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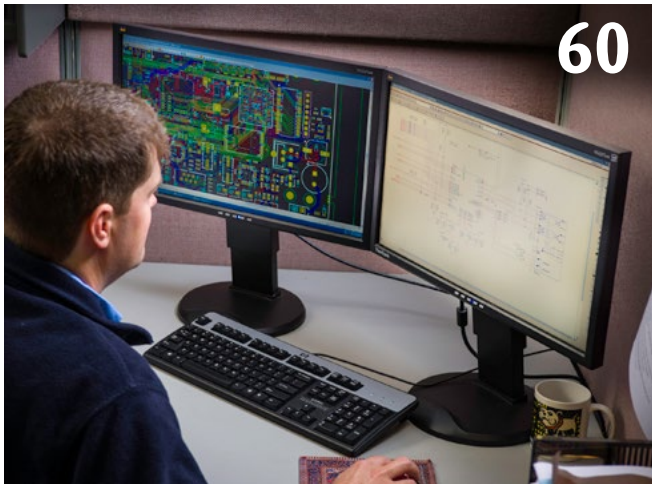

Strategies for Increasing Profit

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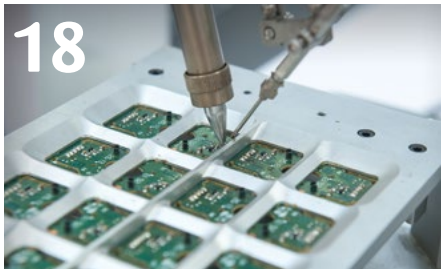

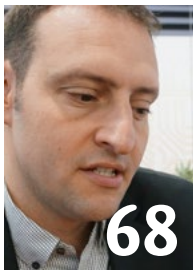

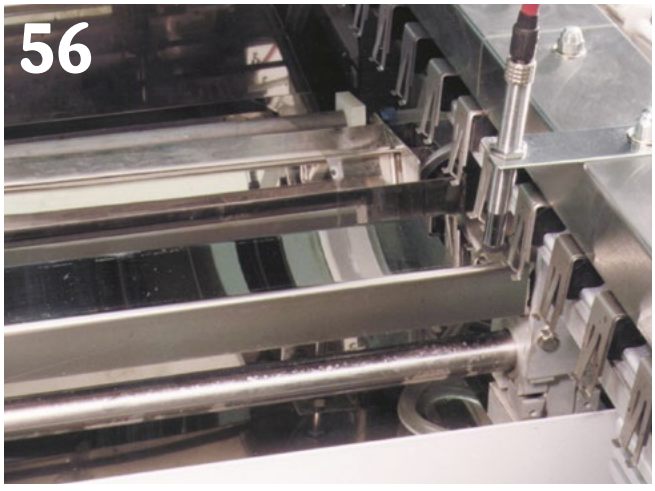

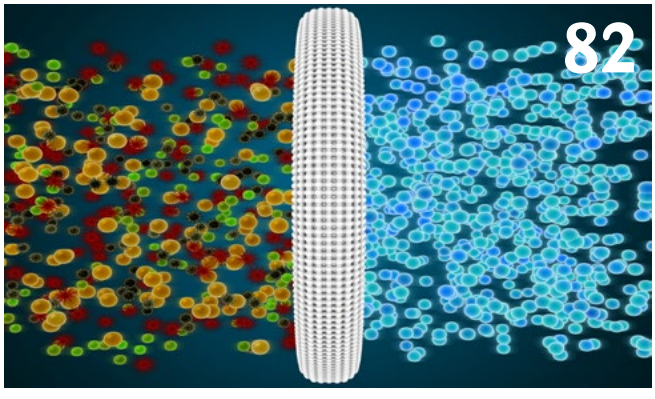

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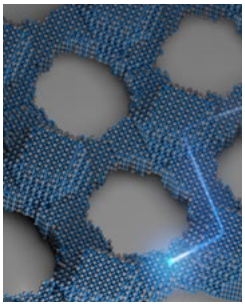

Ensuring Profitability

by Stephen Las Marias
I-CONNECT007

I don't think there is a one-size-fits-all approach to ensuring a profitable business. This is especially true in the intensely competitive electronics manufacturing and assembly industry, where product lifecycles and the ever-increasing complexity and sophistication of electronics products, among others, more often than not dictate the business strategies of these electronics manufacturers.

But there are definitely sure-fire formulas for success when it comes to improving the bottom line and profits. According to an Entrepreneur article, there are three top secrets to market leadership: operational excellence—the ability to produce a company's products and services at a cost substantially lower than its competitors; customer intimacy—having a close relationship with customers based on an excellent knowledge of your customers' needs or business; and technological superiority—offering a product or service that's (technologically) superior to that of your competitors.

In the electronics industry, one company comes to mind: Apple Inc. The creator of iPhone and iPad and the Mac, Apple has those three qualities that enable it to sustain revenue and net profit growth year after year, despite a very crowded consumer electronics market and macroeconomic uncertainties worldwide. From 2011 to 2015, Apple has posted net revenues of $108.25 billion, $156.5 billion, $170.9 billion, $182.8 billion, and $233.7 billion, respectively. Net incomes, meanwhile, were $25.9 billion, $41.7 billion, $37 billion, $39.5 billion, and

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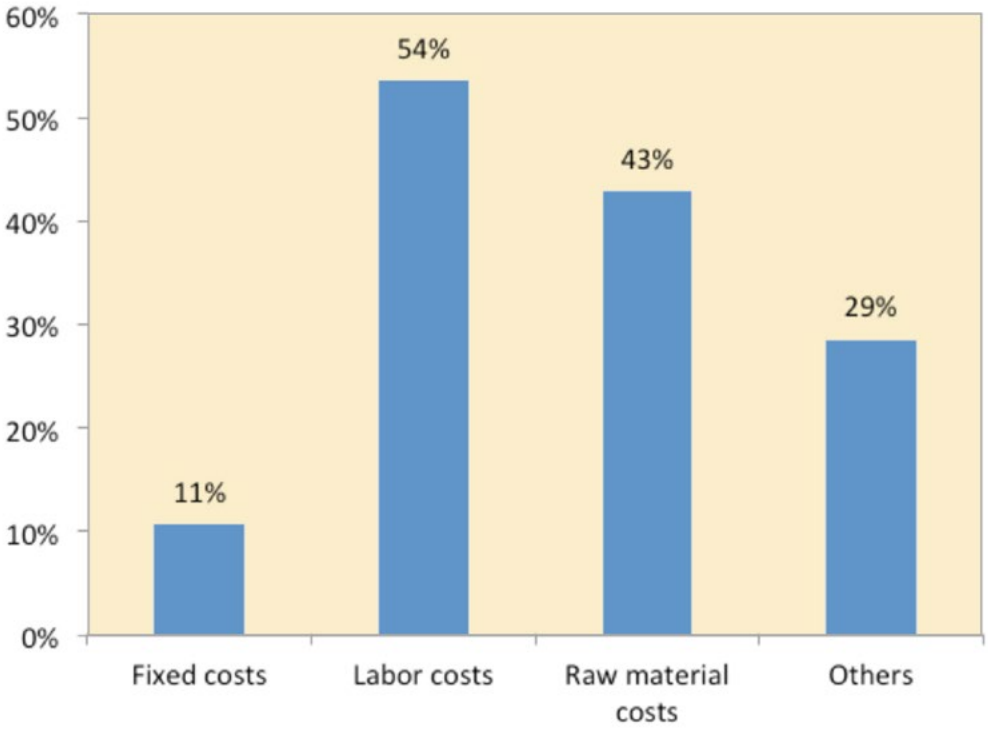


Figure 1: According to our survey, labor costs provide the greatest impact to profit.

$53.39 billion during the same period. In 2014, in fact, Apple became the first U.S. company to be valued at over $700 billion.

How so? For starters, Apple produces its products at a substantially lower cost by outsourcing its manufacturing and assembly to Taiwan-based Foxconn Electronics (Hon Hai Precision Industry), which is the largest electronics contract manufacturer, worldwide. From a customer intimacy standpoint, Apple has achieved a high level of brand loyalty, and is said to be one of the world's most valuable brands. Finally, from a technology standpoint (and even though I haven't owned any Apple device yet), I believe the company's technology is one of the best there is.

Well, Apple is just a simple example that I could think of based on the top secrets mentioned above. Of course, a lot of other successful technology companies out there continue to remain in their businesses and industries by continuously being profitable and relevant.

Meanwhile, we did a survey about profitability challenges and issues that electronics assemblers and contract manufacturers face. Based on our survey, chief among the issues are cost, process improvement, changing customer demand, design, training, and Lean manufacturing. When it comes to cost, labor provides the greatest impact to profit, according to 54% of our respondents, followed by raw material costs, and then fixed costs.

In line with those challenges, this issue of SMT Magazine highlights processes and strategies that will help electronics manufacturers address those issues and achieve profitability in their operations.

For starters, MB Allen of KIC Thermal discusses today's environment characterized by short production runs and frequent production line changeover. She notes that while improved technologies for line balancing, production planning, smart feeders, MES and more are being used more effectively to allow for faster production line changeover and less downtime, some issues persist, in particular, the reflow oven. She explains that the use of more effective production planning and scheduling as well as modern data mining software to identify one or a few oven recipes may provide dramat-

ic improvements to line changeover time and, consequently, profits.

Firstronic's Tony Bellitto writes about a proper onboarding process that can build a strong organizational culture and help reduce employee turnover.

W. Scott Fillebrown of Libra Industries Inc., meanwhile, discusses finding a way to thoroughly test a fully populated circuit in a timely, cost-effective way, without compromising signal integrity.

For his piece, Inovaxe's Ben Khoshnood writes about the business impact of material acquisition and handling costs, and discusses how EMS companies can win the race for survival, growth and profitability.

Terry Morgan of Voxvia talks about the challenges of finding the perfect partner and the rewards of having a good partnership.

In his article, Jered Stoehr of Milwaukee Electronics details why only a few EMS providers provide design for manufacturability and testability support to their customers, and discusses the benefits of having a combined engineering and manufacturing strategy.

Focusing on providing cable and harness assembly services in-house, Adrian Nishimoto of Spectrum Assembly Inc. illuminates the benefits of a vertically integrated approach to EMS.

For his column this month, Michael Ford of Mentor Graphics examines the real issues to tackle when considering automation for PCB assembly processes.

Robert Voigt of DDM Novastar, on the other hand, lends his perspective on popular options for wave soldering, and important considerations when selecting a wave soldering system.

We also feature an interview with Mentor Graphics' Oren Manor regarding what exactly Industry 4.0 brings to manufacturing, and how Mentor's design-to-manufacture solution helps OEMs make the transition to Industry 4.0 without a complete factory overhaul.

Finally, Stefan Meissner follows up on his article about reducing risk to employees' health with extraction and filtration technology (*SMT Magazine* August 2015). In this issue, he writes about filtration principles for air pollutant removal in electronics production.

I hope you enjoy this month's issue of *SMT Magazine*. Next month, we will talk about improving process engineering, while maintaining and improving production rates, efficiencies, yields, costs, and quality standards.

Stay tuned! **SMT**

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

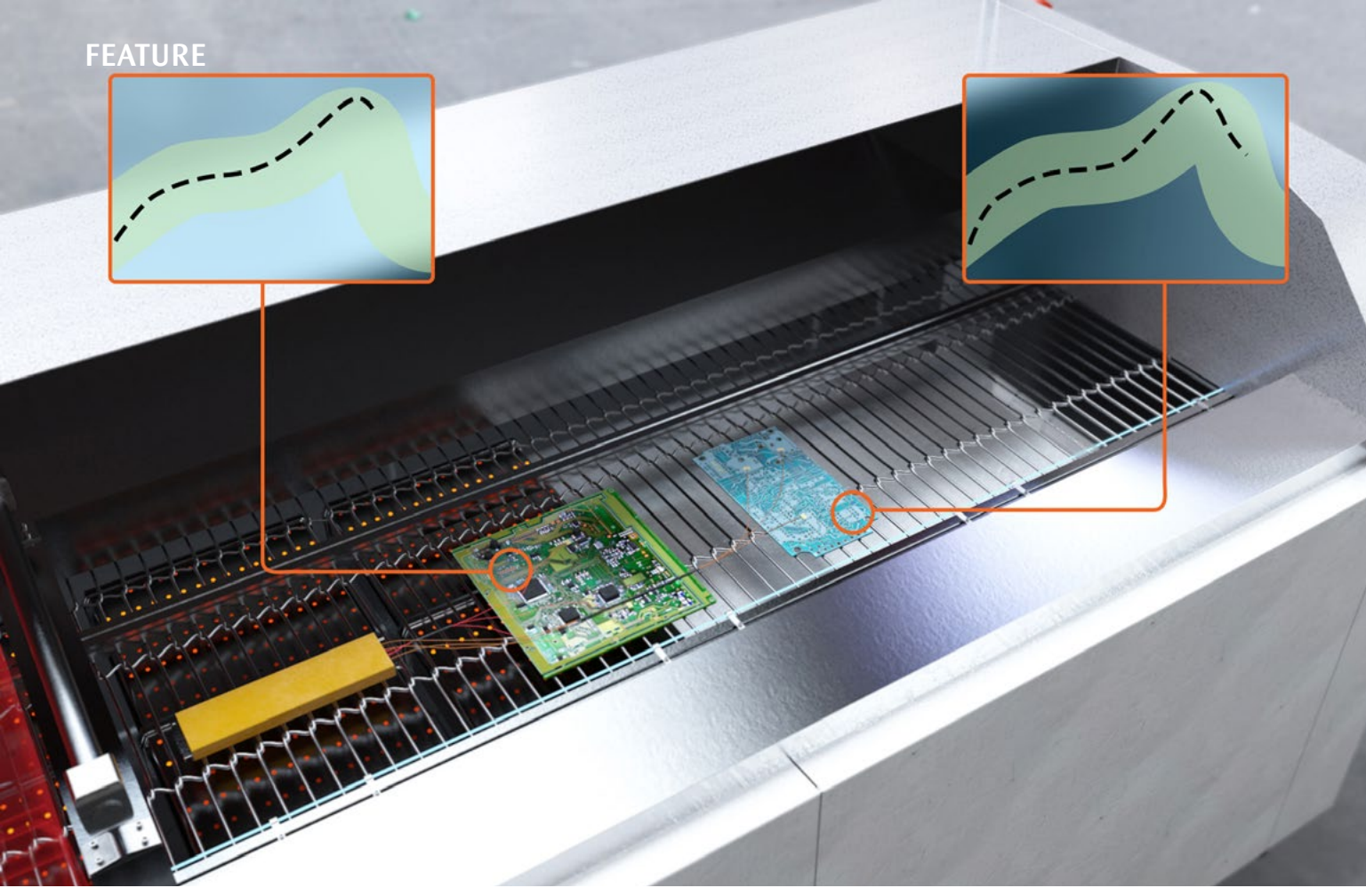
Microchip Shrinks Radar Cameras to Fit into a Palm

Scientists at Nanyang Technological University (NTU) in Singapore, led by Assistant Professor Zheng Yuanjin from NTU's School of Electrical and Electronic Engineering, have developed a chip that allows new radar cameras to be made a hundred times smaller than current ones. With this technology, radar cameras that usually weigh between 50 kg and 200 kg and are commonly used in large satellites can be made to become as small as palm-sized.

Despite being small, they can produce images that are of the same high quality compared to conventional radar cameras. They are also 20 times cheaper to produce and consume at least 75% less power.

Developed over the past three years at NTU, the technology has already secured $2.5 million in research funding from Singapore government agencies.

The radar chip has attracted the attention of several multinational corporations, and is now being researched for use in UAVs and satellite applications.



Instant Reflow Oven Changeover in a World of Short Production Runs

by MB Allen
KIC THERMAL

A clear industry trend now spreading beyond the traditional North American and European markets is characterized by short production runs and frequent production line changeover. Improved technologies for line balancing, production planning, smart feeders, MES and more are being used more effectively to allow for faster production line changeover and less downtime.

One obstacle tends to be the reflow oven. Having a $2 million production line sitting for 30+ minutes while waiting for a $40,000+ oven to stabilize on a new recipe will wreak havoc on profits. The goal should be instant oven changeover, and that goal is achievable in the majority of applications.

Figure 1 (above): There are predictive software that are fast enough to do exhaustive search on the recipes, and to select the optimal oven setup that will produce an acceptable profile for a wide range of different assemblies.

First, a few observations on the purpose of a reflow oven. I always ask process engineers the following question: What is the main job performed by the reflow oven? The answers tend to be to melt solder, solder the components onto the board and create a strong solder joint. All of that is true, but there is more to it. Clearly, we do not want a strong solder joint that cracked the component in order to achieve it. So the reflow oven needs to solder the assembly within the tolerances/process window set by the relevant solder paste, components and substrate.

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The way we measure and control this is by the time vs. temperature profile of the solder joints, PCB, and most importantly, the components. In other words, the oven needs to produce the correct profile. We can even think of the reflow oven as a profile-producing machine.

A reflow oven has literally billions of alternative recipes. Each different set of zone temperatures and conveyor speeds will produce a unique profile on a given assembly. It is imperative that the correct recipe is selected to establish the acceptable profile for all the different PCB assemblies. Therein lies the challenge. It may take an oven 10, 20, 30 or even 40 minutes to stabilize on a new set of temperatures, especially if the new recipe is cooler than the previous. (It takes longer to cool down an oven than to heat it up.) The key to instant or fast oven changeover is intelligent selection of the oven recipe. Clearly, if two different PCB assemblies are very similar and have the same process window, then it will be possible to select a single recipe that will produce an acceptable profile for both assemblies. An experienced process engineer can find such a recipe manually.

But what if the PCB assemblies are quite different in terms of size, thermal mass, and so on? This is a great challenge and it is not time-efficient to perform a trial-and-error experiment on billions of alternative oven setups to evaluate the resulting PCB profile for each one in order to find a common recipe. But such a challenge is perfect for data mining using computers. Predictive software, even running on an old XP computer, is fast enough to do an exhaustive search on the recipes, and to select the optimal oven setup that will produce an acceptable profile for a wide range of different assemblies. This may seem complex, futuristic, and expensive, but the fact is that several competing technologies have been able to do this for many years at low cost. The technology you choose, the applications you have and the reflow ovens you use will affect your success. For example, if you enjoy a modern oven with 10+ zones and you have a range of PCB assemblies that do not include the extreme low- as well as high-thermal mass, you may find a single recipe that can produce an acceptable profile for all your assemblies, hence the phrase in the title of this piece:

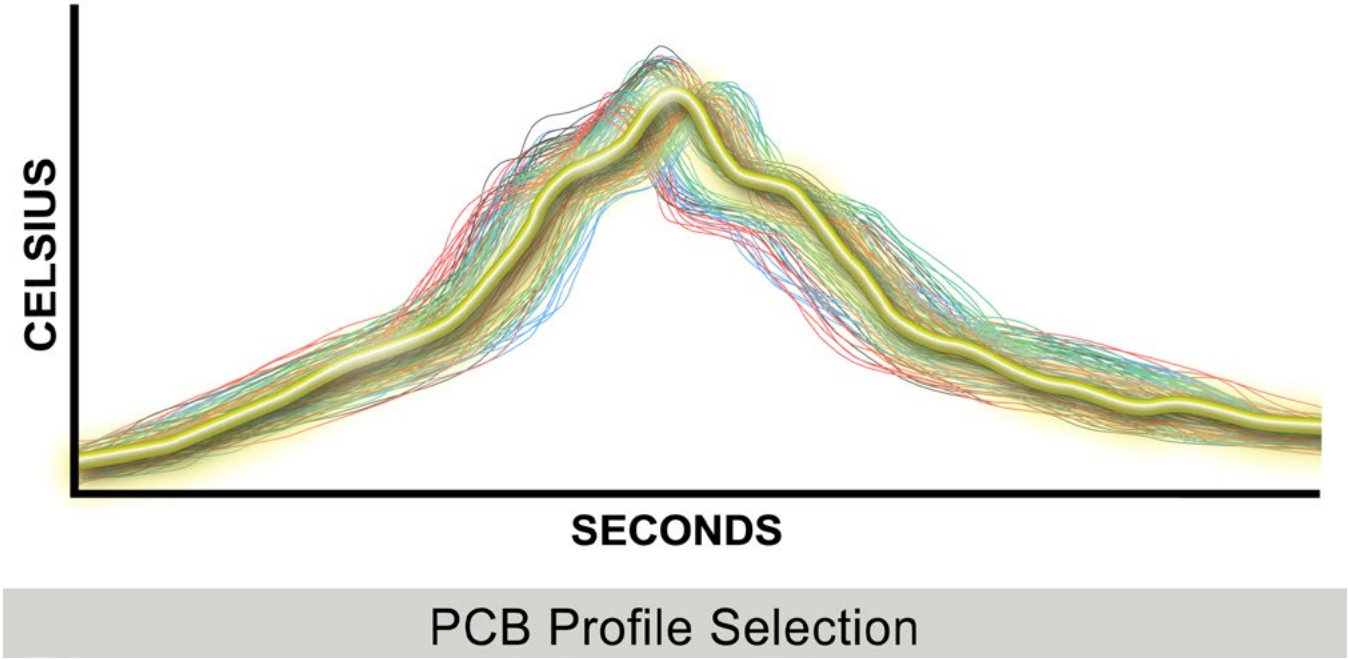

Figure 2: The reflow oven needs to solder the assembly within the tolerances/process window set by the relevant solder paste, components and substrate. And the way to measure and control this is by the time vs. temperature profile of the solder joints, PCB and, most importantly, the components.

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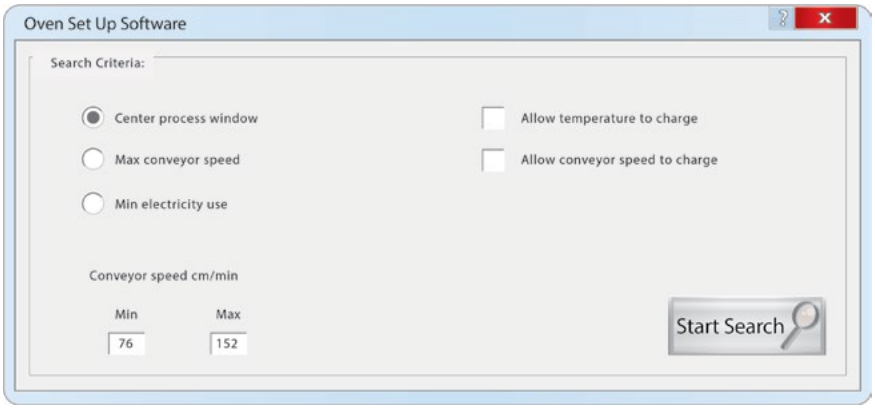

Figure 3: Reflow oven setup.

"instant reflow oven changeover." The fastest oven changeover is no changeover.

In practical terms, one method to achieve this is to attach both the largest and lowest thermal mass PCB to the profiler and to run this train simultaneously through the oven. The data mining prediction software will select the correct oven setup only seconds after a completed profile. This is a simulated or predicted result so you are encouraged to verify the accuracy of the prediction by running a profile on the PCBs after the oven has stabilized on the new settings. Please note that this method also can be used when individual components on the same assembly have different process windows. The data mining software will search for an oven recipe that positions the profile inside every process window for every measured component on both PCBs. The probability is high that all the other PCBs that fall between the two extremes used for the recipe generation will have a profile in spec as well.

For a less capable reflow oven or a wider range of either thermal mass assemblies or process windows, there likely will not be a single oven setup that can handle everything. In that case, follow the same method described above, but narrow the grouping of PCBs. Users may end up with two recipes (small vs. large PCBs) or three or four groupings. In that case, there will be oven changeover delays, but limited to the few recipes there now are. Even in this case, it may be possible to eliminate or reduce the changeover time.

Prediction software or oven setup software allows control over the variables used for searching on the ideal recipe. For example, search on new recipes while allowing conveyor speed but not zone temperatures variables to change. Depending on the applications, it may be possible to get in spec on all or most assemblies simply by changing the conveyor speed. While an oven may take a long time to stabilize on new temperatures, the change in conveyor speed is near instant. To avoid the risk of making the oven the bottleneck in the throughput, limit the range of allowable conveyor speeds to a minimum speed that is faster than the rest of the line.

If the temperature must be changed in the oven, production planning should consider that an oven heats up faster than it cools down. It may be possible to start production with the coolest recipe and progressively go hotter throughout the production day.

Conclusion

It is not uncommon for high-mix electronics assembly factories to have more downtime due to changeover than actual production time. It is important to take a holistic view on the effect of production changeover for each production line as well as the entire operation. When drilling down to the individual machines, you may find that the biggest drag on your productivity is the reflow ovens. The use of more effective production planning and scheduling as well as modern data mining software to identify one or a few oven recipes may provide dramatic improvements to line changeover time and, consequently, profits. **SMT**

MB Allen is a product manager at KIC Thermal.

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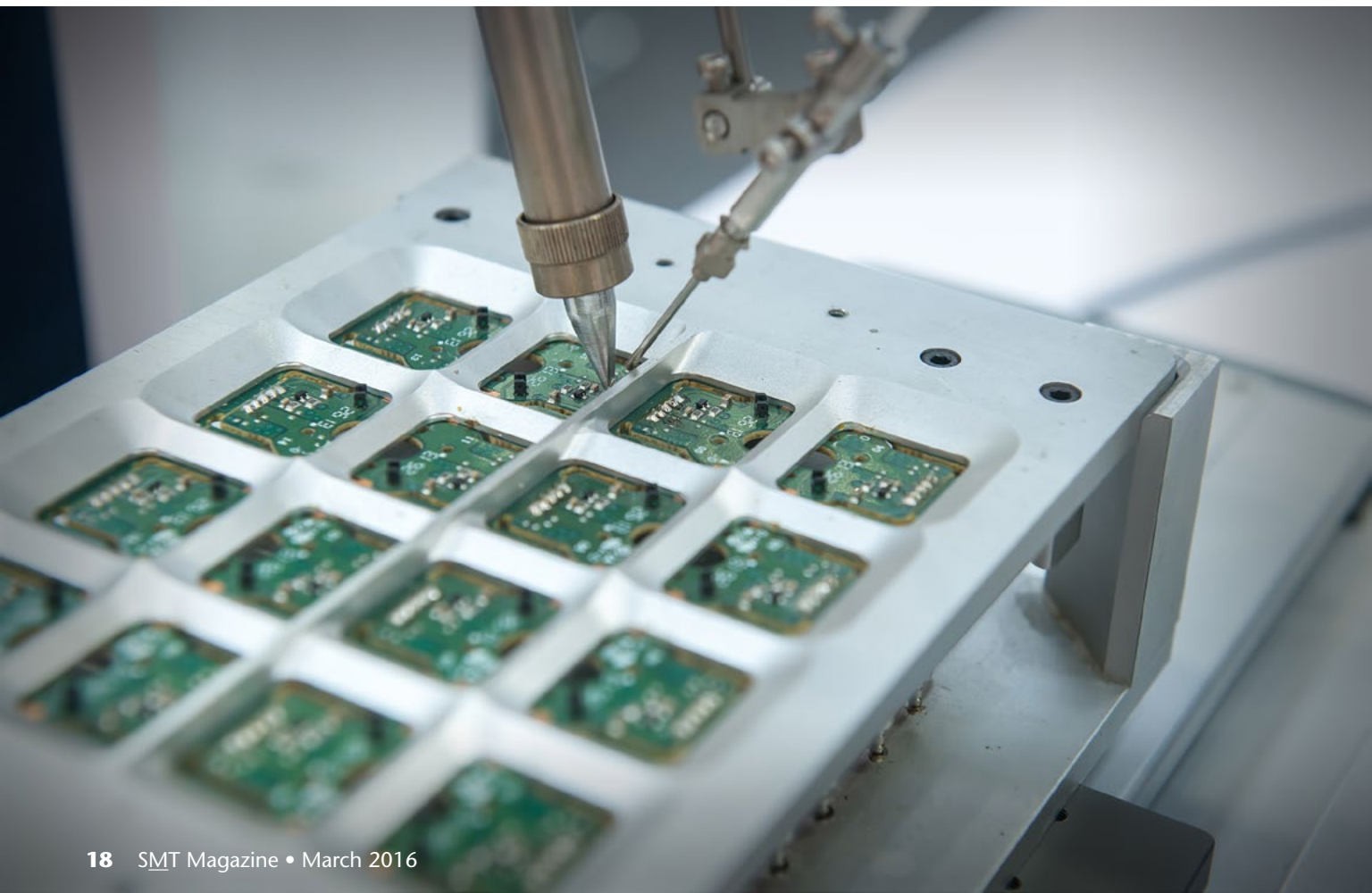
The Buyer's Guide to Automation

by Michael Ford
MENTOR GRAPHICS

Automation for PCB assembly processes in 2016 is a world away from where it started in the 1990s, when high-volume production was still enjoyed by most operations. The idea of replacing remaining manual operations with automated processes that offered a compelling return on investment, reduced variation, and higher reliability seemed like a great idea, although the technology at the time did not quite deliver on expectations.

Fast forward to today, and the same ideas and goals for automation are once again in play; but this time, although technical capabilities have vastly improved, little high-volume is left. Automation now has to be part of a high-mix production environment, with flexibility as factories are called on to be more responsive to shorter term changes in demand. Manual processes are the most flexible of all, so now the stakes for introducing automation are higher.

This high-mix environment has created an irony in PCB assembly manufacturing with SMT. Automated SMT machines are faster and smarter, with wider capabilities and efficiencies, and they are generally more flexible in how they can be used. However, some engineers are embarrassed when showing visitors (or top management) around the SMT area because many of the machines appear to not be working. Productivity levels of higher than 80% are commonly reported, which would imply that the machines should be working 80%



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of the time; but this is clearly not the case, especially when visiting any factory doing high-mix production. When calculating the absolute productivity, or asset utilization, the figures are actually closer to 40%.

No matter what effort a factory makes, the absolute asset utilization of SMT machines and other related complex processes declines sharply as the number of product changes increases. This decline is caused by the extensive setup time when changing between different models. With the trend of increasing product mix and decreasing lot sizes, the problem is growing worse…and it's not going away. The fluctuation of customer demand is brought more directly to the factory, as the stock holding in the distribution chain is reduced to save significant costs to the overall business. If we are to introduce further automation into PCB assembly, we must be able to achieve the return of investment goal that it should be capable of while making an automated factory that is flexible and efficient. And to do this, we need to once and for all resolve the issue of decreasing productivity.

"With the trend of increasing product mix and decreasing lot sizes, the problem is growing worse…and it's not going away."

Simply adding more automation is not a panacea

These goals will greatly affect the choice of new automation and how it is implemented. The SMT machine is a classic example of this "no-win" situation with automation and flexibility. A line of high-performance SMT machines dedicated to making a single product used to be the normal state of manufacturing, where dedicated lines would run for many days before changing products. Machine program efficiency and line balancing were the critical elements for high-volume manufacturing because a change of as little as 1–3% in line performance would be reflected almost directly on the bottom line of the operation.

When changing a line from one product to another on an SMT line, the key bottleneck was the removal of all materials of the out-going product, followed by the setup and verification of all of the materials for the incoming product. This could typically take hours, which was not such a problem for the high-volume environment because it only happened every few days and offered the opportunity to perform essential and routine maintenance on the SMT machines.

The real issue came as the changeovers on dedicated lines became more and more frequent, perhaps once every two days, and then once every day. The time that it took to perform the changes to the materials was now much more significant, as was the sheer volume of materials that would be set up for the more frequent line changeovers, as well as the flood of materials that now needed to be returned to the warehouse.

The immediate solution came from SMT programming engineers who realized that different products could be made on dedicated lines by keeping sets of materials in place that were common to all products. If the products within the group were variants of each other and had an almost identical bill of materials, product changeover between products within the group could happen without any loss time at changeover from material setup. Even products with roughly similar bills of materials could be included in the common material setup grouping, perhaps with just a few materials needing to be exchanged at changeover if the total number of material feeders needed by the whole group of products exceeded the capacity of the machines in the line.

This approach succeeded at reducing the changeover time of SMT lines, but at a price. The program efficiency of SMT machines is highly dependent on the physical setup of the materials with respect to the number of placements of each material and in which area of the PCB they

are to be placed relative to their pickup position on the feeder table to minimize the travel time during placement operation. When creating optimized SMT programs with a fixed material setup common to a group of products, that aspect of the machine program optimization is compromised. The result is a significant reduction in program efficiency for each product in the group, reducing line throughput accordingly. This loss was deemed acceptable in cases where grouped products were nearly identical, but as lot sizes have decreased further, the variation in the groups of products has increased, which has reduced program efficiency significantly.

Unlike down-time at changeover, this loss is hidden from the casual observer because it appears that the SMT machine is working full time. However, the throughput of the machine is likely to have been reduced by around 5% in the best case, to around 80% in some exceptional cases where the common material setup has severely compromised the machine operation. Productivity reports are based on the machine run-time per PCB produced, which is derived from the machine program. The program has this inefficiency built in already, and it is often not compared to what should be the raw machine capability so these losses are not included in management reports.

For companies that have recognized this issue, another alternative has been explored where trolleys of materials can be used to support the exchange of materials between products, which avoids the need for common material setups

or at least a limited common setup where the more variable materials would be available on a "hot-swap" basis. This compromise, however, is often no better than the problem.

With multiple trolleys dedicated to different individual products or groups of products, the amount of material on the shop-floor increases rapidly. This additional material needs to be paid for, and it also needs to be managed. Those materials cannot be stored on the shop-floor on trolleys for a long time because many components being sensitive to moisture. Defects caused by moisture-sensitive components increase significantly when materials are stored on the shop-floor trolleys, again often hidden from management reporting because of the variable nature of defect symptoms.

> "Even the investment in the additional feeders that are required to hold the materials on all of the trolleys, which can cost around $1,000 each, is a significant additional cost."

Additional material management and logistics are needed to manage materials, including baking and taking them to and from the dry store. The space required to store all of the trolleys on the shop-floor reduces the space available for additional SMT machine lines. Even the investment in the additional feeders that are required to hold the materials on all of the trolleys, which can cost around $1,000 each, is a significant additional cost.

No matter what clever ideas come along, one way or another, the cost to the SMT operation of high-mix production with smaller lot sizes is extremely significant, resulting in overall manufacturing cost contribution that can be double or triple the cost compared to the time when automated SMT production lines were dedicated to high-volume products without frequent changeovers. Is this the kind of environment into which we can simply introduce more automation and expect to have a genuine and swift return on investment?

Automation needs computerization to work smarter and faster

Introducing a new piece of automation into SMT assembly is like trying to drive a Ferrari though a major city center at rush hour. With all of the traffic competing to get ahead, and the multitude of stop lights, the performance and capability of the Ferrari is not going to help much. Haven't we all wished at some time or another that we had one of those fabled "clickers" that can be used to change the traffic lights to green just as we approach them? That would certainly speed up progress through the city, while adding only a mild inconvenience for everyone else. This is actually analogous to what needs to happen in SMT manufacturing.

With communication between all devices and processes on the shop-floor (an Internet of manufacturing), software computerization can take all of the relevant information, such as the progress of production, the status of the processes, and even process data such as test results and inspection images, to start the automation of various management processes. It can also take information from the supply chain, engineering, and quality. Computer software can then do in a few seconds what would likely cause a nervous breakdown for a human planner: create live optimization and simulation of the whole shop-floor operation. This would ensure the best flow of products through all of the automated processes, grouping products based on delivery schedule, while ensuring orders were completed on-time and that all materials and other resources were available when needed.

The computerization is able to go far further that any human would be capable of, even with the aid of Microsoft Excel, with the ability to look at future delivery demands, simulate run-rates and changeovers, and compare machine and line capabilities against the different products to intelligently "direct traffic" around the

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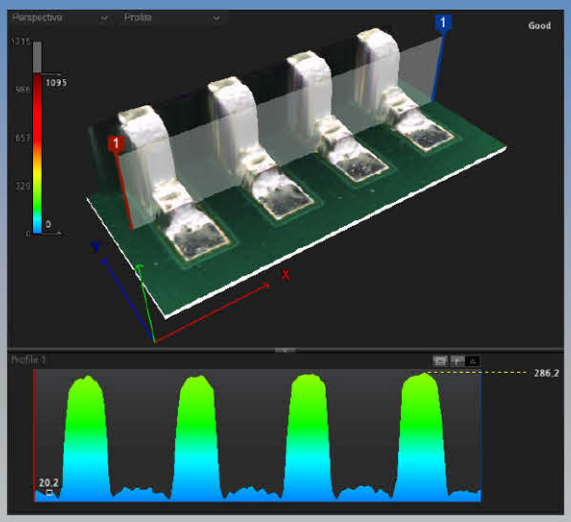

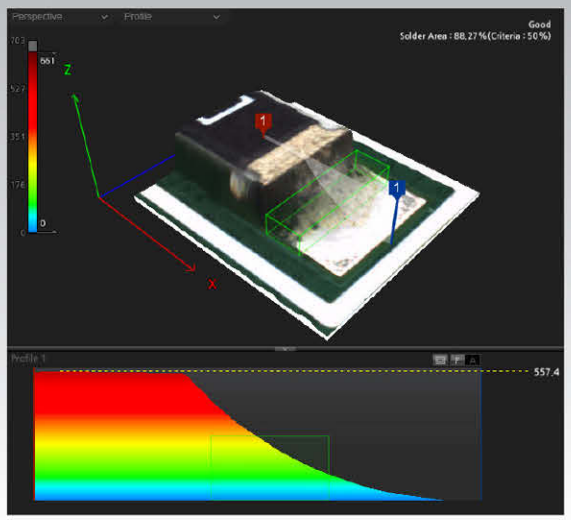

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SMT shop-floor in the most optimized way. It can produce more efficient plans for optimized SMT machine programming, including specialization options of material grouping and the use of trolleys. This creates a flexible and dynamic factory operation that evolves continuously as production demands change.

Only in this environment can automation work according to expectations, fulfilling the return on investment criteria without simply resolving one issue at the expense of another and hiding it away. Such software that is available today has been shown to increase absolute productivity in high-mix operations by more than 30%. This is a really important metric in manufacturing, although the difficulty has always been the understanding of what complex processes, such as multi-lane, multi-module, and multi-head machines should be capable of as a benchmark to be measured against. However, the detail of the process-timing model for productivity measurement purposes only needs to reflect the machine technology; it does not have to go to the depth that an SMT optimization algorithm would go to squeeze out the last percentage point of line performance. After all, the differences in the losses of machine program efficiency are what is needed to compare different product allocations and feeder setup methodologies.

Standardization is required to move automation forward

The critical element missing in the automation market for PCB assembly is the standardization of communication for all machines and processes. All of the visibility and computerization discussed here is based on the ability to gather real-time information from all of the shop-floor processes. This information needs to include process run-time, the start of processing, the end of processing, operational mode, and any times for which any added value operational parts of the process are waiting or are stopped for any reason, including the reason code. Material consumption and spoilage against each reference designator and other material-related events such as material exchanges, splicing events, alternate feeder, and test results inspection images are also needed, all of which combine to provide the computerization of planning, production flow, and supply chain management and traceability.

Communication between processes also needs to be bi-directional so that machine operation can be controlled and modified according to issues such as minor material shape changes between suppliers, x-y placement drift, etc., all of which could be implemented as automated corrections without requiring the SMT machines to stop or require operator intervention. This would ensure higher productivity, reduced maintenance, and improved first-pass yield.

These examples of computerization applications exist today, but they are severely limited to specific applications where proprietary software development creates specific customization. On a standard communication platform, these functions would be available on any combination of vendors' equipment.

What is needed in the industry is a complete and usable communication standard that would reflect all of these needs, that could be applied to any machine and process, whether automated or manual (which can still become bottlenecks for automated processes), so that normalized data could be exchanged between processes from any vendor or of any type. And it could be used in the various forms of shop-floor computerization such as those suggested by Industry 4.0 or Smart Factory 1.0. Now would be the time to include this requirement in the specification of automated machine purchases. The true future-proofing that is needed is not so much the proprietary solutions that a select single machine environment can offer in isolation; rather, it is the ability for automation to fit into the smart factory or to embrace Industry 4.0. This is your guide to buying automation. **SMT**

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

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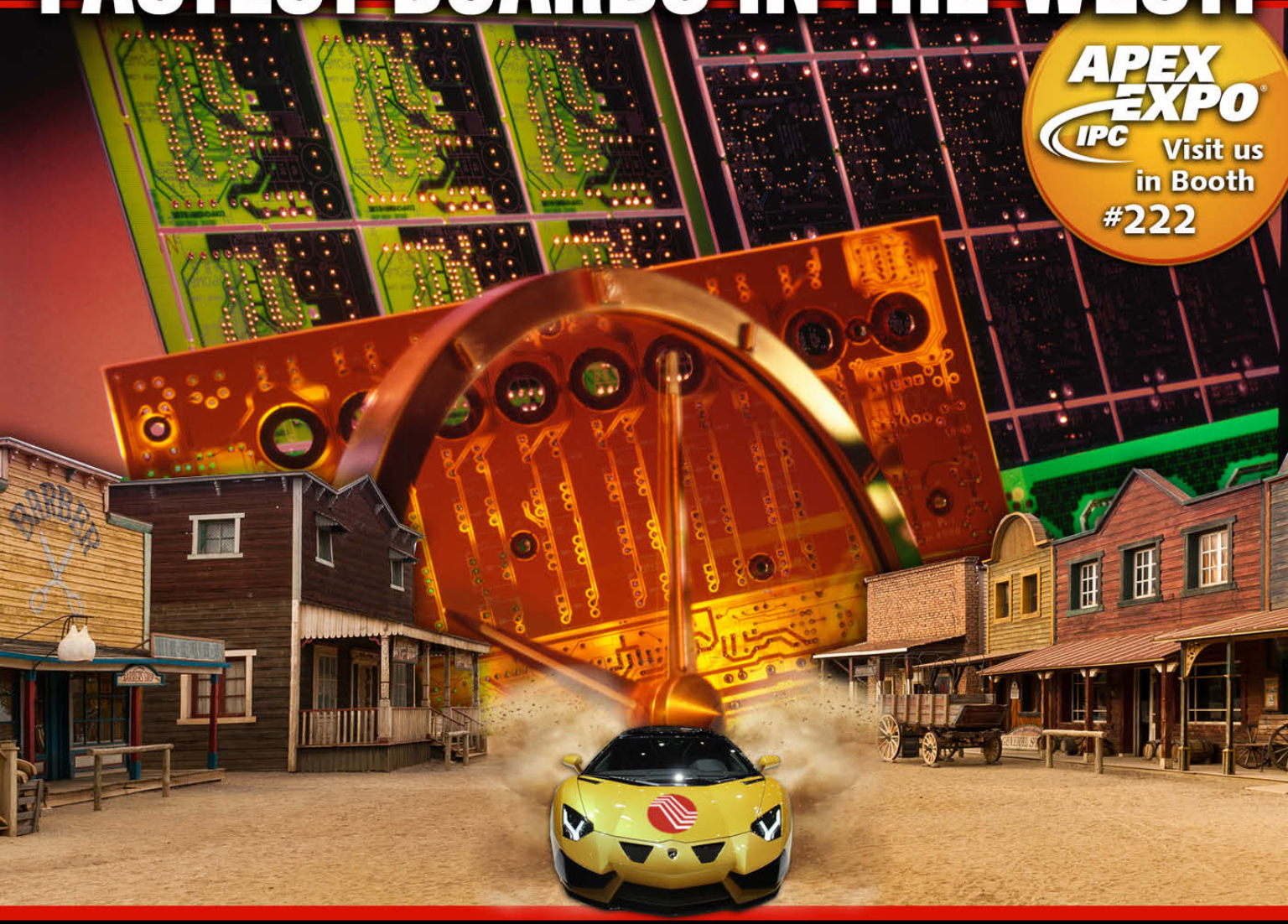

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An Onboarding Process Can Build a Strong Organizational Culture

by Tony Bellitto
FIRSTRONIC

One of the biggest challenges faced by U.S. manufacturing companies is finding ways to attract, engage and retain workers. Today's generation of 20-something workers is unfamiliar with manufacturing as a career option. Factory work is something their grandparents did. At the same time, some companies are proving that U.S. factories can be cost competitive and that the jobs created are transformative, in that production operators have a career path beyond entry-level work if they choose to pursue additional company-sponsored training.

In 2014, electronics manufacturing services (EMS) provider Firstronic nearly doubled its workforce in Grand Rapids, MI, adding 110 workers. Most were entry-level workers. A $300,000 grant from The Right Place Inc., in collaboration with the Michigan Economic Development Corp. (MEDC), and the City of Grand Rapids, as well as a $289,550 Skilled Trades Training Funds (STTF) grant from the Michigan Workforce Development Agency, was used to offset the costs of the training required to hire the additional workers.

To efficiently meet their rapidly growing customers' demand, the company adopted a 24/7 work schedule that has production employees working 12-hour shifts on alternating three- and four-day weeks. Of the four shifts, shifts one and two work the same schedule of long and short weeks, with shifts three and four covering the alternate weeks. Employee training was scheduled in four-hour blocks on one of the days during employees' three-day "short" work week. Employees were paid for training time and could pick the day and time block that worked best with their schedules.

The quality department developed a training program, delivered in three phases, which was rolled out in the first three quarters of 2014. Phase I focused on core training for all employees; Phase II provided advanced system training; and Phase III defined and implemented certified operator training (COT) evaluations and classifications.

However, by early 2015, employee turnover was becoming an issue. New hires were

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going through training and leaving within the first year. Turnover on fourth shift (which includes every Friday and Saturday night) was highest, topping 6% per month. Virtually all of the turnover involved employees with less than a year on the job and the majority of that turnover came from people who had less than six months on the job. The question became, "how can we identify the right candidates who are geared for manufacturing jobs and change our process so that our new employees become instilled with Firstronic's DNA and a desire to grow with our company?"

The quality, operations and human resources departments carefully analyzed the recruiting, hiring and training process to determine what improvements should be made. Several issues stood out:

- Not all employees recently hired were a good fit for the jobs they were hired to do
- The amount and content of training given to new employees over a relatively short period overwhelmed some employees
- Employees on less populated shifts (especially fourth shift) felt isolated and didn't feel they had good coaching resources as they were learning the job
- The large amount of classroom training was not as effective in reinforcement as on-the-job (OJT) based training
- Some concepts, such as advanced training on the Plex Online ERP system, were presented before employees had enough work experience to fully understand how the system supported the jobs they performed

The human resources department contracted with AccuMax, a third-party employment screening firm to administer tests designed to analyze job applicants' competencies and aptitudes, with the end goal of matching them to the positions for which they were best suited. This was particularly important because many new hires had no concept of what was involved in the job they applied for. That disconnect and the subsequent realization that they didn't like

Figure 1: A mentor (burgundy smock) watches while his mentee performs an assembly operation.

the job they were performing led to some of the turnover. Under the new system, applicants are scored as green, yellow, and red. Greens are hired, yellows are evaluated carefully prior to hiring and reds are not hired.

Communications between HR and training personnel were also improved. Previously, there had been little advance notice to the operations team when new hires would start work or be officially considered as headcount in production. Now the teams coordinate this closely and new hires are not counted in production headcount for the first two weeks of training.

The next step was creating a comprehensive onboarding process. The goal was to engage employee interest from day one on the job while providing a support network that ensured that new employees always had a mentor to coach them while learning new skills. The onboarding plan for HR and trainers outlines a list of relationship-building activities during the employee's first few weeks, in addition to specific training activities. The goal is to not only give new employees the knowledge they need to do their jobs, but also help them feel that they belong to a team that values the contributions they will be making.

Trainers were given a formal presentation that consolidated the introductory training into a master presentation to ensure that material was delivered consistently in all classes. The trainers were also coached in interpersonal

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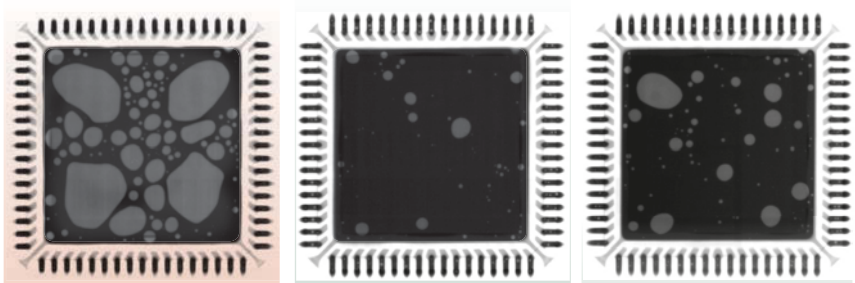

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skills to ensure that they maintained an open and supportive attitude during the training process to align better with the way today's younger generation is used to learning.

A mentor program was also created on the production floor. People with strong expertise and good communications skills were handpicked to act as mentors. Compensation was increased for these additional duties. Mentors do their normal work, plus engage in new employee mentoring on an as-needed basis. A mentor training guide defines the correct ways to deliver and reinforce OJT training to ensure that the mentoring process is as consistent as the classroom portion of the training. This mentoring process is critical to setting a new employee up for success. It is also one of the aspects of new hire training that is commonly overlooked by the manufacturing community as a key element to employee understanding and satisfaction.

The training program was completely revamped to include a larger OJT component, longer training period and slower introduction to more advanced skills such as systems training.

For the first two weeks, employees spend 2.5 days in class and 7.5 days being mentored on day shift. After the first 2.5 days of class, new employees get a training plan that maps out the course of their training over the next 60 days. They stay on first shift until they have completed their initial two-week training period, rotating through mentors as they learn the production floor. Firstronic's holistic approach to Lean manufacturing principles requires a cross-trained workforce capable of moving among production areas as demand changes.

During the 60-day training period, new employees receive classroom training that includes general human resources-related training on health and safety; basic production related training on printed circuit board assembly (PCBA) handling, component identification, ESD protection and Kanban systems; and seven modules of IPC-A-610 certification courses.

Toward the end of that period, they are introduced to the ERP system and taught to perform the transactions necessary for their job functions.

When new employees complete their training, there is graduation "recognition." Color-coded smocks are used to denote employee classifications on the production floor. Production operators and technicians who have completed training wear burgundy smocks. Quality personnel wear black smocks. Trainees wear blue smocks. When an employee completes training, the blue smock is exchanged for a burgundy smock during a production floor communication meeting. Trainees get excited about earning their burgundy smock and it adds another layer of engagement with the team.

The results speak for themselves. Turnover dropped by more than two-thirds, to 2.1% per month. Headcount has grown to 150 in production with a total of 200 employees at the facility.

A similar process is used in Firstronic's Juarez, Mexico facility and some of the changes made to the Grand Rapids program were a result of transferring engagement techniques used by the Juarez HR and training teams.

The end result is greater employee engagement, lower turnover and a team focused on the responsiveness and quality their customers expect. In combination with a Lean manufacturing focus, this highly trained workforce delivers industry leading metrics that include:

- On-time delivery over 99.6%
- Inventory turns between 12–14
- Gross margin >21%
- Compound annual revenue growth rate >50%

It really comes down to one simple concept in today's hiring environment: Design the onboarding process with the goal of making employees feel valued by the company. **SMT**

Tony Bellitto is Firstronic's director of quality. He can be reached at tbellitto@firstronic.com.

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MilAero007 Highlights

Exception EMS Expands Technical Capabilities and Capacity

UK-based EMS firm Exception EMS has recorded its highest ever turnover in its history during 2015, as it continues to grow its business into key vertical sectors including telecommunications, energy and defense.

Plexus Posts $617M Revenue for 1Q FY 2016

Plexus Corp. has reported revenue of $617 million for its first quarter fiscal year 2016. The company has also won 34 programs during the quarter, representing approximately $179 million in annualized revenue when fully ramped into production.

Sparton Appoints Joseph Hartnett as New Interim President and CEO

Sparton has appointed Joseph J. Hartnett, current Chairman of the Board of Directors, as interim president and chief executive officer and will serve in that position until a new president and CEO has been appointed.

Kitron Reports Improved Profitability, Strong Cash Flow in Q4 2015

Kitron has posted revenues of NOK 525 million for the fourth quarter of 2015, and operating profit (EBIT) of NOK 33.6 million.

Celestica Reports Higher-Than-Expected 4Q 2015 Revenue

Celestica has announced a revenue of $1.515 billion in the fourth quarter of 2015, above its previously provided guidance range of $1.375 billion to $1.475 billion, and an increase of 8% sequentially and 6% compared to the fourth quarter of 2014.

Varitron Invests More than $10M in its North American Facilities

EMS firm Varitron is investing heavily, to the tune of $10 million, to boost the efficiency of its three North American plants.

IEC Reports 1Q Revenue Growth of 14%

IEC has posted net sales of $32.9 million for the fiscal first quarter ended January 1, 2016, an increase of 14.2% compared to net sales of $28.8 million during the first quarter of the last fiscal year.

PPI Acquires New Age EMS

PPI-Time Zero has acquired New Age EMS, a contract electronics manufacturer based in Attleboro, Massachusetts.

IEC Receives Supplier Excellence Award from Harris

IEC Electronics Corp. has been selected for a supplier excellence award from Harris Corp. in recognition of the company's exceptional delivery performance.

Ducommun Names New CFO and VP of Strategy and Business Development

Ducommun Inc. has appointed Douglas Groves, a member of the company's executive leadership team, as vice president, chief financial officer, and treasurer effective January 1, 2016, succeeding Joseph Bellino, who retired at the end of 2015 as part of a succession plan previously announced.

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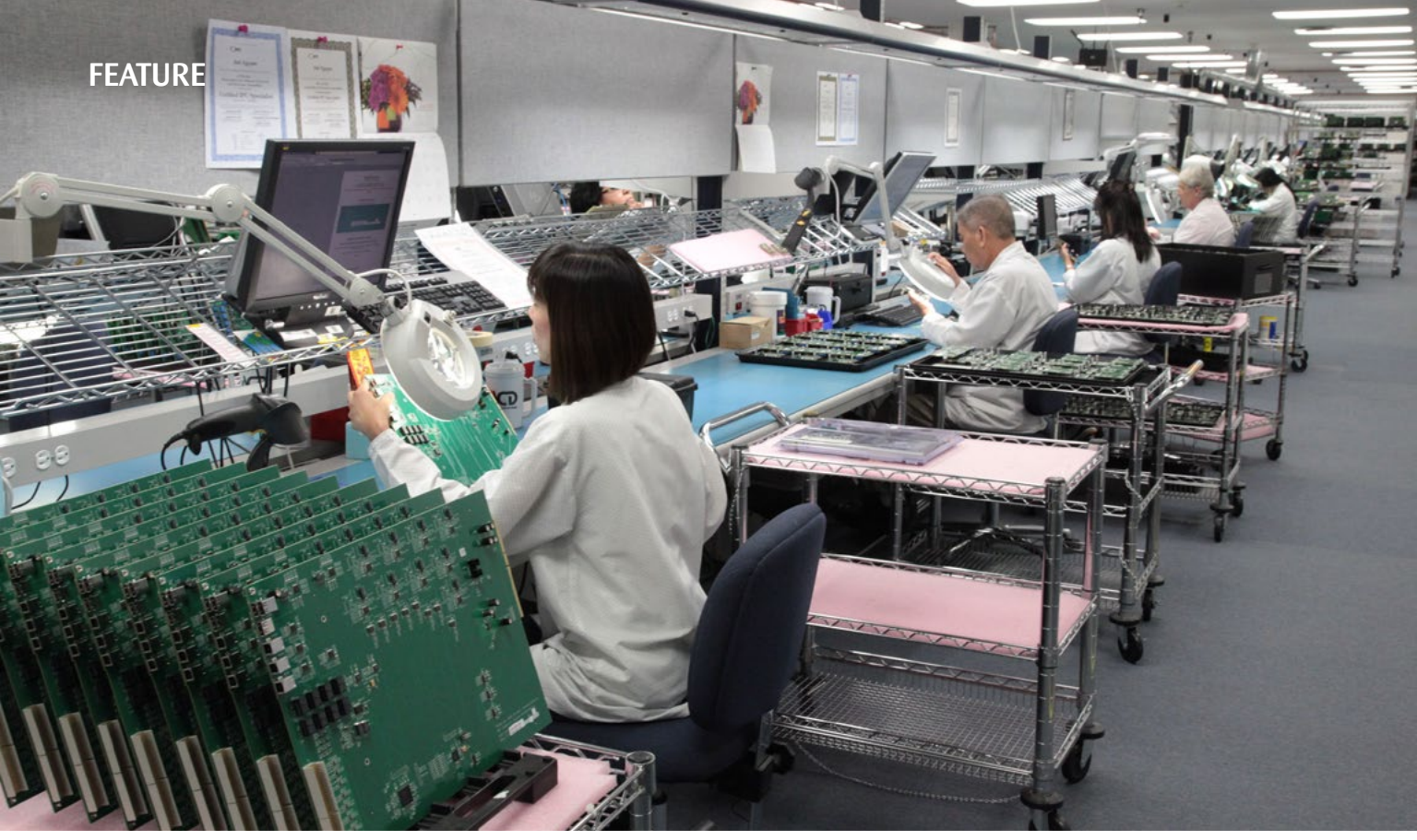


Design for Test in the U.S. Market

by W. Scott Fillebrown
LIBRA INDUSTRIES INC.

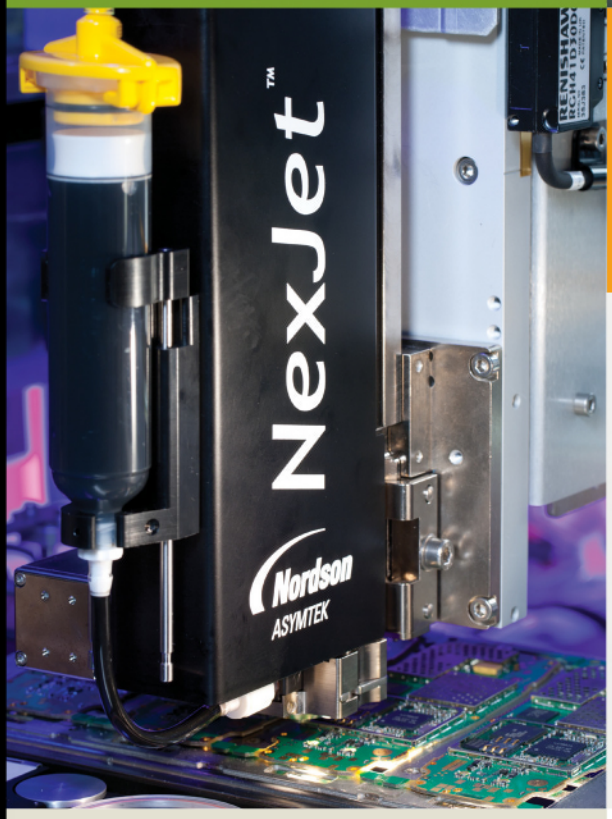
With most high-volume printed circuit assembly being sent outside the United States, we have a unique challenge for testing the lower volume/high turnover assemblies domestically. However, with a little planning and the right contract manufacturer (CM), test does not need to be an issue.

Here is the challenge: The U.S. market mainly is comprised of higher technology/lower production quantity assemblies. In many cases, in-circuit bed of nails testing is not an option due to development time and cost, not to mention the difficulty associated with finding a place for 30–40 mil test points. These same test points also create significant EMI concerns for most electrical engineers. The challenge is to find a way to thoroughly test a fully populated circuit in a timely, cost-effective way, without compromising signal integrity.

Depending on the technology, the challenge can be as simple as making minor design changes, which actually can happen at the Gerber level versus requiring a significant revision to the board in question. First let's conquer the simple. For analog, RF, and lower technology digital boards, the approach is the simplest. Typically, straightforward flying probe test is the answer. The better EMS companies use a dual-sided flying probe tester as shown in Figure 1. For this test approach, the test engineer simply asks that the vias not be covered with soldermask, which can be a simple change handled at the CAM/Gerber level. Because flying probe testers can generally test a via with a 20 mil pad and a 10 mil hole, the holes do not need to be plated shut. Depending on the test coverage, the test department may recommend adding vias, assuming the design can handle it from an electrical perspective.

Many CAD systems can add the via as a test point. One via per net provides 100% access, increasing the odds for very good actual test coverage. If vias are being avoided, as in sensitive analogs or RF technology boards, the tester may be able to test at the solder joint. The challenge with this approach is many sensitive analogs or an RF design can minimize the size of the pad,

Ready...



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increasing the chances of testing at the lead and not the pad. This should be avoided due to the risk of damaging the component. Also the customers need to be open minded about "witness marks" left behind by the tester. Harder solder—for example lead-free—reduces this problem. Testing this technology typically results in higher test coverage approaching 100%.

Higher-technology product can pose a much more significant challenge. The technology in this class includes high-speed digital, via in pad, blind buried vias and high BGA count. The curveball in this case is the number of circuits that actually never see an external via, making it impossible to probe the circuit. The previous advice still applies: Try to have a via exposed for every circuit. This includes making sure they are not covered by a component or soldermask. Test coverage can be enhanced if the engineer allows all exposed vias to be unmasked. This approach will give the test engineer options to test the circuit; solving common problems like testing around tall components. Typically, this results in "okay" test coverage, but no one wants to be just okay!

Superior test coverage on this type of product includes the use of boundary scan (JTAG) technology to significantly increase the test coverage as well as reduce test time. Stating the obvious, this presumes that the components on the board are boundary scan capable. Assuming this is the case, the five signal boundary scan daisy chain circuit needs to be connected. Generally, the electrical engineer connects them, but not for test purposes. Instead it is seen as a method for programming components. It is important to note that the original intent of boundary scan was to test and not program; however, it is used more often for programming.

Implementing boundary scan for test can be no different than your current programming routine. Simply connecting the chain opens up the possibility of test, and is a great beginning but only the beginning. It is recommended that a test engineer who specializes in boundary scan test review the schematic before layout begins. Doing so typically will yield a faster, more thorough test. Test throughput also increases by removing all circuits tested at boundary scan from the flying probe test program. This approach has been used on boards with more than 35,000 test points, which resulted in 95% test coverage.

So the challenge has been met. It is possible to have a highly tested product built in the United States at an affordable price. Amazingly, what has been outlined here requires less upfront and design work than the traditional bed of nails in-circuit test and can be used in all phases of development, including prototype, pilot and production runs. **SMT**

W. Scott Fillebrown is the chief Technology Officer of Libra Industries Inc.

Eternal 5D Data Storage Could Record the History of Humankind

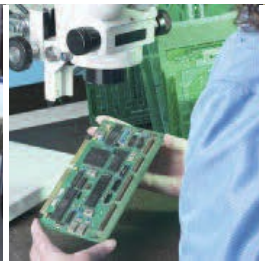
Scientists at the University of Southampton have made a major step forward in the development of digital data storage that is capable of surviving for billions of years.

Using nanostructured glass, scientists from the University's Optoelectronics Research Centre (ORC) have developed the recording and retrieval processes of five dimensional (5D) digital data by femtosecond laser writing.

The storage allows unprecedented properties including 360 TB/disc data capacity, thermal stability up to 1,000°C and virtually unlimited lifetime at room temperature (13.8 billion years at 190°C) opening a new era of eternal data archiving. As a very stable and safe form of portable memory, the technology could be highly useful for organizations with big archives, such as national archives, museums and libraries, to preserve their information and records.

The researchers are now looking for industry partners to further develop and commercialize this ground-breaking new technology.



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Electronics Industry News
Market Highlights

IoT Chip Market Worth $10.78B by 2022
The IoT chip market is expected to grow from $4.58 billion in 2015 to $10.78 billion by 2022, at a CAGR of 11.5% between 2016 and 2022.

Global 3D Printing Market in Healthcare to Grow over $3.89B by 2022
The 3D printing market revenue in healthcare application is expected to cross $3.89 billion mark by 2022, at an estimated CAGR of 21.9%, calculated between 2016 and 2022.

Infrared Detector Industry: Many Innovations to Drive Arrays Costs Down
Driven by smart lighting, smart buildings, and mobile devices, the infrared (IR) detector market will reach about $500 million by 2020.

Solar PV Installations Revenue to Top $1.2T from 2015 to 2024
According to a recent report from Navigant Research, global revenue from solar PV installations is expected to total more than $1.2 trillion from 2015 to 2024.

TrendForce: PV Demand Remains Strong in 1Q16
The general outlook for the 2016 PV market has become more certain as China, the United States and the U.K. finalize their respective subsidy policies.

Global TV Panel Shipments Reach Almost 270 Million Units in 2015
Among the large-size LCD panel applications, the TV market had the best shipment performance for 2015, growing by 8.9% year on year to 269.8 million units in total.

Semiconductor Acquisitions Surge in China
In 2016, semiconductor equipment spending is expected to be $5.3 billion, 9% up from 2015 spending. Total spending on semiconductor materials in China will be $6.2 billion, with China representing the highest growth rate of all the regions tracked by SEMI.

Worldwide Smartphone Shipments Surpass 1.4 Billion in 2015
According to preliminary data from IDC's Worldwide Quarterly Mobile Phone Tracker, smartphone vendors shipped a total of 399.5 million units during the fourth quarter of 2015, up by 5.7% compared to the same period in 2014.

Global Device Shipments to Grow 1.9% in 2016
Worldwide combined shipments of devices (PCs, tablets, ultramobiles and mobile phones) are expected to reach 2.4 billion units in 2016, a 1.9% increase from 2015, according to Gartner Inc.

Global NB Shipments Fell to 164.4M Units in 2015
Worldwide notebook shipments for 2015 totaled 164.4 million units, representing a year-on-year decline of 6.3%, according to TrendForce.

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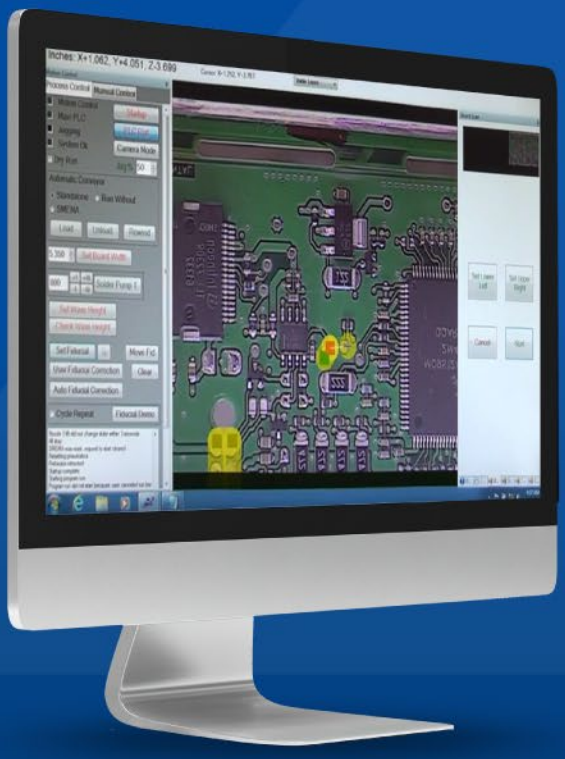

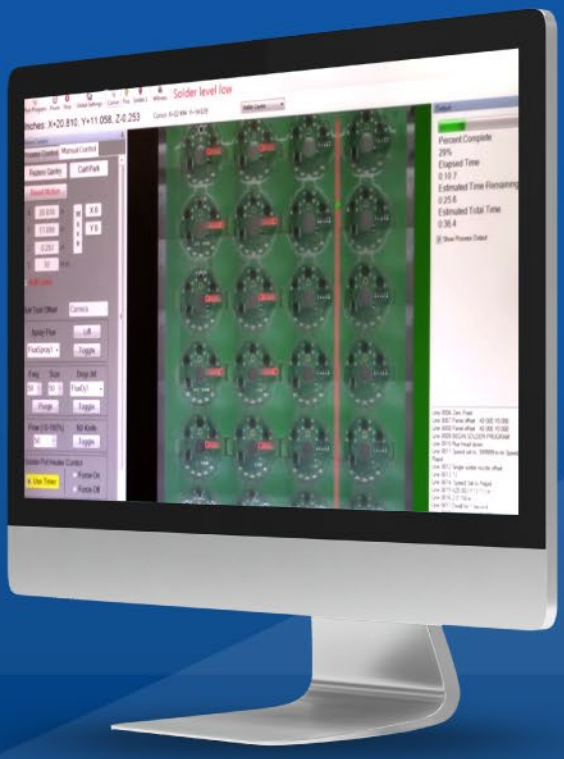

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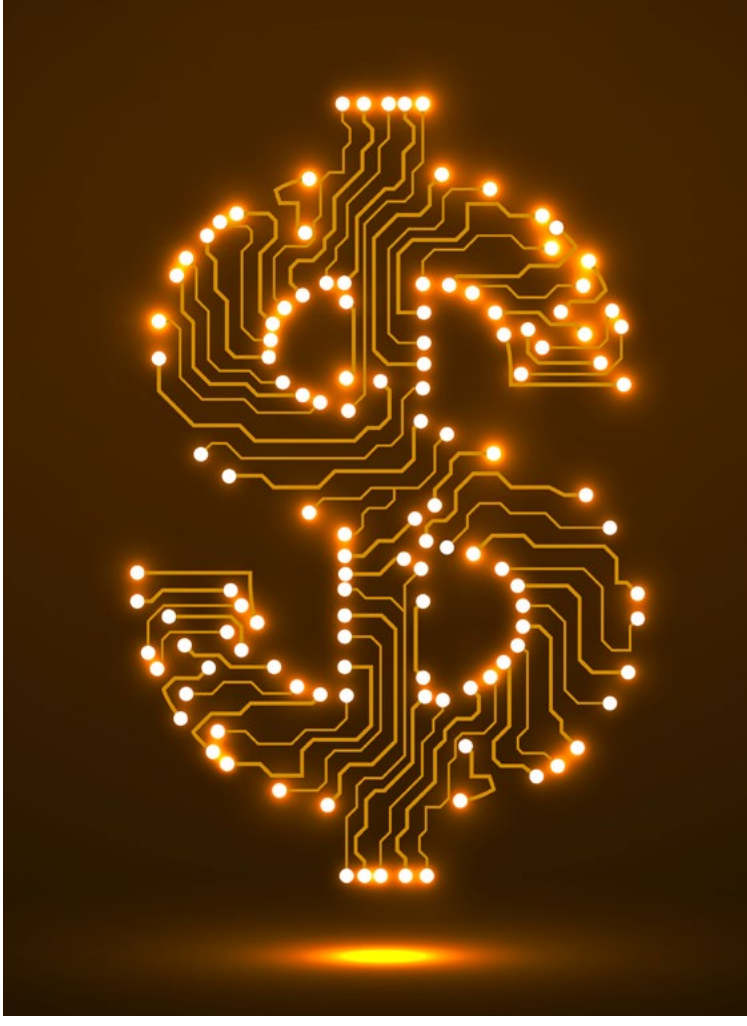
A Practical Guide to Managing Material Cost Impact



by Ben Khoshnood
INOVAXE

When you ask the EMS management team what is the material impact on their business, they typically respond by adding up the number of people that work in the stockroom, and those involved in kitting and material stock return, plus shipping and receiving.

For so many years we did not pay attention to, or totally understand, the business impact of the material acquisition and handling costs. The more EMS providers get squeezed out of their profits from the vise grips of distributors and end customers, the more imperative it is that the industry totally focuses its attention, not only on the supply chain, but also on how material is delivered, handled, and managed in the operation. It is time to send in the armies of black belt, Lean Six Sigma ninjas to work, and provide the Western Hemisphere EMS providers with more hope to compete globally. When bottlenecks are removed and automation is fully implemented, locally manufactured product is most cost effective.

Background

Many years ago, I was running a high-mix, low- to mid-volume EMS business, and like everyone else was experiencing at the time surprise shortages that were driving the million dollar SMT lines to screeching halts. It was often that the sound of "cha-ching" would stop, and everyone, and I mean everyone, was dealing with trying to find the part that was supposed to be in the factory, but was nowhere to be found. The program managers, material staff, purchasing, production staff and I would get hourly calls from the customer who wanted to know the status of their desperately needed job. We would look everywhere, and no one seemed to have the answer as to where the part was placed. My purchasing manager would raise her right hand and swear that she brought the part in. All this would take place while the SMT line was shut down waiting for us to find the penny part. This is so common that the EMS industry added a phrase to our lexicon: surprise shortages.

In one instance, when we finally found the part it was placed on top of a shelf because the

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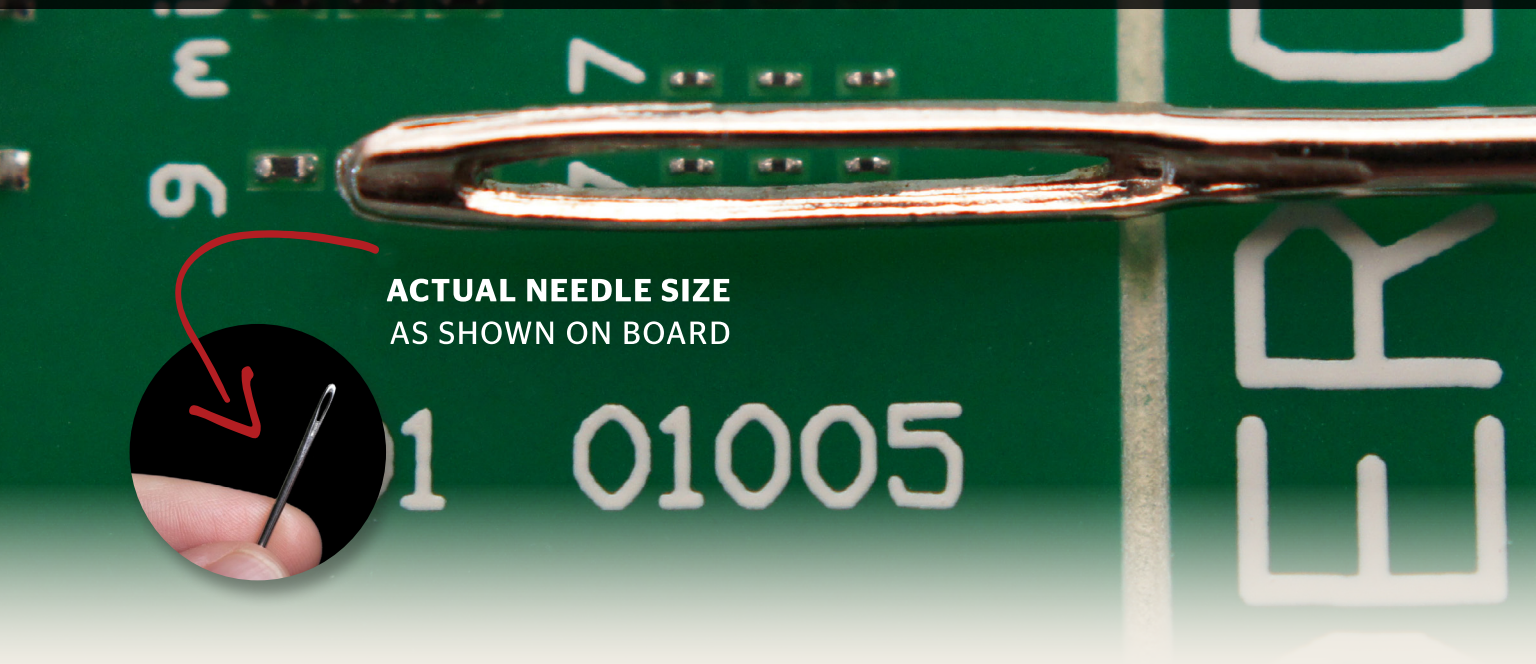

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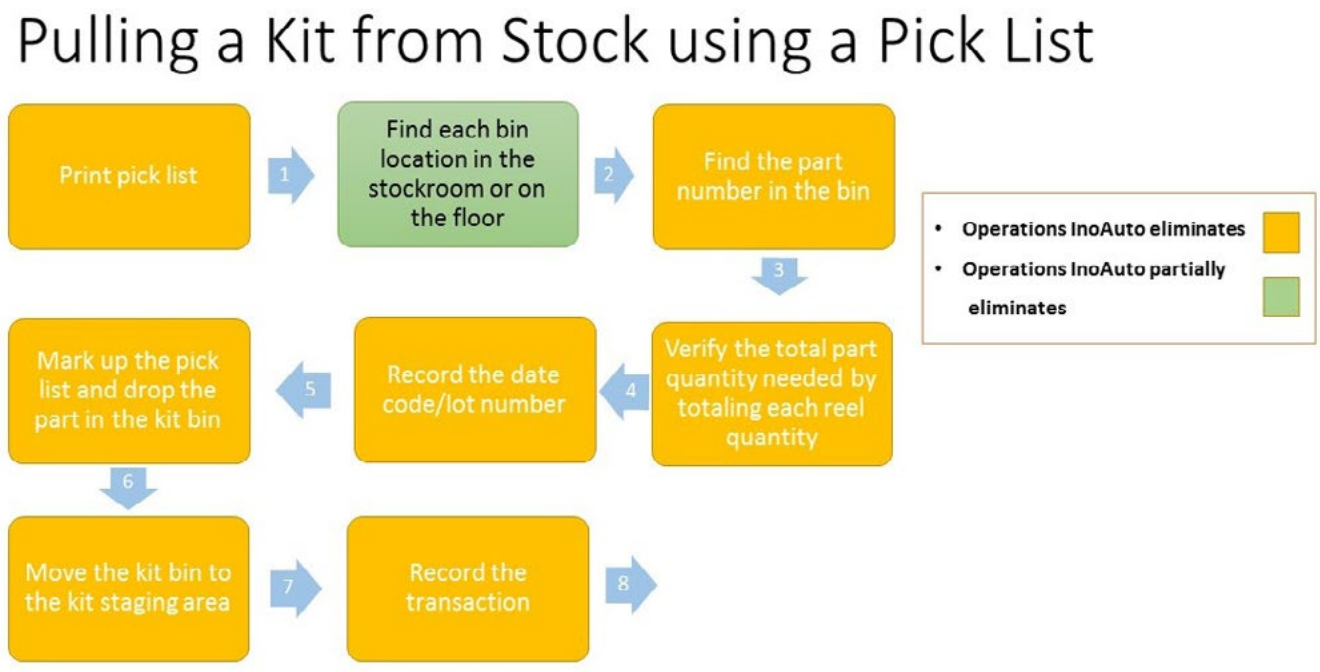

Figure 1: Flowchart of a typical factory after the parts are received and moved to the stockroom.

part needed to go directly to the floor when it arrived, and there was no specific bin assigned for the part. Sound familiar? Also, by the time we found the missing part, reordered it, and paid for an overnight shipment, we were now late on the demanding customer order, and overtime was in place to get the assemblies out ASAP. And then to top it off, my management team was meeting with a high-speed SMT equipment manufacturer to order another line, so that we could meet customer demands! It dawned on me then, "What if we never had surprise shortages? What if we could pull the kits instantly and accurately? What if the feeder set-up crew could find parts in seconds?" It was an endless series of "What ifs."

The answer was painful and enlightening. We could have exceeded our customer demands with one less line. The existing staff could have supported the increase in volume of the business threefold without adding any more staff. My buyers would have had more time to strategize material deliveries and negotiate prices more effectively. My program managers were not material expediters and could have provided a lot more customer service. The overtime would have been far less, the cash flow would have improved, the material costs would have come down, my staff would have had more time to prevent the excess and obsolete inventory build-up, and our profit would have soared.

So what is the answer? A fresh look at how we deal with material kits and inventory! When the Six Sigma revolution started to improve quality in the '80s, we were not setting goals to improve by 10%. Drastic change was required, not incremental improvements. Today, this means the traditional shelves and bins need to go; metro carts and Home Depot shelving and bins are no longer the best way to store your parts. Close your eyes and envision a factory where the right amount of material arrives when you need it, and is placed in a location that, within a few seconds, can be picked up and loaded into a feeder without human error.

Improving Material Operation

Let's try to map out a standard material handling operation. The flow chart of a typical factory after the parts are received and moved to the stockroom looks something like what is shown in Figure 1.

This operation could take anywhere from 4–10 minutes per component in a typical stockroom with bins and shelves. There are many different methods that have been jerry-rigged to help with finding parts quicker or making the reordering process faster, such as Kanban, dual bin systems, weighing the parts, folder-style reel holders, reels in bags hanging from racks, etc. Many methods (contraptions) have been put together to hold the reels in a kit, so that they can be identified when moved to the feeder loading station, such as a peg board with long pegs, wire divider metro rack carts, manila folders and file cabinets, etc. Recently, a number of products have been introduced to help automate stocking and kitting processes. Typically, this type of equipment is large robotic systems with low reel storage counts per cubic foot, an expensive elephant in the room with a high installation cost. These robotic systems retrieve one reel at a time, taking sometimes more than 30 seconds per reel, which is much faster than a typical 4–10 minute retrieval time.

The next area that has a lot of opportunity for non-value added labor reduction is the feeder setup operation. The operator typically generates a feeder setup sheet and goes through the stacks of reels the stockroom put together in order to find the right parts in order. If you really think about it, the stockroom takes a relatively organized stockroom and creates a disorganized pile of parts when they create a kit. Now the operator must locate these parts one by one and make sure they will not mistake the 1-ohm resistor for a 100 ohm resistor. The only reasons I can think of why a stockroom does this are:

1. They want to ensure the parts are there, and the stockroom parts match the system inventory. Somehow we believe that if we place the parts behind a locked door, the part counts miraculously become accurate.
2. The parts are far away from the SMT area. Companies justify this because they carry too much inventory and traditional storage shelves have too much wasted space to place the inventory next to the SMT lines.
3. The parts are expensive and need to be behind closed or locked doors. Due to the cost of components, many companies store them behind locked doors. During allocation periods, some parts do need to be protected because of their demand and or high dollar value. Regardless, in each company, there are only a handful of parts that should be totally locked up.

All of this creates extra work, which is prone to human error and mistakes that result in a labor intensive material handling operation.

Figures 2 and 3 outline a typical process flow chart for loading feeders and reloading the feeders on the SMT machine.

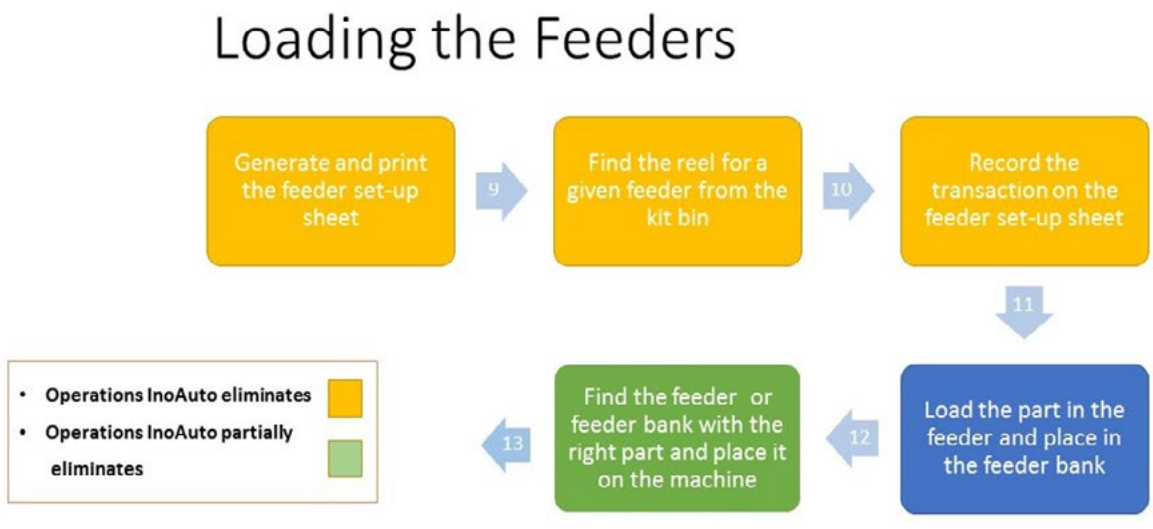

Figure 2: Typical process chart for loading feeders on the SMT machine.

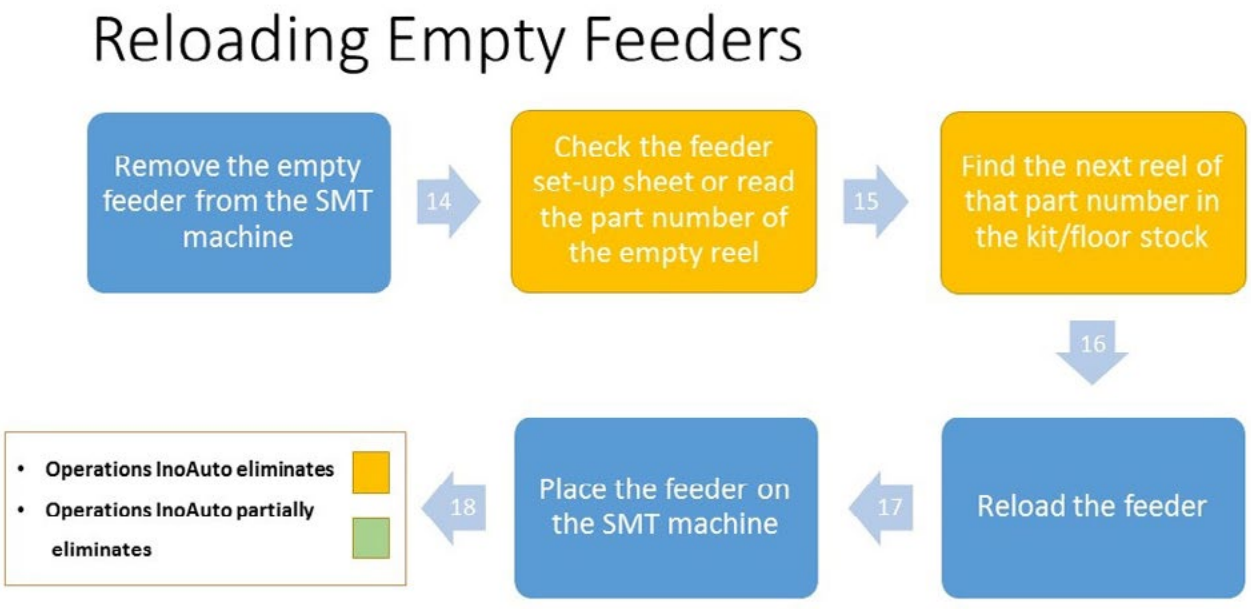

Figure 3: Typical process chart for reloading feeders on the SMT machine.

Racks and standard shelving cannot do too much to streamline the above process. The robotic systems and Inovaxe's InoAuto system can eliminate the flow chart operations highlighted in yellow. The challenge with the robotic equipment is their size, which makes it impractical to place stock right next to the machines on which they are needed. The Inovaxe smart carts are ideal for point of use inventory storage because they can hold over 3,300 reels in an 11'L x 1.25'W x 5.3'H space. One of InoAuto's clever features is that it can identify the parts you need in their feeder order. It can also identify the parts you need before a reel runs out on a feeder. The ROI on this type of automation can pay back the investment in less than six months in many cases. This product substantially improves the efficiency and throughput of loading the feeders, and running the SMT line.

The next area with significant opportunity for improvement is returning reels to stock after the kit is finished going through the SMT line. I call it the material "black hole." Figure 4 shows a typical flowchart of this operation.

The return of parts back to stock can often cause the most problems. Typically the job is done, the pressure of meeting demand is reduced, and returning parts may have to wait until the material people are not very busy, so they have enough time to count parts and finding bin locations. This is a time-consuming and slow process for a typical shelf and bin operation. In the case of using vertical or carousel storage systems, the problem is the bottleneck. The input and output is typically through one person and the bottleneck can back up returns. It will take anywhere between 4–10 minutes per reel to count the inventory correctly, find the location, and place the parts in the bin. This is where the problem starts, as the parts that are not returned may be needed on another job, and, in some cases, they are all in a pile. Finding a particular part number in the pile is like finding a needle in a haystack. This operation typically gets the least attention because everyone is working on new jobs. This is also the area in which, depending on the way WIP is accounted for, you may buy the same parts that you have in the pile, because you need it in your new job, and your MRP has lost track of it. Now, this has created more work for buyers to bring the parts in, and the program manager has to determine when you can ship the product and call the customer to reschedule the delivery, of course, after expediting the part. Are they a true program manager, or an expensive expediter?!

All of these also affect the accounting process, as the operation has to buy more material,

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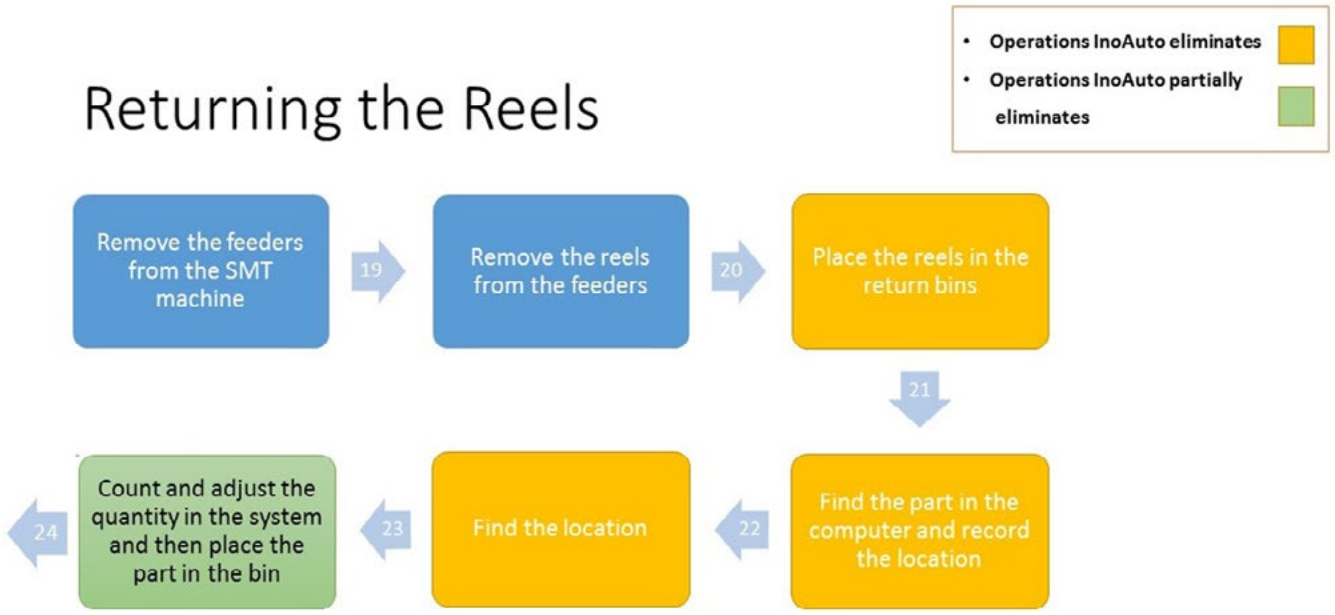


Figure 4: Flowchart showing reels returned to stock after a kit has passed through the SMT line.

juggle the vanishing cash flow because of the increase in inventory, and process more invoices. Not to mention, the line has been sitting idle waiting for the parts to arrive.

The robotic storage system can provide a good solution for the part return process, as long as travel time and size is not important. The InoAuto smart cart is an extremely effective tool for this process as well. Returning parts to bins takes less than three seconds and, in many cases, part counts can be adjusted automatically by the machine software.

Now let's look at the spaghetti chart of the material process before automation and streamlining. Figure 5 is a typical presentation of the material flow through a SMT factory.

One can get dizzy looking at this chart! The irony is when you create the spaghetti chart with the effect of the material flow throughout the other factory operations; program management, purchasing, production, test, etc. doesn't look very messy and actually looks very streamlined. The other irony is that we are paying every day for all of that busy, inefficient work. We deal with simple big-box store shelving and metro carts, and will not even think to budget for complete automation of this mess and bring all of that wasted cash to the bottom line. One way to help bring those wasted dollars to the bottom line is to use 21st century equipment to streamline the process.

Figure 6 is one representation of a material spaghetti chart with substantially fewer noodles. In the new process map your reels are stored at the point of use in a smart cart line InoAuto, next to the SMT line. Upload a pick list or a BOM to the smart cart computer and it will light up the location of each part in your kit and now you can get them in seconds versus hours. You can receive the parts in picking order by locating the parts one at a time, as the LED will blink one at a time, indicating one location for each one of the feeders. After the job is done, remove the reel from the feeder, scan the part number, and place it in any empty location on the cart. It is as easy as that, and as it looks in the chart above. Let those wasted dollars be invested into your growth, your customers' and employees' satisfaction, and your shareholders' delight.

Conclusion

Managing your material is one of the most important parts of running a manufacturing operation. The human error mistakes, material bottlenecks, and inventory inaccuracies

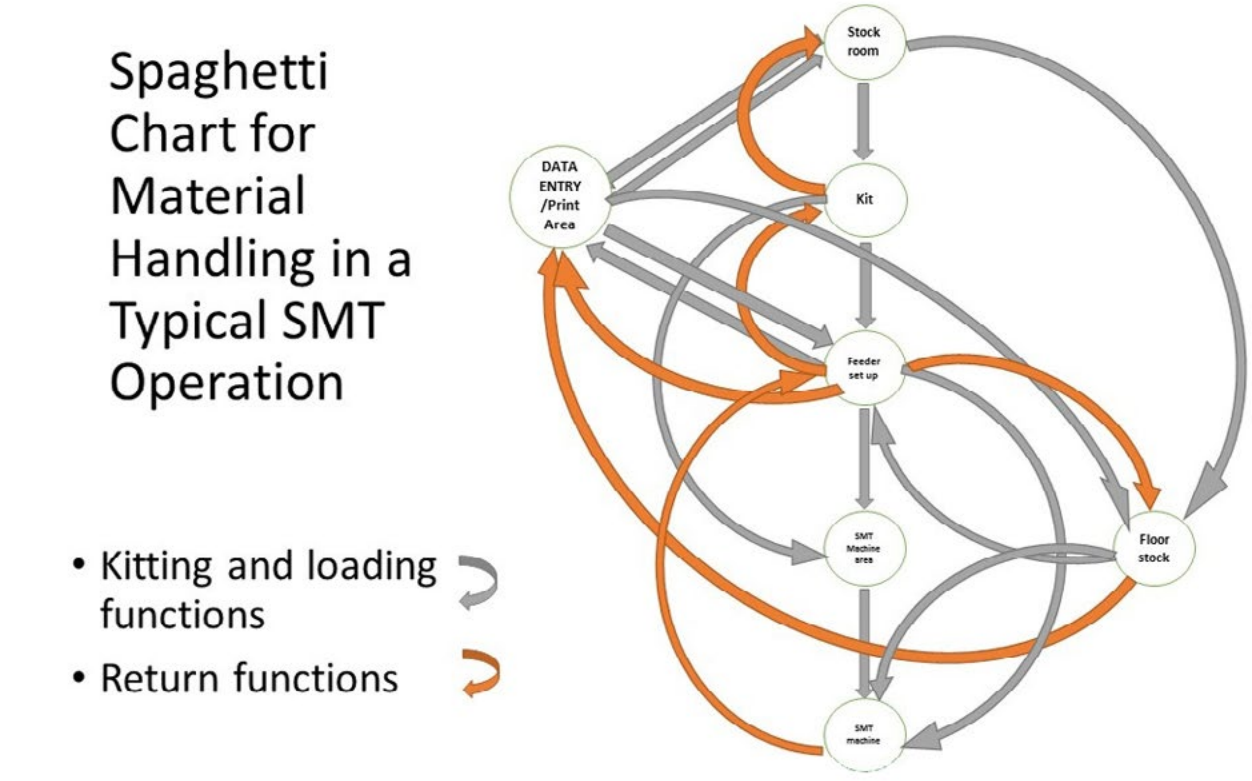


Figure 5: Spaghetti chart for material handling in a typical SMT operation.

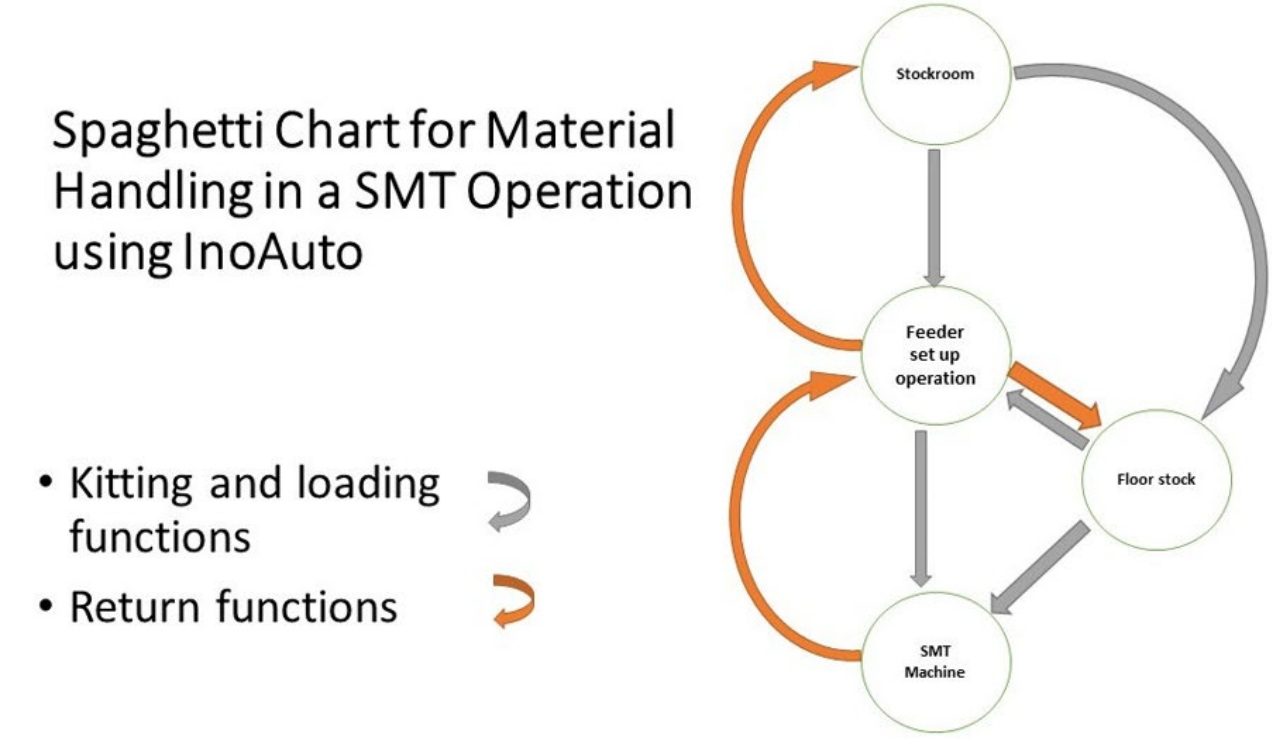


Figure 6: Spaghetti chart for material handling in a SMT operation using InoAuto.

will have a broad effect on the health of your business. The impact of problems in the material department can be felt in customer satisfaction, employee satisfaction, cash flow, revenue growth, and profitability.

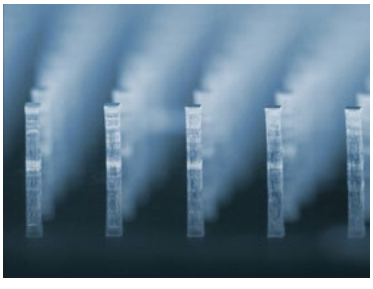
The traditional method of handling material, at first glance, appears adequate and low cost, but, the spaghetti chart of the material operation shows how expensive it really is. Because life goes on and in many cases painfully, more capacity for SMT lines, better software to run the ERP, more metro racks with typical bins and some with barcode locations continue to be the practice and unfortunately, win the budgetary decision.

Think ROI, not just the cost of smart cart vs. standard shelves and bins. Before you send out the black belt Lean ninjas to fight the material challenge, make sure they are familiar with the latest material handling systems, or you may end up with more jerry-rigged contraptions.

To win the race for survival, growth and profitability, companies must give the highest priority to the material operation and material handling tools. More SMT lines, faster machines, or new ERP software are not the only, or even the best, answers to achieve their business goals. Fortunately, there are now a number of solutions that can help electronics manufacturers to streamline and take control of the material black hole. These are robotic storage systems if you are an OEM or have limited part numbers, and money is no object, and the smart cart if your needs are easy to use, and a fast, flexible, small foot print, with a ROI of less than one year. **SMT**

Ben Khoshnood is the President of Inovaxe Corp. He may be reached at ben@inovaxe.com.

Breakthrough for Lab-on-a-chip Material



Researchers at KTH Royal Institute of Technology have developed a new polymer suited for photostructuring, opening new possibilities for medical diagnostics, biophotonics and 3D printing.

The so-called off-stoichiometry thiol-enes (OSTE) polymer was developed specifically to meet the need for a material suitable for both experimental prototyping and large-scale manufacturing of labs-on-a-chip.

"It can be very useful in a variety of applications such as near-patient diagnostic tools," says Tommy Haraldsson, one of the developers and a docent in the department Micro and Nanosystems at KTH.

One of the unique qualities of OSTE polymer is that its surface is chemically reactive without adding anything or preparing the surface in a special way. Upon exposure to UV light, the molecules of the polymer arrange themselves in a manner that significantly enhances photostructuring, a technique by which UV light is used to solidify micro-scale 3D shapes in liquid polymer.

"These microstructures can guide light, such as with waveguides. Or they can be used to control fluid flow, such as with microfluidics channels," says Gaspard Pardon, a post-doc researcher in Micro and Nanosystems at KTH.

The OSTE polymer was developed over the last five years to bridge the "lab-to-fab-gap", and create an alternative to suboptimal off-the-shelf materials, which have poor mechanical or chemical properties, that are now used for conceptual lab-on-a-chip device development.

With the KTH material however it is possible to easily add different layers of material or to modify the surface properties for handling microscopic flows of fluids, without using glue or otherwise treating the material surface.

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Supply Lines
Highlights

K&S and Assembléon: A Perfect Marriage of Technology and Services

Jeroen de Groot and Chan Pin Chong of Kulicke & Soffa talk about the company's acquisition of Assembléon and its benefits to their customers. They also discuss the latest innovations happening at the company's product lines and key trends driving their product development strategies.

Henkel Expands Partnership with Ellsworth Adhesives through New Moldman Systems LLC Equipment Division

Henkel Adhesive Technologies' long-time business relationship with global distributor Ellsworth Adhesives has grown to now include Moldman Systems, which was acquired by Ellsworth Corp. in 2014.

Ellsworth Adhesives to Display the Latest in Adhesive Technologies at Strategies in Light Conference

Ellsworth Adhesives, a global distributor of adhesives, specialty chemicals and dispensing equipment, will be exhibiting at this year's Strategies in Light conference and trade show at the Santa Clara Convention Center in Santa Clara, California, from March 1–3, 2016.

Wistron Installs ACE Selective Soldering System in China

Wistron Corp. has installed ACE Production Technologies Inc.'s KISS-101IL in-line selective soldering system at its facility in Kunshan, China.

Manncorp West Coast Office Moves into New San Diego Facility

The recent acquisition of a new, 18,000 square foot facility in the Kearny Mesa area of San Diego now provides Manncorp's West Coast operations with office and warehouse space needed to better serve its customers and staff.

Mycronic Acquires RoyoTech and Kognitec

Mycronic AB has acquired 75 percent of RoyoTech Digitalelektronik GmbH and has an option to acquire the remaining 25%. At the same time Mycronic acquires 100% of Kognitec Vertrieb and Service GmbH. Both companies are based in Höhenkirchen, Germany.

ATS: Small, Flexible Candlestick Sensor Measures Air Temperature and Velocity

Advanced Thermal Solutions Inc. (ATS) now provides the base-and-stem Candlestick sensor for simultaneously measuring air temperature and velocity when characterizing thermal conditions inside electronic systems.

Factronix Now an Official KYZEN Partner and Distributor

Factronix GmbH, a leading specialist in electronics assembly manufacturing, is now an official partner and distributor of KYZEN specialty cleaning products for the electronics and semiconductor industries.

Kurtz Ersa Hires Technica to Keep Up With Growing Demand

Technica will represent Ersa in a wide territory, spanning from Northern California, Northern Nevada and Oregon, to Washington, Idaho, Colorado, Utah, Wyoming and Nebraska.

BTU will Demo Comprehensive RecipePro Prediction Tool at productronica China

BTU International Inc. will showcase its RecipePro recipe generator software at productronica China, which is scheduled to take place March 15-17, 2016, at the Shanghai New International Expo Centre.

Finding the Perfect Partner

by Terry Morgan
VOXVIA

Whether you're making screen printers or producing solder paste, whether you're part of a multinational conglomerate or you've spotted a niche and you've launched a startup company, one day you'll need someone to find you new business, sell your stuff and keep your customers happy.

At some point, all sizes of SMT equipment manufacturers (OEMs) and consumable materials makers will rely on a network of "channel partners" to engage with, sell to and service their customers. These partnerships take many forms, ranging from a one-man (or woman) band to countrywide distributers, or even super-distributers, working across continents.

The way the partnerships work varies with the demands, responsibilities and consequent legal obligations of those involved. It's a fast-evolving business: as manufacturing technologies converge to satisfy the customer's need for greater flexibility, faster operation and smaller product, there's a growing imperative for channel partners to understand the applications and technology of the machinery and materials they support.

Add continual shifts in economic, legal, cultural and environmental factors to the mix and these partnerships can be tested—which is challenging because they're vital for delivering consistent sales, great communication and the quality of service that customers expect—and you want to deliver. Everyone in the partnership should have the same goals: to maximise sales and build a reputation for providing the best value, with the best available technology, and exceptional customer service.

The rewards for a good partnership are increased margins and improved sales turnover, built through repeat orders and referrals. (A good reputation is a prize all too often underestimated when it comes to the bottom line.) However, finding the right balance of qualities when matching OEMs to channel partners can be a challenge. Get the partnership wrong and the result could not only be low sales performance, but the more drastic implications of poorly serviced global key accounts (GKAs), or interminable and expensive legal wrangling to solve disputes, or worse.

For a successful partnership, it's essential to understand who is responsible for each of the fundamental steps in the chain that drives the business. No matter what the product or service

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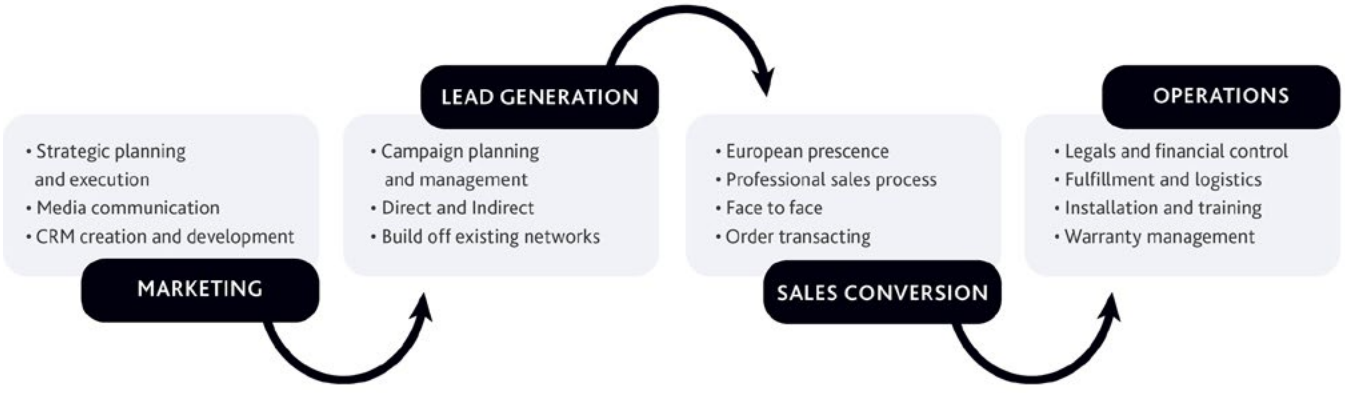

on offer, or where in the world it is, the chain can be broken down into four steps:

- Marketing
- Lead Generation
- Lead Conversion
- Operations

When it comes to marketing, it tends to be OEMs that set the direction. The target client group will be dictated by the nature of the equipment, its capability and price point (or in case of materials makers, the type and application). What a channel partner needs to show is a systematic and consistent means of lead-generating among those target clients.

Larger OEMs may also be concerned with areas of corporate social responsibility (CSR) so channel partners will need to prove their credentials in terms of environmental and employment policies.

For partnerships to work, both sides must have faith that what is promised is what will be delivered. Channel partners need confidence in the security of supply and pricing structures and OEMs need to value channel partners' locally established personal customer relationships. A workable sales strategy and timely targets are essential for a mutually beneficial and professional relationship to develop and thrive.

A means of sharing KPIs and project details via a CRM or some other form of integrated database and sales ordering platform helps provide consistent, accurate communication.

Performance is the watchword at a technical level: OEMs must provide the technical, logistical and administrative support for channel partners to physically deliver, commission and train operators, deliver customer service, and handle warranty events. The product needs to do what has been promised, and to do it on time, every time.

Finally, ignore the respective legal responsibilities of a partnership at your peril. You should fully understand:

- The legal structure of the entity you are engaging with and its creditworthiness
- The fail-over plans in the case of business interruption
- Any necessary product or public insurances or licenses required to trade legally and that might be affected by any regulatory standards or approvals (i.e., CE or WEEE compliance)
- The need to observe non-disclosure agreements (NDA) and data protection requirements

Transparency is essential in a successful partnership. There's much to be said for knowing who does what and when, for whom and for what return. As ever, the key to success lies in the detail! **SMT**

Terry Morgan is CEO of Voxvia consultancy with 30 years of experience, specialising in European sales and distribution networks of equipment and materials within the electronics manufacturing industry. For more information click here.

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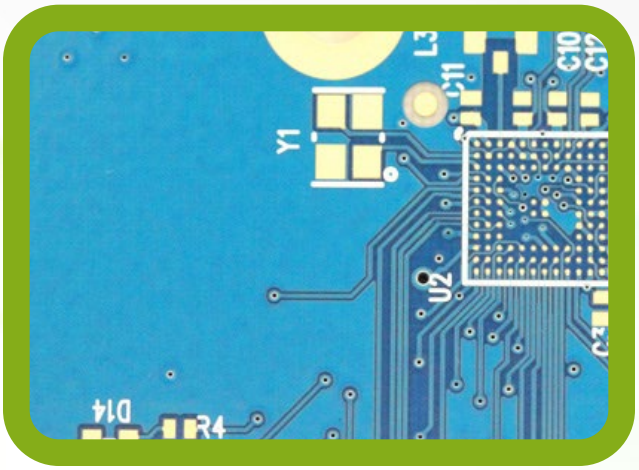

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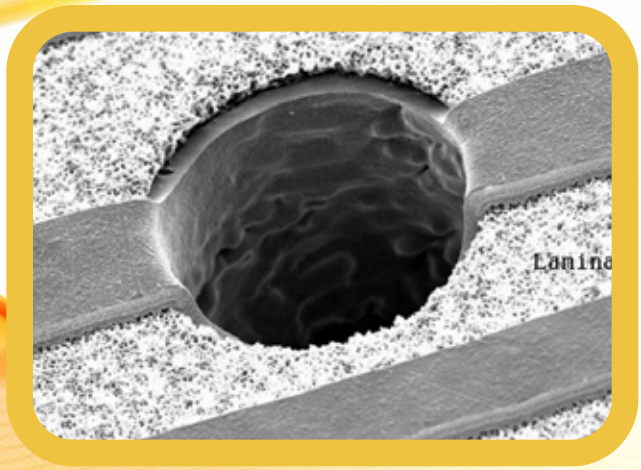

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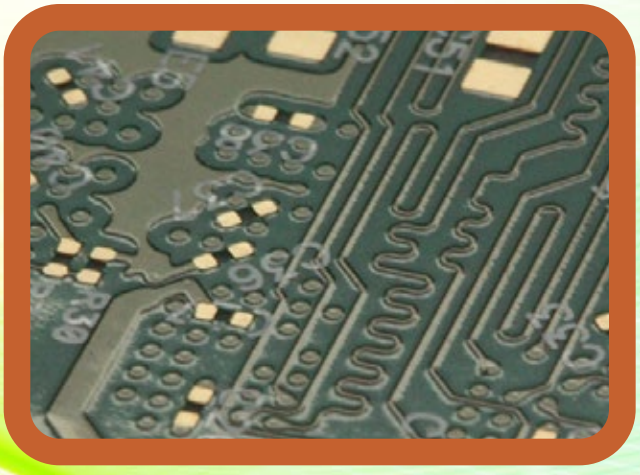

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Selecting a Wave Soldering System, Part 4

by Robert Voigt
DDM NOVASTAR

In the last column, we covered board handling techniques for through-hole assembly systems. Now, we'll address some popular options for wave soldering systems.

Some common options for wave soldering include:

1. Air knife cleaning
2. Recirculating cleaning system
3. Inerting systems
4. Roll-out solder pot
5. PC interface

Preface to Cleaning Options

Process requirements, based on IEEE, IPC or other standards will usually dictate the type of flux to be used in a particular process. IPC standards, such as J-STD, are used in the electronic assembly/manufacturing industry. Among other things, this standard dictates the type of solder, materials and processes to conform to specific specifications. If a highly active acidic flux is used, it will often leave a residue if not cleaned in process, whereas a "no-clean" flux is burned off during pre-heat and doesn't usually require cleaning after wave soldering.

For no-clean fluxing systems, flux should be completely dry prior to its entering the solder wave. Many wave solder systems today using no-clean flux will include an extended preheat time (that is, a longer preheat travel distance) for activation, to ensure completely dry boards and provide an effectively clean board. The solder flux manufacturer will provide these recommended specifications.

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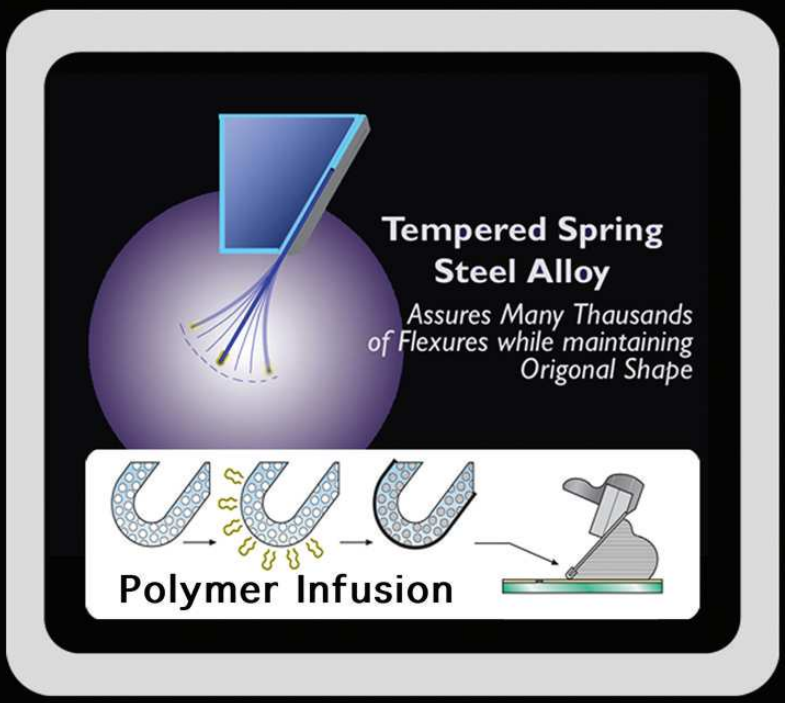

Technology for Improving SMT Print Quality and Production Yield

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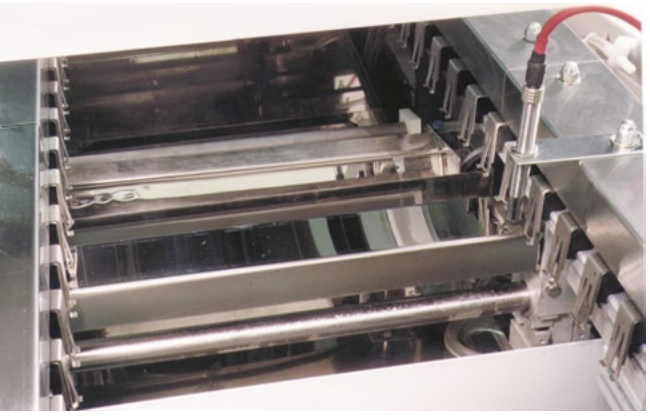


Figure 1: Flux air knife.

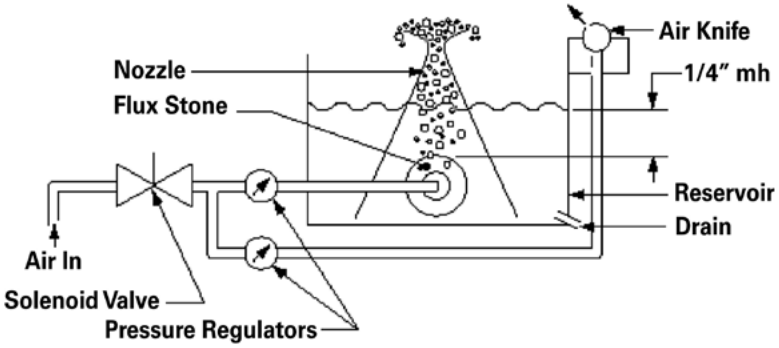


Figure 2: Diagram of flux air knife.

Air Knife Cleaning

An air knife is used for removing excess flux by blowing it off the bottom of the board before entering the wave. It is usually used with foam fluxing methods but can also be used with spray fluxing.

- ***Pros:*** Eliminates most post-wave cleaning; returns excess back to the flux reservoir to conserve material
- ***Cons:*** Adds a little cost but saves on post-wave manual cleaning
- ***Typical cost range:*** Usually runs less than $1,000 as an add-on to a wave solder system

Recirculating Cleaning System

This is a cleaning system for finger-type or board edge conveyors. It sprays a solution onto the conveyor just before new boards are loaded. The system includes an alcohol detergent solution along with brushes.

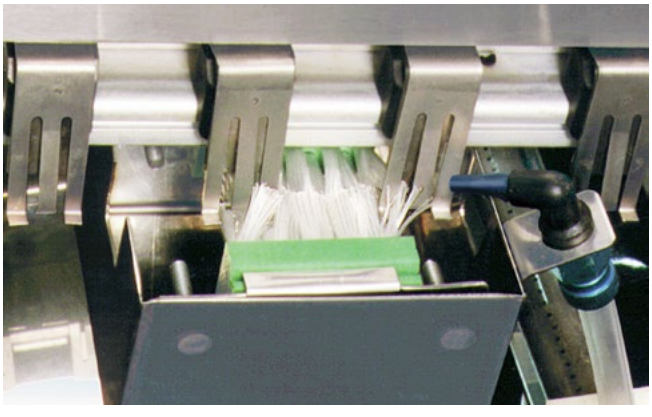


Figure 3: Finger cleaner.

- ***Pros:*** Reduces maintenance labor and downtime caused by flux residue buildup. Flux is a fairly sticky substance and can cause production problems if not dealt with regularly.
- ***Typical cost range:*** Usually adds between $1,000–2,000 to a wave machine purchase.

Inerting Systems

Inerting systems are used to introduce nitrogen during the soldering process. Nitrogen is contained within the solder pot by a hood, to reduce oxidation in the pot and in the critical moments while soldering the boards. Nitrogen inerting is recommended for lead-free solder, which will oxidize rather quickly otherwise and can adversely affect joint quality. Nitrogen is by far the most commonly used gas in an SMT application.

- ***Pros:*** Ensures high quality joints to meet IPC standards when required
- ***Cons:*** Adds significant cost
- ***Typical cost range:*** Can add up to $4,000 to a wave solder system

Rollout Solder Pot

On larger wave solder systems, the solder pot itself, when full, can weigh up to several hundred pounds. A rollout option simplifies main-

tenance by facilitating the removal and cleaning of the pot, which should be done weekly to remove solder dross in a typical production environment.

- ***Pros:*** Simplifies cleaning and maintenance, reduces opportunity for injury
- ***Cons:*** May add $2,500 to a large wave solder machine with a heavy solder pot

PC Interface

This feature connects your wave solder system to a PC or networked computer to enable fault monitoring or data logging for QC purposes, or to allow the user to connect to the machine for remote control.

- ***Pros:*** A data logging interface is important for ISO certification and record-keeping
- ***Cost:*** Will range from $1,500–$3,500

Check references

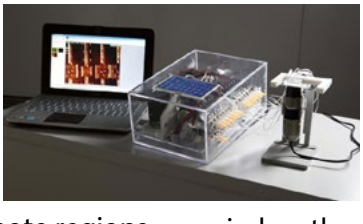
Remember to consult a variety of machine providers, talk to the manufacturers themselves if possible, and get references to contact before making a purchase. An important consideration for a complex machine such as a wave soldering system and associated options is factory support, specifically training,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

Figure 4: Rollout solder pot.

In the next column, we will discuss selective solder machines. **SMT**

Robert Voigt is VP of global sales at DDM Novastar Inc. To reach Voigt, click here.

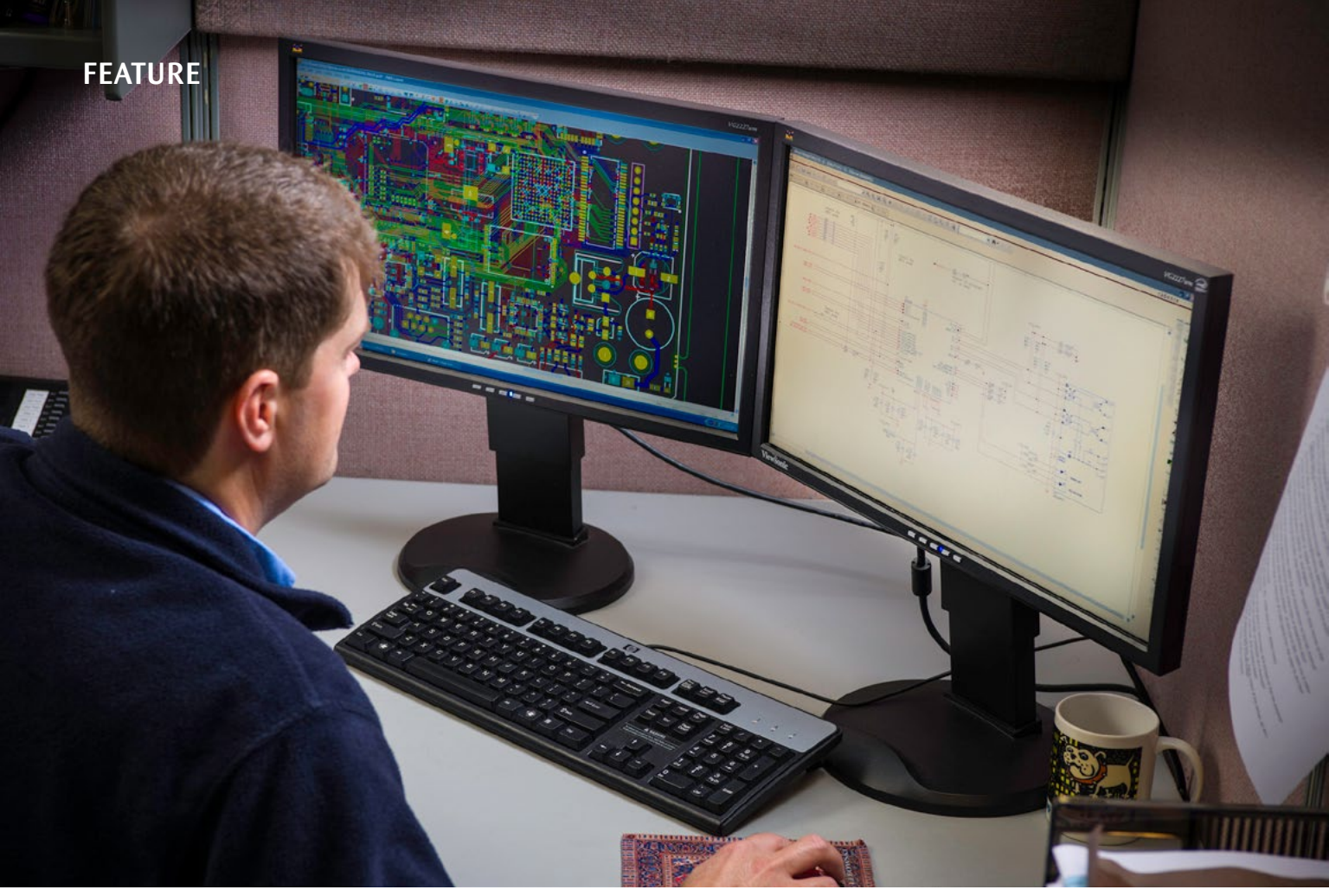
Portable Device for Rapid and Highly Sensitive Diagnostics



A portable and low-cost diagnostic device has been developed at the École Polytechnique Fédérale de Lausanne (EPFL). This new microfluidic tool, which has been tested with Ebola, requires no bulky equipment, and thus is suitable for use in remote regions.

Developed at the Laboratory of Biological Network Characterization (LBNC) and headed by Sebastian Maerkl, the new microfluidic platform, which is composed of both analog and digital detection mechanisms, runs on battery power and is completely self-sustained. It operates seamlessly with inexpensive microscopes and provides very high levels of accuracy and detection. The platform, which is described in a recent ACS Nano article, can quantify up to 16 different molecules – or biomarkers – in less than 0.005 milliliters of blood.

"The platform will lead the development of new kinds of tests to meet the increasing demand for on-site diagnostic testing. It will prove very useful for medical staff working in resource-limited regions," said said Francesco Piraino, the article's lead author.



The Appeal of a Combined Engineering and Manufacturing Solution

by Jered Stoehr
MILWAUKEE ELECTRONICS

Most EMS providers have some ability to provide design for manufacturability and testability (DFM/DFT) support to their customers. Some even offer layout services. However, the ability to offer product development engineering support at the conceptual level is rarely found outside of tier one EMS providers. This can be an underserved niche since projects that start as outsourced design projects can take one to two years to ramp to full volumes and even then the volumes may not reach the scale attractive to a global EMS provider. Often the solution is a design firm and job shop followed by transition to larger EMS provider once the job shop is outgrown. This can be inherently inefficient since the OEM may be outsourcing design and subsequent manufacturing to multiple suppliers, resulting in multiple project transfer costs and concomitant inefficiencies.

Why wouldn't more EMS companies fill this niche? One reason is that it can be challenging to keep the right mix of design engineers working at capacity in an EMS-only environment. There are basically two ways to address this challenge: form strategic alliances with independent design firms or develop an in-house capability that stays at capacity through a combination of independent design projects and EMS-related projects. One company that is effectively utilizing this model is Milwaukee Electronics. Its Design Engineering Services group follows a simple "fit what customers need" model. The group is designed to integrate with customer engineering teams and fill the gaps. They can support standalone product development efforts with-

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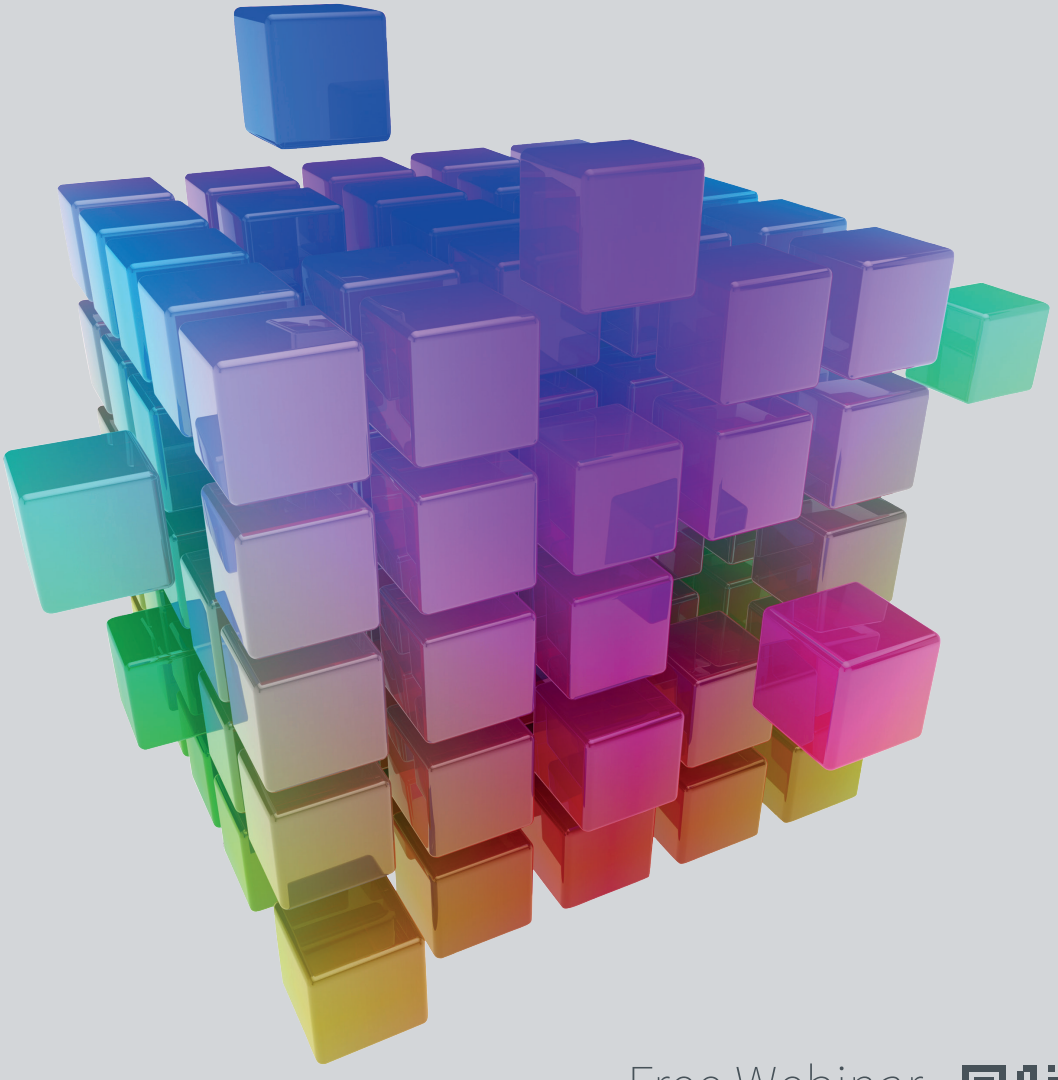

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out manufacturing, niche engineering needs or a complete engineering and manufacturing process. The team has significant experience in microprocessor and micro-controller hardware and software design, as well as mechanical and circuit board design. There is also strong expertise in in-circuit, functional and Checksum MDA test.

This type of business model has a number of advantages for companies outsourcing engineering and manufacturing. One big advantage is engineering team stability. While standalone engineering firms often expand and shrink with contract personnel as business volume changes, this type of blended engineering support model level loads a core team that works over a range of projects. Some engineers support EMS-related activities, while others are involved in exclusively in standalone engineering projects.

The ability to work with the same engineering team over a period of years can save OEMs product development costs. This was the case with one construction equipment OEM. Their handheld surface finishing unit safety interlock system was being defeated by workers wanting to operate the machine one-handed. Their internal team had been unable to develop an electromechanical solution and opted to outsource design with their contractor. The contractor's team designed an integrated a single plane gyroscope with a small microcontroller that is mounted onto the equipment's horizontal frame. This control monitors the horizontal rotation of the machine while ignoring the back and forth swinging action during normal operation. If the handle is suddenly released by the operator, the control monitors the acceleration in rotation and then snubs the engine spark causing the RPM sensitive braking system to activate within a single revolution of the entire machine. During initial prototype testing of the control, the unit was unable to meet the stopping requirement due to the gyroscope response time. The team resolved this issue by implementing a pre-emptive snubbing software algorithm.

The contractor was also able to provide a manufacturing solution to address the severe environmental conditions in which the machines were operated by assembling the PCBA into a custom potting cup enclosure that is then sealed with an epoxy resin for protection from the physical elements and the extreme temperature conditions that are generated by the gas engine.

Several years later the customer requested help with a control redesign for the ride-on version of the equipment. The same engineering team was able to heavily leverage the previous design to save customer significant engineering development costs.

Most new product development projects also see economies of scale on PCBs and components when using a contractor with engineering services, since much of the bill of materials may be already in stock for manufacturing activities. In the combined engineering and manufacturing model, there is also a smoother project launch as the product development team and manufacturing engineering team interact much earlier in the development process than found in projects where engineering and manufacturing are performed by separate companies. Most importantly, once the design is final, the quoted manufacturing cost is accurate and during the design process it is possible to easily calculate the impact of proposed changes on manufacturing costs.

An additional benefit is an engineering team co-located with manufacturing operations often has significant expertise in Dfx. For example, in this contractor's model, DFM and DFT are addressed in both the product development process and again as manufacturing engi-

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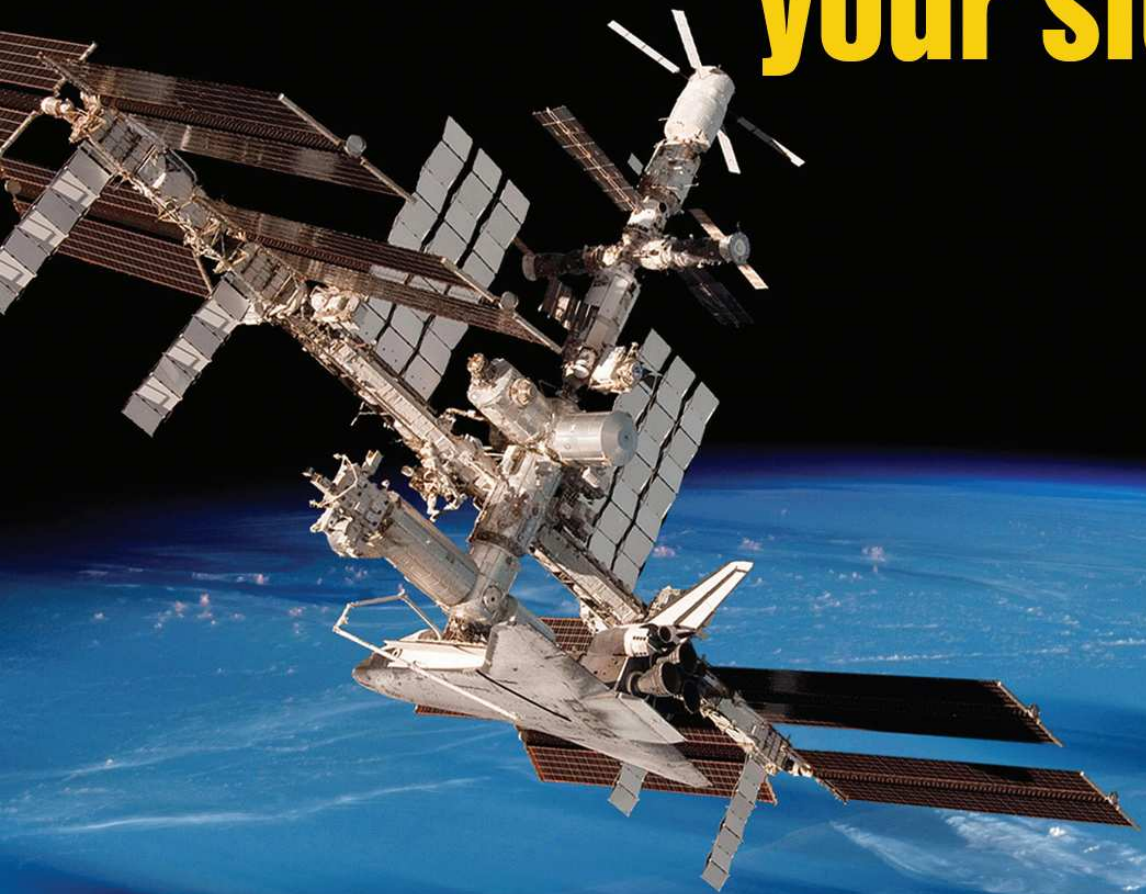

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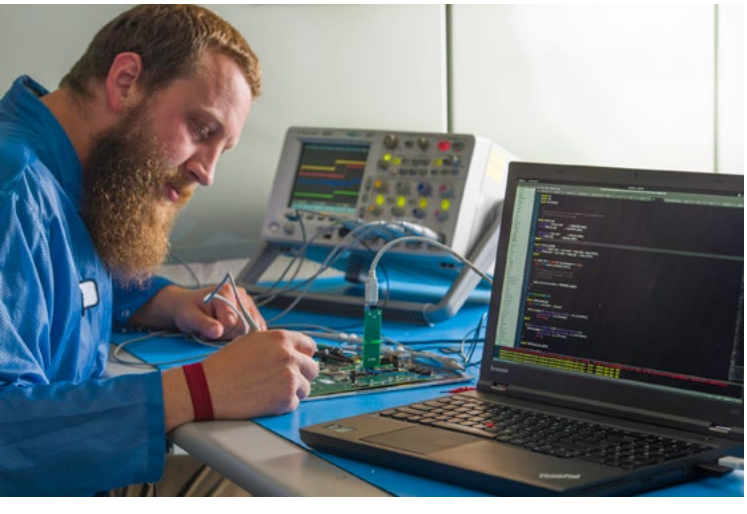
neering begins the new product introduction. On PCBAs, the team works to optimize designs with SMT layouts that minimize labor cost. However, the product development team also looks at product lifecycle management (PLM) issues, plus design for procurement. Factors such as component commonality with the customer's existing products, availability, supplier quality and price are considered in bill of material (BOM) and approved vendor list (AVL) development. Finally, agency pre-approval testing is also supported to ensure that the final design is manufacturable, cost competitive and compliant with regulatory issues.

The benefit of this integrated approach becomes even more obvious when a PCBA project that is in not manufacturable is awarded. For example, an OEM who had worked with an EMS provider with limited design capability awarded a project which included a PCBA that had been modified to pass agency testing with kapton tape, jumper wires and through-hole components with uniquely formed leads. In a traditional EMS-only model, there would be limits to the redesign support available. In this case, the manufacturing team did not feel the PCBA could be manufactured in volume efficiently or with consistent quality, however the engineering team was able to redesign the PCBA to be both manufacturable and pass agency testing.

DFT is another area where a combined design and EMS model can enhance support options. In the traditional EMS model, DFT expertise focuses primarily on design enhancement to improve accessibility and test coverage. Test program development and fixture design are also commonly available. In the integrated design and EMS approach services may expand to functional tester design or a standardized test platform approach. This broadens the range of lower cost test options, as modifying a standard platform for multiple customers can reduce non-recurring engineering costs. This can be particularly important to OEMs with low volume products, legacy products and highly regulated products. For example, when customers don't have strong test expertise in-house, this contractor's engineering team can help with both DFT recommendations and development of custom functional testers. Test fixture design and fabrication is also supported. The engineering team takes custom requirements and designs rack-based test systems with mechanical interfaces. Software is written using National Instruments' Labview. Capabilities include standard electronics and electro-mechanical devices. Systems can include use of optical interfaces or automated visual inspection with cameras. Typically, these custom functional test systems are best for low-to-medium volume production.



In-line functional testers which include a clamshell box with safety systems to protect employees from high voltage have also been developed. These systems typically use a National Instruments data acquisition card embedded in the test box with additional peripheral circuitry with varying voltages, relays and switches that interact with test points though pogo pins. These testers typically support medium volume in-line production.

The ability to look at a wide range of test considerations during the product development process enables an engineering team to design in built-in tests such as JTAG or a fixtureless testing via a test through connector strategy. This flexibility can be important for dense PCBAs with limited space. This contractor uses in-circuit test systems in the design process to provide a report on coverage. Functionality is analyzed by circuit block. Where possible PCBAs are layout to facilitate a bottomside surface mount test probe, however, options for this are limited if the PCBA has high-speed circuitry or high-precision analog circuitry. To reduce the

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March 29 & 31 | 1:00pm EST
Solder Paste Printing for Beginners
Chrys Shea, Shea Engineering Services

April 26 & 28 | 1:00pm EST
Solder Reflow Fundamentals - Thermal Profiles & Defect Mitigation
Fred Dimock, BTU International and Karl F. Seelig, AIM

May 17 & 19 | 1:00pm EST
It Is Time For Low Temperature - Low Temperature Solders, New Development, & Their Applications
Ning-Cheng Lee, Ph.D., Indium Corporation

...More topics to be announced.

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SMT Processes
September 27-29
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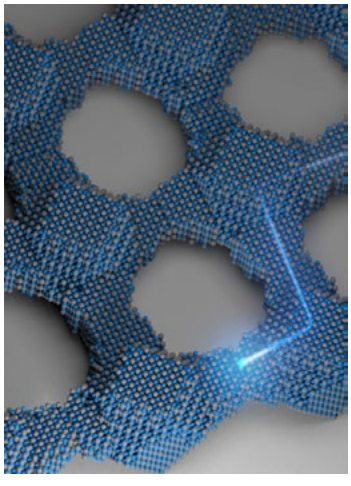
cost of functional testing the test engineering team has developed proprietary software code that speeds up functions test from minutes to seconds. While it is optimal to add it in the design phase, it can be added to build-to-print product. The end goal of the final mix of test and inspection strategies is always to provide the best coverage at the lowest cost.

In the example above, the contractor is seeing a steady stream of engineering projects that convert to manufacturing projects. The trust built in the product development phase often translates to competitive advantage in the manufacturing phase. The ability to flexibly support build-to-print customers' needs for redesign to deal with obsolescence or a need for increased functionality is valued by customers with limited in-house resources. In a world where OEMs have been sold on the value of outsourcing manufacturing and reduced internal problem solving resources, an EMS business model that leverages the synergies of strong design engineering, supply chain management and manufacturing expertise helps fill the gaps that occur as OEM internal resources are reduced. **SMT**

Jered Stoehr is Milwaukee Electronics' vice president of sales and marketing. To reach Stoehr, click here.

Quantum Dot Solids: This Generation's Silicon Wafer?

A group of Cornell researchers is hoping its work with quantum dot solids can help usher in a new era in electronics.



Led by Tobias Hanrath, associate professor in the Robert Frederick Smith School of Chemical and Biomolecular Engineering, and graduate student Kevin Whitham, the multidisciplinary team has created two-dimensional superstructures out of single-crystal building blocks. Through directed assembly and attachment processes, the lead selenide quantum dots are synthesized into larger crystals, then fused together to form atomically coherent square superlattices.

The difference between these and previous crystalline structures is the atomic coherence of each 5-nanometer crystal. Each crystal is connected directly to each other. The electrical properties of these superstructures potentially are superior to existing semiconductor quantum dots, with anticipated applications in solar cells and other electronic devices.

The paper, "Charge transport and localization in atomically coherent quantum dot solids," is published in Nature Materials.

Whitham did most of the experimentation and is lead author of the work. Also contributing were Jun Yang, postdoctoral researcher; Benjamin H. Savitzky, graduate student in the field of physics; Lena Kourkoutis, assistant professor and Morgan Sesquicentennial Faculty Fellow in applied and engineering physics; and Frank Wise, the Samuel B. Eckert Professor of Engineering.

Professor Hanrath explains his group's work on assembling quantum dots into ordered, two-dimensional superlattices has potential applications in optoelectronics.

This latest work has grown out of previous published research by the Hanrath group, including a paper published in Nano Letters that reported a new approach to connecting quantum dots through controlled displacement of a connector molecule. That paper referred to "connecting the dots" as being one of the most persistent hurdles to be overcome.

That barrier seems to have been cleared with this new research, which could be the first step toward discovering and developing other novel materials with programmable electronic structure.

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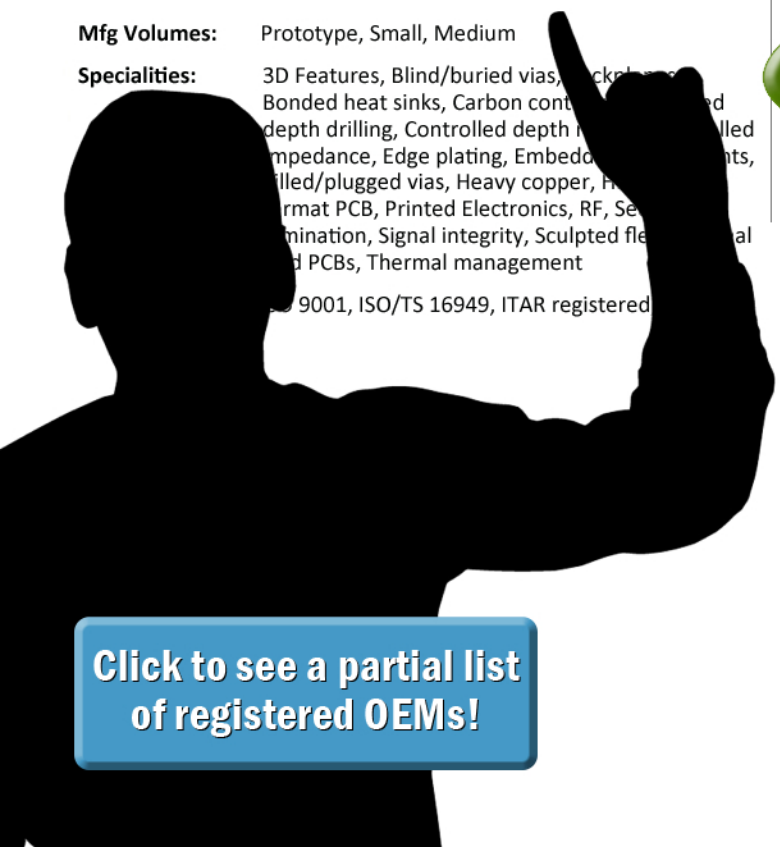

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Mentor Graphics' **Oren Manor** Explains Exactly What Industry 4.0 Brings to Manufacturing

by Barry Matties
I-CONNECT007

I had the opportunity to speak to Oren Manor of Mentor Graphics about their design to manufacture solution, and specifically how it helps OEMs large and small make the transition to Industry 4.0 without a complete factory overhaul.

***Barry Matties:** Tell our readers a bit about Mentor Graphics, and what you do, Oren.*

Oren Manor: Mentor is an EDA company, and one of the unique things about Mentor is our full design-to-manufacture flow. Unlike maybe some of the other EDA companies out there, Mentor is unique in the sense that it really does provide a full solution ranging from silicon design, board design, to preparation of production and then everything around the shop floor control, so it's really a complete solution.

That's where we have an edge on some of the other EDA companies and that is also our advantage when we compete with some of the other EMS companies out there. We are the only ones that can really handle the design data and prepare it for manufacturing, program the different machines and then control the actual process. The end-to-end solution has a lot of advantages for the customer, especially for vertically integrated manufacturers, where the OEMs actually have some manufacturing in-house. So the majority of SMT lines are still owned and managed by these vertically integrated OEMs, and that's when the Mentor portfolio is most appealing.

***Matties:** So it is a captive facility.*

Manor: It is a captive facility. We do deal with EMS companies as well, of course, some of them also offer some design services, but one of our advantages from an OEM perspective is our very wide portfolio. Of course from a sales perspective, as well, Mentor deals with customers on a global level giving them both the software for their design as well as the software for the manufacturing, making the flow of data, and the bridge of the data, very robust.

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***Matties:** It really is about flowing the data from one point to the next in a timely, accurate way that gives invaluable feedback, post production.*

Manor: Yes. We always talk about this wall between design and manufacturing. Even if we go to a vertically integrated automotive manufacturer, where we still see a lot of in-house manufacturing, the design guys don't really know the manufacturing guys and the manufacturing guys don't trust the design guys. There is a big barrier between them. We always think of them kind of hopping off the design side and not really trusting these guys. There's a lot of mistrust.

> "It is a win-win for everybody and of course management sees it."

When we come in we simplify the flow. We use our ODB++ format, which is much more intelligent data, and we can build trust there and make this much leaner. Then the designers are happy, because their boards come back faster and manufacturing is happy with less questions, less spends, and everybody at the end of the day gets ahead with this. It is a win-win for everybody and of course management sees it. We try to explain to management that you have to leverage the effectiveness of the machines that you own. You could always go and outsource and go to Foxconn or Flextronics—everybody can do that. But you've got your own lines. Take advantage of that. Take down that barrier. Take down the wall. We've been talking about this lean NPI for a couple of years now. Now I think with smart manufacturing this is becoming even more and more important because it's hard to be very good at manufacturing if you get bad data.

***Matties:** Industry 4.0 is something that you guys are talking a lot about here. You have a display at the show depicting what it really looks or feels like. It is a great depiction, by the way, with the cars. Tell me a little bit about 4.0 and what that really means to people.*

Manor: I think there is a lot of misconception about Industry 4.0 and smart manufacturing. People think, "I get data from the machines. I talk to them. Great. This is Industry 4.0." But that's not true. That's maybe Industry 3.0, or maybe 2.0. We're doing that with a lot of vendors. We communicate with the machines but this still doesn't really make it Industry 4.0.

Industry 4.0 is about machine to machine connectivity. So you have to bring in some kind of Internet of Things [IoT] or Internet of Manufacturing [IoM] in order to be able to really talk between the machines.

***Matties:** And IoT is really just the sensors inside of equipment that talks to the next piece of equipment?*

Manor: Exactly. Think of a Coke machine talking to another Coke machine saying, "I'm out of Coke. You've still got a Coke. I'm going to send the guys over there." It does this without going to some centralized cloud server and making the decision in the server. This is decentralizing some of the decisions and allowing the machine to actually act as some kind of small factory on its own, to make decisions and also communicate with other machines on the line.

You definitely have to enable that and we have software and hardware that really can make that happen. I think in 15 years any machine that is sold will probably have integrated IoT or Internet of Manufacturing.

***Matties:** They'll have to.*

Manor: They'll have to, but as we know the SMT market will take years for this equipment to trickle down. For the next decade we're basically stuck with machines that don't have that built-in capability. Then it's up to vendors like us and others to come up with these solutions to basically make these IoT or IoM ready while when they were bought and manufactured it wasn't integrated. They'll need some retrofits

and some added software in order to make the lines IOT ready when this equipment was obviously designed maybe 10–15 years ago.

***Matties:** In a perfect world your equipment talks to you and to the next piece down the line saying, "Here's what's coming. Here's how to set up. Or I'm low on this solution. Replenish over here." That's the sort of thing you're describing.*

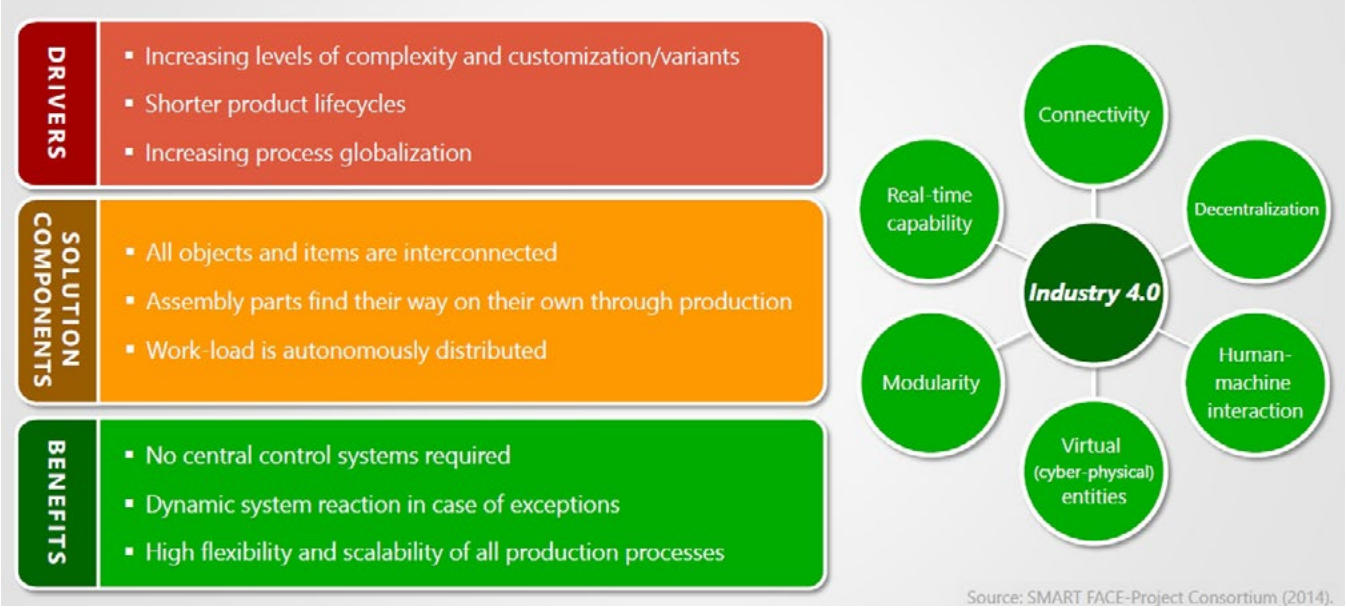
Manor: That sort of thing and also some things like, "I have some optical inspection and I see some misalignments." It communicates to the machines down the line and the engineer to say, "Look, there's too much of these misalignments. Maybe there's something wrong with your assembly process."

The engineer gets some snapshot on his mobile phone, sees the actual image coming from the optical inspection and says, "Yep, misalignment. Please do the corrective action." Or maybe, "Don't do the corrective action." And if this happens enough maybe he'll put in some rule and then the machine does it automatically so if it happens every day we can automate it. Not necessarily every decision is going to be made by the machines, but we're going to have a lot of more decision supporting tools which will allow the operator interim time in the cafeteria to actually get the information, make the decision and then decide if he should automate it. From now on let the machine do it automatically or does he continue mandating this manually because it's a very sensitive and process driven issue.

***Matties:** Is the risk in this new Internet of Things, Industry 4.0, too much data? Data overload?*

Manor: We definitely see data everywhere. When we used to talk about big data it was something for big banks or big insurance providers, but now nearly every factory which produces large volumes has a lot of data. The machines output a lot of data. The testers, the functional testers, the inspection testers, and it doesn't really matter what you make. You've got a lot of data.

If you want to also keep the data for some six months, nine months, or a longer period of time, you want to quickly query it. I think everybody at the end of the day is going to have to invest in big data solutions. Some will probably go to the big ERP solutions like SAP HANA. These guys are also working on big implementations of big data, which I believe some of the larger organizations would go to. But even smaller manufacturers will have deploy some kind of big data solution. That's also something we're working on because people at the end of the day want to query and get results fast and accurate and be able to run dashboards. If they



see that their process is going out of control they can do something about it. Otherwise if you have to wait hours to get a result what's the point of collecting all of this data? Then there are a lot of scraps. So you want to be able to query quickly and get data so you can make decisions and for that you're going to have to rely on real big data solutions.

***Matties:** Understanding what data you really need is key, too. You have to look at the right data to make the right decisions.*

Manor: Yeah, and also you can archive some of the data. Not all of the data needs to be in real-time. There's some queries that somebody can sit in the office and if he has to wait ten minutes for the result, that's fine. But if he's doing some big investigation and trying to drill down but there's some cockpits and some management dashboards that need to be in real-time to see whether he's making bad boards, those things you need to know so you can stop.

The idea is that some of this data is really collected on the line level and then maybe the line manager can go with his tablet to the line, see the overall equipment efficiency and the defects per millions, get all of these classic metrics, and see he's okay. The manager might get something for the enterprise and the full site and he can see that. Somebody on the corporate side, which might have six different sites, can see a comparison between the site in China and the site in Mexico and he can run some metrics to see who is better. That is probably not needed in real-time.

You have to differentiate between who is seeing the data and how well it's aggregated and that will really give different people the ability to intersect with the data and also do it remotely. You could sit at home, see your dashboard and see that nine six is down from 9:00 in the morning and say, "Okay, you know, I have to do something about it." You don't have to be physically at the factory and look at the traffic light like we have to do today.

***Matties:** Now in sectors like automotive, big companies, the tier ones, can afford to do this right away. They are 4.0. They have to be, right? They have the money, the funds, and the resources to do it. It's the tier two and below who probably can't get to it quite as quickly.*

Manor: We're sitting here and our message says, "Enable Industry 4.0 today without changing your world." One of our main messages is you don't have to go to a huge IT project with millions of dollars and implement this massive MES system. We might be able to help you get to Industry 4.0 by just bridging in some of those systems with our IoM, getting the data and supplying you the data and you do everything else. Tier twos cannot come up with a big project that costs $3 million; it will never fly. No one shut down their whole operation for three months to do a massive upgrade.

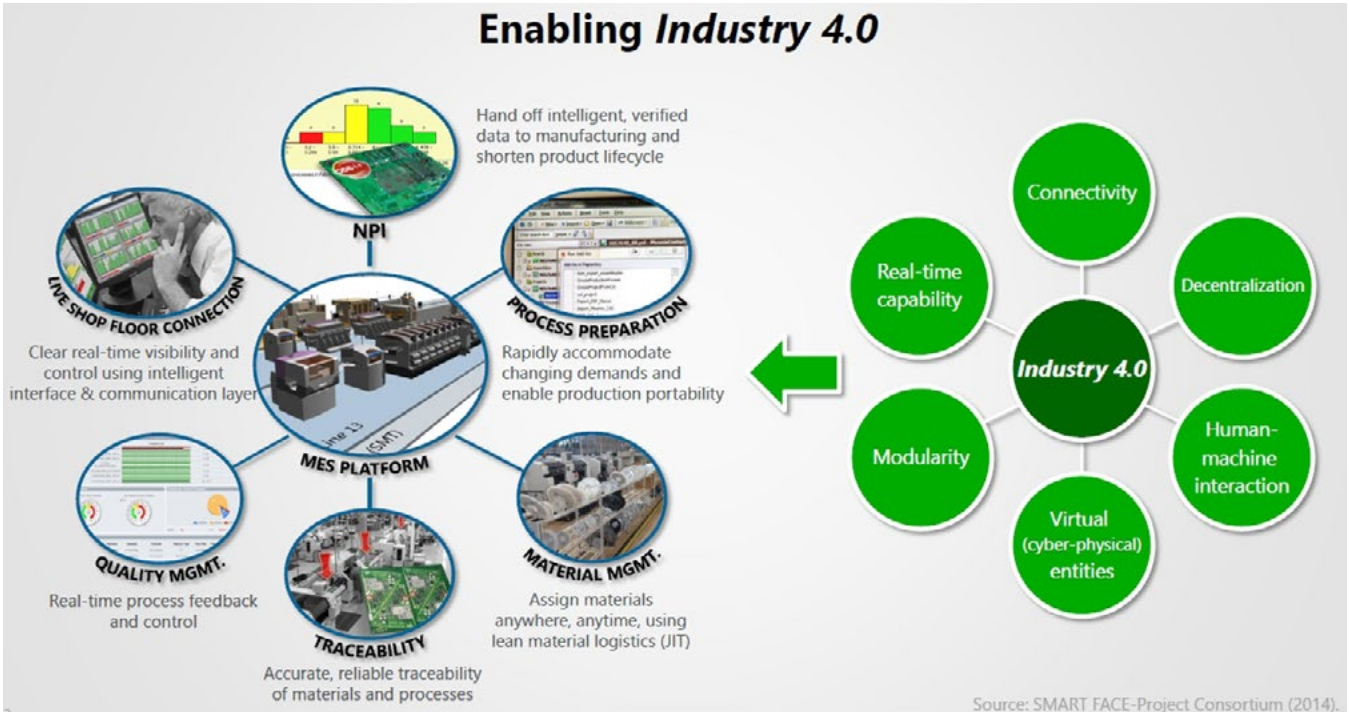
***Matties:** And they don't want to go out and buy new equipment. It's not in the forecast.*

Manor: Exactly, so we have to keep their existing infrastructure, their existing IT systems and slowly start bridging in these elements, making it Industry 4.0 compatible. And that's something we're going to try to focus on. The key message here is we don't want to change your world. We don't want to make you have to buy a lot of new machines. The idea is to focus on data acquisition and the ability to make decisions autonomously, in addition to the machines, with some clever hardware that can do this bridging. This will be a tier two, tier three enabler.

***Matties:** What sort of gains can they expect from this type of investment?*

Manor: I can tell you two things. First of all, from a planning perspective, this allows our production plant to be much more efficient. The machines today are all very flexible. They're accurate and they're fast. But people don't really leverage the capabilities of the machines that well. The overall equipment efficiency in the industry is probably about 50% and we can do much better.

If we look at the airline industry, the planes fly 16–18 hours a day. They have been able to really maximize the usage of the airplanes. If you compare that to our industry, the machines are



idle half of the time because the material hasn't gotten there, because they didn't plan the work orders correctly, the next shift never came in, a lot of different reasons. When we have very accurate data coming from this stuff that allows us to plan much better it's a big gain. So we can plan and group better, especially in high mix, high variance. It's no longer about the volume manufacturing and optimizing the specific program on a specific machine, it's much more about how well you plan and group so you don't have to do setups all the time and you can run for a full shift.

The other thing concerns materials. This allows us to much better manage the materials. We can do just-in-time replenishment, which means the machine has a low-level warning. Only then would we issue the material request and that's when we prep the material. So you don't have all this material lying around the factory. You're much leaner. You're much less cost on your stock and also much less material being lost, stolen, rejected, etc. Traditionally, we had operators who kept materials 48 hours in advance. That means for 48 hours they have all of the material lying around the factory. It could have been material they might not produce at the end because of issues about the machines, lines down, maybe orders cancelled. We can really do that in maybe three, four hours before manufacturing, in real-time. That saves a lot of money.

***Matties:** Does the type of employee change now because you don't have somebody with as much process knowledge anymore?*

Manor: I don't think so. I think maybe with all of these decision supporting tools they might need less operators.

***Matties:** But it seems to me that the skillset shifts to more of data analysis than process.*

Manor: You have to be IT savvy and you have to know how to use these tools. It's not a lot about know-how in the brain, some of the know-how is moving from individuals to the machines. But somebody has to make a decision in real-time. Do we have an issue because the processes are wrong? Or do we have an issue because the design of the product is flawed?

***Matties:** A lot more analytical thinking goes on based on the data that's being produced.*

Manor: Yes, and we can provide you more guidelines to make that decision. We can give you more data to support the decision. But at the end of the day, we need somebody who has know-how and industry and manufacturing experience to decide, "Is my stencil bad, or is the printer off?"

Twenty years ago test engineers were these unique set of guys who had a lot of experience in test and they would only do test. Most companies today can't afford that. Cost is driving them to have the SMT guy also do the test. So now you lose knowledge. He is not this test guru he was 30 years ago, and that's when we really use our systems to try and help him. Because you know there is less knowledge. They are going to need operators who can do extensive SMT and test. That's why they cannot be the same experts we had 30 years ago.

The machines are going to have to support the engineers and data is going to have to help them drive the decisions. But will we go to these autonomous lines running around and the humans don't do anything? I don't know about that.

Matties: Maybe 20 years down the road perhaps. But even right now, when we look at the labor pool that's available in the world, the specialty knowledge isn't necessarily as much as a requirement as the IT which is a broader base to pull from. If someone understands systems, data and IT they're probably going to be a great operator for your process that's embedded with 4.0. When you bring automation in you need fewer people as well.

Manor: Yeah, you do. I agree with you. Even today when we go to service lines, we see a line in China where 10 people are managing the line. Then we go to a site in Germany and you see one. We see that where cost is a factor customers are leaner and they have much less people around. So we know you don't really need all of these people, even today. And that's probably going to evolve and continue that trend as I imagine that low-cost countries are going to adopt these kinds of techniques to be more cost effective.

Matties: So the third benefit is lower total operating costs. Faster to market, lower costs, fewer employees to manage and smarter processes. What stops people from jumping on this bandwagon? Those seem like compelling benefits.

Manor: First of all, some of this really requires a change of manufacturing. So it's not just adopting an IT system and continuing to behave the same way. It's a behavioral change.

Matties: That's a hard one. That's management.

Manor: Management has to dictate.

Matties: It's got to go from the top, right?

Manor: Yeah, and also we need the buy-in from the operators. Otherwise they switch off the systems. They work around the actual computers.

Matties: Those are the ones that get fired. If management's bought into it, they're not going to tolerate that.

Manor: Yes, but we've seen issues where we've tried to put verification systems into organizations and there was a big rejection by operators because it takes more time or nobody trusts it.

Then management has to be very strong and very active in mandating that. You need middle management also to understand this behavioral change. They have been doing something for 15 years, and now you come in and ask them to wait for a computer to tell them what's best. The other thing is the budget. You have to convince them that they have to spend this money.

Matties: What are you looking at? Maybe a quarter of a million dollars or something like that for the system?

Manor: Maybe a quarter up to a million if they want to really go with a much more extensive solution. It's not cheap but then again it's not a 10 or a $100 million investment.

Matties: And someone who invests a quarter or half-million dollars, what sort of return on that investment do they expect?

Manor: If the material is someplace we control then it's a very strong ROI. Usually in nine months return on investment. We do have to do a lot of changes in implementation and be very exact. A lot of labeling is required. This really has to be a change from the incoming material, registration, to all across the shop floor. But if you do it right, you can get it.

The other thing you get is compliance. If you're an EMS and you want to make automotive, aerospace, or medical stuff, this thing really gives you as a byproduct a much more verified process. You can trace the process and that makes you much more compliant. Usually compliancy is important because the EMS companies want to be compliant and want to show the design organization, the OEM, their customer, that they have a very bulletproof process. But there is ROI in that. The materials is where we can actually prove the ROI. And then if we do a compliancy and material project we say, "Guys you get the return on investment and you're compliant." That's usually a win-win for everybody in the organization. And that's the way to sell it internally and to management.

> "If you're an EMS and you want to make automotive, aerospace, or medical stuff, this thing really gives you as a byproduct a much more verified process."

Matties: So when it's all put together they're running 4.0, big data, and all that. Is this what we call a smart factory?

Manor: Yeah, I think you can probably call that a smart factory.

Matties: The race is who can get there first because the competitive advantage is for those who adopt this the fastest, right?

Manor: Definitely. So let's say 15 years ago was all about economies of scale and the big EMS companies would just do this procurement of components, a lot of machines, manpower, and low cost. This is how they competed but that's really dying out. Salaries in China are going up. The compliance has been driven up, especially in Asia, where we see a lot of smart manufacturing being discussed in Korea and China. We're going to see these countries really invest in these kind of things to automate everything and be as competitive as they can with this. We're definitely going to see the OEMs and the EMS companies invest in this and try to market themselves as the smartest factory.

Matties: Oren, is there anything else that we should talk about that we haven't covered regarding this topic?

Manor: That's a good question. Maybe one other thing is product portability. We know today that customers want to switch the production between different factories and that's because supply and demand changes. You might be making, let's say, a consumer electronic product in China, the Chinese market kind of goes down and suddenly you see a lot of demand coming from Brazil. Your shipping cost is very high so you would rather move production from China to Brazil. This movement of the production is very expensive for the customer. He has to do a full NPI cycle again. The manufacturing environment in the Brazil factory is probably different than the Chinese factory, with different people, and that takes a lot of time.

With this smart manufacturing we can also make that a much leaner and a smoother transition. We see all of the global players here talking about, "We want to be much more flexible in moving the production between sites." So if our customer comes and says, "Guys I want less units in Latin America and I want more units in Europe." Or, "I want to switch production." He wants us to be able to quickly move the production between the site and not have to do a full NPI cycle.

A couple of years ago, I was talking to a large EMS company and they told me that they actually shipped a lot of the lines on boats between

site to site. And that's because they certified the line. Rather than going through a whole certification process they'd rather put them on a container on a ship and ship it. Of course, that's expensive.

If you could certify a number of lines in advance and convince your customer that you can move the production seamlessly using different kind of techniques and move the production easily within, days and have the same quality production levels, that would be very appealing. I think that's something we're going to see. Especially we saw what happened with the tsunami in Thailand. Suddenly you have a big impact of component, the supply chain is killed, and you've got to move production fast. You've got to be able to ramp up production in a different location. We see a lot of customers with these backup mirror sites, and that's one way to deal with it, but that's costly and expensive because you basically have products being manufactured in every location. I think being agile and having the ability to move is important and we have tools which can really help doing that and this I think we also leverage our competencies in design and the data intake that we talked about initially. So that's maybe another thing that we're going to see customers talk about a lot.

***Matties:** I think that's a big issue, to be able to do that. You're right. Things are shifting a lot right now, from region to region.*

Manor: Yeah, and I might have a lot of Fuji machines in China. I acquired a factory in Brazil. That's all, let's say, Panasonic machines. And now suddenly taking these programs and moving it between systems is not prudent. And you need good processes and good software that can help you automate that movement and really reproduce the same kind of environment easily and go into production.

***Matties:** So when you go in and you retrofit a company do you bring in training for their people and support? How does that work?*

Manor: Yeah. Usually we do a site survey when we start the discussion and we bring some industry consultants. These are 30-year veterans of the industry. They go around and snoop the factory. They look and the come and say, "This is a snapshot of the factory today. Here are our metrics. This is the kind of cost we have to date. If we implement we believe we can get this ROI. And that's how we think we should focus." That's also when we know who we need to train, and then when we implement the training we take another snapshot and then we can come back and say, "Look. Six months have passed. Here's where we were. Here's where we are now. Here's your ROI. Here's the action improvement."

***Matties:** It becomes very tangible.*

Manor: Or perhaps we haven't been successful here because of rejection by that team. We haven't really gained penetration because a side is refusing to work with our tools.

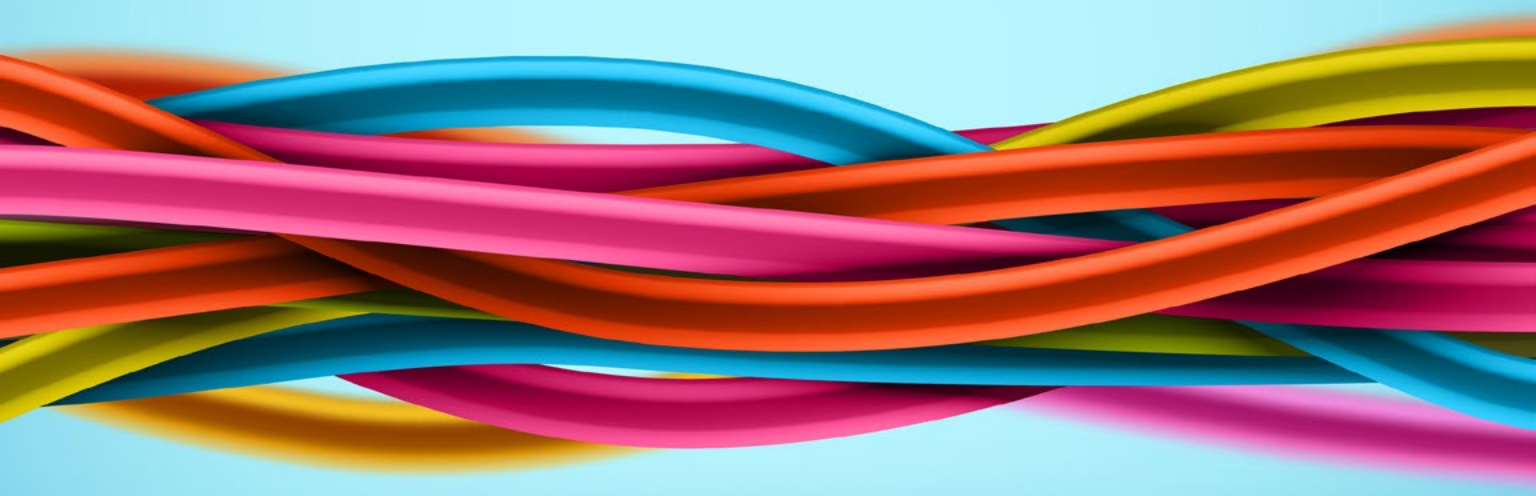
***Matties:** Whatever the variable happens to be.*

Manor: Then we can get management to come and say, "Guys you've got to get on this train because that's it. We're moving. We've invested, but we're not capitalizing on all of what we could because of issues in the implementation." And a lot of IT projects fail. At the end of the day when you look at the industry, the majority of these projects fail.

We've got to be very diligent in how we take a clear snapshot. We can do metrics. We can give an objective. Sometimes we in go and say, "Look. Your factory's perfect." Maybe that's the case. We can do a very marginal ROI because you're lean, you've created your own IT systems, you're almost Industry 4.0 compliant and maybe the gap isn't that big. Or we can come and say, "Guys, look. We can really make a night and day difference here."

***Matties:** Oren, thank you so much. This has been really informative. You know your subject matter very well. I'm impressed.*

Manor: Thank you very much. **SMT**



The Benefits of a Vertically Integrated Approach to EMS

by Adrian Nishimoto
SPECTRUM ASSEMBLY INC.

Many electronics manufacturing services providers are expert at board-level and box build assembly. However, most do only limited cable and harness assembly in-house.

The benefits of providing cable and harness assembly services in-house to customers are three-fold. First, the business focus on cable assembly ensures that volumes are present for both cost competitive material prices and a level of automation that keeps labor costs competitive. For example, on a medical device with both printed circuit board assemblies (PCBAs) and cables, an EMS firm that has the capability to provide cable and harness assembly will be able to reduce the cost on the product's cables by leveraging their cable buying power.

Second, doing the work in-house does more than eliminate a layer of supply chain markup; it also decreases lead-time while improving the ability to respond to customer schedule changes.

Finally, expertise in cable assembly adds value when product designs have cable manufacturability issues. The ability to provide expertise in cable assembly can add significant value because cables are often thought of as a less challenging part of product design. Typically, companies put a great deal of focus on design of the PCBAs and the overall unit itself, but the design team may not be expert at cable design.

Some common cable design related issues include:

• **Wrong terminal or contact for specified wire gauge:** If the contact is too large, the crimp will be too loose and will fall off. Conversely, if it is too small the crimp will be too tight and may damage the wire strand immediately or completely destroy it over time. In some cases, the terminal specification is correct, but an incorrect wire gauge or tolerance is specified.

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• **Male connector housing with female terminal:** While this mistake is easily fixable, it can generate significant non-value activity if not caught in documentation.

• **Incompatible materials on header and cable:** For example, specifying a gold-plated header on the PCB connector, but using tin on the cable terminal, can create resistance issues immediately and corrosion longer term.

• **Cable documentation shows pinout but doesn't identify connector:** If the pinout only shows a single view and the connector isn't identified, in the best case it slows down the new product introduction process and in the worst case it can result in an incorrect connector being used.

• **Incomplete or missing wire list:** This is a frequent mistake with two-wire connections. It can cause quality issues.

• **Proper crimp tool not specified:** The tools used to crimp wire are specifically sized for the cable. Failure to specify the correct tool size or specification of an incorrect tool can create quality issues. IPC-A-620 includes a requirement for specification of crimp height and tool test.

• **Insufficient electromagnetic interference (EMI) shielding or placement issue:** Insufficient EMI shielding or placement of sensitive cables near a power supply can create intermittent product failures.

Figure 1: SAI uses a "working smarter" philosophy in project launch, working with customers to ensure transfer of a manufacturable product.

Figure 2: Humidity-controlled towers are used to store components as part of line-side stocking programs.

From a business model standpoint, this level of vertical integration offers benefits to EMS providers as well. Projects that start at the cable or board-level often grow to subassembly or complete unit builds as customers see the value of utilizing a single source for the full product. Additionally, the mix of board-level, cable and box-build assembly makes it easier to maintain full utilization of a highly trained staff by rotating cross-trained production operators through areas experiencing the highest of level of demand. Some EMS firms choose to optimize this approach by fine-tuning sales focus on the types of projects likely to keep all three areas near capacity. This varies from the typical regional EMS provider model of dealing with demand variations by increasing and lowering production operator headcount primarily through the use of temporary staffing options.

A strong focus on quality in all operations is a critical point of the business model. The focus on ensuring that cables and harnesses meet the requirements of IPC-A-620 is equal to the level of detail put into ensuring that PCBAs are compliant with IPC-A-610 requirements. SAI has invested heavily in training. For instance, there is an in-house trainer certified as an IPC trainer for J-STD-001, IPC-A-610 Rev. E, and IPC/WHMA-A-620. Team leaders and select operators

in each area have been cross-trained and certified to multiple standards to facilitate shifting the workforce among areas as demand varies. Personnel working in the box build area have the greatest level of cross training. An adjunct benefit of this training has been that operators in each area handle the material they are assembling much more carefully. For example, operators in box build are more cognizant of the potential damage they can do to a cable or PCBA if too much stress is put on that component in the final assembly process because they have detailed understanding of the vulnerabilities of the components they are assembling.

With most box build projects, SAI performs an installation qualification (IQ), operations qualification (OQ) and production qualification (PQ) process to ensure that the product and processes meet customer requirements. When work is transferred from a customer new to outsourcing this often involves a very detailed step-by-step process where notes are taken on each step to ensure compliance with less documented portions of the customer's prior in-house processes. Aegis Manufacturing Operations Software is a key component. Its iView module creates a paperless factory floor, making it easy to maintain revision control on documentation, create intelligent visual aids and include multi-

Figure 3: SAI automates portions of its cable assembly process.

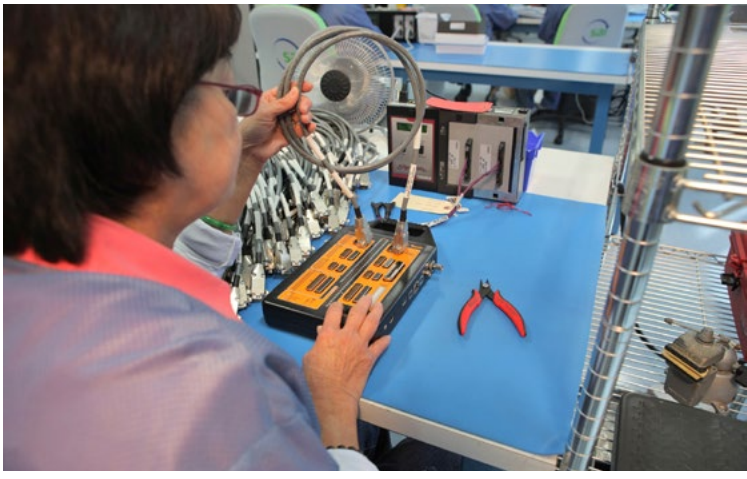
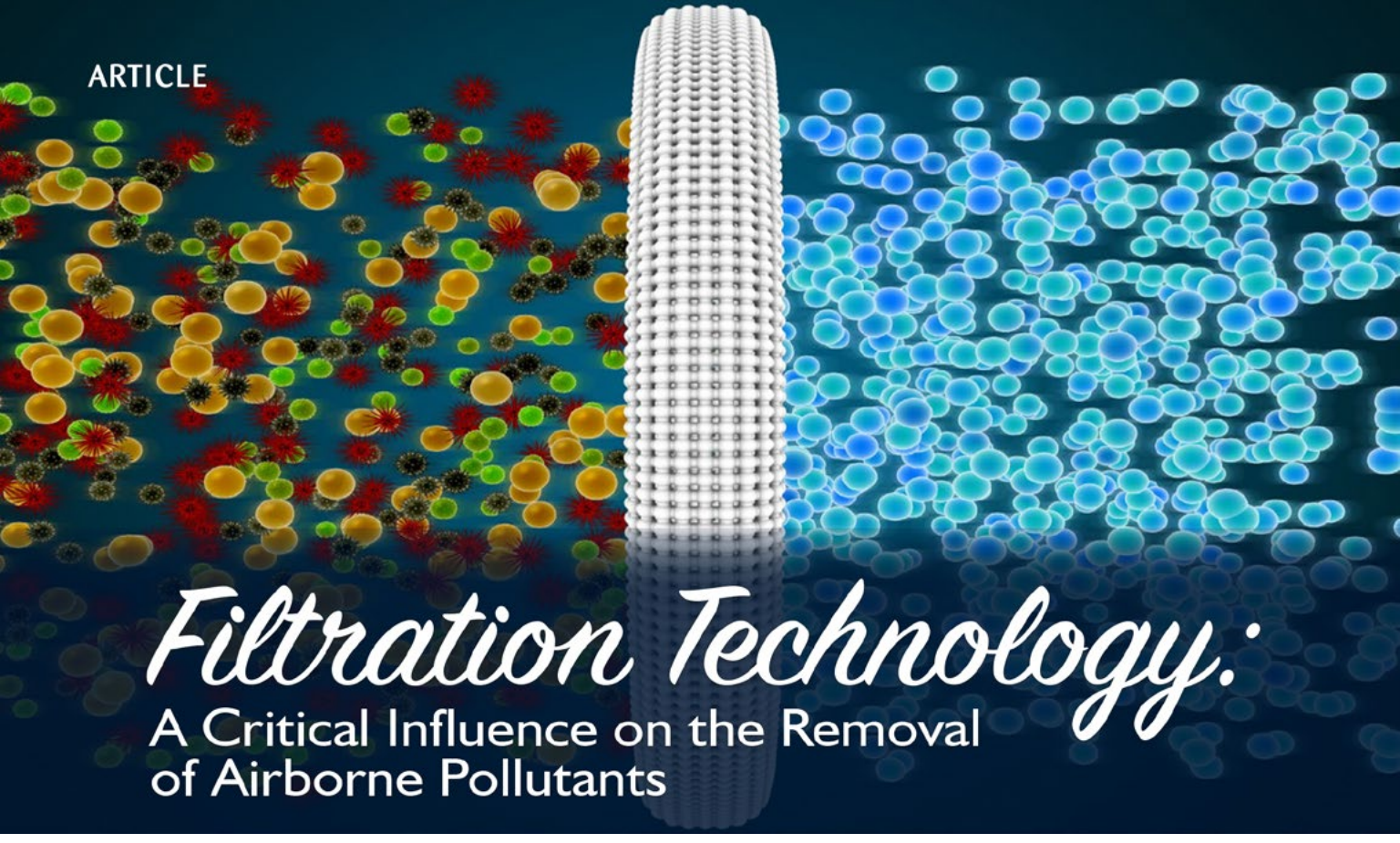


Figure 4: An operator tests a cable.

media work instructions. In terms of customer benefits, the system makes it easy to upload customer data and then validate the bill of materials against the Gerber and CAD files. It also shortens project launch time as pick and place and AOI programming can be driven through the same data import, and makes engineering change order (ECO) implementation faster.

The end result of the combination of vertical integration and investments made in workforce and systems is a responsive, cost competitive and scalable business model. This approach begins by eliminating defect opportunities at the project transfer stage. And, because the team has the expertise to identify cable manufacturability issues upfront that could impact form, fit or function, relatively small issues which left unaddressed could cause production delays are corrected immediately. There is similar strength in analysis of issues in mechanical assemblies. Customers are able to get the flexibility and responsiveness typically found at a regional EMS provider, along with the commitment to quality and systems more typical of large EMS providers. In short, the business model is a win-win for both parties. **SMT**

Adrian Nishimoto is an operations manager at Spectrum Assembly Inc. To contact him, click here.



ARTICLE

Filtration Technology: A Critical Influence on the Removal of Airborne Pollutants

by Stefan Meissner
ULT AG

The electronics production industry is characterised by a multitude of processes. From joining and separation technologies by means of laser, soldering and gluing, soldering processes, and the utilisation of fluxes or rapid prototyping—there is a wide range of various technologies. All these procedures have one thing in common: they generate harmful particles of any size, form and composition. These particles have an undesirable effect as they have impact on humans, machines and products because of their chemical and physical characteristics. They can cause diseases, affect machine functionalities and pollute products, thus can be responsible for malfunctions and production failures.

Extracting is not Enough

Utilising an extraction system seems logical. Indeed, it is. However, systems vary in effectiveness and many critical parameters must be considered when selecting the most suitable extraction and filtration system. In order to completely removing all occurring dusts, fumes, odours, gases, and vapours, it is necessary to utilise the appropriate filtration technology and understand all the characteristics of the airborne pollutants and processes. A distinction is made between particulate and gaseous substances. Partially, gaseous substances may react and become particles. Modern procedures such as welding, laser or other thermal processes cause the emergence of particles, which become increasingly smaller and some are known to be in the nano range.

Particle size is one criterion that decides on the utilisation of the best suitable filter medium.

Additionally, knowledge on particle characteristics (adhesive, condensing, etc.), gas content or flammability is important. These factors also have influence on the selection of the ideal filter.

Air Filters and Subdivisions

Filtration means separation of solids and gases, and there are many techniques used:

- Gravity separators (settlement tanks)
- Centrifugal separators (cyclones)
- Wet separators (washers)
- Electric separators (electrostatic filters)
- Filtering separators (fabric filters, cartridge filters)
- Adsorptive filters (activated carbon)

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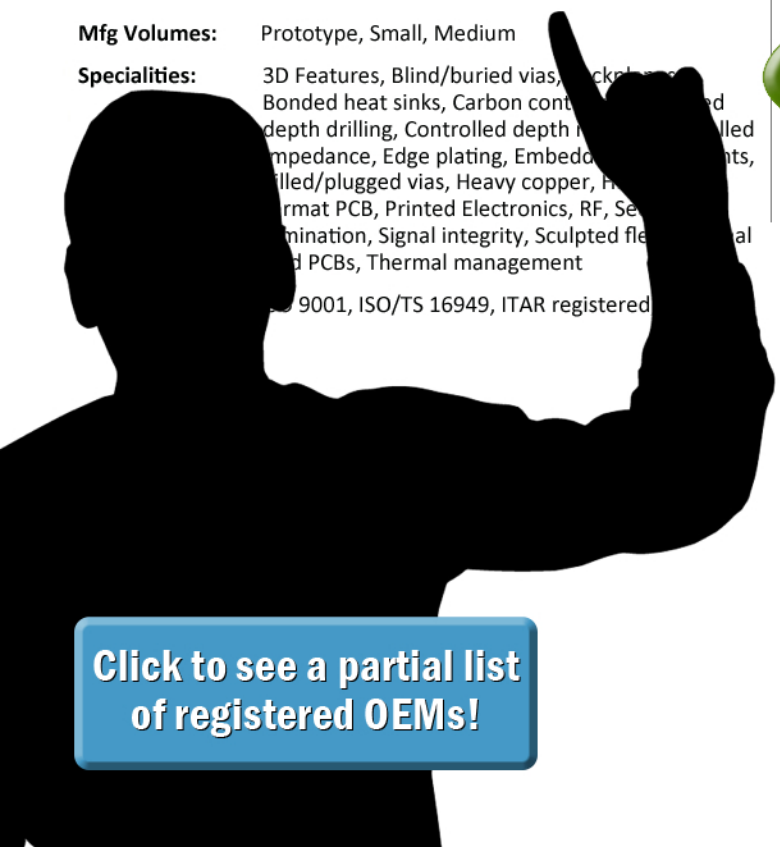

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This article focuses on filtering separators, also known as bag filters and fibre filters, as they are used across a wide range of industrial sectors. The German association Verband Deutscher Maschinen- und Anlagenbau (VDMA)/German Engineering Federation) subdivides filtering separators into different classes (Figure 1). Thus, a distinction is made between fine particulate (according to DIN EN 779:2012) and coarse particulate air filters (according to DIN EN 1822:2011).

Particle size is critical for the selection of filter type. With a given air volume and filtration efficiency, the following parameters are key

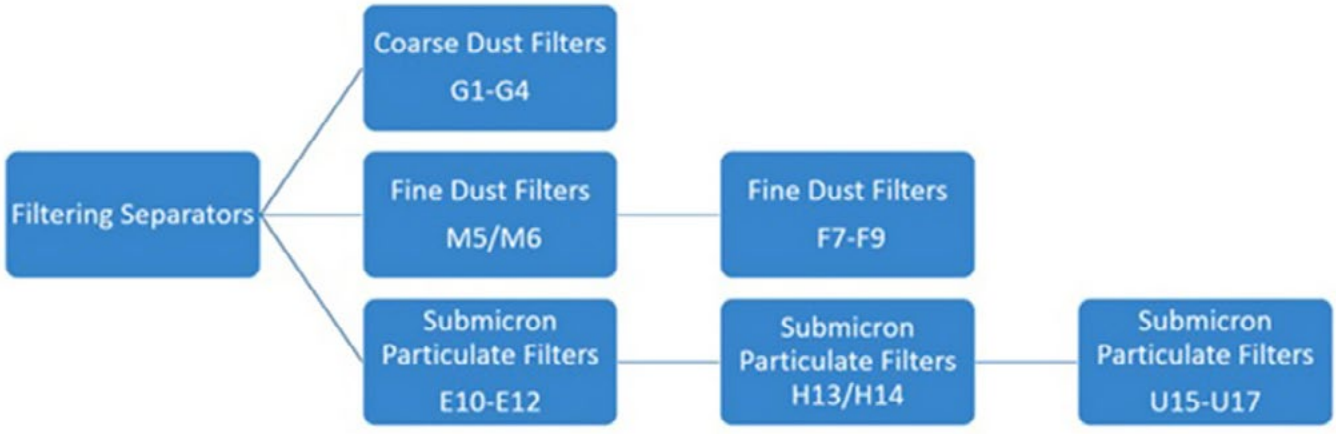

Figure 1: Classification of filters.

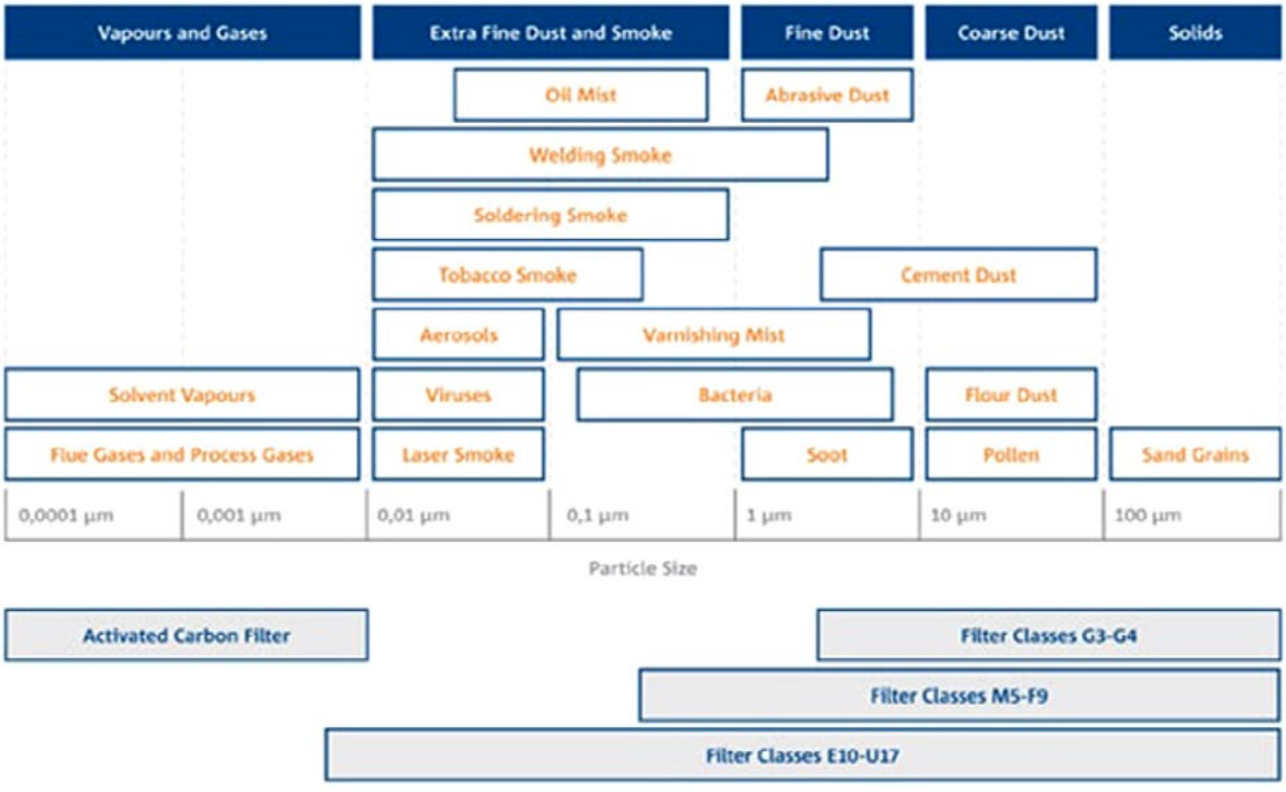

Figure 2: Filter classes in accordance with particle sizes.

variables and performance figures for practical sizing of air filters:

- Incoming particle characteristics
- Initial pressure drop and pressure drop progression
- Lifetime or possible duration of usage

Filter performance (degree of separation/efficiency), pressure drop and particle type are the most essential criteria for selecting best suitable air filter. In addition, the first two criteria have a critical influence on energy issues, which should also be considered.

Coarse Particulate Filters/ Saturation Filters

Coarse particulate filters are commonly used as pre-filters. Primarily, they separate coarse dust types >10 µm. In industrial applications, configurations as filter mats, filter cassettes, pocket filters, metal mesh filters or wire frame filters are well proven. Since coarse particulates are mainly dry dusts, this filter selection is based on the percussion effect, i.e., due to their inertia forces particles are bound on the filter surface. After the formation of a so-called filter cake and respective saturation, the filters can be cleaned/dedusted and reused. The precondition is a constant air flow. The benefit of saturation filters is the low initial investment and high flexibility, but set against high maintenance and operation costs.

Fine Particulate Filters/Storage Filters

Fine dust filters are primarily used for separating airborne pollutants > 1 µm. Although they are available as pocket filters or compact cassettes, their utilisation as cleanable or regenerative filters (e.g., in the form of cartridge filters) has been proven in industrial applications. Long life is the benefit of cartridge filters (i.e.,

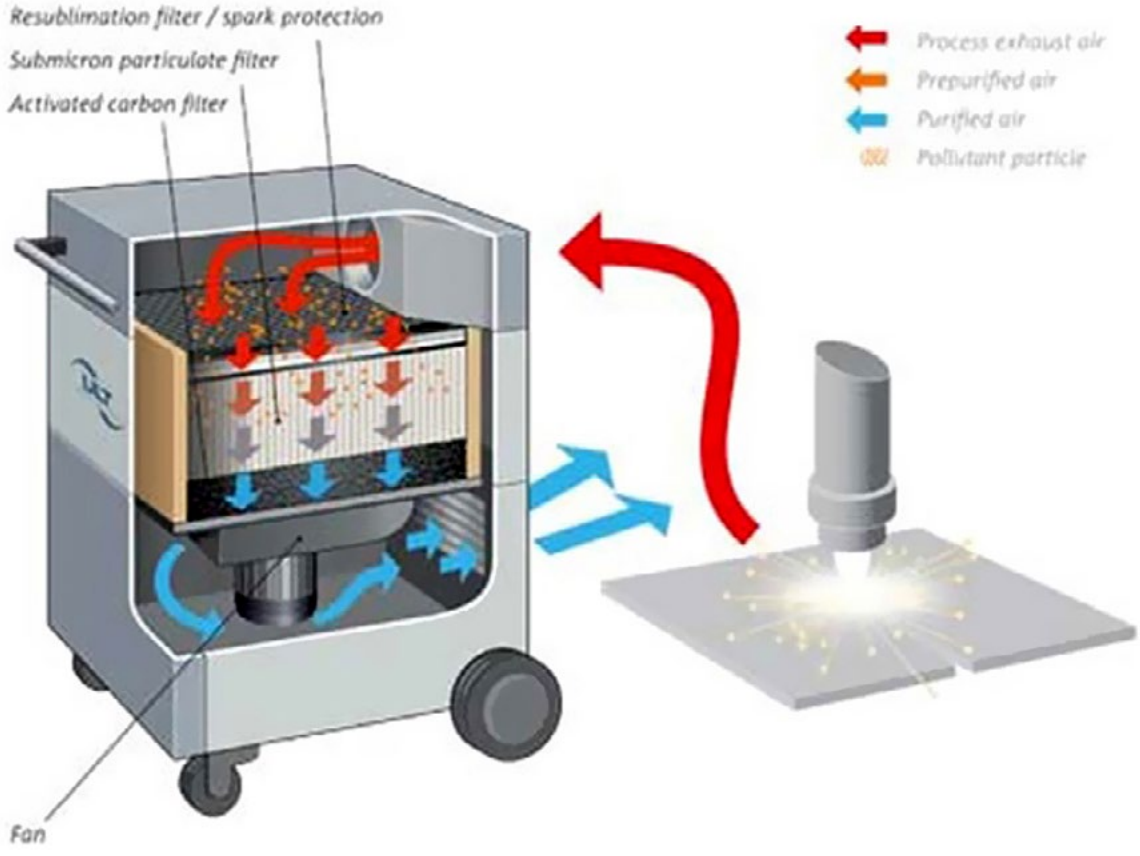

Figure 3: Principle saturation filter system.

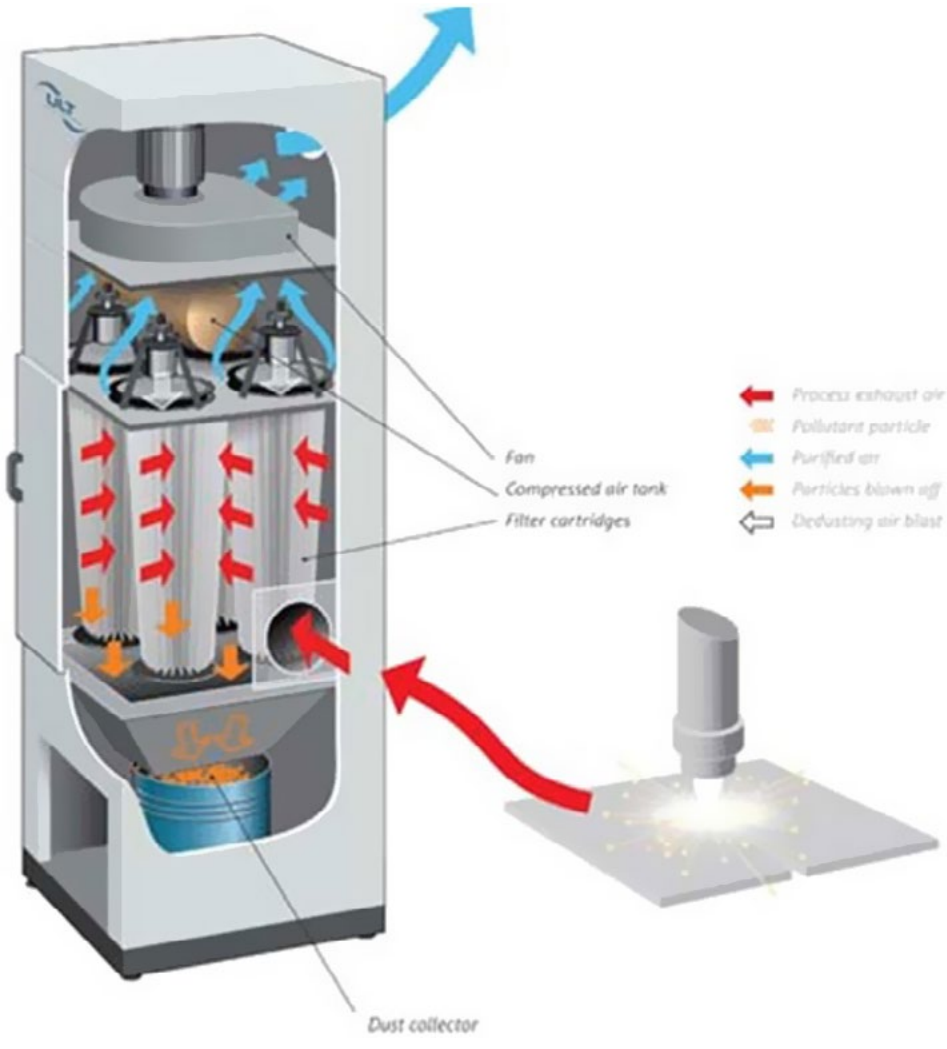

Figure 4: Principle cartridge filter system.

their separation efficiency is constantly high) and also in case of varying air flow (up to 98%). Further advantages are low maintenance and energy costs. Cartridge filters, however, are less flexible and require a higher investment.

High-efficiency Submicron Particulate Filters

Processes that apparently generate fewer pollutants are particularly critical, because low quantities of emissions in the nano range no longer effect an agglomeration, and nanoparticles keep their sizes (< 1 µm). These extremely fine particles enter the lungs and blood, and might in the worst case result in a shortened life expectancy. The utilisation of HEPA filters/ H-class filters (high-efficiency particulate air filters) is critical for effective filtration. HEPA filters are used for air purification of up to 99.995%. They are primarily utilised as storage filters in the form of cassettes. In cleanroom technology, they are also used as plate filters or fan filter units (FFU), which means a combination of HEPA filters with controlled fan or prefilter. Ultra-low penetration air filters (ULPA) are applied if the air flow has to be nearly particle-free (degree of separation from 99.9995%).

Modular Systems

Airborne pollutants are usually a mixture of coarse and fine particles—processes often produce particle sizes between >1 µm and <10 µm. In practice, extraction and filtration systems that combine the advantages of both filter principles are well proven. Such units are specifically developed to meet special application requirements. Additional benefits are the availability of the equipment, price-related attractiveness as well as flexibility if application conditions change.

Adsorption of Gaseous Air Pollutants

Gaseous and vaporous substances can be stored in activated carbon or other sorbents. Activated carbon is made of organic materials (e.g., peat or nutshells) and provides an adsorption-capable surface of up to 1,700 m²/g. This means an extremely high degree of separation and an enormous storage capacity, which finally results in very high filter life. If particle concentrations are higher, combustion processes seem reason-

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KEYNOTE ADDRESS

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Michael Osterman, Ph.D.
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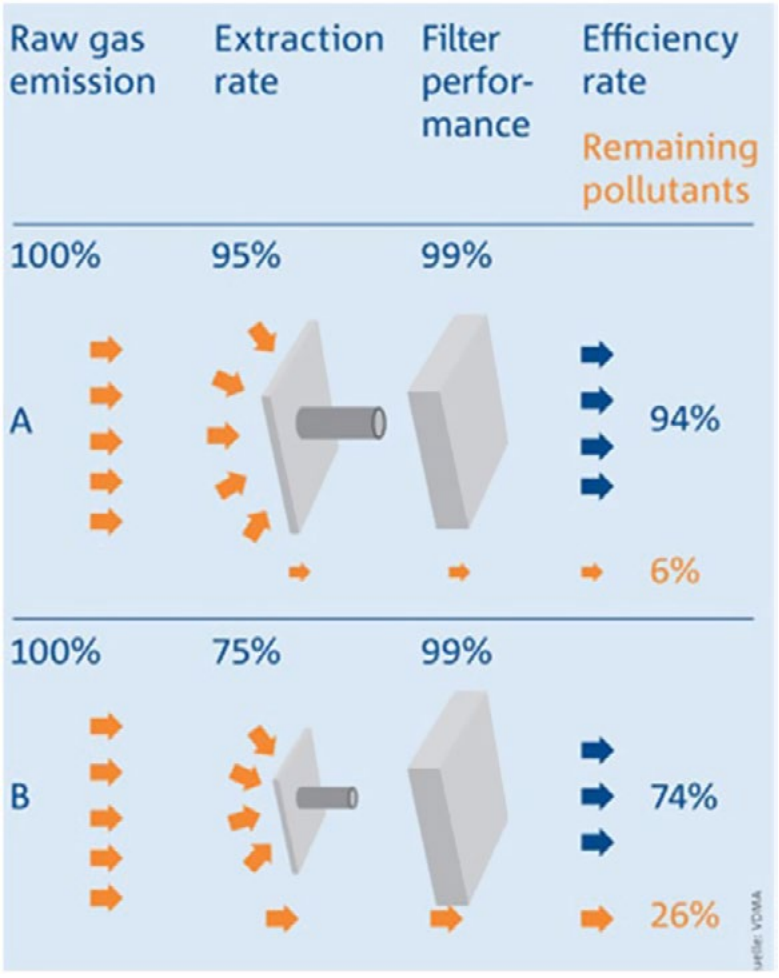

Figure 5: Impact of the extraction rate on efficiency. (Source: VDMA)

able. In terms of energy, they are only profitable if the combustion process is stable and runs without additional power supply. Catalytic processes represent an intermediate stage. They always require a constant contaminant mixture. Overall, sorbents provide a better flexibility but need a strict obedience to organisational measures or change intervals.

Pollutant Capturing

Quality of pollutant collection is the linchpin of extraction and filtration technology. Basically, the appropriate capturing element can deliver a substantial contribution to the quality of the extraction and filtration device. The degree of capture rate forms the basis for subsequent high-grade filtration, finally providing high overall efficiency and low residue in the returned clean air.

In particular, capture at the source of the pollution generation is of critical importance. A general rule says that twice the distance between emission source and capturing element requires four times the exhaust performance in the extraction and filter system. That gives an exponential conclusion to the energy requirement—in times of energy conversation a remarkable aspect.

Extraction and Filtration: Foremost Self-protection

Extraction and filtration systems have their unquestioned positions in many companies—in manual workplaces, in automated and semi-automated production lines. Occupational health and safety (OH&S) protection in electronics manufacturing companies as well as in laboratories has gained importance in recent decades, because the impact of airborne pollutants on employees, machines and products has a critical influence on production and profitability. The maintenance of production equipment, accuracy of product quality and functionality, as well as OH&S measures can generate high costs. It should be the goal of any company, which produces high-quality goods, to minimize these costs. The most suitable extraction and filtration system will help. **SMT**

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2. Grundlagen der Filtertechnik. Luftfilterbau GmbH, V2.4, 5/2012.

Stefan Meissner is the head of corporate communications at ULT AG.

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1 The Road Less Traveled (Part 1): Contract Manufacturing Differentiators

The word "differentiator" is tossed around a lot these days in the electronics industry—especially within the contract manufacturing (CM) community. When evaluating a new potential CM partner, decision makers frequently ask: "What would you say differentiates your organization from other contract manufacturers?" This article talks about three powerful and very real difference-makers that would set a CM apart from the competition.

2 Doug Pauls Explains Ion Chromatography

Doug Pauls, principal materials and process engineer at Rockwell Collins and chair of the IPC Cleaning and Coating Committee, drew upon his 25 years' experience in the use of ion chromatography for electronics assembly improvement to discuss ROSE techniques, how ion chromatography can be used to determine electronic cleanliness, what specifications exist and how they were derived, and how ion chromatography can be used for process troubleshooting and optimization.

3 IPC: Slight Upturn in Salary Increases in Electronics Assembly Industry for 2016

IPC's recently published biennial wage and salary study for the electronics assembly industry shows a nominal upturn in salary increases from 2015 to 2016.

4 Newbury Electronics Invests in Latest X-Ray Machine Technology

Newbury Electronics has enhanced its production capabilities by investing in a new, highly accurate X-ray reference hole drilling machine.

5 SMTA International 2015 Best Papers Announced

The SMTA has released the list of best papers from the recent SMTA International 2015 conference.

6 Key-Tech Electronic Systems Boosts Capabilities; Installs New Equipment

Key-Tech Electronic Systems is further advancing its production ambitions with the recent installation of two fully automated Yamaha Z:LEX YSM20 modular surface mount machines.

7 EMS Transactions Down in 2015

There were 27 EMS transactions recorded in 2015, down from 33 recorded in 2014, according to Lincoln International.

8 Flex to Manufacture HiQ Solar's TrueString Inverters and Accessories

PV inverter innovator HiQ Solar has selected Flex to manufacture its TrueString inverter family.

9 Key Tronic Posts 21% Growth in 1H FY2016 Revenue

EMS firm Key Tronic has announced total revenue of $242.6 million for the first six months of fiscal year 2016, up by 21% from $200.7 million in the same period of FY 2015.

10 SMTC's China Facility Receives ISO 13485 Certification

SMTC's manufacturing facility in Dongguan, China has been awarded ISO 13485 certification for medical device manufacturing.

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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.

Houston Expo & Tech Forum
March 1, 2016
Stafford, Texas, USA

Dallas Expo & Tech Forum
March 3, 2016
Plano, Texas, USA

IPC APEX EXPO Conference & Exhibition 2016
March 15–17, 2016
Las Vegas, Nevada, USA

CPCA Show (China International PCB & Assembly Show)
March 15–17, 2016
Shanghai, China

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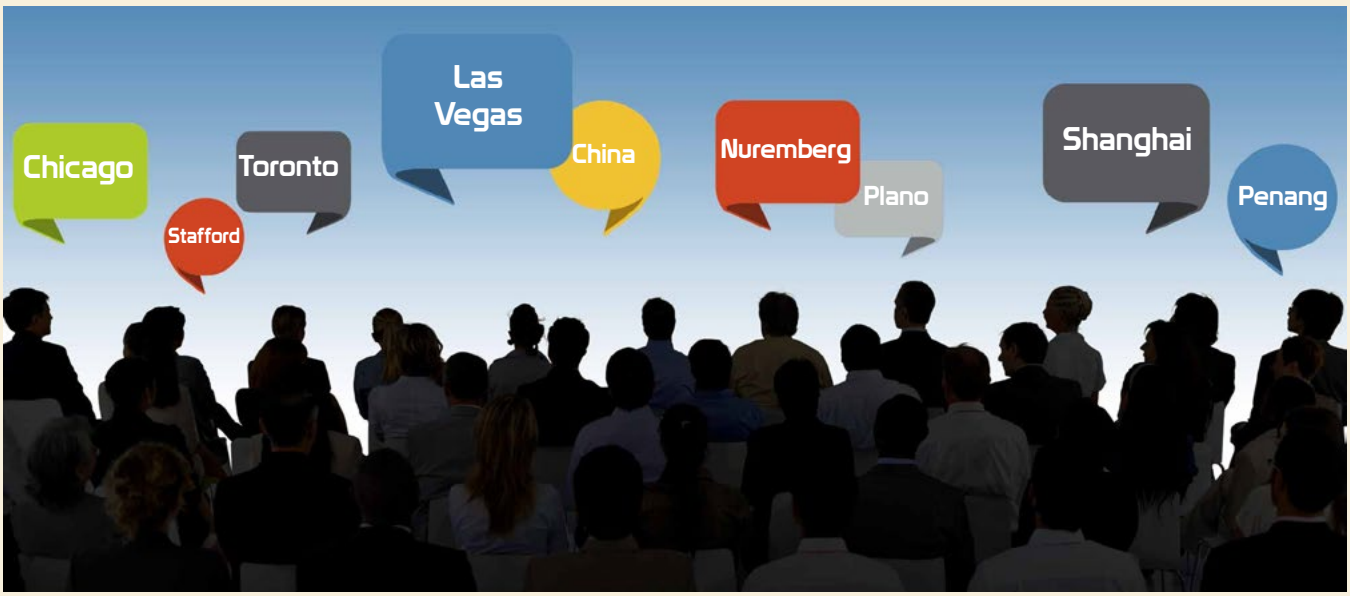

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