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Degrees of Freedom

by Jamie J. Gooch

The Next Industrial Revolution

In my latest scientific observation, I have noted that amazing things happen when two powerful forces converge on the same space at the same time. This morning, that space was our upstairs bathroom, and the forces were my daughters. The results were not revolutionary, though the energy emitted by an arguing teen and tween was certainly explosive.

But such convergences aren't always so destructive. The joining of two powerful forces—water and mechanization—ushered in the first industrial revolution. The second industrial revolution replaced steam power with electricity to bring about mass production. The third added electronics to the machines to enable automation. The fourth industrial revolution, according to many smart people who spend much of their time trying to figure out such things, involves cyber-physical systems (CPS) that bring together software, sensors, processors, and communication technologies.

One of those smart people is James Truchard, the co-founder and CEO of National Instruments. He shared his vision of where he thinks industry is headed during the opening keynote last month's NIWeek.

Cyber-physical systems bring together software, sensors, processors and communications.

"Cyber-physical systems have the components of computation, control and communication ... all in an integrated environment that let you merge the real world with the virtual world," he said. "A programmable world, Internet of Things, intelligent systems, big analog data, the cloud, Industry 4.0, the smart factory, machine to machine, industrial Ethernet ... all of these things are converging. The technologies are becoming available to solve these problems."

You Can't Fight the System

History has a habit of repeating itself. Hindsight shows us Henry Ford didn't get rich by making cars, he got rich because he invented a system to produce cars more efficiently. Other tycoons of the late 1800s understood the importance of a system as well. Whoever controlled the system of rails that allowed the technologies of the day to converge held the true power.

Likewise, whoever creates or controls even a small portion of the "system" in cyber-physical systems will lead the fourth Industrial Revolution. That may be why Truchard is positioning NI as the platform that will enable CPS.

"We use graphical system design to build cyber-physical systems — advanced measurements and advanced controls in a single platform," he told NI Week attendees.

Designing Production

If NI is building the modern-day equivalent of a railroad that will bring disparate, raw technologies to bear, other companies are focused on creating the Industry 4.0 version of Henry Ford's assembly line. Industry 4.0 was coined by Germany's Research union, an organization of scientists and business and industry executives that advises the German government. One of those expert advisers is Marion Horstmann, head of strategy at Siemens' Industry Sector.

Siemens, which calls itself the world's leading supplier of automation technology and industrial software systems, may be piloting the assembly line of the future in one of its electronics factories in Amberg, Germany.

"The Amberg factory is a good illustration of where we're heading," Horstmann is quoted as saying on Siemens' website. "Digital planning still has to be transferred into real production 'by hand' in Amberg, as the two processes are currently sequential. However, in the future they will increasingly overlap, and they will ultimately be concurrent ... When that happens, engineers who plan a new product, such as a new switchgear, will use special software to simultaneously design its manufacturing process, including all associated mechanical, electronic, and automation systems."

It's an amazing concept to contemplate. Look at how simultaneously being able to design and simulate mechanical and virtual systems has already drastically changed the design engineer's job responsibilities. The ramifications of simultaneously being able to impact the workings of a factory of the future as you're designing and simulating a product are mind boggling.

Horstmann's prediction won't come true overnight, but if and when it does, the definition of design engineering will broaden so much that today's state-of-the art will barely be recognizable. Increasingly, many design engineers are tasked with bringing computation, control and communication technologies together in one product—one system—via mechanical, electronic and software-based solutions. We may be witnessing the first steps toward the design-driven factories of the future. **DE**

Jamie Gooch *is the managing editor of* Desktop Engineering. *Contact him at de-editors@deskeng.com.*

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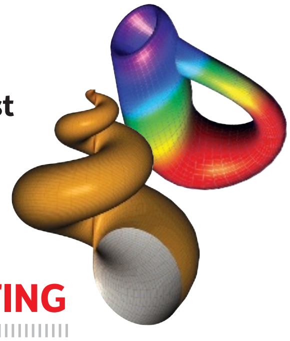
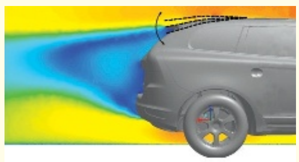
ON THE COVER: A new design process takes materials and manufacturing requirements into account.
Images courtesy of Dr. Akbar Farahani, ETA.





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BPA WORLDWIDE

by Kenneth Wong & Beth Stackpole

Enigma Buy Extends PTC's SLM Push

As part of its efforts to stake out new turf beyond CAD and product lifecycle management (PLM), PTC has steadily built a broad portfolio of products in the service lifecycle management (SLM) space. PTC's strategy is to tap into the growing number of large companies that are looking to overhaul service processes and build synergies between service groups and engineering to transform service from functioning as a cost center to becoming a steady source of new revenues and profits.

PTC's latest acquisition in this arena is Enigma, which markets software used to deliver product, parts and service information to engineers and service technicians working in maintenance facilities, field service or dealer environments. What Enigma provides that PTC currently lacks is a centralized "Service Center" portal for delivering third-party service information — be it CAD files or some other technical document — that was created outside of the PTC platform. Currently, PTC provides capabilities for delivering and publishing service-related information, but the materials had to have been authored and stored in PTC products like Creo Illustrator or Arbortext, notes Dave Duncan, PTC's vice president, product management for its SLM segment.

"What we've been lacking on the Service Center side is an efficient way to deliver third-party created information," he explains. "There's a broad range of illustrations created in different products, and we want to be able to deliver that feedback efficiently. That's where Enigma fits in."

Having one system for services that can provide the latest configuration-specific content and parts information will greatly improve how technicians work. It will also promote better quality, product uptime and ultimately, customer satisfaction, Duncan says.

There is also an upside for engineers: As technicians perform their service work, they can provide feedback, identifying problem areas that engineering can address in workarounds or subsequent designs. They can also identify poorly written technical information.

"Typically, engineering hasn't gotten this kind of feedback unless problem reports are logged into the contact center," says Duncan, adding that most companies have disjointed, manual processes and maintain multiple systems so there is no tight integration between engineering and service groups.

— B. Stackpole

Inventor HSM Express Now in Public Beta

Eight months ago, Autodesk bought the technology of HSMWorks, which is considered to be a leading CAM software house. The acquisition is now bearing fruit. In July, Autodesk released a public beta version of Autodesk Inventor HSM Express, a plug-in that lets you study and simulate machining operations from inside Autodesk Inventor.

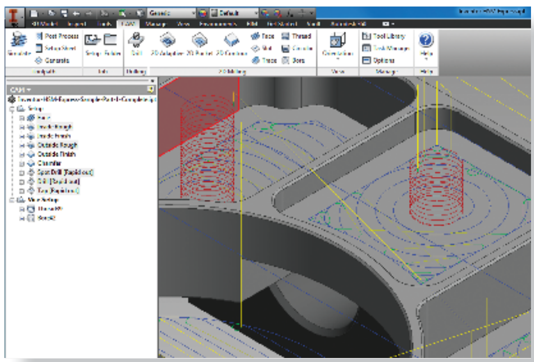
Before the acquisition, HSMWorks had already made a name for itself with the popular SolidWorks add-on, HSMXpress for SolidWorks. Despite the slight variation in spelling (Xpress for SolidWorks, Express for Inventor), the two packages offer identical feature sets, according to Anthony Graves, an HSMWorks veteran who joined Autodesk as a product manager after the acquisition.

Like HSMXpress for SolidWorks, HSM Express for Inventor is free. Both are limited to 2.5-axis milling operations. To simulate more complex operations, you'll need the paid version. For those who work with organic shapes and surfaces, the commercial versions are better options.

Like the commercial versions, the free versions are also programmed for distributed computing, which tends to speed up tool-path generation when dealing with complex geometry. However, the type of geometry possible with 2.5-axis is not usually complex enough to justify multicore processing, so users will not likely take advantage of it.

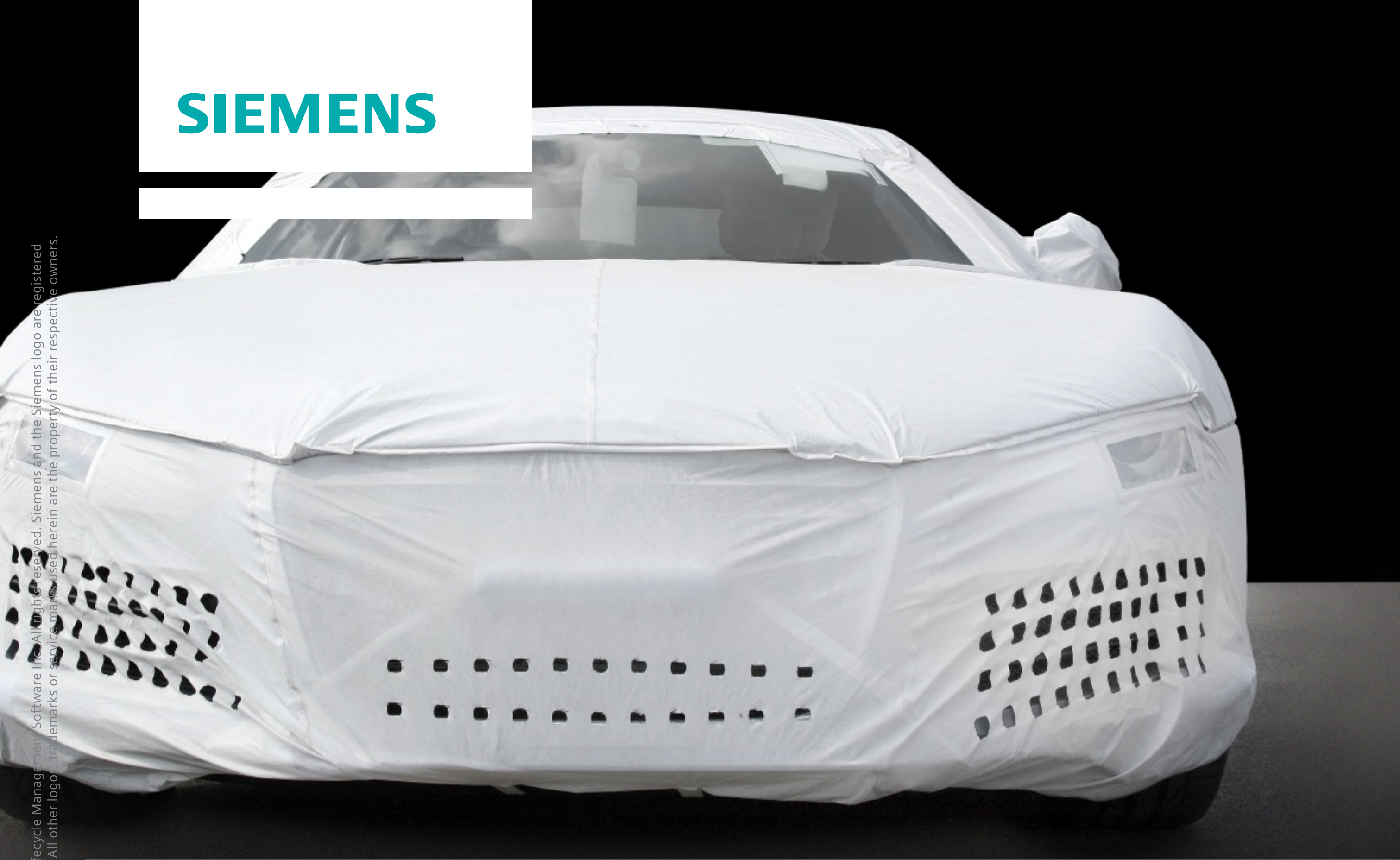
The free versions, Graves says, target "designers and engineers who are interested in subtractive manufacturing or machining. The express products give them a risk-free way to explore CAM, right inside the design tool they're used to working with."

— K. Wong



Eight months after acquiring HSMWorks, Autodesk released Inventor HSMWorks Express, a free CAM plug-in for Inventor.

SIEMENS



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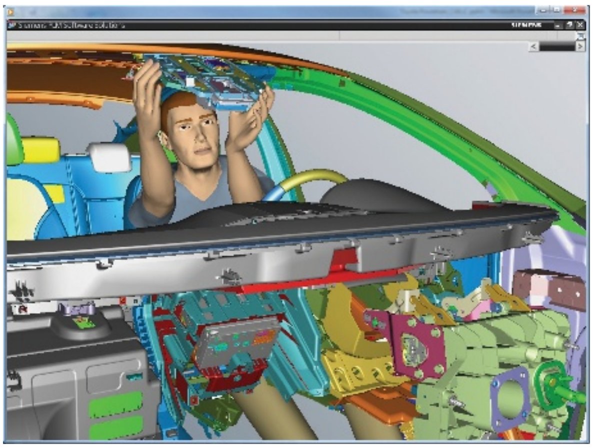

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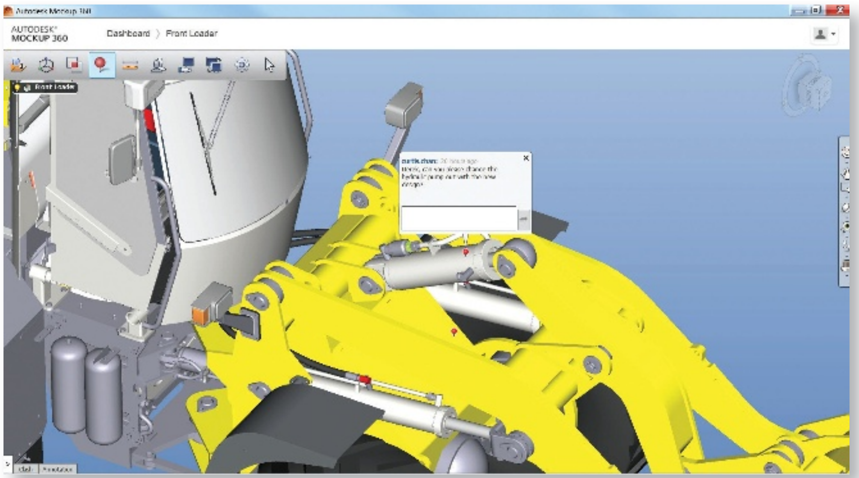
Answers for industry.

by Kenneth Wong & Beth Stackpole

Autodesk Fills out 360 Cloud Portfolio

At first, it seemed like Autodesk was just talking up the cloud. Then the maker of professional design software embraced the cloud as a springboard for a whole new family of consumer-oriented design capabilities. Now, Autodesk is back in the cloud spotlight with a pretty robust lineup of services intended to bring flexibility, compute scalability, and more collaborative interaction to professional design engineers.

On the heels of the official debut of Autodesk Fusion 360 in June, Autodesk unveiled a trio of offerings: Autodesk Mockup 360, a cloud-based, real-time collaboration and digital mockup tool; Autodesk Configurator 360, a cloud-based configuration service; and Autodesk Sim 360, a cloud-based, lightweight application for mechanical simulation and finite element modeling. These latest additions are based on the Autodesk 360 cloud-based design platform, which launched in September 2011 and which Autodesk claims has already been accessed by 15 million users.



Autodesk Mockup 360 allows up to 500 people online to be connected to the same model. *Image courtesy of Autodesk.*

Entrepreneurs Flock to the Cloud

While Autodesk says small entrepreneurial businesses (actually, what they call "very small businesses") are the most avid adopters of the new cloud-based tool portfolio, it says companies of all sizes are experimenting with the new paradigm, according to Richard Blatcher, Autodesk's senior global industry marketing manager. What's interesting, though, is rather than companies choosing between a traditional or cloud-based delivery model for their design tool software, Autodesk sees companies leveraging both styles depending on the particular workflow — a scenario Blatcher likens to the evolution of working in both 2D and 3D depending on the task.

"It's not a decision of whether to work traditionally or work in the cloud, it's an 'and' play," he explains. "A huge number of customers will continue to work in Inventor and add [cloud-based] services at their own pace."

Where Blatcher and other Autodesk execs see the value of the cloud is in its flexibility to accommodate what has fast become a nearly universal need to collaborate on designs with outside partners, suppliers, customers and even outsourced engineering teams.

"Many traditionalists think organizations operate independently in closed bubbles of their own, but that's not correct in today's marketplace," notes Steve Hooper, Autodesk's senior product line manager for mechanical design.

While the universal hurdle to the adoption of cloud-based design software has been concerns around security, Autodesk says companies are becoming more comfortable with the model. Moreover, the tried-and-true ways of sharing engineering IP and CAD models across a dispersed design team has been through email or an overnight delivery service — both of which have their own inherent security risks, Hooper says. "It's infinitely more secure to share IP through a professionally managed cloud-based service," he adds. "To see the cloud as a risk is to ignore how people do business today, and to ignore the market drivers in terms of global supply chain collaboration."

What follows is a snapshot of the new Autodesk 360 offerings.

Mockup 360

This cloud-based, real-time collaboration and design mockup tool will allow engineering groups to capture and aggregate CAD data from various sources and formats (PTC's ProE, SolidWorks, STEP and IGES files, among others) and bring it together in one environment. Up to 500 people can be online concurrently connected to the same model, Autodesk says, allowing them to create markups, edit positions and check for interferences without the need to install desktop solutions.

Continued on page 12 ...

... Continued from page 10.

Configurator 360

This cloud-based service improves productivity and reduces cycle times, allowing companies to deliver an online catalog of products to customers and sales reps for the purposes of building custom models for quoting or for new product design. Accessed via a browser or mobile app, users start by uploading an Inventor or Inventor Engineer-to-Order (ETO) part or assembly to Configurator 360, which then identifies the parameters or rules as defined in iLogic or ETO, providing the ability to define customization options before deploying the configurator.

Sim 360

Building on what it announced last September, Autodesk took the wraps off of Sim 360. It was designed to address a key problem Autodesk heard from customers — that they were lacking the computational resources to do mechanical simulation on any grand scale, according to Derrek Cooper, senior product line manager for simulation. Sim 360 has capabilities for finite element analysis (FEA), computational fluid dynamics (CFD) and Moldflow. It also provides a cloud-connected workflow for simulation, which can store data locally in-house while leveraging the infinite computing resources of the cloud to do the heavy computational lifting. Now, instead of being limited to two or three simulations, companies can run many more simulations concurrently — which leads to more effective design optimization, Cooper says.

All of the new 360 products, including Fusion 360, are available for a free 90-day trial. For video demos of how some Autodesk cloud-hosted products work, visit deskeng.com/virtual_desktop/?p=7312.

— B. Stackpole

Cloud Computing Gone Native

The punch line came about 20 minutes into the demo. Osman Kent, CEO and co-founder of Numecent, showed a mischievous smile as he clicked off the last of his PowerPoint slides.

"You've just seen a PowerPoint presentation," he said. "But I don't have PowerPoint installed on my machine."

What he had was a thin client, showing a list of applications he was running remotely. PowerPoint was listed in that registry. Then it dawned on me. The presentation I just saw was also a demo. It was running on Numecent's cloud-streaming technology, dubbed NaaS (Native-as-a-Service).

Kent was in San Francisco in July, part of his tour to promote NaaS. We met at a gourmet coffee stand in the Mission, the Bohemian district where unorthodox ideas are universally encouraged. Kent described NaaS as a "white-label cloud-paging platform." NaaS is a play on the familiar terms SaaS (Software-as-a-Service), PaaS (Platform-as-a-Service), and IaaS (Infrastructure-as-a-Service). It's "white-label" because it's meant to work behind the scenes, as an invisible middleware — or, if you'd like, backgroundware.

Streaming Software

Kent is currently pitching Numecent's technology to independent software vendors (ISVs). His proposition to CAD/CAM/CAE software makers is quite straightforward: You want to get into the cloud commerce without rewriting your legacy desktop code? Just offer a web-streaming version using Numecent's NaaS.

"As the delivery of digital goods moves unstoppably toward the cloud, companies offering SaaS have been reaping enormous economic benefits with their Web applications," Kent explains. "However, until the advent of NaaS, most ISVs with native applications have been unable to participate in this new economy due to technical, financial and resourcing barriers. NaaS changes all that. It is an instant enabler for ISVs large and small who want to monetize their inventory now — with or without subscription. NaaS is an effortless on-ramp to the cloud economy for ISVs."

NaaS is different from SaaS in one aspect, according to Kent. NaaS allows you to stream, cache and run a native CAD program; SaaS lets you access the software on a remote server and stream pixels to your monitor. The NaaS advantage, Kent points out, is that you're working with native CAD geometry, not just sending and receiving pixels.

Another significant difference between SaaS and NaaS: SaaS applications rely on the remote server to do the lion's share of the work and only transmit pixels representing the results (edited geometry, simulation results, and so on). NaaS applications transmit the necessary chunks of code and run them on your local machine's resources.

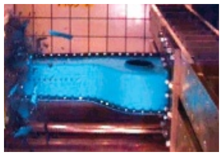
NaaS requires you to possess the hardware suitable for the software you're streaming. Kent says he believes that wouldn't be a hurdle for the design and engineering market, however, because most users do have the necessary hardware.

So why bother streaming? Why not just use the desktop-installed version? Kent's list of NaaS benefits include the options to:

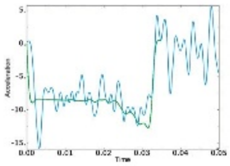
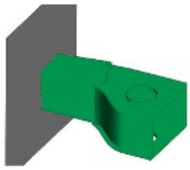
- rapidly "cloudify" and "SaaS-ify" software inventory;
- rapidly integrate with web services such as e-Commerce or CRM;
- enjoy drastically reduced piracy; and
- offer friction-free trial or beta programs.

— K. Wong

CRUSHING


Composite Simulation

CZone for Abaqus, from Dassault Systèmes, provides fast transition to predictive composite crash simulation.

The Automotive and Rail Industries are moving to composites to improve fuel efficiency, but now face the challenges of predicting composite crash performance. Composite structures can provide significant gains in energy absorption over traditional materials — if designed well. How can structural simulation be used to evaluate crushing of composite designs, without extensive test correlation? One solution is CZone for Abaqus from SIMULIA, an application from Dassault Systèmes, the 3DEXPERIENCE company. CZone for Abaqus offers a realistic 3D composite crush simulation experience for customers, says Marc Schrank, who heads up the SIMULIA Key Customer Engagement group of Dassault Systèmes.

Requirements and Key Functionality

Crushing and energy absorption have been extensively modelled for metallic structures, where progressive local buckling and collapse is a dominant mode. Composite-intensive structures present a new challenge due to very different characteristics. When a composite structure is subjected to crushing loads, the composite layup progressively 'disintegrates' into fine debris or develops complex crush patterns. This disintegration generally provides for much greater energy absorption capacity than for metals.

CZone for Abaqus is an add-on to Abaqus/Explicit that provides a unique methodology for composite crush simulation occurring in a vehicle impact. It is based on CZone technology from Engenuity Ltd., in the UK. The uniqueness of the CZone technology is the recognition of "crush stress" as a material property for composite laminates that can be measured from coupon tests in a lab test rig. This measured crush stress can then be used in crash simulations.

Compare this to traditional methods requiring extensive element material parameters that need to be tuned against test at the full component level. With the traditional approach you often have to know the results of expensive physical tests before building the components into an overall vehicle simulation.

This fact is not lost on several major automotive manufacturers who are renowned for needing fast, accurate, and reliable simulation as early as possible in the design cycle. BMW's evaluation of CZone for Abaqus is reported in a recent paper by Schrank and co-authors from BMW and Engenuity[1].

The other well-established crash and impact technologies inherent in Abaqus/Explicit are available to use in conjunction with CZone for Abaqus. Accurately simulating both the crushing response and the crush loads transmitted throughout the rest of the structure are important. If overall load levels become too great, the structure may fail or lose its integrity due to fracture or buckling modes. Simultaneously using built-in features in Abaqus/Explicit to predict such potential non-crushing failures away from the crush zone is important to using simulation most effectively when designing crashworthy composite-intensive structures.

The CZone Breakthrough

Traditional composite crush simulation relies on developing the methods used for metallic structures by controlling element stiffness and deleting elements as material is destroyed. Due to the brittle nature of composites, this is difficult in high-speed composite impacts, hence the need for elaborate tuning against tests.

The CZone for Abaqus approach is elegant and pragmatic. A contact surface interaction is used to control the crushing material behavior. The crush stress property is used in the simulation to predict the forces a crush zone will transmit to the structure. The technique has shown excellent correlation in predicting both the energy absorption in the crush zone as well as potential failures away from the crush zone in complex assemblies.

Minimal Testing

"Simulation professionals in the Automotive Industry are carrying out highly productive analysis today with CZone for Abaqus," Schrank says. "The key to this is minimal test correlation to validate the local material crush response, enabling predictive simulation, from full component up through full vehicle simulation."

Those working in the composite material crashworthiness field should closely evaluate the Dassault Systèmes realistic simulation technology available in CZone for Abaqus. DE

Source: *1. System Level Design Simulation to Predict Passive Safety Performance for CFRP Automotive Structures. Lescheticky, J., Barnes, G., and Schrank, M., SAE Technical Paper 2013-01-0663, 2013*

SIMULIA

INFO → SIMULIA, Dassault Systèmes: www.3ds.com/simulia

University of Tokyo Develops e-Skin

In cooperation with the Johannes Kepler University, University of Tokyo scientists have developed a flexible sensor thinner than plastic wrap and lighter than a feather. The scientists refer to their breakthrough as "imperceptible electronics," or e-skin. When a patch of the material is fastened to the human body, researchers claim it is all but impossible to notice.

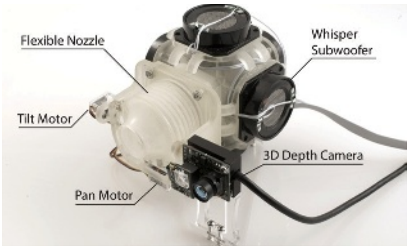
Along with providing a touch-sensor type system, the imperceptible electronics could also be used to monitor the health of a patient, embedded as part of a prosthetic to provide feedback, and possibly form the basis for robotic skin in the future. The nearly indestructible material is manufactured in huge plastic sheets by putting a thin layer of aluminum oxide over an equally thin polymer foil. Circuitry is then added using carbon-based organic components, which can be tailored to use in a method similar to standard electronics.

MORE ➜ engineeringontheedge.com/?p=5154

Disney's AIREAL Next Generation Haptic Tech

Disney Research is pushing the boundaries of the user interface with its AIREAL haptic feedback system, which provides users with a touch experience sans screen or any other physical device.

The almost entirely 3D-printed system is designed to use a vortex, a ring of air that can travel large distances while



keeping its shape and speed. When the vortex hits a user's skin, the low-pressure system inside it collapses and imparts a force the user can feel. An actuated flexible nozzle allows a vortex to be delivered to any location in 3D space.

Stacking multiple AIREAL systems in an area increases the haptic feedback, potentially creating a method of interacting with digital 3D objects.

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Cardboard Printer Made From Recycled Paper

The Origami is a personal mono laser printer with an exterior made out of 100% recycled paper. Designers at Samsung Electronics created it to simplify the complex structures usually required for building a printer. The exterior provides the same durability as a plastic cover via an origami-based assembly method to house the print engine. The designers also claim that it's waterproof.

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Magnetic Direct Drive Motors for Weed Whackers, Wind Turbines

Montana-based CORE Outdoor Power has come up with an interesting alternative to gas-powered motors. The Conductor Optimized Rotary Energy (CORE) motor uses printed circuit boards (PCBs) to generate motion in a wireless, ironless form factor. A circular, multi-layer PCB is sandwiched between ring-shaped magnets. A battery sends electricity through 10 layers of copper conductors; this action spins the magnets and turns the motor.

Currently, the company offers the motor as part of its Power Lok Drive Unit, which can be connected to blower and trimmer attachments.

Parent company Core Motion also has a wind generation division, Boulder Wind Power, which will use the same basic motor concept for wind turbines. The direct-drive generator technology touted by the company boasts the ability to deliver the same torque with half the mass of comparably rated iron-core direct-drive generators.

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Sweat Machine Draws Attention to the Lack of Drinkable Water

According to UNICEF, approximately 780 million people around the world lack access to clean drinking water. As part of its efforts to raise funds to provide water purification tablets to those who need them, the organization teamed up with the Gothia Cup youth soccer event and developed the Sweat Machine — a device that can extract sweat from clothes and turn it into potable water.

Participants and visitors at the tournament were asked to contribute their sweaty clothes and, if they were willing, drink a glass of the resulting water. The machine spins the clothes to remove the sweat, then filters the liquid to remove salts, bacteria and fibers. The International Space Station uses similar technology to turn urine and sweat into potable water.

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2SEAS Surveillance Drone Built Using AM

The 2SEAS drone, designed by the University of Southampton, has been developed specifically to help the United Kingdom, France and the Netherlands patrol the North Sea and the English Channel for smugglers and drug traffickers.

The body of the 2SEAS was built using additive manufacturing (AM). 3D printing allows designers to make lighter aircraft to help increase the amount of time a

drone can spend in flight. Large pieces of the plane can be created in a single build, from a single piece of material, rather than from multiple parts. Fewer parts makes for a lighter aircraft, which reduces fuel expenditures.

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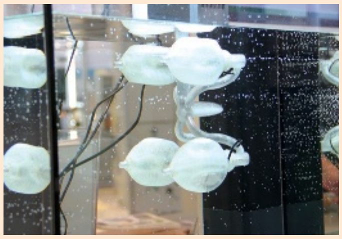
3D-printed Water Propulsion System Inspired by Octopods



The Fraunhofer Institute has been studying octopods to determine the natural mechanisms that allow the creatures to swim and, more specifically, how they manage to create a quick burst of speed when they need to make a quick getaway.

"We have integrated this propulsion principle into our underwater actuators: Four elastomer balls with mechanical inner workings create propulsion by pumping water," explains Andreas Fischer, an engineer at the Fraunhofer Institute in Stuttgart, Germany.

To operate, water is drawn into an elastomer ball through an opening that is equipped with a recirculation valve to keep the water from escaping. A motor pump then operates a hydraulic piston, which flexes the mechanical version of an octopus' muscle, pushing the water back out of the ball. The system provides enough propulsion to maneuver small watercraft, and could also be used as a swim aid for divers.

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New AM Process Leads to Stronger Alloys

Germany's University of Rostock has done research into metal additive manufacturing (AM), with a focus on spark plasma sintering (SPS) as the method of building parts. SPS uses pulse energizing and mechanical pressure to quickly sinter metal powder into the desired shape. While SPS isn't new, the step immediately following a build is where researchers have made a breakthrough.

Researchers used a titanium alloy part for their experiment. Instead of allowing a part to cool naturally, it was subjected to a two-step cooling process. When analyzed, the part was found to be 12% harder than titanium parts left to cool naturally, and had an improved ductility up to 34±3%. Additionally, the research suggests the faster a part is cooled, the harder it becomes.

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Printing Metal 3D Objects at Room Temperature

3D printing with metal is accomplished by a number of processes, usually involving creating a melt pool to build an object, or sintering the powder into solid form.

These processes often require a vacuum-sealed chamber or high-powered lasers to create a build, resulting in AM systems with a hefty price tag.

But researchers at North Carolina State University have discovered a method to build 3D structures using liquid metal at room temperature. The structures are built without the use of a vacuum chamber or laser.

The researchers' work revolves around the binary eutectic alloy of gallium and indium, but, according to the team, should work with just about any alloy of gallium. EGaIn remains a liquid at room temperature and possesses metallic conductivity. Exposure to air forms a thin skin atop the metal, allowing it to maintain its shape while the interior hardens.

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New AM Process

Brian Harms, a design research master's program student at the Southern California Institute of Architecture, has advanced a new additive manufacturing (AM) process he calls "suspended deposition." In its current state, suspended deposition employs a robotic arm and liquid resin to build 3D objects in a tank of gel.

The gel acts as a support material for builds, allowing objects to be built with a light-curing resin material. Working in this manner allows for builds to proceed in three dimensions, rather than ending in a 3D object. Different parts of an object can be built up before returning to the base and working on a separate area, and alterations in the design can be achieved by adding to "finished" portions of the object during the same build.

In addition to building in three dimensions, the nature of the light-curing resin suspended in gel allows for subtractive methods.

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5 Questions to Ask Before Buying a Workstation

Use this checklist to ensure you're making the best decisions.

While an entry-level workstation may command a slightly higher price point than a top-of-the-line desktop, the few hundred-dollar difference is more than offset by productivity increases that experts estimate can be as high as 30% for common engineering tasks like CAD design and simulation. To avoid being penny wise and pound foolish, experts suggest answering the following five questions before determining that a workstation is cost prohibitive.

1. Do I really need a workstation? The answer to that question boils down to whether the work you do is essential to the actual design of a product. If you are doing full-blown CAD design or running simulation, a workstation is the better choice not only due to increased performance, but because a workstation is tested, optimized, and even certified to run critical engineering applications. For example, most workstation configurations include ECC (Error Correcting Code) memory, which detects and corrects the most common kinds of internal data corruption, ensuring that critical design work and intellectual property is properly protected.

2. What processor best meets my needs? Resist the compulsion to purchase the fastest processor on the market. Spend time evaluating the applications and workflows essential to getting your job done. Most design applications are frequency sensitive, but investing in the fastest processor isn't the only way to ensure optimal performance. By buying a system equipped with a processor that's one or two frequencies down from the top-of-the-line model, users can channel potential savings towards other, less expensive technologies that can impact performance.

3. How much memory do I really need? Studies show that engineering users should outfit their system with twice as much memory as the largest model they are working with. Doing so mitigates the need for paging (accessing the hard drive), which can deliver a potential performance increase of 2X, according to experts. Therefore, redirecting savings on lower frequency processors to additional memory resources can be an effective way to escalate workstation performance without breaking the bank.

4. What kind of graphics solution is necessary? Back away from the testosterone-driven conclusion that a workstation needs to be equipped with the biggest and baddest graphics card. If your day-to-day work involves non-linear editing or you are working with graphics models that are extraordinarily large, than yes, you might need to invest in a system with a top-of-line GPU. More realistically, however, most engineering users can get away with a mid-range or even entry-level graphics card and still see more than sufficient performance with common CAD modeling tasks.

5. What's the appropriate storage medium for my system? Most high-end desktop systems are configured with hard disk drives, but engineering users can greatly benefit from the added performance of solid state disk drives (SSDs), which are a staple of most workstations. Research shows that configuring a system with SSDs delivers dramatic productivity improvements. For example, Computer Aided Technology, Inc. estimates that enterprise workers can see productivity gains of up to 3X via use of SSDs, particularly when opening and closing multiple files and working with large data sets.

So don't fall into the trap of assuming a properly configured workstation is out of reach. By working through the answers to these questions and by remaining open to a range of performance-boosting technologies, a workstation can end up as the most cost-effective and efficient route to optimizing design productivity. **DE**

INFO → **Intel Corp:** intel.com/go/workstation

Editor's Picks

by Anthony J. Lockwood

Each week, Tony Lockwood combs through dozens of new products to bring you the ones he thinks will help you do your job better, smarter and faster. Here are Lockwood's most recent musings about the products that have really grabbed his attention.

Mechatronics Solution Reduces Configuration Time, Costs

EEC One provides structured access to product and machinery configuration data.

You may know EPLAN for its EPLAN Electric P8 electrical planning and engineering tool, the EPLAN Harness proD 3D software system, and its EPLAN Pro Panel 3D CAE solution for engineering control cabinets and switchgear systems. EPLAN Engineering Center One – EEC One – is the mechatronics-centric solution in the company's integrated suite of engineering solutions for electrical product design and automation development broadly known as the EPLAN Platform.

The basic idea of EEC One is to reduce configuration times and costs by providing structured access and information exchange across engineering disciplines.

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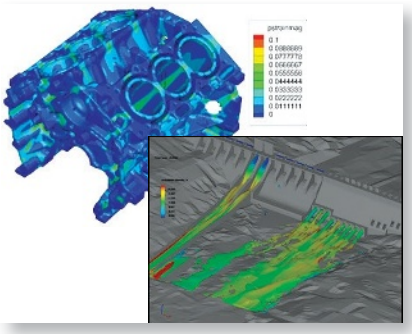

CFD Software Scales for Multi-Core Clusters

FLOW-3D/MP sees the debut of an improved automatic decomposition tool intended to save preparation time and effort.

FLOW-3D/MP is the distributed version of Flow Science's FLOW-3D CFD solution for transient, free-surface CFD modeling. That is, FLOW-3D/MP is a parallel code version of the software that's optimized for multi-core 64-bit Linux clusters. It has the potential to scale up to 128 cores or more.

FLOW-3D itself is a general-purpose CFD system. It is intended to give you the means to tackle pretty much any fluid dynamics and heat transfer problem life throws at you. By the way, it handles meshing and post-processing without additional modules.

MORE → deskeng.com/articles/aabkcy.htm

Workstations Accelerate Engineering

Microway also announces servers using NVIDIA Kepler technology.

The WhisperStation line of workstations from Microway is engineered to be quiet while being powerful engineering systems. The trick is that Microway assembles its WhisperStation line with quiet fans and power supplies and, perhaps more importantly, internal sound-proofing.

The single or dual multicore CPU WhisperStation-Maximus workstations also leverage NVIDIA Maximus 2.0 technology and NVIDIA Quadro accelerators with companion Tesla K20 GPUs (graphics processing units). This provides you with simultaneous visualization and interactive design capabilities.

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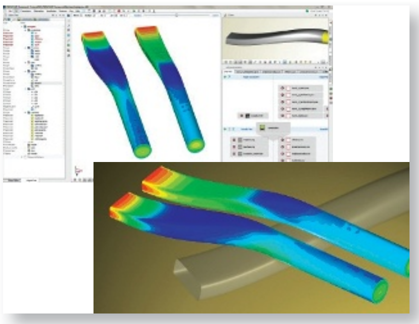

Shape Optimizer for CFD-Driven Design Updated

Company also announces a complimentary release said to help more engineers leverage simulation-driven design.

FRIENDSHIP-Framework from Friendship Systems is a CFD-centric 3D parametric modeler, a portrayal that turns conventional thinking on its head. What this all means is that you can create shapes with smart parameters relevant to simulation without hassling with the features baggage that traditional CAD models come with. You can use the software as your main CAD tool, according to the company, but it also integrates with design tools like CATIA, NX, PTC Creo, and SolidWorks.

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13th LS-DYNA® U.S. & International Users Conference

June 8th - 10th, 2014
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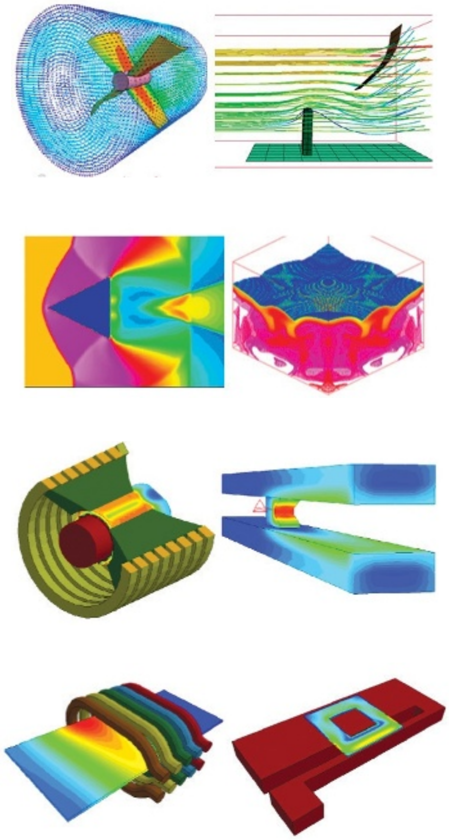

Welcome and Call for Papers

Livermore Software Technology Corporation (LSTC) and **DYNAmore Germany** are pleased to bring engineers, professors, students, consultants, industry leaders and interested parties together at the 13th International LS-DYNA® Users Conference to be held at the Adoba Hotel (formerly the Hyatt Regency) Dearborn, MI.

Important Dates:

Abstract Deadline: Nov 11, 2013
Email Your Abstract to: papers@lstc.com
Notification: No later than Dec 15, 2013
Paper Deadline: Mar 5, 2014

The presenter of each accepted paper will receive free admission to the conference, provided that the presenter registers for a room at the Adoba Hotel under the LSTC Conference registration.

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Point-Counterpoint
Subtractive vs. Additive

Editor's Note: *As Kenneth Wong illustrates on page 24 of this issue, there is plenty of room in upfront design engineering for both additive and subtractive rapid prototyping technologies. To have a little fun pointing out the strengths and weaknesses of both technologies, we decided to pit Todd Grimm (representing additive) against Anthony Graves (representing subtractive) in this point-counterpoint arena. While both Grimm and Graves see the value in using both approaches, we asked them to pick a side and come out swinging.*

Point: Additive manufacturing is capable of making complex, intricate and delicate parts and products that subtractive techniques cannot.

Todd Grimm: What is impractical or impossible with subtractive manufacturing is encouraged with additive manufacturing. Instead of reviewing a design to decide if it is possible and how to approach the machining operations, additive manufacturing allows you to print virtually anything that the mind can conceive.

FOR ADDITIVE TECHNOLOGIES: Todd Grimm, founder and president of T. A. Grimm & Associates, Inc.

In the impossible category, additive manufacturing can reproduce internal, S-shaped channels; deep, narrow slots; tall, thin walls; and deep undercuts. And that is just the tip of the iceberg. There is no need to contemplate how to reproduce complex, intricate or delicate features. They are simply a given with additive manufacturing.

In the impractical category, include all the design features that add excessive time and cost to the machining operation. With additive manufacturing there is rarely a negotiation between design (complexity) and manufacturing (time). In the subtractive world, especially for prototypes, the question "Do you really need that?" is common.

In the additive manufacturing world, the time and cost equation is turned on its head. For example, adding features can actually decrease both. With subtractive manufacturing, every hole, pocket or slot increases time and cost. With additive manufacturing, they remove material, which decrease build time and material consumption.

Counterpoint: Subtractive manufacturing is capable of producing a high volume of finished parts.

Anthony Graves: While 3D Printing is almost always the go-to-technology when it comes to rapidly prototyping complex parts and assemblies, there is simply no substitute for CNC machining when it comes to producing large volumes of parts out of metals, plastics, and wood. Very sophisticated multi-tasking CNC machines and horizontal machining centers designed for production machining are capable of producing thousands of parts a day.

FOR SUBTRACTIVE TECHNOLOGIES: Anthony Graves, Autodesk product manager for HSMWorks.

Point: Subtractive manufacturing is faster than additive manufacturing, even for small runs.

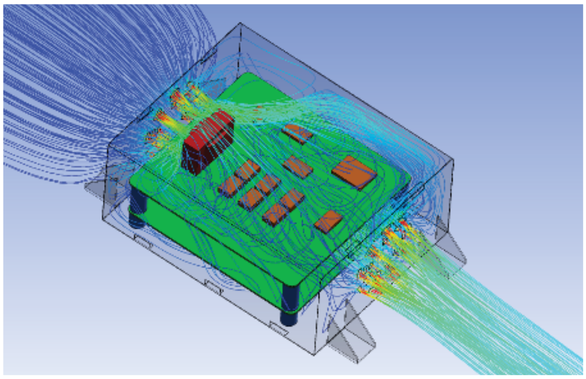
Graves: Many parts produced today, even those with organic 3D surfaces, can be produced on CNC machines very quickly. As CAM software has evolved, more and more companies who once outsourced their machined parts are recognizing that they are able to produce parts in-house much faster when it comes to prototypes and even small production runs. The variety work holding options available today allows users to produce.

Counterpoint: Additive manufacturing requires little setup and can print multiple pieces simultaneously without intervention.

Grimm: Faster is subjective. If speaking of only the time spent cutting material, I agree that subtractive processes are generally, but not always faster. However, once we include all time, both productive and non-productive, the total elapsed time for additive manufacturing is hard to beat for one-offs and small batch production. Just minutes after a design is complete, the part(s) can be building…no CAM programming, no fixture making, no setups.

And once running, the process is automated and unattended. With subtractive processes, do you really trust your program enough to let a first run go unattended, or do you babysit the machine tool to watch for tool crashes? And how often do you have a single setup run? Even with an expensive 5-axis machine tool, you will need a second setup to make the bottom of the part.

Setups and machinist oversight means overnight and week-



end runs of a machine tool aren't going to happen unless you have staffing around the clock. So, it's 4:45 p.m. on a Friday — with additive manufacturing, the part is complete the moment you walk in the door on Monday.

But let's forget about all that and focus solely on multi-part runs, which are the hallmark of additive processes. You can put any combination of parts in a single run. Running in parallel, versus the serial subtractive approach, will always be faster and much more efficient.

Point: Additive manufacturing allows design engineers to quickly test multiple new ideas without waiting on a machine shop to ship a prototype.

Grimm: With additive manufacturing, two or more design revisions can be completed in less than a day. It is common practice to design, print, review, redesign and reprint a new concept in a single workday. This means that a design engineer will produce more iterations in a given period of time, leading to better designs.

That statement assumes a serial process (one revision at a time) and a centralized additive manufacturing operation that supports multiple design teams. But if we change the practice, the design process becomes even faster.

Put a desktop additive manufacturing equipment on a design engineer's desk to make the process self-serve. Now there is no queue, no waiting for resources and no haggling to get a job expedited. Prototypes are cranked out as fast as the design ideas arise.

And what if the design engineer has two, three or four design ideas? With additive manufacturing, he/she can print them all at the same time and review them side-by-side to pick the best.

Counterpoint: Small subtractive manufacturing equipment can be used in-house, much like 3D printers, to produce prototypes on demand as well.

Graves: Depending on the complexity of the finished part or assembly, having the ability to machine parts in-house allows you to turn parts around faster and for less money than outsourcing. It all depends on the type of part you are trying to produce and the job shops you have access to. And, unless you work specifically with a firm that specializes in rapid turn-around of machined parts, you will contend with the same market forces that drove you to purchase your own 3D printer in the first place; turn-around time, cost, and quality.

Point: Subtractive manufacturing techniques require less finishing than additive manufacturing techniques.

Graves: With today's advanced CAM and machining technology there is usually zero work required after the machining process, with the sole exception being the occasional debur. Even large mold and die jobs that required a great deal of polishing and handwork in years past require little to no post-machining hand work. Today, most parts can be pulled off a machine, wiped off, and sent off to shipping, where they are sent directly to the customer or outside suppliers for additional processing like heat-treat, anodizing, etc.

Counterpoint: Secondary operations aren't foreign to subtractive processes.

Grimm: At a cursory level, I grant that subtractive manufacturing makes parts with surface finishes and accuracies that match most product specifications. But secondary operations aren't foreign to subtractive processes. Ever had to add post-machining grinding to match the product spec or do a deburring operation? Ever had to tweak mating parts in an assembly? Ever had to split a part, and then join the pieces to make shadowed or internal features?

With additive manufacturing, parts will never be split due to the complexities of the design. On the contrary, we promote combining multiple pieces from what has to be an assembly in the subtractive realm. This eliminates all of that secondary work.

Point: Subtractive equipment costs more than entry-level additive manufacturing equipment.

Grimm: Let's assume a company is starting from scratch. It doesn't' have equipment, trained staff, facilities or supporting tools and equipment. In the world of additive manufacturing, companies can get started with a few thousand dollars, an electrical outlet and a day's worth of operator training. With that tiny investment it can be cranking out models, prototypes, patterns and production parts.

As that company's demand for additive manufacturing grows, a single trained operator can schedule, manage, oversee and run multiple machines.

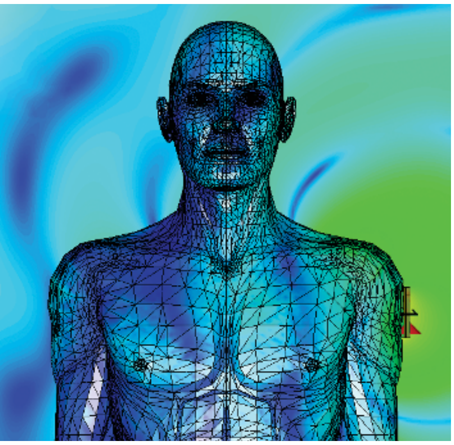
Counterpoint: Desktop-sized and used milling/CNC machines are available at prices comparable to professional 3D printers.

Graves: Whether you are looking for an entry-level device for students, a prosumer level device for serious hobbyists and makers, or a full-on professional grade tool for prototyping or manufacturing, you can find a wide range 3D Printers and CNC machines for almost the exact same price. For example, most entry-level 3D printers run between $500 - $1500 for DIY quality and versatility. The same is true for your entry-level benchtop CNC milling machines. There are a wider variety of both devices found between the $5,000 and $15,000 price range. And, if you are looking for more versatility, flexibility, and performance, you can start your shopping around the $50,000 mark. With material, tooling, and accessories, you are looking at another $10,000 – regardless of whether we are talking about a 3D printer or a CNC machine. And, you can easily spend in the hundreds of thousands if your requirements are even more demanding. **DE**

The debate continues online, with additional arguments from Todd Grimm and Anthony Graves. Join in on the discussion by commenting on the full article at rapidreadytech.com.

INFO ➜ T.A. Grimm & Associates: tagrimm.com

➜ Autodesk's HSMWorks: hsmworks.com



Part 1

A **New Look** at Subtractive Prototyping

When it comes to functional prototypes, subtractive manufacturing still offers some advantages not yet available in 3D printing.

BY KENNETH WONG

The allure of 3D printing is pretty difficult to resist. Once commercial 3D printers became available in the mid-1980s, the technology captured the imagination of many product designers. The affordable, consumer-friendly desktop printers brought the technology to a broader audience. It even popularized the term additive manufacturing (AM), as a way to distinguish itself from how machine tools traditionally remove materials to produce parts.

While traditional manufacturing, or subtractive manufacturing (SM), is still ideal for high-volume production of metallic parts, 3D printing offers the option to economically and speedily produce low-volume mockups with varying flexibility. It was an option previously beyond the reach of garage-dwelling tinkerers and independent inventors with limited budgets.

Nevertheless, in the shadow of 3D printing's meteoric rise, SM continues to evolve. Today, with the availability of personal milling machines comparably priced to desktop 3D printers, subtractive hardware isn't ceding its place in prototyping.

If the aim of your mockup is to study the design's form, a 3D-printed part may be adequate. But when it comes to building mockups with the weight, strength and durability of manufactured parts, SM often proves to be a tough competitor, because milling is still a sensible way to produce metallic parts.

Then there's the hybrid method: Some experts propose that a mix of affordable AM and SM technologies is the best approach to personal creativity and prototyping.

Market Comparison

According to AM industry watcher Wohlers Associates, "the market for 3D printing in 2012, consisting of all products and services worldwide, grew 28.6% (compounded annual growth rate, or CAGR) to $2.204 billion. This is up from $1.714 billion in 2011, when it grew 29.4%. Growth was 24.1% in 2010. The average annual growth (CAGR) of the industry over the past 25 years is an impressive 25.4%. The CAGR is 27.4% over the past three years (2010–2012)."

Alan Levine, managing director of Open Mind Technologies, acknowledges that the advance of AM took away some market share from SM. "But subtractive techniques are also growing," he adds. "We don't see a declining market. Nobody is suffering here in subtractive."

Open Mind specializes in CAM software, serving the numerically controlled (NC) manufacturing discipline. Analyst CIMdata tracks the NC market using reported end-user payments. "The worldwide NC software and related services market grew by 10% in calendar year 2011. The estimated end-user payments grew from $1.333 billion in 2010 to $1.469 billion in 2011," CIMdata reports. The growth rate, however, dropped in 2012.

"In our most recent report, we estimated that the NC market grew 5.9% last year," says Stan Przybylinski, CIMdata's VP of research. Neither Wohlers Associates nor CIMdata track the subtractive hardware market separately; therefore, it's difficult to compare the sales volumes of personal 3D printers (AM) vs. desktop milling machines (SM).

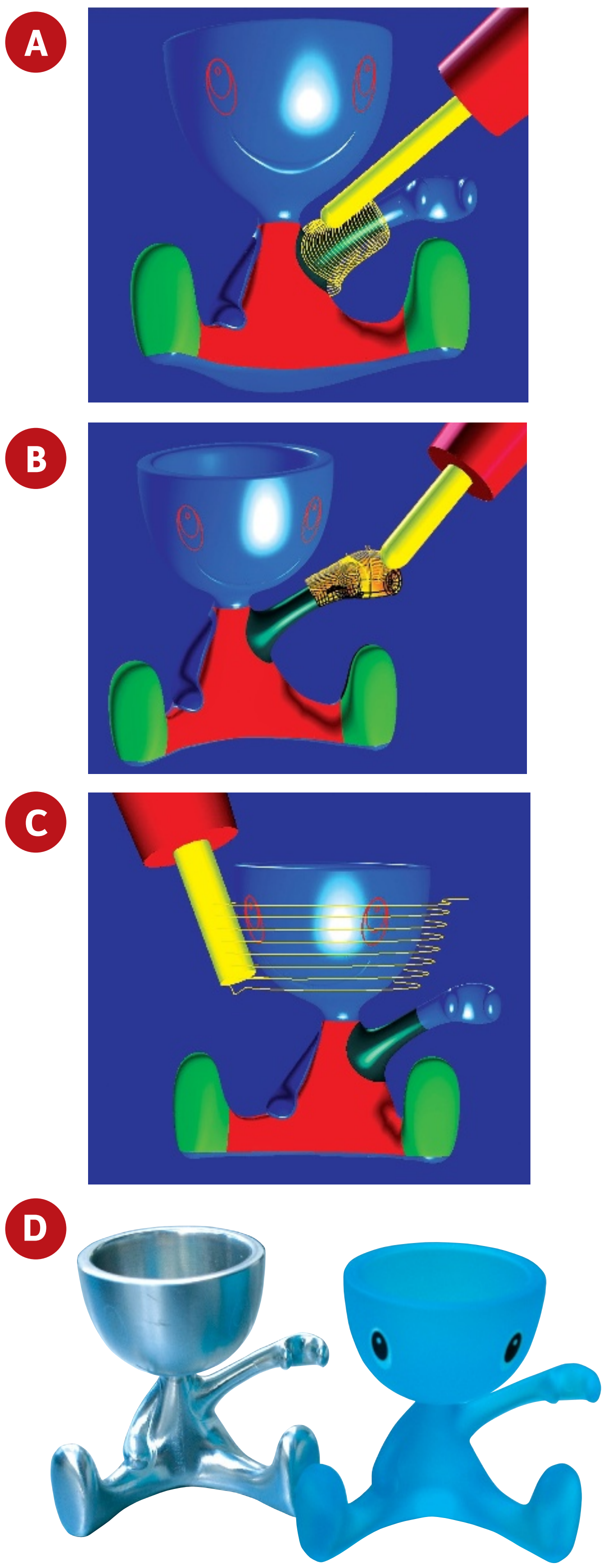
Cost Comparison

Personal 3D printers targeting the hobbyists, enthusiasts and DIY community start around $1,500. 3D Systems' Cube and CubeX, for instance, are listed at $1,299 and $2,499 respectively. MakerBot Replicator 2, a desktop 3D printer, is priced $2,199.

Roland DGA's iModela, described as "a digital hobby mill," is priced $899. Roland's portable milling machines and scanners, MDX-15 & MDX-20, are priced $3,495 and $4,995 respectively. Tormach's benchtop PCNC milling machines — targeting machinists, engineers, inventors, makers and hobbyists — begin around $6,850.

The Purpose of Prototyping

Mcor offers hardware that prints 3D objects using standard office paper. Other companies are developing tissue-printing machines for biomedical applications. However, these technologies are not the norm: At the moment, the materials available for affordable in-house 3D printing are mostly limited to resin or plastic. If the purpose of your mockup is not just to study its geometric shape, but also to subject it to real-world testing, a 3D-printed part may not be sufficient — the prototype doesn't accurately represent the metallic characteristics of the manufactured part.



Using Open Mind's HyperMill software to simulate the milling sequence of an egg holder (A, B, C); the resulting prototypes were milled in the DMU 60 monoBLOCK milling machine (D).

"Subtractive is particularly attractive when structural tests on actual materials are necessary, and you are testing fit and finish," notes Rachel Hammer, product manager for Roland. "Also, high-quality surface finishes and prototyping on metals can only be achieved with subtractive technologies or very expensive high-end additive machines."

Andy Grevstad, an applications engineer for Tormach, agrees: "When you talk about real-world materials — metals, composites, medical plastics, even engineering ceramics — subtractive is often still the only way to make those parts."

For example, in medical device applications, a functional prototype is necessary to assess material strength, environmental reactivity or surface properties. When material properties are of primary importance to the design, the prototype must be made out of the same material as the final design, Grevstad points out.

Nishant Saini, the director of product sales and marketing at CAM software developer Geometric, uses a metal spring as an example. "If you have a prototype and you need to put it through 20,000 stress cycles," he says, referring to a common practice to predict a product's lifespan, "if you do it on a 3D-printed part, it may provide you with inaccurate results."

Grevstad says that many people still only think of SM as a way to make machined parts, "but really, if you have a CNC machine, you can do so much more. For example: mill prototype circuit boards; build tooling for stamping, vacuum forming, or composite layup; make plastic injection molds or blow molds; and also create specialized jigs and test fixtures."

The Role of CAM Software

Generally speaking, 3D printers can produce tangible parts from STL files, a format exportable from almost all professional 3D modeling software programs. With SM, the CAD model must go through CAM software to generate the machine code.

"CAM software plays an important role in how quickly and easily you can produce your prototype," Hammer says. "Roland's SRP Player CAM software, for example, uses a five-step wizard-based system so users can create parts with minimal training and without prior knowledge of NC code."

Anthony Graves, Autodesk product manager for HSMWorks, concedes that CAM software is an added step in SM. His message to prospective SM technology consumers sitting on the fence: "Don't be intimidated by CAM software, by the machines, by the moving parts. The software today is so easy to use. The tools you use inside your CAD program require a much steeper learning curve than those in CAM software."

Graves joined Autodesk after the company acquired his previous employer, HSMWorks, a leading CAM software developer. In July, nearly eight months after the acquisition, Autodesk released HSMWorks Express for Autodesk Inventor, a free CAM plug-in for Autodesk Inventor CAD software users. The company plans to continue developing and supporting its pre-existing product HSMWorks Xpress for SolidWorks, despite fierce competition between Inventor and SolidWorks.

"The key is learning the machines," says Graves. "Once you understand the concept of machining — 2.5 axis, 3-axis, and so on — then you can easily find CAM software that's easy to use."

Observing the way a milling machine produces a part can give you insights into what's possible and what's not. For example, some geometric features are possible in 3- or 5-axis machines, but not possible in 2.5-axis machines. Other features may require a combination of 2.5- and 3-axis operations. Because of the way tool tips work around blocks of metal, square corners cannot be made; therefore, designs intended to be machined should include corners with acceptable radii.

"Not all designers have this [NC manufacturing] background," notes Geometric's Saini. "Today, the process involves reviewing the design with the manufacturing team and going back and forth."

Some CAD software can quickly scan the design's geometry and identify potential manufacturing issues, such as geometric features that cannot be machined or molded. Autodesk Inventor users can use the Design Checker module (a free technology preview, currently available for download at Autodesk Labs) to scrutinize the geometry.

Similarly, SolidWorks CAD software users can accomplish this using the DFMXpress module, included with all versions of the software. "This tool enables manufacturers involved in mill/drill and turning CAM operations to assess their parts based on typical manufacturing rules," explains Eric Leafquist, SolidWorks product portfolio manager, Dassault Systèmes. The SolidWorks plug-in was developed by Geometric, a partner of SolidWorks. Geometric's own DFMPro CAD plug-in addresses similar problems in milling, turning, drilling, injection molding, casting and sheet metal fabrication.

CAM software like HSMWorks, Open Mind's HyperMill and Geometric's CAMWorks let you simulate the machining sequence to produce your design using subtractive hardware. "[Our software] can look at complex parts, identify repeating characteristics, and build processes around these characteristics so they can be automatically programmed," says Open Mind's Levine.

Tall and Clean or Short and Curvy?

3D printers build geometry by depositing and bonding materials one layer at a time; therefore, the height of your design directly affects the build time. Simply put, the taller the design, the longer it takes to print. That is not the case with milling machines.

3D printers generally prove to be much more efficient in handling organic shapes — forms with complex spline curves. However, with 3D printing's laying approach, extremely thin walls tend to collapse, because there's no good way to build such features with sufficient structural strength using layers. Milling machines can produce thin-walled parts, but they, too, face similar challenges with structural integrity if the walls are too thin. In machining, deep pockets or inside corners with small radii could be difficult (and in some cases, impossible) for the end-mill to produce.

Roland DGA's iModela, a hobbyist's milling machine, is available for less than $1,000.

"Using the same technology for prototyping allows you to simulate tool paths and other aspects of manufacturing," says Roland's Hammer. "As a result, you can virtually eliminate the costly reworks associated with designs that are not optimized for manufacturing."

The Hybrid Approach

HSMWorks' Graves says he believes the ideal setup is to combine 3D printing and desktop milling. "If users have access to both a 3D printer and an NC machine, then they can create parts for destructive testing [better suited for parts produced with SM]," he adds. "Suddenly, they have eliminated the limitations in each, and it opens up a whole new world of capabilities and flexibilities."

Even though AM and SM technologies appear to be the opposite of each other (especially in their namesakes), they are more complementary than you think. Like a good pair, one is stronger where the other is weak. Together, they form a combo that overcomes geometric complexity as well as material strength. If you have one without the other, the prototyping process is a compromise at best, a handicap at worst. **DE**

Kenneth Wong *is* Desktop Engineering's *resident blogger and senior editor. Email him at kennethwong@deskeng.com or share your thoughts on this article at deskeng.com/facebook.*

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➜ **Dassault Systèmes SolidWorks Corp.:** SolidWorks.com

➜ **Geometric:** CAMWorks.com

➜ **HSMWorks:** HSMWorks.com

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➜ **Mcor:** McorTechnologies.com

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➜ **Roland:** RolandDGA.com/products/milling

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Overclocking Breaks the Frequency Plateau

3DBOXX 4150 XTREME features overclocked Haswell.

Fed up with sluggish response times when loading massive 3D CAD files, or perhaps your system slows to a crawl when switching between standard office applications and heavy-duty design tools?

What's the antidote to these productivity-sapping performance problems? In many cases, the performance issues are tied to a decision by IT to pair expensive design software with insufficient hardware, simply to take advantage of lower cost. Others try to solve the execution issue with a multi-core workstation, but there are problems with this approach as well.

The reason is that most engineering applications, from SolidWorks to Autodesk Inventor to Revit, are frequency bound, meaning their single-threaded architecture predominantly makes use of a single processing core. Therefore, instead of throwing more cores at the problem and paying for technology that won't be put to good use, what's really needed is a workstation platform that supports fewer cores, but higher frequencies. Yet despite some architectural improvements, processor frequencies have remained virtually stagnant for the last few years resulting in what many industry players call the frequency plateau.

BOXX Technologies, which specializes in workstations that are purpose built and performance driven, is taking a unique approach to solving these performance constraints and breaking free of the frequency plateau. As an expert in overclocking technology, BOXX offers a series of overclocked XTREME workstations with a variety of core options tailored to different types of workflows, from the four-core 4150 XTREME to the 16-core 8980 XTREME, designed for simulation, rendering, and other 3D applications. Each of the systems leverage overclocking technologies to achieve faster speeds over the base frequency of 3.7 GHz, ultimately translating into optimized engineering workflows, greater efficiencies, higher productivity, and a better overall user experience.

The BOXX Advantage

BOXX has shipped workstations with its unique overclocking technology since 2008. It has thousands of systems deployed in the field. The company works closely with Intel to stay within the parameters of safe overclocking, allowing it to deliver increased performance without applying significantly larger increases in voltage and with no effect on processor failure rates, company officials say.

BOXX's latest offering for such extreme processing is the 3DBOXX 4150 XTREME, a new compact, professional workstation featuring the latest in Intel processor technology—an overclocked fourth-generation Intel Core i7 processor, known as Haswell. BOXX is the only manufacturer featuring a safely overclocked version of the new Intel micro architecture, and it backs up the system with a three-year warranty.

Adding an overclocked fourth-generation Haswell Core i7 processor to the mix enables the 3DBOXX 4150 XT to run at 4.3 GHz, outperforming previous models. In addition to its emphasis on performance, the system, priced starting at $2,800, also features advanced liquid cooling and a new compact chassis, ensuring quiet operation and making it an ideal fit for space-constrained environments.

Rounding out the 4150 XTREME's high-end capabilities are solid state drives and a gold level power supply along with the ability to integrate NVIDIA's Maximus technology, which combines the visualization and interactive design capability of NVIDIA's Quadro GPUs with the high-performance computing power of the NVIDIA Tesla GPUs.

So if performance is the primary bottleneck to efficient design at your organization, it's time to rethink your workstation strategy and shift the emphasis from multi-core systems to higher frequency processing. Rather than allocating budget to multi-core systems that won't be utilized, spend your dollars wisely on an overclocked workstation that can fully optimize the engineering workflow.

You can find out more about BOXX Technologies 3DBOXX 4150 XTREME and its overclocking technologies at the website below. DE

INFO → BOXX Technologies:

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Opportunity is on CAFE's Menu

Automakers look for technology and expertise to meet the new Corporate Average Fuel Economy (CAFE) standards.

BY JAMIE J. GOOCH

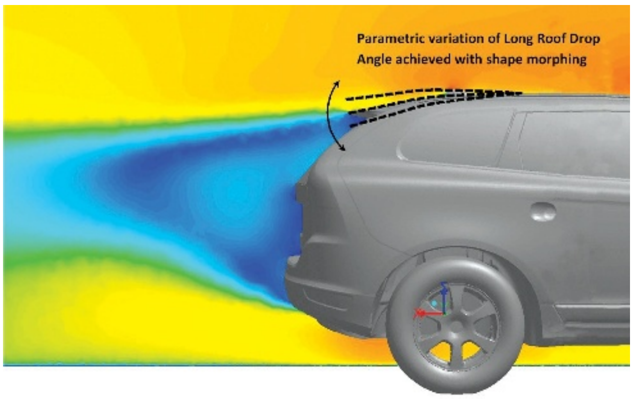
When new fuel efficiency regulations were finalized last year, the clock started ticking for automakers and their suppliers to increase fuel economy to the equivalent of 54.5 mpg for cars and light-duty trucks. That's nearly double what new cars and trucks get today.

But this is a marathon, not a sprint. The final deadline to meet the new standards isn't until 2025. And the 54.5 mpg target isn't what you'll see in every vehicle you buy in 12 years. As its name implies, the Corporate Average Fuel Economy (CAFE) is an average of automakers' fleets of vehicles, and the fuel economy is measured in a lab, which always returns more efficient results than the real world. On top of that, the targets can shift based on automakers' production tallies to allow them to produce the types of vehicles that people want to buy.

Advancing Engineering

Even with those caveats, the new rules are expected to lead to significant investments in technology to make vehicles lighter, more efficient, and more aerodynamic.

The National Highway and Traffic Safety Administration (NHTSA) and the U.S. Environmental Protection Agency (EPA) "expect automakers to use a range of efficient and advanced technologies to transform the vehicle fleet," according to an NHTSA press release on the regulations.



The aerodynamics of a car design. ***Image courtesy of ANSYS Inc. Geometry courtesy of Volvo Cars Corp.***

"I think that the automakers are very serious about CAFE standards," says Sandeep Sovani, Ph.D., ANSYS' director for Global Automotive Industry. "A significant amount of effort and research and development is being placed in fuel economy and emission standards — probably the majority of R&D."

On the other hand, Sovani says, it's "not a challenge they cannot solve. It's not that they are terribly anxious about it. I think the government chose this number and timing, 2025, widely because it is a challenge, but not one that cannot be met."

MSC's senior manager of simulation services, Derek Barkey, agrees with Sovani's sentiment. Barkey oversees a team of engineers who work with MSC customers to improve those customers' products via simulation and optimization.

"In general, automakers are pretty confident they can meet the requirements," Barkey says. "The concern is meeting the standards and still have a cost-effective vehicle for customers."

Take the new BMW i3 as an example. With zero emissions, it exceeds emission standards. But with a sticker price of $41,350, it doesn't meet that many consumers' purchasing standards.

Both Barkey and Sovani present the BMW i3 as an example of how designing a fuel-efficient vehicle can effect every part of the design — from its carbon-fiber reinforced plastic passenger compartment and plastic outer skin to its aluminum drive module, which houses all the drive and chassis technology.

"It's a very lightweight electric car," says Barkey. "Having improved aerodynamics and improved materials not only makes more fuel efficient, but helps with aesthetics. It also helps improve maintenance, since composites are dent- and corrosion-resistant."

On the flip side, no one expects the auto industry as a whole to make drastic design changes to their lineups the way BMW has with its i3. Rather, one optimization will likely lead to advances in other areas of the vehicle.

"There will be lots of small innovations," says Barkey. "We see a lot of those happening already. Look at Tesla's aerodynamics, even the way they do the door handle. That's been helped a lot by CAE. Lots of these small, incremental improvements will allow automakers to reach the goal for the CAFE standard."

Sovani says he expects engines to be downsized and turbocharged, combustion strategies to be revisited, transmissions to be tuned for fuel efficiency, aerodynamics to be improved via new materials, and weight to be optimized for every part in the vehicle, from seat mounts to structural geometry.

"There will even be cool new inventions, like shutters for the front grill that are rotated by motors to adjust the angle, based on the amount of airflow needed by the engine," he predicts. "Other technologies will focus on recovering waste heat from the exhaust system by using the thermoelectric effect."

The BMW i3 shows how fuel efficiency can influence every aspect of an automobile's design. *Image courtesy of BMW.*

Experts in Demand

While ideas for more fuel-efficient vehicles are a dime a dozen, the expertise needed to make them reality is in shorter supply. That could spell opportunity for engineering service providers.

"One challenge comes when you start moving away from legacy processes and materials," says Barkey. "Automakers understand well how steel behaves, how to protect it from corrosion, what thickness is needed to avoid warranty issues … A lot of that is based on rules of thumb and legacy knowledge. When that's not there, they can run into long-term problems for the vehicle."

Sovani agrees there is a dearth of fuel economy development expertise, but he says automakers will try to add to their in-house teams before looking for outside help.

"Companies are fighting to gain control of that expertise," he says. "Companies are hiring simulation and development engineers to get the expertise. They're doing the work in-house as much as possible to give them a strategic advantage."

Barkey says, in his experience, there are two things clients need most from software developers and engineering service providers right now: an understanding of alternative materials, such as composites, and some help managing the large amounts of CAE data being produced.

"When you generate all the simulations needed to evaluate new design concepts, just keeping track of which have been evaluated — which are best for one thing or another — is a challenge," he says. "You might lose track of the data and just have the model, but not know why it's better than another."

Giving Innovation a Push

While it remains to be seen whether the new fuel economy standards will "encourage investment in clean, innovative technologies that will benefit families" like the NHTSA press release claims, Barkey does say he expects them to hasten the inevitable.

"Automakers' interest in improving design has always been there," he says. "It's why we don't still put wood in cars as a structural material. CAFE is focusing that innovation."

In previous decades, he says, innovations focused on safety, such as crumple zones and airbags. Those innovations were also encouraged by regulations, but likely would have happened anyway because safety is important to customers, says Barkey.

"CAFE accelerates the pace and focuses innovation on the use of CAE and simulation to aid in the development of cars," he concludes. "It was going to happen anyway because using simulation makes sense — it keeps costs down, and ensures materials are used efficiently." DE

Jamie Gooch *is managing editor of* Desktop Engineering. *Contact him via de-editors@deskeng.com.*

INFO ➜ **ANSYS:** ANSYS.com

➜ **MSC:** MSCSoftware.com

➜ **NHTSA:** NHTSA.gov

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Simulation's Evolution

Sandeep Sovani, Ph.D., ANSYS' director for Global Automotive Industry, says simulation's progress in the auto industry can be tied to decades of advancements:

1970s: Automakers were just finding out what simulation was.

1980s: Research and development was investigating how well simulation worked.

1990s: Automakers began adapting simulation for specific applications.

2000s: Simulation was being integrated into production processes.

2010s: Automakers are extending the use of simulation into nearly all aspects of production.

"The next decade is going to be about system simulation," Sovani predicts. "If we look at how simulation is used, it's done separately for aerodynamics, separately for engines. The whole vehicle is optimized as a system by engineers sharing reports, and then making tradeoffs among aerodynamics, combustion, cooling, etc.

"Eventually," he adds, "the vehicle will be simulated as one entire system where the whole model is constructed as designed. That's what I think will be the simulation advancement of next decade, including simulating the software of the vehicle as part of the system."

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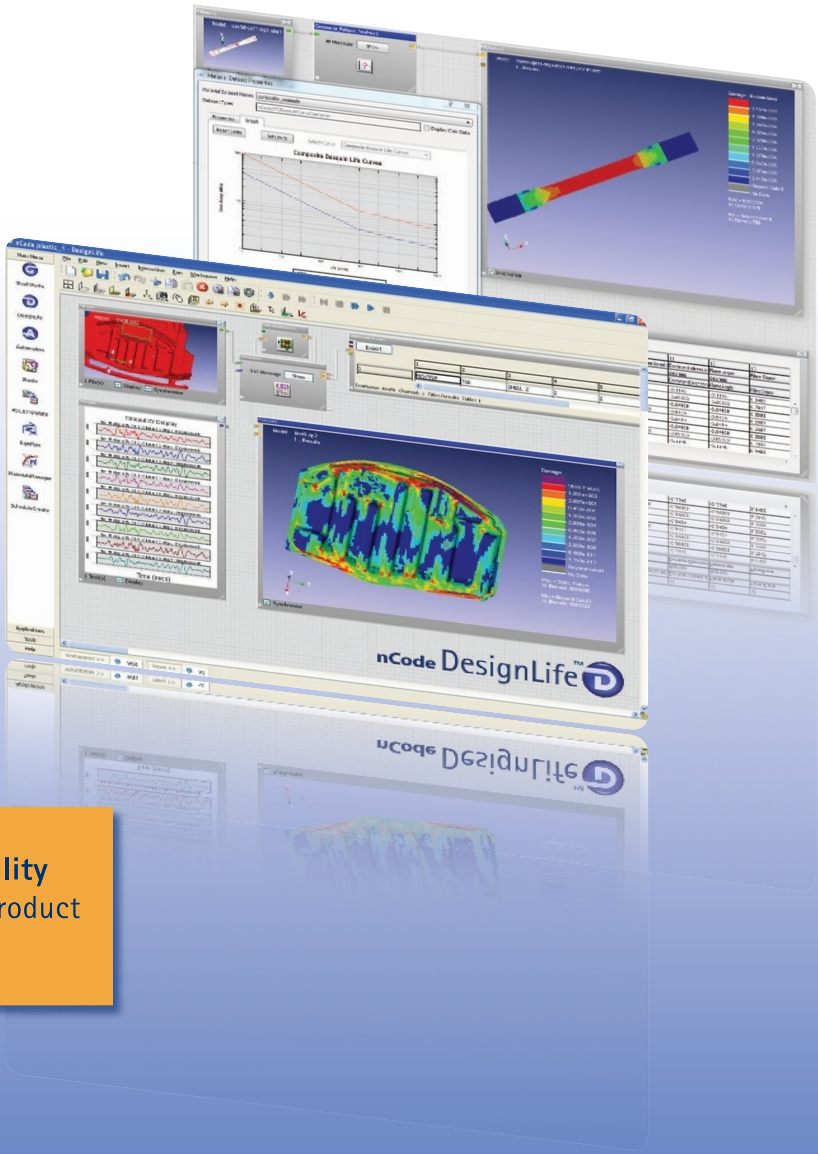

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Negotiating IP Security in the Age of Contractors

The growing reliance on contractors makes IP security a priority — and a complex issue.

BY KENNETH WONG

PDX Effects' Tommy Mueller uses GrabCAD Workbench, a cloud-hosted secure CAD file sharing service, to work on projects with his clients. They include many independent inventors and startups in need of CAD drafting and rendering services. Shown here is a digital prototype created for his client Adaptive Footwear.

It all begins with a contract, an agreement between the client and the contractor that spells out what must remain confidential during the project. "Whether we're working with an independent inventor, an automotive and aerospace customer, or a military client, we typically start with the non-disclosure agreement (NDA)," says Tim Smith, vice president of design engineering, Altair Product Design Group.

Dr. Metin Ozen, president of Ozen Engineering, concurs: "Ninety percent of the projects start with an NDA. The clients don't show us anything until the NDA is signed."

On one end of the spectrum are clients who, because of compliance rules and market competition, demand absolute secrecy about their projects. Aerospace and automotive titans, military institutions, and government entities fall into this category. On the other end are independent inventors and startups, with a less predictable attitude to intellectual property (IP).

Tommy Mueller, who offers 3D CAD modeling, rendering and simulation services as co-owner of the firm PDX Effects, deals with clients who belong to the latter category. He sometimes finds himself educating his clients.

"I worry about their IP," he says. "I almost behave like a lawyer. I try to urge them not to talk to anybody. I want to make sure they're protected. But some of them don't know better."

Ozen, who has also dealt with startups, observes, "Maybe the social-media type companies are more relaxed [about IP], but not so with the companies we're working with. They're device makers, like biomedical equipment makers, implants makers, or semiconductor makers." For Ozen's startup clients, keeping the design under wraps is essential.

The clients' insistence on a NDA might be universal, but their attitudes toward IP are hardly the same. The spectrum requires contractors and clients to negotiate the safety measures and implement what suits them best. Sometimes a trusted relationship is sufficient. Other times encryption technologies, online collaboration spaces, and working protocols augment the confidentiality. It almost always takes a combination.

What to Protect, How to Protect

Mueller, a veteran user of SolidWorks CAD software, works with many startups and independent inventors who have promising product ideas, but neither the time nor the skill to document them in 3D CAD. He relies on GrabCAD Workbench, a cloud-hosted collaboration space for sharing CAD files. With a mix of social media features, the online GrabCAD community also provides Mueller with a way to showcase his work and attract new assignments.

"Email attachments of rendered images just don't work," Mueller adds. "I once traded 75 emails with a client to accomplish something." The secure co-viewing function in GrabCAD allows Mueller and his clients to review, discuss and revise design ideas online through standard browsers.

Ozen keeps his clients' projects in an internal shared drive, cordoned off from the web. "If the customer wants a file, we actually write it on a DVD — and most of the time, hand-deliver it," Ozen says. The firm does have an FTP site, but on extremely sensitive projects, "we don't even use our own FTP," Ozen says, noting that the hand-delivery policy is preferred.

Ozen's clients usually hire the company to run simulation and finite element analysis (FEA) using ANSYS software on design ideas under consideration.

"The most sensitive documents are the reports," says Ozen. "They contain the actual performance data of the machine or the model. They're usually in PowerPoint, Word or PDF. The second most-sensitive are the ANSYS result files and the database, because someone who sees them sees the real design."

Altair's Smith notes that while some customers demand encryption for any project-related emails sent back and forth, "others limit it by saying no product data or information must pass through emails." In many cases, Smith says, the email serves as a notice that a confidential report has been transmitted via a secure server, but the report itself is never passed along in the email. Altair's custom IT infrastructure ensures that a report cannot be forwarded to someone else by the recipient; all intended recipients must be pre-approved so they can access the report through the embedded link.

Some of Altair's military clients conduct an on-site security audit to ensure the company complies with its contractual security requirements.

"They might come and say 'show me the server' or 'show me the list of users who have access to this file,'" Smith explains. "Obviously, we have to have IT that supports this type of tracking."

When working on projects with some brand-name automakers, Altair has direct access to the client's product lifecycle management (PLM) environment. "In those

With its OptiStruct software, Altair Product Design group refined the cap design of Lynx brand deodorant (a Unilever product; the brand is known as Axe in the U.S.). While this project may not be top secret, the firm routinely uses OptiStruct with aerospace and automotive customers who demand strict confidentiality in consulting projects.

cases, the client would come and inspect our hardware to make sure it's robust enough, and they would prescribe the type of firewalls we need to have to connect," he explains. "We would test the data transfer, then we would get access."

A Need-to-See Basis

The most protective companies don't give contractors the full design — that is, the detailed assembly in CAD. "They cut it up, and give us just the part they want us to analyze," says Ozen. "We get the design of the full device only if they want us to analyze the entire device. Like the biomedical device we're working on right now — we need to study its torsion, bending and strength, so we do need everything."

"With highly sensitive military clients, it's always on a need-to-know basis," says Altair's Smith. "We always tell them, we need to see [the design] in context so we understand the application and simulate it properly as it'll work in the field."

The partial sharing often leads to negotiations between the client and the contractors, and is also reflected in the explicit disclaimers when delivering the analysis outcome. "If the rest of the design [withheld by the client] has some effects on elasticity, for example, we may be ignoring it," Ozen points out. "So we put that in the report, and the client knows the limitation."

"Invariably they give us as little as possible; invariably we point out to them, well, you have NDAs with us, so show us a little more," says Altair's Smith. "They don't have to show us the rocket engine that'll take the craft from here to Mars. But if we're going to help them land it, we need to see at least the landing mechanism."

IP Control is Bi-directional

In some transactions, security is a two-way street.

"We also have intellectual properties we deliver as a service provider, the methods and techniques we apply to our customer's problem," notes Smith. "There's usually some negotiation that goes on with each customer."

In many projects, Altair Product Design Group is hired to provide expertise in topology optimization — identifying the best geometric shape that satisfies the client's requirements. Whether the project involves designing bridge trusses or airplane wing spans, Altair can deploy its OptiSruct software to explore a range of designs possible and pinpoint the best options. Impressed by the result demonstrated by Altair, the client in one such project considered applying for a patent on the resulting shape.

"We had to explain to them that they can't patent that form because it's not theirs. It's intellectual property we brought to that project," Smith recalls, noting that a client having a patent on the optimal shape "would have precluded us from offering the same solution in other projects."

New Commerce, Evolving Security Protocols

In dealing with automotive clients, Altair also uses Trubiquity, a subscription-based encrypted file-transfer service. With one client, Smith says, Altair successfully worked on a remote CAD software program through a VPN connection — something unthinkable just five years ago because of bandwidth limitations.

"My design engineers could actually remote-control the CAD application on [the client's] desk," Smith says. "Frankly, I was amazed at how responsive it was."

This new model — the use of cloud-hosted CAD software — is being explored by software developers like Autodesk and its rivals. The shift to such a working mode is currently not commonplace, but could be in the future. If so, IP checks governing the client-contractor relationships must also evolve to keep up.

If Altair Product Design Group and Ozen Engineering represent the face of classic engineering consulting, Mueller's PDX Effects must be the face of an emerging trend: the rise of affordable drafting, rendering and modeling service providers who cater to small, independent inventors. To these clients, freelance CAD and rendering experts like Mueller are the extended project team. They belong to the do-it-yourself (DIY) movement, fueled by personal creativity and small-scale manufacturing, producing everything from batteries with moving parts to gigantic mechanical spiders.

"We're driving the future economy, the next manufacturing movement," Mueller says. "Today, it only takes a group of people, not a large team, to get these ideas across."

The advantage of a smaller team, he concludes, even if it's kept small not by choice but by budget and operational constraints, is fewer possibilities for IP leak. **DE**

Kenneth Wong *is* Desktop Engineering's *resident blogger and senior editor. Email him at kennethwong@deskeng.com or share your thoughts on this article at deskeng.com/facebook.*

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➜ **ANSYS:** ANSYS.com

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The Future of Steel

The Accelerated Concept to Product process is helping to optimize vehicle design.

BY MARK CLARKSON

FutureSteelVehicle uses design optimization methodology, coupled with an expanded portfolio of high-strength and advanced high-strength steels and an array of steel technologies, to achieve a 39% mass savings in a battery electric vehicle. *Images courtesy of Dr. Akbar Farahani, ETA.*

About nine years ago, Engineering Technology Associates was engaged by the Auto/Steel Partnership, a consortium of North American steel companies and automotive manufacturers.

"They were trying to increase the use of advanced high-strength steel," recalls Akbar Farahani, Ph.D., vice president of global engineering for the Troy, MI-based ETA. "We did several projects for them, doing weight reduction using optimization technology and software — sometimes reducing the gauge of the product and changing from mild steel to advanced high-strength steel."

This simultaneously improved crashworthiness and durability, he says.

Those projects got Farahani thinking about ways to be more efficient on weight and mass reduction, ways to organize the whole product development cycle differently. He says: "I thought, 'How can we have a holistic view of product design and development, from the beginning to the end?'"

The result was an optimization methodology he dubbed the Accelerated Concept to Product Process (ACP). ACP uses a holistic approach with multiple CAE tools to reduce product development time and costs, as well as to reduce product mass and improve product performance.

Last Things First

"The normal way to design," says Farahani, "is that we have a structure and we try to fit that structure to our requirements. I'm changing the statement of the problem: What are the requirements — for crash safety, for durability, for noise, for vibration, for vehicle ride and handling? I want to put that at the front of the process, then design the vehicle based on those requirements."

ACP also brings potential building materials and manufacturing requirements into the process at the very beginning, when the project is still at the concept stage.

"ACP looks at the concept from its inception," says Farahani, "before you put any type of structure or shape to it. Based on your goals and targets, on your materials and manufacturing requirements, the ACP system creates structures that meet your requirements.

"The system will define the best material for the best location for the best performance," he adds, noting that material might be steel, aluminum or carbon fiber composites in any combination.

Low-fidelity Design

Using topology optimization, ACP creates a low-fidelity design of your structure. "This low-fidelity design has the main structures and the materials and the material grades," says Farahani. "It is going to give you the general sizes and shapes of the components."

It does not include, however, styling considerations or design details, such as the radii on access holes. "We turn it over to the design engineers to design the way the car looks," Farahani says.

Because that optimization automates so much of the low-level design work, ACP requires only about half as many design engineers as a traditional design process. "But they are always involved in the whole process," Farahani points out. "The ACP process is like a search engine. It cannot create; it just finds the best solution within the design space provided. The design engineer is the one who is creating the design space. We humans have to tell the optimization where to go and where not to go."

The final phase — design for manufacturing — uses 3D optimization for the manufacturing process. The result of all this optimization is a very efficient structure.

FutureSteelVehicle

In 2010, ETA was approached by WorldAutoSteel, the automotive group of the World Steel Association, about development of a concept vehicle, dubbed the FutureSteelVehicle (FSV).

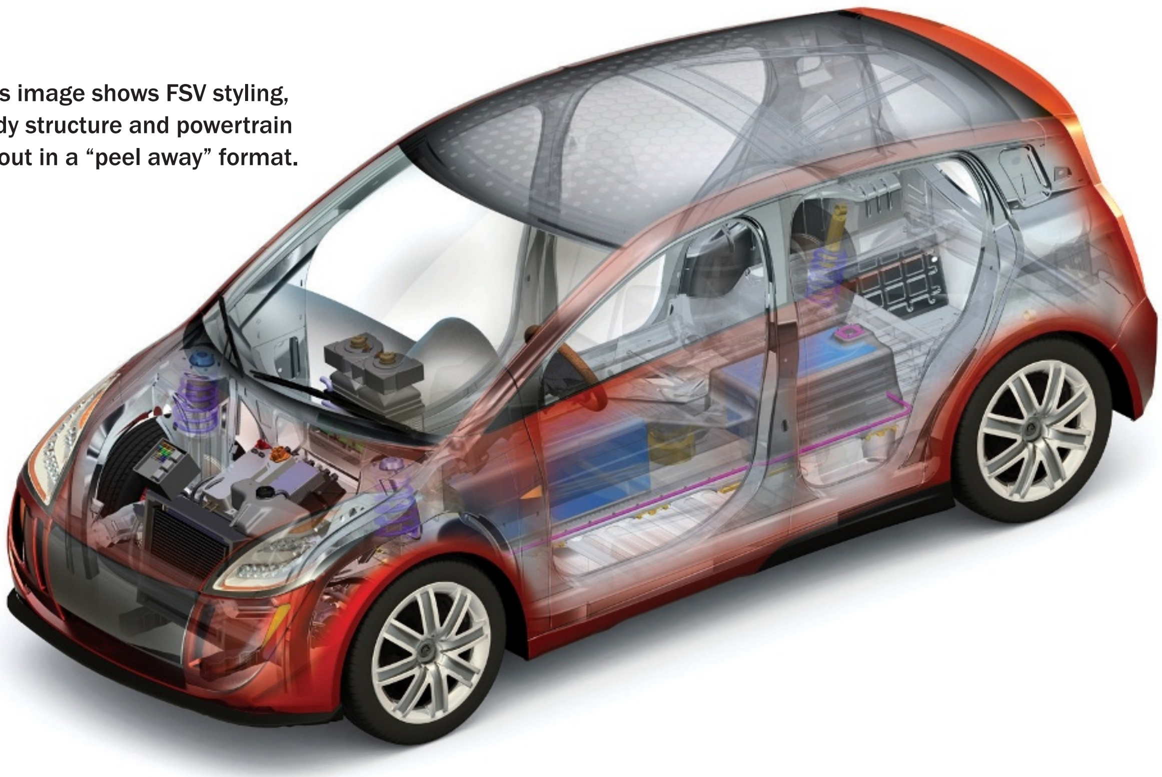
"They wanted to do a concept vehicle, using the 2010 Volkswagen Polo as a baseline," says Farahani. "They said, 'We want to compete with this vehicle. How can we reduce the mass using advanced high-strength steel technology?' WorldAutoSteel provided all the technology they had available for this vehicle; we applied ACP."

Because this was the FutureSteelVehicle, Farahani adds, the materials under consideration were mainly various grades of steel — especially advanced, high-strength steels.

Reducing the Gauge

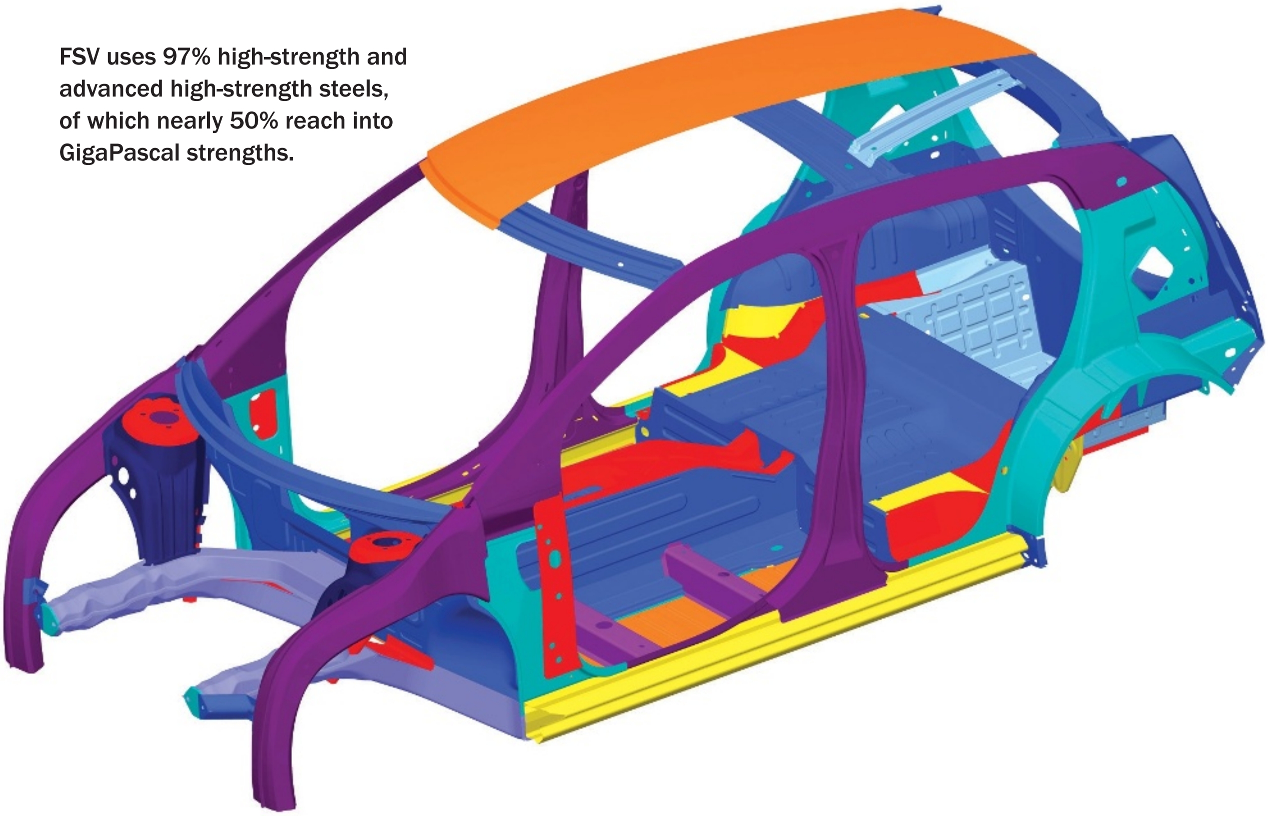
"Putting the right material, with the right strength, in the right location, is the key," says Farahani. "Advanced high-strength steel costs more and may be difficult to manufacture, but the FSV uses this advanced high-strength steel in locations where we need a lot of strength for, say, crashworthiness."

The standard way to increase the strength of steel parts, says Farahani, is through use of higher gauges



This image shows FSV styling, body structure and powertrain layout in a "peel away" format.

FSV uses 97% high-strength and advanced high-strength steels, of which nearly 50% reach into GigaPascal strengths.



of steel. This, unfortunately, adds weight. Rather than thicker steel, the FSV uses stronger steel. "We find where the critical load paths are," says Farahani, "and then use the right strength of steel — as thin as is possible."

A normal vehicle design uses plenty of 1 to 2mm gauge steel. Where strength is required for crashworthiness, it can be 2.5mm or thicker.

"The highest gauge of steel that we use in FSV is about 0.9mm," says Farahani. "Usually it is very, very thin. We can get all the strength that is required, but more efficiently and with less mass."

Saving Weight and Cost

"We created a vehicle that provided a 39% mass reduction, compared to the VW Polo baseline vehicle," says Farahani. "We reduced more than 100 kg of the mass of this vehicle body structure."

That's an impressive reduction in weight, yes, but how much does it cost?

"We did a cost analysis for FSV," says Farahani. "The interesting thing is you spend more money on advanced high-strength steel — but because we use a lot less material, we basically break even. At the end of the day, there's no cost to it."

The Future is Now

As its name implies, the FutureSteelVehicle was designed for the future. "This vehicle was designed for 2015-2020," Farahani says. "Some of the manufacturing technologies were pushing the envelope, but in the last four years that I've been involved with the FSV, I've seen a lot of those technologies in current production vehicles. I see Ford and GM using these technologies quite a bit in their products.

"They caught up very, very quickly. It surprised us." **DE**

Contributing Editor **Mark Clarkson** *is* DE's *expert in visualization, computer animation, and graphics. His newest book is Photoshop Elements by Example. Visit him on the web at MarkClarkson.com or send e-mail about this article to DE-Editors@deskeng.com.*

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→ **American Iron & Steel Institute:** Steel.org

→ **Auto/Steel Partnership:** A-SP.org

→ **Engineering Technology Associates:** ETA.com

→ **WorldAutoSteel:** WorldAutoSteel.org

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Competing with Composites

The auto industry turns to an old, familiar friend for help in optimizing vehicle weight: steel.

BY MARK CLARKSON

Needless to say, the steel industry isn't content to sit by and watch new materials erode their market. They are working hard to come up with new and better steel all the time to fend off the increasing competition from composites and aluminum. And for manufacturers like the auto industry, steel has the appeal of the familiar.

How Strong is Ultra-Strong?

"The auto industry is really trying to squeeze as much as they can out of steel auto bodies," says Regu Ramoo, vice president of engineering at Altair Engineering. "The Acura 2007 MDX, for example, has seven different grades of high-strength steel in the body."

And what, exactly, is high-strength steel? You can categorize steel broadly into three grades: everyday mild steel, high-strength steel, and ultra-high-strength steel. These categories, and the divisions between them, are somewhat arbitrary: Definitions change over time, and may vary depending on your source.

"Traditionally, anything that is not mild steel was referred to as high-strength steel or HSLA," says Ramoo, referring to the acronym for high-strength low-alloy. "So, by American Iron & Steel Institute standards, anything above 275 MPa yield strength is HSLA." (MPa = megapascals, or newtons per millimeter squared).

It used to be that the top end for high-strength steel had a yield strength of around 550 MPa, about twice that of commodity mild steel, Ramoo adds. Anything above that was considered ultra-high-strength, exotic or special-purpose. These days, with the top end in the vicinity of 1,700 MPa, definitions have shifted.

"Most automotive engineers today would consider high-strength or advanced high-strength to start at about 350 MPa," says Ramoo. "We would designate steels above 950 MPa as ultra-high."

Not surprisingly, high-strength and ultra-high-strength steels cost considerably more than mild steel. They are also more difficult to stamp and form.

As steel gets stronger, it becomes less malleable, says Ramoo: "The allowable elongation — the allowable strain-to-failure — is less. Your typical steel can go up to about 50% strain-to-failure. In really high-strength steel, you're talking about maybe less than 10% strain-to-failure."

Forming and Joining

Ultra-high-strength steel is still formable, just less so. It may require special processes such as hot forming, which can add to the complexity and cost.

But when it comes to formability, Ramoo says, you just can't beat steel. "There are very few parts you cannot make out of steel, and the cycle time to stamp out steel parts is so much shorter," he says. "They have that inherent advantage over composites. When you need high volumes, you can't go with composites because the cycle time is so long."

Those stamped steel parts are not only faster to make, they are much more consistent than composite parts. It's also much easier to join steel parts.

"We understand welding of steel parts far more than we understand welding aluminum — and far more than we understand joining composites," Ramoo explains. "There are a lot of things we just don't know about aluminum and composites. It might be fine for the first three years, but after five years, what's going to happen to the join? Is it going to creep? Are the bolts going to loosen? Will it become brittle?"

Ramoo points out that you can even weld steel of different strengths together in a blank to create fancy, tailor-welded blanks, to get multiple grades of steel through a single part — a sort of steel composite, if you will.

We Love Steel

Let's face it, steel's the standard. Consequently, it's easier to work new kinds of steel into the existing manufacturing process than totally new materials.

"Look at the current infrastructure," says Ramoo. "Everything in most auto plants is designed for a steel body right now.

"The cost penalty for high-strength steel is smaller than for aluminum and composites," he continues, "and there are a lot of parts that you can improve by replacing them with the new grades of higher-strength steel. There's a lot of room for automakers to lighten the steel body without having to resort to aluminum and composites."

Steel is cheap, it's recyclable, and we understand how to work with it pretty well. While composites certainly have their place in today's auto industry, steel's not going to be replaced anytime soon.

At Your Service

Although it's best known as a maker of mathematical and analytical software, an ever-increasing part of Maplesoft's business comes from providing engineering services.

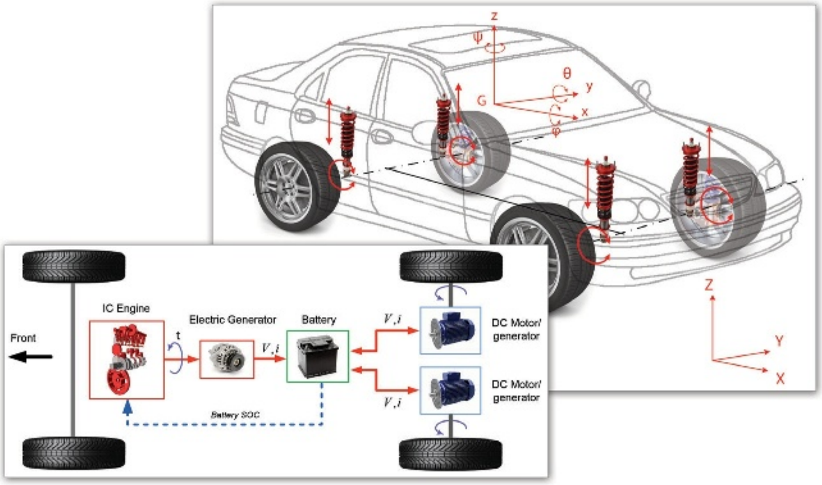
BY MARK CLARKSON

Maplesoft has existed for more than two decades as a purveyor of mathematical and analytical software, notably Maple and MapleSim. But the marketplace is changing.

"We've learned over the past five or six years that the glory days of a software company developing software, and then pushing it out to a hungry market are long over," says Paul Goossens, vice president for Professional Services at Maplesoft. "You have to add other elements to the offering. For us, it's the service element."

Maplesoft is a mathematical modeling company, so those services are of a mathematical modeling nature. And while engineering services is still a small slice of business compared to the license sales, it's helped the company to sell and upsell its software products. Originally, that was its sole purpose: to support the sale and implementation of Maplesoft's software. Now, the focus has shifted a bit.

"In the last couple of years, we're starting to get people coming to us saying, 'We have a problem. Can you please help us solve it? We don't care what tool you use.' We just happen to use our tools to do it," Goossens says.



Maplesoft's engineering services business is growing by leaps and bounds, thanks in part to its electric propulsion expertise. *Image courtesy of Maplesoft.*

Battery Expertise

Maplesoft's engineering services are varied, but the company has had a lot of success in electric propulsion engineering, particularly in the automotive industry, says Goossens: "We're working on everything from the motors to the e-drives to the engines and the batteries."

Maplesoft's work on batteries, he says, represents the leading edge for mathematical models of batteries.

"We can model the physics behind the charge and discharge characteristics of the battery," says Goossens, "right down to the actual internal physics and the ion transfer from one electrode to another. The physics vary from chemistry to chemistry, but the underlying mathematics doesn't change that much; it's just down to different parameter values.

"We can characterize the different chemistries just by changing the parameter values. We can model the battery being charged. We can model the battery being discharged," he continues. "We can look at battery degradation over multiple cycles. That's just another set of equations that sit on top of that core set of equations."

That's a pretty sophisticated model, with many, many hours invested, however. Most applications won't require anything like that level of detail, he says.

"The majority of the work that we do, from a mathematical modeling or simulation perspective, is not that complex," says Goossens. "It just requires the hands and brains to get it done."

Why Can't I Do That Myself?

Maplesoft uses its own tools, primarily MapleSim, to build these models. But since you can buy MapleSim for yourself, right off the Internet, why not just model your own battery or other widget?

"Maybe the customer comes from a mechanical engineering background," says Goossens, "and what they want to model is on the electrical side. Or they may have a lot of experience on the empirical side, with testing and hands-on work, but not a lot of expertise and knowledge in terms of doing mathematical models."

The majority of people using MapleSim to simulate batteries, for example, aren't the battery manufacturers themselves; they are the designers and engineers putting together systems that happen to require those batteries, he explains.

"We do a lot of work with consumer electronics," says Goossens. "The guys who are putting the design together are electrical engineers and electro-mechanical engineers who don't really have in-depth knowledge of battery physics. They just want a battery model to implement in their full system model."

Not Enough Time in the Day

Some of Maplesoft's customers actually do have the requisite expertise to develop their own models, but this expertise is currently being deployed somewhere else. "They just don't have the resources or the cycles to do it," says Goossens. "They can bring us in to just do that one project."

Managers like the fact that they can just "turn on the funding to do a project, and then turn it off when it's finished," he adds. "They don't have to worry about retaining highly qualified staff for that kind of work."

Sometimes you have the expertise, and still can't crack the problem in time, says Goossens.

"We have customers who say, 'Look, we gave it our best shot, but we need some help to get this model completed by a certain deadline.' We'll work with them to make sure they understand how we've developed the model, and hopefully they'll learn something from that."

Other times, Maplesoft doesn't have all the expertise that is required.

"We have very close relationships with the engineering departments at various universities," says Goossens. "If it's a particularly thorny problem, if the research hasn't been done on it, or if the information is scant, we would reach out to one of our academic partners, introduce them to the customer, and start defining a research project to solve that problem."

Maplesoft is currently gearing up for a project with a well-known battery manufacturer to study the problem of charge leakage during storage. "This is a company that does have this kind of expertise," says Goossens, "but they've still not been able to find a way to do this. It is going to require a full research project, so we're bringing in a couple of professors from universities to do this work. We'll engage them in doing full research, with our customers partially funding it."

Every Kind of Client

Battery models are just a small part of what Maplesoft's engineering services do. In fact, it's difficult to categorize its current clients. They might be individual engineers, small firms or globe-spanning manufacturers, building anything from mining equipment to trucks to satellite systems.

"We're working with a manufacturer of tattoo machines," says Goossens. "They're a very small company that has no expertise in this area, but needs to get a handle on the internal physics of their design so they can improve it. Some of our customers are huge, but they've never done this kind of work before."

Goossens says he's been surprised by how many traditional engineering companies have approached Maplesoft that have not previously used model-based design tools or virtual prototyping.

"For them, designing was putting your drawings into CAD, putting your production drawings out, building a prototype, and then figuring out what the problems were," he explains. "They're looking at the benefits that people in the aerospace and automotive industries have derived from using these modeling tools, and they're now gearing up to use these tools themselves. They can't just keep investing in prototypes and then finding out what the problems are."

A good case in point, he says, is truck manufacturers: "They've been able to design and build trucks very successfully without using model-based design tools. But now, they're being hit up with fuel efficiency regulations, and being pressured to reduce costs. They are now starting to adopt tools like ours in a big way."

Subsystem Interaction

What, exactly, are these tools? "We describe our tools as system-level, 1D simulation," says Goossens. "You're simulating your full design, which can have different domains — electrical, mechanical, thermal, fluid, hydraulic chemistry — and you're trying to put the whole lot together to see how the various subsystems interact with one another."

In other words, you just want to understand whether the system you're designing is going to work.

"Let's say we put a bigger motor in here. That's going to pull more power from the battery," Goossens offers as an example. "What effect is that going to have on the charge/discharge cycles for the battery? What effect is that going to have on its life? What seems like an innocent change to one subsystem can have a significant effect on other subsystems. It's important to be able to get a view of the whole system, so you can understand what effect a change is going to have."

The engineering services segment of Maplesoft's business is growing rapidly, Goossens says.

"It's actually quite astonishing," he adds. "We started down this route two or three years ago, just to support the sale of and implementation of licenses on customer sites. But it's turned into something where people are coming to us to help solve their engineering problems." **DE**

Contributing Editor **Mark Clarkson** *is* DE's *expert in visualization, computer animation, and graphics. His newest book is Photoshop Elements by Example. Visit him on the web at MarkClarkson.com or send e-mail about this article to DE-Editors@deskeng.com.*

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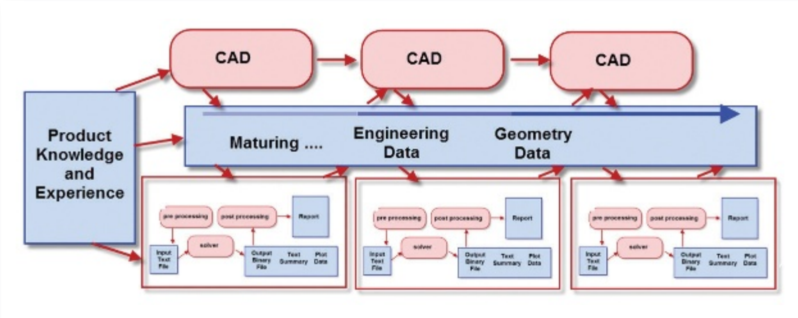
Integrate FEA and CAD

There are several obstacles that act as roadblocks to the successful integration of finite element analysis with CAD. Let's take a look at what they are and how to avoid them.

BY TONY ABBEY

Editor's Note: Tony Abbey teaches the NAFEMS FEA live classes in the United States, Europe and Asia, and teaches e-learning classes globally. Contact tony.abbey@nafems.org for details.



An ideal FEA process and data flow.

For much of engineering product development, it is a CAD-centric world. That's great if you are a CAD driver, but spare a thought for the manufacturing and analysis side. Getting that CAD model into a format that's ready for delivery to a numerically controlled machining program or a finite element analysis (FEA) solver can be really tough.

While technology has evolved tremendously over the past 40 years (see "A Brief History of CAD-to-FEA Data Transfer" on page 50), there are still trouble spots. This begs the question: If the current state of the art is mature enough to allow a high level of compatibility between geometry and meshing, why can't we seamlessly integrate CAD with FEA?

I have covered adequacy of CAD geometry for FEA in previous *DE* articles on meshing (January 2013) and idealization (April 2013). We can break down four areas that may be problematic as follows.

1. Geometry

There are several issues affecting the preparation of an FE model that are simply due to the definition of geometry coming from CAD. These are generally well understood, but represent a burden for the analyst. Small slivers and tolerance errors result in cracks or negative volumes in the geometry as perceived by the mesher. Unwanted features such as tooling holes, and unwanted parts such as handles, sealing rings, etc., need to be removed.

Specialist software provides geometry cleanup and defeaturing — and the technology is migrating to the general-purpose preprocessor. However, it is never foolproof and the geometry still has to be carefully reviewed.

The job of segregating out unwanted parts can be a major task. A piping installation analysis I did several years ago had a part count of more than 5,000. There was no way to automatically identify how each instance of solid geometry related to a physical part. It took many man-hours to reassemble and idealize in the preprocessor, and reduce to 200 structural parts.

2. Configuration

The CAD model defines the product in a specific configuration. So, for example, bearings are concentric within housings. Structural analysis may require the bearing hard up against its mating surface under a particular loading. This means changing the configuration. Other examples include crane arms, suspension fittings, control services, etc. — each of which will be drawn at datum positions, but will need analyzing in operating configurations. It can take trial and error to find critical configurations.

3. Robustness

CAD geometry robustness may be poor because of the interdependence of geometric features. For example, removing a hole or fillet may invalidate the CAD model. To some extent, this can be aided by improving the hierarchy, but that is a tough thing to do as a design is evolving.

One major CAD breakthrough here is synchronous technology, whereby a hierarchical interdependence can be transformed to a simpler parametric definition. Some preprocessing technology helps by allowing the import of dumb geometry and subsequent intelligent parameterizing. The danger here, however, is that design intent may be lost.

4. Idealization Method

This is probably the biggest roadblock to automated CAD and FEA integration. Some structures, described as "potato-like" in appearance, require minimum de-featuring and allow rapid meshing with 3D elements. If the real-world loading and constraint conditions can be matched, we have an adequate representation of the structure.

At the other extreme, thin-shell fabricated structures such as aircraft, ships, buildings and pressure vessels may be difficult to work with. My current FEA project does not use any original CAD geometry solids or surfaces, for example. The general approach is to clone and adapt surfaces, and slice with keyline geometry to suit the 2D element idealization.

Breaking through the Roadblocks

The key to successful integration between CAD and FE in these cases is to use "FEA-friendly CAD." In a manual approach, the analyst and designer work together to identify features and parts to be eliminated and cleaned up in a variant of the CAD model intended for FEA. The level of idealization, from minimal in largely solid-type structures to extensive in fabricated thin-shell structures, is the main driver.

I have seen this implemented very successfully in some companies. But in other companies, cultural, geographical, union or other factors prevent the approach — and management misses a fundamental opportunity to increase productivity.

The software industry still strives to make integration happen automatically. Gazing into a crystal ball, I imagine sitting down with the designer in front of CAD/FEA-integrated software that would allow us to guide the geometry manipulation and subsequent meshing. We would agree on the level of idealization and what key geometry should be tagged to represent the structure efficiently and accurately. We may end up with skeleton geometry that sketches the structural representation. Association of materials, properties and loads and boundary conditions should be highly interactive. The software would then stitch this up and carry out the meshing.

When Do We Do the Data Transfer?

We're trying to push simulation as high up the design chain as possible, so that it can really have an impact on the product. Often, FEA occurs after all design is complete and is part of the sign-off process. This can cost time and money if redesign is needed, and can make FEA appear as a roadblock.

The CAD-to-FEA integration needs to be a lot smarter to achieve this. It is not just about file formats and geometry transfer. It is about the way people collaborate on creating

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A BRIEF HISTORY OF CAD-TO-FEA DATA TRANSFER

I started doing serious finite element analysis (FEA) in the mid-1970s. CAD had not been thought of yet. I remember my skepticism when I was first shown remote text terminals linked to the mighty IBM mainframe! Drawings were produced the old-fashioned way: on drawing boards.

Constructing a mesh required overlaying tracing paper onto the drawing, and penciling in nodes and elements. This was extremely tedious and error-prone. Luckily, most structures were thin skin components that could use 2D element meshing. I built some meshes to carry out damage tolerance analysis on 3D lugs, which predated the Rubik's Cube in spatial complexity.

Fig. 1 shows the typical workflow from that era. The only computer program shown is the FE solver. The pre- and post-processing required a written text input file converted to punch card format and fan-fold paper text output. The figure indicates knowledge and experience of the product, as well as other engineering data, such as material properties, load cases, fabrication techniques, etc.

When thinking about CAD-to-FEA integration today, the same importance must be placed on this information as well as the geometry definition. The end result is still familiar today — the required reporting level to support sign-off, design review or whatever the objective of the analysis is.

The Eighties Revolution

Fig. 2 shows one revolution of the early 1980s, the digitizing tablet. The drawing is pinned to a special board that has a mesh of fine resolution wires able to detect mouse location. Clicking creates nodal points in the preprocessor as a starting point for the meshing.

As CAD came on-stream, geometry data formats were developed to allow file transfer of data between CAD and the FEA pre-processor. Typical formats were STEP and IGES. Data transfer success was hit and miss; it was dependent on the compatibility of the geometry mathematics and tolerances in the CAD and FEA pre-processors.

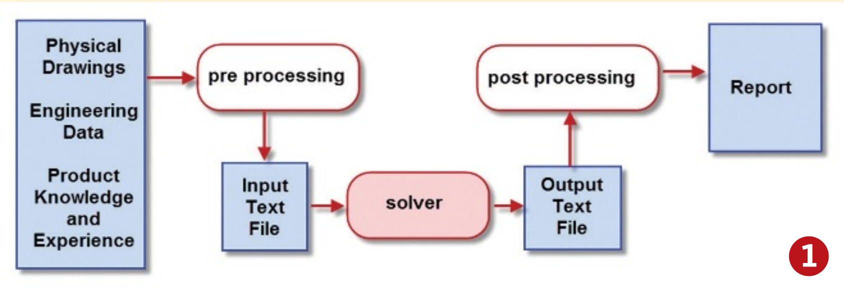
I first came across solid modeling technology in the mid-1980s, with very early incarnations of GEOMOD, CATIA and the like. Fig. 3 shows a missile-packaging project we were very proud of — the date on the screen is February 1984! This technology has developed tremendously since those early days, with corresponding improvement in the mathematical sophistication and completeness of the geometry definition. It is now expected that the data interchange between a CAD program and an FEA preprocessor will be good. The tightest linking is between embedded FEA solutions within a CAD program.

The State of the Art

Fig. 4 shows a typical setup today. The pre- and post-processing are enabled with meshing and results visualization tools. Many CAE solutions now include all three elements within a single, or closely linked products. The input text file to the solver still remains in the vast majority of cases. It is often relegated to a background role, but it's in such a definitive and robust format that it defies evolution. Conversely, output format continues to evolve, driven by the data storage and retrieval requirements of today's large models.

Fig. 4 also adds CAD into the process, with technically tight data exchange with the FEA pre-processor. The designer and analyst still both need to refer back to the broader range of product data, and the knowledge and experience surrounding that.

— T.A.



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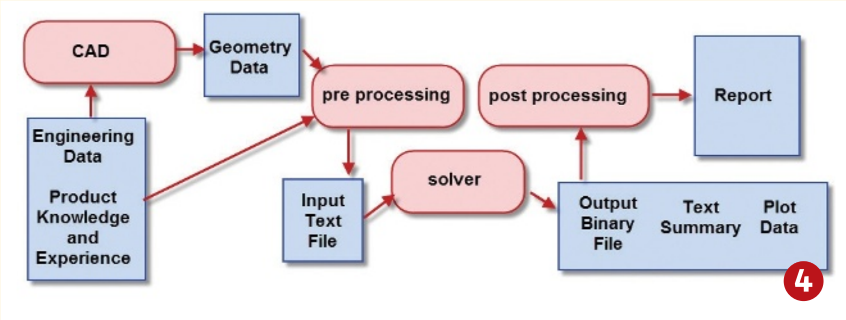

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...Continued from page 49

an engineering product. It is not even just about the tools, such as product lifecycle management (PLM), simulation data management (SDM), etc. It is about creating the culture that enables and encourages the transfer of maturing design intent and structural integrity through the conceptual phase to the final product definition.

The diagram on page 48 shows an evolution from today's typical process flow. We want any product knowledge and experience to be used early in the design evolution to influence both CAD and FEA, as shown by the links in the figure. On the FEA side, the key is having a modeling paradigm that can adapt quickly to changes, and offer as feedback useful structural information to the design process. Changes include configuration, materials and loading environment, and are bound to occur as the design matures.

We have a sequence of FEA tasks now. Each may represent very different approaches, such as initially a simple 1D beam representation maturing through to a full solid model. Or each may be modifications to a common model, evolving through the design phases. Current collaborative screen-based tools allow sharing of model descriptions and design intent, and this will streamline the process. However, what is less clear is how actual geometry data can be meaningfully transferred between the CAD and FEA functions.

Closer, But Not There Yet

We have come a long way since the 1970s and '80s; however, it is still frustrating that the long-held dream of FEA-to-CAD integration has not been fulfilled. Some will point (quite rightly) to specific, highly successful, integrated processes that underpin significant company success. However, in my experience, each of these represents a focused investment in customized solutions. As such, they are a testament to the vision and innovation of the engineers and management involved.

I think that sums up where we are: You can make CAD-to-FEA integration work very successfully in your company. Having a standardized product line helps. But in general, with the current level of technology that is available, you are going to need a clear vision, skill and ingenuity to develop your process. **DE**

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BMW Robust Design Quest

Multi-objective optimization with modeFRONTIER solves the problem.

When optimizing crankcase fatigue life and gasket behavior, BMW Motoren Gmbh needed to resolve the problem of noise affecting uncertain variables in the design process.

The engineering team noticed that solutions which performed well at concept level did not pass the validation stage due to unforeseen factors.

To tackle this issue the team considered the uncertainty related to certain input parameters which could not always be precisely determined under real manufacturing and operating conditions. Moreover, a product designed for a specific scenario was not suitable for other environments. Therefore, they looked for a way to come up with designs with a lower variability of performance.

The modeFRONTIER platform provided BMW with the perfect solution: its robust design and multi-objective optimization functionalities, together with powerful integration and process automation tools, proved the winning combination.

The modeFRONTIER Multi-objective Robust Design Optimization (MORDO) tool and modeFRONTIER Response Surface Models (RSM) accelerated the analysis of the entire design process and investigated the noise factors in the vicinity of the best designs.

modeFRONTIER state-of-the-art algorithms addressed the multi-objective optimization challenge by allowing one variable and three constants to be defined as stochastic. During the optimization, the platform automatically created a set of sample designs with a user-specified distribution for each stochastic variable — centered at the initial value point — optimizing their mean values and minimizing their variations. The effective integration approach of the modeFRONTIER workflow editor helped create an automated pipeline connecting the different software packages required to solve the optimization challenge.

By using the RSM approach to run a virtual, robust optimization with thousands of computations and by validating the virtual designs, BMW was able to improve the Fatigue Safety Factor by 15% — a solution which also constrained the variation of the measured output to less than 1%. **DE**

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POWER to the People

As part of its 3D Printing Production Quest, GE is challenging the crowd to create an aircraft engine bracket using additive technologies. *Image courtesy of General Electric.*

Companies are experimenting with crowdsourcing and open innovation approaches to accelerate the flow of new product ideas — and to get faster and better answers to tough engineering questions.

BY BETH STACKPOLE

For more than 80 years, Madison Electric Products ran a traditional business, selling commodity electrical components and doing very little in the way of new product development. In 2010, looking to springboard into new markets, the company took a risk on a non-traditional tactic: leveraging a new phenomenon known as crowdsourcing to fuel a product pipeline built around innovation.

The company established the Sparks Innovation Center — what it dubs its new product incubator — to solicit ideas from working electricians to solve the challenges they face regularly on the job. The idea for the innovation community came from a chance encounter at a trade show, where Madison Electric Products President Brad Wiandt happened upon a product created by a licensed electrician who wasn't fully committed to seeing it through manufacturing and production. The two hammered out a licensing deal, and a door opened for Madison Electric to formalize an approach that would help with the ideation of novel products.

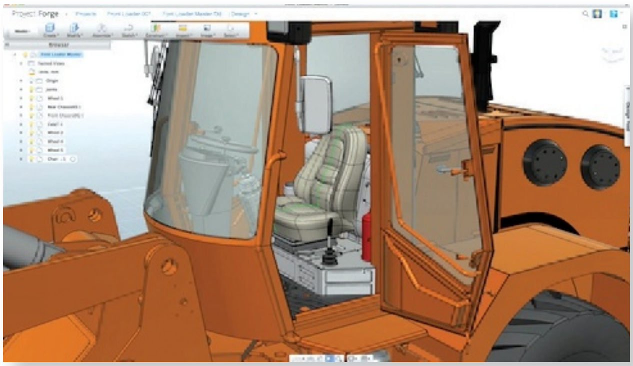
> "Product development can no longer be done in a vacuum or in an ivory tower ..."
>
> *—John Jacobsen, Quirky's head of products*

"We wanted to transition our business to the next level, and we needed a reason to get new customers to look at us. New products was the hook," Wiandt explains. "Yet we were very lean in the area of engineering and product development — and we realized there's a lot of great ideas out there. We just had to connect to the contractors and users on the jobsites to get to those ideas."

The relatively small Madison Electric is on to a new product innovation strategy that is in the experimental phase at a growing number of big manufacturers, including General Electric, Philips North America, BMW and even the U.S. Department of Defense. These traditional players, in the company of new upstarts like Quirky and Local Motors, are harnessing the collective wisdom of the crowd for everything from design ideation to the co-creation of products to getting answers to tough engineering questions.

While not necessarily new, the practice of crowdsourcing is being reinvented thanks to the arrival of new social networking, visualization and Web 2.0 technologies. Moreover, interest in crowdsourcing is on the rise today, given ongoing competitive pressures and as companies look to be more customer-driven while reducing time-to-delivery cycles for new products.

"If you can leverage a broader group of experts that are not inside your four walls, as well as creativity not bound by typical corporate processes, and include users in that process, you can drive that customer orientation," says Karsten Newbury, senior vice president and general manager for mainstream engineering software at Siemens PLM Software.



Companies like Peterbilt and BMW are turning to Local Motors to leverage its FORGE collaboration platform as part of their own crowdsourcing efforts. ***Image courtesy of Local Motors.***

While crowdsourcing as a product development and engineering strategy is still relatively unproven, Newbury says it's turned the corner in terms of being taken more seriously.

"What's exciting is there are a number of serious players looking at this, not just as a fun activity or as a way to get a nice product name or conceptual design, but as a real innovation tool," he says. "Nevertheless, it's still going to take

Ianis Vasilatos of Romania took first place and a $2,000 cash prize in Local Motors' Cruiser Design Challenge, a crowdsourcing effort to create the company's first motorized bicycle. *Image courtesy of Local Motors.*

several years to see how manufacturers should best leverage it and make it a core component of their process."

Testing the Waters

Competitions have become the proving ground for crowdsourcing's potential. Take Philips North America, for example. Through its recently announced Innovation Fellows competition, the company is tasking innovators to submit their ideas for future innovations aimed at improving people's everyday lives, specifically in the areas of living well, being healthy and enjoying life. Entrants to the contest have a shot at winning $100,000 in prize money from Philips North America, and the company is also encouraging participants to garner more financial support for their ideas on Indiegogo.com, a global crowdfunding site.

"By focusing the Innovation Fellows competition toward the priority areas identified through the Philips Meaningful Innovation Index, we can continue to pioneer and foster products, services and game-changing innovations that will help people, communities, healthcare systems, governments and future generations address the critical issues surrounding how we live, how content we are, and our own roles in those dimensions of our lives," says Greg Sebasky, chairman of Philips North America.

Sebasky says the crowdsourcing model can work at any stage of development, but it's particularly useful for early ideation. "Crowdsourcing is valuable from an idea-generating standpoint, because many people are developing ideas that personally matter to their lives," he explains. "The method encourages the generation of new ideas to the market, but also allows individuals or smaller organizations to receive the proper funding and support they need to bring the product to life."

General Electric (GE) is another industry behemoth experimenting with several variations on the crowdsourcing theme. In addition to its Ecoimagination Challenge to spark the best ideas around sustainability in areas like renewables, grid efficiency, and eco-friendly homes and buildings, the company has partnered with the Massachusetts Institute of Technology (MIT) and DARPA (Defense Advanced Research Projects Agency) to help create a crowdsourcing platform. The platform is aimed at enabling a global community of experts to rapidly design and manufacture complex systems such as military vehicles, aviation systems, and advanced medical devices — all of which can traditionally take decades to develop.

Along with those efforts, GE regularly hosts open engi-

Egg Minder is one of several "connected home" products to be released as part of the Wink consumer line, which is a crowdsourcing partnership between Quirky and General Electric. *Image courtesy of Quirky.*

neering quests as part of its investment in advanced manufacturing. Most recently, the company launched two global additive manufacturing (AM) quests: one that invites participants to come up with a 3D-prinable design for an aircraft engine bracket, and the other to use 3D printing technology to produce highly precise and complex parts, potentially for medical imaging applications. GE has partnered with GrabCAD, an open CAD community, to launch the design quest and has taken on NineSigma as a partner on the 3D printing production quest.

According to Prabhjot Singh, Ph.D., manager of the Additive Manufacturing Lab at GE Global Research, the quests help GE stay connected with the latest technologies in the field — and are particularly useful for the discovery process. With AM, for example, GE is looking for designers who have experience and an eye toward designing shapes that weren't possible with traditional manufacturing methods.

"We are looking for people not encumbered by more conventional forms of manufacturing," he explains. "The thought process needs to be fresh, and to do so, we need to look outside of the company."

Community-Driven Product Development

In yet another iteration of crowdsourcing, GE has partnered with Quirky, a consumer product innovation platform, to develop the Wink: Instantly Connected line of consumer products for the connected home. As part of the arrangement, GE is giving the Quirky inventor community access to thousands of its U.S. patents to use as a starting point for new designs. Among the treasure trove of patents at their disposal: optical systems, including holographic and fast-focusing lens technologies; barriers coatings; and telematics and asset tracking capabilities.

The Quirky community and innovation platform will serve as the genesis for co-creation, and the products selected for commercialization will start to be released later this year, says John Jacobsen, Quirky's head of products. One early example of a possible Wink offering is the Egg Minder, an egg tray and corresponding app that alerts consumers to the number of eggs left in the tray, as well as their remaining shelf life. To date, more than 1,000 Quirky community influencers have participated in some way in the Egg Minder's development, according to Quirky.

"Product development can no longer be done in a vacuum or in an ivory tower, and ideas are not necessarily formed in the boardroom — they're formed in the living room or on the drive home," Jacobsen says. "Companies are realizing they are not structured for it. They're looking to partner with people who are."

Local Motors, a global community focused on co-created vehicle design, is rapidly becoming a go-to crowdsourcing partner for entities from the U.S. government to corporate giants like BMW and Peterbilt. Its most prominent effort to date is its work with DARPA to enlist the crowd to help develop the XC2V Combat Support Vehicle, and its VehicleFORGE co-creation community is also being tapped to develop ideas for the Fast, Adaptable, Next-Generation Ground Vehicle (FANG). Local Motors' co-creation approach was even cited by President Obama back in 2011 as an example of an innovation in manufacturing that could help facilitate faster and cheaper product development.

In addition to those high-profile DARPA projects, Local Motors uses the crowdsourcing model to generate ideas such as the development of its Rally Fighter vehicle — and more recently, for a motorized bicycle. The Local Motors FORGE community is also engaged on development projects with Peterbilt, to dream up the styling elements for its Road Icon Generation 2 (RIG2), for example, and with Domino's Pizza to create the ultimate delivery vehicle, among other initiatives.

Alex Fiechter, Local Motors FORGE engineering community manager, contends that if implemented properly, a crowdsourcing approach can operate far more efficiently while generating better ideas than traditional development. But he notes that companies pursuing a crowdsourcing model do need to get a few things straight.

The most important thing is to understand the types of experts you are trying to attract, and structure the community so that it has value and motivates them to participate, he says. Companies also need to make all the necessary resources available to the crowd — CAD models, critical IP, specifications, part models, whatever it takes — so they can accomplish the task with which they've been charged.

"Crowdsourcing can really work at every stage of development," Fiechter maintains. "But companies that want to leverage the crowd effectively need to do some growing in terms of their mindset, and be willing to give the crowd everything they need to get the job done. If you can't come to grips with that, crowdsourcing is a non-starter right there." DE

Beth Stackpole *is a contributing editor to* DE. *You can reach her at beth@deskeng.com.*

INFO → General Electric: GE.com/about-us/openinnovation

→ **Local Motors:** LocalMotors.com

→ **Madison Electric Products:** MEProducts.net/sparks

→ **NineSigma:** NineSigma.com

→ **Philips North America:** Philips.com

→ **Quirky:** Quirky.com

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Paving the Way to Better Engineering Simulation

The UberCloud CAE Experiment is exploring high-performance computing as a service.

BY DR. WOLFGANG GENTZSCH, DR. DENNIS NAGY AND BURAK YENIER

The UberCloud CAE Experiment is making high-performance computing (HPC) available as a service on demand for engineers doing simulation. Participants of the experiment are exploring the end-to-end process of using remote computing resources in HPC centers and in the cloud for their CAE. In the process, they're learning how to resolve many of the common roadblocks.

There are more than 300,000 small and medium-size manufacturing enterprises (SMEs) in the U.S. alone — and many of them rely on workstations for their daily CAE design and development work. According to the U.S. Council of Competitiveness, more than 50% of them need more computing power from time to time. Buying an HPC cluster is not always an option, and renting computing power from HPC centers or an HPC cloud provider still comes with several roadblocks, including:

- the complexity of HPC itself;
- intellectual property and sensitive data and privacy concerns;
- massive data transfers;
- inflexible software licenses;
- performance bottlenecks from virtualized resources;
- user-specific system requirements;
- missing standards; and
- the lack of interoperability among different clouds.

Last but not least, the currently growing numbers of different service offerings in the cloud can strain the non-HPC-expert engineer who is desperately looking for the best-suited solutions or services matching application requirements.

On the other hand, if these roadblocks could be removed, the benefits of using remote computing resources become extremely attractive. For example:

- no lengthy procurement and acquisition;
- shifting budget from capex to opex;
- gaining business flexibility (getting additional resources on demand); and
- scaling remote resource usage automatically up or down according to actual needs.

More computing available on demand means more geometry variations, more physics parameters and more computing jobs, in less time — thus increasing product quality and decreasing time to market.

The Purpose of the Experiment

To better understand and overcome the roadblocks, the open, voluntary and free UberCloud CAE Experiment was started in July 2012. The experiment promotes the wider adoption of digital manufacturing technology to SMEs. It is an example of a grassroots, crowd-sourced effort to foster collaboration among engineers, HPC experts and service providers to address challenges at scale, with the aim of exploring the end-to-end process employed by design engineers to access and use remote CAE computing resources in HPC centers and in the cloud.

In the intervening year, the UberCloud HPC Experiment achieved the participation of 500 organizations and individuals from 48 countries. At press time, more than 80 teams have been involved. Each team consists of an industry end-user and a software provider (ISV); the organizers match them with a well-suited volunteer resource provider and an HPC expert who serves as the team leader. Together, the team members work on the end-user's application — defining the requirements, implementing the application on the remote HPC system, running and monitoring the job, getting the results back to the end-user, and reporting results and key findings about the HPC process in a case study.

Detailed results are published after each three-month round and are available upon registration. Round 3 concluded at

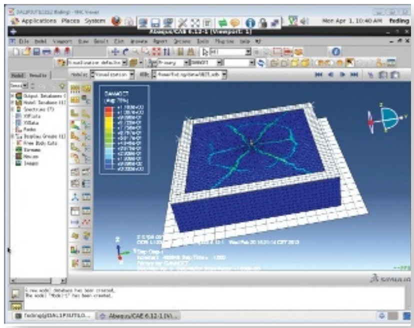

FIG. 1: Structural analysis model using HPC in the cloud.

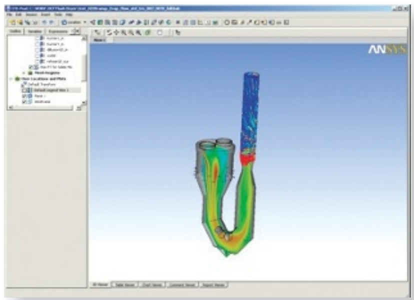

FIG 2: Flash dryer model viewed with ANSYS CFD-Post.

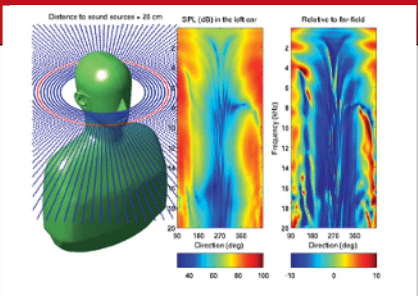

FIG 3: Simulation model (an acoustic dummy): Dots indicate all locations of monopole sound sources used in the simulations. The red dots are sound sources used in this image. The figure in the middle shows the sound pressure level (SPL) in the left ear as a function of the sound direction and the frequency. On the right, the SPL relative to sound sources in the far-field is shown.

the end of June 2013, and at press time, teams were ramping up Round 4.

As a glimpse into the practical results so far, below are four of the successful teams that participated in Round 1 and Round 2, demonstrating the wide spectrum of CAE applications.

Heavy-duty Abaqus Structural Analysis Using HPC in the Cloud

The applications (*see Fig. 1*) for this team range from solving anchorage tensile capacity and steel and wood connector load capacity, to special moment frame cyclic pushover analysis. The HPC cluster at Simpson Strong-Tie is modest, consisting of 32 cores. Therefore, when emergencies arise, the need for cloud bursting is critical. Also challenging is the ability to handle sudden large data transfers, as well as the need to perform visualization for ensuring that the design simulation is proceeding along correct lines. The team consisted of engineer Frank Ding from Simpson Strong-Tie, software provider Matt Dunbar from SIMULIA, resource provider Steve Hebert from Nimbix, and team expert Sharan Kalwani.

Flash Dryer Simulation with Hot Gas to Evaporate Water from a Solid

Computational fluid dynamics (CFD) multiphase flow models are used to simulate a flash dryer using CFD tools that are part of an end-user's extensive CAE portfolio (*see Fig. 2*). On the in-house server, the flow model takes about five days for a realistic particle-loading scenario. ANSYS CFX 14 is used as the solver. Simulations for this problem are using 1.4 million cells, five species and a time step of 1 millisecond for a total time of 2 seconds. A cloud solution allowed the end-user to run the models faster to increase the turnover of sensitivity analyses. It also allowed the end-user to focus on engineering aspects instead of using valuable time on IT and infrastructure problems. The team consisted of Dr. Sam Zakrzewski from FLSmidth; the software provider Dr. Wim Slagter from ANSYS; the resource provider Marc Levrier from Serviware, a Bull Group company; and the HPC expert Ingo Seipp from Science + Computing.

Simulation of Spatial Hearing

A sound emitted by an audio device is perceived by the user of the device. The human perception of sound is, however, a personal experience. For example, spatial hearing — the capability to distinguish the direction of sound — depends on the individual shape of the torso, head and pinna (the so-called head-related transfer function, or HRTF). To produce directional sounds via headphones, one needs to use HRTF filters that "model" sound propagation in the vicinity of the ear (*see Fig. 3*). These filters can be generated using computer simulations, but to date, the computational challenges of simulating the HRTFs have been enormous. This project investigated the fast generation of HRTFs using simulations in the cloud. The simulation method relied on an extremely fast boundary element solver. The team consisted of an engineering end-user from a manufacturer of consumer products, the software provider and HPC experts Antti Vanne, Kimmo Tuppurainen and Dr. Tomi Huttunen from Kuava Ltd, and the HPC experts Drs. Ville Pulkki and Marko Hiipakka from Aalto University in Finland.

FIG 4: Velocity color plot, generated with the CADNexus Visualizer Lightweight Postprocessor.

WHY PARTICIPATE IN THE CAE EXPERIMENT?

The UberCloud CAE Experiment has been designed to discover and reduce many of the barriers mentioned in the main article. By participating in this experiment and moving engineering applications to remote computing resources, engineers can expect several benefits, including:

- A vendor-independent matching platform for digital manufacturing.
- No need to hunt for resources and services in the emerging and crowded cloud market.
- Free, on-demand access to hardware, software and expertise during the experiment.
- Carefully designed end-to-end, step-by-step process to access remote resources.
- Learning from the best practices of other participants.
- Risk-free proof-of-concept: no money involved, no sensitive data transferred, no software license concerns, and the option to stay anonymous.
- Leading the way to increasing business agility, competitiveness and innovation.
- Not getting left behind in the emerging world of cloud computing.

The list of benefits for service providers (software, resources and expertise) to participate in this experiment includes:

- Getting immediate, constructive feedback from the experiment's end-users on how to fine-tune your services.
- Gaining deeper and practical insight into a new market and service-oriented business model.
- Risk-free, no failure experimenting, allowing you to improve your services during the experiment on the fly.
- Getting in touch with potential customers.
- Gaining public attention by becoming part of widely published success stories.
- Last but not least, all service providers are encouraged to make use of the interactive UberCloud Exhibit to present their services to the wider CAE community.

Team 58: Simulating Wind Tunnel Flow Around Bicycle and Rider

The CAPRI to OpenFOAM Connector and the Sabalcore HPC Computing Cloud infrastructure were used to analyze the airflow around bicycle design iterations from Trek Bicycle. (*See Fig 4*.). The goal was to establish synergy among iterative CAD design, CFD analysis and HPC Cloud. Automating iterative design changes in CAD models coupled with CFD enhances the productivity of engineers and enables them to make better decisions. Using the cloud to meet the HPC requirements of computationally intensive applications decreases the turnaround time of iterative designs, and reduces the overall cost of the design. The team consisted of end-user Mio Suzuki from Trek Bicycle Corp., software provider and HPC expert Mihai Pruna from CADNexus, and resource provider Dr. Kevin Van Workum from Sabalcore Computing.

DE readers are invited to join Round 4 of the UberCloud CAE Experiment by registering at CAEExperiment.com. **DE**

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INFO → **Aalto University:** Aalto.fi/en

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→ **Serviware, a Bull Group company:** Serviware.fr

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Fast 3D Graphing Tops Latest Version of Software's Features

With Origin 9, users get faster graphics, simplified implementation and more.

BY RANDY FRANK

Less than a year after announcing version 8.6 and a month after celebrating its 20th anniversary, OriginLab released version 9 of Origin and OriginPro. One question that users of any software with regular upgrades and periodic new versions may ask is, what determines the difference between a minor modification and or a new revision? Dr. Easwar Iyer, vice president of technology for OriginLab explains his company's philosophy.

An *x.x* is considered a minor release. "Although we call it minor, there are usually many, many features that we add," he says. The *x.0* version is a major release. "A major release is something where we feel we have invested quite a bit of time and implemented something new that significantly changes the product," he says.

As an example, Iyer cites the Auto Update feature introduced in Origin 8. "If you change the input data, all the output will automatically update — allowing you to perform tasks more efficiently, and even perform batch processing using what we call an Analysis Template," he says. This makes Origin 8 markedly different than the previous 7 version.

Carrying Technology Forward

For Origin software, the capabilities grow with each minor and major revision. "We don't eliminate features. Typically, we enhance them or add new ones," explains Iyer. While this adds to the complexity, OriginLab offers many tools in Origin to help users understand the capabilities of earlier versions, as well as the new features in the latest version.

"One of the things we do is publish many movies," Iyer says, noting that more than 100 video tutorials are easily accessible from a link on OriginLab's homepage. But users can get up to speed or get refresher information directly in Origin, too.

In addition to the helpful learning/teaching tools and the built-in explanations, OriginLab provides additional help through training courses for Origin 9 that could provide even greater use of the newest software.

Compelling Enhancements

As a major revision, Origin 9 has more than a dozen significant enhancements. What sets it apart is mainly enhanced 3D graphing. Compared to Origin 8, the ultrafast 3D graphing in Origin 9 ranges from 17 to as much as 340 times faster in certain tasks. The reason for the improved performance is OpenGL (open graphics library), a standard library that many other products use.

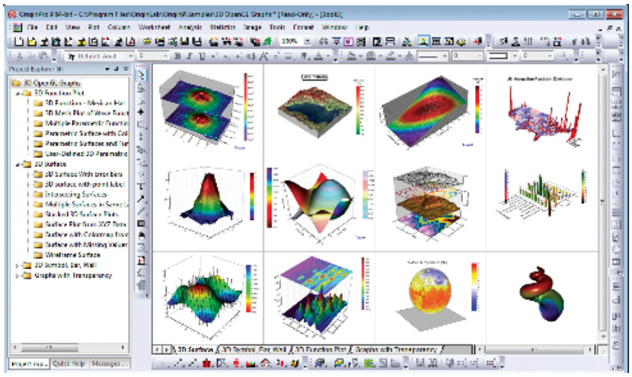

FIG. 1: Origin provides example projects with sample graphs and analysis. Projects include instructions for creating graphs and modifying analysis settings.

"All 3D graphs used to be based on Windows drawing core, Windows GDI (graphics device interface), and that was rather slow and did not have modern options such as lighting effects," says Iyer. "What we did in version 9 is to revamp our 3D to use OpenGL. That makes things a whole lot faster." (*See Fig. 1.*)

Today, graphics cards come with OpenGL capability and are fine-tuned for handling OpenGL graphing. Updating the driver allows users to keep up with the latest OpenGL capability. "So it really takes advantage of the graphic card's capability, as well as in providing better performance for 3D graphics," says Iyer.

The 3D parametric function plot is another major new graphing feature. "That allows customers to put in an equation and create complex 3D plots from a function," says Iyer. (*See Fig. 2.*)

Iyer notes that a significant fraction of OriginLab's customers use 3D, and bringing in large volumes of data and being able to make a quick surface plot is important to them. As seen in Fig. 3, users can now stack multiple surfaces and quickly view the data from many angles, and zoom in and pan in the program.

More Features

There are many other new features in Origin 9 beyond its 3D graphing capabilities, of course. The data filter is one example. "If you have many columns of engineering data, you can

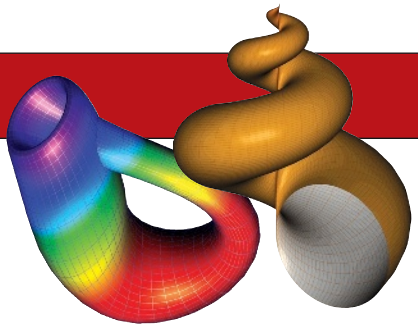

FIG. 2: The OpenGL 3D parametric function plot allows the generation of complex shapes such as a Klein bottle (left) and seashell (right) in Origin 9.0.

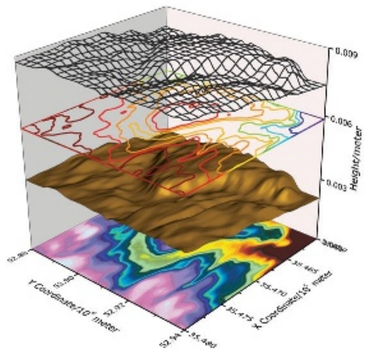

FIG. 3: Stacked surfaces are easily viewed from many perspectives in Origin 9.

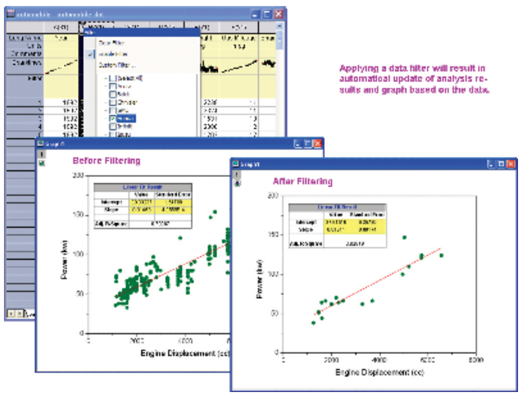

FIG. 4: A data filter applied to a collection of automotive data allows the selection of a single make without showing the other data. Any analysis automatically updates.

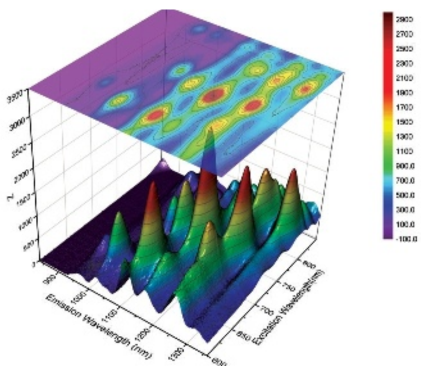

FIG. 5: Locating a 3D surface is one of the tricks that users can do with the animation capability of Origin 9.

quickly reduce that data by putting conditions on columns," explains Iyer. (*See Fig. 4.*)

With Origin 9, users even have a movie creation capability to animate their data (*see Fig. 5*). "That's pretty significant, and it is slowly catching up to customers," says Iyer. "Say they have multi-column data and they want to graph one column at a time and keep changing it, so they can see the trend in the data, or it can be some 3D surface.

"We recently had an engineering customer that studied temperature variations inside a furnace, and they wanted to simulate how the temperature changes over time and make a movie of it," he continues. Even with the improved 3D graphing capability, he adds, the 3D capability in animation is much better than 3D graphing: "It allows looking at almost real-time 3D data as a movie."

A table of key features by version on the company's website shows the numerous changes from Origin 7.5 through Origin 8.0, 8.1, 8.5, 8.5.1 and 8.6 vs. Origin 9 for the Origin Interface, graph types, graph customization, gadgets, importing, exporting, data manipulation and more.

"We really bent over backward to add more features to the product," Iyer says.

Time for a Change?

Origin has historically been viewed as a high reliability graphing product. Starting with version 8, the analysis advanced in several areas, including statistics. "We are seeing more and more users migrating to Origin to tap into its analysis capabilities," Iyer observes.

Combined with the superior graphing capabilities of Origin 9, the analysis could provide the compelling requirement threshold for new users. Easily customized workbooks, introduced in Origin 8, allow users a similar feature to Microsoft Excel. "But it has much more capabilities in terms of housing metadata in the book and being able to manipulate the data, analyze the data, graph it and then combine everything together to make a nice free-flowing document, which can then be exported as a PDF or image file," explains Iyer.

OriginLab's customer base is rather broad; it distributes software products worldwide, with German and Japanese versions as well as the English version.

Who is a potential user of Origin? "Typically, any scientist or engineer who is frustrated with Excel," says Iyer. "Anyone who is looking for a better graphing capability, a better analysis capability." **DE**

Randy Frank *is a contributor to DE. Send e-mail about this article to DE-Editors@deskeng.com.*

INFO ➜ OriginLab: OriginLab.com

For more information on this topic, visit deskeng.com.

Top-performing Portable

The new BOXX GoBOXX G2720, a mobile workstation with a familiar lineage, proves to be incredibly fast.

BY DAVID COHN

We've never had a chance to test one of BOXX's mobile workstations. That situation changed with the arrival of the GoBOXX G2720.

The company's desktop workstations all come housed in custom-designed aluminum cases. So imagine our surprise when we opened the G2720's shipping carton and discovered a mobile workstation nearly identical to the Eurocom Panther 4.0 we reviewed in June. A quick call to BOXX verified our suspicion that both the BOXX and Eurocom mobile workstations are built by the same original equipment manufacturer (OEM).

Once we started taking measurements, however, we noted a few subtle differences. The GOBOXX 2720 is slightly smaller than the Eurocom system, measuring 16.5 x 11.3 x 2.4 in. — and at 13 lbs., is a half-pound heavier. The 330-watt power supply for the G2720 weighs less (2.75 lbs.) and is a bit smaller, although we'd hardly call 7.75 x 3.75 x 1.62 in. small.

BOXX equips the G2720 with a 2-megapixel webcam centered above the LCD, flanked by a pair of microphones. Three speakers are located in the hinge below the LCD, with two more in the top corners above the keyboard. Between these are a series of touch sensors for adjusting speaker volume and toggling the Wi-Fi, Bluetooth and webcam on and off, as well as hard drive and keyboard status indicators. These controls, as well as the large round power button to the right of the keyboard, glow bright blue when active.

Well-appointed Base Configuration

Although built by the same OEM, BOXX Technologies starts with a very well-appointed base configuration and offers a smaller array of options than Eurocom. All GoBOXX 2720 systems come with the same 17.3-in. Full HD backlit LED clear glare screen and a choice of either an NVIDIA GeForce GTX 680M or the Quadro K5000M provided in our evaluation unit. Systems based on the GeForce start at $3,582, while the base price for a G2720 equipped with a Quadro K5000M is $5,289.

The GoBOXX 2720 is based on the Intel X79 chipset. It comes standard with the 3.6GHz Intel Core i7-3820 quad-core processor, although BOXX does offer three higher-priced options, including the six-core 3.5GHz Intel Core i7-3970X. The i7-3820 in our evaluation unit has a maximum turbo frequency of 3.8GHz and a maximum thermal design power rating of 130 watts. The system can accommodate up to 32GB of DDR3 1600MHz memory. While the base configuration comes with 8GB of RAM, our evaluation unit included 16GB installed using four 4GB small outline dual in-line memory modules (SO-DIMMs), adding $260 to the base price.

A 120GB solid-state drive (SSD) is standard in the base configuration, with larger SSD drives as well as a 750GB SATA

INFO → BOXX Technologies, Inc.: BOXXTech.com

BOXX GoBOXX G2720

- **Price:** $5,985 as tested ($3,582 base price)
- **Size:** 16.76 x 11.44 x 2.48 in. (WxDxH) notebook
- **Weight:** 13.0 lbs. as tested, plus 2.75-lb. power supply
- **CPU:** 3.6GHz Intel Core i7-3820 quad-core with 10MB cachee
- **Memory:** 16GB 1600MHz DDR3 SDRAM (32GB max)
- **Graphics:** NVIDIA Quadro K5000M with 4GB memory
- **LCD:** 17.3-in. diagonal (1920x1080)
- **Hard drives:** 240GB SSD SATA, 750GB 7,200 rpm SATA
- **Optical:** 8X DVD+/-RW dual layer
- **Audio:** line-in, SP/DIF-out, microphone, headphone, built-in microphone and speakers
- **Network:** Gigabit Ethernet (10/100/1000 NIC); Intel 802.11 a/b/g/n wireless LAN; optional Bluetooth 4.0
- **Other:** two USB 2.0, two USB 3.0, one mini IEEE-1394 (FireWire), eSATA/Powered USB 3.0 combo, 9-in-1 card reader, DVI-out, HDMI-out, DisplayPort, 2-megapixel webcam
- **Keyboard:** 102-key keyboard with numeric keypad
- **Pointing device:** two-button touchpad

drive as options. Our evaluation unit came with a 240GB Intel 520 Series Cherryville SSD SATA drive as the primary storage device, plus a 750GB Seagate Momentus XT 7,200 rpm hybrid drive for additional data storage.

With the lower power requirements of its Core i7 CPU, we had hoped that the 78.44Wh lithium-ion battery in the GoBOXX 2720 would last longer than the one in the Eurocom system. But the G2720 ran just one minute longer, shutting down after 75 minutes in our battery rundown test.

The G2720 stayed relatively cool during our testing, although the noise from its cooling fans was quite pronounced — and became louder when running our benchmark tests. But the results on those benchmarks were very impressive.

New Performance Champ

On the SPECviewperf test, which focuses solely on graphics, the GoBOXX 2720 outperformed every mobile or desktop system we've ever reviewed, with the exception of BOXX's desktop workstations.

For our second benchmark, we recently switched to the new SPECapc SolidWorks 2013 benchmark, which performs a lengthy series of tests and yields composite scores for graphics and CPU performance. The G2720 also outperformed the Eurocom Panther on all but the CPU tests (thanks to the Panther having double the number of CPU cores).

On the AutoCAD rendering test, a multi-threaded test in which systems with more CPU cores have a clear advantage, the GoBOXX 2720 completed the rendering in 79.2 seconds. That's a bit slower than expected, but still respectable.

Of course, all of that power comes with a price tag to match. As configured, our evaluation unit sells for $5,985. That price includes Windows 7 Ultimate Edition 64-bit, as well as a one-year limited warranty. A two-year extended warranty adds $295, while a three-year warranty costs $495.

While the GoBOXX 2720 clearly delivers performance once only available in a desktop workstation, its price and weight make it more of a niche solution, aimed at high-end users. But if you need desktop performance that you can carry with you, look no further than the GoBOXX 2720 from BOXX Technologies. DE

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Mobile Workstations Compared		**BOXX GOBOXX G2720** (3.6GHz Intel Core i7-3820 quad-core CPU, NVIDIA Quadro K5000M, 16GB RAM)	**Eurocom Panther 4.0** (3.1GHz Intel Xeon E5-2867W 8-core CPU, NVIDIA Quadro K5000M, 16GB RAM)	**Lenovo ThinkPad W530** (2.90GHz Intel Core i7-3920XM quad-core CPU, NVIDIA Quadro K2000M, 16GB RAM)	**HP EliteBook 8560w** (2.30GHz Intel Core i7-2820QM quad-core CPU, NVIDIA Quadro 2000M, 16GB RAM)
Price as tested		$5,895	$6,800	$2,592	$4,063
Date tested		5/28/13	4/20/13	12/29/12	5/1/12
Operating System		Windows 7	Windows 7	Windows 7	Windows 7
SPECviewperf 11	Higher				
catia-03		73.23	65.87	34.82	27.49
ensight-04		61.24	61.01	18.40	18.46
lightwave-01		78.03	65.85	62.75	48.21
maya-03		111.58	102.18	62.04	58.12
proe-5		16.06	13.82	15.58	9.77
sw-02		63.26	55.06	39.48	35.85
tcvis-02		60.91	59.28	30.63	23.12
snx-01		63.57	64.62	25.14	19.85
SPECapc SolidWorks 2013	Higher				
Graphics Composite		2.72	2.26	2.06	n/a
RealView Graphics Composite		2.93	2.42	2.18	n/a
Shadows Composite		2.93	2.42	2.18	n/a
Ambient Occlusion Composite		6.09	5.14	3.76	n/a
Shaded Mode Composite		2.66	2.41	2.13	n/a
Shaded With Edges Mode Composite		2.78	2.12	2.00	n/a
RealView Disabled Composite		2.02	1.72	1.65	n/a
CPU Composite		3.61	3.72	3.59	n/a
Autodesk Render	Lower				
Time	Seconds	79.20	57.33	62.00	89.83
Battery Test	Higher				
	Hours:min	1:15	1:14	6:09	2:37

Numbers in blue indicate best recorded results.
Numbers in red indicate worst recorded results.

Printers *take on* Collaboration

Large-format printers and scanners embrace the cloud to send prints and scans anywhere.

BY JAMIE J. GOOCH

The world seems like a smaller place than it once was. You can collaborate with colleagues on the other side of the globe via the Internet, and the technological tools you use continue to shrink. What was once a building-sized supercomputer can now sit on your desktop, and the large-format printer/scanner that once filled a room at a local service center can now stand in the corner of any small office.

Those two factors — collaboration and smaller form factors — are enabling new workflow possibilities for engineers. But as fast as technology changes, it can be difficult for company cultures to catch up. Take printing from the cloud, for instance.

"No question: Cloud-enabled workflows are ahead of the curve," says Bob Honn, director of product marketing for Canon Solutions America, which recently introduced its new Océ PlotWave 340 and Océ PlotWave 360 large-format monochrome printing systems that have cloud-based features. "Users are still catching up. It still remains to be seen how much they're going to adapt to it.

"How many people do you see working with iPads and other tablets?" Honn asks. "Those are the ones catching up with the curve. We've got the tools, and we're making it accessible and available so we can see where it goes."

Canon is not the only large-format printer/scanner company embracing a collaboration strategy. Epson released three printers in its SureColor T Series late last

Canon Solutions America's Océ PlotWave 340 and Océ PlotWave 360 (pictured) large-format monochrome printing systems feature 10.4-in. multi-touch panels that allow users to control the printer via tablet-like gestures.

Large-Format Printers at a Glance

Large-Format Printer	Speeds)	Dimensions (WxDxH)	Media	Of Note
Canon Solutions America Océ Plot-Wave 340/360 printing system	Océ PlotWave 340: 4ppm (D-size/A1); Océ PlotWave 360: 6ppm (D-size/A1)	60.6 × 31.5 × 58.9 in., including top delivery tray	1-2 rolls from 11 to 36 in. wide	Less than 1 second warm-up time
Epson SureColor T-Series	25 seconds per D-sized plot in fastest mode	41.3 to 63.3 x 32 x 44.4 in., depending on model	Cut sheets up to 44 in. wide or 1 roll from 24 to 44 in. wide, depending on model	Resolution up to 2880 x 1440 dpi
HP Designjet T920 and T1500	21 seconds per D-sized print in fastest mode	55.1 x 36.1 x 43.7 in.	8.3- to 36-in. wide sheets, or 1 to 2 rolls from 11 to 36 in. wide	Integrated output stacking tray for flat, collated prints

year, which are designed to work with leading cloud-based services. The latest Contex IQ 4400 scanner series makes use of the company's PageDrop technology, which allows you to scan and send documents via email, cloud services like Dropbox and Google Drive, or any HP ePrint-enabled printer. Speaking of HP ePrint, this summer, the company released its HP Designjet T920 and T1500 ePrinter series, which are designed to help users access, view and print projects from the cloud.

"We have mobile tools to collaborate across the globe," says Alex Monino, strategic marketing manager for HP's Designjet Business, "but printing up until now has been local."

Integrating the cloud into an engineering workflow is changing all that.

"There is still a need for the prints, but the point of need has changed," says Andrew Vecci, director of business development at Canon Solutions America. "Instead of mailing prints to a site, people are receiving files digitally and need to print them. They're moving away from dedicated print operators, so we need to accommodate untrained walk-up users and build printers that are easy to operate."

Mobile Matters

Mobile computing has not only influenced printer manufacturers to provide cloud-based printing and apps that allow users to control printers and scanners on the go, it has also changed the way walk-up users interact with their products. Every major printer/scanner manufacturer has incorporated some type of touchscreen, because non-expert users can walk up to the printer and be guided through various functions by on-screen prompts.

For example, Canon's Océ PlotWave 340 and Océ PlotWave 360 printing systems' 10.4-in. multi-touch screen also provides a means to present a print preview, which Vecci notes is handy when you have multiple users sending jobs to the printer. It can also be used to navigate through an inbox of prints a user sent to the printer and scroll through thumbnails to choose a print job.

The HP Designjet T920 and T1500 ePrinters include HP Designjet ePrint and Share, a free Web service that allows users to save copies of projects to the cloud when printing. Users also can email projects to print by attaching a PDF or other print-ready file to an ePrinter's dedicated address.

"I keep hearing about our customers using tablets and going fully digital," says Monino. "But when we talk to customers, we discover some can do their work digitally, but there's so much pan and zoom it's not efficient. They want the ability to collaborate on paper, and then bring that design back into digital world."

Proper Paper Handling

Today's large-format printers are small enough to be pushed against a wall to save space in any office. They are also designed to avoid downtime by making paper handling and refills more efficient.

The HP Designjet T920 and T1500 ePrinters have an integrated output stacking tray that is built in on top of the device to deliver flat, collated prints. Built for against-the-wall operation, the front-roll loading feature allows users to load media easily, even while seated, according to the company.

HP has introduced two web-connected printers, the Designjet T920 and T1500 ePrinter series, which feature a new ergonomic design.

Canon's new Océ PlotWave systems have an integrated top delivery tray that uses Oce's air delivery system to keep documents stacked and collated, according to the company.

Epson's SureColor T-Series uses a spindle rod that makes it easy to slide media rolls into the printer, says Tim Check, product manager of Epson America's Professional Imaging Group. The series also has a passive stacking system that uses a set of bars inside the print basket. "As it continues to print, the paper goes over the top of basket and folds over the bars," Check says. "A guide keeps the paper stacked atop each other."

All of these large-format printer manufacturers are trying to make it easier for small- and mid-sized businesses, or even engineering departments within large enterprises, to purchase, use and maintain their own large-format printer. While engineers continue to evolve into a digital workflow, the large-format printer's place in that workflow is not going away.

"Printing digital files at point of need is where it's moving," says Canon Solutions America's Honn. "It's the biggest segment of the market, and the one to which we continue to sell the largest number of devices." **DE**

Jamie J. Gooch *is managing editor of* DE. *Send e-mail about this article to DE-Editors@deskeng.com.*

INFO ➜ Canon Solutions America's Océ: OCEusa.com

➜ **Contex:** contex.com

➜ **Epson:** Epson.com

➜ **HP:** HP.com

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Océ ColorWave 900 Launching in U.S.

Canon U.S.A., Inc. is launching the Océ ColorWave 900 printer at the PRINT 13 show in Chicago this month. The company says it closes the gap between digital inkjet and traditional offset technology. It is designed to increase productivity, lower running costs and increase flexibility for variable data and short- to medium-run length print jobs.

"We see the Océ ColorWave 900 printer as a disruptive technology because of its ability to provide a cost-effective and efficient alternative for producing short-run jobs," said Junichi Yoshitake, senior vice president, Business Imaging Solutions Group, Canon U.S.A. in a press release. "Using this technology, shorter print runs can now be more economical by eliminating plate making and make-ready, while still maintaining the high image quality that our customers expect."

According to the company, the Océ ColorWave 900 printer has a print speed of more than 12,000-sq.-ft. per hour. It is capable of resolutions of 1,600 x 1,600 dpi, and has a maximum media width of 42 in.

Images courtesy of National Instruments.

NIWeek 2013 Recap

Annual graphical system design conference and exposition draws record attendance, sees introduction of new products.

BY ANTHONY J. LOCKWOOD

Last month nearly 4,000 engineers, scientists, educators, students, tech enthusiasts, and media members such as myself descended on the Austin Texas Convention Center for the 19th annual National Instruments Graphical System Design Conference. I have attended almost every NIWeek since the beginning and, as soon as I got there, this one felt big. Turns out I was right. NI says it was the largest NIWeek yet. It was a whirlwind three days, but here's a quick recap of some of what I saw.

As is its wont, NI announced several new products during the conference. Of particular interest to *DE* readers are the 2013 version of the LabVIEW system design software, the new NI cRIO-9068 software-designed controller for embedded control and monitoring, and a new 8-slot NI CompactDAQ Ethernet chassis designed for distributed or remote measurements in extreme environments. More on these in a minute.

NIWeek offered attendees more than 250 interactive technical sessions, case study presentations, industry-focused technical summits, and panel discussions for beginners and advanced developers. Major topic areas included automated test systems, data acquisition, embedded systems, and software development techniques. In addition to its variety of technical sessions, NIWeek attendees had the opportunity to see nearly 300 demonstrations on the main stage as well as throughout the exhibit hall over the course of the three days of public events.

The Fourth Industrial Revolution

Dr. James Truchard, president, CEO, and cofounder of National Instruments, delivered the opening keynote address for the conference. Dr. T, as they call him at NI, spoke of the evolution of instrumentation from vacuum tubes to software-enabled instrumentation platforms. He believes that we have moved into the Fourth Industrial Revolution, and at the hub of this revolution is what he calls cyber-physical systems.

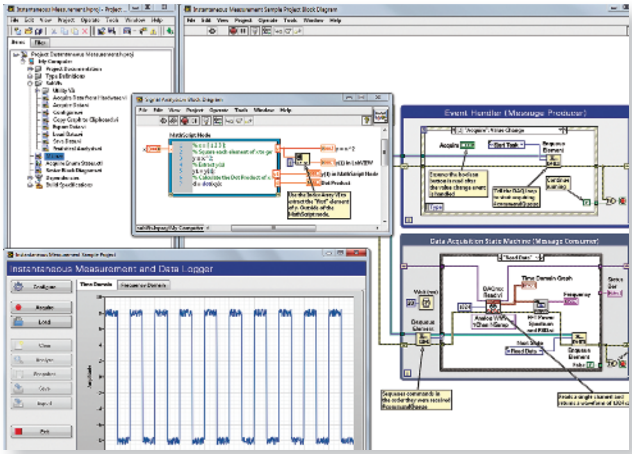
"Cyber-physical systems" refers to the convergence of the digital and physical worlds where everything is linked together, all around us, and operating, say, to keep what we perceive as our world up and running. As such, cyber-physical systems represent an emerging infrastructure in which computation, communications, and control function together and with varying degrees of decision-making autonomy. Smart grids instantly and automatically adjusting for sudden power interruptions or load imbalances would be example of a cyber-physical system.

NI sees its LabVIEW software as well positioned to provide the software development platform for the integrated networks of sensors, devices, and IT equipment that comprise a cyber-physical world.

"We're seeing the idea of ubiquitous computing and real-time systems becoming center stage to the next industrial revolution," said Truchard, who added that technology is also "seeing a transition take place to platform-based solutions built around software."

To that end, NI introduced its new cRIO-9068 software-designed controller for embedded control and monitoring. The cRIO-9068 represents a completely redesigned controller, albeit one that maintains full NI LabVIEW and I/O compatibility with NI's CompactRIO product line. The cRIO-9068 embodies this idea of platform-based solution: It's fully software programmable with LabVIEW to perform the functions an engineer assigns it.

The cRIO-9068 controller features a Xilinx Zynq-7020 All Programmable system on a chip (SoC), which combines a dual-core ARM Cortex-A9 processor and Xilinx 7 Series FPGA (field programmable gate array) fabric, on a single chip. The cRIO-9068 controller also heralds the arrival of an open platform with its comple-



NI says that, with LabVIEW 2013, it integrated the latest and most innovative technologies while reducing design complexity from basic measurements to full test platforms.

The NI cRIO-9068 software-designed controller offers improved hardware performance, programmability with LabVIEW, and full backward compatibility with NI LabVIEW and I/O compatibility with NI's CompactRIO product line.

Advertising Index

This robot being developed at the University of Texas-Arlington uses facial expressions to help diagnose autism in children.

mentary introduction of the NI Linux Real-Time operating system.

NI LabVIEW 2013, the newest version of the company's system design software for engineers and scientists who are building and using basic measurement systems on up to full test platforms, has been enhanced with native support for the newest hardware from vendors like ARM and Xilinx, which enables higher-performing systems. Version 2013 also offers some new, streamlined deployment technologies for developers who deliver applications to users.

One new feature that drew widespread audience approval during the LabVIEW 2013 rollout demonstrations was a suite of code management, documentation, and review tools. Also drawing enthusiastic crowd approval was the announcement of LabVIEW dashboards for remote monitoring and system control anywhere at any time through iOS and Android mobile platforms.

"LabVIEW 2013 exemplifies our commitment to ensuring that engineers and scientists are equipped with the latest technologies while simplifying the complexity of designing a system that uses these advancements," said Ray Almgren, vice president of marketing at National Instruments.

From Data Acquisition to Robotics

On the data acquisition front, the NI cDAQ-9188XT made its debut. This 8-slot NI CompactDAQ Ethernet chassis is designed for distributed or remote measurements in extreme environments such as those encountered in the automotive, military and aerospace industries. This device can survive temperatures from -40 to 70°C as well as 50g of shock and 5g of vibration. Additionally, the unit's chassis is the first in the NI CompactDAQ platform to offer an onboard watchdog with defined safe states to help protect tests and equipment.

Lots more went down at NI Week, including the unveiling of the NI roboRIO controller, which all teams will use for the 2015 season of the FIRST Robotics Competition, and the NI myRIO, an embedded hardware device to help students design real, complex engineering systems quickly and affordably. In the exhibit hall, there was a demo of a robot being worked on by researchers at the University of Texas-Arlington that uses facial expressions to help diagnose autism in children.

Finally, for the first time ever, NI live-streamed the morning keynotes to the NI community across the globe, so technically there were even more attendees at NI Week than reported. **DE**

Tony Lockwood, *is editor at large for* Desktop Engineering. *Contact him via de-editors@deskeng.com.*

INFO ➜ National Instruments: ni.com

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Commentary

by Paul Goossens

Slow Hand, On Demand

DE Managing Editor Jamie Gooch's editorial in the March issue, "Engineering Help Wanted," prompted me to share how many of the factors he describes have affected our own service business. To give this some context, Maplesoft has been developing tools for model-based design (MBD) and analysis for 25 years. But it has become increasingly apparent that the glory days of the 1980s and 1990s, when an engineering software company could pump out new products for consumption by a technology-starved market, are long over. Engineers are now drowning in "productivity tools." They are now much more interested in a complete solution than "better technology."

This has led us to provide a service offering as a complement to our tools — training, application development, through to development of turnkey solutions. It's a concept that has worked well for us over the last decade.

Many engineers struggle to find the "practice time" they need to be fully competent.

However, in the last year or so, we have seen an explosion in demand for our services, to the point where our technologies are almost secondary to delivering the solution. Clients have an engineering problem, they need to solve it quickly and they really don't care what technologies are used to do it. Many of the driving forces in Jamie's article have contributed to this increased demand; the fact this has happened over the last couple of years as the economy starts to recover from the "Great Recession" has certainly been a major factor. There is now a major skills shortage in our business area that is very difficult to reacquire.

But there are other factors at play to consider. Global competitive pressures are forcing many engineering companies to re-evaluate their own design practices to improve product reliability, speed up time-to-market and, of course, reduce costs. They are now learning lessons from industries that have managed to achieve this — in particular the aerospace and automotive industries — which have been the main adopters of many technologically driven design practices such as MBD. The ability to develop high-fidelity "virtual" prototypes to help identify and address design flaws has been a major accelerator within their design processes. Other industries are also beginning to incorporate MBD — and tools like ours — into their own processes. Of course, it's one thing to have the tools to do this, but it is another to have the skill set to implement them.

Advanced Tools Require Training

The good news for late adopters of any technology is that all the mistakes have been made, and most have been fixed. This is particularly true for MBD tools, where engineers can now access enormous mathematical power through intuitive, polished and robust user interfaces. However, even with advanced tools that ease the process, the development of engineering system models still requires highly skilled people to carry it out. Developing that skill set takes training, and concentrated, sustained effort on a wide range of applications.

To use a musical analogy: A guitar, no matter how expensive, is just a tool. It is relatively easy to learn some scales and chords to play it somewhat competently, but it takes years of intense practice to play anything like Eric "Slowhand" Clapton.

Because developing simulations of their designs is only part of what they do, many engineers struggle to find the "practice time" they need to be fully competent. Fortunately for them, companies like ours that offer such a specialized service are able to develop the virtuoso-level skills that can only come from constant activity in their chosen fields over a wide range of applications.

To touch on another of Jamie's points, paying for this level of skill for the duration of a project, and not when it isn't needed, is very attractive to many engineering managers. This is the main reason why clients are engaging us in increasing numbers. Of course, this introduces a whole new set of business issues in terms of defining projects, and bringing them to a successful conclusion. But success of a project, we have learned, is not just about satisfying the client: We have to aim for delight. This is as much about trust-building and managing expectations as developing the Statement of Work. (But that's a topic for another discussion!) DE

Paul Goossens *is vice president, applications engineering for Maplesoft. Send e-mail about this article to DE-Editors@deskeng.com.*

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