# THE pcb design MAGAZINE

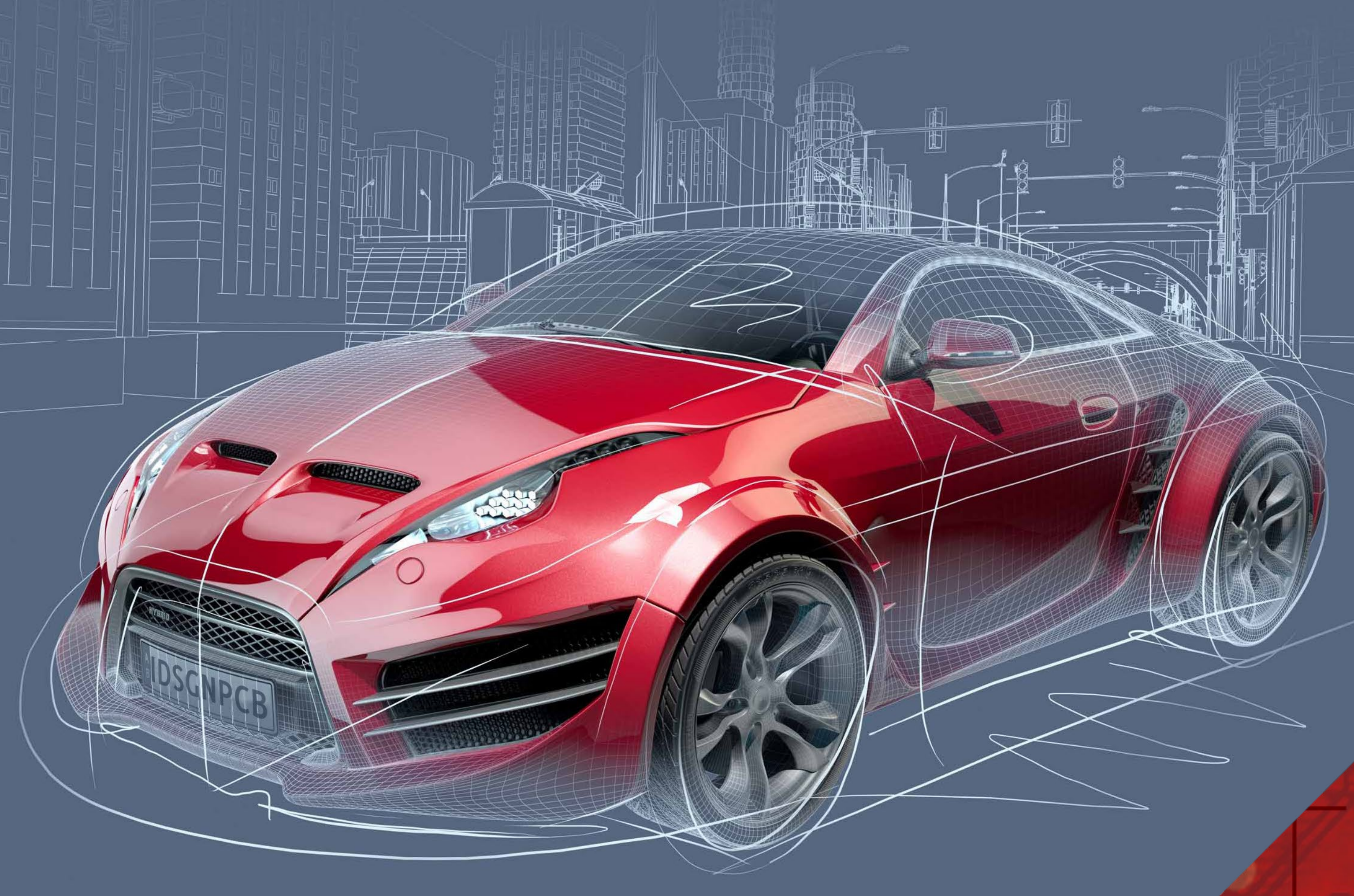
September 2015

an I-Connect007 publication

The Challenges of Being Competitive in Automotive Electronics Manufacturing p.24

Physics of Failure Durability Simulations for Automotive Electronics p.34

## CARS: A Driving Force in the Electronics Industry




## Automotive Systems Design: A Support Engineer's Perspective

*by Monica Andrei, page 12*

# Seeking Experienced Sales Person to Join Our Team!

Work where you live! The I-Connect007 team is seeking an experienced salesperson to generate and manage a revenue stream for content marketing campaigns in new e-publication series and supporting online ad campaigns within our online directories and publications.

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I-Connect007
GOOD FOR THE INDUSTRY

THE pcb design MAGAZINE

September 2015

## THIS MONTH'S FEATURE ARTICLES

# Cars: A Driving Force in the Electronics Industry

Cars now have exponentially more electronic features than a decade ago, and automotive electronics is one of the "driving" forces in electronics design and manufacturing. This month, we're featuring automotive articles by Monica Andrei of Continental Automotive Systems, Tom O'Connor and James G. McLeish of DfR Solutions, and Michael Ford of Mentor Graphics.







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- **IS680** materials offers a complete laminate materials solution for single- and double-sided printed circuit designs and is a cost-effective alternative to PTFE and other commercial microwave materials.
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- **TerraGreen®** halogen-free, very low-loss, thermoset materials are available in a variety of laminate and prepreg offerings. This material is inexpensive to process – improving your company’s bottom line, as well as the environment.
- The revolutionary **Astra® MT** ultra low-loss thermoset laminates are a replacement for PTFE. These materials have been used for hybrid applications with Isola’s 185HR and 370HR products.

| | RF/MICROWAVE MATERIALS | | | | |
|---|---|---|---|---|---|
| | IS680 | I-Tera® MT RF | I-Tera® MT | TerraGreen® | Astra® MT |
| Tg | 200°C | 200°C | 200°C | 200°C | 200°C |
| Td | 360°C | 360°C | 360°C | 390°C | 360°C |
| Dk @ 10 GHz | 2.80 - 3.45 | 3.38, 3.45 & 3.56 | 3.45* | 3.45* | 3.00 |
| Df @ 10 GHz | 0.0028 - 0.0036 | 0.0028, 0.0031 & 0.0034 | 0.0031* | 0.0030* | 0.0017 |
| CTE Z-axis (50 to 260°C) | 2.90% | 2.80% | 2.80% | 2.90% | 2.90% |
| T-260 & T-288 | >60 | >60 | >60 | >60 | >60 |
| Halogen free | No | No | No | Yes | No |
| VLP-2 (2 micron Rz copper) | Available | Available | Available | Standard | Standard |
| Stable Dk & Df over the temperature range | -55°C to +125°C | -55°C to +125°C | -55°C to +125°C | -55°C to +125°C | -40°C to +140°C |
| Optimized global constructions for Pb-free assembly | Yes | Yes | Yes | Yes | Yes |
| Compatible with other Isola products for hybrid designs | For use in double-sided applications | Yes | Yes | Yes | Yes |
| Low PIM < -155 dBc | Yes | Yes | Yes | Yes | Yes |

* Dk & Df are dependent on resin content NOTE: Dk/Df is at one resin %. Please refer to the Isola website for a complete list of Dk/Df values. The data, while believed to be accurate & based on analytical methods considered to be reliable, is for information purposes only. Any sales of these products will be governed by the terms & conditions of the agreement under which they are sold.

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**http://www.isola-group.com/conversion-service**

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- This software tool provides a design or an equivalent dielectric constant to facilitate modeling for PCB designers to predict impedance and other design attributes. The software computes changes in the effective dielectric constant due to dispersion at higher frequencies. The software then computes the total insertion loss – a measure of power lost through heat for power handling calculations, including the dielectric loss, conductor loss, and the loss due to the surface roughness. The main factors affecting the typical power-handling capability of a material are its thermal conductivity, the maximum operating temperature, and the total insertion loss.

**https://isodesign.isola-group.com/phi-calculator**



**www.isola-group.com/RF**

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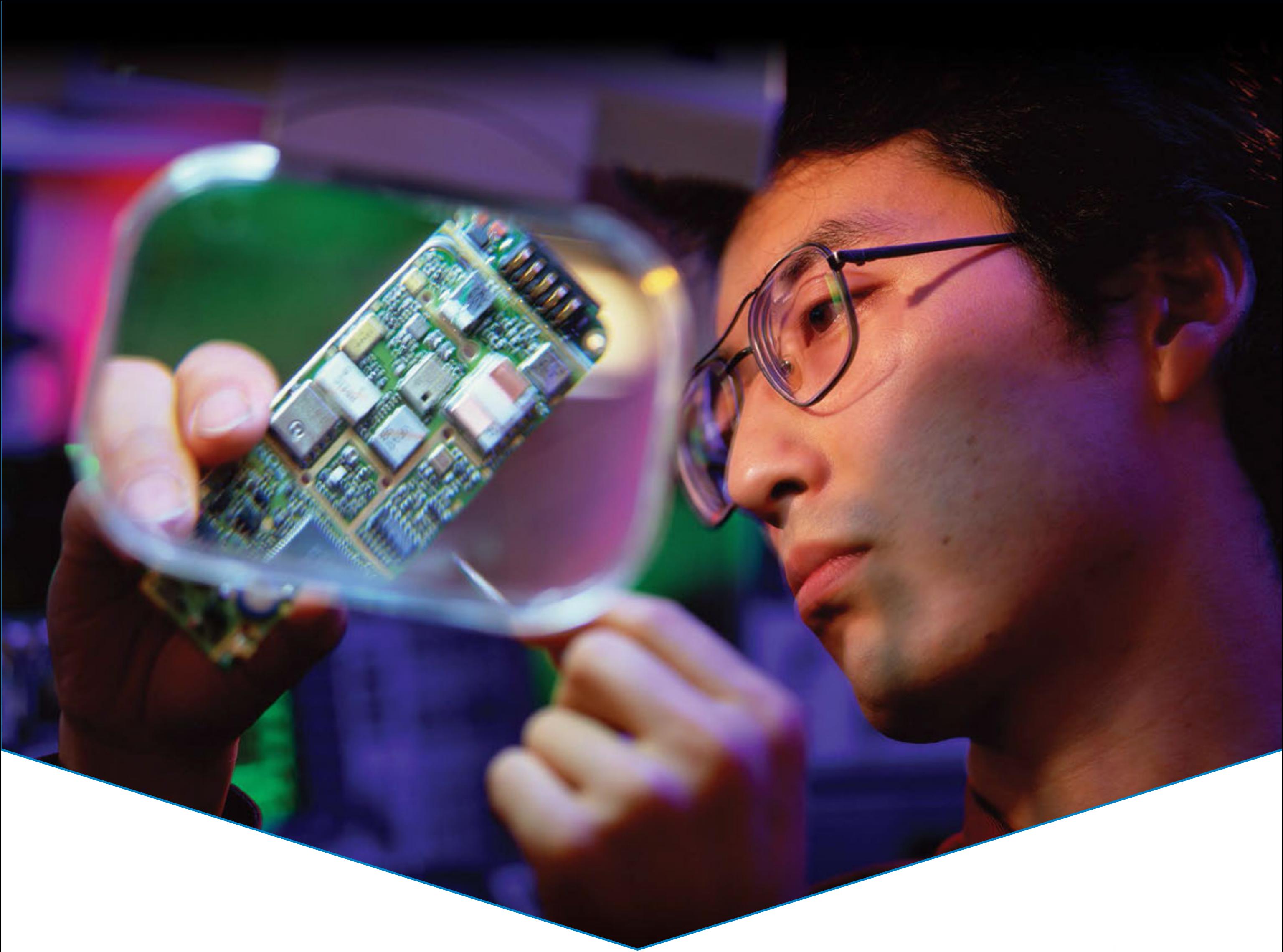


# Car Talk

**by Andy Shaughnessy**
I-CONNECT007

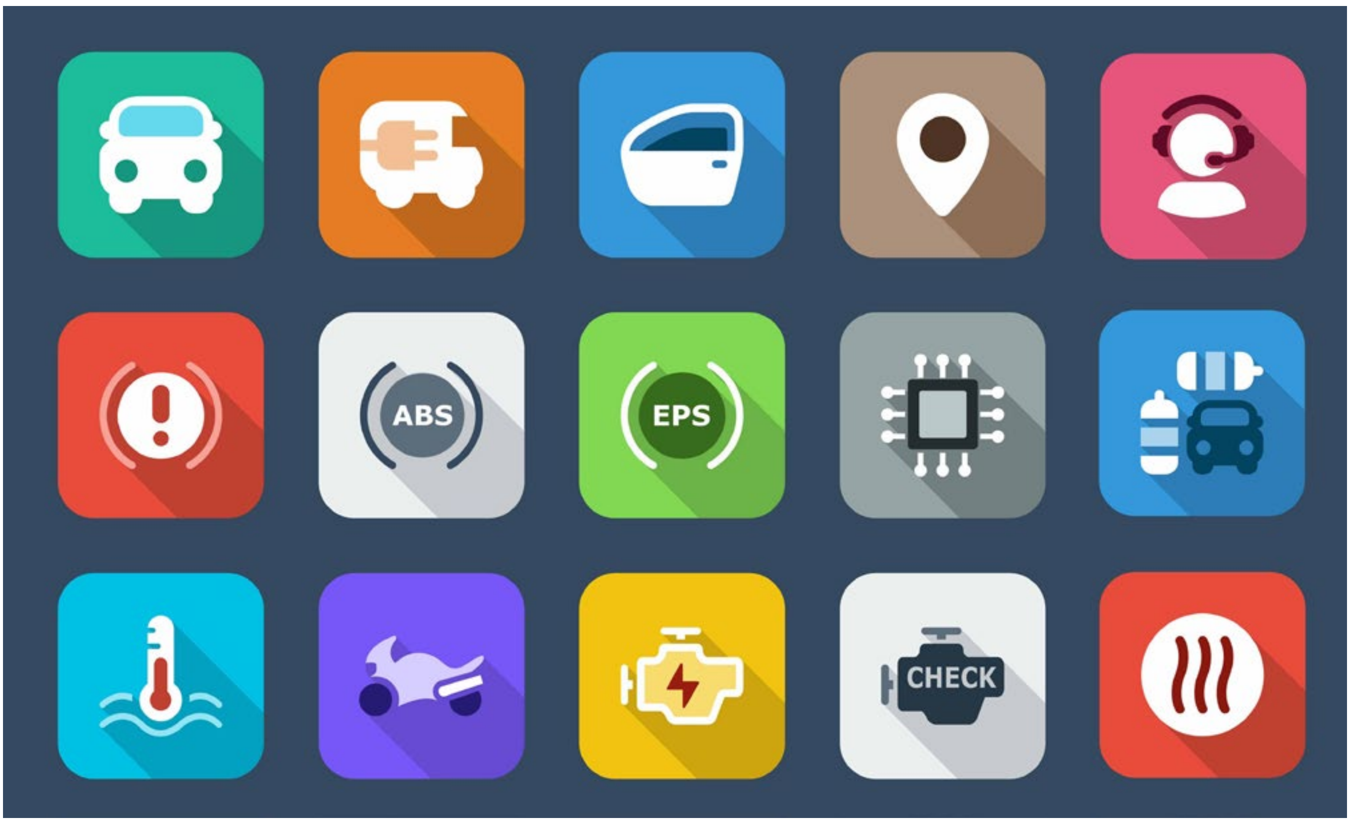
My girlfriend Rita doesn't like to drive in traffic. As an Atlanta resident, this is a problem for her, because Atlanta has some of the worst traffic jams in the U.S. (I think it's worse than Los Angeles; I've never sat for three hours in the same spot in LA.) So, after her last motoring miscue, she bought a new Mazda 3—the cheapest car Mazda makes—but it's tricked out with every anti-collision feature available.

Now, it's almost impossible for Rita to trade paint. Hit the turn signal when another car is passing, and all kinds of alarms go off. If you drift over and touch the yellow line on either side, the car starts beeping like crazy. If the car ahead of you slows down when cruise control is engaged, the car applies the brakes automatically and keeps you a certain number of car lengths behind Mr. Slowpoke. And if the reverse video doesn't do the trick, the car starts beeping if you're about to back out in front of a vehicle that you can't see.

Yes, I poked fun at Rita for having all of these countermeasures beeping and pinging, but they work great. You can even turn them off, which I would do if I had to drive her car for any length of time.

Plus, the entertainment system has a great GUI; you feel like you're sitting in your couch at home, flipping through the channels. You barely have to take your eyes off the road (or the handy speedometer in the heads up display) to find another CD on your phone's Bluetooth, which is the point.

All of these electronic features come at a price, though: about $5,000, in this case. But we're willing to shell out extra cash for features that will make us feel safe, or offer us greater convenience or entertainment.



## CAR TALK


Yes, the automotive electronics segment has exploded. Early cars didn't have much in the way of electronics. Even in 1950, electronics made up only 1% of a car's cost. (That was probably just the Philco AM radio.) But that figure is expected to hit 35% in 2020, and 50% in 2030. The global automotive electronics market is forecast to hit $314.4 billion by 2020, and that means a whole lot of PCBs.

And that's where we come in! This issue of *The PCB Design Magazine* features a cover story "Automotive Systems Design: a Support Engineer's Perspective," written by Monica Andrei of Continental Automotive Systems. As a design support engineer, she supports 1,700 PCB designers across dozens of countries, speaking a variety of languages. In this article, Andrei explains in detail how Continental transitioned from a traditional PCB design structure to a true systems design approach.

We're also bringing you a feature article by Mentor Graphics' Michael Ford, "The Challenges of Being Competitive in Automotive Electronics Manufacturing." Ford explains how the automotive electronics landscape continues to evolve, as well as the effects of various economic, compliance, and legislative elements on this market.

And we have a feature by Tom O'Connor and James G. McLeish of DfR Solutions, "Physics of Failure Durability Simulations for Automotive Electronics." They explain how carmakers' design teams can use reliability physics to help predict how and why electronic systems, components and materials fail. Since the typical new car is chock-full of electronic systems and components, the potential for failure is greater than ever.

Some automotive analysts and technologists believe that within 100 years, everyone will own a self-driving car. These cars will stay in constant touch with each other, and accidents will become a thing of the past. Does that sound crazy? Maybe, but it's not impossible. One thing is certain: Automotive electronics is one of the "driving" forces in the PCB community.

Next month, we'll focus on a variety of ways to accelerate the PCB design cycle. In the meantime, the trade show season is kicking off, with PCB West coming up September 15–17 in Santa Clara, California, and SMTA International September 27–October 1 in Rosemont, Illinois.

See you next month! **PCBDESIGN**

**Andy Shaughnessy** is managing editor of *The PCB Design Magazine.* He has been covering PCB design for 16 years. He can be reached by clicking here.


# Automotive Systems Design: A Support Engineer's Perspective

**by Monica Andrei**
CONTINENTAL AUTOMOTIVE SYSTEMS

Assume you need to design a multipart complex product requiring several PCBs to be fitted into a tight housing. Assume also that you have to bring product iterations to market as fast as possible, be it at regular intervals or on demand. Finally, assume that you will have to do this not only faster, but also at an increasingly lower cost. This is a trend that becomes the norm for products in many industries, not least in automotive electronics.

Specifically, automotive electronics require connecting an increasingly higher number of signals, fitting a multitude of PCBs into a single housing, checking a large number of electric and mechanical parameters and being able to simulate their interaction in the system functionality context.

With product complexity growing, space availability at a premium and a market that becomes more demanding in terms of quality and reliability, you would surely appreciate a suite of tools that gives you the ability to take care of all these interrelated demands. Not surprisingly, automotive electronics system designers are definitely among those who badly need the means, tools and support to cope with all these developments and many more.

In this new fast-changing environment, at a minimum, you would like to be able to design, test and simulate, so that:

- All functions perform to expectation
- All signals are connected throughout the system
- The signal integrity is guaranteed over the entire frequency range
- The supply power and grounding comply with all specific component requirements
- The electromagnetic interference is kept under control
- All boards, when assembled, fit into the case, so that
- The entire system ends up fit for purpose

This method has been dubbed a system design approach. Although this entails more steps than traditional approaches, it allows for streamlining the design, as well as for testing and verifying each operation separately and in concert. Overall, it gives designers the ability to be and to stay in control when designing complex systems with a multitude of requirements that appear contradictory.

Moreover, the system design approach allows for:

- Checking functionality on system level, which improves reliability
- Simulating product test cases, which augments quality, and
- Optimizing redundancy, which reduces system costs

In a nutshell, the promise of the system design approach is to allow for hitting the "sweet spot" in terms of functionality, quality and reliability, in the shortest possible design time and with the lowest possible resource investments.

> "At this junction, the question of whether the systems design approach is already reality or not becomes most important."

In an industry that has a very long time to market (on average around 1,000 days), steadily increasing quality demands and an ever intensifying pressure to lower costs, all these promises become most attractive and compelling.

### Getting Started

You obviously must begin working with the new tools taking the first step first, which means identifying which suite of tools offered by the market best fits the company needs. Once the needs have been defined, determine where to purchase these tools. If you are a newcomer to this situation, research the market for the most appropriate suite of tools and make a decision based on the cost-benefit analysis results. Among others, factor in the cost of testing the offers versus the risk of not making the best choice. For this aspect of the decision-making process, it is important to rely on the information the supplier provides, which, as matter of experience, can be deficient or incomplete. It is obvious that this first step becomes a challenge by any measure.

But if you have a long-standing relationship with an EDA tool provider, how do you decide? What if your designers are accustomed to that provider's approach, culture and peculiarities? You probably will correlate the above-mentioned aspects with the cost of changing the provider. There is a high probability you will arrive at the conclusion that working together with your current provider yields higher benefits than the alternative.

At this junction, the question of whether the systems design approach is already reality or not becomes most important. Well, currently it is not wishful thinking, but it is not quite available either. The market is in the midst of implementing this much-needed evolutionary design methodology.

The market offers tool suites that aim at designing, testing and simulating an electronics system by taking a system approach. In complete configurations, most suites aim to fully support:

- System schematics design
- Functional simulation
- PCB design
- Signal integrity simulation across the system (including board interconnection),
- Power integrity simulation across the system
- Mechanical simulation for assembling the PCBs into the housing, and
- Collision simulation.

For these tools to work as specified, you have to consider the host platform characteristics, primarily configuration, bandwidth, operating system and cost. For the time being, a powerful Windows PC with an acceptable display appears to be good enough. You can consider adding a tablet to increase the usability.

## The Automotive Sector, by the Numbers

**Automotive Electronics**

• The global market for automotive electronics is expected to reach $314.4 billion by 2020, with an estimated compound annual growth rate (CAGR) of 7.3% between 2012 and 2020.

• The OEM automotive electronics sector accounts for an estimated share of 86.3% in 2013, which equals to $165.2 billion in the overall automotive market. This segment is expected to reach $277.1 billion by 2020, a CAGR of 7.6%.

• In 1950, automotive electronics made up 1% of a car's total cost; by 2000, that figure had jumped to 20%. That percentage is expected to reach 35% by 2020, and 50% of total car cost in 2030.

A most critical factor is the design team. You need technically skilled PCB designers who can envision the system as a whole and cope with the challenge of ever-increasing limitations and constraints. In this newly created environment, they have to understand not only the logic and electrical behavior of the system, which used to be the key requirement, but also the mechanical and electro-magnetic requirements, stemming from fitting the boards into the housing. Designers will have to test and simulate system functionality and conformity at logical, electrical, mechanical and, increasingly, at EMC levels.

### Systems Design Flow Implementation

Tools implementation should begin with the learning phase, which entails familiarization with the individual design tools. I would start with those new tools that directly replace the legacy tools as they are discharged, only because this allows for faster learning, comparisons and benchmarking. Gradually, new tools should be integrated into the design flow, until the designers master the entire suite of tools. The learning curve entails not only the learning effort itself, but also a cultural shift, for inertia always takes care that changes can be made only incrementally. Finally, along with the designer mindset, you will need to change the company culture up to the point when the new tools become for everybody, not only for the designers, a necessity, rather than a luxury.

Well, now you have your hands full because the real implementation work can begin. You need to run test cases for each new tool and application segment. It's best to begin with the ones that you are familiar with from previous work, like designing schematics and designing boards. Verify how well the new tools work for each application segment. The next step would be to integrate those test cases into the design flow, which now becomes a hybrid with a combination of legacy and new designs. By repeating this step for each of the other tools in the suite, the legacy design process will be gradually transformed into a new design process. For a useful evaluation of this work, it becomes critical to correctly assess and then measure how much effort is required to:

- Configure each tool to fit into the design process
- Bring designers up to speed for using the new tools
- Migrate legacy designs to the new tools, without interfering with design and production
- Find out how the third party tools, needed for supporting additional functions, can be integrated into or replaced by the new tools

After testing and validating all tools of the suite, you need to validate their interaction. This time around, focus on the specific features that support the system design approach, such as the electric diagram for the system as a whole, the method for assigning schematic blocks to different boards, and the ability to move components or groups of components from one board to another.

In addition, run the various checks you are familiar with from the board level at the system level, verify how all the boards fit into the hous-

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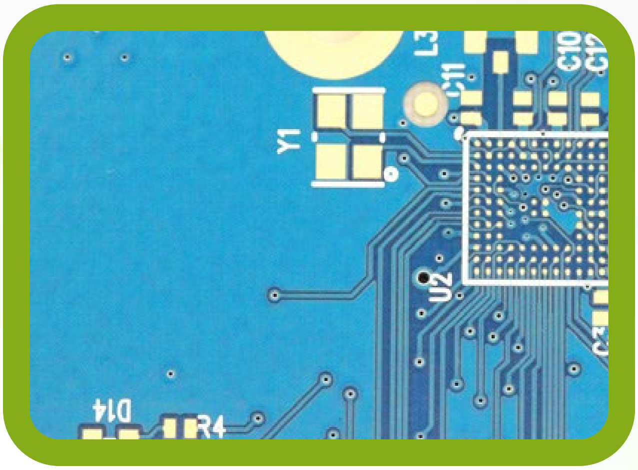

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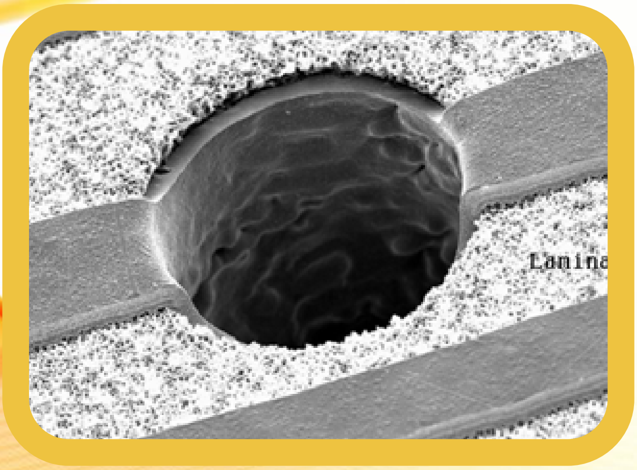

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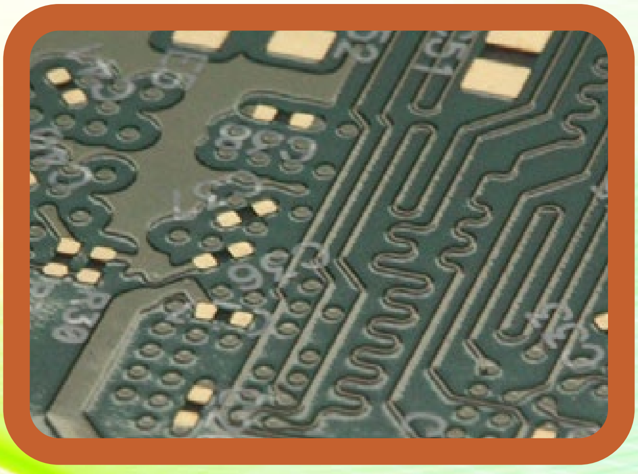

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## The Automotive Sector, by the Numbers

**Automotive Sales**

- More than 800 million passenger cars are in use globally.
- The world has 165 passenger vehicles per 1,000 inhabitants.
- Toyota, General Motors and VW are the largest passenger car manufacturers in the world.
- Daimler is the world's largest truck manufacturer, followed by Dongfeng Motor and VW. Dongfeng plans to expand from China into the UK, Ireland, and Paraguay.
- In 2000, 41 million automobiles were produced globally; by 2005, that figure had risen to 47 million.
- US car sales increased steadily (an estimated 3.69 million per year) from 1960 to 2006, only declining during 1990-1991's mini-recession and stagnating in 1997.
- Total US car sales in 2014 hit 16.5 million; electric car sales were less than 1% of that.
- US electric car sales rose 23% YOY in 2014, to 119,710 vehicles.
- Worldwide, 283,202 electric cars were sold in 2014.

ing, verify the results, and output the manufacturing files.

To keep the implementation of the new design flow under control, best practices would recommend a gradual incremental approach. In the following order, be sure to:

1. Run test cases (mock designs)
2. Design pilots (real designs that go into production)
3. Aggregate everything into a consolidated, coherent flow

Within this process, move on to the next step only if and when the preceding one yields satisfactory results. Verify that the old designs can be ported to the new platform in a satisfactory way and that all functions are working to expectation. Before concluding the design flow migration, make sure that the new design process is fit for purpose in all respects, like functionality, flexibility and user friendliness.

A key design flow ingredient is the library with all electric, mechanic and magnetic characteristics required for creating models for each individual component. Those characteristics are used not only for designing, but also for spotting an electrical lack of compliancy, mechanical collision or electromagnetic interference conditions that might result from the way the components are laid out on the PCB. Identifying and fixing these errors early in the design process not only saves time and resources, but also improves quality.

### Assembling the Team

A successful design flow implementation assumes the close cooperation of a team of specialists comprising electronic engineers, mechanical engineers, cross-domain specialists, PCB designers, project managers, support engineers, and trainers.

On the other hand, in a global corporation such as Continental, with a large spectrum of products, implementation challenges increase exponentially. In a multinational corporation, you must deal with different design approaches depending on electric system specifics, designers coming from different cultures, and designs having to be transferred from one design team to another.

Specifically, as a design support engineer, you need to actively champion the implementation of the new tools suite by providing:

- The optimum tools configuration, such that it accommodates the proprietary design processes
- Technical support during the test phase, aimed at spotting and solving issues and problems
- A real-time account of all open issues and problems
- Training sessions for the user community
- A disproportionate amount of technical support for the users during the learning phase

## The Automotive Sector, by the Numbers

**On the Road Today**

• NYC is the only locality in the US where more than half of all households do not own a car. In Manhattan, the figure is 75%; nationally, it's 8%.

• In 2012, 254,639,386 light duty vehicles were registered in the US, along with 8,190,286 vehicles with 2 axles and 6 or more tires, 2,469,094 vehicles classified as "truck, combination," 8,454,939 motorcycles, and 764,509 buses.

• In 2001, 70% of Americans drove to work.

• As of 2011, the median age of all US vehicles was 10.8 years.

In addition, involve your suppliers in solving those issues and problems that cannot be handled internally by the design support team.

In the transition period from legacy to the new design flow, the challenge is augmented when the same design support team needs to provide support for the ongoing developments, while introducing the new tools. The team has to continue supporting designers who use the legacy tools to achieve objectives and hit deadlines. At the same time, they have to champion test cases and pilots and identify tool configurations that best fit the design process in place. They also have to train designers who are in the process of switching to the new tools and support the daily activity of those designers who use them already.

Generally, design support needs to cover the entire community of users. In this case, we have thousands of designers across many locations in most of the industrialized countries. Barriers created by nearly as many languages and cross-cultural hurdles need to be overcome. For simplification, a good advice is to limit the number of internally used languages, with English functioning as the lingua franca.

Flexibility turned out to be the paramount requirement for the new development environment. We have chosen an open tools suite, for it provides the needed customer adaptation flexibility. Further, each tool needs to be adapted to the company design and manufacturing processes. Moreover, the tool suite needs to adapt to a broad variety of electric systems as well. Adapting the tools suite to the company processes has revealed that some of the required functionality is not included in the native tool suite. This creates the need to provision for including such functions as add-ons not only for current, but also for future needs.

In terms of implementation, in an ideal world you would like to use the tool suite as it has been delivered. It is well known that this is how tools work best. However, if you already use legacy tools and you need to keep up with real design and manufacturing needs, it is important to transition smoothly from the legacy to the new tool suite. For the transition phase, we have decided to replace the legacy tools in a selective sequential mode into the design flow used presently. Know exactly where the tools are compatible and where they are not, and configure the environment so that it is supportive of an incremental transition to the new tool suit. Thus, design support has to demonstrate flexibility in assisting designers throughout this transition phase. Moreover, design support needs to take ownership of the changes to best advise pilot team designers how to achieve goals and hit deadlines.

These transition efforts, as well as specific circumstances, have more clearly revealed the amplitude of the challenge to cover all the design support tasks with the present team. Bringing design engineers up to speed is a lengthy, laborious and tedious process. To work as a team, in addition to the technical skills, design engineers have to develop soft skills to blend into the team and company culture; a dysfunctional team is a counterproductive team. It became obvious that the existing technical support team will have to be enlarged, both in terms of number of people and skills, to keep up with the transition work. The expectation is that support engineers act as the catalyst for both requirements, which points to key additional job requisites for future candidates.

### The Results

Overall, the transition process evolved at the forecast pace. As expected, there were some inherent glitches, but the team pulled together to overcome them. With the benefit of the hindsight, it appears that the company has made the right choice to adopt an incremental transition from the legacy to the system design approach. The testing of the new tools during the pilot phase reveals that this transition process can be kept under control. The current focus in this ongoing process is on adding functionality and on making the process more user-friendly, which should bring about improved design efficiency.

Introducing a new suite of tools is a long and winding road and you need all the help you can get from the supplier of the tools suite. Software in general and design tools in particular are per definition works in progress, which makes the cooperation between customer and supplier a bare necessity. Changes are required not only for ameliorating characteristics and performance, but also for keeping pace with the steadily changing market requirements.

Although suppliers constantly improve their products, customers always require faster and increasingly more reliable tools that can lower the design costs and shorter time to everything: time to test, time to pilot, time to prototype, time to production, and time to market. As they say, no matter how much you give to a customer, he wants more, and suppliers have to accommodate those concerns on an ongoing basis.

So far, the transition to the new tool suite has demonstrated that the efforts are worthwhile, and because the new tools can be made more user-friendly, they are more flexible, they have new and enhanced functionality, and database integrity is better protected. Not least for these reasons, the benefits of the new system design approach clearly outweigh both challenges and drawbacks. **PCBDESIGN**

**Monica Andrei** is CAD support engineer with Continental Automotive, a global automotive electronics company.

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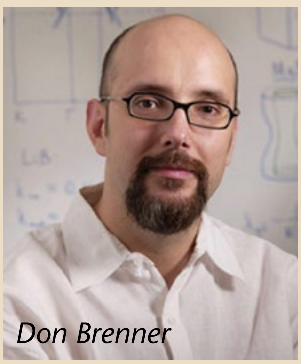
## Researchers Develop New Techniques for Creating High-Temp Alloys

A new grant seeking to develop new techniques for creating high-temperature materials is taking advantage of Duke University's expertise in computational materials genomics—the computer modeling of novel materials to identify which might have desirable properties.

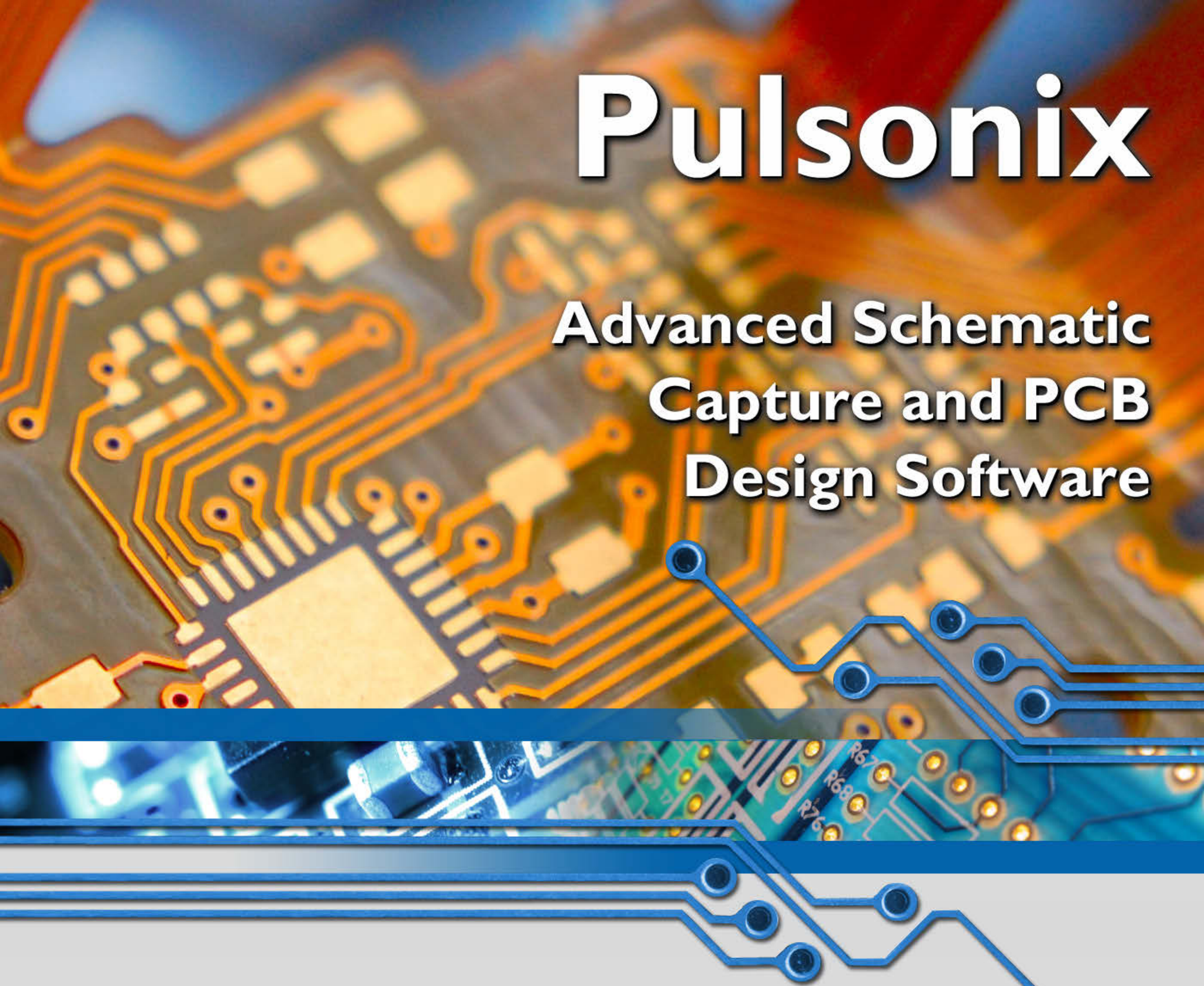
Led by NC State University's Stefano Curatolo (pictured), the new initiative addresses fundamental scientific questions that could lead to so-called "entropy-stabilized alloys." The initiative also includes the University of Virginia and the University of California, San Diego, and is funded by a five-year, $8.4 million grant from the Office of Naval Research (ONR).



*Don Brenner*

"The Defense Department has a need for materials that are mechanically and chemically stable at temperatures of 2000°C or more," says Don Brenner, Kobe Steel Distinguished Professor of Materials Science and Engineering at NC State and principal investigator under the ONR grant. "These materials can have significant aerospace applications, but the number of usable materials is currently small, and those materials rely on strong chemical bonding to remain stable. At high temperatures, most materials are simply no longer stable."

These alloys are of interest for use in ultra-high temperature applications because of their unique ability to "absorb" disorder in a material's crystalline structure that otherwise would lead to the breakdown of a material.

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# The Challenges of Being Competitive in Automotive Electronics Manufacturing

**by Michael Ford**
MENTOR GRAPHICS VALOR DIVISION

Tight money and severe liability requirements make competition tough for OEMs, as well as EMS providers and ODM counterparts in the market for automotive electronics. Manufacturers with the technological infrastructure to create low-cost, integrated traceability solutions and Lean process controls will most likely succeed in the forthcoming industrial climate, while those with heavy overhead burdens and sluggish enterprise resources are likely to retreat or fail.

In the highly competitive automotive industry, prices for electronic products across a vast range of applications have generally reduced to the point where meeting all the aspects of quality, reliability, and safety has become a serious challenge, far more so than in other sectors of critical electronics manufacturing such as aerospace, medical, and military, where price pressure has been far less significant. Automotive is unique in this respect, having to provide the most critical of products in the most cost-competitive way. Regardless of the price point of the vehicle, the purchaser always expects perfect quality supporting a "perfect" safety expectation. This is not a new situation per se, but dealing with this challenge in today's evolving automotive environment in terms of increased adoption of technology, is now a critical factor for the success of automotive manufacturers and their suppliers.

### The Evolving Significance of Automotive Electronics

Simple electronics were gradually introduced into automobiles from the earliest times. At first, these were just simple electro-mechanical devices to make cars work without manual effort, such as to start the engine and keep windshields clear. A little later, electronics evolved for convenience and entertainment, for example, radios and heaters. It is relatively recently that we see the introduction of more sophisticated systems for safety and performance, appearing relatively recently in the life of automotive as an industry. As an initially insignificant component in terms of manufacturing cost and

therefore, electronics sub-assemblies have had to follow the same management requirements, directives and rules governing other parts of the automotive manufacturing process. But in this past decade, we have seen the effects of the gradual growth of issues with electronics systems, with recalls caused by safety issues that cost automotive manufacturers millions of dollars. Electronics within an automotive environment today requires a new approach to ensure a higher level of quality perfection.

Traditionally, traceability in the automobile industry was invented to identify, in the case of a market problem occurring, the precise scope of cars that were potentially affected by the issue, to reduce the exposure and cost if a recall had to be made, limiting the damage and erosion of brand confidence in the market. As more safety-critical applications with the potential of new problems are becoming ubiquitous in today's vehicles, such as air-bags, breaking and stability systems, and more recently radar control, millions of cars and their drivers can be affected by issues related to electronics.

> **"Cameras and sensor-based systems have progressed to the point where even the family car can now park itself. Cars can also now brake automatically to avoid collisions with the addition of radar."**

The trend to install more sophisticated electronics into vehicles is set to continue to increase rapidly. Pretty much every aspect of the driving experience is now associated with electronics. Several computers are involved just to keep the engine running. Maneuvers that seem to defy the laws of physics are now possible using sophisticated monitoring and control of suspension, braking, and traction systems.

Instrumentation has also changed with electronics—LCD panels that replace mechanical gauges, heads-up displays, trip computers, and automated warnings of blown bulbs and fuses, wipers, lights are all there to assist the driver. Navigation systems, telephones, and high-end sound systems are all commonly part of the customers' options list. Cameras and sensor-based systems have progressed to the point where even the family car can now park itself. Cars can also now brake automatically to avoid collisions with the addition of radar.

A long time ago, most vehicle manufacturers stopped making their own sub-assemblies and outsourced them to specialist companies who have ended up making most of the extended components that go into making a vehicle, especially the electronic ones. For the sake of efficiency and quality, manufacturers agreed between themselves and their suppliers on the standardization of many quality management and manufacturing practices, requiring the suppliers then to comply with those standards. And over the years, a close relationship between electronics suppliers and vehicle manufacturers developed.

The requirements for conformance of operation in automotive components, especially in critical areas such as air bags and engine management systems, became stricter as concerns for safety and reliability of new technologies grew. Electronic component manufacturers were faced with weeks of preparation and testing of products manufactured on any individual production line. Only when products manufactured on sample runs were fully tested and approved by their customer, as part of a qualification process, would actual production be allowed to start. Once started, the production processes could not be changed in any way whatsoever—to do so would mean that the entire configuration would have to again be tested and approved, which could take several more weeks. This system didn't allow much flexibility to remove potential losses or inefficiencies in the manufacturing processes.

As a result, some of these manufacturing lines ran for many years, most of the time not running at anything near peak capacity, creating a lot of waste. Details of materials and pro-

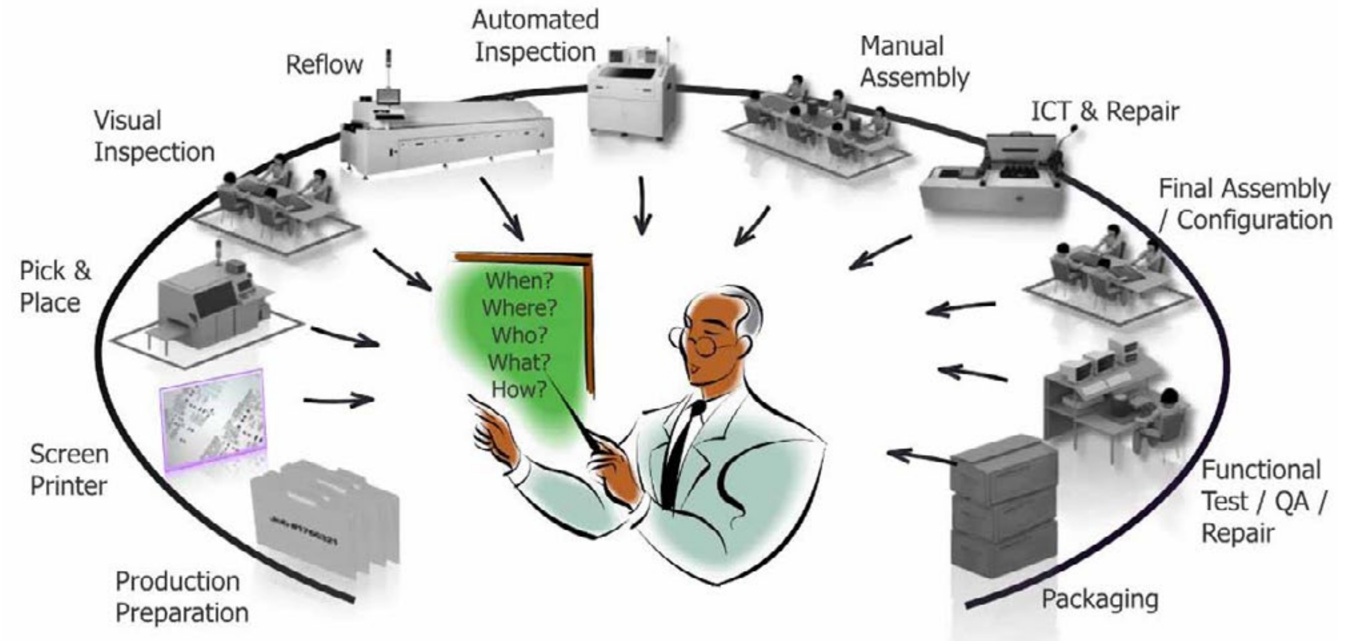


Figure 1: Automobile electronics suppliers can be more competitive by having automated and fully integrated control over their entire manufacturing operation.

cesses were recorded, which was also mandatory as part of the standardization requirements. There was little room for automotive electronics suppliers to maneuver, little opportunity to find creative methods for performance improvement, use of advanced engineering, and quality management as seen in other electronic manufacturing sectors.

Meanwhile, progress marched on at a rapid pace in the rest of the electronics industry, as performance radically improved in the late 1980s with the introduction of SMT. Quality levels generally improved by orders of magnitude as processes became more automated, with more operational information management and improved process management. Machine capabilities and reliability improved. Materials quality also increased significantly. Less effort was needed to manufacture a higher quality product. Despite these strides, improvements were adopted far less rapidly in the automotive industry, due to the limitations of their qualification processes. For traceability however, automotive had been one of the first industry sectors to adopt it, but in turning the technology around to benefit manufacturing all the way through the supply chain, automotive appears to be last to benefit.

Automotive manufacturers, like other sectors in the industry, are now also however facing the challenges of more rapidly changing customer demands. A while ago, automotive companies decided to allow customers to personalize their cars with luxury and performance items, rather than simply choosing from a limited range of models or configurations. Quite often, added optional extras are technological in nature, thus creating a variable demand for non-standard accessories. And now, the contribution of electronics cost and value is increasing as a ratio with other manufacturing costs. Price competitiveness in automotive electronics can only increase, as will the expectation from the consumer to have a desired configuration available with an ever-shortening lead-time.

### Key Ingredients for Competitiveness—Now and in the Future

Now is the time for manufacturers in the automotive electronics industry to consider their future. Any company today that is already in-

volved with automotive electronics manufacturing has an inherent advantage with their experience over newcomers to the market, but they will only be successful going forward if they have the key ingredients to adapt and compete.

One key ingredient is the ability to reduce the long new-product-introduction process down to levels that are more cost-effective and agile to meet the changing customer demands. The need to do it perfectly remains a requirement before volume manufacturing can start; what's needed is to bring more of the work into the virtual domain of the design and engineering tools, rather than relying on extensive physical process verification.

Compliance and conformance are a significant cost overhead. The methods used to achieve these goals also must contribute to improvement in best practices, operator guidance, waste elimination, productivity enhancement, and overall asset utilization. When these activities are integrated, the cost overhead disappears and real value can be achieved.

One of the keys to competitiveness is an integrated manufacturing solution that provides areas of functionality that can be selected to meet the needs of electronics manufacturing in either stages or modules or end-to-end.

The critical change is that conformance, compliance and the gathering of exact data for traceability is now built into a standard and efficient operation at every process, integrated across the whole shop-floor. The automation of data capture from these processes ensures the timeliness and accuracy of captured data, de-

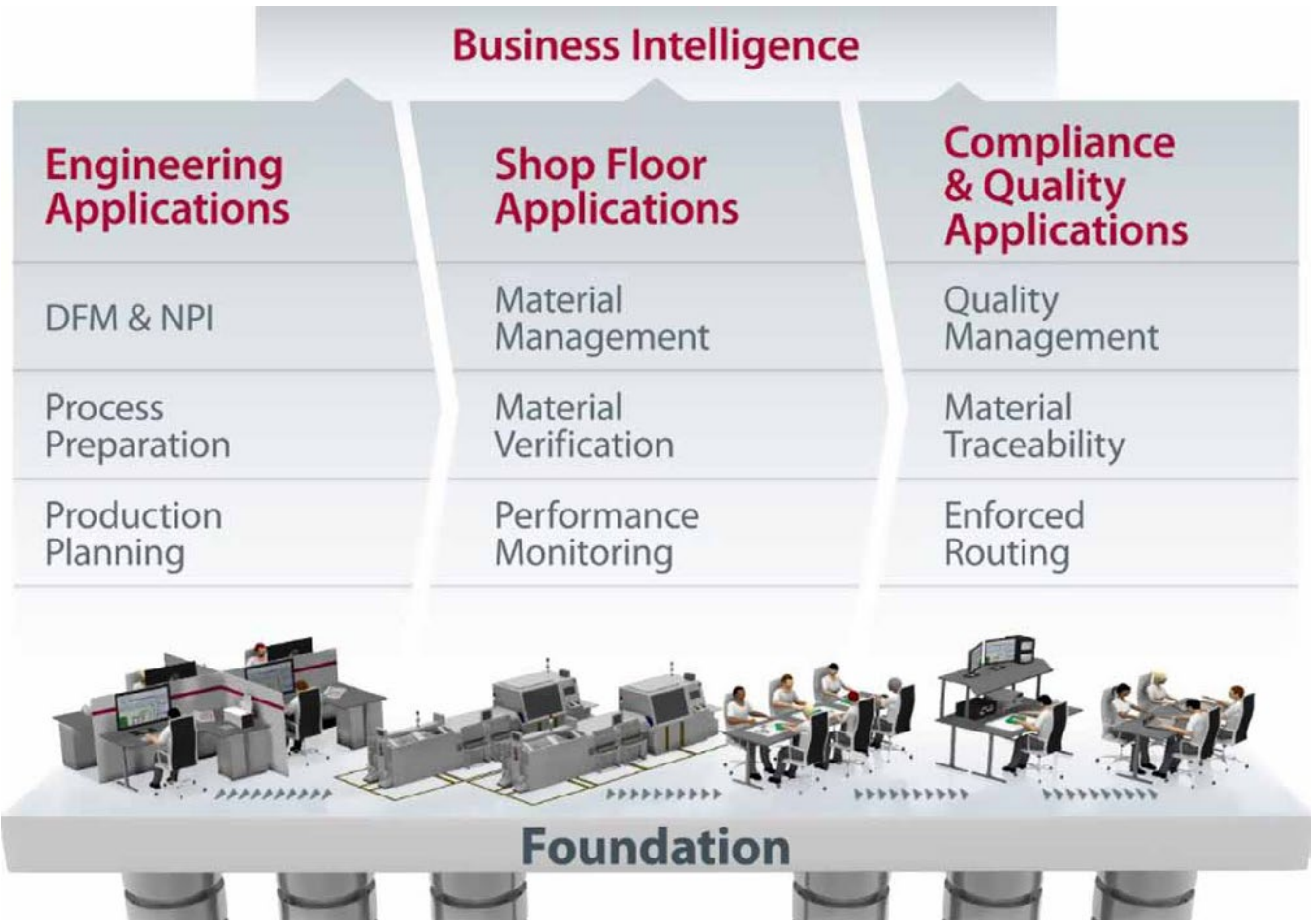


Figure 2: Applications and services can use a single central data resource for the control, management, and reporting of the operation in real-time.

creasing associated costs whilst bringing opportunities for extended use to generate additional values, such as the computerization of such functions of Lean material delivery and finite live production planning. Such an integrated and sophisticated manufacturing software platform provides greater connectivity and increased agility, which results in opportunities for improvement, both in performance and the ability to attract additional high-end business. This enables an automotive electronics manufacturer to combine the critical aspects of quality, reliability, and safety assuredness, plus accessible pricing and lead-time to meet customer expectations that puts it out in front of the competition.

To learn more about this automotive industry solution, click here to download the white paper "How to Keep Your Competitive Edge in Manufacturing's High Growth Automotive Electronics." **PCBDESIGN**

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

## Nanotechnology Project to Improve Safety Gets Funding

The University of Southampton has been awarded a multi-million grant from Lloyd's Register Foundation to bring together some of the world's brightest early career researchers to find new ways of using nanotechnologies to improve safety at sea, on land and in the air.

Dr. Themis Prodromakis, a reader within the Nanoelectronics and Nanotechnologies Group at Southampton, is leading the £3 million programme, which will receive match funding from partner organisations.

He says, "Researchers are always looking for funding for high risk, high reward ideas. They want to collaborate with the best scientists and engineers in the world and gain access to state-of-art facilities. The Lloyd's Register Foundation International Consortium in Nanotechnologies (ICON) will assemble the world's leading universities, research institutions and innovative companies to help them tackle many of today's most challenging issues by recruiting talented PhD students from every continent."

Breakthroughs already being developed include cars, boats and planes built from lightweight materials stronger than steel with new functions such as self-cleaning and repairing; flexible textiles that can become rigid and shockproof to protect the wearer; sensors in hostile environments such as the deep ocean and space; tiny implants for real-time monitoring to aid diagnoses for doctors; and smart devices that harvest energy from their environment.

### Using Nanotechnology to Improve Safety

Professor Richard Clegg, Managing Director of Lloyd's Register Foundation said, "We are pleased to support the University of Southampton in developing this global cohort of scientists. Their research will develop applications to further the Foundation's safety goals whilst also providing training and building technical capacity in support of our educational mission. The doctoral students joining this consortium will gain an understanding of how their research can benefit society whilst developing international research networks at an early stage in their careers."

# Physics of Failure Durability Simulations for Automotive Electronics

**by James G. McLeish & Tom O'Connor**
DFR SOLUTIONS

Automotive electronics systems are becoming increasing complex and essential for the proper, safe operation of cars and trucks. Vehicle controls for basic operation and safety functions are increasingly being implemented by electronic modules. The ability of these electronic systems to function reliably is becoming a greater aspect of vehicle safety as was dramatically demonstrated by the 2009–2011 recall of over 9 million Toyota vehicles for unintended acceleration issues.

After the Toyota incident, the U.S. National Academy of Science issued "Special Report #038: The Safety Challenge and Promise of Automotive Electronics—Insights from Unintended Acceleration" in January 2012. The report cited that federal safety regulators in the National Highway Traffic Safety Administration (NHTSA) lack the expertise to monitor vehicles with increasingly sophisticated electronics, as was demonstrated by the need for NHSTA to call in NASA electronic personnel to assist in the investigation.

But 2014 was an even worse year for the auto industry, plagued with a record 700 recalls of over 60 million vehicles that has cost billions of dollars, involved numerous NHTSA safety investigations, record federal fines, damning publicity, unsettled legal liabilities, and congressional investigations. Severe new vehicle safety legislation is now under consideration. With many of these reliability issues, the vehicles' systems functioned for years before failures with safety consequences occurred. Others involved situations where product teams, executives and regulators did not recognize the safety consequences of product and system quality, reliability and durability (QRD) capabilities, especially when new technology is involved. The industry now searches for ways to ensure that this never occurs again.

While electronic reliability issues were widely suspected, but eventually ruled out as a root cause, the crisis revealed the challenges of evaluating, validating and investigating the reliability and safety assurance aspect of modern, distributed and interactive vehicle controls systems that are equally taxing on OEMs, electronic system suppliers and regulators.

Meanwhile, in Europe, the new standard ISO 26262, "Road Vehicles—Functional Safety," defines an automotive-specific approach for determining risk classes and requirements for validation and confirmation measures to ensure a sufficient and acceptable level of safety and reliability is being achieved.

### CAE Apps and Physics of Failure

Reliability physics a science-based approach that is rapidly being employed in automotive electronics. It involves application of knowledge derived from physics of failure (PoF) research into how and why systems, components and materials fail. Knowledge of what initiates and propagates the failure mechanisms that result in failure modes enables product designers to evaluate the potential failure susceptibility and risks of specific materials, structures and technologies in specific applications. This enables a virtual "analyze and optimize" form of reliability where susceptibility to failure risks can be rapidly identified early, at low cost, and designed out or mitigated, while the design is still on the CAD screen. This article will provide an introduction to reliability physics methods and tools and discuss how they can be employed to optimize the product integrity (i.e., quality, reliability durability and safety [QRDS]) of vehicular electronics systems.

A new set of CAE tools can help evaluate the safety and reliability of vehicular electronics models to meet these needs and support the new ISO standard. CAE modeling and simulation tools are now widely viewed as an automotive engineering core competency. These tools are needed to reduce new product development time in order to get products to the market faster, at lower costs by helping to design them right on the first attempt.

Electrical and electronic (EE) engineers historically have gravitated to CAE tools for circuit, functional and software analysis with less emphasis on structural analysis tools that were viewed as less essential to their field. However, as advancements in electronic technology have produced smaller and smaller devices that handle ever-increasing amounts of power and heat, the micro-structural integrity of wire bonds, micro-terminals and solder joints become increasingly important, especially in the auto industry where the ability to endure 10–15 years of harsh environmental conditions is a requirement. This is underscored by the fact that the majority of field failures of electronic modules are physical and structural in nature, related to items such as thermal over stress and fracture or fatigue of wires, solder joints, component terminals, wire bonds, and circuit board through-hole vias.

> "The time and cost of building and testing prototype electronic components has been a limiting factor in efforts to accelerate the product development-validation process of automotive electronics."

Today, evaluating and achieving the structural integrity, durability and reliability of automotive electronic modules still primarily depends on traditional design-build-test-fix (D-B-T-F) reliability processes that employ a variety of environmental stress and usage durability tests of physical prototypes. The time and cost of building and testing prototype electronic components has been a limiting factor in efforts to accelerate the product development-validation process of automotive electronics.

As vehicular electronic content continues to climb into and beyond the range of 70 to 80 modules per vehicle (on internal combustion engine vehicles), the burden of integrity

assurance/reliability/durability testing is becoming an even greater drain on the industry. The conversion to hybrid and electric vehicles brings with it an even greater increase in electronic content. For example, the Chevy Volt lithium Ion battery module requires seven circuit board assemblies for battery system management and safety. Each of these assemblies must be tested in accordance with an extensive durability profile which costs hundreds of thousands of dollars and months of additional testing.

### A True Physics-Based Modeling App

To address this situation, a new class of knowledge-based automated design analysis (ADA) CAE tools for performing physics of PoF durability simulations and reliability assessments to ensure the structural integrity of electronic modules has been developed. One new CAE program is called Sherlock Automated Design Analysis™ for its ability to investigate a design and predict its susceptibility to failure mechanisms related to the intended usage environment of the application. The program works by performing a durability simulation in a virtual environment and calculating the durability life and reliability distribution of various failure mechanisms for the electronic component and structural elements on the circuit boards of an electronic module. This is similar to the way structural durability analysis is now performed for vehicle body, chassis and other mechanical systems and parts.

Sherlock software is the result of years of PoF research to identify the failure mechanism

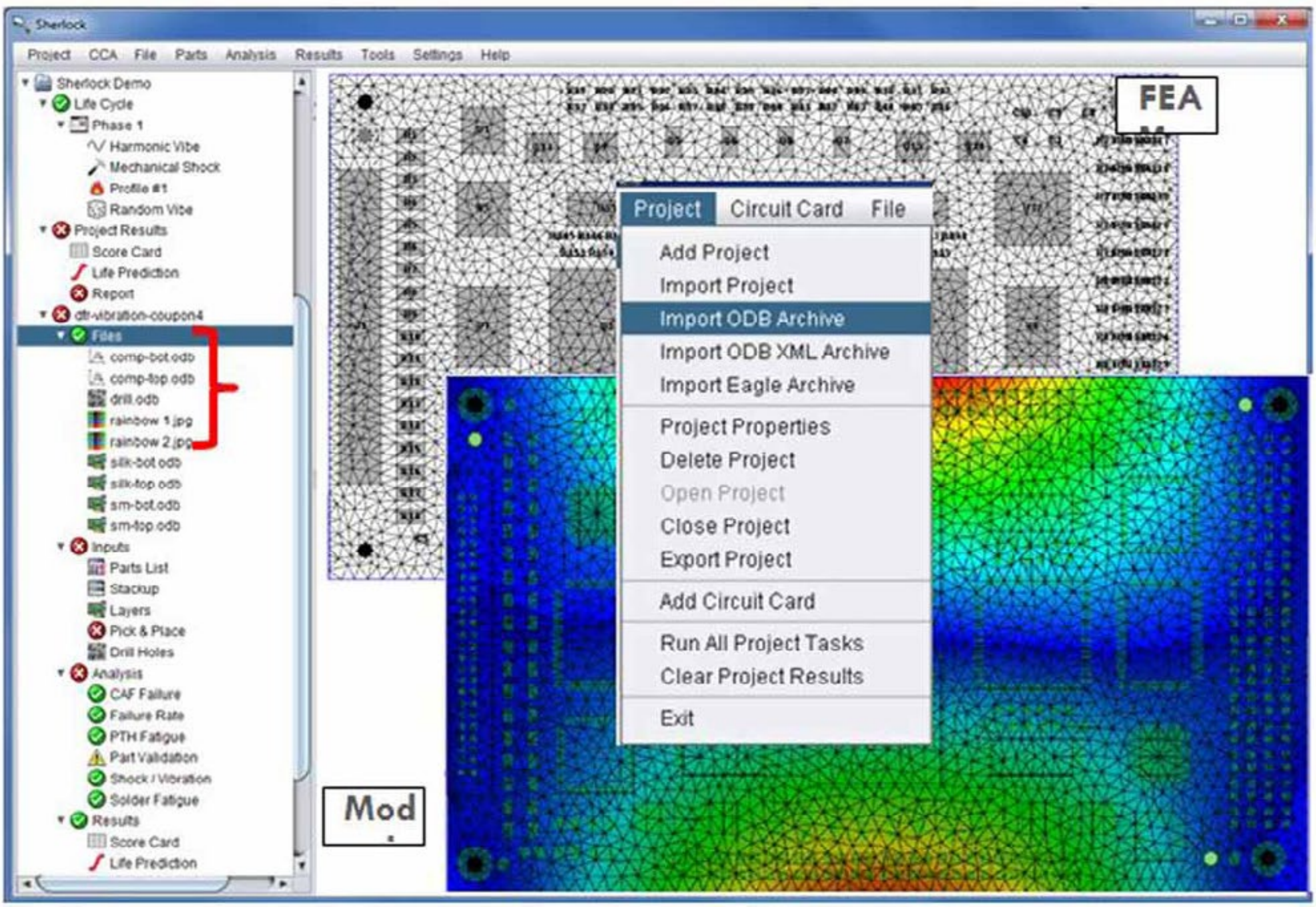


Figure 1: Sherlock software imports standard circuit board CAD/CAM Gerber files or ODB++ archives and uses them to automatically create and run finite element models for structural analysis and PoF durability simulations/reliability assessments.

of how and why different electronic components and materials fail, then develop and calibrate a mathematical model of each failure mechanism that could be incorporated into the CAE analysis program. Previously, these PoF analyses were performed by traditional finite element analysis (FEA) tools. This required a long, complicated, model creation process performed by a highly trained expert—a capability that was rarely available to most electronic engineers.

However, Sherlock software is designed to be used by non-CAE experts who quickly create and perform PoF durability simulations and reliability assessments. This is accomplished by a high degree of automation in the program that includes preloaded libraries of: component models, material properties, design templates, analysis wizards and environmental profiles for specific applications. The automation features enable electronics engineers, circuit board designers, and quality/reliability personnel to use the analysis tool to incorporate reliability into the design process.

First, a product life cycle is created for the PCBA. The life cycle is a combination of the expected life of the assembly and the failure rate at that time. A typical automotive life cycle would be 15 years with 5% failure at 15 years.

The creation of a virtual module of a circuit board assembly is greatly simplified by importing the same CAD files created during a typical circuit layout design process that are sent to a circuit board fabricator and a circuit board assembler for use in their CAM equipment. Once the CAD-CAM files in either a traditional Gerber or

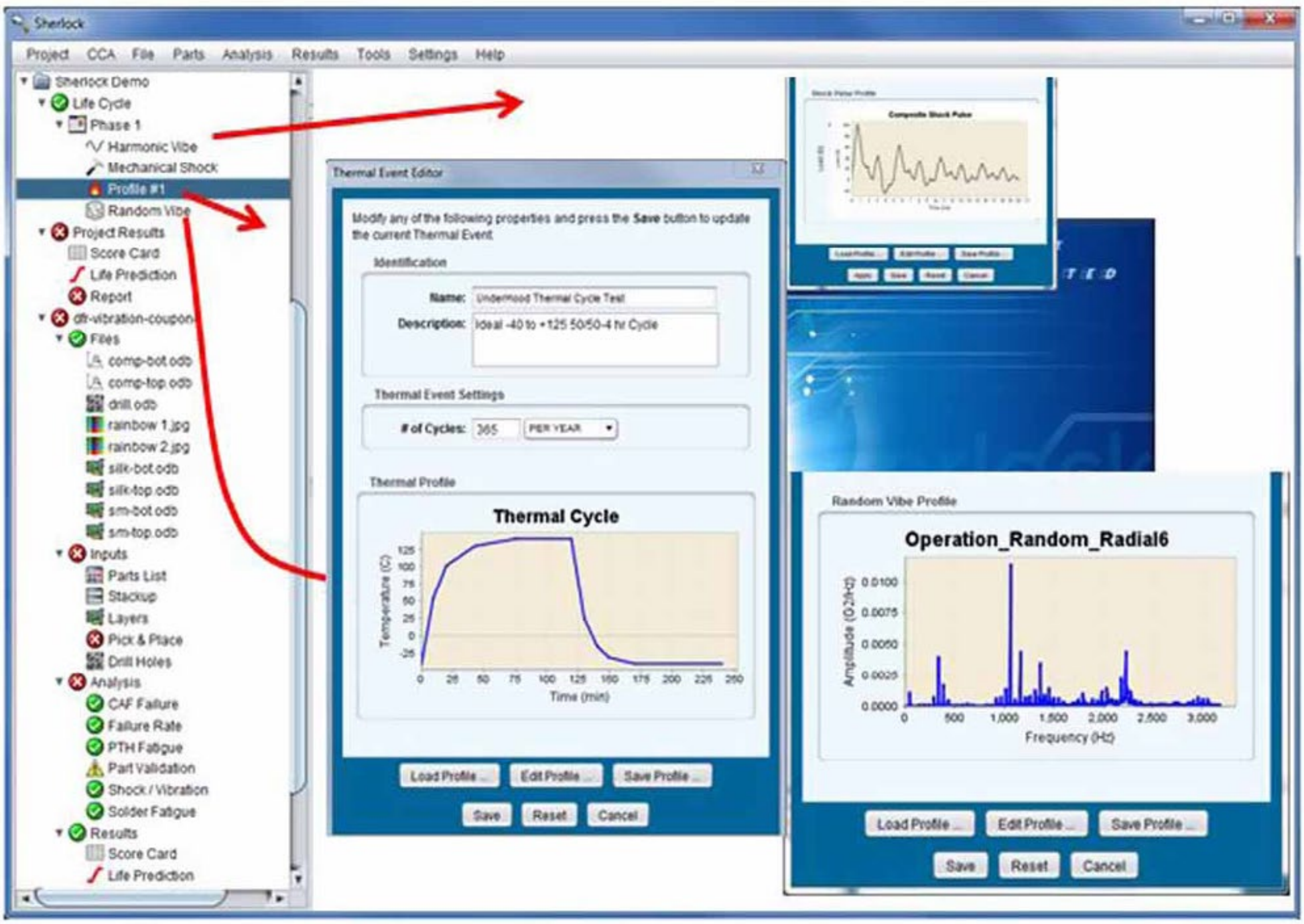


Figure 2: The user can define and save an unlimited number of test or field environmental and usage stress profiles to perform virtual test to field correlations and simulated aided testing studies.

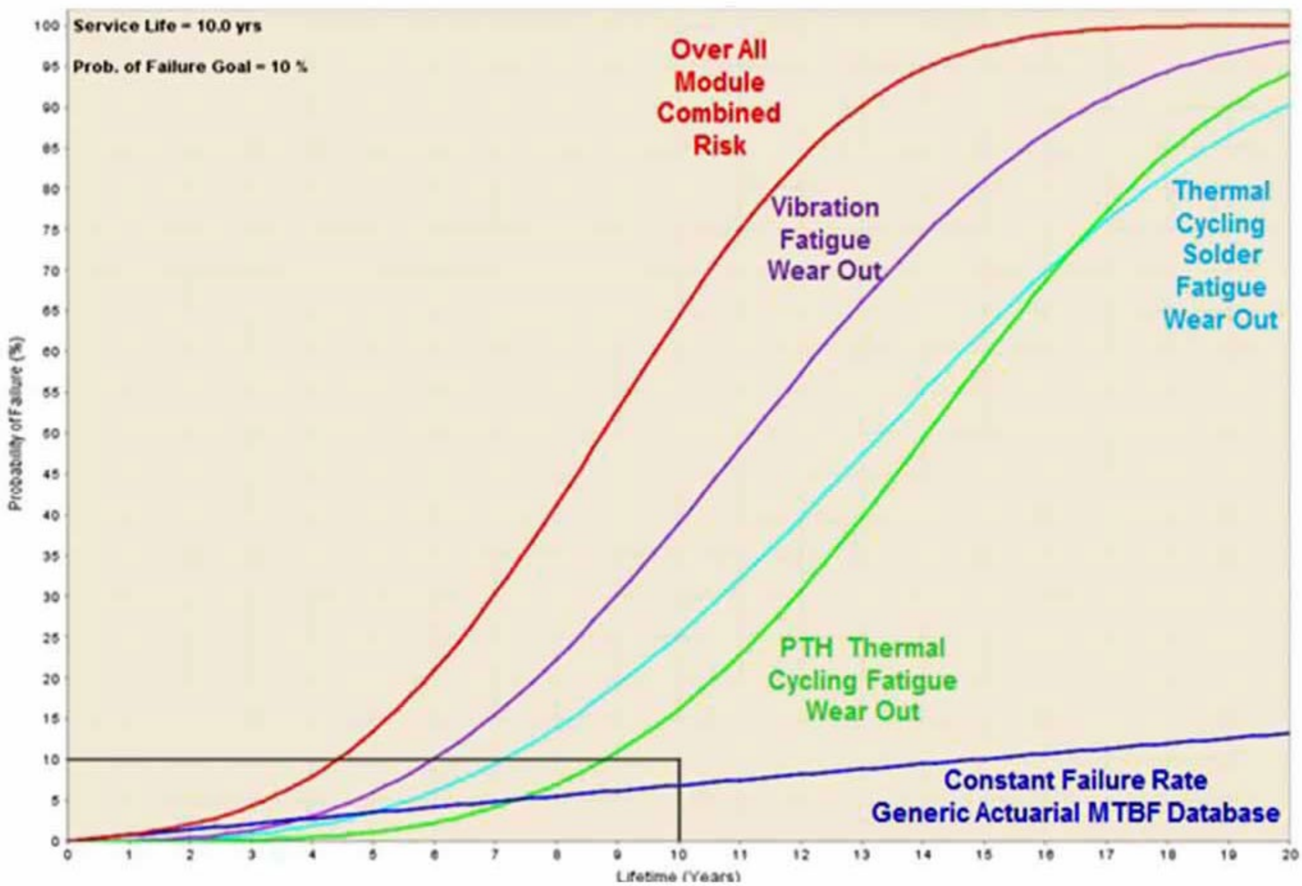


Figure 3: Sherlock software plots individual and overall combined risk timelines curves for the failure mechanisms the device is susceptible to. This early identification of specific risks allows the design to be improved, at low cost, while the design is still on the CAD screen.

the ODB++ format are loaded, Sherlock automatically self-generates the virtual FEA models needed for structural analysis as shown in Figure 1. The environmental and usage conditions to be evaluated along with the durability time frame and reliability objectives of the application are then defined.

Next, the user selects the types of stress analysis to be performed which determines the types, intensity and loading frequency of the stresses the device is required to endure during its service life as shown in Figure 2. The stress conditions automatically become inputs to various PoF failure mechanism model to determine the susceptibility of the electronic assembly's devices, materials and components to various failure mechanisms which produces a projection of the time to mean failure and the failure distribution about the mean of each susceptible failure mechanism to each element in the design.

Sherlock then tallies all the failure risks of each element to calculate a combined failure risk life curve for each failure mechanism and an overall risk life curve for the complete electronic module (Figure 3). It also produces an ordered Pareto list that identifies the components or features projected to have the greatest risk of failure for each failure mechanism that enables easy identification and prioritization of all the weak link items. It also identifies why they are expected to fail, so that corrective actions can be implemented while the design is still on the CAD screen, without the time and expense of building prototype modules for physical reliability/durability testing.

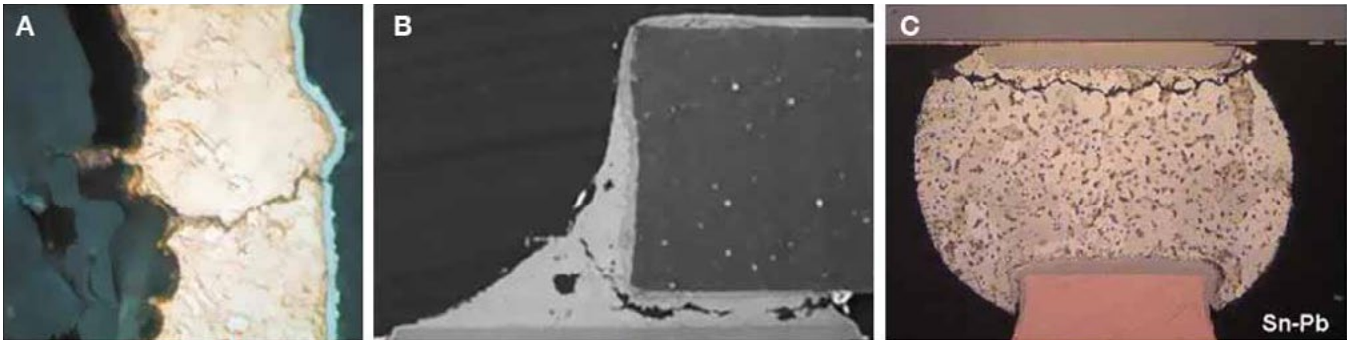


Figure 4: Examples of typical circuit board structural failures: (a) cracked copper barrel wall in a signal carrying plated through-hole via, (b) solder attachment crack at a surface mount resistor, and (c) solder ball crack in a BGA integrated circuit.

Sherlock performs the following stress, wearout or overstress failure simulations and risk assessments:

- FEA vibration modal analysis—stress assessment
- FEA shock modal analysis—stress assessment
- Thermal cycling fatigue of solder joints—wearout failure mechanism
- Thermal cycling fatigue of plated through hole vias—wearout failure mechanism
- Mechanical vibration fatigue of solder joints—wearout failure mechanism
- Mechanical shock fracture of solder joints—overstress failure mechanism
- Conductive anodic filament formation—risk assessment
- Thermal derating

Examples of real-world failures that this type of analysis can detect and prevent are shown in Figure 4.

## Case Study

An automotive OEM that has now owned Sherlock for over two years performed a before and after study on four assemblies that used Sherlock this past year. Before purchasing Sherlock the company used the classic D-B-T-F reliability process for DVT. For the year that Sherlock was used on the four assemblies the OEM calculated it saved an average of $346K/PCBA. The saving was just for the reduced testing done in DVT. It did not include savings of getting the product to market more quickly. The total saving for the four assemblies was over $1.3 million. But, most importantly, the OEM feels that they are providing a more reliable, durable product to their customers.

Meanwhile, other automotive OEMs are working with their Tier 1 suppliers to evaluate using Sherlock to improve their products' reliability. The OEMs are determining if the Tier 1 passes a Sherlock analysis with the OEM's environmental conditions whether they can give the Tier 1 credit for passing their first EVT.

This is a win/win/win. The OEM gets a better product at less cost with better reliability data. The Tier 1 supplier gets a deeper commitment from the OEM. And the customer gets a better automobile at a lower cost. Physics-based modeling is the way of the future to make automotive electronics reliable, durable and cost-effective. **PCBDESIGN**

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# PCB007 Highlights

**i3 Electronics Wins Medical Opportunity**
i3 Electronics, Inc. (i3) announced that it has earned the opportunity from an industry leading medical OEM for the development and manufacture of advanced, flexible, circuitized substrates. The product is a flexible, LCP substrate that will be used in the neurostimulation market.

**IPC Releases White Paper on Conflict Minerals Due Diligence**
The Dodd-Frank Act continues to be burdensome for companies required to report on the usage of conflict minerals. In order to address industry concerns, IPC – Association Connecting Electronics Industries has released IPC-1081, Conflict Minerals Due Diligence White Paper (IPC WP-1081), a document designed to help with some reporting woes.

**Keeping on Top of Laser Safety**
With consumer electronics continuing to get thinner and packed with more functionality, laser processing systems have become a permanent part of the manufacturing landscape. Lasers are used to produce ever-smaller microvias in increasingly delicate flexible and rigid-flex circuits.

**New Battlegrounds Emerge for Conductive Inks and Pastes**
Core applications of PV and touch panels continue to grow demand, but new opportunities emerge in the form of wearable technology, circuit boards and structural electronics.

**Is Wearable Technology Just a Fad?**
It wasn't too long ago when every techno blogger was writing about the newest wearable technology, perhaps predicting the next technology avalanche that would rival smart phones. The granddaddy of wearable technology was Google Glasses, which apparently was leading the revolution. Analysts were predicting a mega industry upheaval. Then Google Glasses crashed and burned.

**Supply Chain in the 21st Century**
The shift away from vertical integration has pushed the topic of supply chain management to the forefront of strategic planning for many manufacturers. Having a supply chain that provides a competitive advantage will be the differentiator in today's business environment.

**Taiwan: The Barometer for Consumer Electronics**
The Tankan Survey is a popular economic survey of Japanese businesses issued by the central bank of Japan. The survey focuses on companies with a specified minimum amount of capital and is a valuable tool to determine market trends.

**A Well-Designed Laminate Supply Chain has to Own It!**
Designing a supply chain for the provision of laminates and pre-pregs to the PCB fabricator shouldn't be that complicated, should it? The laminate is simply manufactured and then shipped...what could possibly go wrong? It turns out it is more complicated, partly because the supply chain is not fully owned by one supplier, and hence cannot be fully customized to the needs of each customer.

**Start-up Identifies Market Potential for Flexible Printed Electronics**
EU funding has enabled Portuguese printed electronics start-up Ynvisible to fully assess the potential of applying flexible printed electronics to consumer objects. The six-month feasibility study completed at the beginning of August 2015 involved carrying out tests on the new platform – called PRINTOO – which enabled the company to better understand the needs of various end users.

**It's Only Common Sense: Marketing Makes Selling Superfluous**
From Peter Drucker: The aim of marketing is to make selling superfluous. The aim of marketing is to know and understand the customer so well that the product or service fits her and sells itself. Ideally marketing should result in a customer who is ready to buy....the right motto for business management should increasingly be "from selling to marketing."

# Top Gear: PADS Professional Road Test

**by Barry Olney**
IN-CIRCUIT DESIGN PTY LTD AUSTRALIA

We hear all the hype about new EDA tools, but how do they actually perform on your design? This month, I road-test Mentor Graphics' new PADS Professional and put it through a rigorous performance evaluation. Let's see how the Xpedition technology actually performs when integrated into the PADS tool suite.

Opening the hood, we see an impressive line-up of features including signal and power integrity, thermal analysis and DRC support for traces violating split planes, reference plane changes and shielding. All the essentials for today's complex high-speed designs! Plus, I am looking forward to trying the dynamic plane generation feature—regenerating copper pours is always a pain to perform, in any software. And of course, PADS Professional includes all the standard features one would expect in a high-end tool.

Based on Xpedition technology, PADS Professional is a major improvement over the previous PADS suite of tools. I was first impressed by this technology in 1994, when I attended the VeriBest PCB training and the sales kick-off in Boulder, Colorado. During the sessions, a few of the Intergraph Electronics sales guys were taken out the back, into R & D, and where shown the latest routing technology—eyes lit up with dollar signs as the VeriBest (now Xpedition) router was put through its paces.

Figure 1: Time for a road test.

Meanwhile back in Australia, where I was responsible for Intergraph Electronics sales and support, customers were also suitably impressed. My first sale was six seats of VeriBest PCB with 20 seats of Design Capture to Fujitsu Australia, who had previously used Cadence. Both Cadence and Mentor presented their flagship products (Allegro and Board Station, respectively), but the VeriBest router was so impressive that the competition did not rate mentioning. Ron Oates, CAD manager of Fujitsu Australia at that time, stated in a press release, “VeriBest is light years ahead of the competitors.” And it is still arguably the best routing technology available today. Mentor went on to acquire VeriBest in 1999, as the lack of routing technology formed a fairly large hole in their PCB offerings. Needless to say, Mentor’s stock rose 9% after the acquisition was announced.

I won’t bore you with a full list of functionality or standard EDA tool features, but rather I will take you through, in detail, what I see as the outstanding features of PADS Professional.

PADS Professional utilizes xDX Designer as the front-end design entry tool. This schematic capture package was originally a ViewLogic Systems tools called ViewDraw, which became the unified front-end tool for all Mentor PCB products some years ago following an acquisition. Originally developed for creating hardware description language (HDL) function blocks for digital and mixed-signal systems, such as FPGAs and ASICs, it has a multitude of interfaces and is adaptable to many environments. In the PADS environment, it interfaces to the PCB (of course) but also allows FPGA I/O optimization, the integration of library tools, DxDatabook, and downstream digital and analog (EZWave) simulation tools.

But as far as I am concerned, the ability to launch HyperLynx LineSim at the schematic level is its best attribute. After selecting a net, the LineSim link loads the data from xDX Designer and exports it to HyperLynx to create a pre-layout free-form schematic view of the nets topology as in Figure 2. You can then simulate a

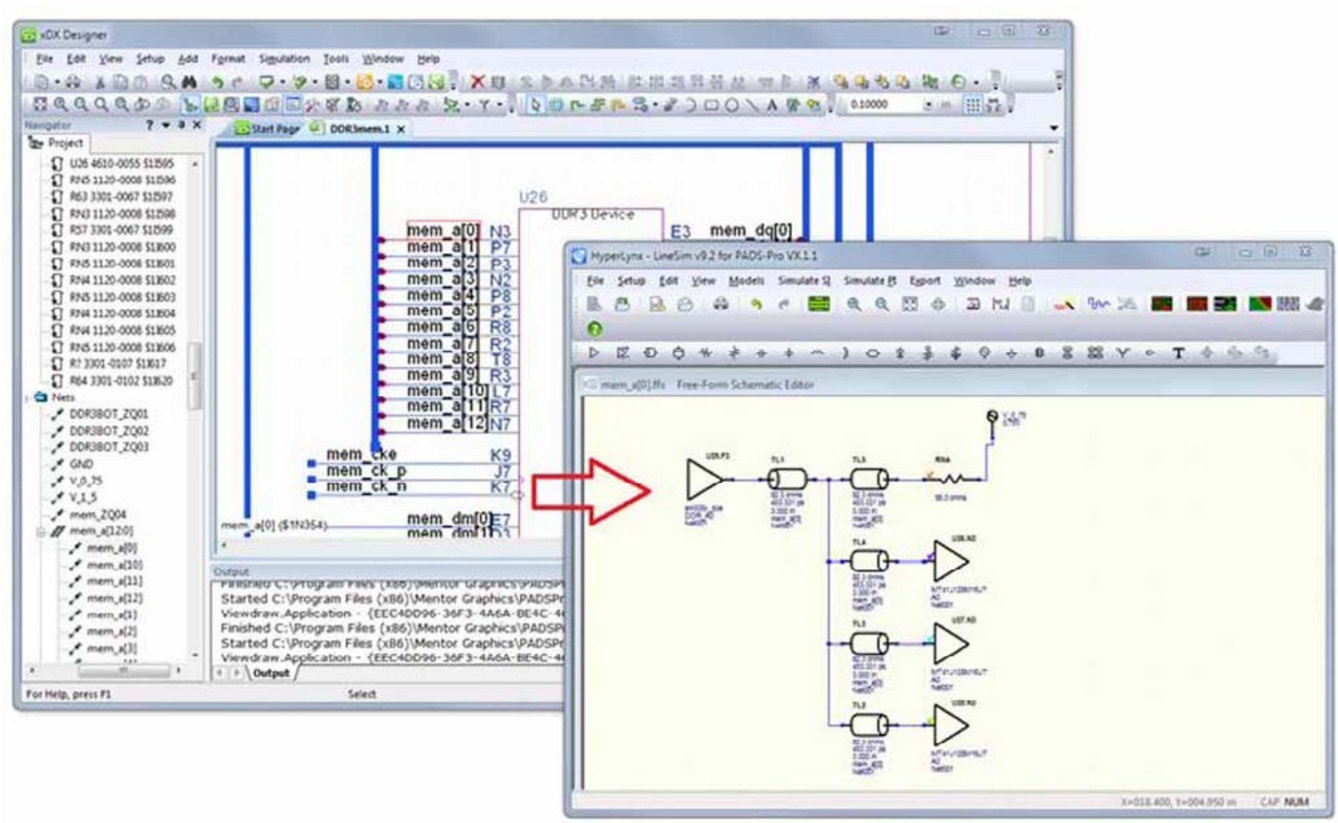


Figure 2: DDR3 memory address net topology exported to LineSim.

sample of nets for, say, data, address, clocks and strobes to define the layout design rules. These rules are embedded in the schematic via the constraints manager, and they will then flow through to the layout database with forward annotation. Constraints are maintained through a common database that is consistent and in an easy-to-use spreadsheet interface. There is no need to learn an obscure program language to create complex constraints as in other tools.

Consequently, any unsightly waveforms (under/overshoots) can be dealt with by the Termination Wizard, which automatically selects the correct type and value of termination based on the IBIS model characteristics and that of the transmission line. It really makes signal integrity too easy. And providing engineering intent to the layout designer at the schematic level imparts an error-free process.

Integration of the schematic and PCB is through a common database, so there are no netlist errors to contend with. Simply package and begin layout. The first thing I noticed when I entered the PCB environment is the smooth panning of the graphics. Once I got used to the correct mouse buttons to use, panning and zooming were a breeze—amazingly fast and smooth. Another highlight is that if you happen to move a previously routed component, it just re-routes the connections for you. Obviously this has limitations, such as with large BGAs, but most ICs can easily be moved to rearrange the placement and routing. Moving vias and routed traces is also a breeze. Simply click and drag with seemingly limitless shove capabilities, and even differential pairs are pushed and shoved whilst maintaining their design constraints.

Additionally, the use of mouse strokes for quick execution of commands, rather than hotkeys, is a pleasant flashback from my UNIX past. Basically, you can define stroke patterns to represent any command so that you just keep moving the mouse rather than having to refocus on the keyboard. This makes executing commands very fast.

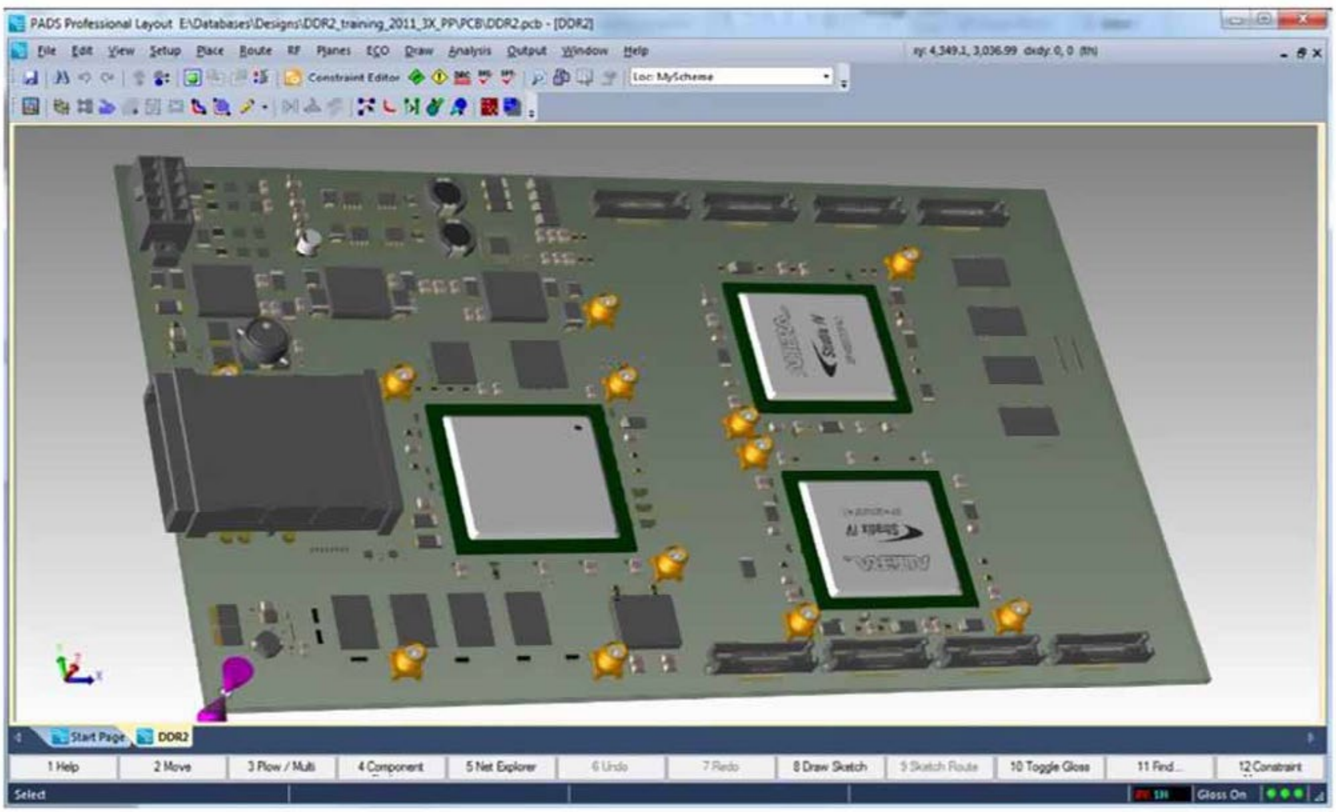



Figure 3: 3D view of the PCB.

## TOP GEAR: PADS PROFESSIONAL ROAD TEST

As with all Mentor PCB design tools, the ability to place and route directly from the schematic is a major time-saving trait. The Component Explorer is used to setup placement. You can place parts directly from the select list or by cross-probing with the schematic. The latter is the most effective way, as the components are then placed by functionality. Placement groups of components can also be defined. Components can also be placed in the 3D view, which gives you added confidence in the avoidance of height restrictions and interference with other components. A cut in 3D can be placed to view the cross-section. Additionally, a 3D mechanical assembly (such as an enclosure) can be imported to enable the visualization of the overall product fit. Exchange of data with MCAD tools is achieved via the collaboration tool.

The obvious downside here is that this is not "live." A COM Server dynamically linking ECAD/MCAD applications would be a more elegant solution for real-time collaboration. But the collaboration tool would work well in a large organization where an MCAD department has to sign off on the mechanical aspects.

Are you tired of shelving and repouring plane areas? I certainly am! But what if you could simply plow straight through a copper pour or plane and gracefully push the copper out of the way as you go? The dynamic plowing is as smooth and fast as routing a normal trace. As the trace plows through the copper, clearances are effortlessly generated automatically.

PADS Professional provides a selection of routing tools with each optimized to perform a particular function. Typically, using one routing tool will not satisfy the requirements of an entire design. Obviously, you will not achieve acceptable results if the entire design is completely autorouted. The typical flow would be to first set up the design constraints, fanout, interactively route and tune critical nets, and then use the automated tools to perform the more mundane tasks including clean-up after fixing critical signals.

But once you get your hands on the router—wow—what can I say? You certainly won't want to digress back to that inept PCB tool you previously used with pride. This routing technology is definitely something you have to see to believe. For years, it has left rivaling tool salesmen scratching their heads with disbelief, and it just keeps getting better.

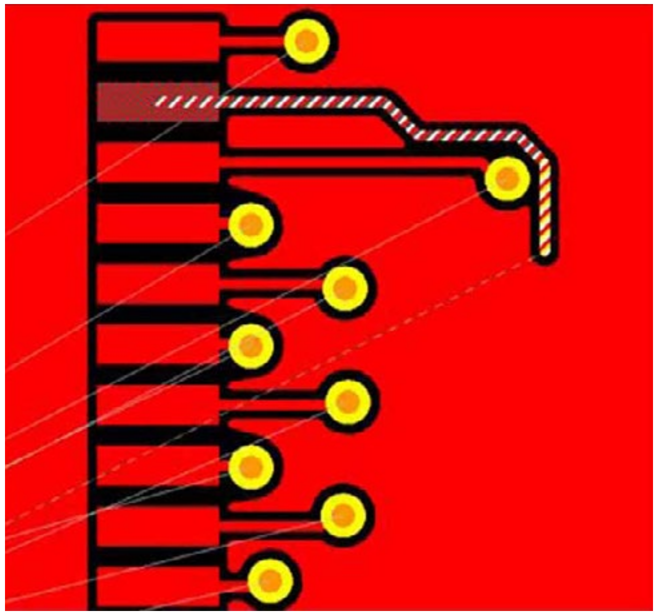


Figure 4: Plowing dynamically straight through a copper pour.

The latest evolution of the Mentor's routing technology is the sketch router. Two factors enable high performance: escape optimization and multiple net routing. When considering the set of netlines to route, the sketch router will simultaneously escape the two ends of the netlines out of the BGAs and order them so that the routing can be completed without additional vias. It is this approach that makes an incredible difference in performance. There are two modes of sketch routing: packed and unpacked. The packed style groups the traces together, and it's very useful for dense, synchronous buses. The unpacked style uses a more direct, efficient approach that will naturally spread the traces apart, reducing crosstalk between adjacent trace segments. In both cases, the tuning algorithms are post-processed with the existing traces pushed and shoved to allow space for the serpentines. Screenshots of the router really don't do it justice. View the PADS demo videos to get a feel for how it works dynamically.

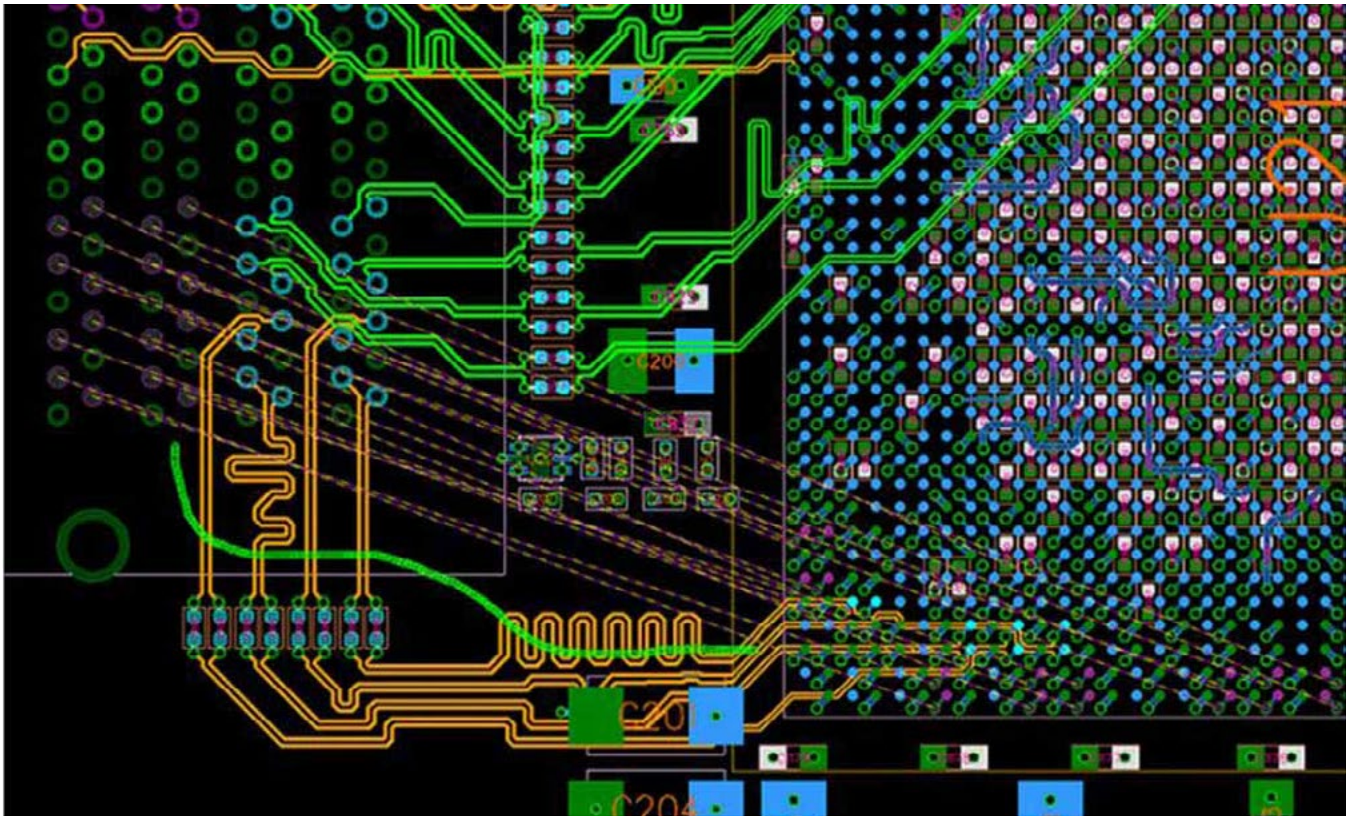


Figure 5: Interactive sketch routing technology.

Once the board is completely routed and you are satisfied with the tuning, HyperLynx BoardSim can be launched to verify the signal timing and analyze any crosstalk that may be produced from adjacent signal segments. A preliminary generic batch simulation scans nets on the entire PCB, flagging signal integrity, crosstalk and EMC hot spots. Then interactive simulation takes the analysis to the next level, simulating trouble spots identified by the batch analysis in order to further resolve the issues with greater accuracy. Field solver views clearly show the adjacent or broadside coupled crosstalk regions. A thermal simulation can also be run to check for hot spots. A DDR batch mode wizard, HyperLynx DRC for SI rule checking, and DC drop analysis are also available as options. This is an impressive line-up of post-layout simulation tools.

In conclusion, PADS Professional certainly lives up to all the hype. The latest routing technology is fast, smooth to drive and hugs the corners well. With all the horsepower you need for the most demanding design, PADS Professional will definitely get you across the finish line ahead of the field. I will give it a 4.5 star rating simply because nothing is perfect, although it doesn't get any better than this. **PCBDESIGN**

### References

1. For more information on Mentor Graphics PADS Professional documentation, click here.

2. For information on the PADS Professional, click here.

**Barry Olney** is managing director of In-Circuit Design Pty Ltd (ICD), Australia. This PCB design service bureau specializes in board-level simulation, and has developed the ICD Stackup Planner and ICD PDN Planner software. To read past columns, or to contact Olney, click here.

# MilAero007 Highlights

## RED Epic Dragon Camera Captures Riveting Images on Space Station

In October 2014 NASA delivered high-definition, 3D footage of astronauts living and working on the International Space Station to the Internet, posting video of astronauts exploring water tension in microgravity. The same engineers have now delivered a new camera capable of recording images with six times more detail than either of the previous cameras.

## NASA's Space Launch System Design 'Right on Track' for Journey to Mars

You know the feeling of pride and achievement when you've worked really hard on a term paper, and finally turn it in? That's how the critical design review team for NASA's Space Launch System is feeling this week as the program completed its review.

## Agricultural Drones and Flexible Circuits

According to MIT Technology Review, one of the Top 10 breakthrough technologies last year was the agricultural drone. I focused on drones in one of my recent columns, Flexible Circuits and UAV Applications, which briefly mentioned agriculture as one of the uses for drones.

## Could 'Windbots Someday Explore the Skies of Jupiter?

Among designers of robotic probes to explore the planets, there is certainly no shortage of clever ideas. There are concepts for robots that are propelled by waves in the sea. There are ideas for tumbleweed bots driven by wind, rolling across Antarctica or Mars. Recently a team of engineers at NASA's Jet Propulsion Laboratory wondered if a probe could be buoyant in the clouds of Earth or a distant gas giant planet, like Jupiter.

## Airbus Defence and Space and Lockheed Martin to Upgrade German Navy P-3C Orion Fleet

Airbus Defence and Space together with its team partner Lockheed Martin Overseas Services Corporation (LMOSC) are to undertake a Mid-Life Upgrade (MLU)—re-winging—of the German Navy fleet of P-3C Orion maritime patrol and anti-submarine warfare aircraft.

## Gary Ferrari Shares His Thoughts on PCB Design and More

Recently, I had a chance to talk with Gary Ferrari, the director of technical support at Firan Technology Group Corporation (FTG). Our conversation ranged from CID training to the need for reaching high school students as a way of introducing more young people to career opportunities in our industry. We also covered strategies for helping customers design and build better product, and keeping designers provided with the most critical part of their supply chain—information.

## Latent Short Circuit Failure in High-Rel PCBs Due To Cleanliness of PCB Processes and Base Materials

Latent short circuit failures have been observed during testing of PCBs for power distribution of spacecraft of the European Space Agency. Root cause analysis indicates that foreign fibers may have contaminated the PCB laminate. These fibers can provide a pathway for electromigration if they bridge the clearance between nets of different potential in the presence of humidity attracted by the hygroscopic laminate resin.

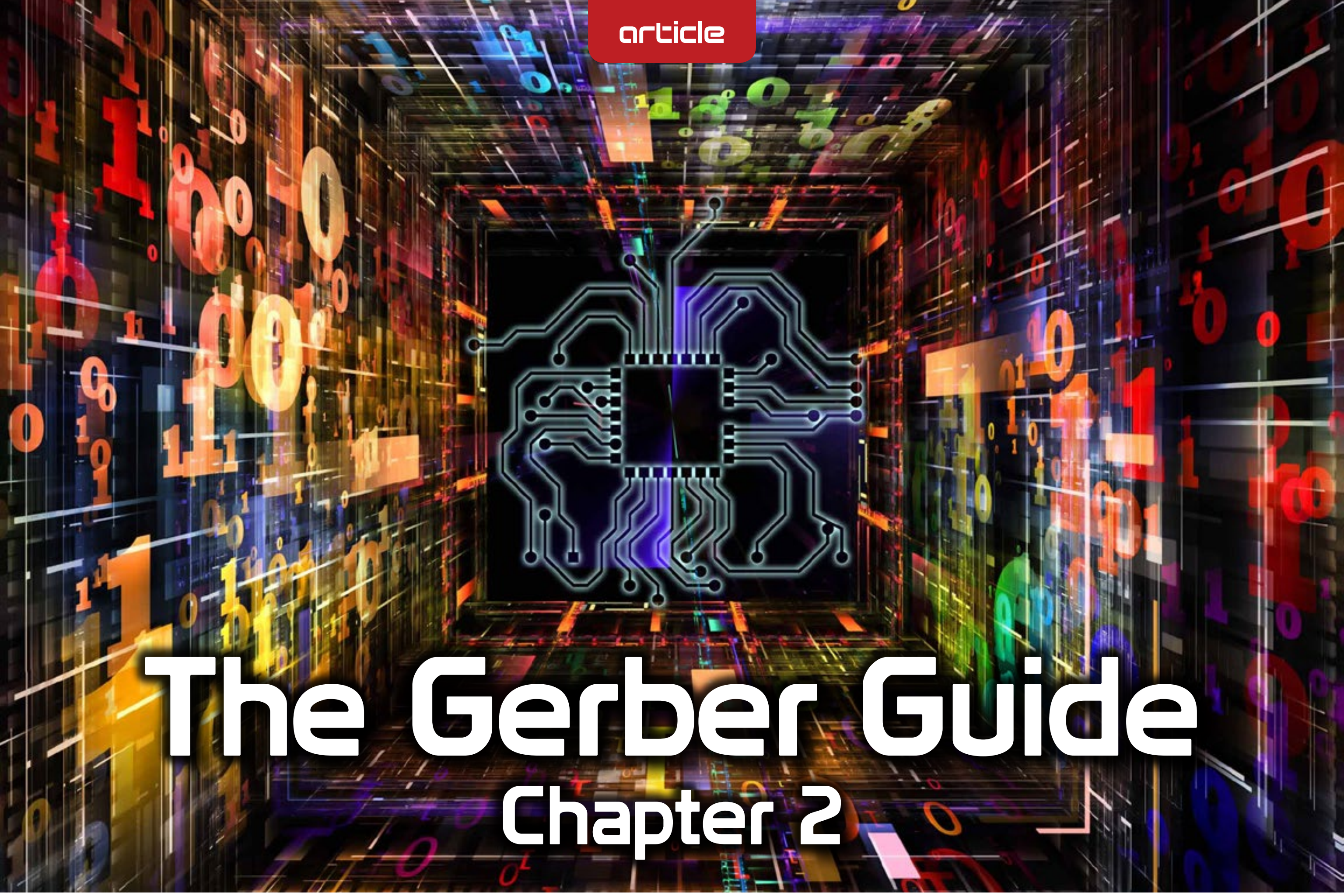
## Boeing Salt Lake Team Trades Hand Tools for Robots

To help meet Commercial Airplanes increased production rates, Boeing Salt Lake employees are transforming the way they build and paint 787-9 horizontal stabilizers.

## Future Army Nanosatellites to Empower Soldiers

One Army project is making the future of satellite communications more responsive to Soldiers' needs. The U.S. Army Space and Missile Defense Command/Army Forces Strategic Command's Nanosatellite Program, or SNaP, will be a small satellite communications, or SATCOM, constellation. This will allow communication across great distances using existing UHF tactical radios.

article



# The Gerber Guide
## Chapter 2

**by Karel Tavernier**
UCAMCO

It is clearly possible to fabricate PCBs from the fabrication data sets currently being used; it's being done innumerable times every day all over the globe. But is it being done in an efficient, reliable, automated and standardized manner? At this moment in time, the honest answer is no, because there is plenty of room for improvement in the way in which PCB fabrication data is currently transferred from design to fabrication.

This is not about the Gerber format, which is used for more than 90% of the world's PCB production. There are very rarely problems with Gerber files themselves; they allow images to be transferred without a hitch. In fact the Gerber format is part of the solution, given that it is the most reliable option in this field. The problems actually lie in which images are transferred, how the format is used and, more often, in how it is not used.

In this monthly series, Karel Tavernier explains in detail how to use the newly revised Gerber data format to communicate with your fabrication partners clearly and simply, using an unequivocal yet versatile language that enables you and them to get the very best out of your design data. Each month we'll look at a different aspect of the design to fabrication data transfer process.

This article has been excerpted from the Guide to PCB Fabrication Data: Design to Fabrication Data Transfer.

### Chapter 2: Alignment (Registration)

Never mirror or flip layers! All layers must be viewed from the top of the PCB, which means that the text must be readable on the top layer and mirrored on the bottom layer. Alas, sometimes, in a mistaken attempt to be helpful, designers flip layers because they must anyway be mirrored on the photoplotter. This could be helpful in a world where the designer's files are used directly in fabrication, but these data layers are actually input for the CAM system. This needs the correct 2.5D PC structure, so designers need to follow the standard protocol for providing digital data. The fabricator's CAM system

will do the rest: it will optimise and panelise the PCB and on output of the final, panelised data, it will mirror, rotate, shift and scale as required by production. Any designer that mirrors layers can only hope that the CAM engineer notices this and 'unmirrors' them.

Sometimes the drill/rout files use completely different coordinates from those used by the copper layers, typically because the copper layers are output in Gerber and the drill files in Excellon. (We will look at this in more detail in Chapter 4.) This results in misalignment, which the CAM engineer must then correct. This is generally relatively easy as the pattern of drill holes and pads is quite characteristic, but it's less easy with very symmetrical jobs. Easy or not, the goal is to take the guesswork out of data transfer, and deliver aligned drill files. The simplest remedy is to output drill and rout files in Gerber so that the same coordinates are used for both file types.

In fact, all physical layers should be aligned, so those same coordinates should be applied to the solder mask, legend, board outline, and peelable layer, and for the sake of clarity, even though it's not mandatory (as they are not a physical part of the PCB) to any accompanying drawings.

Sometimes, registration is resolved by adding alignment targets to the images. Don't do this. CAM engineers must manually move the layers around until the targets align, and then manually remove the superfluous alignment marks, both of which take time on the CAM system and are a far cry from automatic, standardized data transfer. Eliminate complications by using the same coordinates, and register your data files.

Your favorite Gerber viewer will no doubt allow you to verify that they are aligned. Remember: Output all layers in the same coordinate system.

Next month we'll look into Chapter 3. See you then. **PCBDESIGN**

**Karel Tavernier** is managing director of Ucamco.

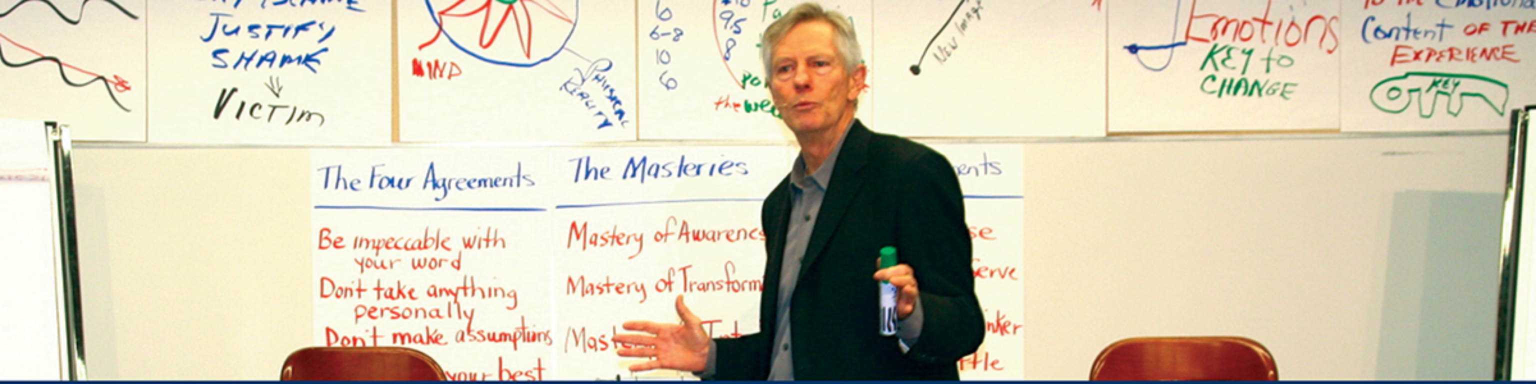
## New Graphene-based Catalysts for the Energy Industry

Researchers at the Universitat Jaume I in Spain have developed materials based on graphene that can catalyse reactions for the conversion and storage of energy. The technology patented by the UJI combines graphene and organometallic compounds in a single material without altering the most interesting properties of graphene, such as its electrical conductivity.

The technology, developed by the Group of Organometallic Chemistry and Homogeneous Catalysis (QOMCAT) of the UJI, is of great interest to the energy industry and is part of the so-called "hydrogen economy." An alternative energetic model in which energy is stored as hydrogen. In this regard, the materials patented by the UJI allow catalysing reactions for obtaining hydrogen from alcohols and may also serve as storage systems of this gas.

It is a novel technology since it uses graphene for the first time as a support of organometallic compounds. These hybrid materials have catalytic properties and are modular and recyclable. Thus, the catalyst developed at the UJI can be recycled ten times without suffering a loss of activity, a very attractive property from the industrial viewpoint.

The new material is also obtained from a novel system of obtaining hybrid materials in a single step. An easy and affordable system that allows that all the technology that is currently based on graphene can be easily converted using these new materials. Thus, the patented materials can be used both in the development of catalysts as well as storage batteries or other energy types.

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# TOP TEN

## Recent Highlights from PCBDesign007

### 1 Beyond Design: Stackup Planning, Part 2

In Part 1 of the Stackup Planner series, I looked at how the stackup is built, the materials used in construction and the lamination process. And I set out some basic rules to follow for high-speed design. It is important keep return paths, crosstalk and EMI in mind during the design process. Part 2 follows on from this with definitions of basic stackups starting with four and six layers.

### 2 The Shaughnessy Report: The PCB Design Supply Chain

We asked readers of The PCB Design Magazine if their supply chain was a problem for them. Almost two thirds of respondents said no, but a solid 37% said yes. And surprisingly, for many it was an emphatic "yes." Navigating the supply chain is a huge challenge for some of our leading companies.

### 3 Nick Barbin: From Designer to EMS Company Owner

Many PCB designers would rather do just about anything than pore over a P&L spreadsheet. But Nick Barbin isn't a typical designer. He co-founded Optimum Design Associates over two decades ago, and later expanded into contract manufacturing. I caught up with Nick recently and asked him how he wound up leading an EMS company on the Inc. 5000 list.

### 4 Training the Next-Generation Engineer: When Does it Begin and End?

American engineering companies are seeing a severe shortage of the homegrown engineers required to compete globally. Just go into any company today and you'll notice that increasingly, the engineers are foreign-born. Our local universities are seeing fewer and fewer American engineering students each year.

### 5 Mentor White Paper: Analyzing Crosstalk's Impact on BER Performance

This paper by Mentor Graphics' Vladimir Dmitriev-Zdorov and Zhen Mu discusses two major issues associated with channel crosstalk that have not been fully addressed previously: models from measurements and algorithms for BER prediction. It presents a practical solution that allows designers to add in near-end or far-end crosstalk.

## 6 ICD Expands Reseller Network in Europe

In-Circuit Design Pty Ltd (ICD), Australia, developer of the ICD Stackup and PDN Planner software, has expanded its reseller network in Europe. Premier EDA Solutions Ltd. has been appointed the ICD distributor in the UK and Ireland, and will also service the Europe-Middle East-Africa (EMEA) regions.

## 7 Fighting the War on Failure

Multiple iterations and board re-spins weren't an issue until price and time-to-market made them an issue. Once high-speed PCBs became the norm, doing redesigns and building prototype after prototype was no longer financially feasible. Design teams began using simulation and analysis, the "right the first time" movement took off, and now we look at the old way as a failure.

## 8 Engineer Steve Weir Has Passed Away

We're sad to report that engineer Steve Weir has died. A cutting-edge engineering consultant, Steve had an irreverent sense of humor that you don't find among most engineers. At DesignCon, Steve introduced me to a few other EEs, with caveats such as, "John's an SI engineer, but more importantly, the statute of limitations has run out on his unprosecuted felonies. And don't let him near your wife. Or your son, for that matter." It was like that with Steve. We need more people like him.

## 9 Polar Instruments Launches New Language Versions of The Speedstack PCB Layer Stackup Design System

Polar Instruments has launched new language versions of Speedstack, the industry's best-selling PCB layer stackup design system. In addition to English, Speedstack is now available in German, Japanese, simplified Chinese and traditional Chinese versions.

## 10 IPC APEX EXPO 2016 Seeks Technical Abstracts

IPC invites researchers, academics, technical experts and industry leaders to submit technical conference abstracts for IPC APEX EXPO 2016 at the Las Vegas Convention Center in Las Vegas. The technical conference will be held March 15-17, 2016. The deadline for technical conference paper abstracts has been extended to September 14, 2015.

# events

For the IPC Calendar of Events, click here.

For the SMTA Calendar of Events, click here.

For a complete listing, check out *The PCB Design Magazine's* event calendar.

**electronica India**
September 9–11, 2015
New Delhi, India

**productronica India**
September 9–11, 2015
New Delhi, India

**PCB West**
September 15–17, 2015
Santa Clara, California, USA

**Medical Electronics Symposium 2015**
September 16–17, 2015
Portland, Oregon, USA

**SMTA International 2015**
September 27–October 1, 2015
Rosemont, Illinois, USA

**IPC Conference on Government Regulation**
October 13, 2015
Essen, Germany

**IPC Europe Forum: Innovation for Reliability**
October 13–15, 2015
Essen, Germany

**Long Island SMTA Expo and Technical Forum**
October 14, 2015
Islandia, New York, USA

**TPCA Show 2015**
October 21–23, 2015
Taipei, Taiwan

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# ADVERTISER INDEX



## Coming Soon to *The PCB Design Magazine:*

*October:*
**Accelerating the Design Cycle**

*November:*
**Managing Your Design Data**