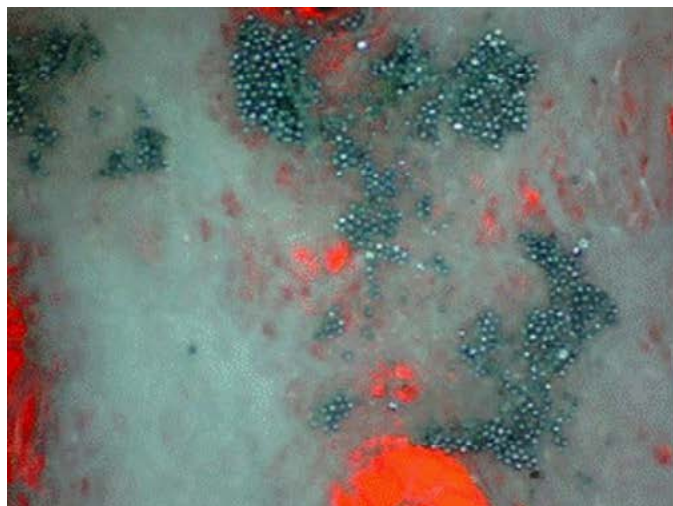


Figure 1, left: Solder balls on the surface, resulting in potential for contamination.

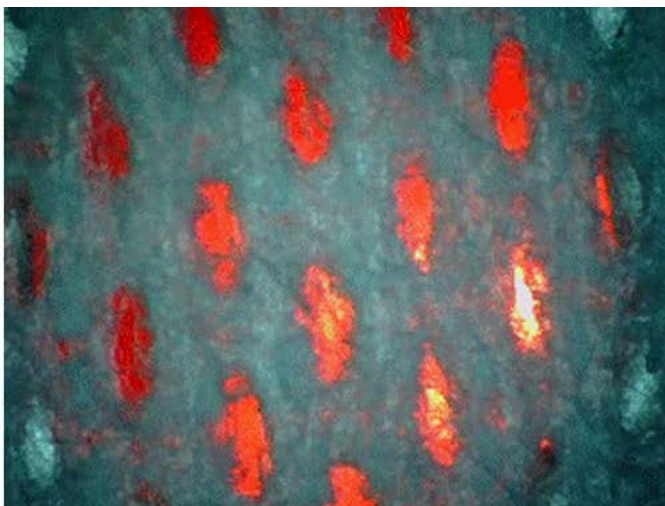


Figure 1, right: Solder paste shows dominant fibre direction, resulting in small surface area for cleaning.



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Uni-directional fibres do not have the same cleaning ability as those that are more random (non-wovens) due to tiny spaces between the lines that reduce cleaning performance.

These properties result in solder balls remaining on the surface of the paper that are not captured within the fibre structure of the paper, which gives a high potential for contamination. Figure 1 was taken at 400x magnification, and shows the solder balls on the surface of the paper. The right-hand photograph shows the dominant fibre direction.

Smooth surface, one dominant fibre direction, and the density of the fibre structure, all define the space for air to pass through the paper and so influence the effectiveness of the vacuum. This product does not perform well, especially in the wet vacuum cycles.

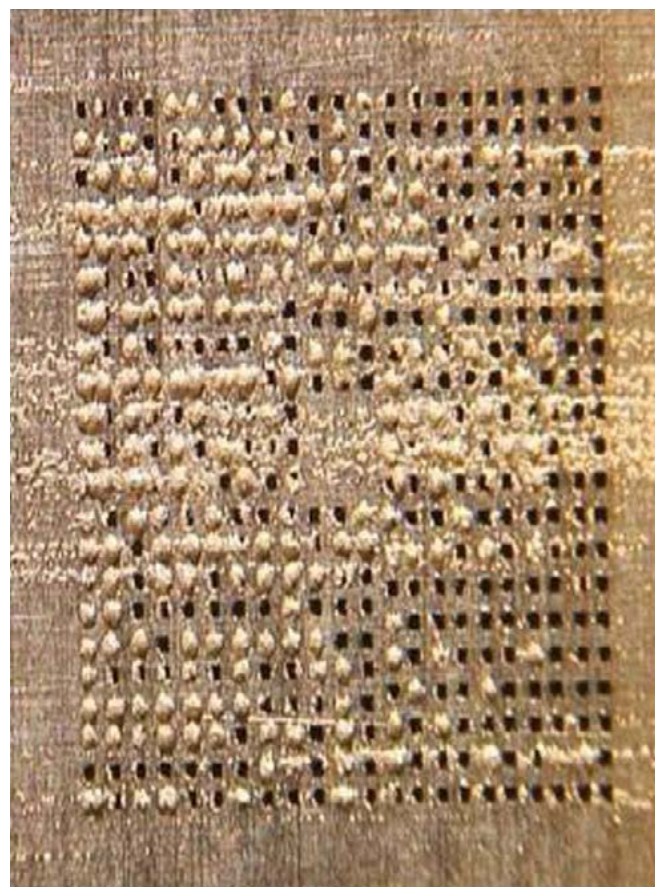


Figure 2: High percentage of solder paste not removed due to ineffective vacuum.

The presence of cellulose fibres means that more solvent is needed to provide enough of the cleaning medium, because the fibres have to get saturated before any liquid will be on the surface. When the paper is wet, the physical properties are totally different from when it is dry, as the fibres swell and the paper has a mushy feel to it. This further impedes the vacuum effectiveness and can also lead to paper jams.

Figure 2 shows how ineffective this product is in the vacuum cycle. The apertures were completely filled and excess paste removed. You can see clearly that this product doesn't have sufficient porosity for the vacuum to remove the solder paste.

Cellulose/polyester hydro-entangled

The make-up of this product is the same as the one above, apart from the fact that no chemical binders are used. The fibres are locked together by the action of high pressure water jets and hydro entangling. However, the fibres still have a dominant linear direction as shown in the photographs below. This process results in a more compact paper with an even smoother surface and the consequent loss of cleaning power.

Fibre voids are reduced resulting in higher paper area density. Whilst this produces a stronger fabric (not necessary for stencil cleaning) it further reduces the effectiveness of vacuum. This is a huge contradiction, making the fabric stronger, which is not necessary, and leaving less space for air to pass through, which is necessary for an effective vacuum cycle. Smooth surface, one dominant fibre direction, and density of the fibre structure, all define the space for air to pass through the paper and influence the effectiveness of the vacuum.

As with the prior product, more solvent is needed to provide enough of the cleaning medium due to fibres that must get saturated before any liquid will be on the surface. It also shows the same differences in the physical properties when the paper is wet vs. dry and further impedes the vacuum effectiveness and may lead to paper jams.

Rayon (viscose)/polyester paper/fabric

The statements made in the cellulose/polyester paper section are also relevant to this product.

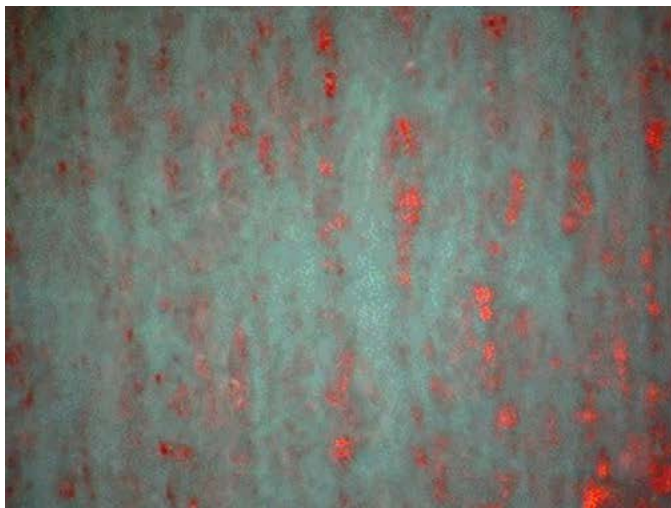
UNDERSTANDING SMT UNDER STENCIL WIPER ROLLS *continues*

Figure 3, left: Dominant fibre direction results in uneven cleaning.

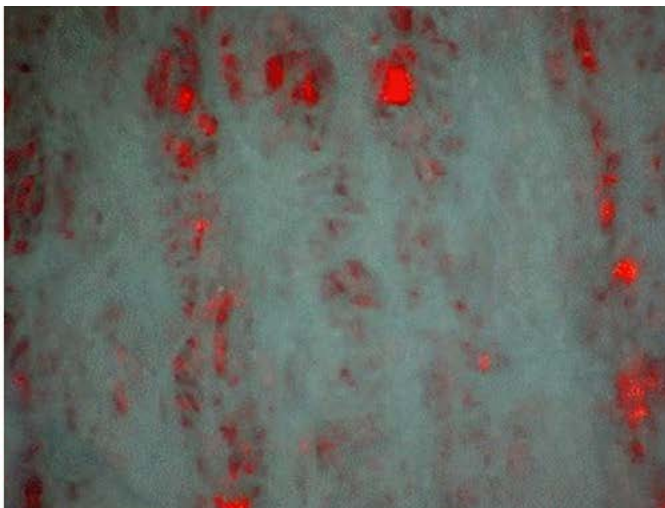


Figure 3, right: Large areas of the paper are not used for cleaning.

In view of the environmental problems in making this product it is an enigma why anyone would wish to offer and/or use it as an SMT stencil wiper roll.

Rayon is often referred to as artificial silk as it has a very smooth, shiny finish, the last thing you would expect to want for stencil cleaning. Smooth surface, one dominant fibre direction, and density of the fibre structure all define the space for air to pass through the paper, which influences the effectiveness of the vacuum.

Figure 4 shows how ineffective this product is in the vacuum cycle. The apertures were completely filled and excess paste removed. This product doesn't have sufficient porosity for the vacuum to remove the solder paste.

This result is worse than the cellulose/polyester paper due to the factors mentioned above. The very smooth texture of the surface is most likely the cause.

100% Polypropylene non-woven

In this material, the fibres are totally random; there is no dominant fibre direction which provides an optimum cleaning surface.

The relationship between coefficient of friction and abrasion is different for plastics than other materials. The coefficient of friction for polypropylene is between 0.2 and 0.6, but it is not abrasive as it would be in other materi-

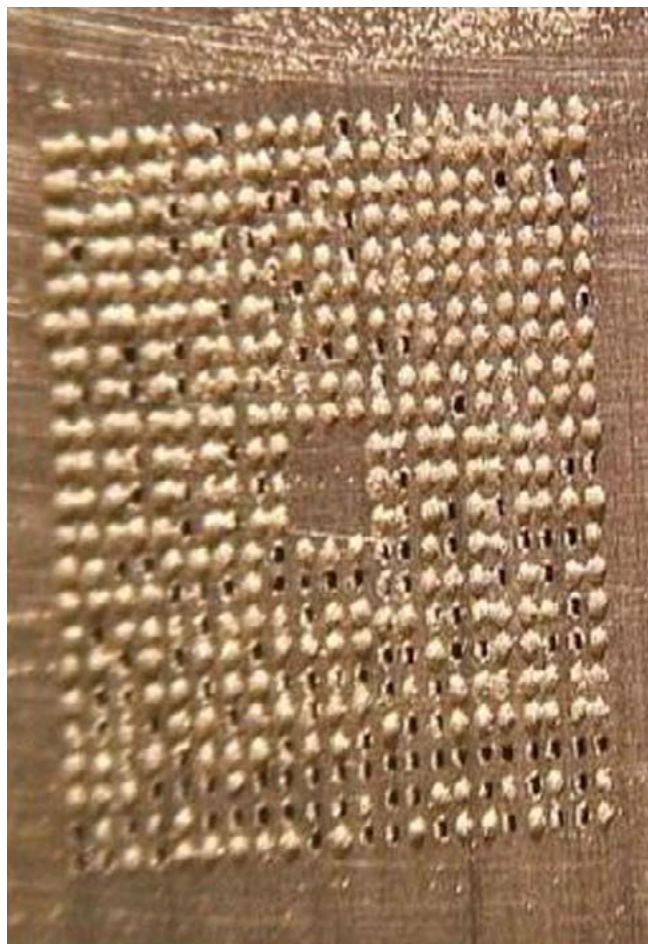


Figure 4: About 85% of solder paste not removed due to poor vacuum performance.

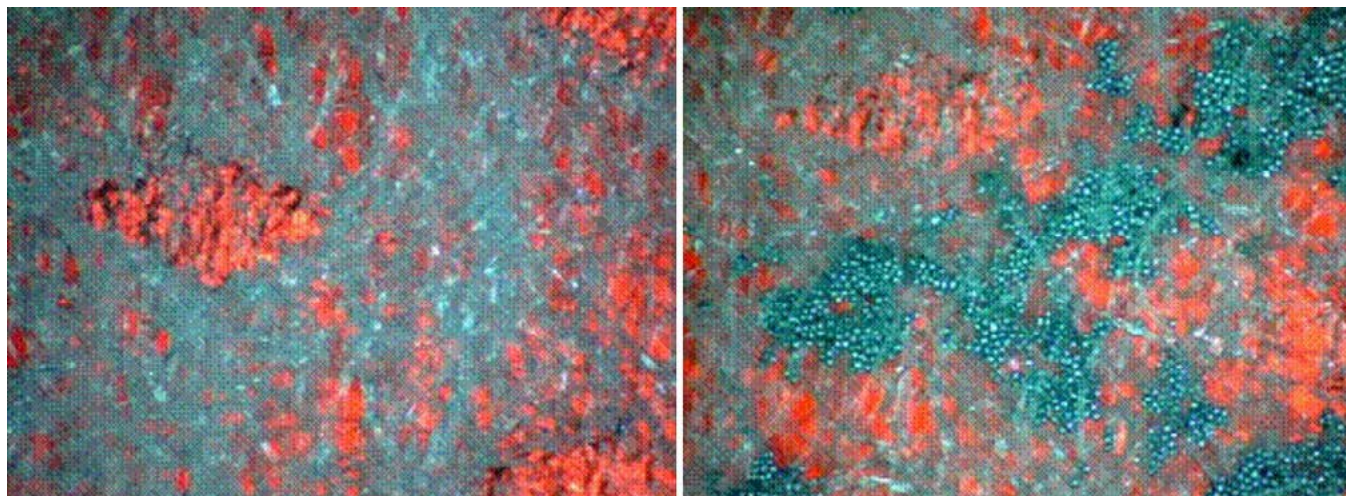
UNDERSTANDING SMT UNDER STENCIL WIPER ROLLS *continues*

Figure 5: Random fibre pattern, with large surface area used for cleaning and solder balls trapped within the fibres.

als. In under-stencil cleaning there is a need for some friction to do effective cleaning and polypropylene provides that without the abrasion, which results in a longer stencil life.

Figure 5, at 400x magnification, confirms no dominant fibre direction; it is completely random. The photograph on the right clearly shows that the solder paste and solder balls are trapped inside the fibre structure, thereby preventing any contamination.

One hundred percent polypropylene is a true dry-laid non-woven product having all the properties necessary for a high-performance stencil wiper roll. Sufficient spaces between the fibres ensure a highly effective vacuum process, wet or dry. This is confirmed without any doubt in Figure 6. The apertures were completely filled and excess paste removed. Polypropylene non-woven is the most effective of all the products discussed here, with about 90% effectiveness.

The fibres do not swell and the physical properties do not change in any way when wet, which is the ideal material for a cleaning process that demands both wet and dry cycles. The surface is not smooth due to the thermal bonding process and contributes significantly to its superior cleaning performance. The density of the fibres is perfect for the job, as super strength is not required, but there is enough to eliminate any fabric breakages.

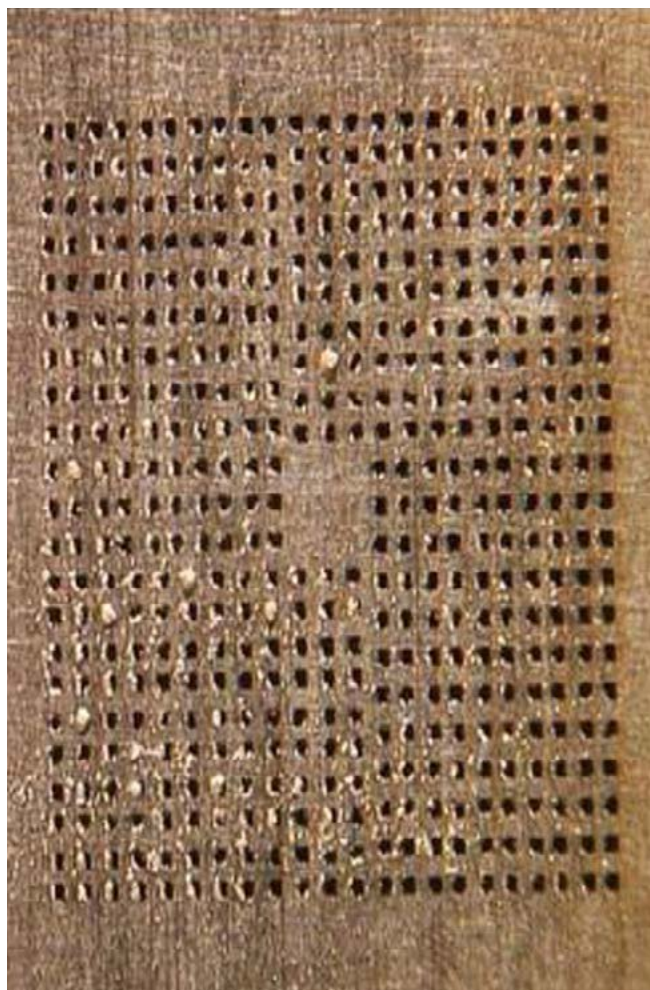


Figure 6: Good fabric porosity results in an effective vacuum cycle.

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The solvent is not absorbed into the body of the fibres, but stays on the outer side, putting the solvent where it is needed. This gives potential for solvent reductions if engineers are prepared to make small changes depending on the cleaning job requirements. As they say, if you never try, you never know. Isopropyl alcohol is the most common solvent used which is bad for the environment and human bronchial systems so it is worth trying.

Conclusion

As pitches become finer and apertures get smaller, stencil cleaning products must keep pace with these developments and consider the environmental issues and job challenges that stencil cleaning wiper rolls face. **SMT**

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References

1. Association of Southeast Asian Nations (ASEAN)



Dennis O'Brien is director (owner) of Swiftmode Malaysia (Penang) Sdn Bhd, located on Penang Island, serving Swiftmode Philippines and a network of distributors in Asia and Europe. Contact

O'Brien at dobrien@polygroup.biz.

ORNL Highlights 3D Printing Capability

Things have come a long way since the mid-1980s when 3D Systems cofounder Chuck Hull worked out the technology to print objects in three dimensions, one very thin layer at a time. Hull called his new technology "stereolithography."

In it, a guided beam of ultraviolet light is focused on a vat of liquid polymer, solidifying areas where it hits. When one layer is complete, the platform holding the object lowers a bit, and the process is repeated.

The technology was impressive, but limited, with the printed objects serving as prototypes but not much else. In the intervening decades, and especially in the last few years, 3D printing has made it to the big time, taking off both in capability and application.

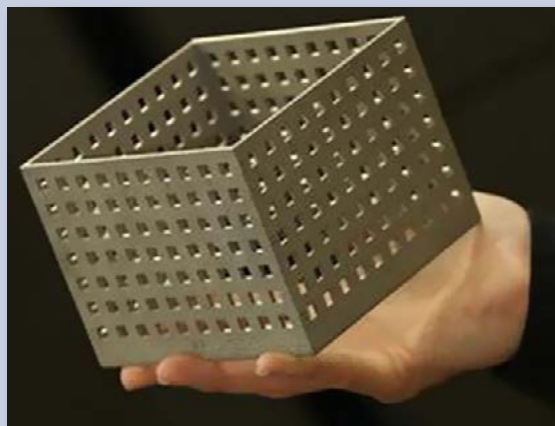
Consider the following:

- Electron beam melting systems create intricate, high-quality components by sweeping a precise layer of metal

powder over an object and selectively melting it to the object. Swedish manufacturer Arcam AB has used this process to produce more than 30,000 acetabular cups, the components in a hip replacement that attach to the hip socket and hold the ball joint. These printed components are literally walking all over Europe.

- Boeing uses 3D printing, also called additive manufacturing, to produce more than 20,000 military aircraft parts, and GE Aviation has announced it will produce more than 100,000 additive-manufactured components for its LEAP and GE9X jet engines by 2020.

ORNL's focus on printing is led by the Deposition Science & Technology Group within the Manufacturing Demonstration Facility. The DST



is young, created just this year. According to group leader Chad Duty, it works with a variety of advanced manufacturing technologies such as carbon fiber, magnetic field processing and printed electronics. And, of course, the group works on additive manufacturing. In this realm its role is a combination of research and education.



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News Highlights from SMTonline this Month

① **Creation Technologies Earns U.S. FDA Registration**

"The role of the FDA is to protect public health, ensuring that strict standards are in place. We're proud to say that Creation understands these standards and adheres to the Good Manufacturing Practices that enable us to provide expert design and manufacturing for medical devices and products that must comply with the FDA's food code," said Ron Euer, quality and Lean leader.

② **IPC Recognizes Contributions to Electronics Industry**

The association presented Committee Leadership, Special Recognition, and Distinguished Committee Service Awards at its Fall Standards Development Committee Meetings last week in Fort Worth, Texas. The awards were presented to individuals who made significant contributions to IPC and the industry by lending their time and expertise through service on IPC committees.

③ **For Contamination, Prevention is Better Than Cure**

No-clean practices have altered the printed board manufacturing processes, eliminating steps once used to remove fluxes and other unwanted materials. But the drive to array packaging and other bottom termination configurations requires renewed focus on cleaning and contamination.

④ **IPC-2581 Consortium Seeks New Members**

Getting OEMs, design tool providers, EMS providers, and others to agree on a standard for transferring data files has proven a difficult challenge. The IPC-2581 Consortium, formed to help industry settle on a data transfer document, is beefing up its efforts by opening its membership to individuals.

5 ControlTek Earns Oregon's Healthiest Employer Award

ControlTek received the award based on the electronic manufacturer's high participation levels for its new Forward Living program, a company-wide wellness program that includes a Health Risk Assessment, individualized health consultation and planning, and rewards for progress made towards individual employee goals.

6 Celestica's Q3 Revenues Down 5%, But Within Guidance

"Celestica delivered a solid third quarter with revenue and adjusted EPS above the midpoint of our guidance range, driven by strong demand in our communications and storage end markets," said Craig Muhlhauser, president and CEO.

7 Flextronics Posts Solid Q2 Results

"This was a solid quarter for Flextronics from a financial perspective as we hit many of our financial objectives," said Chris Collier, chief financial officer. "Our revenue and adjusted EPS both grew sequentially and came in at the high-end of our guidance ranges."

8 Sanmina Ends Fiscal Year 2013 with Solid Q4 Results

"Revenue was up modestly, operating margins expanded 40 basis points sequentially, and we generated cash flow from operations of \$90 million for the quarter and \$318 million for the fiscal year," stated Jure Sola, chairman and CEO.

9 Researchers Unveil Reason Behind Tin Whisker Growth

"We're convinced it's got to be stress from the intermetallics that causes tin whiskers to form," says Chason. His presentation, "Real Time Study of Whiskers/Hillock Formation in Sn-Cu Systems During Thermal Cycling," will provide information on the systematic experiments conducted to confirm it.

10 OnCore Launches Interconnect Business

"We have assembled an engineering and operations team with an average of 18 years of cable and harness manufacturing experience," commented Bob Weber, vice president of manufacturing. "OnCore Interconnect fulfills our customers' requirements for a high-quality interconnect source that is integrated into their product's manufacture."

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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](#).

HKPCA & IPC Show

December 4–6, 2013
Shenzhen, China

International Printed Circuit & Electronics Assembly Fair

December 4–6, 2013
Shenzhen, China

Semicon Japan

December 4–6, 2013
Chiba, Japan

Austin (CTEA) Expo and Tech Forum

December 5, 2013
Austin, Texas, USA

BELEX

December 5–8, 2013
Bursa, Turkey

International Electronic Components Trade Show

January 15–17, 2014
Tokyo, Japan

Electronix R&D Japan

January 15–17, 2014
Tokyo, Japan

Electrotest Japan

January 15–17, 2014
Tokyo, Japan

Material Japan

January 15–17, 2014
Tokyo, Japan

NEPCON Japan

January 15–17, 2014
Tokyo, Japan

Automotive Electronics Expo

January 15–17, 2014
Tokyo, Japan

CAR-ELE Japan

January 15–17, 2014
Tokyo, Japan

DesignCon 2014

January 28–31, 2014
Santa Clara, California, USA



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Next Month in *SMT Magazine*: Reliability

How can the reliability of an electronic assembly be assured? How reliable does an electronic assembly have to be, and what factors determine it? How much influence does design wield, and to what extent can reliability be improved by cleaning and conformal coating?

These are just a few of the questions our feature contributors will speak to in the January issue of *SMT Magazine*.

Enjoy the holidays and we'll see you in 2014!