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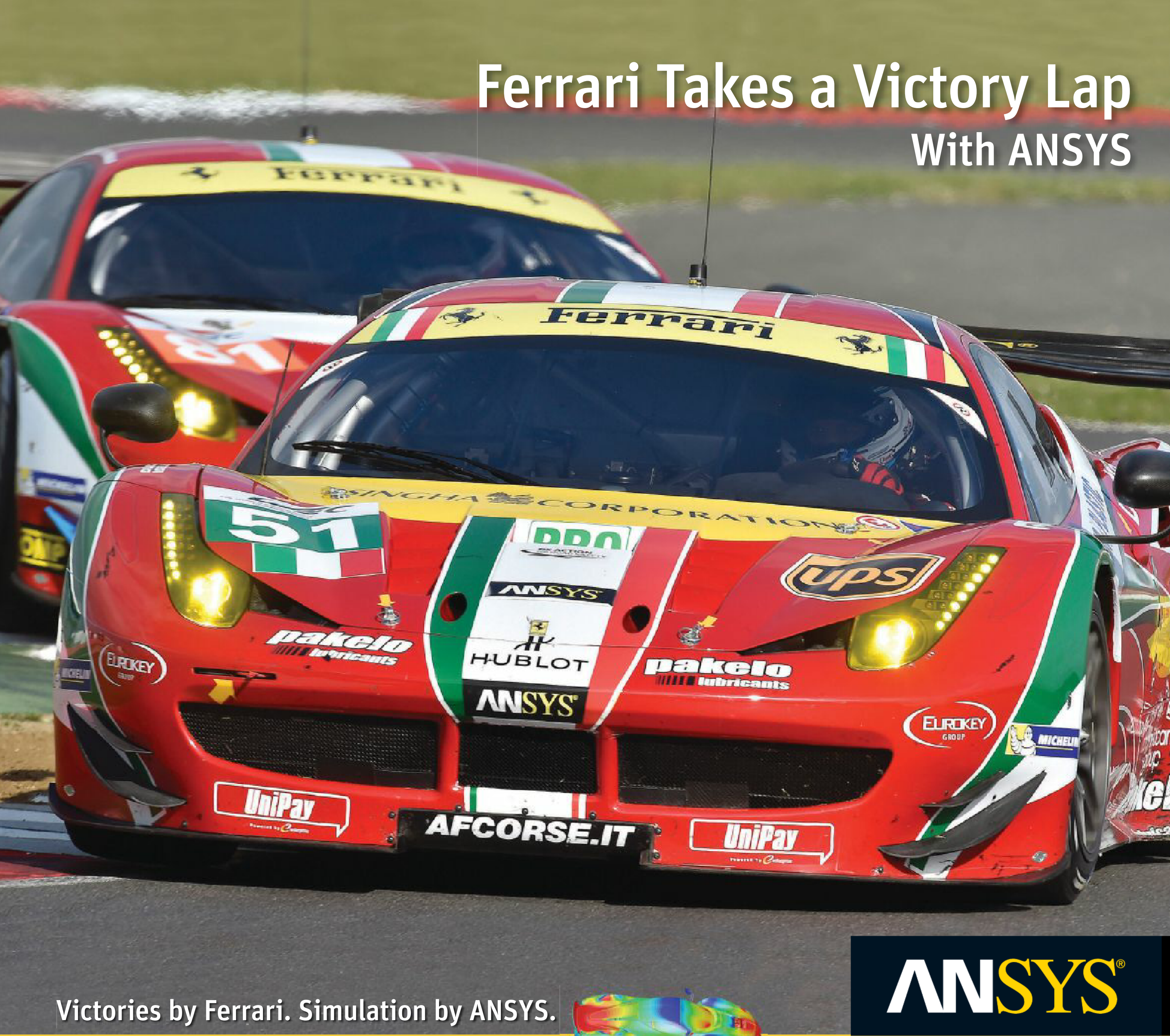
July 2015 / deskeng.com

Workstation Virtualization

Ferrari Takes a Victory Lap
With ANSYS



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by Jamie J. Gooch

The Difficulty with Simplicity

There's a rule often taught to journalists and others trying to clearly convey information: keep it simple, stupid (KISS). Perhaps it's a distant cousin of Occam's razor, a principle attributed to a 14th century logician and Franciscan friar. To paraphrase his philosophical method of reasoning: When faced with two equally valid, competing theories, the simpler one is better. The famous one-liner, sometimes attributed to Albert Einstein, takes it a step further: "Everything should be made as simple as possible, but not simpler."

There are many other witticisms on the importance of simplicity. It's easy to say things should be simple. Though making them simple, especially in engineering, is much more difficult.

Feeling Bloated

Product complexity is increased by many factors, from regulations to new materials to adding new features that will set a product apart or keep up with user demands. Increasingly,

The complexity of products seems poised to outpace our ability to manage them.

those demands are for "smart," connected products and systems that require embedded electronics and software. The move toward adding such technology to products exponentially increases product complexity. Let's ignore the added complexity in desiging and simulating connected electronics with their electromagnetic, thermal and signal integrity challenges and just look at how software adds complexity.

With software, a volume button doesn't just turn your phone down, it might also snap a picture; the power button might also ignore an incoming call. New functionality can even be added after the product is in users' hands. Without proper planning and oversight, it's easy to allow new software features to creep into a product and overcomplicate it. Those layers of complexity have far-reaching effects for an organization that has to track each new feature and function, then support and maintain them throughout a product's lifecycle.

Now consider that industry watchers peg the number of connected devices to reach anywhere from 25 to 75 billion by 2020 as the Internet of Things explodes into the mass market. If you don't have a system in place — both in terms of a business process and a software platform — it will become impossible to effectively manage product complexity in the very near future. Excel spreadsheets can only take you so far.

Prepare the Platforms

Many companies see the need and are hoping to fill it. "The clash of the old and the new — established enterprises with deep pockets hoping to park their R&D dollars in high-yield IoT projects, and start-ups and new tech talents challenging the status quo with their Kickstarter- and Indiegogo-funded campaigns — is one of the most fascinating dichotomies in the Internet of Things," writes Kenneth Wong in his coverage of the 2015 IoT World conference (see page 8).

Platforms and ecosystems are cropping up to help develop, deploy and manage connected products and the big data that goes with them. Some promise a seemless cradle-to-grave product development workflow, while others are building on existing business management systems. This creates its own layer of complexity as organizations try to find the right solution for their current and future needs. Unfortunately, many businesses haven't settled on or finished implementing a product lifecycle management solution, and some don't even have engineering document management. The complexity of products seems poised to outpace our ability to manage that complexity. But it doesn't have to.

The Simplicity Cycle

When implemented correctly, software allows complex tasks to be carried out behind the scenes and the user is neither baffled with too many options nor left wanting more advanced functionality. Making the complicated simple is absolutely critical to business because product complexity limits market potential. If a product is designed to be so easy to use that anyone can operate it, then you've automatically increased the pool of potential buyers. Take a look at Windows vs. DOS or PalmPilot vs. the iPhone. In each example, ease of use opened the flood gates to a much larger market of potential users.

Who will create the Windows or iPhone of product development platforms? The design engineering industry is ripe for the same type of transformation that technology-made-simple has brought to consumers. We talk a lot about what the "democratization" of simulation or ubiquitous access to high-performance computing would mean for product design. Just imagine what a "simple as possible, but not simpler" product development platform would do for enterprises and small businesses alike. DE

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

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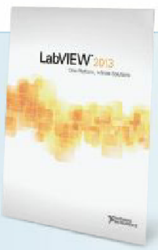

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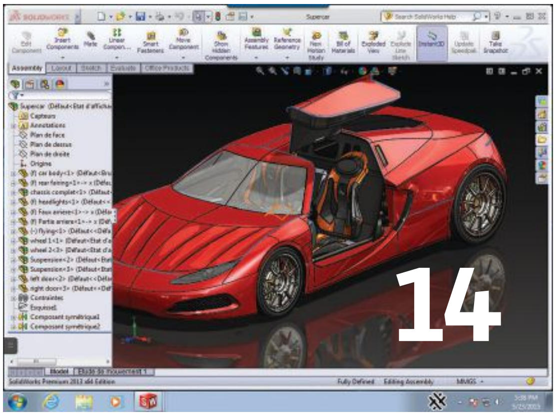

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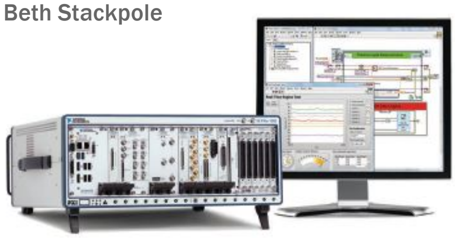
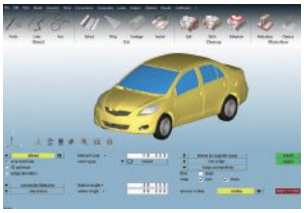
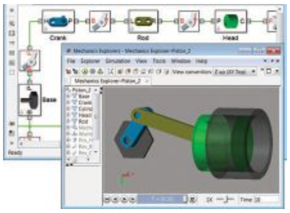


ON THE COVER: Access and use engineering software on your workstation from anywhere via virtualization technologies. *Images courtesy of Dell, BOXX Technologies and David Cohn.*

DESIGN





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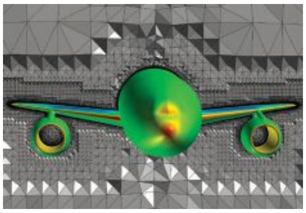

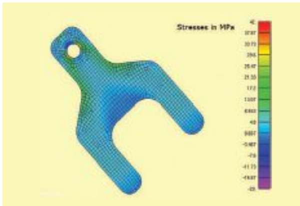

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***Desktop Engineering*®** (ISSN 1085-0422) is published monthly by Peerless Media, LLC, a division of EH Publishing, Inc. 111 Speen St., Ste. 200 Framingham, MA 01701. Periodicals postage paid at Framingham, MA and additional mailing offices. *Desktop Engineering*® is distributed free to qualified U.S. subscribers.

SUBSCRIPTION RATES: for non-qualified; U.S. $108 one year; Canada and Mexico $126 one year; all other countries $195 one year.

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BPA WORLDWIDE

by Kenneth Wong, Beth Stackpole & Jess Lulka

Siemens' Big Data Solution Drives Product Performance Intelligence

When Siemens snapped up Camstar last year to round out its product lifecycle management (PLM) business, Gartner noted the Omneo quality management platform is "the most valuable aspect" of the Camstar acquisition. It provides Siemens with the ability to drive a "feedback loop from customer usage aftermarket services into product and process design for end-to-end product quality management." Omneo, which launched in April 2014, was still in its infancy at the time of the Siemens acquisition and was actually run as a separate startup within Camstar.

"When we acquired Camstar, we saw Omneo as a foundational opportunity," said Bill Boswell, Siemens PLM Software's senior director of Cloud Services Marketing Business Strategy. While the rest of Camstar was brought under the manufacturing wing of Siemens business, Omneo was carved out and put under the new cloud services team to create an enterprise product.

Industry watcher Gartner described the Omneo quality management platform as "the most valuable aspect" of Siemens PLM Software's Camstar acquisition. One year after the acquisition, Siemens PLM Software launches Omneo Performance Analytics as a SaaS product.

Performance Analytics

That vision is starting to become a reality as Siemens launched its first application built on Omneo in May to address what it calls Performance Analytics. A Software as a Service (SaaS) offering, Omneo Performance Analytics (Omneo PA) is designed to monitor data across the entire supply chain and customer experience. It can analyze billions of data combinations in seconds (under 3 seconds, in fact, according to Siemens officials) to discover hidden intelligence that can help organizations proactively pinpoint the source of product issue, as opposed to finding them months, maybe even years after a product has been in use in the field.

The solution draws data from a variety of sources — for example, CRM (customer relationship management), ERP (enterprise resource management), PLM, field service platforms, manufacturing systems and Internet of Things (IoT) data — to create the basis for intelligence into product performance that was previously unattainable with traditional business intelligence solutions, Boswell says. Through its discovery capabilities, Omneo PA rapidly combines and analyzes all possible data sets, helping companies clearly identify and display the highest contributing factors to data anomalies and get answers to questions they previously had no capacity to ask, he explains.

"Today, companies are making decisions on a pretty short set of data because traditional business intelligence can't take advantage of all this big data," Boswell says. For example, an electronics manufacturer might be able to look at the design of a hard drive in the PLM system to drill down into performance issues, but that's a far more limited view than being able to see all the performance aspects of all the hard drives in the field among all of its customers. "This field quality data, combined with engineering data, helps them ask a different set of questions," Boswell says. "It lets them start looking at everything from identifying supplier quality issues leading to costly recalls to improving the customer experience by spotting trends and addressing them in future products," he says.

Along with the discovery capabilities, Omneo has a graphical monitoring capability that provides a complete view of product performance across the value chain while letting companies track current and emerging trends related to their products. The user-friendly dashboard workspace lets non-data scientists create custom data analytics definitions and key performance indicators (KPIs), which help deliver insights far more quickly than having to wait days or weeks for answers.

—B. Stackpole

Revamping Cloud for the Enterprise

For small and midsized businesses, the cloud's appeal is evident in its low-cost, low-maintenance proposition. But to entice the enterprises accustomed to working with its own in-house servers, the cloud may have to be repackaged with adequate security measures and new licensing models, along with the means to harness the hardware already onsite. Some vendors have already begun the process.

Rescale, which provides on-demand software-hardware combo platform for simulation, has launched a new product dubbed ScaleX Enterprise. "The reality is, companies that are interested in cloud computing will have to transition to it over two-three years. Some have already made the investment in clusters, have been using them for 10 years or so. The key here is, ScaleX lets them use their existing HPC hardware and the cloud. They can use the Rescale portal, a single unified platform, to manage both," says Joris Poort, founder and CEO of Rescale.

The portal in ScaleX Enterprise lets an IT person decide when to buy additional licenses or add a server, designate access to different users and groups and manage budgets. An enterprise with existing hardware can use ScaleX Enterprise's on-demand cloud resources in conjunction with on-premise high-performance computing (HPC) clusters.

Rescale introduces ScaleX Enterprise, designed to attract the IT crowd.

ANSYS on the Cloud

In the same week, ANSYS also began offering ANSYS Enterprise Cloud, the option to setup and run ANSYS on Amazon Web Services. "The new solution, running on Amazon Web Services (AWS), simplifies and accelerates the transition to cloud-based simulation by providing a reference architecture for end-to-end simulation that can be deployed within days — minimizing risk while boosting productivity. Customers who adopt the ANSYS Enterprise Cloud can scale their simulation capacity — including infrastructure and software assets — on demand," ANSYS writes.

To be clear, ANSYS Enterprise Cloud on AWS is not SaaS (Software as a Service). It's not the option to use ANSYS from a browser in a pay-as-you-go model. Rather, it's the option to run ANSYS in a "virtual private cloud," set up on public cloud provider AWS's infrastructure.

The new product offers "business agility" to customers with "projects that come and go," says Barbara Hutchings, director of Strategic Partnership at ANSYS. "Taking simulation to the cloud is not trivial. We have a highly engineered solution that we can deploy for our customer within a matter of days. So [users] now have a way to go to the cloud at low risk, rapidly. The solution has already been tested and is supported by us."

Hutchings explained that ANSYS is introducing what it calls "elastic licensing." It's ANSYS' initiative to "evolve its business model to mimic the cloud's elasticity," she added. ANSYS also has a partnership with Rescale, which lets businesses run ANSYS software on Rescale's on-demand HPC infrastructure. "The Enterprise Cloud is a perfect fit for customers who have an IT initiative to use the public cloud. Solutions from partners like Rescale are a good fit for customers who don't have an IT initiative, want to have access to HPC (high performance computing), and want to be largely hands off," says Hutchings.

—K. Wong

Imagining Next-Gen Engineers

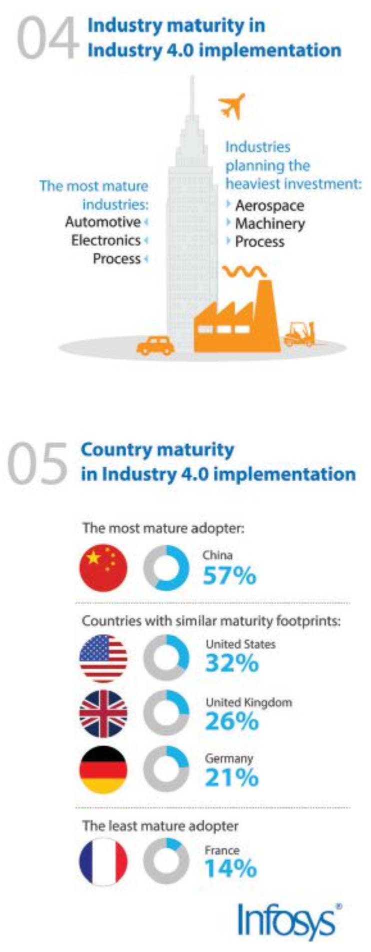
Think you could diffuse a bomb with putty, duct tape, nail clippers and some rope? Even if you couldn't, you might remember a TV character who could — Angus MacGyver. Every week, the engineer-turned-spy found himself in a similar situation, but managed to save everyone with random items around him.

The show is the inspiration for a contest aimed at getting women involved in STEM careers. "The Next MacGyver" provided an opportunity for contestants to write the pilot of a show starring a female engineer. Applications were due in May and the top 12 finalists will be announced soon. The top 5 winners will then be awarded $5,000 and be paired with industry and engineering mentors to polish and execute their individual ideas. The contest is being sponsored by several science and engineering organizations, including The National Academy of Engineering, The MacGyver Foundation and the USC Viterbi School of Engineering.

—J. Lulka

IoT World 2015: Big, Open Data

On the third floor of San Francisco's Moscone West conference center, charcoal and blue suits wondered the aisles of IoT World. One floor down, programmers and developers in beanies and skinny jeans flocked around the entrance of Apps World North America. Inevitably, the two crowds crossed paths in the corridors, coffee stands and nearby lunch spots. The clash of the old and the new — established enterprises with deep pockets hoping to park their R&D dollars in high-yield IoT projects, and start-ups and new tech talents challenging the status quo with their Kickstarter- and Indiegogo-funded campaigns — is one of the most fascinating dichotomies in the Internet of Things (IoT).



A snapshot of the state of IoT adoption, as depicted in an infographics by Infosys
Image courtesy of Infosys.

Keynotes Address Divides

The IoT keynotes and panel discussions took place on three different podiums: the Open Source Summit, Analytics Summit and Ecosystem Center Stage. Adam Benzion, cofounder of Hackster.io, issued a blunt warning with his talk titled "Open Source Hardware is Eating the World." It wasn't all gloom and doom; part of the talk was "Your Survival Guide." "Make it possible for others to engage with your device," he advised. In other words, leave room for others to "hack" into your product — a notion that would make many manufacturers uncomfortable.

One big name manufacturer that has welcomed the hacker community is GE. Its demo station at the show featured the ChillHub, a wired refrigerator complemented by smart apps. It's a product of GE's FirstBuild initiative, designed to foster collaboration between GE and the maker community. Through ChillHub's USB and Wi-Fi ports, tinkerers could access GE's GreenBean module, the brain of the appliance. The hardware runs on open source Ubuntu software. Early apps available for ChillHub include the Milkyway, an app that can remotely detect the volume of milk remaining.

Programming logic that harnesses Milkyway's accumulated data over time could lead to predictive and semi-autonomous operations. For example, if a household always replaces the milk carton when the volume gets down to 15%, ChillHub could be designed to place a milk delivery order from a grocer's online store when the app detects the level.

Security and Size Concerns

With connectivity comes also a security risk. Once connected, every appliance, tool or product is accessible through its own IP (internet protocol) address. IoT's tantalizing potentials are inseparably linked the cloud; so too are its vulnerabilities.

Peter Jensen, CEO of the data-analysis software provider ParStream, said, "There's too much data to analyze, so some users collect the real-time data, but don't get around to analyzing it." When Bosch's Director of Solution Sales Robert Magnetti delivered his talk, he highlighted the same problem. "I heard that 90% of the data gathered today isn't used," he said.

Citing IBM, a *ComputerWeekly* article stated, "90% of data currently generated by connected devices, including smartphones, tablets, connected cars and appliances, is not analyzed or acted on, and most of it begins to lose its value within seconds of being generated" ("IBM sets up $3bn IoT unit to integrate unused data," March 31, 2015). For example, the knowledge that the milk carton's content has reached the 15% threshold is useful only for a time. A week after the initial detection, the data is no longer fresh enough for consumption (neither is the milk).

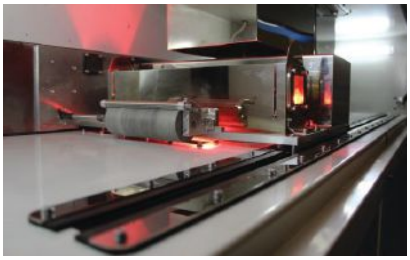
Bosch manufactures 2.5 million sensors a day, making it one of the largest sensor makers. "We have a data analysis division with roughly 200 people crunching data to get to the use cases that the customers want," Magnetti said.

IoT's emphasis on real-time data, connectivity, and timely reaction changes traditional definition of "products." The focus of product design now shifts from geometry to data. A connected product (like a self-driving car) is more than the vehicle itself. It's an experience augmented by automation, real-time data, services and apps.

—K. Wong

High Speed Sintering on Track for 2017 Release

The University of Sheffield has been working on a solution 3D printing's speed, and its name is high speed sintering (HSS). In development for over six years, HSS promises to bring speed and volume production to additive manufacturing, which can result in reduced expenses.



Currently, small parts can be built with HSS at the rate of 1 second per part, which would make the process a match for injection molding. Assuming the system can scale that pace for larger parts, it might be possible to produce the customary Yoda head, wrench or Eiffel Tower tests in minutes rather than hours.

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GE Ventures Invests $5.75M in MatterFab

MatterFab, an additive manufacturing startup, has gained industry attention for its work in developing a new metal 3D printer. GE Ventures has invested $5.75 million into MatterFab in hopes of producing an metal AM system that is faster, scalable and less expensive than those currently available on the market.

MatterFab's system uses third-party apps and development tools already used in the manufacturing sector, making it easier for new customers to adapt to building and designing AM parts. Use of existing tools also frees MatterFab to concentrate on building the best AM platform possible without having to worry about software design.

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Printing a Mars Rover

Undergrad engineering major Aavron Estep first suggested building a 3D-printed space shuttle as part of a class project. He petitioned the university for a budget (which he got) and also received help from professors in the aerospace and mechanical engineering departments. Eventually, the project evolved into 3D printing a remote-control vehicle for exploring Mars.

Estep now leads a 30-person team that is developing the rover and testing different types of materials.

"My goal is to determine if it would be a viable option to take printers to Mars and use them to manufacture parts for rovers that would be exposed to extremes in temperature and terrain," Estep said.

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DARPA Continues 3D Printing Research

Nearly every advance in technology is investigated for practical applications by the defense industry. Additive manufacturing offers to solve a number of supply chain management problems and already has a limited presence in the field. If NASA can print a wrench in space, the Army should be able to produce similar tools wherever they are needed.

Along with the ability to build bespoke parts in the field, DARPA is also interested in quantifying the resilience of 3D-printed parts. If a tool breaks every third time it's used, building that part with AM doesn't make sense. To study potential problems and solutions offered by AM, DARPA created the Open Manufacturing program.

To assist with research, the defense agency has set up two Manufacturing Demonstration Facilities (MDF); one at Penn State and the other at the Army Research Laboratory. The Penn State facility is focused mainly on AM, while the (MDF) at the Army Research Laboratory is investigating bonded composites.

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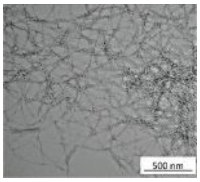
American Process Partners with ORNL

Much of additive manufacturing involves a tradeoff of some kind. Objects printed with plastic filament trade fine detail for affordability. Items printed with resin offer improved detail at the cost of durability. Choice of material, and thus which printing process is used, generally comes down to the end use of a printed object.

A new partnership between American Process and Oak Ridge National Laboratory (ORNL) offers the potential to bridge the gap between the fine detailing offered by resin and the durability of plastic. The partnership was formed to conduct research on a new material for use in AM called nanocellulose. The new material is expected to be strong, lightweight, inexpensive and environmentally friendly.

The partnership was established to create a new nanocellulose resin for use in AM systems. The new material has a large number of potential applications, including replacing carbon fiber parts in cars with stronger, lighter and less expensive parts.



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Change in the Air at 2015 Americas Altair Technology Conference

Engineers change the world, but they're not known for their love of change. That's the tightrope engineering software vendors face. Altair Chairman and CEO James Scapa walked that line as he took the stage at the Ford Motor Company Conference and Event Center in Dearborn, MI, a town that knows something about the need to change with the times.

"The right way to design is to start with a technology that really lets humans be creative, but allows all the simulation technology to play with optimization methods to really drive and evolve and synthesize the design," he said.

User experience is one of the trends driving the 30-year-old company, according to Scapa, who revealed Altair is developing a new user interface for all of its products. Products like solidThinking Inspire and HyperWorks Virtual Wind Tunnel were the first to roll out the new user interface. He also said the company is focused on design synthesis, electronics and communication simulation, visual analytics and machine learning, and simple solutions to leverage the cloud.

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Simulating Innovation and Experience

At this year's SIMULIA Community Conference (SCC), held in Berlin, Germany, the theme "Simulation Powers Innovation," presented itself from three different angles: Technology, Platform and Innovator.

"In the simulation world, we need to take simulation beyond just craftwork. We need to go from solve to innovate," said Bruce Engelmann, chief technology officer at SIMULIA.

To help engineers create products that innovate and enhance the consumer experience, Dassault is starting with its own platforms. CEO Bernard Charlès told attendees that the 2015x 3DEXPERIENCE Platform doesn't manage engineering data sets, but is structured into roles.

"The role-driven approach has this duty that we create the digital experience of using the capabilities as opposed to learning the capabilities," Charlès said.

His words echoed those of Scott Berkey, CEO of Dassault Systèmes' SIMULIA brand and newly appointed managing director of Dassault Systèmes' North American business during the COE Annual Experience and TechniFair keynote in Charleston, SC.

"Creating the best product will no longer win the marketplace today," said Berkey. "We need to create the best product, but then communicate it to our customers in the context of experience."

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RAPID 2015: An Industry Coming into Its Own

Now in its 25th year of SME (Society of Manufacturing Engineers) sponsorship, the 2015 RAPID event attracted a record-breaking 4,512 people (up 30% from 2014), with a balance of newcomers and seasoned attendees.

Keynote speech topics were cutting-edge, from the challenges of 3D printing in zero gravity described by Jason Dunn, CTO of Made in Space, to the painstaking work of bioprinting materials that support drug development as explained by Dr. William Warren, vice president of Sanofi Pasteur.

Well-known industry consultant Terry Wohlers of Wohlers Associates said industrial customers and manufacturers will continue to form the bulk of 3D printing adopters. His keynote speech, based on his 20th anniversary Annual Report on the state of the additive manufacturing (AM) industry, covered topics ranging from HP's entry into the AM world and the possibilities for hybrid manufacturing systems, to the need for more metal AM units and the benefits found with personally customized products.

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Siemens Dials in on Digitalization

At the 2015 Siemens PLM Connection Americas User Conference hosted by the PLM World user community, Siemens PLM Software President and CEO Chuck Grindstaff called out social, mobile and analytics as "mega trends" that are revolutionizing business and challenging manufacturing.

The results of these trends can be seen in the technologies grabbing headlines these days: deep learning, self-driving cars, custom manufacturing, the smart grid, the Internet of Things,

automation and robotics.

"The process of innovation is changing," Grindstaff said. "We need to have the tools and techniques and systems to support that change in a way that can help you be more competitive, go faster and meet customers' needs."

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by Anthony J. Lockwood

Editor's Picks

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.

Technical Printing System Has Cloud Connectivity

The Océ ColorWave is eco-friendly and automates the printing workflow.

The Océ ColorWave 500 printing system incorporates many communications technology conveniences. For example, it's cloud-ready, meaning you can submit a print job from your smartphone or tablet. You can print from and scan to a cloud application of your choice. The secure cloud connectivity is unlimited, and, admins take note, it supports WebDAV and third-party services like Amazon, Dropbox or Google Drive.

The Océ ColorWave 500 printing system has lots of automation. It automatically selects print modes, positions images and determines media.

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Cloud Simulation Gets Real

ANSYS 16.1 includes the ANSYS Enterprise Cloud, a turn-key solution.

ANSYS has released version 16.1 of its portfolio of engineering simulation applications. A key new addition is something called the ANSYS Enterprise Cloud. I know you've heard a lot about the cloud and may have even tried a few things out. ANSYS Enterprise Cloud appears to be a much different solution.

For one, it makes the entire ANSYS application suite available. Two, it's supported by Amazon Web Services, which should simplify and speed up your transition to cloud-based simulation. Three, it's designed to give you consistent, enterprise-specific simulation workflows and data.

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Siemens Releases Solid Edge ST8

The company has also launched the Solid Edge App Marketplace for add-ons.

The general themes for this release are increased design speed and helping improve your ability to leverage synchronous technology — that's the ST in ST8. What ST gives you is a combo of the speed and flexibility of direct modeling and the detailed control of dimension-driven design. The philosophy here is to get operating software out of your way so that you can focus on designing stuff.

Particularly cool is that Solid Edge ST8 fully supports tablets running Microsoft Windows 8.1. Beyond that, you can do real design sessions on the Microsoft Surface Pro 3.

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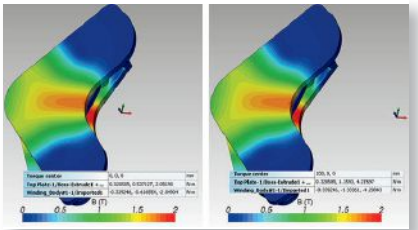

MagNet for SolidWorks Updated

The solver has a new interface and enhanced post-processing capabilities.

MagNet for SolidWorks handles non-linear analyses, second-order time stepping, core losses, proximity effects and eddy currents. You can execute simulations of AC or time harmonic electromagnetic fields as well as magnetostatic fields. It has a nifty feature that automatically determines current flows and sets up coils.

Infolytica says that model setup, visualization and transparency modeling as well as loading large data sets are all faster in the newest version of MagNet for SolidWorks.

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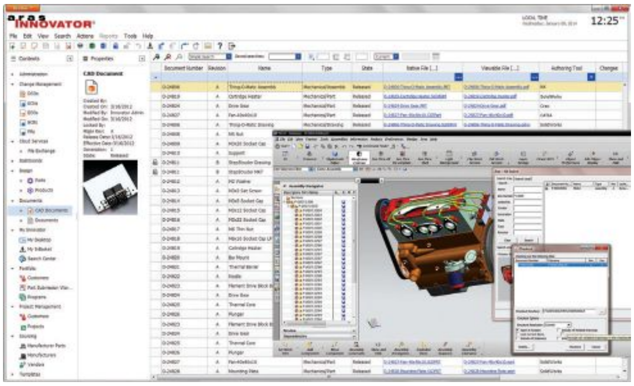
Future-Proof Your PLM

Is you product lifecycle management ready for skyrocketing product complexity?

The future is coming at design engineering teams fast. Increasingly complex, connected products must be designed, simulated, optimized, tested and deployed all within a short development cycle. Once deployed, many of those sensor-laden products will begin reporting back with all kinds of real-world use data that engineering teams can then analyze to further improve their designs.

The ability to continue to develop more innovative products in less time largely hinges on product lifecycle management. To support the fluidity of technology and business, PLM solutions need to be able to easily adapt to the shifting landscape without holding companies hostage or requiring them to start over from scratch.

Like enterprise resource planning (ERP) software and other major corporate systems, PLM can be one of the more costly and labor-intensive enterprise endeavors, in some cases taking years to deploy and costing millions of dollars. Organizations aren't likely to jump at the chance to replace a PLM system once it's up and running. More than likely, they will be tempted to make do with functionality limitations and stick with outdated business processes rather than go through the pain and expense of a full-scale migration to a next-generation PLM platform. In fact, according to a recent report by PLM industry analysts CIMdata, PLM systems are updated on average only every six years and, for a third, every 10 years.



Aras Innovator® 11 provides extensive CAD integrations for CATIA, SolidWorks, Inventor, Creo, AutoCAD, NX, Solid Edge, ECAD and more.

Product Complexity in Context

The number of connected cars is poised to multiply **more than sixfold** from 2013 to 2020, reaching an estimated **152 million vehicles**.

— *IHS Automotive*

Over **40 billion** active connected devices are forecast by **2020**.

— *ABI Research*

Forewarned is Forearmed

A resilient PLM platform is the best way to avoid this scenario and future-proof your investment, creating a solid foundation that can evolve with the times. A resilient PLM solution provides the best chance of accommodating a 20-year-plus corporate time horizon where market conditions constantly change, product complexity continues to skyrocket and global competition further intensifies.

A resilient PLM solution never boxes a company out of the latest technologies, empowering organizations to readily switch browsers, adopt new databases, or upgrade to the latest operating system when it makes sense and any time it's ready. Because resilient PLM isn't platform specific, it can easily accommodate whatever comes down the pike with minimal disruption and without requiring any kind of clairvoyance about what lies ahead for emerging technologies or future business requirements.

Aras Innovator is a PLM system architected from the ground up with resiliency in mind.

"You need to be sure that whatever PLM software you choose today will work when you have more users and greater workloads," notes Peter Schroer, Aras president. "You need to make sure you don't get stuck because your PLM platform won't grow as big as you need it to."

For more information, download the free paper, Making the Case for Resilient PLM *at deskeng.com/de/CaseForPLM, produced by* Desktop Engineering *and sponsored by Aras.*

Ready for the Future?

Is your organization planning to do any of the following in the next 10 years? If so, your PLM system might hit a wall if it lacks resilience.

- Add or modify hardware to support end-user growth?
- Change or modify vault file storage?
- Add more sites to the network?
- Add new functionality, departments, and workflows to an existing PLM system?
- Go through an acquisition or merger?
- Change or add an ERP system, CAD program, or another major tool set?

The Increasing Complexity of the Product Design Universe

As the physical and digital worlds increasingly overlap, thanks in part to the billions of connected products making up the Internet of Things, resilient product lifecycle management is critical.

Access Your Workstation from *Anywhere*

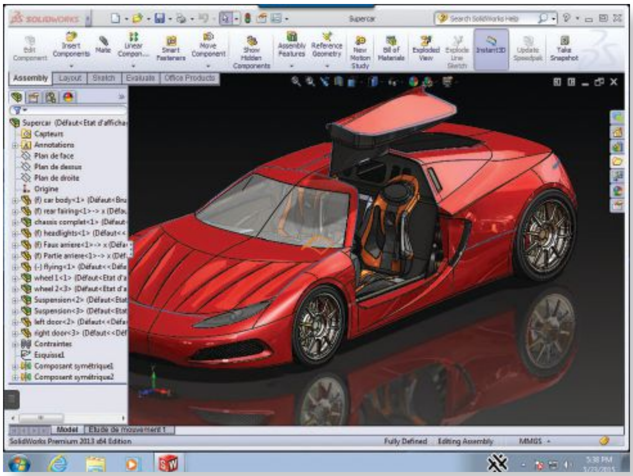
We put Teradici's PCoIP Workstation Access Software through its paces.

BY DAVID COHN

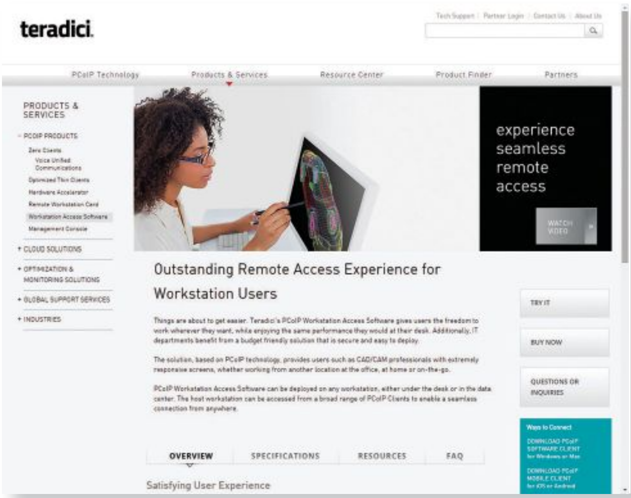
You've left your office to go to a client site. When you arrive, you realize you need to refer to some CAD files on the workstation back at your office. No problem. You pull out your iPad, establish a network connection, open an app and within seconds you're running your CAD software — or literally any other program — on your office workstation from your iPad. You get the data you need from the drawing, maybe even add some notes and look at some other information in a Word document or Excel spreadsheet. The programs and data remain back at the office — but you see it all and control it all from your tablet, out in the field. That's just one of the promises of PC-over-IP, or, PCoIP.

PCoIP is one of several display protocols available to connect a remote user to their workstation, a technology called desktop virtualization. Others include Microsoft's Remote Desktop Protocol (RDP), the Independent Computing Architecture (ICA) developed by Citrix and HP's Remote Graphics Software. Similar to Voice-over-IP (VoIP), PCoIP delivers full audio as well as USB connectivity and the full user display. PCoIP offers several advantages over the other protocols. Because it leverages the very fast UDP protocol, it does not suffer from the long refresh rates that can cause RDP to time out. It is also easy to implement because it requires simple host and client software rather than a Citrix server and UNIX-based ICA client. In addition, when networks get congested, PCoIP encoders can adjust to provide the best image quality with the available bandwidth; when network traffic returns to normal, PCoIP returns to maximum image quality. As a result, PCoIP has become the most prevalent virtual desktop protocol and is poised to find a home in many small- and medium-sized businesses (SMBs).

Developed by Canada-based Teradici, PCoIP is a display protocol that allows the complete compression of a desktop, which is then displayed on a client over a standard IP network. PCoIP transmits pixels, not data. Founded in 2004, Teradici operated in stealth mode until 2007, when the company announced its first products: a blade server card and a small hockey puck shaped client utilizing a Teradici-designed chip that implemented its PCoIP protocol. In 2008, VMware an-



Running CAD software remotely on an iPad was simple. The icon in the lower-left lets you access the iOS virtual keyboard or disconnect from the remote workstation. ***Image courtesy of David Cohn.***



You can download a free trial of the Remote Access Software from the Teradici website. ***Image courtesy of Teradici.***

nounced it was licensing Teradici's PCoIP protocol. Teradici developed a software implementation of PCoIP, which VMware began shipping in 2009 as part of VMware View 4.0. Today, Teradici's products are sold almost exclusively through OEMs (original equipment manufacturers).

Seeing for Ourselves

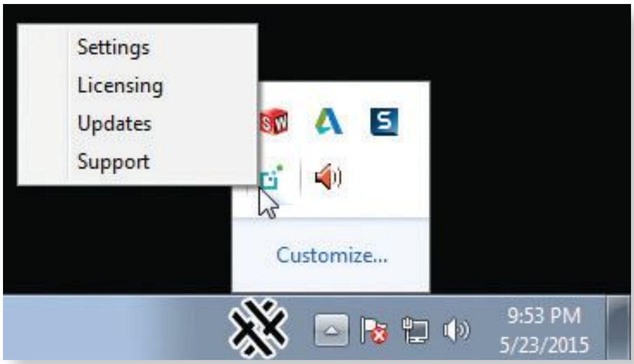
Although we had been aware of Teradici for several years, the company really grabbed our attention last summer at the SIGGRAPH 2014 conference in Vancouver, Canada. At that show, Teradici and Dell jointly announced the release of a software-only PCoIP solution that promised to deliver a rich remote computing experience — the freedom to work from anywhere — through an inexpensive, ultra-secure, easy-to-deploy solution (see "The Promise of Remote Instant Access," deskeng.com/de/?p=20307). The Dell announcement was followed several months later, adding BOXX Technologies as the second company offering its PCoIP workstation access software. Then, in late April, Teradici released version 2.0 of its Workstation Access Software as well as client apps for both iOS and Android devices. At that point, we knew that we had to try it out for ourselves.

Teradici's PCoIP Workstation Access Software consists of two components: a software host that runs on the workstation and a software client that runs on the remote system. BOXX and Dell each loaned us hardware for our tests. From Dell, we received a Precision Tower 5810 workstation, while BOXX sent us its APEXX 2 workstation. After setting up the systems and loading our CAD software, we went to the Teradici website and downloaded the PCoIP software.

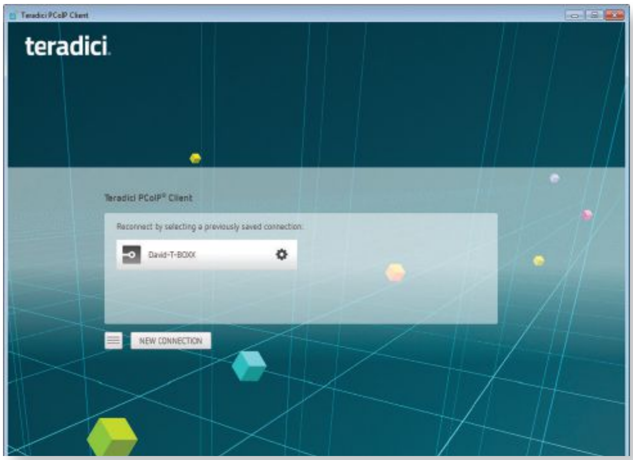
Anyone can download the Teradici software and try out PCoIP free for 30 days. The download consists of a 61MB ZIP file that includes both the host and client software along with user guides in PDF format. The company claims that its software is easy to deploy and we found this to be very true. It took less than five minutes to install both the host and client software.

The PCoIP access software runs in the background on the workstation as a Windows service. To install the software, you simply log on to the workstation as an administrator, launch the installation wizard and follow the on-screen instructions. In order to connect to the workstation for the first time, you need to know its IP address or fully-qualified domain name (FQDN), if applicable. The installation wizard automatically gathers this information and includes it in a readme file. Once installed, the PCoIP control panel icon is visible and can be accessed at any time from the Windows taskbar. You must enter a 16-digit activation code sent via email to unlock the free trial, which is good for up to 10 host workstations. After the trial period, you must purchase a full license and enter a new license key.

The PCoIP Software Client is free for Windows or Macintosh and installs like any other program. Once the host software is up and running on your workstation, you simply launch the client, enter the IP address (or FQDN) of the host, optionally assign a name by which you can more easily identify the con-



The Teradici host software runs as a Windows service on the workstation and can be accessed at any time from the Windows taskbar. *Image courtesy of David Cohn.*



We were able to quickly install the host and client software and access the workstation from a very basic laptop. *Image courtesy of David Cohn.*

We also tested the Teradici PCoIP solution using zero clients from both Teradici and Dell Wyse. *Image courtesy of David Cohn.*

nection, and click Next. Once contact has been made with the host workstation, you must enter a username and password to log onto the workstation, choose whether you want to connect using a window or full-screen display, and click Connect.

We installed the client software on a variety of notebook computers, including a BOXX GoBOXX G1980 mobile workstation and an ancient Dell laptop with just 2GB of memory. For our iPad, we accessed the Apple App Store and installed the free PCoIP Mobile Client application.

Working within our office — so that all of the systems were inside our local area network — the entire process was fast and worked flawlessly the very first time. We were able to quickly access and run any of the software installed on the host workstation. Seeing SolidWorks run on the inexpensive Dell laptop and the iPad was simply astounding. With the PCoIP software delivering up to 30 frames per second, we experienced almost no latency — a situation in which commands issued from the client are slow to reach the host or the image on the client cannot keep up with what is happening on the host. Transmission delays, router processing or any number of other factors can cause latency. Latency was almost unnoticeable when running our CAD software, it was only when playing back animations that we saw any smearing or experienced dropped frames.

Moving Beyond the Basics

With our initial tests complete, we turned our attention to some of the other components provided by BOXX and Dell. From Dell, we received a Wyse 5020 P25 DVI Zero Client. BOXX provided both a Teradici Tera2220 PCoIP Host Card and a Teradici Tera2321 DVI Zero Client. The host card can improve PCoIP performance by boosting transmission to up to 60 fps.

We installed the host card in an empty PCIe slot in the BOXX workstation and connected it directly to our router, since the Teradici host card gets its own IP address in addition to the workstation. We also had to connect a video port from the NVIDIA Quadro K5200 discrete GPU (graphics processing unit) in our workstation to the Teradici card using the cable provided. We skipped the optional PCoIP power button cable, which would enable a remote user to reset the host workstation if it were to become non-responsive.

Setting up the zero clients was even easier. Both the Wyse and Teradici hardware consists of a small box — about the size of a paperback book — weighing just over a pound. The front panel includes a power button, two USB ports and headphone and microphone jacks. The rear panel provides two video ports (a pair of DVI ports on the Teradici client vs. DVI and DisplayPort on the Wyse box), two more USB ports and an RJ45 network jack. We simply attached a mouse, keyboard and monitor, and connected the zero client to our network. As soon as it powered up, the zero client immediately identified the BOXX workstation host. A single click was all it took to connect to the workstation. You can use a zero client with either the software host or a host card.

One advantage to using a zero client over the client software running on a laptop is that you can plug a USB drive into one of the ports on the zero client and access that drive as if it were connected to the remote workstation. That capability does not currently exist when using the software client on a laptop.

Local vs. Remote Access

PCoIP offers numerous benefits, including remote access, security, application independence, local collaboration and high performance. PCoIP technology transmits pixels, not data, and even those pixels are encrypted. Because the software sends pixels from the workstation display, it works regardless of the applications being used and the types of content being generated. The software is optimized for NVIDIA K2000 GPUs or higher, but works with any discrete GPU and runs on the latest 3D APIs (application programming interfaces), including OpenGL and DirectX, enabling end users to remotely access even the most demanding 3D applications without sacrificing performance. And local workstation users can collaborate by sharing their screen with a remote user leveraging the same Windows OS account.

While we found it extremely easy to set up direct connections within our LAN (local area network), setting things up for remote access proved a bit more daunting. We first had to determine the external address of our cable modem and the IP address of the host workstation. We then had to reconfigure our router, creating a reservation to ensure that the host workstation would always be assigned the same IP address. Next, we had to forward several ports to make sure that remote clients would be able to connect to the host workstation residing within our LAN. We also had to create a registry key containing the IP address of our cable modem. Thankfully, we had the help of a Teradici technician who talked us through this multi-step process.

The Teradici Tera2220 PCoIP Host Card is a single slot PCIe card that improves the remote user experience by boosting performance up to 60 frames per second. ***Image courtesy of Teradici.***

Once we had made those changes, however, we were able to access the host workstation from wherever we could obtain a network connection — at a client's office, the local public library or the neighborhood coffee shop — by connecting to the IP address of the modem. Connecting remotely over a WAN was no different than connecting from within our LAN. We saw significant latency with animations, but software response was barely affected. On the iPad, we could pan and zoom using touch gestures and tap where we would normally click a mouse, and the addition of a Bluetooth keyboard really helped. On a laptop, the user experience was nearly identical to sitting at the actual workstation.

Products Tested

PCoIP Workstation Access Host Software (version 2.0)

- **Supported OS:** Windows 7 Ultimate 64-bit, Windows 7 Enterprise 64-bit, Windows 7 Professional 64-bit, Windows 8.1 Professional 64-bit, Windows 8.1 Enterprise 64-bit (also Windows 7 64-bit versions on VMware vSphere 5.5 or later with GPU)
- **Price:** $199 plus $40 one-year mandatory support and maintenance contract

PCoIP Software Client

Available for Windows, Mac, or Mobile Clients (iOS and Android)

- **Price:** Free

Teradici Tera2220 PCoIP Host Card

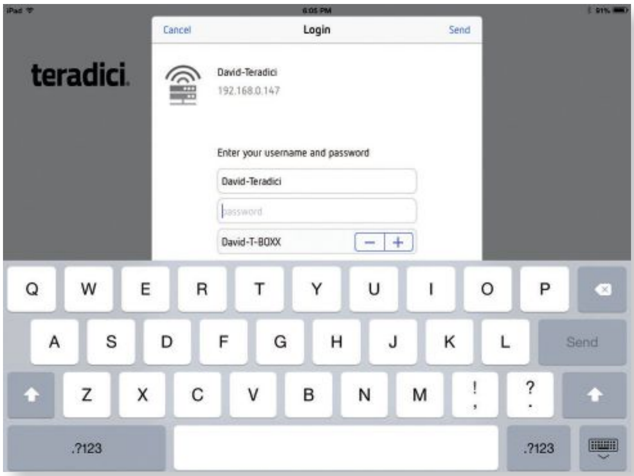
- **Specs:** 2.713 x 6.8 in.; requires single PCIe slot (x1, x4, x8 or x16); maximum resolution: two displays at 1920 x 1200 at 60Hz; frame rate: 60fps; includes 128MB memory; consumes 13 watts
- **Price:** $390

Teradici Tera2321 DVI Zero Client

- **Specs:** 7.21 x 5.22 x 1.76 in. (HxWxD); 1.5 lbs.; 512MB DDR3 RAM; supports two displays at up to 1920 x 1200 @ 60Hz or one display at up to 2560 x 1600 @ 60Hz; front panel: two USB 2.0 ports, headphone and microphone jacks, power button; rear panel: two DVI-D ports, two USB 2.0 ports, speaker jack, RJ45 network port, Kensington lock slot, 12 volt DC power jack and adapter; consumes 12 watts; supports full Wake-on-LAN and Wake-on-USB.
- **Price:** $364

Wyse 5020-P25 DVI Zero Client

- **Specs:** 1.14 x 6.97 x 4.57 in. (HxWxD); 1.2 lbs.; 512MB DDR3 RAM; supports two displays at up to 1920 x 1200 @ 60Hz or one display at up to 2560 x 1600 @ 60HZ; front panel: two USB 2.0 ports, headphone and microphone jacks, power button; rear panel: one DVI-D and one DisplayPort, two USB 2.0 ports, Kensington lock slot, 12 volt DC power jack and adapter; consumes 9 watts.
- **Price:** $364



Connecting to the workstation using the Teradici PCoIP client on the iPad. ***Image courtesy of David Cohn.***

Port forwarding in order to establish a remote connection is suitable for only the smallest companies, however, because it permits access to just a single host workstation. But it can be accomplished by anyone confident enough to configure a router and make minor changes to the Windows system registry. According to Teradici, most customers with multiple remote users accessing multiple host workstations use a virtual private network (VPN) so that the client software or zero client sees the host on the same network. Customers can also use the Leostream Connection Broker, a virtual appliance that manages and assigns hosted desktops and applications to end users.

With affordable pricing, Teradici's PCoIP solutions let you keep CAD workstations at the engineer's desk or consolidate them in a secure data center. Either way, they remain accessible from virtually anywhere. You can connect from another workstation, a laptop, a zero client or even a mobile device, with each providing the full desktop display environment and excellent performance. But while most users will be able to install and configure the host and client software for LAN access, you will likely need to enlist the aid of an IT professional to enable remote connections. **DE**

David Cohn *is the technical publishing manager at 4D Technologies. He also does consulting and technical writing from his home in Bellingham, WA and has been benchmarking PCs since 1984. He's a Contributing Editor to* Desktop Engineering *and the author of more than a dozen books. You can contact him via e-mail at david@dscohn.com or visit his website at dscohn.com.*

INFO → BOXX Technologies: BOXXTech.com
→ **Dell:** Dell.com
→ **Leostream:** Leostream.com
→ **Teradici:** Teradici.com

Dell Advances Virtual Workstation Adoption

Dell's Workstation Virtualization Center of Excellence showcases how virtualization can speed engineering tasks and reduce costs.

BY FRANK J. OHLHORST

Cutting the ribbon at the Dell Workstation Virtualization Center of Excellence in Round Rock, TX

When Dell first launched the Dell Workstation Virtualization Center of Excellence (CoE) last year, it was with the intention of exposing customers to the next generation of workstation computing. However, Dell's original CoE, which is located at the Dell Solutions Center in Round Rock, TX, spawned multiple ideas, case studies and new HPC (high-performance computing) ideologies, all of which showed the benefits of moving workstation chores into the virtual realm. What's more, the initial success of the Round Rock-based CoE led to the creation of additional CoE labs, with a second CoE launched in Limerick, Ireland. The Ireland location allows Dell to work more closely with ISVs (independent software vendors) and customers based in Europe to better demonstrate decentralized workstation load processing across multiple CoE labs.

Dell's CoE sites offer full support for remote customers to carry out performance benchmarking, conduct subjective user-assisted testing and choose the right endpoint devices and monitors before leaping into the world of virtualized workstation solutions.

"We are seeing a change in the way users of data and graphics intensive applications are able to securely access their data outside of the office. The idea of the fixed location-based workstation has changed as users need to be mobile and collaborate efficiently with others both within and outside of their organization," says Andy Rhodes, executive director, Dell Precision. "Furthermore the notion of a 1:1 relationship between a user and a piece of hardware is going away, as an increasing number of IT managers see desktop virtualization as a viable means of providing users with a secure, manageable and resource efficient way to access their desktops and applications."

Dell's CoE concepts have offered immediate benefits to customers delving into virtual workstation architectures. However, Dell has also gained insight from operating the CoE. For example, the CoE has been instrumental in helping Dell build reference architectures for the Dell Wyse Datacenter for Virtual Workstations. "Those reference architectures should save our customers countless hours of deployment time," says Gary Radburn, head of Workstation Virtualization at Dell.

"The CoE has proven to be a major success and on numerous occasions has allowed our customers to experience a virtual workstation environment, without any upfront expense. Customers have also been able to work with major ISVs to prototype software solutions, test scalability of workstation applications and develop proofs of concept before making any major purchases," Radburn says.

ISV usage of the CoE has proven to be an effective and instrumental capability. "This is the first time a major technology company has worked closely with the ISV community, on behalf of the customer, to bring validated solutions to market in the form of reference architectures that can be readily deployed and easily scaled to meet varied customer needs within virtual environments," says Radburn.

Dell has released, tested and certified configurations for workstation-class applications for Siemens PLM Software, as well as reference configurations for Autodesk, PTC and Dassault Systèmes. Organizations can deploy the reference architectures on Dell Precision R7610 rack workstations or Dell PowerEdge R720 rack servers with NVIDIA GRID K1 or K2 graphic cards on the VMware Horizon View and Citrix XenDesktop platforms.

ISVs Flock to the CoE

The CoE provides ISVs with a simplified way to compatibility test and certify existing applications for virtual workstation environments, and evolve their offerings to leverage the benefits of the new technology in this area.

"Dell's Center of Excellence for virtual desktops will be an invaluable resource for both Siemens PLM Software and our customers," said Paul Brown, senior marketing director, Siemens PLM Software. "We've completed certifications of our NX software on a variety of virtual configurations helping to provide our customers with deployment options to future proof their architecture. Our customers can duplicate and test their planned configuration to confirm the hardware and software environment meets their requirements."

Dell is also working with several other ISVs to develop reference architectures, including Autodesk, PTC and Dassault Systèmes, each of which are looking to move workstation-class applications into the world of virtual workstations.

"Design and engineer professionals are more mobile and distributed than ever before and they are working on projects with ever increasing complexity. These projects teams need the ability to access critical design data from anywhere and at any time," said Ben Cochran, senior architect for Platform Products, Autodesk. "Virtualization solutions give designers and engineers the flexibility, security and power to run sophisticated 3D design applications such as AutoCAD, Inventor, Revit or 3ds Max on virtually any device, or via a Web browser. We are excited that Dell is providing a virtualization solution targeted at our professional customers."

Behind the scenes at the Dell Workstation Virtualization CoE.

A Cloudy Future for Workstations?

Although workstation prices have fallen over the last few years making them ever more affordable, there are still major driving factors for engineering-type businesses to move to a virtual architecture. Those issues include mobility, efficiency and ultimately, total cost of ownership.

The innovations flowing out of Dell's CoE are helping to redefine the engineer/workstation relationship. One of those innovations comes by maximizing hardware usage. "We have developed reference systems that allow organizations to do design chores during regular business hours, and then basically flip a switch to run intensive simulations during the off hours, all on the same hardware," says Radburn. That capability is further fueled by the concept of cloud access to HPC systems, which are built upon virtualized workstation infrastructures.

What's more, Dell is designing dedicated server class hardware to drive workstation virtualization ahead — case in point is Dell's Precision Rack 7910 XL, a 2U rack mountable workstation that is optimized for ESX and Citrix environments. Options include AMD FirePro, NVIDIA Quadro, Grid and Tesla GPUs.

The ability to leverage reference architecture allows organizations to rapidly move over to a virtual workstation infrastructure, which democratizes access to workstation level performance. Other notable advances will come in the form of "workstations as a service," where MSPs (managed service providers) can build remotely accessible datacenters built on Dell's Wyse Datacenter for Virtual Workstations architecture. Those MSPs can then lease workstation access to customers, allowing them to scale up and down as needed, with little or no upfront expenses.

The Dell Wyse Datacenter for Virtual

Dell Launches Virtual Workstation Appliance

For those who want a quick virtualization solution they can deploy in-house, Dell has released the Dell Precision Appliance for Wyse, which it calls the industry's first ISV-certified virtual workstation appliance solution.

It uses the Dell Precision Rack R7910 workstation, NVIDIA Quadro and GRID GPU (graphical processor unit) technology, Teradici PCoIP remote workstation technology and VMware virtualization software to provide access for up to three users per appliance in dedicated GPU mode or four to eight users per appliance in shared GPU mode.

The solution offers certified configurations for workstation-class applications including those from Siemens PLM software. Other ISV partners include PTC, Autodesk and Dassault Systèmes.

According to the company, users can expect a similar experience using an ISV application with the virtual appliance as they would on a traditional workstation. Dell says the appliance can be deployed in five minutes once powered on, and can be managed without a dedicated IT staff, or by IT staff with limited virtualization experience.

Workstations architecture enables engineers and designers to run demanding workloads remotely, bringing geographic flexibility to those working beyond traditional office environments. What's more, remote access can be combined with BYOD (bring your own device) programs, which can result in improved workflows as well as significant time savings.

The CoE also exhibits recognizable benefits for those charged with managing IT resources, thanks to its centrally hosted and managed graphics environment. IT managers are able to more efficiently deploy high-end workloads and use IT resources more effectively while ensuring data integrity and efficient failover. Other benefits of cloud-accessible virtualized workstations include the ability to share a centralized data set, which should boost productivity and create secure collaboration opportunities with third parties. Simply put, the CoE demonstrates that Dell Wyse Datacenter for Virtual Workstations' architecture allows users from across the globe to remotely access the same data and applications on an as-needed basis.

Making the Virtual Leap

For those who doubt the viability of a virtualized workstation infrastructure, Dell simply points to the successes of VDI (Virtual Desktop Infrastructure), which serves as a viable example for moving compute resources into the cloud.

"Desktop Virtualization has long been gaining popularity in the enterprise as a means to securely deploy applications to users both in the office and working remotely," said Steve Lalla, general manager and vice president, Cloud Client Computing, Dell. "We are delighted to be working closely with our partners Citrix and VMware on extending virtualized desktops to those users requiring high performance solutions with the additional flexibility to use the tools of their job wherever and whenever they choose." **DE**

INFO ➜ **AMD:** AMD.com

➜ **Autodesk:** Autodesk.com

➜ **Citrix:** Citrix.com

➜ **Dassault Systèmes:** 3DS.com

➜ **Dell:** Dell.com

➜ **NVIDIA:** NVIDIA.com

➜ **PTC:** PTC.com

➜ **Siemens PLM Software:** plm.automation.siemens.com

➜ **VMware:** VMware.com

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

Frank Ohlhorst *is chief analyst and freelance writer at Ohlhorst.net. Send e-mail about this article to DE-Editors@deskeng.com.*

The Forgotten Art of Simplicity

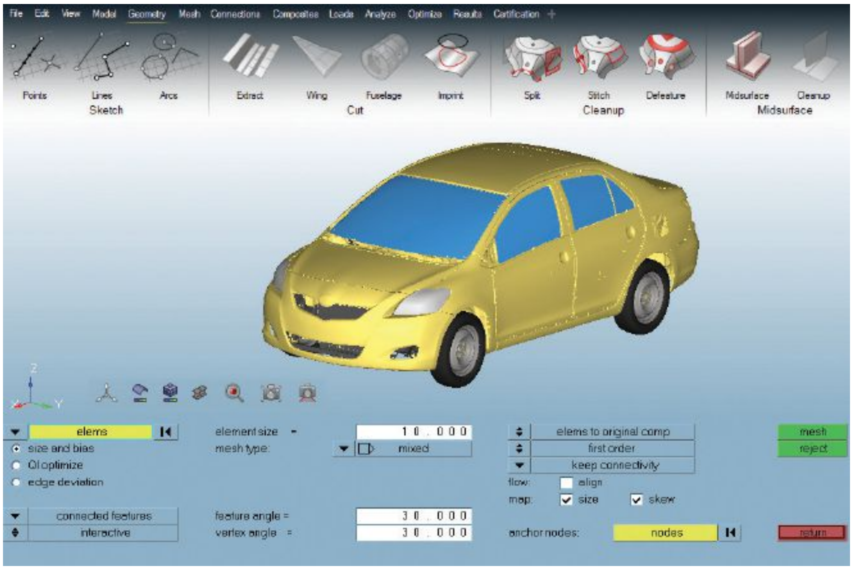
The iPad generation's mentality prompts design software interface overhauls.

BY KENNETH WONG

Blaise Pascal, a 17th century French philosopher and mathematician, wrote in a letter: "I have made this longer than usual because I have not had time to make it shorter." American literary giant Mark Twain is also credited with some variants of the same witticism. Commenting on the growing complexity in CAD and product lifecycle management (PLM) software, David McLaughlin, Siemens PLM Software's user experience (UX) lead for Active Workspace, inadvertently echoed Pascal and Twain. "It's really hard to make things simple; it's really easy to leave things complicated," he says.

Engineering software complexity was the prevailing tradition. It was accepted as a tolerable tradeoff for the richness in features, swelling up with each new release. Some users even learned to take pride in their mastery of complex programs, which ensured job security. But the rise of mobile devices and ubiquitous apps appear to challenge this practice. People's expectations of technology are now drastically different. They want devices to be intuitive and foolproof; they won't tolerate software that demands a high learning curve.

The new consumer mentality is putting pressure on the design software industry to reform. Some vendors have already initiated interface overhauls. In those projects, developers take on what seems like an impossible mission: to reinvent their products for the new generation without alienating their loyal user base.



In an upcoming release of HyperWorks, users can pull up the familiar commands hidden in a slider bar at the bottom of the screen or work entirely in the new interface, modeled after solidThinking Inspire. ***Image courtesy of Altair.***

Guided by the Compass

Philippe Laufer, CEO of Dassault Systèmes CATIA, explained the dilemma of CAD interface redesign. "We have some customers with thousands of CATIA users. Each of them spends thousands of hours on CATIA every year," he says. "That's millions of hours spent on CATIA every year. So if we change something in the software that affects productivity, these customers feel the pain."

Laufer regularly seeks input from a network of user advocates and champions, whose job it is to make the case for user-desired changes. At Dassault Systèmes, Laufer said UI (user interface) changes are governed by what the company calls "fundamentals:" mobile friendliness, natural controls, productivity and consistency across different brands.

When preparing for a new release of CATIA, Laufer estimates he and his team consider approximately 1,000 user requests, issues and topics. They usually implement about 500 new functions and artifacts in each new version. "Not all of those 500 are from the users," he says, "because we add our own to the list too."

UI design demands the gift of anticipation, the ability to spot what the users need before they request it. Case in point: The 3DEXPERIENCE Compass. It's now an integral part of Dassault Systèmes' brand aesthetics. It's also the anchor point for navigating the company's software suites. At first it was a novelty, a departure from the typical drop-down menus in CAD and PLM interfaces. "First people asked, what is it?" says Laufer. "Now that users have discovered its power, it has become the way they explore."

The compass divides distinct workflows — social collaboration, product data, simulation apps and modeling apps — into its north, east, south, and west buttons. The center, marked by an oversized arrow, signifies real-time visualization of design. These placements and groupings were not arbitrary. For example, there's a good reason the social apps are pegged to the most prominent northern tip in the Compass. "Designers are not social by nature, as we found out," says Laufer, "so now, with that Compass, they have easy access to their peers to discuss design challenges."

Sometimes Laufer's team has to find creative ways to accommodate users' habits as they modernize the interface. The current look and feel of CATIA is clean and de-cluttered, with the screen real estate reserved mostly for 3D model display.

"To do that, we had to minimize the number of icons that appear by default in the Action bar at the bottom," says Laufer. "Then we heard from one CATIA guru that when he's working, he has 148 icons [or shortcuts] in his Action bar. So we prototyped, tested and created a way for these users to use the iPad as the second screen to house their shortcuts and custom icons."

Starting from Scratch

In the first week of 2015, Jon Hirschtick, cofounder of SolidWorks, set out to explain why he and his colleagues felt the need to reinvent CAD with their Onshape startup. In a blog post titled "Why we started from scratch (again) in the CAD business," he listed the top two reasons:

1. The way that design and manufacturing teams work together has dramatically changed.

2. We are in the midst of the biggest change yet in computing platform technology, from the old world of desktop PCs to the new world of cloud, Web and mobile computing.

But starting from scratch doesn't mean Onshape can ignore the established practices. "We don't have to deal with the restrictions of legacy code. Still, there're lots of hard-baked ideas of how things should work," says Lou Gallo, member of Onshape's user experience (UX) design team.

Onshape retains the classic parametric modeling methods in 2D profile extrusion, cutting holes, blending edges and many other areas. But the software's cloud-hosted architecture gives them the ability to introduce auto-save. Users don't have to initiate the Save command; the software regularly saves the latest version, much in the same way Google Docs works.

"When users stop worrying about making mistakes that could be hard to fix, it frees them to focus on their design ideas instead," says Gallo. The same function might be possible in a desktop program; but, Gallo points out it is better suited for the cloud's infinite storage capacity and collaboration-friendly architecture.

Inside Onshape, users may invoke the Feedback command, which freezes the screen and presents a series of annotation tools (Comment, Highlight, Virtual Pen and Arrows, to name a few). The function can be used to create a screen capture of what users feel is a flaw or a bug in Onshape to send to the developers.

"Because the software is running from a browser, I can extract relevant information about their OS, browser version and graphics from the feedback they submit," says Gallo.

The Model is the Menu

Another developer making a break from the past is Altair, best known for its CAE software. Its flagship product, HyperWorks, is deeply rooted in the older Windows OS aesthetics, marked by menu bars and dialog boxes.

"[The desire for a UI change] has been mounting over the last few years," said James Dagg, Altair's CTO for Modeling and Visualization. "Older users know how to use the product. It's second nature to them. But among younger users, those who are coming out of college, the expectation is different. It was hard to train them on a UI that requires too much hidden knowledge."

In redesigning the HyperWorks UI, Altair is guided by the success of solidThinking Inspire, one of its products introduced in 2009. Targeted at the designers rather than simulation experts, the product lets users conduct topology optimization in a clean, guided user interface. The Inspire UI also benefitted from the involvement of graphics designers, whose demand for simple elegance nudges the product toward icons and context-sensitive popups instead of command lines and input fields.

Part of the intuitiveness comes from Inspire's use of 3D icons that offer clues to the operations they represent. Inspire icons are slightly larger than normal CAD software icons. The icon for Blend, for instance, lights up the rounded edges in the miniature model when you hover your mouse over it. Similarly, the Hole command lights up the holes visible in the icon. This approach gives users clear visual clues to the operations executable.

"In our usability labs, we don't give testers lots of directions or instructions. We just let them use the software, let them stumble and take notes," says Chris Peterson, director of UX at Altair.

Dagg and Peterson feel the responsibility to shepherd the previous users through the transition. The hand-holding takes the form of an unobtrusive slider. "You can pull that slider up from the bottom of your screen to get access to your old menu items," Dagg says. "First we were worried the slider might make the old users never migrate to the new one. But it's been surprising to see that even the old users, once they got over a small hump, are happy to go along with the new tools. I expect in two to three years, most of them won't be using the slider bar."

Altair plans to release the next HyperWorks as two executables: HyperWorks 14, which works only in the classic mode; HyperWorks 14X, which gives access to the old and the new UI.

The New Face of PLM

The new face of Siemens PLM Software's Teamcenter system is called Active Workspace, a browser-based, mobile-friendly client. Much of the inspiration for the look and feel comes from smartphones, revealed McLaughlin.

"Find a button on your phone that doesn't work," he says. "I bet you can't find one. They all have a function. That's the approach we're taking." Typically, CAD and PLM interfaces give you all the buttons you could want in the main screen. If certain commands and buttons are irrelevant to the task at hand, they may be grayed out. But that's not good enough for McLaughlin.

"We don't keep grayed out buttons; we remove them from the screen if they're not useful," he says. "That means, there are no dead clicks, and users can't make too many mistakes. We think you'd like to work in a world with seven buttons instead of 40 buttons."

In 2010, Siemens PLM Software unveiled what it described as HD PLM, the use of the 3D assembly model itself as the navigation interface for finding and displaying project and product data housed in Teamcenter.

"The traditional approach is to look at the tabulated data [part number, part owner, release status, cost, and so on], then ask the software to show you what the part looks like. We decided to flip it around. We use the product you're working on to communicate the other data associated with it. So, for example, you can see parts that are on-hold or parts with compliance issues highlighted in red," says McLaughlin.

Active Workspace runs on any modern computing device from a standard browser with HTML5 support. There is no special app to install or any special plug-ins required. The code is multi-touch enabled, so if you launch Active Workspace from a touch-supported device (iPad or Microsoft Surface Pro, for instance), you would be able to use fingertips to control and navigate.

Not One-Size-Fits-All

The developers undertaking UI redesign are recognizing the one-size-fits-all approach is no longer favored by users. In fact, it might have been one of the characteristics that drove the software toward its current complexity.

To accommodate power users who like access to a toolbar with hundreds of icons, Dassault Systèmes created a way to load custom icons on a mobile device. *Image courtesy of Dassault Systèmes.*

"You won't navigate inside a virtual building the same way you navigate through a mechanical assembly. The designer prefers crisp, clear, on-screen visualization even without ray tracing; the mechanical engineer cares more about software performance," says Dassault Systèmes' Laufer. Catering to different industry segments, Dassault Systèmes partners with Boeing, Toyota, Procter & Gamble and architecture firms to ensure it can offer different configurations of CATIA that fit the habit, taxonomy and workflow requirements in different industries.

There's also mounting pressure to support mobile platforms to harness the device's eccentricities and distinct characteristics. Onshape has recently released Onshape Mobile (iOS version is available; Android version is on the way), which goes beyond viewing and markup. It's designed to let you build and edit parts from scratch with fingertip input.

Siemens PLM Software recently announced that you can interact with its Solid Edge CAD software using the Microsoft Surface Pro 3 tablet's touchscreen, click-in Surface Type Cover, mouse or the Surface Pen. When using the Surface Pen, different UI options are available.

Dassault Systemes' Laufer is not ready to reveal the details about the R&D initiative his team is undertaking with Microsoft to put CATIA on a Surface Pro tablet, but he promises the changes will "disrupt the way people have been working."

"As an industry, we kept moving toward power [in our software], but lost sight of simplicity. We put in powerful features, just in case someone might need them. We forgot there are people who don't need all this power onscreen all of the time," says Siemens' McLaughlin.

Heavily populated toolbars, once considered a hallmark of professional enigneering software, are not seen as a virtue to the iPad generation. Design software UI's return to simplicity will likely accelerate as users show greater comfort and reliance on the cloud, mobile devices and gesture computing. DE

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INFO ➜ **Altair:** Altair.com

➜ **Dassault Systèmes:** 3DS.com

➜ **Onshape:** Onshape.com

➜ **Siemens PLM Software:** siemens.com/PLM

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The Importance of Being Photorealistic

Using the right software and hardware can enhance and expedite the product development process.

BY MARK CLARKSON

We know that digital prototyping is all the rage right now, paving the way to magically reduced development time and costs. But how good, exactly, do those digital prototypes really need to look?

You are probably aware that, if you've seen an automobile ad on TV in the past few years, there's a good chance that the car or truck was entirely computer generated. But that's marketing – displaying products to the buying public – and there's little question why photorealism is required there. You're not going to entice potential consumers to buy a $30 toaster – let alone a $30,000 Hublot watch – with anything less than beautiful imagery.

But how pretty do those images and animations really need to be for everyday design or engineering reviews? Isn't photorealism a bit of overkill?

Turns out, it really isn't.

Virtual Prototyping

It's no secret that advances in computer software and hardware are drastically reducing the time between the initial idea and the final product. As far back as 2013's International Supercomputing Conference, for example, Intel demonstrated a 52-node cluster, powering real-time predictive rendering of Audi automobiles via Autodesk software. While it was set up to wow visitors to Intel's booth, Audi design teams are increasingly using similar systems today for actual digital prototyping work.

"They're able to do in seconds what used to take them hours," says Wes Shimanek, marketing manager, Intel workstations. "They are able to re-shape the car, put in different fabrics, change the lighting – all interactively. Let's say [Audi has] 22 models. Each model would have required four physical prototypes, but now they're down to one or two. With each prototype costing upwards of a million dollars, you can quickly see that the technology isn't expensive when you compare it to what it's doing for you. There's a quick ROI (return on investment) on that."

Still, if you're going to employ virtual prototypes, they're going to have to look as good as the real thing.

The interior of a Beechcraft 350 Beechwood aircraft, rendered in 3DEXCITE DELTAGEN.

It's Really About Communications

You, yourself, may not need to see a photorealistic render of a part or set of simulation results in order to understand what's going on; shading will probably suffice.

"Engineers know what they're looking at," says Curtis Evey, manager of Creative Client Services at 3DEXCITE. "They can look at a spreadsheet and know that you need to increase the thickness of the steel in that one part." It's the people who need to be convinced of that engineering fact — upper management, for instance, or accounting — that require realistic imagery.

Photorealistic images are, at some level, about avoiding distractions, says Evey. The better you can communicate your message, the easier it is for others to make correct decisions based upon it. When things look wrong – even little things – they inevitably distract from the message you're trying to communicate. "If the ground shadow is too dark," Evey says, "then your eye gravitates toward that instead of the object in front of you. Or, if the glass doesn't read as transparent or reflective as you understand glass to be in the real world, then you're going to focus on that."

And if you're taking your virtual prototype to upper management to ask them to spend several million additional dollars on development, you can't afford any distractions.

The Common Denominator

"The base, common denominator is visual experience," says Mark Peters, director of Business Development USA for 3DEXCITE. "Photorealism is so massively powerful, because you can legitimately, efficiently lead anyone to a good decision based on it."

An actual offset front impact collision of a 2014 Acura MDX (left) side-by-side with the same simulated collision rendered in Real Impact.

"It's easy to imagine the benefits [...] where various internal constituencies' cross-functionally come together for a review," he says. "You have the accountants, the manufacturing engineers, the marketing team and the lawyers. All those people bring a different set of eyes and brains to that meeting, but now you're talking the common language of a visual, life-like experience. You've taken so many variables out. Perhaps the accountants and manufacturing engineering guys have been having an argument about the material thickness [of a part.] Now, you've just solved that argument."

Making an Impact on Communications

The benefits of photorealism are not limited to design reviews. Honda is using software called 3DEXCITE DELTAGEN Real Impact, to improve how they communicate crash test simulations. "Real Impact doesn't solve models," says Eric DeHoff, principal engineer/CAE technical leader, Vehicle Structures Research and Automotive Safety for Honda R&D Americas. "It's rendering software. You get the results out of the crash solver — in this case, LS-DYNA. We put those results into Real Impact software to make the end result look more real, to [serve as a] better communication tool to non-CAE experts."

Crash results from some simulation programs can be difficult for those outside the world of FEA to understand. "When you show it to a room full of [non-engineers], it tends to create more questions than it does answers," says DeHoff.

"By taking that result and rendering it photorealistically, I can now recognize the elements of the car that we're all familiar with, and it tends to take a lot of the misunderstanding out of the picture," he says.

Some Hardware Required

What hardware do you need to produce photorealistic images, scenes and animations? It's hard to say. Software manufacturers are increasingly attentive to the idea of scalability in their applications, creating them to run on a wide range of platforms, from iPads, to workstations, clusters and the cloud. Most software will run on most machines. Granted, you can't load a Boeing 777, complete with wiring harnesses, hydraulic lines and so forth, onto your workstation, but you won't have occasion to do so.

The CPU vs. GPU (graphics processing unit) debate continues to rage. Very generally speaking — as CPU manufacturers are quick to tell you — GPUs aren't architecturally as well suited to the tracing of rays as are CPUs, nor do they typically have access to as much RAM. GPU manufacturers are quick to disagree.

"If you program a renderer traditionally, in a serial fashion, like you did in the '90s, then this is correct," says Phil Miller, director of Advanced Rendering, NVIDIA. "But if you program your renderer to be as parallel as ray tracing actually is, then the GPU will deliver superior performance to the CPU."

GPU cards pack thousands of processors, and let you scale up by adding more GPU cards, rather than replacing the entire machine. You can build arbitrarily powerful clusters featuring either or both.

For the most part, it's about what hardware your preferred application best exploits, and how long you're willing to wait for results. "The computers run the same process," says 3DEXCITE's Evey, "whether they run it in a minute or they run it in an hour. The software gives you the platform for quality, and the hardware gives you the speed."

And the hardware cost of entry is so low that even the smallest shops can afford to adopt photorealist rendering technologies on some scale. Most CAD programs offer photorealistic rendering in some form, whether built in or through plug-in or external applications. Dedicated applications such as Keyshot and Bunkspeed can produce great eye candy in extraordinarily little time, even if your machine is a few years old.

"Even small shops can achieve photorealism prior to creating physical prototypes to help make decisions earlier and save money," says Evey, "the same way as the big auto manufacturers, aerospace and defense."

Faking Reality

"Photorealism is like the Holy Grail," says Evey. "Everyone's searching for it. If you have physically accurate math and materials, and you can accurately capture a physical environment then, in theory, the pieces should come together."

Turns out, faking reality inside a machine isn't quite that simple. And the standards keep shifting. What passed for photorealistic five years ago looks painfully fake today.

"You might look at a picture now and say: 'Wow! That's photorealistic,'" says Evey. "But in five years we're going to look at it and say: 'What were we thinking?'" **DE**

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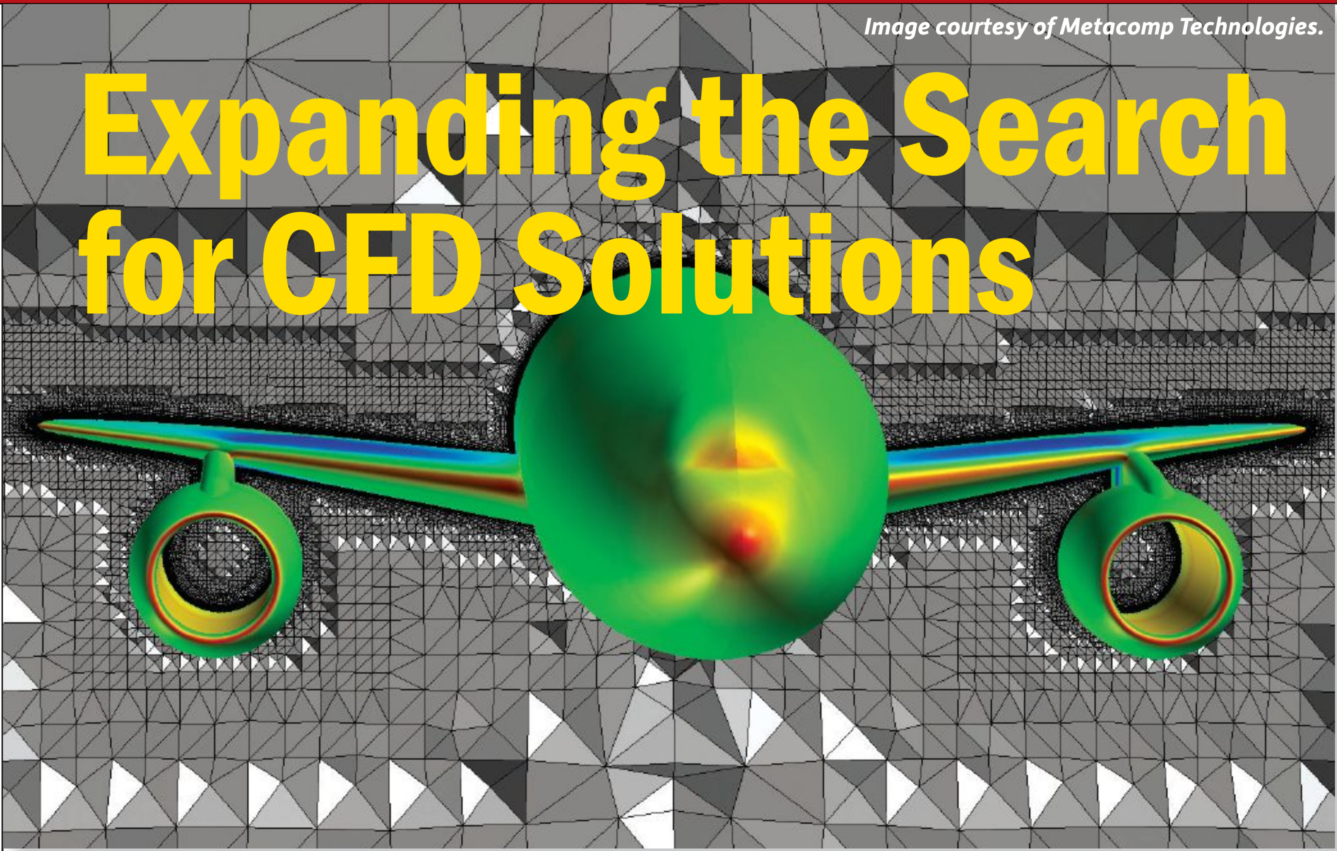


Expanding the Search for CFD Solutions

User-focused fluid simulation software comes in many shapes and sizes.

BY PAMELA J. WATERMAN

I'm sitting with some other engineers and we start talking about computational fluid dynamics (CFD) software (yeah, certified geeks). The question comes up, what's a good CFD package for regular non-Megabucks engineers to use? What if you just do one kind of task over and over? What if you want a general purpose package without major prep-time effort?

Mentor Graphics must have been listening in on this talk. The company has a white paper called "The Third Wave of CFD," authored by Ivo Weinhold and John Parry of Mentor Graphics Germany and U.K., respectively, that states: "The CFD software market is becoming more diverse ... but all have one thing in common: the industrial user, with his or her need for easy-to-use, task-oriented, automated, reliable, efficient and readily-available CFD software as an indispensable tool for digital prototyping, is the focus." The industrial user, it said, not the analyst.

Whether you need external flow capabilities but not internal, only design exhaust systems not sewer systems (or vice versa), or just want a general purpose CFD code without the demands of classic meshing, one of the numerous lesser known CFD packages could be just right for you. Many are purpose-built to do a few things well, while others take advantage of open-source software.

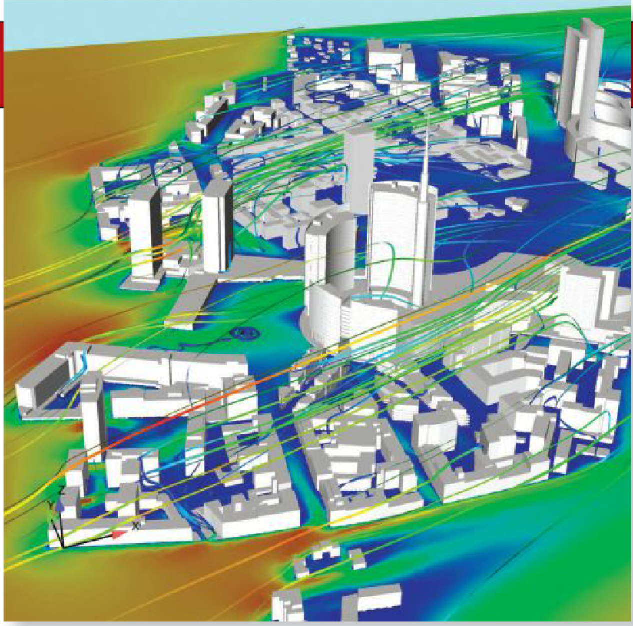
Best Kept Secrets?

Navier-Stokes, Euler, Boltzmann and other equations can be used to describe the behavior of fluid flow, but in the early days, solving those equations was limited by processing and memory resources. A handful of approaches worked, so people stuck with them. Today's parallel processors, expanded memory structures and improved graphics have allowed developers to revisit some of the older intractable solutions. Add in more pre-processing approaches and customized user-interface options, and you'll find a broad range of CFD analysis choices.

Convergent Science Inc. tackles the challenge of mesh generation head-on. Starting back in 1997, the company developed CONVERGE, a CFD code that uses Adaptive Mesh Refinement to completely eliminate the user time needed to generate a mesh, refine the mesh where it is needed (no need to judge where to increase density) or adapt to moving boundaries — all these steps are automatic. For user convenience, CONVERGE is available for desktop download or in the cloud on a pay-per-use basis, tackling everything from fuel-injection systems to turbines to vascular systems to sports applications. With special emphasis on multiphase liquid/gas analysis, liquid atomization and drop formation, CONVERGE handles large eddy simulation (LES) and Reynolds-Averaged Navier-Stokes (RANS) turbulence models as well as conjugate heat-transfer analysis of solids with fluids.

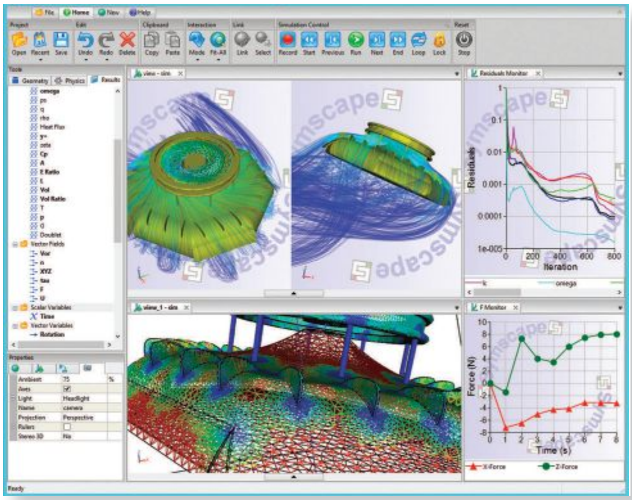
What if your CFD project involves system-level design rather than components? The Flownex Simulation Environment from Flownex (South Africa) distributed in the U.S. by Phoenix Analysis and Design Technologies Inc. (PADT Inc.) lets users examine extensive sets of parameter variations in systems and subsystems that depend greatly on fluid-thermal effects. Flownex lets users enter property values or choose from a library of reduced order models including low-speed turbines, valves, pipes, combustion chambers and electrical controls. Users drag and drop these component models into a system diagram, easily creating a network that is evaluated using the Implicit Pressure Correction Method.

"Flownex was the perfect solution for PADT to offer to clients who knew component but not system behavior. The software models thermal-fluid systems, solving for temperature, pressure and velocity (plus derived values)," says Eric Miller, co-owner and consultant for PADT Inc. Various Flownex modules handle two-phase fluids, gas mixtures, slurries, incondensable mixtures, transient behavior, optimization and more.



Airflow around city buildings in Milan, analyzed with Karalit CFD software. ***Image courtesy of Karalit.***

Hanley Innovations also took customer needs directly into account when it developed Stallion 3D and other CFD packages. "I had a strong desire for my customers to spend their time actually working on solutions for their projects rather than sacrificing precious time honing their CFD gridding skills," said Patrick Hanley, president of Hanley Innovations.



User interface example with CFD analysis results on a UAV, performed with Symscape Caedium CFD software. ***Image courtesy of Symscape.***

With Stallion 3D, users import a CAD model leaving all logos and other "nuts and bolts" details intact, saving time (the unique Hanley Innovations Surface Treatment (HIST) performs automatic grid generation) and supporting more accurate analyses. Users can download the software in the morning and get a complete analysis by lunchtime.

Stallion 3D solves the full 3D Euler or Navier-Stokes equations for aerodynamics and includes pre- and post-processing functions. Applications include aircraft wings, automotive spoilers and sailboat keels. Customers in niche fields such as UAV (unmanned aerial vehicles) design can also use the Hanley 2D MultiSurface and MultiElement packages to determine initial shapes. "An engineer can analyze up to 30 airflows simultaneously on a tablet or laptop," says Hanley.

KARALIT software from Italy may not be a familiar name in the U.S., but its roots in CFD go back more than 20 years. The company website offers extensive FAQs that are highly useful because the software operates in stark contrast to traditional methods. KARALIT CFD is based on a time-saving immersed boundary (IB) approach, where the imported CAD geometry is directly immersed into Cartesian grids. This eliminates the need to create a mesh and maintains cell integrity. Local grid refinement is done automatically. Analysis handles turbulence, porosity, heat transfer, rotating flows, all ranges of Reynolds numbers and more.

In a workflow that KARALIT calls Direct CFD, users set up simulations by entering parameters in simple templates called apps. Current automated apps include Wind Tunnel, External Flow, Building Flow and Internal Flow. KARALIT is offering a webinar on July 22 to show the benefits of its Direct CFD approach.

Metacomp Technologies, founded in 1994, offers three base versions of its CFD++ software: CP (compressible perfect gas), CR (compressible real gas) and IF (incompressible fluid and compressible liquids). Each package solves unsteady, steady, inviscid, laminar and turbulent flows, and works with CFD++ add-on modules that address moving mesh and rigid body dynamics. The platforms also support multi-phase including dispersed phase (Eulerian and Lagrangian treatment), mixture models and interface tracking, non-equilibrium chemistry and thermal non-equilibrium conditions. Tightly coupled rigid-body and fluid dynamics produce accurate transient responses for applications ranging from turbomachinery to launch-vehicle plume computations.

CFD++ software is mesh neutral and offers an easy-to-use interface for problem setup. Metacomp Technologies actively supports design engineers by creating application-specific front ends: "CFD++ already has wizards to help users work on different problem classes (e.g., external aerospace or automotive aerodynamics, reacting flows) and it is very easy to embed in customers' workflow," says Sukumar Chakravarthy, president at Metacomp Technologies.

Stepping aside from traditional CFD approaches is Next Limit Technologies of Spain with its meshless, XFlow CFD software. Since its first release in 2011, XFlow has used a particle-based kinetic algorithm to efficiently solve Boltzmann's non-equilibrium equations. The latter are known to more accurately account for highly turbulent (large eddy) fluid effects than RANS calculations, but prior to parallel processing were difficult to solve in a timely manner.

"To set up the simulations, the user needs only import watertight geometry and then specify simulation parameters. There is no time wasted actually meshing the volumetric fluid domain," says Zaki Abiza, XFlow application engineer, Next Limit Technologies.

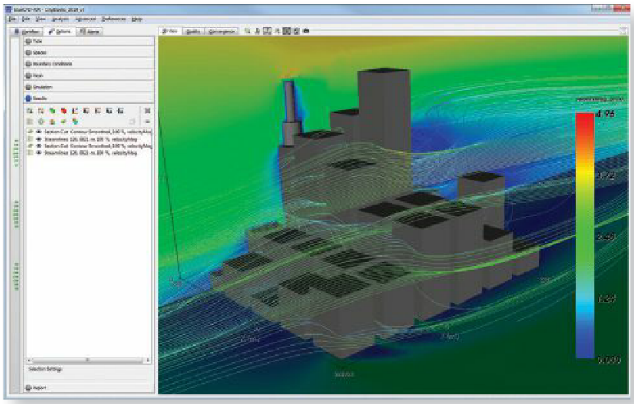
As a result, the complexity of the surface geometry is

One Time-Saving Snapshot

Automotive racing organizations are governed by rules as to how much they can spend on simulations, giving them a great incentive to finding software that works well and works fast.

"Generally, racecar engineers send their geometry to the solver piecemeal and wait while the answer crunches away on hundreds of cores," says Patrick Hanley of Hanley Innovations. "The HIST solver found in Hanley Innovations Stallion 3D eliminates the frustrations of meshing and the time-sink of lengthy analysis runs."

Recently, Hanley says an engineer for a top European racing team who spent months and millions of dollars on meshing and running a traditional high-end CFD package, used Stallion 3D software and achieved identical results for the entire car in a few hours on his laptop, using just two quad processors. – *PJW*



Post-processing of a six-by-six city-block example, for studying the airflow over, around and between buildings. Geometry analyzed and viewed with blueCAPE-AIR from blueCAPE; the software is based on a port of OpenFOAM technology. *Image courtesy of blueCAPE.*

not a limiting factor. XFlow includes setup, solution and post-processing for such applications as external/internal aerodynamics, free-surface analysis, multiphase analysis and real moving parts with up to six degrees of freedom (DOF). The package runs well on both distributed- and shared-memory parallel processing systems.

Open Source Approaches

What about using open source code? Commercial products based on the OpenFOAM (Open Field Operation and Manipulation) technology toolbox — developed by ESI Group and its OpenCFD subsidiary — offer the CFD solvers you expect plus intriguing extensions and user-friendly capabilities. Three options come from Symscape, blueCAPE and TotalSimUSA.

Caedium products from Symscape address the company's core mission of providing "computational fluid dynamics software for all." From the free interactive Caedium Viewer to add-ons such as Caedium RANS Flow, all aspects of analysis are performed within a single, unified simulation environment.

"This unified environment means that CAD, meshing, physics setup, solution running/steering, and post-processing are all in the same application and fully integrated. Each Caedium add-on seamlessly integrates into this simulation environment, so you only need to learn a few basic operations (drag and drop, tools, properties, etc.) and you are immediately productive," says Richard Smith, principal, Symscape.

Built around OpenFOAM technology, the Caedium RANS Flow product includes all the traditional features you'd expect, from various flow types (laminar, turbulent, steady, unsteady, incompressible, compressible and transonic) to multiphase behavior, rotating machinery, and porous media. This package and all other Caedium add-ons, including the Caedium Transient, Panel Flow, Builder (geometry) and Viz Export programs, is available as a 30-day free trial for Linux, Windows and Mac OS X systems.

Another engineering group, blueCAPE of Portugal, is proving that open source solutions can be your best fit for CFD analysis work. The company's blueCFD-Core product offers a high-quality build of OpenFOAM technology for convenient Windows 64-bit implementations. First released in 2009, this port offers a range of useful attributes, from three MPI (message-passing interface) toolboxes for multi-core/multi-machine operation to a "portable" function that allows copying the installed blueCFD-Core onto a USB drive for use on other Windows machines.

Application-specific versions are coming on the market, starting with the current blueCFD-AIR for flow around structures. Bruno Santos, blueCAPE senior R&D engineer, says this package simulates airflow both inside and outside of buildings and involves much more than just a custom GUI (graphical user interface). "Its primary goal," says Santos, "is to make it easier to apply CFD, without the need for a PhD. We're also developing blueCFD-Kernel, essentially middleware software that can aid software developers."

A third player in this field is TotalSim USA, whose aerodynamics experts have the tagline: "We live and breathe OpenFOAM." Although the company does work with some traditional CFD packages, it specializes in creating custom CFD solutions that allow OpenFOAM technology to be better used as a robust engineering tool.

"One interesting aspect of our business is the development of CFD Vertical Applications. These apps are typically tailored to replicate, in modeling and simulation, a specific testing task a company will use in their design cycle," says Raymond Leto, president, TotalSIM. In one app example, a CFD flow-predictor (accessed through a simple Web portal) helps truck designers readily evaluate the aerodynamic effect of vehicle add-ons.

Of course, CFD needs are a moving target. The more well-known CFD and multiphysics software packages provide more tools engineers can use to simulate more phenomena — with service and support that is hard for smaller vendors and the open-source community to match. What you're tasked with simulating today might not be what you need to simulate tomorrow, and more complete CFD suites provide an easy path to follow as users scale up their simulation efforts. Being able to do more types of simulation from a familiar environment can provide a huge advantage in time savings because you don't have to learn a new user interface each time. Having the ability to quickly run different CFD simulations can also help you uncover issues you might not have found otherwise.

Perhaps the Mentor Graphics white paper says it best: "The software will need to adapt to the working environment of the user, his needs and his individual intellectual capacity, and not vice versa." It's nice to see all the ways that is happening now. DE

NAFEMS Courses & Resources

If you only think FEA (finite element analysis) when you read about NAFEMS, you're missing half the story. This professional organization offers a wealth of CFD resources. (The NAFEMS CFD Working Group nafems.org/about/tech/cfd/ has been active since 1995.) A few months ago, I attended the "Practical CFD e-Learning Course" taught by Kamran Fouladi, and in three sessions came away with a terrific overview of points to consider when planning, creating and evaluating use of CFD analysis for a design project. This course is a great introduction for managers, engineers who have moderate experience with CFD, and engineers working on multidisciplinary projects in need of understanding the effects and importance of CFD as part of a larger design process. — *PJW*

Computational Fluid Dynamics for Structural Designers and Analysts e-Learning course July 22 and 29, 2015: nafems.org/events/nafems/2015/el132/

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Simplifying FEA Models: Plane Stress and Plane Strain

These 2D methods can provide an alternative to full-scale 3D models.

BY TONY ABBY

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

A previous *Destkop Engineering* article ("Simplify FEA Simulation Models Using Planar Symmetry," deskeng.com/de/?p=17575) explained that even with powerful modern computers, there is often a motivation to use simplifying techniques in structural finite element analysis (FEA). This follow-up describes how two closely related methods can be used to take 2D slices through a complex structure at regions of interest. The resulting FEA models can give valuable insight into local stresses more rapidly and efficiently than a full 3D model. They won't tell the whole story, but are valuable tools for the CAE engineer.

The two FEA methods are called plane stress and plane strain. Both use 2D planar elements that look like thin shell elements and are meshed using planar surface geometry.

Plane Stress Analysis

Fig. 1 shows the important facts about plane stress analysis. The structural region is assumed to lie in the 2D xy plane, with the third structural dimension relatively small. In the figure, this is the thickness in the z direction. Stresses exist in the 2D plane as sigma x, sigma y (direct stresses) and sigma xy (in-plane shear stress). Each of these stresses is constant through the thickness as shown in the inset. In addition there can be no stress in the z direction. This stress-strain material relationship is defined in 2D plane stress elements used in this type of analysis.

The lack of z stress is the way to remember the element type designation plane stress (i.e. only in-plane stresses allowed). There are also no through thickness shear stresses. We could load the plane stress model in Fig. 1 with a bi-axial load and calculate sigma x and sigma y. There is no sigma z. We can also calculate the corresponding in-plane strains e-x and e-y. If we apply a shear load, we can find shear stress sigma xy and shear strain e-xy. Interestingly, we can also calculate the through thickness strain e-z. This is not zero, as the model is free to thin down in z as it stretches in x and y. There is no out-of-plane constraint to prevent this. In some solvers we can recover the through thickness strain e-z and use it to calculate the change in thickness. (If the model is in bi-axial compression then the z section will get thicker). This is usually considered a secondary strain and may not be available for output — but it is there and can be calculated manually if needed.

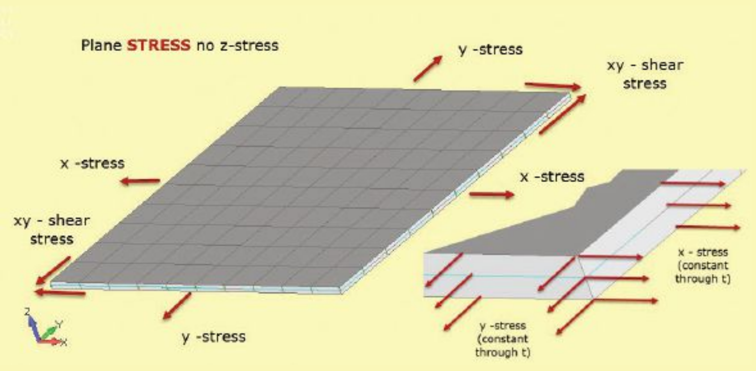

FIG 1: Plane stress; stress state assumptions.

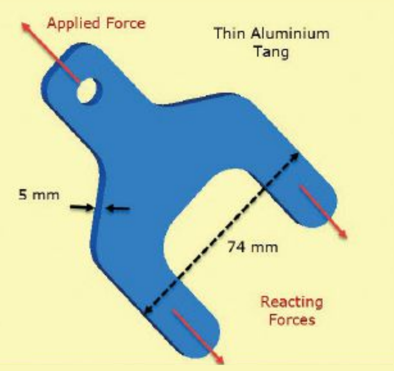

FIG 2: Thin-walled aluminum tang transferring load into composite structure.

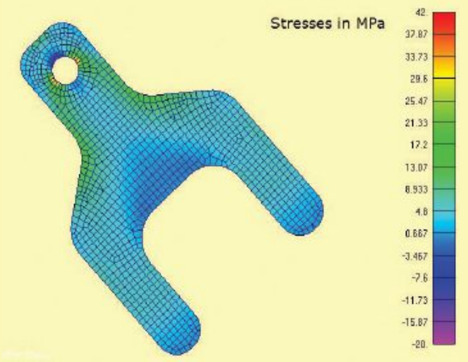

FIG 3: 2D Plane stress elements showing maximum principal stresses.

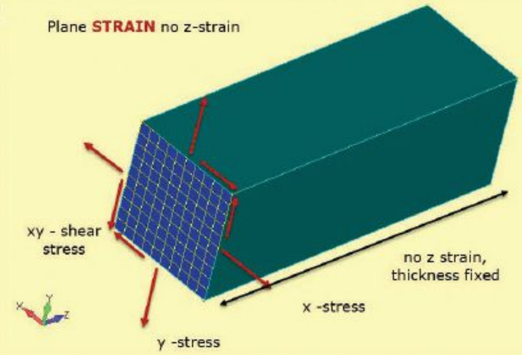

FIG 4: Plane strain analysis; stress and strain state assumptions.

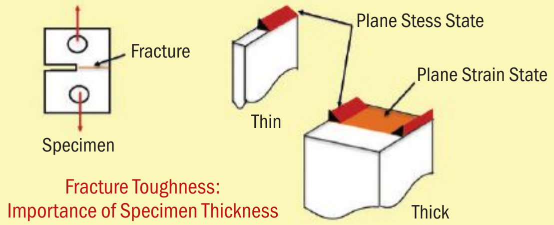

FIG 5: Fracture toughness specimens; thin and thick sections.

FIG 6: Deep-section aluminum tang.

Fig. 2 shows an aluminum lug component. The lug protrudes from a composite sheet layup which has plies positioned and bonded over the tangs (or legs) and lower body section. The tangs transfer the load applied to the lug into the composite structure. In practice, the plies would be stepped to allow a smooth shear transfer through the bond into the composite. The shear transfer into the composite is simulated here by diffused surface traction forces "pulling" on the tangs. These balance the applied lug load.

The key assumption here is that through thickness stresses are zero and the in-plane stresses are constant through thickness in the component. This means the local detail of the shear load transfer from composite to tang is poorly modeled. However the focus of this analysis is to check sizing of lug and tang cross section clear of the composite, using in-plane stresses.

The thickness of the component is small compared to other dimensions. This value is input as the actual thickness in the plane stress element definition.

Fig. 3 shows the FEA model and the calculated maximum principal stresses. The areas of interest are around the lug and the shoulder radii. In the real world the stress state at the stress concentrations would be 3D and through thickness sigma z stresses and shear stresses would balance locally. However, it is very reasonable here to assume the in-plane stresses dominate. This is the same assumption implicit in most traditional stress concentration (Kt) calculations found in handbooks.

One of the convenient features of the plane stress analysis is that it is a strictly 2D analysis, so only three degrees of freedom (DOF) have to be constrained (in-plane translations x, y and rotation about z axis). This lends itself to the 3-2-1 minimum constraint method with balanced load. In a 2D case this degenerates to a 2-1 method. One node has DOF x and y constrained, a second appropriate orthogonal node has DOF x constrained. This allows the reaction load in the tangs to be applied directly as diffused balancing loads. It would be difficult to simulate this boundary condition via constraints to ground.

The through thickness e-z strain and hence thinning of the tangs could be calculated as a secondary effect.

Plane Strain Analysis

Fig. 4 shows the essence of the plane strain method. Again, 2D planar elements are used, but with subtly different assumptions. The in-plane stresses x, y and xy are developed as before. However this time it is the out-of-plane, or through thickness z strain which is set to zero. So plane STRAIN analysis only allows strains in-plane. This works well to represent thick structures such as shown. The presence of this much material tends to stabilize the component and prevent it straining in z. This also means that constant through thickness z stresses are developed in the structure. This stress-strain material relationship is defined in 2D plane strain elements used in this type of analysis.

The figure shows the orientation of the 2D plane strain elements as a cut section through a typical deep component. The assumption is that the stress state at this cut section will be duplicated at any xy plane cut (z station) through the component. The component is assumed to be prismatic (having a constant cross section) down its length.

In practice we use this method where the stress state is varying slowly from plane to plane in a deep component. There should be enough material through depth to stabilize and eliminate the through thickness strain. This is the same principle used on fracture toughness specimens shown in Fig. 5. A failure under plane strain conditions is shown for the center section of the thick specimen. The failure at the free edges and the thin section is a different mode, more like a plane stress state. A plane strain FEA model would by definition be a good representation of the centerline thick specimen behavior, but not of the free edges or the thin specimen.

Fig. 6 shows another component used in a composite structure, forming a bonded joint. Here the section is constant and deep enough so that we can assume the stresses are also constant with depth. The free end surface faces (at +z, -z) will have a different local stress state (actually plane stress, as noted), however the objective of this analysis is to check the net section stresses on the centerline (z = 0).

The 2D plane strain analysis mesh is shown sectioned

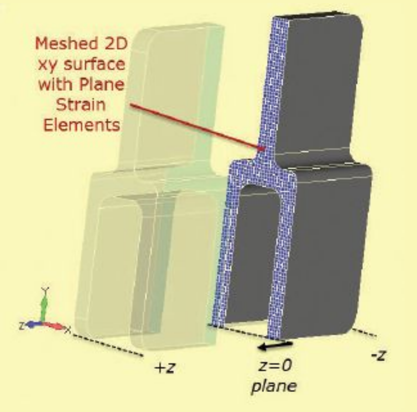

FIG 7: **Section cut through solid section to develop 2D plane strain section.**

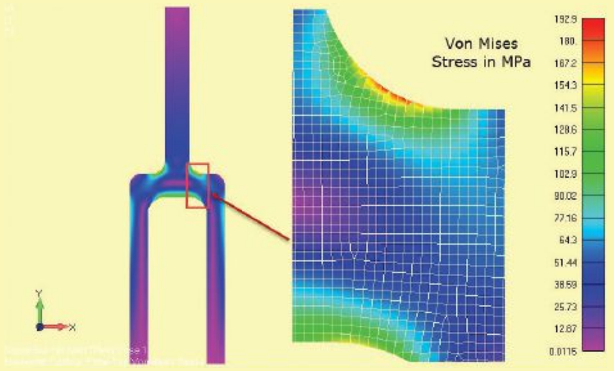

FIG 8: **Plane strain analysis results of a deep tang component.**

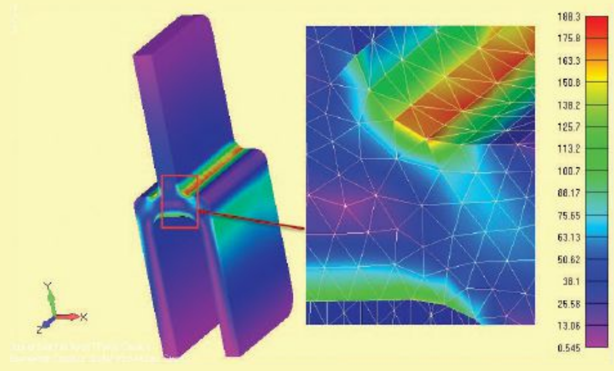

FIG 9: **Full 3D model of the deep tang, showing stress results**

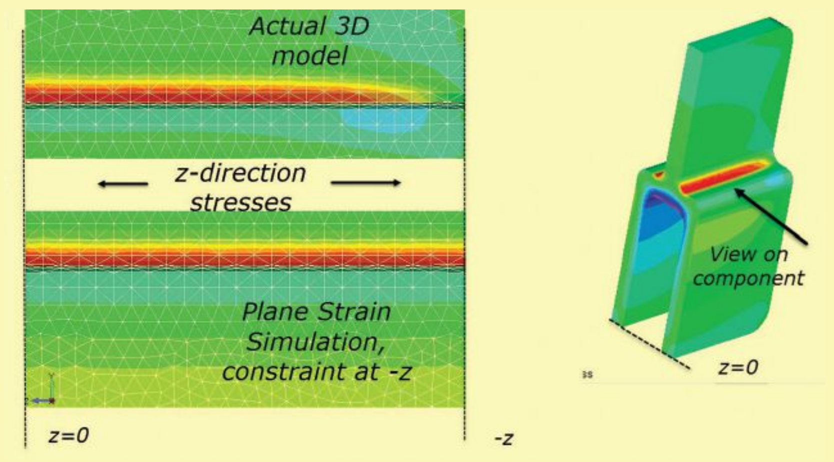

FIG 10: **Diffusion of z-stress toward the free surface.**

into the 3D component in Fig. 7. The section cut is defined at station z = 0.

A very fine 2D plane strain mesh can be used, which will run very quickly compared to a full 3D model. The 2-1 constraint method is used as before. The loading needs to be considered carefully. The "thickness" of the plane strain section is quite arbitrary, and is usually set at 1.0 by default. If the loading on the component is calculated as a running load through depth (N/m, Lbf/inch etc.) then this value can be used directly on the plane strain mesh. It is useful to pick a section, such as the single tang and estimate the nominal or average stress in this section for the full component. This can be used as a sanity check in the plane strain analysis. Incorrect loading is probably the main cause of error in this method.

The results of the analysis are shown in Fig. 8 and show clearly the regions of high stress around the shoulder fillet. The stresses are valid for the central depth region of the component (z = 0).

The stress quantities used will depend on the solver used. Some solvers ignore the z direction stresses as secondary and recover the in-plane stresses. The principal stresses and von Mises stresses then relate to a 2D in-plane stress state. If the z direction stress is recovered then it should be clearly identified, so that the 2D in-plane stress state in the x-y plane can be identified.

What exactly does the z direction stress represent? It is the stress developed due to the enforcement of zero z direction strain. The stress acts as if the free end faces of the prismatic section were fixed. At the central plane of a deep section component these will be the complementary stresses needed to hold the zero z direction strain state. In reality as we move toward the free surface faces, the z-stress drops to zero and becomes a plane stress distribution (as seen in the thick fracture mechanics specimen).

In many cases, such as a pressurized cylinder, the end faces are capped and will in fact develop an axial stress due to axial forces. This will be a different stress from the induced axial stress in the plane strain analysis. A hand calculation will be needed to calculate the axial stresses, or possible a supplementary axisymmetric model for pressure vessels.

The ease of geometry and mesh construction lends itself well to "what-if" studies or more formal shape optimization studies.

For comparison, a half symmetry full 3D analysis of the deep tang component was done and the results are shown in Fig. 9. The nominal stress across the upper single tang leg is identical in both cases — remember this is the basis of any sanity check.

The local shoulder stresses are lower by a small percentage in the full model. This is for three reasons. First, the relatively coarse 3D tet mesh is inferior to the very fine 2D plane strain local mesh. A convergence check on the 3D model has not been carried out.

Secondly, there is a small change in geometry at the free surfaces (+z, -z) compared to the z = 0 section due to the end fillets. In this case, the effect is negligible as the fillets are away from the shoulder regions. In many components, however, there will be local fillets, and run out details. which will vary the geometry from a simple xy planar face. Local stress variations at free end faces may have to estimated or checked with a full 3D model.

Finally, the plane strain assumption of a fixed z constraint at +z,-z sections is not true for a finite depth component. The z stress will diffuse to zero at the "real" free faces. This effect is shown in Fig. 9, which uses the 3D model as is and also as a simulation of the plane strain z stress.

Fast and Efficient

Plane stress and plane strain analyses are useful 2D methods that can often supplement full-scale 3D models. Not all features can be represented, but with some ingenuity, stresses in key areas can at least be estimated. The motivation for using the methods is to enable fast efficient analysis with easy 2D geometry and mesh construction. DE

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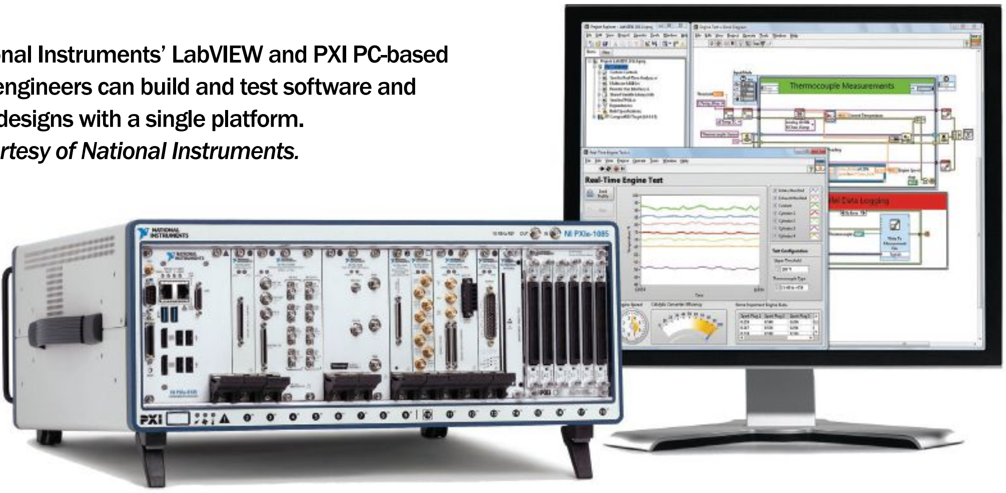
With National Instruments' LabVIEW and PXI PC-based platform, engineers can build and test software and hardware designs with a single platform. *Image courtesy of National Instruments.*



IoT Product Design Calls for Embedded System Savvy

Design engineers need to take a more holistic view of products to successfully partake in IoT design.

BY BETH STACKPOLE

As a design engineer, you know how to push CAD to its limits to translate a semi-formed concept into a refined design. Perhaps you're even the resident authority on thermal dynamics and the resource everyone taps to help steer complex simulations and optimizations.

Yet in this age of Internet of Things (IoT) enabled products, there's a new discipline has come your way: embedded system design — now front and center in nearly every kind of product. While it's not essential to become a master embedded system developer, experts say mainstream engineers are going to require a general understanding of software design, and most importantly, move their attention beyond traditional mechanical or electrical silos to take a more holistic view of product design.

"The challenge today is the disconnection between the different disciplines," says Allen Watson, product marketing manager for Design Ware ARC Tools, OS and Ecosystem at Synopsys. "In the past, you'd have the guys doing hardware design completely separate from the software folks and there might be almost no communications between the two. Today's embedded systems are so complex, you just can't do that. You need all the different disciplines being together from the start when requirements are set."

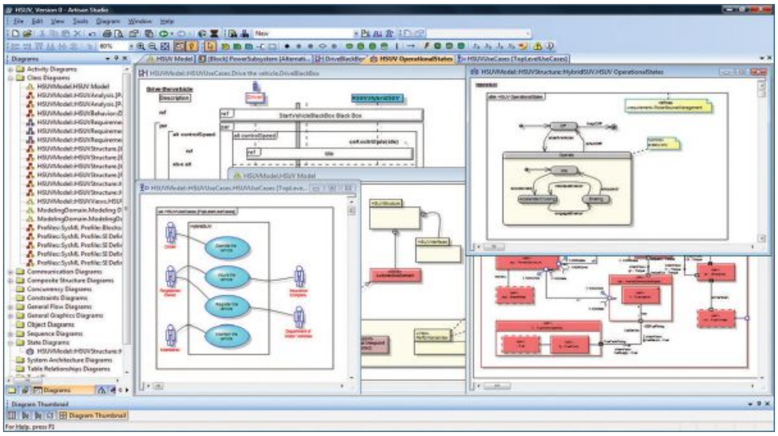
A Holistic View

Universally, the first rule of order for successful embedded systems design is following a systems engineering approach. This means thinking about how all of the components of a product work together as a system at the inception as opposed to retrofitting the various mechanical, electrical and software pieces together midway or later in the development cycle, explains Sudip Singh, vice president and global business unit head of engineering services at Infosys.

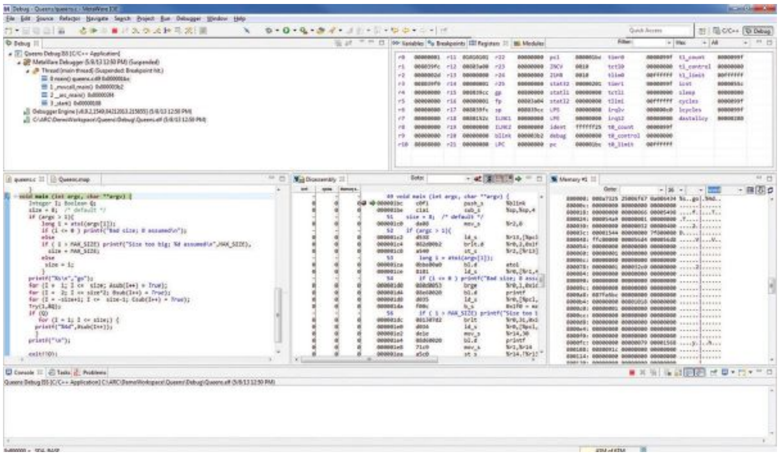
While systems engineering has been a staple of certain industries like aerospace for decades, it's still not an institutionalized best practice across mainstream engineering organizations. Yet rather than a single individual redefining their skill sets to become a master at all the different disciplines, Singh says the fusion of talent needs to happen at a process and platform level.

"It doesn't mean mechanical engineers and embedded engineers should rethink or learn a different language, it means they need to understand system engineering concepts of how a system works together upstream in the development cycle," Singh says. "They need to get to a place where they can don't have an embedded group or a mechanical design group, but they have an systems engineering group that houses the right people from mechanical design and embedded design as a single unit that works as one."

Organizations embracing embedded systems design as part of a shift to IoT-enabled products also need to figure out how to infuse some of the practices of software development into their overall engineering processes. One of the biggest obstacles is getting traditional hardware engineers accustomed to the velocity of change that accompanies software develop-



Model-based systems engineering tools like PTC Integrity Modeler help unify CAD, software and electrical teams with a common, standards-based design language. *Image courtesy of PTC.*



With its graphical interface and detailed representation of both hardware and software, Synopsys MetaWare Debugger helps pinpoint errors in program code. *Image courtesy of Synopsys.*

ment projects, notes Robyn Gold, product manager, Application Lifecycle Management (ALM) at PTC.

"If you look at a physical product like a drive train or blender, the typical development cycle is counted in months or years from design to development," she says. "What you see in the software world is a vastly sped up development cycle. One of the challenges is marrying the two different environments."

Software development's emphasis on process and compliance may also seem a bit foreign to traditional mechanical engineers, Gold says. While matching a product to a set of requirements is the gold standard in the world of hardware engineering, there's a different interpretation in the software development space. "It's almost more important that you have documented processes and follow them in the software world," says Gold. "Hardware design engineers working with these software components will also need to be subject to that end-to-end process rigor."

Another big change is the higher degree of constraints associated with embedded system design compared to traditional mechanical engineering projects. There is far less flexibility in performance characteristics, memory sizes, battery life and other such components when doing embedded systems due to much smaller form factors, according to Michael Minkedich, vice president of Technical Services at Luxoft, a software development services and IT outsourcing company.

With less flexibility in terms of trade offs and fewer degrees of freedom on optimizations, engineers need to be highly aware of how a system will be used and what the constraints are so they don't spec a system with a touch panel, for example, when the embedded processor on board isn't powerful enough to handle that interaction.

"Embedded software is one of the most sophisticated areas of software development in general and requires a pretty good understanding of how the entire system operates," Minkedich says. "Engineers involved in the development of embedded software require an in-depth knowledge of the underlying hardware platform and as such, a pretty good mastery of lower-level languages like C++."

An emphasis on debugging is another distinction that isn't commonplace in the mechanical world, Synopsys' Watson notes. It's not unreasonable for software developers to spend only 20% to 30% of their time on actual design while devoting the bulk of their resources to rigorous verification and debugging practices. In order keep things running smoothly and everyone on the same page, hardware engineers need to understand the debugging process and its potential impact on project deadlines, he says.

As the two development paradigms merge as a result of more complex IoT-enabled products, most of the change boils down to a philosophical shift between hardware and software development. "With software development and embedded system development in general, people deal with the intangible — you can't touch the code — you write so it requires a certain level of abstraction to understand how it operates," Watson says. "When you create something with your hands, you can touch and feel it and understand how it works. This is sometimes a major obstacle from jumping from one space to another."

Smooth Transition

Despite the philosophical and cultural challenges, there are a variety of tools and design platforms that can help break through traditional barriers and encourage systems engineering best practices. Take software coding, for example. ALM platforms and software configuration management tools like PTC's Integrity Lifecycle Manager can help development teams manage software cycles and design reviews, maintain fine-grained version controls and handle processes for check-in and check-out, says PTC's Gold.

Model-based systems engineering (MBSE) tools and practices can also be enlisted as a common language for communicating across disciplines. "How do you collaborate when you have one guy talking electrical diagrams and software people talking C++?" Gold asks. "Many leading companies are moving to a model-based systems engineering approach that allows all technical disciplines to understand each other and share and collaborate more easily."

Tighter integration between tools like CAD, simulation software and platforms such as National Instruments' (NI) LabVIEW will also help connect previously disparate engineering silos and streamline the process of creating and testing embedded system designs.

"Think about the ability to collect sensor data, push it back into the CAD tool and then change design materials to get a different reaction or put a different force on the design, then push it back into LabVIEW for testing," says Shelley Gretlein, director of NI's software group. "By getting rid of siloed tools, you improve communication between experts in a big way. You don't want one tool for creating algorithms, a different tool for mechanical design and yet another for testing. You want a flexible platform for both hardware and software design that flows across all stages."

PLM (product lifecycle management) is also at the forefront of fostering cross-discipline collaboration. "You're not going to be able to sit in an office with the door closed without talking to any one any more — there have to be relationships between subsystems," says Michael Munsey, director of Envoia Semiconductor Strategy at Dassault Systèmes. "PLM is a big piece of that. It's where you start to collaborate across all possible functions, from requirements handling to defect handling."

Aside from the tools, it will take a commitment to continuous learning to make the leap from a traditional mechanical engineering mindset to a true multi-disciplinary, systems level point of view. "There are a variety of options depending on the level of formality, time and budget and individual might have," says Gretlein. "But IoT is a cool catalyst for continuous learning. In the last 10 years, there hasn't been as clear a reason to up your skill set." **DE**

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

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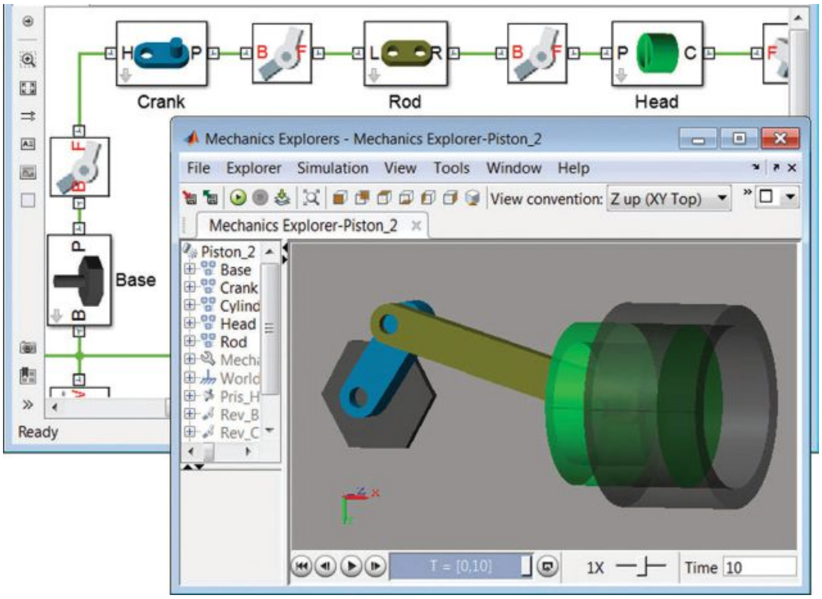
CAD vs. System Modeling

Drag-and-drop user interfaces and automation makes system modeling, test automation and data analysis more accessible to CAD users.

BY KENNETH WONG



Models you create in Simscape have the same structure as the system you are modeling. In the image above, the parts of the piston are clearly visible in the Simscape model and the 3D animation. ***Image courtesy of MathWorks***

It has been said that England and the United States are two nations separated by a common language. The same might be said of CAD modeling and system modeling. The two disciplines rely on the same vocabulary — model, model-based design, components, input parameters and simulation — to describe different objects and practices from their respective fields.

When CAD modelers talk about "the model," they're usually referring to a detailed 3D assembly model. The other side uses the same word to describe a schematic (mostly 2D) representing the data flow, input-output relationship and component hierarchy. A CAD modeler includes inputs such as wall thickness, extrusion lengths, trim angles and other values that define the geometry of the design. System modelers work with fan speed, valve modulation, temperature and power as inputs. In CAD, simulation means studying how stress, pressure and forces would affect the integrity of the design. System modelers conduct simulation by computing the effects of varying inputs on the overall structure of the design. The two groups use different software tools. So the work completed on one side won't be of benefit to the other — or so it seems.

"The tools in the system modeling and simulation industry — not just ours but others as well — have made a big leap in the last five years or so. That hasn't been well communicated to the CAD community. Most [system modeling] tools are moving in the direction to allow data import from CAD models. In ours, some parts of this are automated so you can get a skeleton structure to start your system model," says Johan Rhodin, kernel developer at Wolfram.

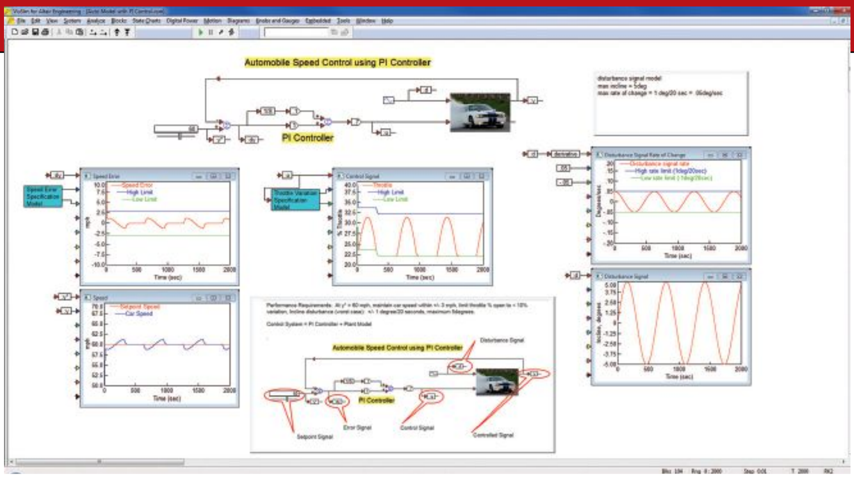
"The computational fluid dynamics (CFD) model — or a simplified version of it, at any rate — could drive a system model in VisSim [Altair's software for nonlinear dynamic system modeling]," says Richard Kolk, chief technical specialist for VisSim at Altair. Efforts to bridge the two disciplines will likely continue as multidisciplinary, collaborative product development becomes standard practice and not just a theory.

Where the Two Meet

The general impression is that the detailed 3D CAD model that defines the geometry of a product is not readable in system modeling software; therefore, the mechanical behaviors, geometric values and component shapes already described in CAD have to be redrawn from scratch for the system model in another software program. But, according to the system-modeling experts, the CAD model could be the starting point.

"Mass-spring-damper models are the most basic building blocks for system models," says Kolk.. "At the simplest level, we can transform a CAD model into a single mass-spring-damper model in VisSim. Then you can refine that model to adequately represent the control system by adding other mass concentration points."

"Any relevant data in the CAD system can be extracted for use in a Simscape model. Often, not all data that is necessary for a Simscape model is present. For example, constraints that define how the parts move with respect to one another are not always defined because the CAD engineer may only be interested in designing the shape of the parts, not in how they move," says Steve Miller, technical marketing manager for Simscape, MathWorks.



VisSim is used here to model the speed response of a car, with a function of the throttle position and incline angle. The purpose is to design and simulate the performance of a speed controller attempting to maintain car speed at a desired value as the incline angle is dynamically varied. ***Image courtesy of Altair.***

Using system model variables — usually sensor data from tests — as input to CAD to initiate real-time visualization of the simulated operations of a cyber-mechanical system is not out of the question. Describing the features of its software SystemModeler, Wolfram writes that a user can "attach visualization geometries from CAD software to components, and automatically create live 3D animations for models with 3D mechanical components."

"You can use DIAdem to map the sensors on your prototype to a 3D model and watch the effects of the test playback on the 3D CAD model," says Stephanie Amrite, product manager for DIAdem, National Instruments (NI).

Sensor Data Gathering and Analysis

Part of the challenge involved in developing an accurate system model is the sensor data collection and analysis involved. Such data, recorded from physical tests, allows engineers to understand the correlations between different system components and how each affects the behavior of the overall system.

NI's Amrite explained that, in automotive sector, for example, engineers might conduct "component testing, by adjusting the design of a particular component and analyzing the data to see which combinations perform the best under certain circumstances; crash test analysis, by post-processing the large amounts of data collected during a very short crash test; or fatigue analysis, to understand the points at which components or parts break."

The advantage with DIAdem is the ability to load any file format and perform complex queries to find the data in question. "DIAdem also allows you to pull in individual channels of data, so you can, for instance, review Thermocouple A from File 1, 7, 19 and 34 in a single view without having to open each file, copy and paste the required channel into Excel or another tool," says Amrite.

For Turbomeca (Safran), a helicopter gas turbine engine manufacturer, conducting altitude tests on a new engine meant "capturing 400 channels of data from temperature, pressure, velocity sensors and accelerometers, generating a total of 5,000 different files," according to a case study published by HBM-nCode.

Jon Aldred, director of Product Management of HBM-nCode, explained why Excel, usually the go-to tool for managing tabulated data, isn't ideal for Turbomeca's purpose. "The data files are ASCII files with over 100,000 rows. Excel does not read this data very quickly," he said.

Turbomeca currently uses HBM's nCode GlyphWorks and nCode Automation software to capture, analyze and manage its test data. "The ASCII format was added to GlyphWorks as a directly supported format and so it is much faster to read. In some cases, GlyphWorks was also used to convert it to a binary format, which means subsequent reading of data is even faster," says Aldred. The case study noted that what used to take 5 minutes to open in Excel now take mere seconds. With nCode GlyphWorks, Turbomeca cut the typical time required to perform analysis on the data.

Playing with Numbers

CAD modelers conduct finite element analysis (FEA) to understand how different geometric values affect the performance of a product: For example, what does increasing the wall thickness of an engine housing by 0.2 mm do to its ability to withstand heat? Similarly, once an accurate system model has been developed, engineers could try out different scenarios by altering the sensor input values.

"The ability to do what-if configurations under different operating conditions is one of the primary purposes of model-based design with tools like VisSim," says Kolk. "VisSim allows you to automate this, so you can slightly alter the parameters and record the behavior matrixes for each [configuration]. You can vary any or all parameters within a range incrementally."

Rhodin thinks it's time to address the disconnect between the geometry modelers and system modelers. "For a time, people thought it was enough to do one type of simulation [with either CAD or system models]. But actually, there's value in doing both in concert." **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.*

INFO → HBM-nCode: nCode.com

→ MathWorks: MathWorks.com/products/simscape

→ National Instruments: NI.com/diadem

→ VisSim: VisSim.com

→ Wolfram Research: Wolfram.com/system-modeler

This article was abbreviated for print. To read the full text, visit deskeng.com/de/modelers.

Rapid Tooling: The Manufacturing Disruptor

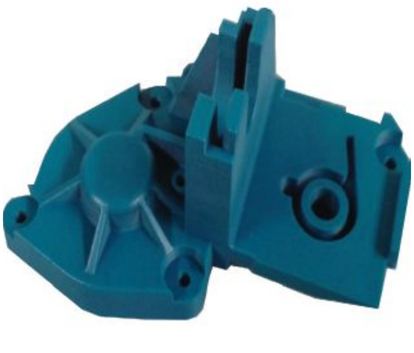
By enabling designers to create customized tools quickly, 3D printing is changing how companies manufacture products.

BY BRIAN BENTON

3D printing is not a new technology, of course. Even though it has been around for several decades in the manufacturing industry, recent technological developments have raised its profile among makers, hobbyists, DIYers and the public in general. The creation of 3D printers on a smaller and more affordable scale has led to a lot of hype about the future of consumer-based 3D printing, but that's not stopping manufacturers from finding more and more practical uses for the technology today.

"There is just an amazing array of very smart, creative people that are figuring out new ways to use this technology. That's no hype," says Bill Dahl, vice president, Products & Marketing at Solidscape, a Stratasys company.

Many companies have been using 3D printing for prototyping or for making end-use parts. However, manufacturers and industrial designers are also using 3D printing for rapid tooling, "a broad term that covers a variety of different types of molds, dies, patterns, forms, fixtures, jigs and other tools that are made using 3D printing or other manufacturing methods that are faster than traditional tool making," says Tom Charron, vice president of Product Marketing at 3D Systems.



3D-printed wax master.
Image courtesy of Solidscape.

Aiding Traditional Manufacturing

Traditional manufacturing practices often use tools and materials that are expensive and can take a long time to create. This forces companies to iterate slowly, creates a need for large production runs and increases risk. What if the product fails or doesn't catch on?

According to Charron, 3D printing your tooling reduces costs and time to market by providing "faster prototype tooling and faster manufacturing ramp-up." It provides lower costs because "3D printed tools themselves are often less expensive than CNC (computer numerically controlled) machined soft tools" and also "because manufacturing problems, such as moldability, assembly problems, etc., are found faster and corrected sooner, before investing in expensive hard tooling ."

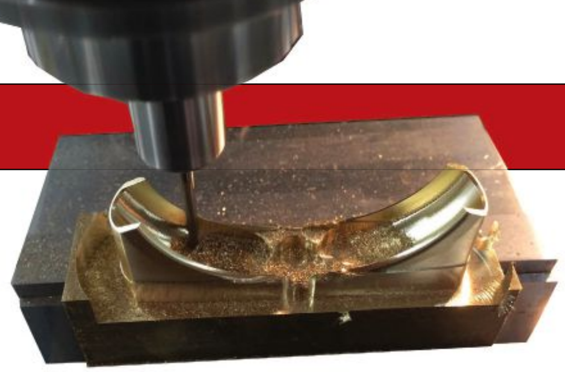
Cost Saving Techniques

While rapid tooling with 3D printing saves money by producing tools more quickly, it can also reduce costs by taking advantage of a digital inventory for those tools.

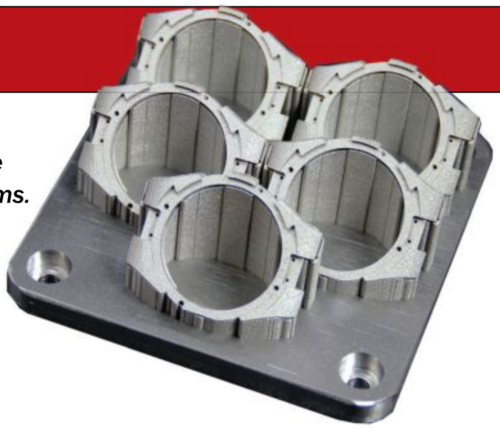
"Rapid tools allow companies to discard or recycle old tools rather than warehousing them for infrequent production of legacy components," Charron says. "With digital inventory, companies just print a tool on demand, produce a short run of parts, and discard or recycle the tool."

3D-printed jewelry casting patterns.
Image courtesy of 3D Systems.

Manufacturers don't have to store forms in a warehouse if they are 3D printed. Simply reprint the forms you need when you need them. Dahl says his company uses Stratasys printers in the manufacturing process to create their own line of 3D printers. They have used 3D printed trays that hold the tools used by the workers. "We have workstations in the assembly of our printers and at each one of those workstations, to operate efficiently, we need the right tools in the right place," Dahl says. "We built custom 3D-printed trays that have the exact tool right there on their assembly bench. If it's not there, they can quickly identify it, order it or make a new tool. But more importantly,



CNC parts or molds are time consuming and expensive for prototyping, but can be produced more quickly with 3D printing. *Image courtesy of Solidscape.*



Direct metal printed tooling inserts. *Image courtesy of 3D Systems.*

it encourages everybody to put the tool back in its appropriate place. You wouldn't believe what this has done. It has built in efficiency into our production process."

Another cost-saving aspect of rapid tooling , according to Andrew Snow, senior vice president at EOS of North America, is that 3D printed tools are "much more precise and can reduce time to market up to 70%." He described the 3D printing tooling process as a way to "grow the tool." According to Snow, costs can be reduced because the 3D-printed tool provides "precise geometry, which means you grow the tool once or twice. Conventional processes take much more time to create and there is a significant savings in material."

Time may provide the largest savings using rapid prototyping. "3D printing is the fastest way to make most types of tooling — typically withsame day or next day turnaround," Charron says. "For example, 3D printed injection molds are printed in a few hours, versus two weeks to three weeks for aluminum soft tools that are rapid CNC machined. 3D printing allows companies to iterate designs faster, shorten development windows, save money on tooling, 3D-printed tools cost a fraction of the money required for traditionally made tools, and produce limited product runs very quickly."

Rapid Tooling Advantages

A client of 3D Systems, Bi-Link, is a supplier of mechanical components. The company uses 3D printed injection molds to create limited run and prototype production plastic parts for a variety of engineering clients.

Snow said EOS' clients can "create more custom jobs, custom designs, can perform quick redesigns, and can employ part count consolidation" techniques so that they can manufacture fewer parts, thus shortening the manufacturing process time.

A Solidscape client created a prototype for a wearable device that wirelessly connects to a smartphone in five weeks and at a cost of $4,000 using conventional methods. Comparatively, the second prototype they made using 3D-printed rapid tooling techniques only cost only $300 and was made in one week. Because of the 3D printers' speed and precision for creating molds and prototypes, the tooling they produce is made quickly and for a far less cost.

What Tooling Can be 3D Printed?

3D printers can handle many materials and print different types of tools. They are being used to create room temperature vulcanization (RTV) molds by 3D printing master patterns for casting materials that include wax, gypsum, low melt alloys, metals, urethane, epoxy or even polyester resins. It is also used in hydroforming to create molds or negative molds for epoxy tool pouring that can be used in the shaping of ductile metals. Also, it creates molds for thermoforming, vacuum forming and fiber layout.

And, 3D printers are being used to create molds with materials like thermoplastic, thermosetting polymers or even elastomers. 3D printing is also a direct tool production solution to create jigs and fixtures, and it excels at making custom 3D printed jigs for special purpose tools or production runs. Molds are also printed for wax patterns for plaster, sand and spin and die casting. According to Snow, the only limitation right now to 3D printing is "the size of the tool you can grow."

The Future of 3D Printing and Rapid Tooling

Rapid tooling using 3D printing techniques has a bright future, but don't believe the hype that it is a replacement for traditional manufacturing processes. "Not completely, but in several cases, 3D printing rivals or even surpasses traditional manufacturing processes," says Charron. "For shorter runs or prototyping, 3D printing has the level of accuracy required and achieves a level of speed that simply can't be matched."

Solidscape's Dahl says 3D printing and rapid tooling will affect the future of manufacturing. "The adoption rate continues to grow. It will democratize this process to the smaller companies," he says.

Snow says 3D printing and rapid tooling will "create new jobs, and new spinoffs creating new units of business."

Rapid tooling using 3D printing techniques offers more flexibility with time, material costs and customization. Designers can create more precise molds more quickly than before, making a better product at a lower price and in less time. DE

Brian Benton *is a freelance writer based in Florida. He writes the CAD-a-Blog website at cadablog.blogspot.com.*

INFO → 3D Systems: 3DSystems.com

→ **EOS:** EOS.info

→ **Solidscape:** Solid-scape.com

→ **Stratasys:** Stratasys.com

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

Review: Artec Eva, Spider and Studio

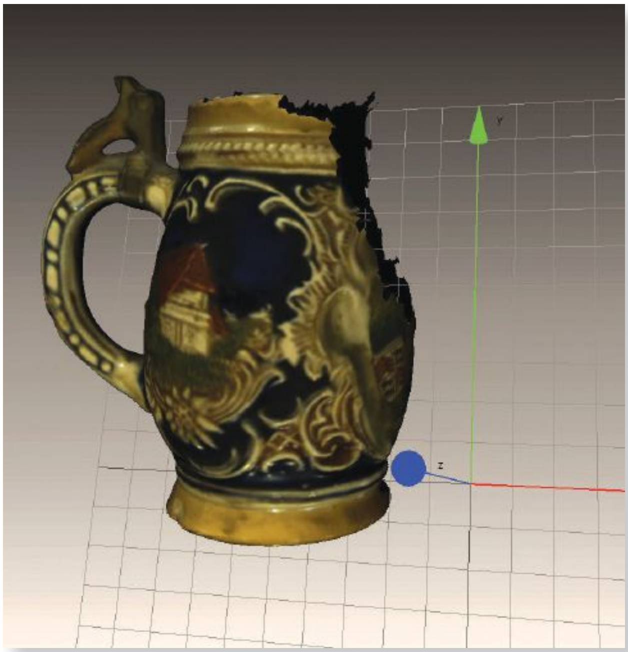
Hardware and software allow engineers to create professional scans.

BY MARK CLARKSON

The Artec Eva and Spider are handheld 3D scanners around the size and shape of an old-fashioned home iron. Scanning with either is simple. You point the scanner at your desired object, press a button on the handle and scan. You can pause at any time by pushing the scan button again. When it's time to restart, you'll need to return the scanner close enough to a previous position so that the software can find its place again.

The scanning process is quite a bit like spray painting: You move your hand up and down, back and forth, rotating your wrist a bit and trying to get complete coverage. Scan from different angles as you go, and remember to direct the cameras at those hard-to-reach spots under overhangs or in recessed areas.

Both the Eva and the Spider have built-in illumination to ensure sufficient, even lighting on your textures. You can also turn the lights off if they are distracting and rely on ambient lighting.

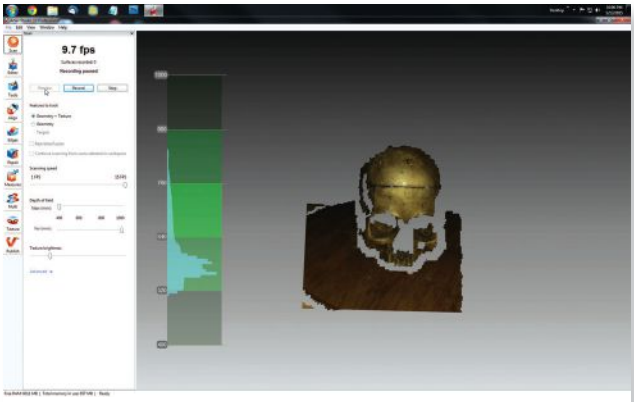


My first scan had some major problems as I climbed the 3D scanning learning curve.

Watch the Screen

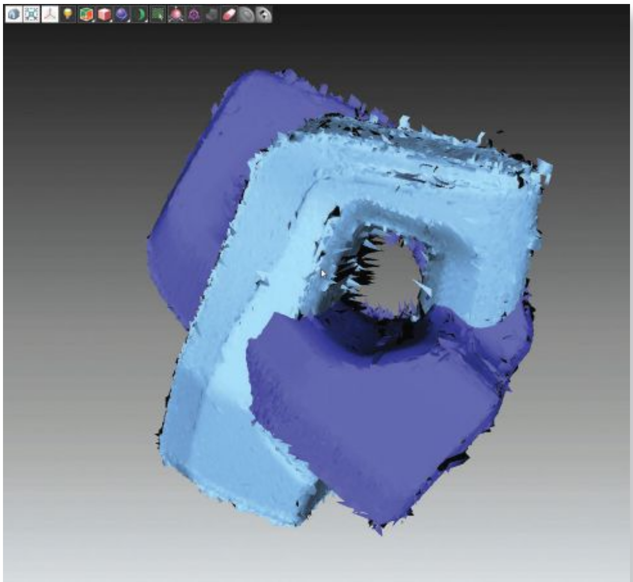
As you scan, you'll want to keep as much of the object's surface as possible within the scanner's field of view. Fortunately, you can see the scan happening onscreen in Artec Studio. In fact, it is essential that you be able to see the computer screen while you scan; there's no other way of being exactly sure what is and isn't getting scanned and to keep track of the distance to your object — something both scanners are very picky about. It doesn't hurt if you can see the scanned object as well.

The ultimate solution would probably be to place your object at a comfortable height in the middle of an empty room, plug the scanner into a powerful laptop, and just walk around in circles, scanning as you go. That wasn't an option for me; my laptop isn't up to the task, so it was a workstation or nothing.

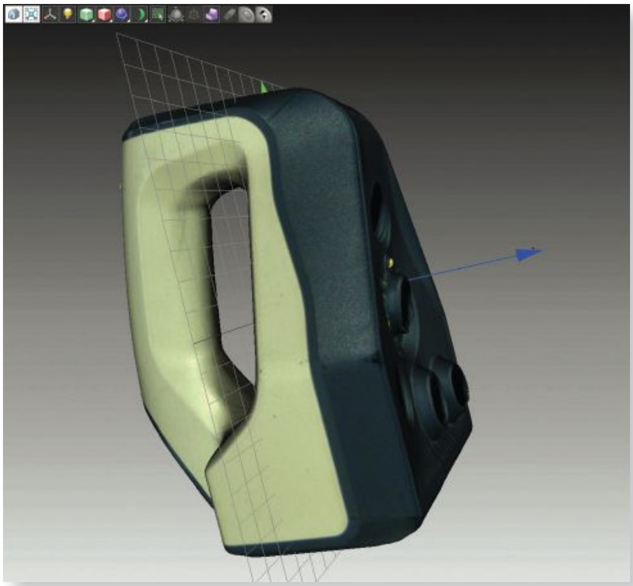


A 3D scan in progress. The histogram shows the object's current distance from the scanner.

The scanners plug into two cords — an AC power cord and a USB data cable. The power cord is about 9 ft. long after the DC converter. The USB cable is just shy of 10 ft. long. If that's not long enough, or you prefer not



Two separate scans of an object, before registration, alignment, fusion and texturing.



A 3D model of the Artec Spider, scanned with an Artec Eva.

to risk tripping over cables while scanning, Artec offers a battery pack designed to work with their scanners and maximize mobility.

My office space, while fine for writing articles, is a bit cramped for 3D scanning. I set up a small table with a turntable on it, which allowed me to turn the object to be scanned and — in theory — keep the scanner itself in more or less the same place, moving the object rather than moving around it.

You can also take multiple scans from different angles (scan, rotate the object, scan again.) If you don't need data from some angles — maybe you're scanning a bust of Lincoln and you don't really care what the bottom looks like — you can easily fill in the hole later in Artec Studio.

You can even hang the object from a cord of some sort. Artec has posted a video using this technique to scan a fish: youtu.be/DmCifB35mRg.

Too Small for Eva

The Eva's preferred scanning range of between 52 and 88 cm (approximately 2 to 3 ft.) was awkward for me when trying to spin the object with one hand and scan with the other. I was constantly coming too close or, worse yet, accidently pointing the scanner away from the object and losing registration. Also, while the Eva has a resolution of 0.5 mm, it seems to be happier with larger objects — say, a foot tall or more. Once I gave up on scanning tiny figurines and coffee cups, and moved up to a series of scans of my son's head, the process became much easier.

If your scanning needs run to smaller objects, Artec makes the Spider. The Spider has five times the 3D resolution (0.1 mm) and a much smaller working distance: around 7 in. to 1 ft. Despite a much narrower field of view and lower frame rate, the Spider usually suited my needs better than the Eva.

Erase, Align and Fuse

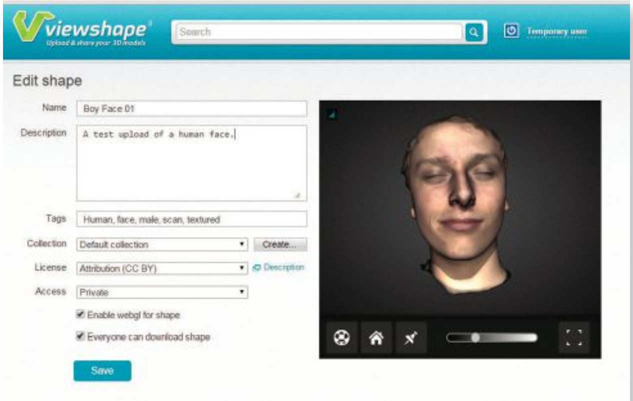
Once your scans are complete, you remove geometry that's not part of your desired object. In my case, I had to cut away the turntable and, sometimes, bits of background items or my hand. There are a variety of eraser tools available in Artec Studio.

Next, if you took multiple scans, you will need to align them. It can be a bit of a challenge to align disparate scans until you get the hang of it. I usually manually moved and rotated things until they were fairly close and then let Artec Studio's automated tools take over.

A scan doesn't immediately result in a single 3D object; rather, the scanning process produces multiple different snapshots — called frames — that contain bits and pieces of the whole. Artec Studio's registration algorithms align the frames within a scan and between multiple scans. You can browse through these individual frames and manually eliminate bad ones (Artec Studio gives each frame a quality score).

When everything is lined up, it's time to weld all of the frames together into what Artec calls a fusion — a single object built from the dozens or hundreds of individual frames. You can create a smooth fusion — good for relatively smooth objects (such as faces) — a sharp fusion

The Eva (left) and Spider (right) scanners from Artec.



A scanned face published on Viewshape.

— better for objects with planes angles and edges — or a fast fusion if you're in a hurry. All allow you to fine-tune the resolution.

Real-Time Fusion

You can actually align frames all in one go, using Artec Studio's real-time fusion. In this mode, the application continually stitches 3D frames together as you scan. As soon as you stop scanning, you've got a fused object. It's the fastest and easiest way to scan, allowing you to skip the registration and fusion steps.

There are downsides, of course. Most importantly, the entire scan has to be completed in a single session; you cannot merge multiple scans and it's often difficult — sometimes impossible — to scan an entire object in one go. Real-time fusion is also marginally less accurate and puts a real strain on your graphics card.

Post-Processing and Texture

Once your fusion is created, it's time to remove anything you don't want in the final object — stray bits of geometry and so forth. You can remove features, patch holes and smooth the mesh. Finally, you can perform a mesh simplification to reduce the "weight" of the object by reducing its polygon count. You have several settings to fine-tune the results.

Your mesh is ready, but it has no texture. If you need one, now's the time to create it. Artec Studio uses captured texture frames to create the final texture, so everything must be aligned and properly registered before this step. You can play with the texture's brightness, hue, gamma, contrast and set the texture's resolution.

Once everything looks good, you can export the model in a standard format such as OBJ or STL, or publish it directly to Viewshape, Artec's online 3D model sharing site.

Ease of Use

As this was my first attempt at 3D scanning, I learned some things along the way. The scanners don't especially care for shiny surfaces, black surfaces or transparent and translucent surfaces. They're certainly not alone in this; all optical 3D scanners have problems in the same areas. They need surfaces that bounce light back in a predictable way.

Both Artec scanners prefer objects with lots of sharp edges. They don't care for flat or repetitive geometry or texture. (Think of a checkerboard, it's easy to get lost and mistake one black square for another, identical black square.)

That said, the Artec Eva and Spider are astonishingly easy to use. That doesn't mean you'll be getting great scans from the very beginning, though. If you're anything like me, your first several scans will take a long time and result in mostly unusable data. But the more you work with them, the faster your scans will go, the fewer frames you'll be producing and the better the quality those frames will be.

Be prepared to put in some time. The $20,000 price tags should make it obvious that these 3D scanners are not intended as consumer products. And even lower-quality 3D scanning products, aimed more at the everyday user take time to learn to use well. However, for design engineers willing to invest a little time upfront, Artec's Eva and Spider 3D scanners can save time and effort that would otherwise be spent building models from scratch. **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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Automating Simulation Processes

Plastics supplier Amcor implemented Altair's Impact Simulation Director to reduce processing time and increase research & development.

In today's competitive markets, the packaging industry needs to be highly responsive to the changing industry. New products are being produced all the time, and packaging professionals must maintain a fine balance between packaging performance, environmental impact and shelf appeal while keeping costs to a minimum.

Headquartered in Ann Arbor, MI, Amcor Rigid Plastics is a leading product packaging supplier. It is always searching for innovative and lightweight container designs that would be aesthetically pleasant and have easy handling for the consumer without compromising the quality, performance or safety. Simulation plays a major role in that search.

Long-time users of Altair's HyperWorks suite, the Amcor team wanted to explore ways to accelerate engineering and analysis tasks. They met with Altair ProductDesign's Enterprise Solution Group (ESG), a team that specializes in assessing and improving product development processes and workflows.

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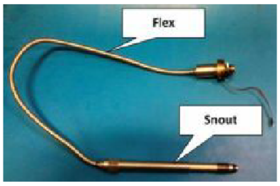
The Old is New Again

Dynisco Instruments uses DFMA to grow its market share and create a more collaborative design process.

The bottom line — it's a familiar term and a figure that many consider the most important item on a company's income statement. It stands to reason that the easiest way to increase the bottom line, thereby making a company more profitable, is by limiting expenses. While true, this line of thinking has also led some companies to offshore inappropriately and move away from better domestic models of design and production efficiency.

At first it may seem as though top line and bottom line growth are at odds, but as Dynisco Instruments, a manufacturer of sensors, controls and analytical instruments for the plastics industry, has proven, you can have it both ways without sacrificing the integrity of your product.



Dynisco has been using Boothroyd Dewhurst's Design for Manufacture and Assembly (DFMA) software since 2009.

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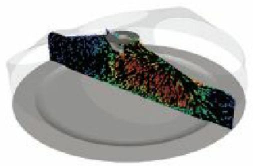
Powering CFD Simulation

ECR Engines uses CONVERGE CFD for effective and faster analysis of valvetrain engine parts.



When an engine specialist as experienced as Brian Kurn is excited about a technology, others in the field tend to take notice. Kurn is in charge of Valvetrain Development together with all Virtual Prototyping technologies, including Engine and Valvetrain Simulation, as well as CFD (computational fluid dynamics) at ECR Engines, a division of Richard Childress Racing.

As an experienced CFD user, primarily to analyze internal flows in the engine, Kurn is at home with state-of-the-art technology. But just over a decade ago, CFD posed problems. "The run-times to do the simulations took too long and when we had to create our own mesh, we really suffered with the variability between users," says Kurn. "It can affect your results, introduce inconsistency and ultimately your trust in the data can go out of the window."

Kurn didn't think the long run-time issue would be solved until he used Convergent Science's CONVERGE CFD software.

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Commentary

by John F. Mannisto

Make CAE Mainstream

I recently asked a couple college interns a question: "how do they teach you CAE?" Their answers: "What is CAE?" "One of my professors offers a class in FEA every other year but it's not very popular."

Not very popular? Yikes! (and these were good Michigan engineering colleges).

A couple years back I did a webinar with engineering professors. They wanted to know what they could do to better prepare their students for industry. I gave them my decidedly biased opinion: make computer-aided engineering mainstream.

Part of the discussion centered around how CAE material is taught. It is my belief that there is too much emphasis on the inner workings of a computer program and not enough on the practical application.

A calculator is a well-accepted engineering tool. We were taught: "Push 1, then +, then 1, and you get 2."

Imagine if I taught the use of a calculator the same way

> **Teach CAE not as a course, but instead build it into the curriculum.**

CAE is taught: "The main processor is connected to the input device which is a series of keyboard sensors. The liquid crystal display (LCD) is often mounted to the main circuit board. More on the LCD in chapter 12."

Crazy, right? Yet grad students struggle with stiffness matrices and shape functions while undergrads run away from any class that has three letters in it: CAE, FEA, CFD. This is a big miss.

Build a Foundation

I have to admit that in my grad classes I had to struggle through a few of these things. Euler, Bernoulli, Fourier, Laplace all inflicted their pain on me — it was how they measured engineering students. But the "real" education came in my many years as a CAE analyst, staring at stress contours, animations and flow fields. I can't derive the beam equation anymore, but I understand how to identify bending stress and membrane stress. I don't remember how upwind differencing schemes work, but I understand flow recirculations and separations.

I would expect my story to be familiar to those who grew up with punch cards, 9-track tape readers and spaghetti FORTRAN. CAE was for the professors who huddled around the "super" computer and could interpret those reams of green and white printer paper. This was not for the faint of heart.

Today, products like ANSYS Workbench and CDadapco's STAR-CCM+ have minimized the need to understand every nuance of the model building process. They are moving to the point where the engineer need only understand the physics of his/her problem, and let the software do the rest. Fourier, Dirchlet, Navier and Stokes can be casual acquaintances instead of daily collaborators.

It was once a badge of honor to write your 10,000 line FORTRAN code with time-step integration, but now the 1-D codes like LMS Amesim or Dymola/Modelica require only a good definition of the operating domains. Runge and Kutta can remain behind the scenes.

Take a Holistic Approach

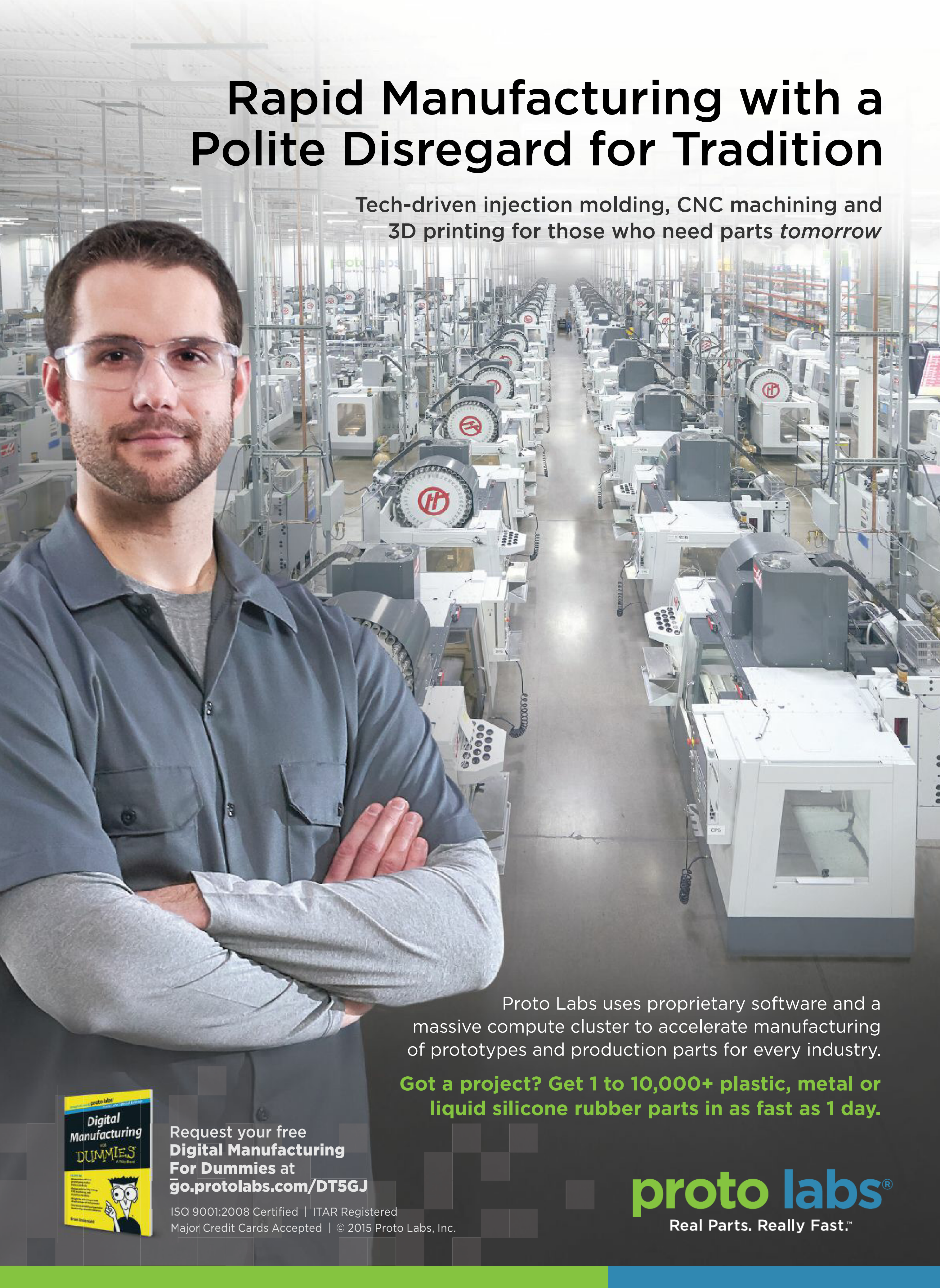
So I repeat my plea to the universities: make CAE mainstream.

Teach CAE not as a course, but instead build it into the entire curriculum. Teach the beam equation, teach Mc/I, then apply it using finite element analysis. Teach continuity, momentum and Navier-Stokes, then show how to define an entrance condition and a pressure boundary in a computational fluid dynamics program. To be fair, my brief survey of university offerings revealed some clear movement in this direction, but I found it to be the exception, not the rule.

I get feedback that professors do not want to teach software usage, they want to teach fundamentals. I agree. If you teach poetry, teach poetry, not Microsoft Word. If you teach accounting, teach accounting, not Excel. Teach the fundamentals, but make the tools available. A $5 memory stick with CAELinux (an array of open-source codes), and a pile of YouTube videos can easily solve this problem. I also suspect many of the software vendors are anxious to provide free/low cost student versions of their commercial codes. They have a vested interest.

While CAE is growing, the rate is limited by the market — by the number of "true" CAE analysts. Democratizing CAE can expand this market 10-fold. The vendors know this, and have been working to make their products as mainstream as possible. Now they just need the market to arrive, and that will come from the universities. **DE**

John F. Mannisto *is engineering director, simulation based design at Whirlpool Corporation. Send e-mail about this commentary to de-editors@deskeng.com.*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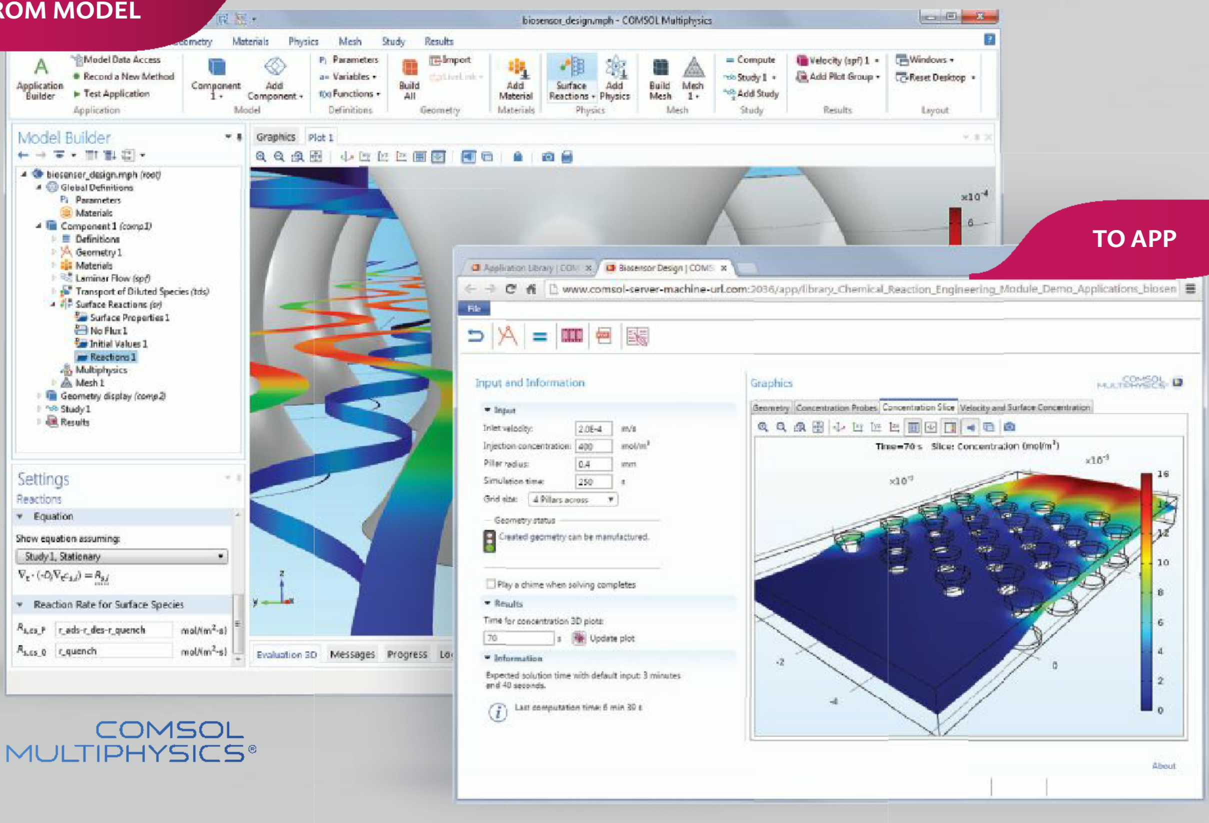
FROM MODEL



TO APP

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