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Simulation Expands into New Markets

Software companies are eager to help SMBs and vertical industries get onboard. P. 14

by Jamie J. Gooch

Advancing Manufacturing

As I type this, I'm surrounded by the ghosts of manufacturing's past in Pittsburgh. This is where Andrew Carnegie built the steel company that he sold to J.P. Morgan to create U.S. Steel, and where Nikola Tesla consulted with George Westinghouse's engineers on AC motors. This is also where public-private partnerships helped right the city's economy after the U.S. steel industry collapsed in the 1980s. It was the perfect backdrop for a discussion on the future of U.S. manufacturing.

Michael F. Molnar, chief manufacturing officer, National Institute of Standards and Technology (NIST), and Director of the Advanced Manufacturing National Program Office, was one of the keynote speakers at the RAPID 2013 Conference and Exposition held last month in the Steel City. He said while the U.S. enjoyed its 100-year run as the world's largest manufacturer, the rest of the world was focused on advanced manufacturing technologies.

Advanced manufacturing initiatives are poised to become this generation's Space Race.

Define and Conquer

What are advanced manufacturing technologies? According to the President's Council of Advisors on Science and Technology Report to the President on Ensuring American Leadership in Advanced Manufacturing, it is "a family of activities that (a) depend on the use and coordination of information, automation, computation, software, sensing, and networking, and/or (b) make use of cutting edge materials and emerging capabilities enabled by the physical and biological sciences, for example nanotechnology, chemistry, and biology. This involves both new ways to manufacture existing products, and especially the manufacture of new products emerging from new advanced technologies."

Molnar seemed to take a page out of Pittsburgh's history as he discussed the need to bridge the gap between government funding of public research and private industry. To that end, the Obama Administration has launched competitions to create three new manufacturing innovation institutes with a Federal commitment of $200 million across five Federal agencies: Defense, Energy, Commerce, NASA, and the National Science Foundation. These institutes would build off what has been learned via the National Additive Manufacturing Innovation Institute (NAMII) pilot. NAMII works with public and private entities with the goal of transforming the U.S. manufacturing sector.

"There is a gap between government and university ideas and private sector products," said Edward Morris, the director of NAMII, who followed Molnar's presentation at RAPID 2013. "NAMII is building a bridge across that gap."

The Department of Defense will lead two of the new Institutes, focused on "Digital Manufacturing and Design Innovation" and "Lightweight and Modern Metals Manufacturing," and the Department of Energy will be leading the third new institute on "Next Generation Power Electronics Manufacturing," according to the White House.

The three new manufacturing innovation institutes will join NAMII in a National Network for Manufacturing Innovation (NNMI) as part of the Administration's vision of 15 such institutes across the country. The President has requested Congress fund a one-time $1 billion investment to expand the network.

The Race is On

On the second day of the RAPID 2013 Conference and Exposition, additive manufacturing industry researcher and consultant, Terry Wohlers, provided some context to the country's position in world of additive manufacturing (AM). Though AM is by no means the only type of advanced manufacturing technology, it is a high-profile segment that many countries are keen to dominate.

Wohlers, who recently returned from China, said the President's call to action on advanced manufacturing was heard loudly and clearly there. He heard it mentioned a number of times on his trip. China's central government is already funding AM to the tune of $245 million for a 7-year pilot program.

"One strategy the country may pursue is to buy its way in," Wohlers said, to meet its goal to become the No. 1 country in the AM industry in the next three years.

History has a way of repeating itself, and advanced manufacturing initiatives seem poised to become this generation's Space Race. But the initiatives mean more than bragging rights. As Pittsburgh's resurgence in the last 30 years and NAMII's initial success both illustrate, public-private partnerships can work. They require leadership from government, academia and private industry to succeed.

For more information, and to get involved, visit manufacturing.gov and namii.org. **DE**

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

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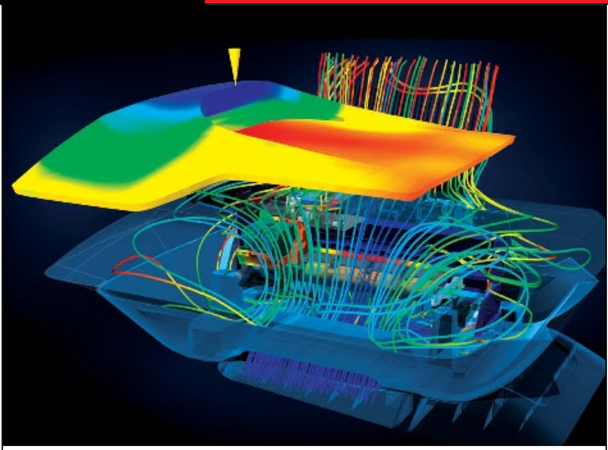

Simulation Expands into New Markets

ON THE COVER: The image shows mechanical stress, Moldflow injection pressure and fluid and thermal simulation. *Image courtesy of Autodesk.*

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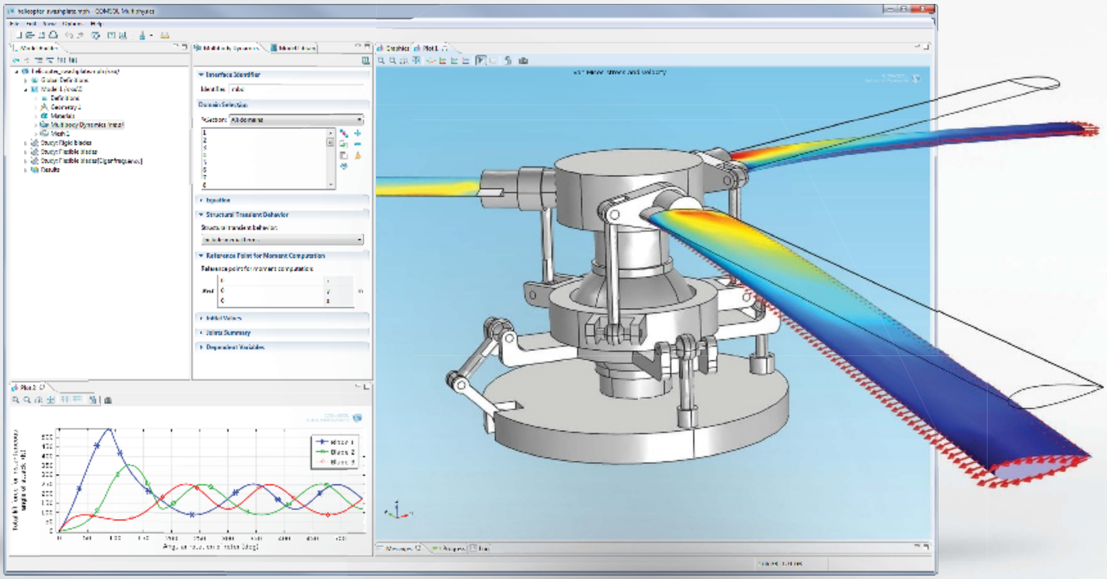
MULTIBODY DYNAMICS: A swashplate mechanism is used to control the orientation of helicopter rotor blades.



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Intel Haswell Signals Shifting Focus

At the beginning of June, Intel debuted its fourth-generation Core architecture, codenamed Haswell. The big splash occurred at Computex in Taipei, Taiwan, at the Taipei World Trade Center Nangang Exhibition Hall. The new product lineup includes:

- Intel Core i7-4770S, 17-4770TE, i5-4570S, and i4570TE for the desktop;
- Intel Core i7-4700EQ for mobile; and
- Intel Xeon E3-1275 v3, E3-1225 v3, and E3-1268L v3 for workstations.

Wes Shimanek, Intel's workstation segment manager, reveals that Haswell processors contain a substantially higher number of execution units in the integrated graphics. According to Intel, "Without the need for a discrete graphics card, the built-in graphics features deliver smoother visual quality, improved ability to decode and transcode simultaneous video streams. Additionally, the new platform can also support up to three independent displays, enabling one system to drive multiple screens." Haswell products will support OpenGL 4.1 and DirectX 11.1, according to Shimanek.

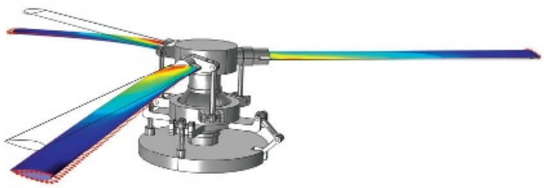
By providing CPU-integrated graphics that can tackle routine CAD visualization, Intel is pushing back against GPU maker NVIDIA's encroachment. For performance-hungry users, NVIDIA would recommend augmenting the CPU's capacity with additional GPUs.

Intel's Shimanek advocates an alternate strategy: "Save a little on graphics and invest in solid-state drives. When you do that, you can actually impact a broader array of applications that users employ in the day in the life of an engineer." (*Author's Note: For more, read "Changes Brewing in the Power Game," June 2013*)

Haswell marks Intel's first use of transactional memory in hardware, a method of "incorporating transactions into the programming model used to write parallel programs" (*Source: "Transactional Memory: Synthesis Lectures on Computer Architecture," James R. Larus, Microsoft; Ravi Rajwar, Intel, Morgan & Claypool Publishers*). The method is expected to yield performance gains in highly parallel applications such as rendering and simulation.

—K. Wong

COMSOL Multiphysics 4.3b Introduces New Modules



In COMSOL Multiphysics 4.3b, new features come in the form of five new modules, each tailored to address a specific type of simulation. COMSOL Multiphysics 4.3 gives users the option to deploy the software straight from within SolidWorks' CAD interface with LiveLink for SolidWorks. In Version 4.3b, the same integration is made available to Autodesk Inventor with LiveLink for Inventor.

Version 4.3b also marks the debut of LiveLink for Excel, a plug-in that allows you to conduct simulation scenarios with multiple parameters using Excel spreadsheets. The plug-in could potentially be deployed so users unfamiliar with COMSOL interface could launch and complete simulation jobs solely from within Microsoft Excel. All the LiveLink plug-ins and specialized modules require COMSOL Multiphysics' foundation product. Modules require additional licensing fees.

The Multibody Dynamics Module is meant for those who need to study the interaction of rigid bodies and flexible bodies. It's capable of simulating transitional and rotational displacements, locking, prismatic joint, hinge joint, cylindrical joint and more. The Wave Optic Module, capable of electromagnetic wave propagation, is a good tool to simulate the behaviors of optical fibers and sensors, bidirectional couplers, plasmonic devices, metamaterials, and laser beam propagation.

The Molecular Module targets users dealing with mass spectrometers, semiconductor processing, satellite technology and particle accelerators. Bjorn Sjodin, vice president of product management at COMSOL, explains the module is commonly used to simulate doping semiconductor wafers. The Semiconductor Module, by contrast, simulates operations in p–n junctions, bipolar transistors, metal-oxide-semiconductor field-effect transistors (MOSFETs), metal semiconductor field effect transistors (MESFETs), thyristors and Schottky diodes. The Electrochemistry Module can be used for glucose and gas sensors, among other things.

But according to Sjodin, COMSOL is working on a toolkit that will allow users to develop their own customized user interface. This could be of tremendous help to users beyond traditional aerospace and automotive markets.

—K. Wong

by Kenneth Wong & Beth Stackpole

Autodesk Partners with NetSuite for ERP

It's no secret that Autodesk has staked its bet on the cloud as a key differentiator for its Product Lifecycle Management (PLM) 360 offering. Now the company is touting a partnership with enterprise resource planning (ERP) cloud provider NetSuite Inc., making closed-loop integration with ERP another ace in its quest to build out a winning PLM hand. The pair is promising to build seamless integration between Autodesk's PLM 360 cloud PLM platform and NetSuite's cloud-based business management suite, including the NetSuite Manufacturing Edition.

The result, officials from both companies say, will be an end-to-end cloud-based solution that supports the full spectrum of activities related to designing and manufacturing products — from ideation, through manufacturing, service and multi-channel sales. The companies are working with Autodesk's PLM Connect cloud-based tool to create the integration between the platforms, says Brian Roepke, Autodesk's director of PLM.

End-to-End Visibility

Timing for the partnership makes sense, officials say, because manufacturers are in need of a system that can deliver end-to-end visibility while also being easy to configure and deploy in the face of continuous time-to-market and costing pressures.

"Manufacturers have increasing challenges and pressures around product development and managing their supply chains," says Richard Blatcher, Autodesk's senior industry manager, at a press conference announcing the extended partnership. "Gone are the days when traditional, build-to-stock manufacturing is the way forward — today, it's the way of the past. Autodesk PLM 360 and NetSuite together deliver a platform that's rapidly configurable and can support continuous product innovation."

The idea is to build bidirectional integration between the systems for seamless data flow in support of a wide array of workflows. Two examples that Autodesk cited include:

- **Approved vendor lists and vendors audits:** Creating a tight, closed-loop cycle between ERP and PLM aids in the vendor approval and procurement process by making sure everyone in the cycle are kept on the same page — from engineers specifying components and parts to warehouse personnel maintaining optimal levels of inventory of those parts. With closed-loop integration, if a vendor is marked as inactive in the PLM system after an audit because it fails to meet quality standards, its status is automatically reflected in other relevant workflows like purchasing or inventory management, ensuring that employees in those departments no longer order or maintain those parts.
- **Intelligent change management:** The bidirectional integration takes change management to another level, ensuring all the information from the PLM system is fed into NetSuite and properly documented, propagated and managed in both PLM and downstream manufacturing. This would ensure that an engineering change order (ECO) affecting a bill of materials (BOM) is also reflected in the manufacturing BOM, so that a work order for assembly routing processes is properly updated, for example.

Easing Integration

PLM-to-ERP integration continues to be a sticky point for companies orchestrating widespread adoption of PLM. While Autodesk is not reselling NetSuite or creating an ERP/PLM service bundle as part of this partnership, the alliance does take challenging integration issues off the table for customers interested in both NetSuite and Autodesk's offerings, particularly small- and medium-sized businesses, notes Tom Gill, an independent PLM consultant.

It also opens up both companies for expansion into new customer constituencies — in Autodesk's case, NetSuite's universe of non-PLM users. In fact, Blatcher says that 70% of Autodesk PLM 360 customers had no prior PLM implementation prior to using the cloud-based offering.

Expanding PLM

In addition to the NetSuite partnership, Autodesk is also touting other areas of expansion around PLM 360. The company has broadened its relationship with other cloud service providers, including Jitterbit, which delivers integration software, and Octopart, a cloud service specializing in material compliance. Autodesk has also gone live with the PLM 360 App Store, which serves as a template library of different business processes that users can leverage in their PLM environment. The PLM 360 apps are available to Autodesk PLM 360 customers free of charge.

"In the traditional software model, companies have to buy new modules every time they want to expand their ecosystem," Roepke says. "With PLM 360, we want to keep it simple and let them expand their system without buying more modules."

—B. Stackpole

Dell Launches New Entry-level and Rack-mountable Workstations

Workstation performance for about the price of a desktop. That's how Dell pitches its new entry-level workstation T1700. The new unit is available in small form factor and mini-tower configurations. They'll be powered by the Intel Xeon processor E3-1200 v3, based on Intel Haswell architecture. GPU options for the T1700 includes AMD FirePro and NVIDIA Quadro cards. According to Dell, the T1700 is the industry's "smallest entry-level tower workstation."

As an entry-level product, the T1700 targets the budget-conscious 2D and 3D design software users. T1700 models are "designed and certified for engineering, architecture and finance professionals. The workstations also are ideal for higher education and high-school students working with 2D, entry-level 3D simulation or multitasking with demanding applications," Dell says in the announcement. Dell's rival HP targets the same segment with its entry-level Z210 workstation, priced beginning $569. (*Author's Note: For more, read "HP's first entry-level workstation: Z210," April 2011*)

The new workstation comes with Dell's Performance Optimizer software, meant to automatically tune software performance on your machine. The software also handles driver updates and system usage analysis. At press time, Dell had not announced the price for the T1700.

Rack-Mountable Workstation

Dell has also launched a new rack-mountable workstation, the Dell Precision R7610. Although fully functional as a workstation, this product is meant for data-center deployment. With this setup, the workstation can be deployed in a secure service room, physically away from the users' desktops and cubicles. Dell partner Teradaci's PC-over-IP remote terminals serve as the intermediary control devices to connect the workstations and the users.

As Dell says in the announcement, "A single workstation can be used by four users without sacrificing performance. The new R7610 achieves this via GPU pass-through and certifications with Citrix XenServer 6.1.0 using Citrix XenDesktop HDX 3D Pro, which allows all the resources of a dedicated discrete graphics card to be uniquely shared with multiple users in a hosted-shared environment or made available to a single user or virtual machine in a virtualized environment."

In a remote PC setup, the option that gives you the best performance is the one-to-one connection. That's where the processor power and memory of one physical machine are made available to one exclusive user remotely. But if your workload is light and you don't need the full force of the entire machine connected to you, you may divide up one physical R7610's resource among four remote users. The virtual GPU sharing, however, is currently only available as a one-to-one setup. In the future, NVIDIA and its partners may improve the virtualization technology to allow GPU sharing among multiple users or devices.

Memory Technology

The R7610 comes with Dell's Reliable Memory Technology, described as a "Dell patented code programmed at the BIOS level that eliminates virtually all memory errors and therefore the need for extensive full memory tests, IT support calls and memory DIMM replacement." This technology, according to Dell, can identify bad memory sectors and quarantine them so you won't write to them. In addition, it can also alert you to replace a memory module if it's too damaged to be reliable.

The Precision R7610 was first made available May 21, at a starting price of $2,179.

—K. Wong

Turn Your iPhone into a Biomed Lab

Bored with your iPhone? Try turning it into a low-cost spectrophotometer. Researchers at the University of Illinois at Urbana-Champaign have come up with an iPhone app and a cradle that will let users detect toxins, proteins, bacteria, viruses and other biological material.

Using the built-in camera, the phone takes a picture of a normal microscope slide, which the app analyzes for differences in wavelength that a photonic crystal built into the cradle can reflect. According to the researchers, the relatively low-cost system (the optical components in the cradle amount to about $200) can perform as accurately as a $50,000 laboratory spectrophotometer.

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Rolls-Royce Backs Supersonic Car Project

Rolls-Royce has signed up to provide its EJ200 jet engine for the Bloodhound supersonic car project, which hopes to drive a car past the 1,000 mph mark.

The jet engine will help get the vehicle to 350 mph, then ignite a rocket motor that will move the car at supersonic speeds. The current land speed record is

763 mph, and members of the team that set that record are involved in Bloodhound.

According to the Bloodhound website, the development team is making considerable use of finite element analysis (FEA) and computational fluid dynamics (CFD) in the 3D design of the vehicle.

At press time, the car is being assembled at a technical center in Avonmouth, Bristol, England. It will make its record-breaking attempt on a dry lakebed in South Africa.

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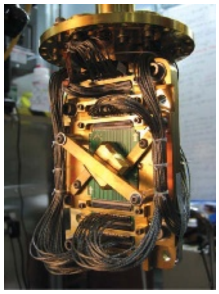
Google, NASA Back D-Wave Quantum Computer



Google and NASA are getting behind the D-Wave quantum computer, and have partnered to start an artificial intelligence (AI) lab at NASA's Advanced Supercomputing Facility at the Ames Research Center in Moffett Field, CA.

Google is interested in how a quantum computer could speed up its search engine — and possibly its voice recognition program. NASA wants to use the D-Wave to design AI that can assist in space exploration.

Just how fast is the D-Wave? One test found the quantum computer could solve a specific problem in a half-second, while the next best competing system required 30 seconds to achieve the same result. A separate test found that the D-Wave could solve more problems in a set period of time than conventional computers, at a rate of about 3:1.

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Portable 'Sound Camera' Can Diagnose Typical Automobile Troubles

Korean designers have come up with a portable "sound camera" that can be easily set up and used to pinpoint the source of specific noises coming from an automobile.

A sound camera uses a microphone array to visualize the distribution of sound. Previous systems were fairly large and cumbersome. Researchers in the Department of Industrial Design at the Korea Advanced Institute of Science and Technology (KAIST) developed a portable version that targets the types of abnormal noises that come from industrial equipment.

The 4-lb. SeeSV-S205 has five microphone arrays that can capture 25 sound images per second. An optical camera in the unit sends images to a computer, which can overlay the sound patterns with the image of the vehicle or equipment.

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Google Flies a Kite

Google X has acquired Makani Power, a company specializing in wind turbine technology that uses a kite-like concept to harness wind energy.

The Makani turbine actually looks more like a miniature plane than a kite. It is a tethered wing that generates power by flying in large circles where the wind is stronger and more consistent. According to the company, it eliminates 90% of the material used in conventional wind turbines, and can access winds both at higher altitudes and above deep waters offshore.

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Full-color Desktop 3D Printer Coming

At press time, new startup botObjects was preparing to launch its first product, a full-color desktop 3D printer. While the woods may be full of desktop 3D printers in general, full-color systems are a bit rarer. botObjects' ProDesk3D is a material deposition system that uses a five-color polylactic acid (PLA) cartridge system to build objects. The cartridges are filled with primary colors that, according to the company, can be mixed and matched to provide full color.

The company is claiming 25μ prints, with a 10.8 x 10.8 x 11.8 in. build area. That large a build area for a desktop 3D printer is fairly impressive, offering plenty of room for most prototyping needs. The ProDesk3D also sports a dual-extruder head, comes with a self-calibrating build platform, and runs on botObjects' ProModel software.

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3D-printed Tracheal Splint Saves Baby's Life

Doctors at the University of Michigan's C.S. Mott Children's Hospital have used 3D printing to save a child's life. From the time Kaiba Gionfriddo was six weeks old, the bronchus responsible for moving air to his left lung would collapse, leaving him unable to breathe. Doctors weren't optimistic about the baby's chances.

Fortunately for the Gionfriddo family, Glenn Green, M.D., and his colleague, Scott Hollister, Ph.D, both of the University of Michigan, had been experimenting with a bioresorbable tracheal splint.

The custom medical device was designed using a CT scan of Kaiba's trachea/bronchus. From there, the design was fabricated with a 3D printer before being sewn around Kaiba's airway. No additional surgery will be required to remove the splint after Kaiba's bronchus grows and stabilizes on its own.

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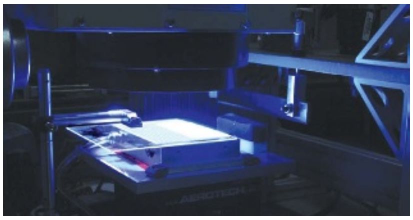
GE Tests AM's Potential

In late 2012, GE made a significant investment in additive manufacturing (AM) technology when it acquired Morris Technologies, and its 3D printing service, Rapid Quality Manufacturing. Now the corporate giant is getting ready to flex its AM muscle with a large-scale industrial test of 3D printing.

GE Aviation, in cooperation with the French aircraft and rocket engine manufacturer Snecma, will be leveraging AM to build nozzles for its LEAP engine. The company intends to begin full production by early 2016 at the latest.

Each LEAP engine requires 10 to 20 nozzles, and GE will need to manufacture around 25,000 of the nozzles each year. That level of production is beyond the norm for AM. You can be sure other businesses will be keeping an eye on



GE's progress to see whether 3D printing scales up as well as the company hopes.

GE will be using laser sintering techniques to build the nozzles.

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Research Begins on AM Graphene Material

The evolution of additive manufacturing (AM) will rely as much on materials as on process, resolution or build envelope. American Graphite Technologies (AG) wants one of the materials used in future AM products to be graphene. The company recently announced a letter of intent with several Ukrainian research facilities, including the Kharkiv Institute of Physics and Technology (KIPT), to find a way to incorporate graphene into AM.

Combining graphene and 3D printing could lead to entirely new areas of production. Graphene conducts electricity better than copper, which means computer architecture could be partially, or completely, created simply by using an AM system.

MORE ➜ rapidreadytech.com/?p=4060

Wohlers Releases Report for 2013

Wohlers Report, produced on an annual basis by Wohlers Associates, tracks the 3D printing industry as a whole and offers analysis and company information pertaining to additive manufacturing (AM) along with other useful information. The latest report weighs in at 297 pages and covers important developments in AM over the last 18 months. A couple tidbits from Wohlers Associates include:

- "The market for 3D printing in 2012, consisting of all products and services worldwide, grew 28.6% [compounded annual growth rate, or CAGR] to $2.204 billion. This is up from $1.714 billion in 2011. Growth was 24.1% in 2010.
- "By 2017, Wohlers Associates believes that the sale of 3D-printing products and services will approach $6 billion worldwide.

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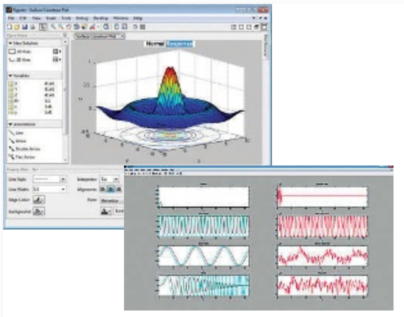
Editor's Picks

by Anthony J. Lockwood

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



MathWorks Releases 2013a MATLAB and Simulink

Updates strengthen wireless capabilities and radar communications system design.

Release 2013a of the MATLAB technical computing environment and Simulink graphical environment for simulation and model-based design of multidomain dynamic and embedded systems is, as you might expect, a sprawling affair. After all, these two product families probably comprise 100 toolboxes for mathematics, simulation, data acquisition, image and signal processing, control systems, and T&M, and more. The latest release offers upgrades to more than 80 family members.

One of the key developments is a new toolbox called Fixed-Point Designer, which works with MATLAB codes, Simulink models, and Stateflow charts ...

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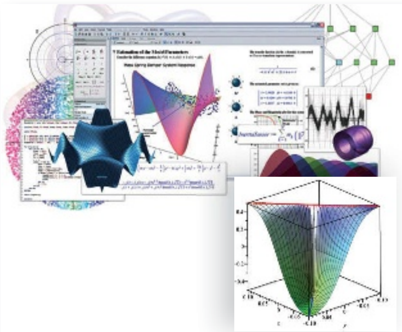

Engineering, Mathematical, and Scientific System Updated

Maple 17 offers over 400 new commands for technical problem solving and application development.

Maplesoft released version 17 of its Maple technical computing and documentation environment. It has some 430 new commands for mathematical problem solving alone. In total, Maple 17 incorporates some 5,565 changes and enhancements overall, including 400 intended to help you be more productive. Let's run through some highlights of the software.

Maple 17 has new functionality in the form of a new class of ordinary differential equations ...

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Altair Releases HyperWorks 12.0

Release focuses on simulation-driven design, composites, and multiphysics analysis.

Altair Engineering recently released version 12.0 of HyperWorks, its suite of modeling, analysis, visualization, and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics engineering. As you might expect with a platform as comprehensive as HyperWorks, the new features and enhancements in this release range far and wide across all disciplines. We'll run through a few items of note and link to more information ...

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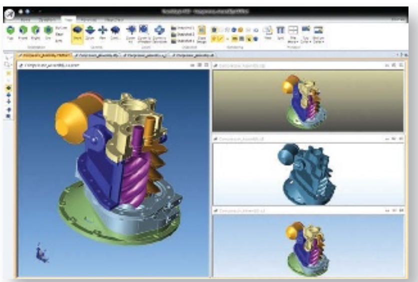

Multi-CAD Interoperability Software Suite Updated

TransMagic releases R10 products, support for Windows 8 and DWG and CATIA V6 formats among enhancements.

TransMagic announced the R10 release of its TransMagic family of multi-CAD interoperability applications. This appears to be a major update. Let's take a quick look.

R10 offers updated support for what seems all the latest versions of the major CAD file formats. Additionally, it extends new support for DWG formats up to 2013 and adds CATIA V6 support as a complement to its CATIA V4 and V5 support, including V5 R23.

The big news is that R10 introduces three new products: TransMagic EXPRESS, TransMagic PRO, and TransMagic CREATIVE.

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Balance is the Best Route to Workstation Performance

Rather than opting for the fastest processor or the highest end state-of-the-art GPU, take a balanced approach to configuring a workstation.

Instead of fixating on the fastest processor or locking on state-of-the-art GPU capabilities to drive CAD and simulation performance, design engineers should take a more balanced approach to configuring their optimal workstation.

Many engineers, hungry for the ultimate in performance, are inclined to shell out top dollar on a workstation simply because it sports the highest-end processor or the latest in GPU technology. However, they do so at the risk of underplaying other workstation components—specifically, memory and storage—which can play key roles in bolstering overall system performance, oftentimes at a lower cost.

Find the Right Balance

By buying one or two frequencies down from what is considered the premiere performance CPU, or by opting for a more basic—and thus less expensive—graphics card, engineers can glean savings, which can then be channeled toward the purchase of additional memory or solid-state drives (SSDs). These options can have a greater overall impact on boosting productivity and delivering the best user experience, especially since engineers don't typically spend all day working with CAD or simulation tools.

Consider this example of the power of balance: With an investment in twice the memory capacity of their largest CAD models, engineers may be able to increase performance by as much as 2X on that model. One simple rule of thumb when configuring a workstation for simulation work is to employ 2GB of memory per core (not per processor).

Save on Graphics to Fund Other Investments

Similar benefits can be had by trading off graphics horsepower to fund additional increments in solid state storage. Most CAD users can work sufficiently with an entry-level GPU. In fact, a recent test by CATi, a SolidWorks reseller, found that the performance difference between a $150 entry-level discrete card and a $1,500 high-end graphics card was approximately 6% during an average day by a typical user. That $1,000 savings can go a long way in funding additional resources to create a more balanced workstation—for example, buying additional SSDs, which can boost user productivity by as much as 3X, or outfitting a workstation with error correcting-code (ECC) memory, which will ensure modeling and simulation results are always accurate.

Xeon Provides Options

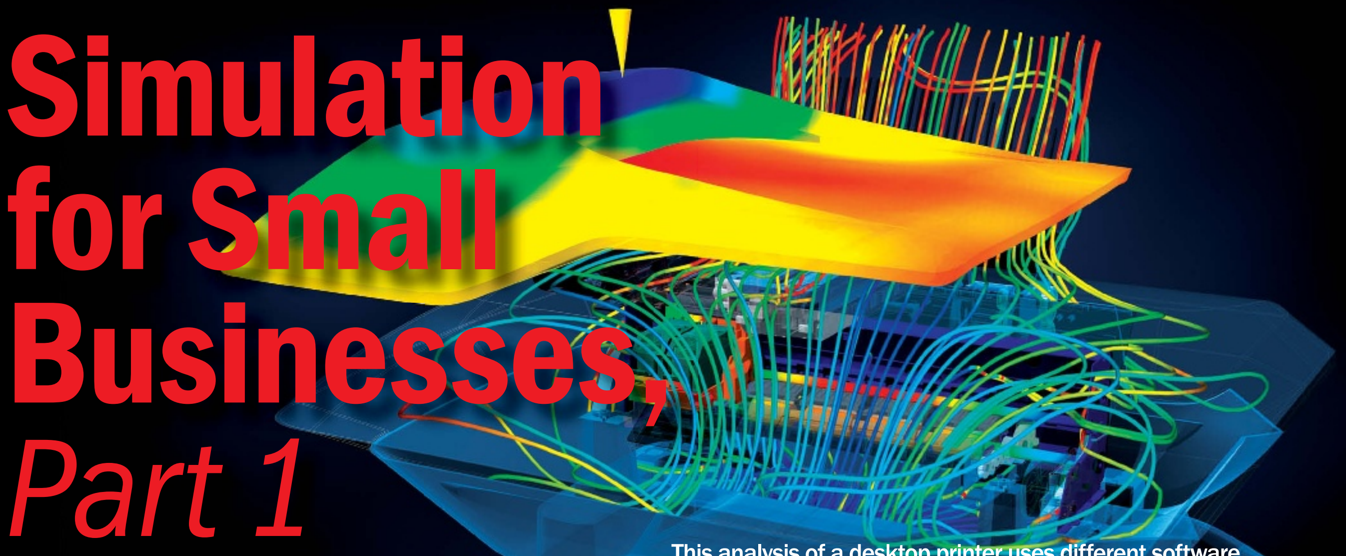
Intel's Xeon-based line of workstation processors, built for professionals, can help drive performance beyond what's possible in a typical desktop while giving engineers the widest array of options for creating a balanced system. With so-called "uncore technologies" like accelerated I/O performance, ECC memory, optimized cache utilization, and new architected data flow, the Xeon E5 family is optimized for handling large data models and enhanced throughput on simulations.

Case in point: A dual 8-core Xeon-based Lenovo system running at a 2.7GHz frequency, equipped with 32GB of memory and dual Intel 240GB SSDs, ran a flow simulation 1.7X faster than a dual 4-core Xeon system with 16GB of memory and dual 250GB SCSI drives despite its higher 3GHz frequency. Benchmark tests showed even greater results (up to as much as 3.5X performance boosts) in PhotoView 360 rendering jobs when comparing Core i7 and Xeon-based workstations.

So don't automatically assume that bigger and faster CPU or GPU horsepower is the only route to a high-performing engineering workstation. Balance, not brawn, is the most cost-effective approach to optimizing a workstation that works for you. DE

INFO ➜ Intel Corp: intel.com/go/workstation

Simulation for Small Businesses, *Part 1*



This analysis of a desktop printer uses different software packages in the Autodesk Simulation 360 family. The image shows mechanical stress (color regions on the ink-jet cartridge holders), Moldflow injection pressure (visible as colors on the top section of the printer), and fluid and thermal simulation (streamlines throughout). *Image courtesy of Autodesk.*

Software companies are eager to help SMBs get onboard.

BY PAMELA J. WATERMAN

Do you work for a small, medium (or micro-sized) business, commonly called an SMB? Maybe you've thought simulation software sounds good, but is too expensive, too complicated and only occasionally needed.

Well, it's time to think again. Companies developing software for analyzing mechanical and/or fluid designs are scrambling to get a piece of the SMB action — and that's paying off to your benefit. They now offer manageable simulation tools that work when your budget is modest (some well below $15,000) and when your analysis "staff" is also responsible for CAD, soldering and printer repair.

DE challenged a number of companies plus a university to detail just what they're doing to make such simulations intuitive, flexible and affordable for non-experts. In Part 1, we'll focus on simulation embedded in CAD software.

More than Just Technically Useful

Since working in one's everyday CAD environment provides a natural comfort zone, it's no wonder that CAD packages with embedded simulation functions have great appeal for many product designers. SolidWorks, Autodesk, PTC and Siemens PLM Software Solid Edge products come to mind.

Delphine Genouvrier, SolidWorks senior product manager, says, "The SolidWorks Simulation solution is fully embedded in SolidWorks 3D CAD, which means product engineers keep using the same interface, product philosophy, familiar workflow and commands when designing and testing a design. This shortens the learning curve." It also means that the 3D CAD model becomes the simulation model without any data translation.

With this single interface, the family of SolidWorks Simulation solutions generates consistent and coupled results. For example, thermal computational fluid dynamics (CFD) results from SolidWorks Flow Simulation can be used as direct input for a large displacement structural simulation in SolidWorks Simulation Premium. As customer needs evolve, users can easily add SolidWorks Plastics for plastic injection simulation (parts and molds), SolidWorks Motion (rigid body dynamic simulation), and SolidWorks Sustainability (for sustainable design testing).

From an engineering design standpoint, SMBs have always been a sweet spot for Autodesk, says Luke Mihelcic, simulation product marketing executive. "We've taken Inventor (3D design) tools and added internal basic functionality to give users a taste of simulation," he says. Outside of Inventor, the company's Autodesk Simulation products run the gamut, from Mechanical and CFD to several versions of Moldflow for parts or assemblies.

Mihelcic adds that what's exciting about making simulation accessible to SMBs are the new Autodesk 360 packages. These take the various desktop products and put them in cloud-based bundles, with a one-year license allowing 120 simulations at greatly reduced prices compared to the standard price structure. For example, Autodesk Simulation 360 Professional bundles Autodesk Mechanical, CFD and Robot Structure Analysis, all for $3,600. The software has full function capabilities — plus, users can buy more simulation runs as needed beyond the 120. Plans are underway for even shorter term licensing models for companies that frequently handle projects where simulations are only run for two to three months' time.

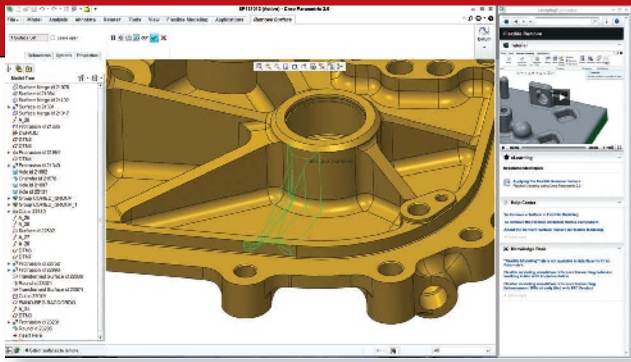
Autodesk is also on the cutting edge of mobile apps for simulation and using wiki sites for on-demand training. The company offers Autodesk ForceEffect and ForceEffect Motion (to quickly get an idea of the forces in a new design) for free on IOS and Android platforms, downloadable through the Google Chrome Web Store. Both apps have been out for about a year-and-a-half, and have seen more than 500,000 downloads. Autodesk's community-enhanced WikiHelp pages step design engineers through Quick Starts, Essential Skills, Tutorials and more — all free and all conveniently accessible on the user's schedule.

PTC's goal has always been to put good structural analysis tools at the fingertips of the desktop engineer — tools that don't require the expertise of a full-time finite element analysis (FEA) expert. Brian Thompson, PTC vice president of product management, notes, for example, that the company's meshing approach uses P elements instead of typical H elements. Because these inherently map well to the geometry, mesh density is not a huge issue; the meshing algorithms don't require multiple passes for optimization, making the whole process easier.

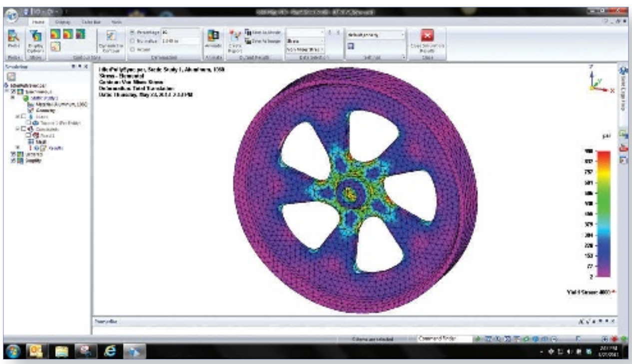
Thompson says, "More recently, we've done some special work to improve adoption and use of our analysis tools for the individual user, completely revamping the user experience. If you look at the PTC Creo Simulate extension, you see a very modern, ribbon-based interface with grouped commands. Also, even without the extension, you actually get a free wizard-based analysis tool with a check-box approach that steps you through the process, limited only by the size of the model."

Other improvements in the PTC Creo Simulate extension include easier software installation, easier bolted-joint idealization, and a simplified way to analyze non-linear problems. For the last, if you have experimental force-vs.-deflection data for a non-linear material, the software will fit a curve to the data and automatically apply it to a given design model. It's a powerful aid to someone just getting started with such problems.

Solid Edge 3D CAD design software, a core component of the Siemens PLM Velocity Series portfolio, includes analysis capabilities that complement those of Femap, the company's specialist software. In fact, Solid Edge Simulation employs Femap for meshing and Seimens PLM NX NASTRAN for solving, but makes it all easier for the mainstream engineer. For example, employing the philosophy of the CAD system — using synchronous technology to edit designs faster — a given material choice not only assigns a color for the CAD image, but also all material properties for mechanical simulation.



PTC Creo Flexible Modeling Extension with PTC LearningConnector gives SMB customers seamless access to an eLearning library, online help and the PTC KnowledgeBase in a context-sensitive way to find exactly the information needed to be efficiently productive. The PTC LearningConnector is a free learning application that comes with PTC Creo, PTC Windchill, PTC Mathcad Prime and PTC Arbortext software. ***Image courtesy of PTC.***



Stress results from FEA of an idler pulley, performed within SolidEdge from Siemens PLM Software. Image courtesy Siemens PLM Software.

Bill McClure, vice president of product development for Solid Edge, Siemens PLM Software, explains that the software also guides users through an analysis by automatically recognizing and applying relevant tasks such as creating a mid-plane on sheet metal, a solid mesh on a solid part and a beam mesh on a beam.

Thermal analysis capabilities were added to Solid Edge in version ST5, and optimization has been added in the recent release of Solid Edge ST6. In other news, Solid Edge plans to launch an online store later this summer where customers can purchase and download the software for use on a monthly subscription basis. McClure notes that the new subscription model is expected to appeal to SMBs, particularly those who are looking for more affordable and flexible alternatives to traditional, professional CAD offerings.

In Part 2 of this article, we'll look at how other companies are connecting CAD with simulation, making computational fluid dynamics (CFD) accessible, and providing training. **DE**

Contributing Editor **Pamela Waterman**, *DE's simulation expert, is an electrical engineer and freelance technical writer based in Arizona. You can send her e-mail to DE-Editors@deskeng.com.*

INFO ➔ Autodesk: 360.autodesk.com/landing

➔ **PTC:** PTC.com

➔ **Siemens PLM Software:** SolidEdge.com

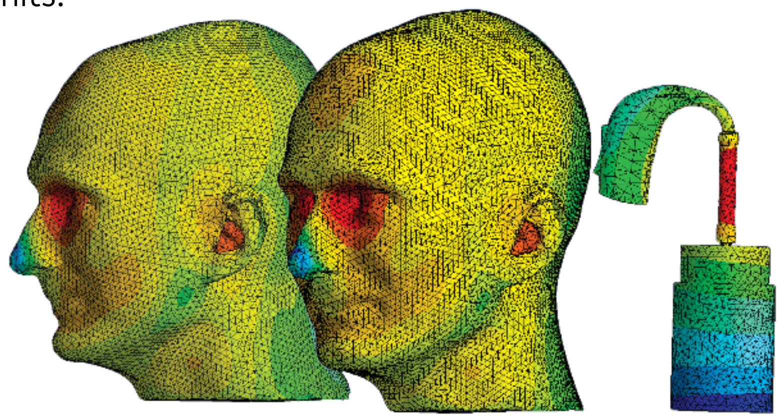
➔ **SolidWorks:** SolidWorks.com

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

From Classical Mechanics to Biomechanics

The adoption of digital simulation in biomedical and life sciences tests the technology's limits.

BY KENNETH WONG



Oticon, a hearing aid manufacturer, uses ANSYS to simulate how its products fit and function inside ear canals.

Martin Larsen, a simulation specialist at Oticon, uses ANSYS Mechanical, the same software automakers would use to reduce brake squeal or test noise, vibration and harshness (NVH). *But Larsen doesn't design vehicles; he designs hearing aids.*

Wind Feng, an R&D engineer at MicroPort, uses Dassault Systèmes SIMULIA. Aerospace manufacturers use the same program to optimize hypersonic re-entry vehicles. *Feng, however, happens to work in orthopedics.*

Darryl D'Lima, M.D., Ph.D., from Scripps Research Institute, has more than 10 years of experience in MSC Software's Marc, a program widely used in transportation and energy. *But D'Lima isn't researching transmissions and gears; he studies cartilage injury, stem cells, and joint wear.*

These are just a few examples of the biomedical profession's flirtation with simulation technologies.

Manufacturing activities in automotive and aerospace fuel R&D and commerce in the simulation sector. Industry titans like GM, Ford, Boeing and Airbus play a big part in shaping the technology and the workflow. Because the software programs have gone through cycles of trial and error over the years, the latest generation of solvers can replicate car- and plane-related phenomena with reliable fidelity. Computational fluid dynamics (CFD), structural dynamics, preprocessing, post-processing and meshing are part of automotive and aerospace engineers' daily vocabulary.

For doctors, physicians, and researchers in life sciences, however, simulation vocabulary might as well be Greek or Latin. Come to think of it, Greek or Latin might be easier for doctors to grasp, because it's the root of many medical terms.

Can these new users easily adopt programs initially designed with another industry in mind? Can the programs used to simulate heat distribution and mechanical operations inside an engine block be used to simulate hearing aids and knee joints? Is specifying the right viscosity, thermal conductivity and tensile strength for human tissue and blood as simple as picking them out of a dropdown menu in a library and adjusting their properties? The answers to these questions suggest simulation software makers have a lot to learn from the new professions they're courting.

Group Treatment Not Available

With a strong presence in healthcare as well as product lifecycle management (PLM), Siemens makes not only medical devices, but also the software used to simulate them. The symbiosis between its device and simulation software divisions is reflected in the ease with which you can reuse magnetic resonance imaging (MRI) data inside NX, the company's leading computer-aided design/manufacturing/engineering software suite. That's according to Martin Kuessner, global lead of NX CAE business development at Siemens PLM Software.

"In medical device, pharmaceutical and biomedical, there's a lot of simulation going on," Kuessner says. "It's rapidly increasing. However, [the use] is not as straightforward as in other industries. It's much more complex, much more diverse. Therefore, it might not have the visibility and the penetration it deserves."

Automotive components have become highly standardized; consequently, developing a custom automotive simulation package is relatively easy. Not so with medical devices, says Kuessner.

"A stent, a heart valve, a tablet dispenser, a liquid container — they have different challenges, demand different degrees of ac-

Continued on page 18 ...

High-Octane Design

The multi-configurable 3DBOXX 8950 is primed for performance, helping to reduce design bottlenecks and accelerate time to market.

What engineer or designer isn't familiar with the dreaded sit-around-and-wait syndrome? That's when a critical workflow like a photorealistic rendering job or a structural/fluid analysis running in background mode slows a system to a crawl, leaving the user in a holding pattern for hours while the machine labors to get the job done.

Tuning workstation performance to overcome such productivity-sapping bottlenecks is what BOXX Technologies is all about. The company harnesses an array of state-of-the-art technologies, from multi-core processors and advanced GPU horsepower to internal innovations in the areas of overclocking and liquid cooling, to prime its workstations for optimal performance. BOXX workstations are designed to handle graphics- and compute-intensive applications like rendering, visualization, and 3D simulation.

The ability to run advanced simulations more efficiently or to employ visualization and rendering techniques to cut down on the number of iterative prototyping cycles is critical for design engineers today. Increasingly, companies across all industries are being pressured to shrink time-to-market schedules and reduce costs. Optimized design and engineering workflows can greatly enhance engineers' ability to meet their targets.

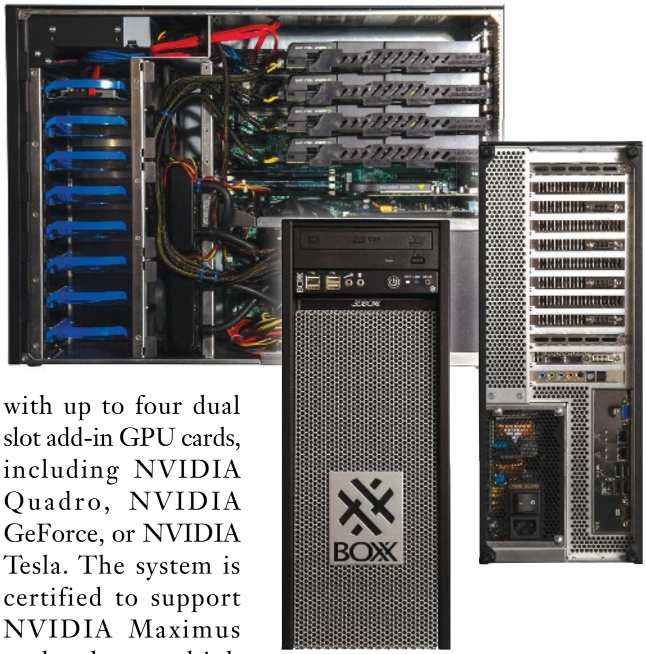
Fast and Flexible

That's where the new 3DBOXX 8950 workstation comes in. Designed specifically to accommodate multi-threading and multiple applications used in advanced engineering workflows, the 3DBOXX 8950 offers the ultimate in flexibility. It supports advanced multi-card configurations, including support for multiple CPUs or GPUs, depending on which approach works best for a particular use case.

The system features dual Intel Xeon E5-2600 Series processors with support for up to 16 cores (32 threads) and up to 512GB of system memory. System expandability comes into play through a total of 12 add-in card slots, which can accommodate advanced multi-card configurations, including a mix of graphics co-processor or accelerator cards.

Specifically, there are four PCI-E x16 slots in addition to one PCI-E x16(x8), one PCIE-E X8, and one PCI-E x8(x4) slots, allowing users to optimize system performance with a mix of add-on capabilities depending on the requirements of their specific applications.

In addition to the raw horsepower, the workstation is extremely GPU-centric. The 3DBOXX 8950 can be stocked

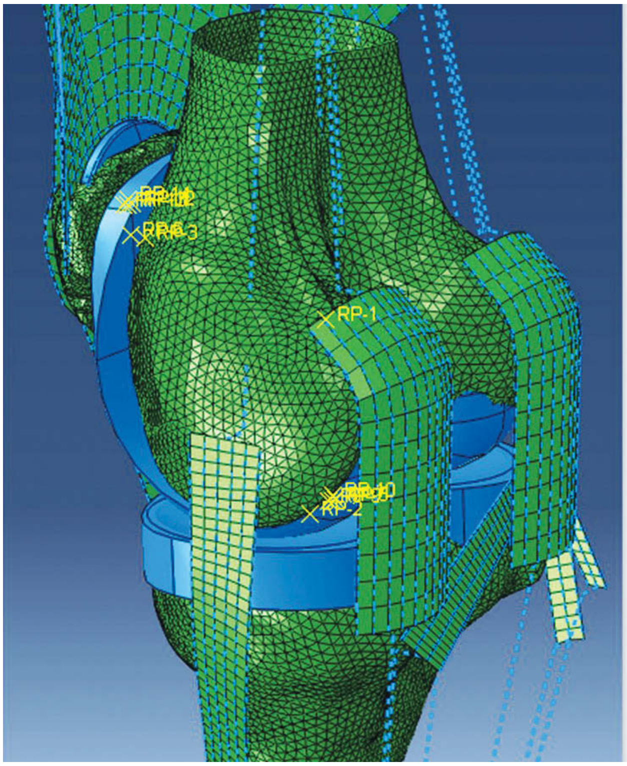


with up to four dual slot add-in GPU cards, including NVIDIA Quadro, NVIDIA GeForce, or NVIDIA Tesla. The system is certified to support NVIDIA Maximus technology, which leverages the graphics horsepower of the GPU with the computing engine of the Tesla accelerator to greatly minimize rendering times and maximize system interactivity. The Maximus configuration helps to further optimize the design cycle, aiding manufacturers in accelerating time to market.

Despite its horsepower and configurability, the 3DBOXX 8950 has been architected to be a model corporate citizen. The system workstation features innovative BOXX liquid cooling, which ensures that the system doesn't run hot and isn't noisy. The 1250-watt, 80 Plus Gold Power Supply also makes sure power requirements are sufficient for the system's high-performance components.

With engineers and designers routinely tasked with accomplishing more in a compressed time frame, no one can afford to wait around for a workstation that can't keep pace. The 3DBOXX 8950 Series gives engineering teams the flexibility they need to take back their workstation and get the ultimate in high-octane performance. For more on the 3DBOXX 8950 series or other BOXX workstations featuring NVIDIA Maximus technology, call 1-877-877-BOXX or visit www.boxxtech.com. DE

NVIDIA MAXIMUS™ TECHNOLOGY



This meshed FEA model of a Total Knee Replacement (TKR) is ready for analysis in the Abaqus Knee Simulator AKS from Dassault Systèmes SIMULIA. The 2D rectangular strips and the vertical lines are tendons. The TKR components are in blue. The two large green knobs are the tibia and the femur.

curacy," he points out. Neither Siemens nor any other simulation software maker can possibly come up with a single "prefabricated, preconfigured simulation solution" to accommodate this of diversity. However, each application area can be covered by its own customized environment for easier access to simulation, he says.

Customization: Pros and Cons

Oticon's Larsen simulates the way sound waves and vibrations travel through the ear canal using ANSYS Mechanical. Larsen and his colleagues tweaked the software to fit their own workflow, based on their accumulated understanding of the inner working of ear canals. They load the software with custom material databases. These, he says, are closely guarded secrets among the handful of companies competing for dominance in hearing aid design.

In its deployment of ANSYS Mechanical, Oticon pays particular attention to acoustic loss, resulting from the use of tiny tubes in hearing aids. Larsen and his colleagues thought about developing a general user interface for acoustic simulation, but found out they didn't need to—ANSYS beat them to the punch by introducing the feature in Version 13. By Version 14.5, ANSYS has come up with acoustic loss analysis. Larsen hopes to see more developments to this function in the future.

In some instances, the requirements of the medical device maker may be too specialized for the general-purpose simulation package to address. In that case, the user has no choice but to develop custom codes or plug-ins. "We try to do everything in ANSYS if we can," says Larsen. "We want to spend our time developing hearing aids, not custom software. That said, we have developed own tools as well."

In the past few years, Chinese medical device and implant manufacturer MicroPort has closely collaborated with DS SIMULIA in structure optimization, kinematics simulation and fatigue analysis. MicroPort's Feng says, "Every customer has its own requirement for simulation. We've made a customized process for a cardiovascular implant, and find it efficient and useful."

At least when it comes to knee implants, MicroPort won't need to write custom code. DS SIMULIA came up with the Abaqus Knee Simulator (AKS), based on its general-purpose finite element analysis (FEA) program Abaqus. The company describes the module as "a validated computational modeling tool for performing basic to advanced knee implant analyses and simulations. This tool offers five fast and easy-to-setup workflows which reduce your reliance on time-consuming trials and expensive lab equipment, while still meeting regulatory requirements."

Feng says simulation helps MicroPort "reduce physical prototyping and shorten mechanical and fatigue testing times. More importantly, it helps us evaluate the biomechanics performance of our design without conducting expensive and lengthy physical tests."

MicroPort uses DS SIMULIA's AKS to simulate two types of knee implants: fixed bearing and mobile bearing.

"Because of their complexity and loading conditions, setting up these two models could easily have taken a week by hand," Feng says. "Instead, it took a day or two. The AKS makes it practical for product development companies to perform simulations as thorough as those at research institutes."

The Language Barrier

Thierry Marchal, ANSYS' industry director for healthcare, says, "Many of the people in medical device have an engineering background. Often, they came from other industries. Some have worked at places like Boeing, so they know simulation, even know the software." But he points out a new class of simulation users are emerging: clinical technicians, surgeons and physicians. "These people are so busy operating on patients and saving lives, there's no way they can invest the time to learn the software," says Marchal. For them, the language in simulation could be a significant barrier. That language consists of material tensile strength, outside pressure, internal temperature, fluid turbulence model, and other computable values.

Siemens' Kuessner sees value in a simulation program with customized input fields. "That way, you won't be talking about Young's modulus, but instead, you can ask for bone types [as input]," he reasons. "At the end of the day, you're still dealing with engineering calculation — strain energy, stress and so on — but the interface should be customized for the user."

Such a concept might be difficult to implement at the software level, however. Ashley Peterson, principal R&D engineer at Medtronic, a medical device manufacturer, points out that there's currently no good way to translate patient data into computable simulation values. Even if it were possible, he wonders whether it would be wise.

"If you take, say, a patient's age and correlate it to a certain blood flow or viscosity, you're saying, that's generally what you find. But that's not true in the cases where the patient has a certain disease, or if they have a slightly elevated blood pressure," he points out. "If you use averages, and remove too many of the details, you may be reducing the accuracy of the simulation."

Carlos Olguin, head of the bio-nano programmable matter group at Autodesk, says, "In my view, it is less about replacing and more about mapping and correlating standard medical terms and measurements to the engineering vocabulary. And the engineering vocabulary itself will also change, depending on the metric scale at which a simulation is performed."

Olguin offers as an example how at the molecular scale, gravity plays a less important role, while diffusion is emphasized: "As one goes even further down in scale, then Newtonian physics are gradually replaced by quantum physics."

When Metal Meets Flesh

Peterson and his colleagues at Medtronic employ CD-adapco's STAR CCM+ (for CFD) to develop and test medical devices. In some simulation scenarios, he needs to understand not just how the medical device operates, but how it interacts with organic matter. To simulate an endovascular stent graft, for example, requires simulating the way the device fits inside a patient's aortic aneurysm and interacts with the blood and vasculature.

In another division of Medtronic, the company uses ANSYS software to simulate how an implanted device behaves when a patient is subjected to an MRI scan. Mariya Lazebnik, Ph.D., senior scientist at Medtronic, points out, "Right now, patients with implantable devices cannot have an MRI scan because of the harmful interaction between the device and the scanner."

During an MRI scan, body temperature rises, which affects the implanted device. "This is a complex problem," says Lazebnik. "The size and shape of the patient will influence the magnitude of that interaction." Medtronic uses coupled physics — electromagnetic and thermal — in ANSYS to simulate these scenarios.

Using MSC Software's Marc nonlinear FEA software, researchers at Scripps simulated wear-related complications in orthopedic joint replacements, in scenarios where metals, polymers and biological materials literally interact with one another. Surprisingly, D'Lima reveals he and his colleagues are using Marc as-is, with little or no customization. He is considering using MSC Adams for biomechanics as a next step.

"We've solved the geometry problem with better imaging tools," says D'Lima. "We can now construct accurate surfaces from CT scans, and then turn them into meshes that the simulation solvers can handle. Getting valid forces and motions are still a challenge. We have machines that measure friction and wear, but material property is a bigger challenge. We can test the heck out of metals and artificial polymers used for implants, but getting the properties of bones, tendons, ligaments ... that's not easy."

It's a bit easier for Oticon, Larsen reports, because hearing aids are inserted into the ear canal; they don't get embedded below the skin or muscles. Larsen doesn't need to worry about simulating tissues. Rather, his challenge lies in customization.

"Each ear canal is very individual," he explains. "No two are alike. We have some very good information on certain types of ear canals. Then there are others we collect using special methods. The problem when obtaining ear canal geometries is to get close to the eardrum, since you can seriously hurt the person if you touch their eardrum."

Ongoing industry efforts include scanning different ear canals and studying them to understand sound-distribution directions, Larsen notes. That fuels his use of ANSYS Mechanical.

"We cooperate with the Technical University of Denmark (DTU), where they can generate 3D models of heads from photos," he adds. The head with the hearing aid shown on page 16 (based on a scan of his own head, Larsen reveals) has been scanned with this method.

Biomaterial Properties

Perhaps the biggest hurdle in simulating biomedical events is the lack of material data. In most cases, the simulation software won't give you the option to pick a suitable type of bone, tissue or blood from a dropdown menu. (It would if you were simulating a plastic, steel or metal part.) Biomaterial data doesn't exist in a form that can be readily delivered inside current software. The simulation experts and software developers interviewed for this article don't always agree on custom biomedical modules' benefits, or on how to make software interfaces more approachable — but they all lament the lack of biomaterial data.

Siemens' Kuessner describes the way it currently works: "The material laws [such as the fundamentals of Young's modulus] are part of the simulation code, the FEA or CFD program. We provide very sophisticated material laws," he points out. "But it'll be the responsibility of the user to put [the sample material] into a test machine if possible, or measure it in situ, calibrate the material, and bring life to the mathematics." This, he concedes, could be a big bottleneck for users.

ANSYS' Marchal says biomedical problems are more complex. "Look at cardiovascular modeling, or simulating blood flow in deformed arteries. When you're talking about blood, its properties are not the same as air for airplanes or water for turbines that can be modeled with a constant viscosity and density," Marchal continues. "Blood properties are not constant; they change with [the patient's] activities, pathologies and conditions such as age, sex and health. Muscles and soft-tissues are not like metal, and need more than a constant Young modulus and Poisson coefficient to be properly modeled. It is therefore crucial to collaborate with clinicians to start building database of patient specific material properties.

"It's easy to develop [a specialized module], but if used inappropriately, it can give you the wrong answer while you would trust it because this is the result of simulation," he says.

Where Do We Go from Here?

"Every simulation is wrong. Some are useful," Siemens' Kuessner says. It's his way of reminding us that, at its core, simulation is a simplified representation of a complex event. Nevertheless, the simplified study of nature, he insists, can be a great help in product design.

"Some people say, 'Oh, we don't know enough about the materials, so we can't simulate,'" he says. "I say that's wrong. You can still do an envelope simulation: Take the worst case, take the best case, and study the range to see where problems can potentially occur."

In April, the *American Journal of Neuroradiology* published a paper titled "3D Cine Phase-Contrast MRI at 3T in Intracranial Aneurysms Compared with Patient-Specific Computational Fluid Dynamics." (Obviously, the language barrier gets worse when biomedical and simulation terms merge.) In the abstract, the authors explain, "CFD has been proved valuable for simulating blood flow in intracranial aneurysms, which may add to better rupture risk assessment. However, CFD has drawbacks such as the sensitivity to assumptions needed for the model … The purpose of this study was to compare flow patterns on the basis of 3D PC-MR imaging with CFD estimates."

It's just one example of the validation needed to ensure the simulated pixels match what really happens inside your body. **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 → **American Journal of Neuroradiology:** AJNR.org

→ **ANSYS:** ANSYS.com

→ **Autodesk:** Autodesk.com

→ **CD-adapco:** CD-adapco.com

→ **Dassault Systèmes SIMULIA:** SIMULIA.com

→ **Medtronic:** Medtronic.com

→ **MicroPort:** MicroPort.com

→ **MSC Software:** MSCSoftware.com

→ **Oticon:** Oticon.com

→ **The Scripps Research Institute:** Scripps.edu

→ **Siemens PLM Software:** Siemens.com/PLM

Speed Thrills

Dana's engineers team up to accelerate product design with simulation lifecycle management.

The recent revival of the U.S. automotive industry is a success story on many levels. Bridge loans granted by the government enabled some automakers to restructure. Tightened fuel-economy and pollution standards spurred new R&D. An improving economic climate released pent-up demand for new cars — and this time, Detroit was ready with fuel-efficient, eye-catching models that brought buyers back to the showrooms. The Big Three (Ford, GM and Chrysler) were on the path to recovery.

As the automakers' business picked up again, so did that of their suppliers. Dana Holding Corp. —a U.S.-based, Tier 1 global supplier of axles, driveshafts, sealing and thermal-management products, off-highway transmissions and service parts — saw a strong turnaround in revenues and margins. While its customers' recovery was certainly a major contributor to these results, credit for Dana's rebound also goes to an evolution in mindset that helped keep the company on track through tough times.

"We underwent a cultural change at Dana from a mainly cost/manufacturing-driven company to an engineering-driven one," says Frank Popielas, senior manager of advanced engineering in the Dana Power Technologies Group and head of CAE for Dana. "This meant a shift in focus — from how to control costs and manufacture efficiently to how to innovate. Obviously, all these need to be integrated. But if you focus solely on costs, product quality will go down. As an engineering-driven company, we look at how to improve a product from a quality and function perspective. Innovation, supported by the right engineering tools, made our company more competitive."

Many automotive suppliers struggled during the recession, and unemployment rates rose. However, since Dana had already developed substantial in-house CAE and high-performance computing (HPC) resources, the company made a point of retaining its design engineering teams.

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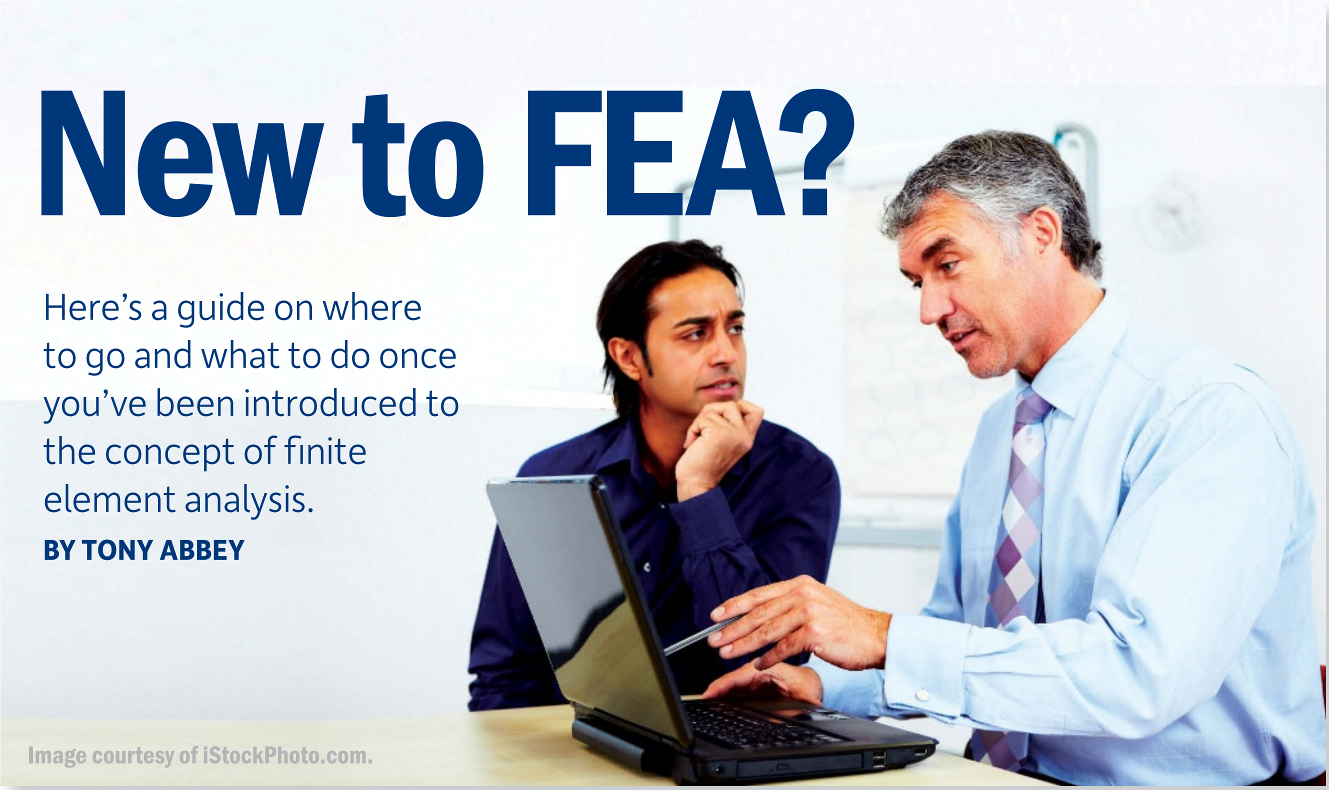

New to FEA?

Here's a guide on where to go and what to do once you've been introduced to the concept of finite element analysis.

BY TONY ABBEY

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

So you have got your first job in the industry, and one of your initial tasks is to start applying finite element analysis (FEA) to real projects. You might well have been told that you are now the company expert and are expected to get the expensive new tools working effectively!

How can you help yourself move forward in this daunting new role? Well, first off, don't think of it as daunting. In fact, chances are you probably have had some initial exposure to FEA in college. These days, I see a lot of exciting project-based FEA training, backed up with self-teach video or other study aids to get just enough exposure to commercial analysis tools. Essential structural engineering theory is still there, but these days, linked to practical application, it is a lot more palatable. Engineers of my generation were subject to deep theory dives with a lot of the material having little practical use. FEA was a bone-dry subject.

Vendor Training

If your company's budget allows it, one of the first options for becoming more FEA-savvy is to consider vendor-based training. This type of training also benefits from modern methods and technology — and importantly, a more integrated approach to the analysis environment.

I first taught vendor classes in the early 1990s using view foils for five days: Day 1 was geometry; Day 2 was meshing. If you missed Day 4 (analysis), then you were stuck because Day 5 was post-processing.

Things have moved on apace since then. Laptops, projectors and perhaps soon mobile apps allow users to get the touch and feel of the software much more directly, and to be able to experiment "off course." Equally, tutors can push their students much harder, with more complex tasks. As the complexity of the software increases, this is really just as well.

I recommend approaching the vendor training with a shopping list of things that you want to explore and understand. This will mean that you can push yourself — and also the course trainers — harder.

Don't just cruise through the training, doing the canned exercises as fast as possible. The objective is not to see who can finish the exercise first; instead, it is to make sure that you understand all the implications of the process you are following. Listen for any tips and tricks that the trainers might share. If the trainers can see that you are enthusiastic and really keen to make the most of the software, then they are also going to be encouraged, and you will get a lot more out of the course.

Making Your Way

It can be useful to delay the vendor-based training until you have had some experience with the software in the real world. While this means that you will struggle more at the start, in my experience it also means that you will know more about what questions to ask and what to demand of the software. Six months seems like a good time to spend on the job, before going to software training. By then, you should be better able to understand the context of the training.

So, after six months of being on your own, the vendor-based training starts to get you fluent and comfortable with the software. If this is going to be your full-time activity, then you need to set your sights on becoming a "power user."

When I was a software trainer and also worked the help desk, it was often rather disappointing to see how ineffectively the average engineer was using the software. However, the key objective of good vendor-based training is to make you as productive as possible with usage of the software. Your ultimate goal should be to master the steps of CAD integration, mesh setup, problem setup, analysis running and post-processing of results — to the extent that you barely need to focus on how to "drive" the software.

It's a bit analogous to driving a car: Once you get experience under your belt, you will be doing the basics so fluently and efficiently that you can concentrate on all the other important tasks, such as defensive driving, navigation, etc. You will be able to react well under different weather and traffic conditions to maximize the survivability of you and your passengers.

Now comes the next phase, which is to start to understand and deal with the problems the real world can throw at you.

Find Your Mentors

It is wise to seek out mentors who can help you, based on their skill and experience. If you are lucky, you will be surrounded by people of this caliber. If you are the new company expert, then perhaps not!

To find a mentor, look for someone who really wants to share the knowledge he or she possesses. This means using some common sense to decide on whom to approach. In the bad old days, we seemed to have a lot of FEA gurus who really wanted to keep all their knowledge tightly hugged to themselves. Thankfully, these days, that seems to be much rarer — but you need to steer clear of anyone who equates knowledge sharing with job threatening.

If you can't find mentors immediately around you, look farther afield. It may be that, by joining an organization such as ASME, the American Institute of Aeronautics and Astronautics (AIAA) or the International Association for the Engineering Modelling, Analysis and Simulation Community (NAFEMS), you link up with people who are prepared to share their knowledge. There may be local groups where you can meet directly — or at least via email, Skype, etc.

Another mentoring opportunity is with your software help desk. The attitude here varies from company to company. In all cases, you need to avoid deluging the help desk with unnecessary questions. It is up to you to establish a good rapport by working hard at your end to debug problems as far as you can, and to assemble all the data and information needed to get the help desk up to speed. With a good software company, you should be able to gain respect and be able to ask a wider range of questions. The person at the other end of the line is only human, and if you present an intriguing problem or question — then interest may be piqued.

There are some very good online bulletin boards that specialize in engineering problems. Several of them have subsets that deal with FEA-related issues. The best of these attract resident experts who deal very authoritatively with a range of problems. If you take the time to pose the question accurately and in a well-written manner, you stand the best chance of getting a good response. A sloppy question will just be ignored or get a sloppy answer. Hopefully, you will get several opinions and a consensus. Be wary of a single answer, which might be inaccurate.

Searching online directly for your problem solution can often come up with useful papers, vendor and academic tutorials and other material. Again, be wary of the quality of the answers. The Internet does attract a lot of opinions, and some of them may be a little dubious.

Self-teaching and Experimentation

Again, self-teaching plays a vital role in developing FEA skills. There may be little scope to go off project or little time to explore some of the issues. However, you have lunchtimes, break times and any other personal time you want to add in there to explore what is in effect a virtual structural laboratory.

I have spent many hours of my own time trying to get to the bottom of complex solution types, material types, special elements and so on. The way to do it is by experimentation. Try to do what the manual says, but if the results don't seem right, then start tinkering and putting in variations. Figuring out the answers to questions in this way is absolutely invaluable.

Continuation Training

My current role as a trainer for NAFEMS is to provide a link between the important academic FEA-based training an engineer will receive in college and the software-specific training required to acquire application skills.

The link, as I have described it, is that knowledge only comes with experience. The objective of these and similar courses is to share the key lessons from that experience. I have made many expensive mistakes using FEA, and have wasted a lot of resources in doing so. That is all part of the learning curve we all need to follow.

That said, describing some of the common traps and mistakes can help others be more effective and productive using FEA tools within a real-world context. Fundamental building blocks can be established with the use of basic theory and application examples. We don't want overkill with the theory — rather, just the right amount to show what's "under the hood." Then we can see the implications for diagnostics, error checking, accuracy, etc.

I would recommend having a look at the NAFEMS website to see the range of live and eLearning-based classes. eLearning may appeal because of the wider range of subjects, the lower cost, and the option to carry out the training more at your own pace.

Follow a Career Plan

I recommend that you set yourself a career plan. One of the fundamental questions is: Do you want to be an engineer throughout your career, or do you see that as a step in the ladder to senior management, owning your own company or other ambitions? The answer to that question is going to dictate the depth and breadth of the subject that you want to achieve.

Regardless of the level of involvement you are looking for, it is a good idea to span as many areas of structural analysis and industry areas as is feasible. If you are working for a large company, this may mean moving from department to department across a range of products and analysis types. On the other hand, you may want to move across several smaller companies over a period of years to get that breadth of experience. In the current climate, layoffs, company closure and other factors may well dictate this for you. If it is any consolation, I can genuinely say that each time it happened to me, it did open up new application areas and broadened my engineering base.

Throughout your career, look for opportunities to work with the physical product that is going out of the door — and become involved with testing. This will all help to give you a more robust and well-rounded approach to engineering. If you are working in the FEA field, there is a distinct danger of becoming a little remote from reality. We are doing simulation of the real thing, not the real thing! A regular dose of reality keeps us all on our toes. DE

Tony Abbey *is a consultant analyst with his own company, FETraining. He also works as training manager for NAFEMS, responsible for developing and implementing training classes, including a wide range of e-learning classes. Send e-mail about this article to DE-Editors@deskeng.com.*

INFO → **ASME:** ASME.org

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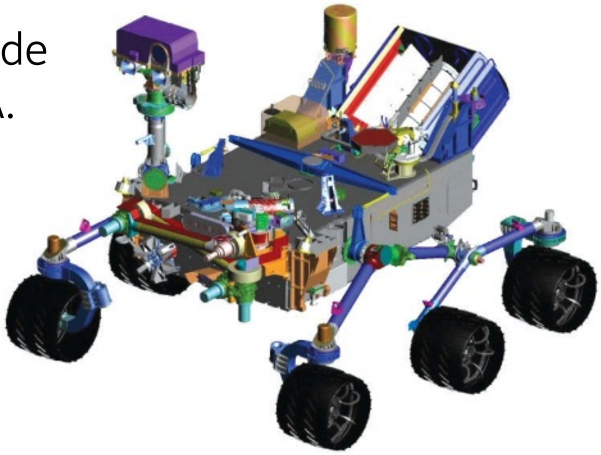
GREATER Than Its Parts

Suppliers and subcontractors provide counsel as well as services to NASA.

BY KENNETH WONG



The NASA Jet Propulsion Laboratory used Siemens PLM Software's NX and Teamcenter for its Mars Rover Curiosity.

In May, Jim Phelan, Siemens PLM Software's director of global public relations, found himself at the Collier Trophy presentation, sitting a few feet away from bona fide rocket scientists. He recognized one of them from NASA's promotional video clip "Seven Minutes of Terror," released just days before Curiosity Rover touched down on the Red Planet's surface.

Named after air sports pioneer Robert J. Collier, the trophy marks "the greatest achievement in aeronautics or astronautics in America." This year, the honor went to the NASA Jet Propulsion Laboratory's (JPL) Mars Rover Curiosity project team.

"The reason we were there is because we provided the software — NX and Teamcenter — used to design, test, and simulate the Mars Rover Curiosity," Phelan explains.

"I get the sense that small business participation in space exploration is increasing, particularly in the private sector," Phelan says. The Google Lunar X Prize — a $30 million pod set aside for the first privately funded teams to safely land a robot on the surface of the moon, have that robot travel 500 meters over the lunar surface, and send video, images and data back to Earth — is also spawning a new generation of smaller, nimbler startups with lunar ambitions (*Editor's Note: For more, read "A New Space Race, Fueled by Simulation," April 2013*).

Last November, Siemens PLM Software acquired LMS, a test and mechatronic equipment supplier. LMS also happens to count NASA as one of its customers. The agency uses the company's Virtual.Lab testing platform to verify the critical loading on giant rocket nozzles of launch vehicles, according to LMS.

High Speed at Low Boom

One of NASA's high-speed initiatives took off quietly, in a manner of speaking. Peter Coen, who manages NASA's supersonic project, explains, "We're primarily working on technologies that help reduce the environmental impact of a supersonic airplane, reducing sonic boom, takeoff and landing noise and high altitude emissions. We're also working on some technologies that help improve the efficiency and reduce the weight and drag of a supersonic aircraft. Our primary focus right now is on what we consider the toughest barrier to future supersonic aircraft, the sonic boom" (Source: *NASA Edge podcast:* "NASA Lowers the Sonic Boom," Feb. 28, 2013).

The project involves three household names in aerospace: Gulfstream, Lockheed Martin and Boeing. But also in the mix is TRI MODELS, a wind tunnel model supplier based in Huntington Beach, CA.

Chris Athaide, TRI MODELS' director of new business, says, "In 2011-2012, for NASA, we were part of the NASA Prime team working on supersonic low-boom testing and also N+2 ultra-high bypass engine/airframe integration. We designed and built various wind tunnel models, support systems and measurement devices used in numerous tests at NASA Ames and Glenn research centers."

TRI MODELS was contracted to build the pressure rail systems — used to measure pressure signatures in sonic boom tests — for Gulfstream, Boeing, Lockheed and NASA. During conference calls and group discussions, it became clear to Athaide that TRI MODELS was expected not just to produce hardware on spec, but to provide input and participate in the project itself.

Athaide recalls, "So at one point, I told them, 'You're trying to measure pressure down to a very small increment, but your [physical] wind tunnels were built roughly in the '50s. They're probably no longer in their ideal conditions. Yet in your wind tunnel modeling [the digital replica used for computational fluid dynamics], you assume ideal conditions in geometry and flow field." And that discrepancy could produce inaccurate results, he pointed out to his project liaisons.

With this compelling argument, TRI MODEL won an assignment to inspect the primary wind tunnel used in the project, and reproduce a digital model that matched the as-built conditions. "We gave them an accurate CAD model of the wind tunnel walls, based on measurements taken with laser trackers," Athaide says. One of the notable features of the digital model produced by TRI MODELS is the surface geometry. They're imperfect — because they reflect the real wind tunnel walls.

Athaide uses digital simulation routinely to verify and improve his designs, but he also cautions that there are certain phenomena digital simulation can't easily detect. "For example, control reversal or roll oscillation. It's something that happens during certain parts of a high-speed flight, but it's not easily reproduced in simulation. It's second-order or third-order phenomenon, but it occurs," he says.

Making a Splash

Mahesh Patel has never been inside NASA's Orion Crew Module, anticipated to be deployed in missions to the moon and Mars, but he can tell you by the numbers what it would feel like when it returns to Earth and makes a water landing. Patel is engineering manager for Altair ProductDesign, Altair's engineering consulting division.

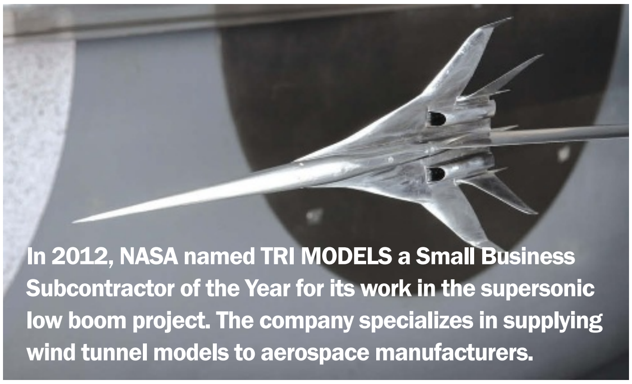
NASA has built a full-scale model of the Orion in boiler plates and steel reinforcements for testing. On a designated day, the prototype was hauled off to a freshwater lake, to be dropped numerous times at different angles. The impact data from the built-in accelerometers, strain gauges and inertial measurement unit was then recorded. Eventually, when NASA contracted Altair ProductDesign to replicate the physical tests in a computer-simulated environment, Patel and his colleagues would use what was recorded during the physical drops as their starting point.

According to Patel, NASA was looking to predict the exact load as the vehicle hit the water upon re-entry to Earth. This knowledge would help the agency design a crew module that could safely withstand the impact without serious structural damage. "A lot of assumptions were used in designing the crew module," says Patel, "so they wanted to know if they were overdesigning it or under-designing it. They can do that with physical tests, of course, but that would be very expensive and time-consuming."

To study the wide range of possible water landing scenarios, the agency would have had to conduct hundreds of physical drop tests at varying angles and velocities in a lake using actual crew modules — something much easier (and cheaper) to execute inside a computer-simulated environment.

"The crew module hitting the water is a very complex phenomenon," Patel says. "NASA was actually trying to predict the pressures generated in the wave that would travel across the surface of the crew module [of the vehicle]. Physically measuring those pressures accurately presents a challenge. Some of the pressure magnitudes and wave front speeds were surprising."

The project called for fluid-structure interaction simulation, to study the rigid vehicle's contact with a body of water. To make the computer simulation realistic, Altair ProductDesign engineers needed to model not just the vehicle's geometry, but also the water with correct interaction between the two properties. Patel and his colleagues used Altair's HyperWorks software suite on this project; HyperMesh



In 2012, NASA named TRI MODELS a Small Business Subcontractor of the Year for its work in the supersonic low boom project. The company specializes in supplying wind tunnel models to aerospace manufacturers.

software to create the simulation models; and the RADIOSS solver to conduct the simulations.

The ProductDesign group was able to digitally replicate the vehicle's water impact with near-identical results to NASA's physical tests. This computer-driven simulation became a reliable basis for predicting what would happen to the crew module in the real world as it splashed into a lake at a certain speed and angle. For its work, the entire Crew Module team, including Altair ProductDesign, was honored by the NASA Engineering and Safety Center (NESC) with a group achievement award.

A Good Return on Our Tax Dollars

The companies featured in this article exemplify the public-private partnerships that will likely define NASA's foreseeable future. Their experience shows NASA is looking for not just subcontractors to provide components and services, but collaborators to contribute counsel and domain expertise. Even smaller players' footprints are in every aspect of the agency's workflow, from conceptual design to simulation and testing. The agency's success — from quieting the supersonic boom to landing the Curiosity Rover on Mars — is just as much the contractors' victory.

In NASA Administrator Charles Bolden's words, "Small business represents the best of the American spirit of innovation, the drive to solve problems and create solutions to our biggest challenges. We're pleased to recognize the excellence of these entrepreneurs, whose work brings a great return on the taxpayer's investment." **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 → **Altair ProductDesign:** AltairPD.com

→ **Google Lunar X Prize:** GoogleLunarXPrize.org

→ **NASA:** OSBP.nasa.gov

→ **Siemens PLM Software:** PLM.automation.siemens.com

→ **TRI MODELS:** TriModels.com

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

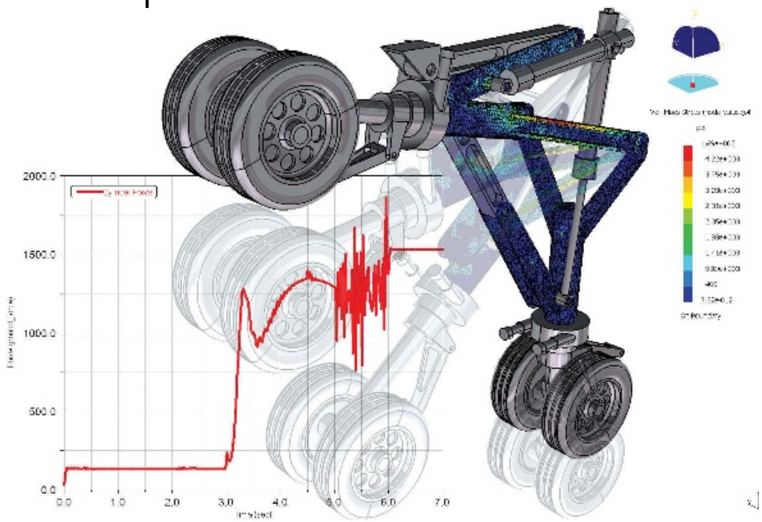
Outside Engineering Experts Weigh In

DE gets the inside scoop to avoiding mistakes when engaging engineering service providers.

BY RANDY FRANK

The largest to the smallest small engineering companies periodically take advantage of engineering service providers. In some cases, the services are delivered on a frequent, and almost regular basis.

When everything goes the way it should, it is a win-win for each party. When things go wrong, well, that's another story. In fact, this is that story, from the service provider's perspective. A few "mistakes to avoid" were commonly found in discussions *DE* recently had with four service providers.



Simulation of a nose landing gear to check the durability is a typical service analysis that could be provided by MCS Software.

Mistake No. 1: Starting Sans Plan

When a company has provided services to numerous customers and has been in business for several decades, it seems reasonable to expect that its team has a very good idea of what should and should not happen when a client engages them. Over its 35-year history, ATA Engineering has had many well-established relationships with long-term clients. They interact in what President and Technical Director Mary Baker, Ph.D., P.E., calls "methods development."

"People usually come to us because they are challenged by their schedule or because they have a new technical issue," explains Baker. "They might have had people who did it before, but aren't with them anymore, or it's just a new method."

Working mainly in the aerospace industry on launch vehicles, satellites, Mars rovers and other specialized space vehicles, ATA Engineering frequently helps customers by simulating the dynamic performance to understand the modes so customers can design to required loads, and can demonstrate by analysis or testing that the loading environmental requirements are being met. These functions include anything from random vibration to temperature variations.

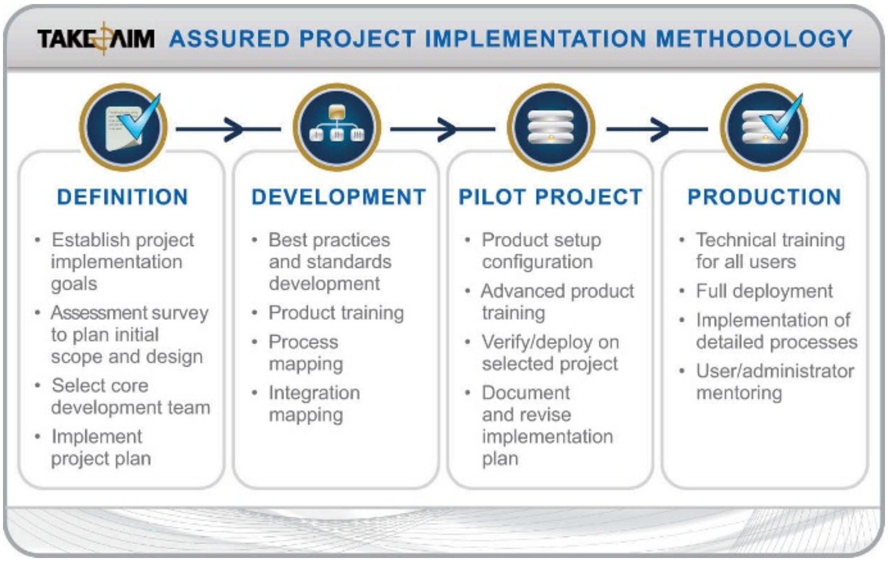
In many instances, outsourcing a service is not part of the project — until a problem occurs. "You're struggling with a problem and you don't know whether it is worth your time to get someone else to help you or not," says Baker. "It's our job to make it easy for you to get our help."

Frequently, ATA Engineering's effort is defined by a statement of work that deals with the customer's challenging issues, including the reluctance to engage an outside service provider. "We often volunteer to write a draft statement that they can edit and change if it doesn't seem right to them," says Baker.

Derek Barkey, senior manager of Engineering Services for MSC Software, has 28 years of experience in the service industry. He has a slightly different recommendation for customers to understand the objectives for the engineering service providers. "Sometimes the process of writing a request for quotation helps customers clarify what precisely they want," he says.

MSC Software started as a services company when it was founded in 1963. Its core software products are oriented around engineering simulation. The company focuses on engineering analysis and the data management around that analysis, performing structural, crash, acoustic and thermal analysis and more. It is frequently subcontracted for one or more of these aspects.

Another engineering service company with a long history is Engineering Technology Associates (ETA). The company is celebrating its 30th year of business. Historically, ETA's cus-



The key steps in IMAGINiT Technologies' Take Aim consulting process for engineering service success address four phases with several subcategories. ***Photo courtesy of IMAGINiT Technologies.***

tomers have been automotive original equipment manufacturers (OEMs) and Tier I suppliers, but new industries are part of its focus moving forward.

According to Akbar Farahani, ETA's vice president of engineering, one of the primary reasons that a customer can encounter problems is failing to plan. A thorough plan should include full discovery, including the project objectives and what they are trying to accomplish — reduce product failures, reduce scrap parts, meet customer requirements, certifications or regulations and all related aspects. In addition to staying focused around the objectives, more successful service engagements occur when the manufacturer dedicates someone to that particular project.

"We see great success when somebody is actually going to be accountable for the project, and they take ownership of the responsibilities in the engagement," says Farahani.

Many companies, especially automotive companies, want to do less testing and prototype building and more virtual modeling. This area is growing rapidly, according to Farahani.

"Investments in physical tests are declining, while investments in virtual prototyping and simulation are on the increase," he says.

Any area with rapid growth can easily produce new participants that are not necessarily as well versed as the more established players, and users can easily expect more than what is reasonable. A process developed by ETA deals with the growing demand.

IMAGINiT Technologies, a Division of Rand, works primarily in the CAD/CAM space.

"The software foundation for a lot of the things we do is around the Autodesk solutions, but the services that we offer are not limited to that by any means," says Bill Zavadil, senior vice president of services for IMAGINiT Technologies. "We've worked with customers everywhere from Fortune 500 manufacturers to two- or three-man shops, so we deal with the entire spectrum."

The experience level of these companies ranges from long-time clients of IMAGINiT Technologies who are evolving new portions of their business, to new clients. Zavadil has a few observations that may help customers to avoid problems.

"It depends on their maturity and how well documented their processes are, and where they are at in their own evolution of trying to standardize their practices and procedures," he advises.

While the first step is identifying the objectives, many clients fail to understand that successful engagement of service providers involves more than buying software and getting training for implementation.

"The software that is out there today, really does start to impact their business process," says Zavadil. "If they don't plan on changing and understanding the impact that it is going to have on their business process, and make plans to make those modifications and hire somebody to help consult with them in terms of what impact it is going to have with workflows and processes, they are going to fail."

Mistake No. 2: Estimating Capabilities

The problem of overestimating capabilities often occurs with the customer whose limitations of equipment, software tools and in-house engineering expertise are not well known or understood.

In contrast, customers can under- and overestimate the capabilities of suppliers. While most of the time expectations are exceeded, in some cases where their expectations are out of line, then it is difficult or impossible to meet them, explains Laura Abert, ETA's director of marketing.

Mistakes can be avoided if the supplier is willing to work with the client up front to determine the requirements and understand the responsibilities of both parties to solve the problem. In fact, understanding the proper problem partitioning can prevent numerous pitfalls.

"It's our job to keep them from having problems," ATA Engineering's Baker says.

In addition to clearly defining the problem and what is required to solve it, the portion being performed by each party must be clearly understood. Baker says she often helps the client solve the problem simply by discussing it. While this discussion doesn't create an invoice, it does usually create a satisfied customer who comes back in the future.

Misunderstanding the statement of work can also cause expectation problems. "The most common problem is that customers haven't truly read through the written statement of work," says MSC Software's Barkey.

A good services statement of work, he adds, will define what deliverables the customer will receive and what their responsibilities are.

In addition to customers not knowing know what to expect, they often do not understand the constraints.

"FEA (finite element analysis) or virtual design is not going to invent," says ETA's Farahani. "Invention comes from engineers. The tools enable us to get to the answer faster. The most important thing is the interpretation of those results."

Mistake No. 3: Engaging without a Process

Companies that have experienced bad results may attribute their situation to wrong internal decisions after being provided accurate analysis. Farahani credits a proprietary process that ETA uses for successful customer engagements to helping customers, especially less-experienced customers, understand what to expect.

In a similar vein, IMAGINiT Technologies uses the Take Aim process as an integral part of its consulting.

Establishing a reasonable schedule for completion and milestones to jointly evaluate progress is an essential part of the process, according to MSC Software's Barkey. He has an associated warning: "Don't try to micromanage the services provider, but you do have a right to know that your money is being spent well."

Mistake No. 4: Too Little, Too Late

The biggest mistake a potential user of engineering services can make is never getting started. "Without using a process such as ours, they do not know what they are missing," says ETA's Abert.

An equally problematic situation can occur if the supplier is engaged too late — after the customer already has analysis that shows the approach it was developing will not achieve its goals, and it has run out of time. In either case, the advice is similar.

"The first step is to have a conversation about the situation, and then jointly define what would help," says ATA Engineering's Baker. "Lots of times, we just point them in a direction that they hadn't thought of." **DE**

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

INFO ➜ **ATA Engineering:** ATA-E.com

➜ **Autodesk:** Autodesk.com

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

➜ **IMAGINiT Technologies:** IMAGINiT.com

➜ **MSC Software:** MSCSoftware.com

The Ins and Outs of Technical Training

To outsource training or not to outsource training, that is the question for growing engineering and professional firms.

BY FRANK J. OHLHORST

Engineering firms that are experiencing growth can be counted among the lucky ones. Growth does come at a price, however: one that translates into an investment in equipment, software and personnel. That investment must offer a return, something tangible and measurable.

Leveraging that investment means that the staff (both old and new) must be able to use new technologies correctly and efficiently to maximize productivity, to create a tangible return on investment (ROI). The secret to generating ROI can be found by effectively training the staff.

On the other hand, training requires resources — such as hiring instructors and purchasing materials. It needs to be executed properly and leveraged to the fullest. That has led many organizations to outsource instructional services. Finding the proper mix of experience, resources and applicability, however, proves to be a challenge.

Hiring the proper trainer takes time and research, as well as a goal. After all, the productivity comes from quickly training individuals how to do a task in the most efficient and expeditious way. That same concept should be applied to selecting a trainer who can accomplish those goals.

Do Your Homework

One of the first decisions is which technologies and processes require professional training to deliver maximum productivity. In the world of engineering, that may come down to CAD/CAM software, simulation applications and workflows, or other types of applications that employees must master.

DE Contributing Editor David Cohn, who is also a technical publishing manager at 4D Technologies, agrees. 4D Technologies provides Autodesk training tools. "Self-paced training paired with self-assessment has proven to be one of the most effective ways to train employees," he says. "By using a combination of self-paced training, seminar presentation and traditional classroom style techniques, students retain more usable knowledge and learn exactly what they need to know."

Those classroom stye sessions often use contracted trainers who create programs specific to the needs of the firm. Yet, due diligence is in order before selecting just any trainer, including:

- **Know what you are looking to achieve.** Are you sure that training is required? If so, will a generic course accomplish the goal, or does it require education for a niche or specific element? Are you able to precisely define what the employees are currently doing, and what they need to do? How will you measure that the training has been successful? What is expected of the employee? What help, support and feedback will they get from the training when they return to work?
- **Train the right people.** Training is only effective when the students will use the knowledge or skills right away. Delays in applying the knowledge gained usually results in lowered productivity.
- **Make the training relevant.** Training should reflect the situation and context that the learners will be experiencing — not some esoteric or generic example that is difficult to apply to the situation at hand.
- **Follow up with a support strategy.** True learning does not happen only in the classroom. Your training needs to be appropriately backed by on-the-job support and coaching. Who will do this? Has this been agreed upon before training takes place?

With the answers to those questions determined, vetting a training organization becomes a little easier. With well-defined goals in hand, managers can then intelligently measure what a training organization has to offer. That said, there are still some basic guidelines that should make the vetting process a little easier:

- **Instructor's curriculum vitae (CV):** Make sure you know who will be providing your training. Asking for a biographical sketch of the instructor's background and qualifications provides you with an opportunity to see whether your instructor has experience in your field.
- **References:** It's a good idea to contact other companies who have used the training provider's services. Ask what the company liked and didn't like about the service it received. This line of questioning often uncovers details that help you make a well-informed decision.

• **Guaranteed delivery:** There are a lot of one- and two-man training companies out there. So what happens if your assigned instructor becomes ill, or other priorities cause you to change your scheduled training? Any planning can easily become wasted time, and delays affect having your personnel qualified for their jobs.

• **Years in service:** You need assurance that your provider has the depth and experience to handle your training for a successful outcome. That experience level should not only just include the amount of time in front of students, but also how familiar the trainer is with the application or process selected.

• **Course material:** What resources will be used during your training? Will the company develop a customized training program? Some companies simply print PowerPoint presentations and call them training manuals. Others rely on bullet points that lack detail for future reference. Training material that is professionally developed — and includes fully illustrated manuals and electronic resources — can serve as a valuable future reference source.

• **Course building:** How does the training provider manage training materials so that all relevant materials are provided for their instructors? How does it ensure that instructors never get caught having to make copies at your facility? Does it just reprint a list of materials that are used for every course it provides? If so, how will it handle your unique applications and equipment?

• **Test development:** Do you want testing as part of the training experience? Tests can be a valuable methodology to determine how effective training is. If choosing testing, find out who creates the tests that are used to qualify your personnel. Find out how the company evaluates its test questions, so the questions fairly evaluate student knowledge.

• **Item analysis:** Ask how the training company evaluates its tests over time to ensure that any underperforming questions are removed or modified. Unless a company uses testing analysis software, it may be impossible to spot under-performing questions — or to guarantee you the highest quality evaluation available. While it may be easy to visually see that a number of students miss a specific question, how difficult is it to see that they each selected the same incorrect response? What knowledge can be gained by reviewing incorrect responses selected by candidates who score in the high percentile range? Do even those who score marginally always answer certain questions correctly? The information obtained from every test allows organizations to quickly spot underperforming test questions and trends.

Training and testing has taken on a hybrid approach, according to Cohn.

"It is interesting that we are now seeing many of the companies that had previously provided traditional, instructor-led, classroom training beginning to incorporate self-paced video-based training as part of a blended approach," Cohn said. "That way, instead of sitting passively and listening to an instructor deliver a lecture and then going off to do some hands-on task, the student first watches a number of self-paced videos to gain an understanding of a topic and then comes to a lab where he/she can complete specific tasks based on what he/she has learned, with an instructor there to answer questions."

Like many other business processes, the value of training can only be surmised by looking at the effort put into it, and then measuring the results. Simply put, the real value can be measured by looking at productivity improvements and efficiency enhancements. **DE**

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Understanding the Value in Value Engineering

Today's design engineers strive for the optimal tradeoff among cost, specification and quality.

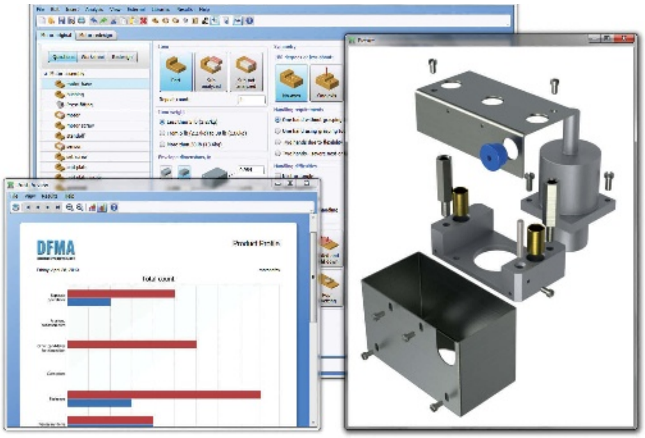
BY JIM ROMEO

When New York's Four Seasons Hotel and Private Residences needed to find ways to reduce overall project costs, it took a closer look at its heating, ventilation and air-conditioning (HVAC) design. This system was targeted because it was estimated to incur 15% of the total cost.

How did the property reduce the cost, and concurrently ensure that its five-star quality was not compromised?

Enter value engineering. Using software called Virtual Environment (VE), a performance simulation tool from Integrated Environmental Solutions, the property's engineering team was able to build a 3D model, simulate the loads, and vary the system inputs to arrive at an optimal system. Ultimately, it reduced cost, while meeting specifications.

"The 3D model allowed VE to create a different profile for each space, then run them as room and block loads," says Eugene Siterman, managing director of VE Solutions Group. He says that the simulation modules allowed the team to examine how heat conduction from people, lighting, the sun and throughout the building itself would affect comfort levels.



DFA 10 software from Boothroyd Dewhurst Inc. guides engineers though a series of questions to identify areas for consolidating unnecessary individual parts into multifunctional components and assemblies. The screen above shows a motor assembly (right) before redesign and a graph (left) showing areas that are open to improvement through product simplification. ***Image courtesy of Boothroyd Dewhurst Inc.***

Defining Value Engineering

Value engineering is often associated with the architect engineering design community with applications like that of the Four Seasons. However, it has a healthy presence in product design as well.

"If you provide an alternate system or product, and it doesn't meet the original specifications and provides diminished quality or experience, you are not doing true," says Jeff Luckett, director of engineering at MBX Systems. "Value engineering is applying engineering know-how to meet the original objectives, at a lower cost or greater value. Engineers are utilizing simulation to run 'what if' scenarios to study the outcomes of design decisions for the product, as well as the manufacturing and assembly processes."

"Back in the day, product and system engineers were given a problem and they set about designing a solution working comfortably in their silo," notes Steve W. Bannes, a professor and director of graduate studies in construction management at Washington University, St. Louis. "In many cases, their design criteria included low initial cost so the product or system could 'sell.'"

Jamie Buchanan, director of Altair ProductDesign in the UK, defines value engineering as the consideration of all costs associated to the part or product, including material costs (raw, processing and recycling considerations), manufacturing costs (production and assembly), and operating costs (servicing, warranty).

"These costs must be looked at in context of performance and ability to meet the required specification," Buchanan continues. "Although traditionally thought of in the context of re-engineering, a lot of the concepts and metrics should be applied to new product development processes as well. There are clear direct benefits to product lifecycle management, as it enables the assessment and consideration of total life costs during the design phase."

Beyond Cutting Costs

There is a discernible difference between designing to reduce costs and designing with value objectives. Value objectives may be achieved via design tradeoffs.

"Value engineering is often confused with cost-cutting," says Brian Frank, product line manager for Autodesk. "But cost-cutting usually leads to degraded performance, life expectancy, higher maintenance costs or other trade-offs that are not ideal. Trade-offs in developing requirements are always required, but value engineering is about achieving those requirements without sacrificing quality. It is really about applying the art of engineering to develop the best and most effective solution to the problem."

Achieving value objectives and employing the principles of value engineering are most often achieved with the help of simulation, Frank points out.

"In reality, the ways in which value engineering can be realized all point to the increased utilization of simulation, both as solutions are being designed, and as a tool or method to find areas of optimization after a product or project has been completed," he continues. "Sometimes schedules prohibit you from performing all of the simulations that should be done to help you understand the product. Time to market, competition, production schedules, and other factors all have an influence on the design schedule."

At the completion of a project, hasn't everyone had that feeling that there were a few more things they wish they had been able to explore? Frank says this is a great opportunity to introduce a value engineering project for the product.

"Value engineering encompasses a number of disciplines, and they can all be viewed at any time in the lifecycle of an offering," he notes, suggesting questions like the following to provide a springboard to discussion:

- Can I make this with a different process?
- Can I assemble it differently?
- Can I use different materials?
- Can I change one system for another?
- Can I change the packaging and transportation to affect the cost?

Function-based Solutions

Value analysis and value engineering (VAVE) shifts the focus for the system-design engineers to the functional requirements of the product, service, or process such that the customer's needs, expectations and preferences are met or exceeded at the system level, according to Chris Tsai, AVS, DFMA Implementation Services Manager at Boothroyd Dewhurst Inc.

"It moves focus away from the parts, subsystems and/or technology that is embedded, enabling visibility to other solutions," Tsai continues. "VAVE process experts can facilitate the value review process with a development team, enabling them to design to the functional requirements of a project."

As a basic example, Tsai offers, imagine an automotive engineer responsible for designing a new car. The engineer focuses her efforts on the function of "generate torque" instead of on the design of an internal combustion engine. The internal combustion engine is one potential solution to the function, but other solutions may be more effective and less costly.

Tsai notes that value engineering actually originated in the product and system-design space, and was first introduced in the late 1940s by Larry Miles, a GE engineer.

"Its use waned as other techniques rose in popularity," he says. "But today, VAVE is making a resurgence due to its ability to directly correlate benefits to cost, directly impacting gross margin. Most engineers and purchasing professionals who are charged with VAVE responsibilities are focused on cost reduction activities after a product has been launched."

Once a product is launched, Tsai points out, the ability of VAVE to significantly reduce cost thereafter is, in most cases, limited. While VAVE tools and techniques can help identify opportunities, the actions are often limited to supplier negotiations and minor redesigns from things like material changes and wall thickness reduction.

"The larger opportunity resides in the development process, and in trying to most efficiently provide functional performance," he says. "This is where design for manufacture and assembly (DFMA) comes into the picture."

DFMA, while similar to value engineering, is actually a disparate topic, notes Washington University's Bannes.

"DFMA is a component of the lean manufacturing process, where the goal is to simplify and therefore reduce initial manufacturing and/or assembly costs," Bannes explains. "Value engineering's goal is not necessarily to reduce initial cost, but to define the best value options to the specified client and project. The VE process may actually increase initial cost in favor of achieving the defined value goals."

So whether it's a mechanical solution or an HVAC system in a five-star hotel, value engineering is — and will continue to be — a key driver in engineering design and simulation software. DE

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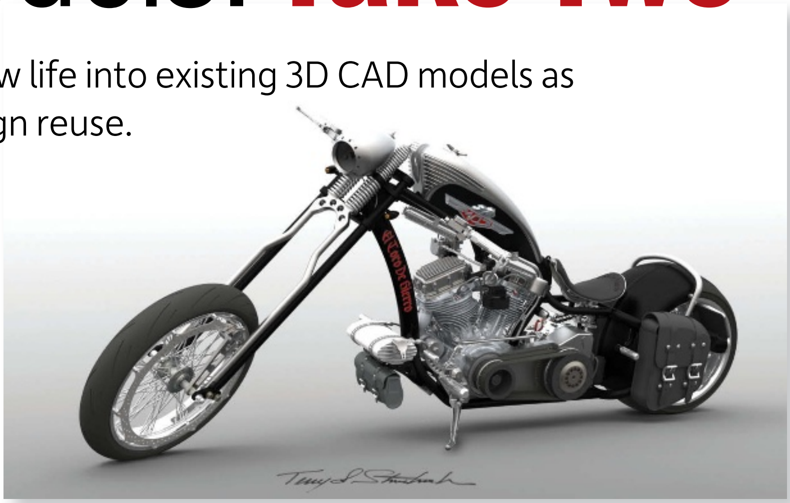
3D CAD Models: Take Two

Engineering firms are breathing new life into existing 3D CAD models as part of a greater emphasis on design reuse.

BY BETH STACKPOLE

As companies explore various ways to optimize their design cycles, effective reuse of 3D CAD models remains one of those evergreen challenges — despite the evolution of technologies intended to facilitate the process and foster deeper collaboration among engineering users.

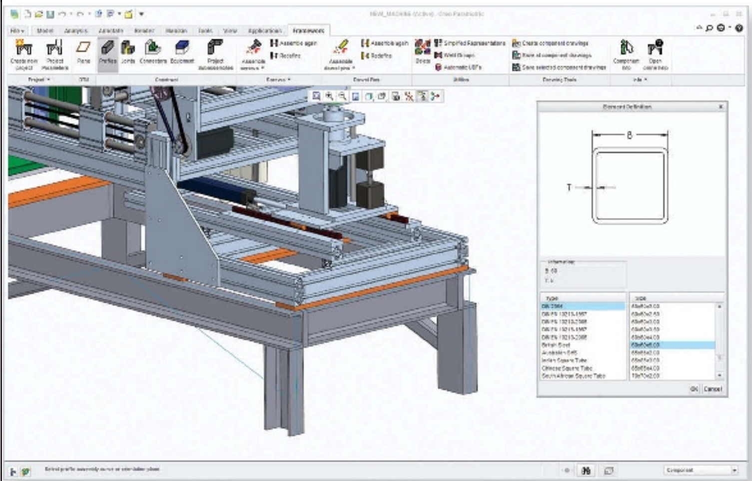
While the idea of 3D model reuse has always been of great interest, most engineering teams have attacked the practice on more of an ad hoc basis, not going far enough in prioritizing and facilitating an effort by putting the right tools and formal processes in place. Yet with product development cycles getting shorter and with engineering resources still tight, companies are doing all they can to make design practices more productive. This mindset has drawn attention to the importance of a well-conceived reuse strategy and ignited exploration into how to best repurpose existing 3D CAD models.



Terry Stonehocker regularly relies on GradCAD to retrieve models of standard parts to jumpstart designs for his custom motorcycle business, including this design done in collaboration with fellow GradCAD member Gary Downer. *Image courtesy of Terry Stonehocker.*

"The typical cost, time and quality pressures are driving interest in reuse," notes Tom Gill, an independent consultant specializing in product lifecycle management (PLM). "Designing a new part, releasing it into production and ensuring it's fully validated is a huge process in any company. If you can reuse something that's already proven, you can save an enormous amount of time and reduce cost."

Experts says a CAD model reuse strategy makes the most sense for standard parts, whether that's for commodity supplier offerings or internally developed components that are used repeatedly across multiple product lines and different engineering groups.



PTC Creo Advanced Framework Extension, tailored for machine designers and equipment manufacturers, is an intelligent library and set of automated drawing capabilities that enable structural framework design productivity improvements of up to 10 times when compared to standard design techniques. *Image courtesy of PTC.*

"Companies want their engineers spending time creating the next great thing or focused on getting to market faster; they don't want them wasting time searching for standard parts or supplier parts, because it doesn't add any value to the company," explains Tim Thomas, CEO of CADENAS PARTsolutions, which provides technology for creating centralized 3D standard parts catalogs.

The continuing trend around mass customization also underscores the importance of a well-functioning CAD model reuse strategy. Whether a manufacturer is designing a new tractor or household appliance, engineering teams are moving toward designing products as more of a modular concept. The goal is to take existing designs and adapt them only moderately to new use cases, according to Bob Noftle, chief evangelist for TraceParts, a provider of parts catalog technology serving up over 100 million 3D CAD models and 2D drawings.

"Companies are aiming to start with existing data whenever they can, and only [model] a small percentage of the design from scratch," he notes.

A Bevy of Options

In addition to the online 3D parts catalog services from companies like CADENAS PARTsolutions and TraceParts, there are a number of options to help engineers and designers jumpstart CAD model reuse. Most modern CAD tools offer fairly extensive capabilities for creating libraries of 3D models for subsequent reuse, although this approach is best suited for helping an individual take advantage of past work, not necessarily for promoting model reuse across a department or a global engineering organization. Product data management (PDM) and PLM platforms take the reuse value proposition further by providing repositories and search capabilities for storing 3D CAD models, but experts say that even those platforms have limitations in terms of usability and search capability.

"Even with PLM implemented, you hear those stories of the large automotive or airplane manufacturer who maintains a model of the same bracket designed 42 different ways," Gill says. "Still, it's much easier to query and manipulate the [CAD models] if you have PLM vs. having data strewn all about the company, making it difficult to find something similar that will work."

To address some of the shortcomings, PLM and CAD vendors are evolving these platforms with new meta data and geometric search capabilities aimed at making it easier to quickly find similar parts models, Gill says.

The combination of enhanced search capabilities and tight integration between the PLM platform and online parts catalogs like those sold by CADENAS PARTsolutions is one of the ways PTC is coming at the problem, according to Brian Thompson, the company's vice president of product management. In addition to Advanced Framework Extension for Creo, which lets users bring a variety of standard component models into their designs, PTC is partnering with CADENAS PARTsolutions on a portal that supports a streamlined workflow for incorporating Creo models of more complex off-the-shelf components into designs, Thompson says.

By leveraging CADENAS PARTsolutions' expertise in delivering geometrically accurate models, Creo users no longer have to spend time approximating the design of a commercially available off-the-shelf product. "They don't have to do any work to validate the geometry, and it's delivered right into their native CAD environment," Thompson explains. "This can really streamline the design process."

In fact, having a vendor-certified (and oftentimes, vendor-supplied) 3D CAD model is one of the primary advantages touted by online parts catalog suppliers like CADENAS PARTsolutions and TraceParts. Engineers downloading parts from these platforms should expect error-free models — unlike some of the newer community sites, where users are invited to freely upload and share 3D CAD models in the spirit of open source development, contends TraceParts' Noftle.

"You're at the mercy of the crowd, so you have to rely on what information is available to them at the time they're creating the model," he says. "They don't have the benefit of a contract with the supplier."

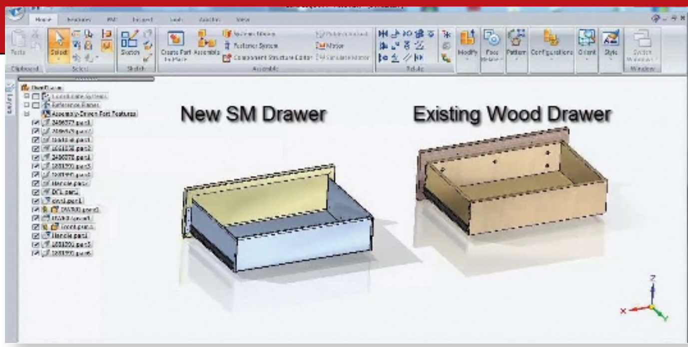
Mark Ortiz, vice president of engineering at Littleford Day, will attest to how the integration of the CADENAS 3D parts catalog is helping the processing equipment manufacturer wrest control over its design processes. The make-to-order shop was struggling to give engineering teams visibility into a burgeoning library of Siemens' SolidEdge CAD models — a result of slightly custom designs. Moreover, if there was a mistake in a design that was subsequently fixed on the shop floor, it wasn't always reflected in the latest CAD model, which could led to repetition of the same mistake.

"Because we had no control over this cloud of 60,000 CAD models, we had no idea what was good or bad, and the spare parts group who did the ordering didn't know whether a part was in stock," Ortiz says. "If you don't have control, you can't go forward."

Now a year into its CAD reuse overhaul, Littleford Day is using CADENAS PARTsolutions' platform to create and maintain a master catalog of 3D models for its standard parts — both internally developed and from suppliers. "It is critical for business efficiency and repeatability to have control over these CAD libraries," Ortiz says.

At Kimball International, the CAD reuse value proposition is really more about repurposing older designs as a starting point for new models in its office furniture line. "We have a lot of new products, but many of the components are very similar," explains Ricardo Espinosa, R&D engineering manager for the firm. "Instead of creating a 3D model from scratch, we want to call up existing components, make modifications, and create a new revision of an existing product without having to spend days or hours."

To do so, Kimball is taking advantage of the Synchronous Technology capabilities in its SolidEdge CAD platform to modify 3D CAD models from its legacy I-DEAS CAD tool without having to deal with the complications of a history tree.



Kimball International created a new metal drawer by reusing existing imported data from its old I-DEAS CAD system. Using synchronous technology in SolidEdge, the task took just minutes. ***Image courtesy of Kimball International.***

CAD Reuse in a Crowd

While 3D models of standard supplier parts are important to an overall CAD reuse strategy, there are additional use cases for redeploying CAD models. That's where community sites like GrabCAD come into play. Say, for example, a designer is creating a bike headlamp and wants to showcase its offering to potential customers or suppliers, but doesn't want to recreate the entire bike model, explains Sara Sigel, community manager at GrabCAD, which has more than 200,000 CAD models created by more than 600,000 members.

"Engineers don't want to spend time recreating the other things that are part of the equation," she says. "They want to set the scene and have all the parts they need to create the bigger picture."

Sigel admits that engineers need to be diligent about checking a model for accuracy and to ensure it's what they want. Depending on how they plan to use the model, there might also be a requirement to get signoff on intellectual property from the original model creator.

Despite any potential extra legwork, however, engineers like Simon Rafferty and Terry Stonehocker see huge benefits in leveraging the GrabCAD community to get a starting point for designs. Stonehocker, a mechanical engineer with a custom motorcycle design business, regularly leverages GrabCAD for models of electrical motors. "Most of the time, I can't find exactly what I want, but I find something close and I can modify it quicker than starting from scratch," he explains. "If you can find something that will save you time, that's very important."

Rafferty, managing director at X-Eng, which makes third-party parts for Land Rover vehicles, has used GrabCAD to download a variety of models. "Even if I have to do some rework, some things are just time-consuming to draw, especially if I don't need them to be accurate," he explains. "Less duplication of effort moves us forward faster, and is invaluable to making the design process easier." DE

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INFO → CADENAS PARTsolutions: PARTsolutions.com

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→ **PTC:** PTC.com

→ **Siemens PLM Software:** PLM.automation.siemens.com

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→ **TraceParts:** TraceParts.com

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Compute Upgrading for **Performance**

There are a few workstation upgrades that might deliver enough performance to justify skipping a generation of new systems.

BY PETER VARHOL

SSDs such as Intel's X-25M can significantly improve performance because they are an order of magnitude faster than rotating disk storage.

While engineering workstations aren't nearly as expensive as they were two decades ago, they can still represent a significant portion of a company's capital expenditure budget. Processors and other computing technologies tend to cycle through a complete generation approximately every 18 months, and buying new computers for all design engineers at that frequency is outside the financial reach of many companies.

Many engineers, unfamiliar with computer upgrades, struggle with less-than-satisfactory performance as software and operating systems require faster processors and more resources. At times, it might mean not buying new software or installing updated versions of existing software.

But falling behind the performance curve doesn't necessarily mean that you have to make a big capital investment in a new workstation. Judicious upgrades of individual components can make an existing workstation last double the time that might otherwise be necessary to buy a new system.

There are many potential alternatives for upgrading. Here's what you should look for in upgrading your existing workstation to continue running new and updated engineering software — whether for CAD, analysis or straight computation.

The Most Bang for the Buck

Conventional wisdom says that faster and new processors mean higher performance, but that's not necessarily the case for every situation. One easy and relatively inexpensive thing that any engineer can do to improve application performance is add main memory to the system. This rule is a function of how operating systems manage running applications. The full application and data set are rarely all loaded into memory at once. Instead, the operating system creates what is known as a "working set" of application components needed to launch and run each application.

The working set is based on a combination of components and data required to ensure continued smooth execution. Other components are kept on the hard disk, and swapped in and out as required. While the swapping is occurring constantly in small chunks, rotating hard disks are more than an order of magnitude slower than any memory. If more can be kept in much faster main memory, any application performs better.

Of course, the amount of memory you need varies depending on the type of work you do. Because most engineers today are using a 64-bit operating system (either Windows 7 Pro or one of the Linux distributions), systems can theoretically address up to 2 terabytes of memory. In practice, workstations support far less, usually up to 192GB. Most don't need that much memory, but with large applications such as CAD, or large datasets as commonly found in analysis and simulation, at least 12GB is useful, and 64GB not uncommon.

This fact leads to the second thing engineers can upgrade to ensure better performance. A few years ago, solid state hard drives (SSDs) were considered expensive luxuries. With dropping prices, however, SSDs are now becoming standard equipment on engineering workstations. While nonvolatile SSDs aren't as fast as main memory, they are an order of magnitude faster than rotating hard disks.

There is still a significant premium for SSDs, but the performance improvement more than makes up for the higher price — at least for storage under around 500GB. If you need more storage, you should consider a combination of lower-capacity, but faster SSDs with a rotating

More memory is another way of boosting performance, as it enables a computer to hold more code and data in a location where the processor can access it more quickly.

hard disk for higher capacity. Just remember to keep the operating system swap file on the SSD.

About that CPU

Upgrading the CPU can be a more problematic issue, depending on your current motherboard and CPU. Many CPUs of succeeding generations have different pin-outs, making it impossible to plug into existing motherboards. While motherboards tend to be relatively less expensive than the processor, the cost of potential motherboard replacement still has to be factored into the thinking. And if the motherboard requires replacement, you have to either make sure it's compatible with your existing memory sticks, or buy new memory also.

If your motherboard does enable you to upgrade CPUs, or add an additional CPU, you should examine your workloads to determine whether this would improve performance. In most cases, faster CPUs in the same motherboard will provide incrementally better performance because the clock speed is likely to be faster. A second CPU would be useful if your applications can utilize the additional cores, as do many simulation and analysis applications.

Note that if you get a faster CPU, you may also have to replace the clock generator on the motherboard to get the full benefits of increased performance. The clock generator sets the maximum speed (typically in gigahertz) of the CPU. If, for example, you buy a 3 GHz processor, but only have a 2.5 GHz clock, the new CPU won't run at its full rated speed.

Some engineers may also overclock their existing CPUs by replacing the very inexpensive clock generator with a faster one. Some modern workstations that use the Intel Xeon 5600 processor family can automatically overclock for limited periods, based on a dynamic analysis of the processing workload.

Overclocking can be effective at incrementally increasing computational performance, but it's probably not a long-term solution to upgrading the performance of your workstation.

Large monitors are often more of a status symbol than a productivity tool, but for an engineer doing visual design, they can be a necessity.

Do GPUs Have a Place?

The rise of GPUs as both a graphics processor and a computational coprocessor has complicated system configuration decisions in recent years. Engineers seeking system upgrades have to ask many questions that involve GPUs, including:

• Do I require high-performance graphics? If you require fast rendering and display, such as for CAD applications, a GPU from NVIDIA or AMD is pretty much a requirement.

• Can my application software take advantage of GPU for computational computing? A growing number of analysis applications support interaction with a GPU — or array of GPUs, if installed.

• Do I require the flexibility to move between computation and rendering? GPUs offer that ability, as long as the computational code is available using the graphics chip set. Another alternative is the Intel Ivy Bridge processor architecture, which includes a microcore of graphics processing using the same industry standard instruction set.

There are so many considerations here that it is difficult to offer clear-cut advice. In general, GPUs aren't as expensive as CPUs, but it doesn't make sense to consider upgrading without a plan in mind. Do you need the high-performance graphics, and/or the computational capability? If the answer to either or both of these is yes, then incorporating a GPU card would probably be a sensible upgrade.

Is Bigger Better?

Some look to large (greater than 25 in.) or multiple monitors as a productivity enhancer. Large or multiple monitors may also be as much status symbols as productivity tools in some organizations. Sometimes size matters, and the largest monitors may denote the most influential engineers or managers. But status doesn't connote productivity.

Still, large monitors and/or multiple monitors make sense under certain circumstances. If CAD, generating graphs and wire diagrams using Maple or a similar math package, or visual design is a primary work focus, then the additional viewing real estate can make sense, especially with the price of these monitors often well below $500. But engineers should first get the opportunity to try them out before making the commitment.

Keep in mind that work also goes hand in hand with fast graphics. Without a GPU or similar high-performance graphics subsystem, large high-resolution displays can take too long to render, and can slow down work.

Giving in to the Inevitable

At some point in time, you can't approach your workstation in a piecemeal fashion. You may already be maxed out on processors, cores and memory in your current workstation, or the cost of the needed upgrades approaches that of a brand-new system. In some cases, individual components such as disk drives or power supplies may be experiencing intermittent failures, reducing overall system reliability and necessitating wholesale replacements.

But how can an engineering organization tell when it's time to ditch existing workstations and make the capital investment in new ones? It makes sense to periodically benchmark the performance of your engineering applications on different systems and configurations. By devising and running a script of actual or simulated applications that represent common workloads across your engineering team, you can determine whether productivity improvements would pay for the investment.

Workstation manufacturers such as Dell and HP will usually let good customers have access to different system configurations to run comparison benchmarks. Organizations can usually determine the performance advantage of obtaining new workstations while investing only their time to set up and run their benchmarks.

Benchmarks can also be available from individual application vendors. Most software vendors will also have sample workloads that reflect common uses of their analysis and design tools. While these benchmarks may not well reflect your common workloads, they can provide you with an indication of possible performance improvements.

Benchmarking using your workloads isn't only for new systems. By periodically running benchmarks with different configurations, you get the information you need on when it's time to upgrade or replace systems.

Whether you upgrade discrete components or purchase entirely new systems, you need to know what your improvements might be. Without data, engineering groups could be waiting too long, which can cost too much in engineering time. Planning and executing a regular benchmarking strategy is the best way to make sure you're getting your money's worth. **DE**

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Luxology modo 701

This 15 million-polygon scene renders twice as quickly in 701.

modo 701, the latest version of Luxology's polygon and subdivision surface modeler and renderer, has some impressive new features.

BY MARK CLARKSON

If there's one thing I always want from a rendering application, it's more speed. I'm happy to report that modo 701 has dramatically sped up the rendering of very large scenes vs. 601.

To compare the two, I loaded a scene with 15 million-plus polygons, turned on global illumination and hit F9. 601 took 12 minutes (and a second) to render a high-resolution still. 701 completed the same render in only six minutes (and a second). Other tests were, admittedly, less dramatic — and occasionally, 701 came in just a touch slower than 601. But things were faster overall.

Replication

Lets talk about that scene for a minute. It's actually a space station and, for all its geometric complexity, it was surprisingly simple to put together, thanks to one of modo's interesting features: replicators. Replicators aren't new to 701, but I haven't given them a lot of love in previous reviews.

Replicators are copies of a mesh ... sort of. Let's say you want to create a 4x4x4 array of a part. You could use the Array tool to create 63 duplicates of that mesh, but that makes your scene 64 times as heavy; you have 64 times the geometry.

Instead, you use the Replicator Array tool. Your final scene renders the same way, but you haven't really increased the geometry at all. modo merely notes all the places where that geometry should appear at render or display time, and draws them in.

Replicators have some key advantages beyond lighter-weight scenes. Any change you make to the base mesh is instantly — well, replicated in all the copies. If you create a traditional array of objects, each will have to be modified individually.

Another advantage is speed. modo renders replicators more quickly than actual meshes. It's often twice as fast, and almost always at least 15% to 20% faster with large arrays.

A third advantage stems from the way replicators work. Replicators use point clouds. In the example above, the Replica Array tool created an array of 64 points, arranged in a cuboid; that's the point cloud. At render time, modo renders as though there was a copy of the base mesh at each of those points.

The Replica Array and similar tools create point clouds for you, but you can roll your own, or use existing geometry. Perhaps you'd like to place drops of condensation on a beer bottle. Or trees on a landscape. Or balconies on a building. Or feathers on a bird. Use the vertices of your bottle, building or bird as your point cloud; create a single drop, balcony or feather; and replicate away.

My CPU-grinding space station is made from a handful of parts replicated four or 52 or more times. They're mostly in the form of radial arrays around the center point, but some are also as trees scattered across the landscape of the glass-domed park.

Progressive Refinement

No one likes waiting for renders to complete to judge the results. That's where progressive refinement comes in. (Progressive refinement rendering is a key feature of easy rendering applications like Keyshot and Bunkspeed.) In a progressive render, the entire scene is rendered more or less at once, very roughly, and then refined over and over until you stop it — or until it meets a specified quality or time.

modo has been doing something like this for awhile now, with its RayGL preview windows. But RayGL windows always stop somewhere short of full render quality and, as importantly, they're small — often just a quarter of the screen.

701's new render preview takes a big step beyond: It will work at full final render resolutions, zooming out as needed to fit in the preview window. It will continue refining renders until it hits the specified quality settings. In fact, it will continue refining forever if you tell it to.

You can easily save the rendered images and — here's the really cool part — you can save the state of the render. If the render's been cooking for an hour and you have to interrupt the application, those 60 minutes aren't lost. Save the render state and, when you load it up again, modo picks right up where it left off.

Holding the mouse over the preview window will focus the renderer's attention on the area under the mouse, allowing you to refine selected areas.

Progressive rendering is great, but it doesn't quite replace the standard renderer yet. You can't save separate passes and layers (alpha, reflections, etc.). You also don't have the full renderer's panoply of image controls, for example.

Retopology

modo does a really good job at retopology, or recreating existing meshes — usually masses of triangles imported from another application. Place an imported mesh in the background, and modo will let you create a new, clean mesh in the foreground.

601 introduced a unified retopology pen tool that takes care of all your retopologizing needs. Luxology has further refined the process in 701, giving the pen more powers to reduce your total clicks and further speed up the whole process.

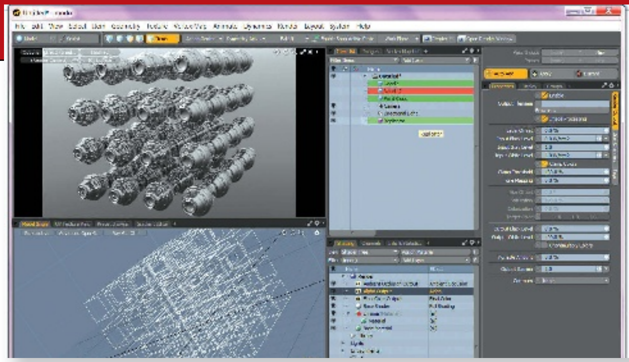
My favorite new tools here are Contour and Continuous Bridge. The contour tool slices through geometry with a plane, producing a curve or polyline that defines the intersection — like a line drawn around the outside of the mesh. You might take five or 10 slices through a human arm or a computer mouse, then use the Continuous Bridge tool to connect these curves together to recreate a new version of the original base mesh.

Interface Changes and Improvements

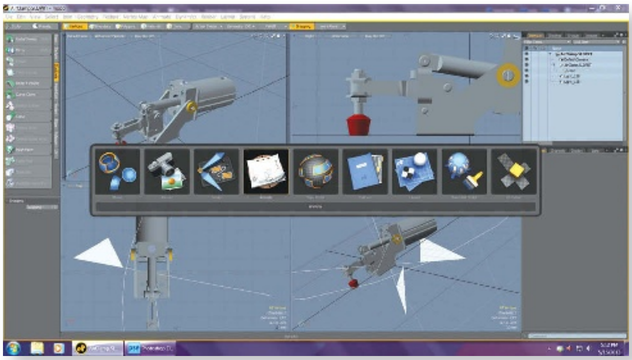
There are a lot of little improvements that speed up common tasks. I'm very happy to see the new Merge and Unmerge commands. Merge combines meshes from different layers, while Unmerge breaks up objects into their constituent meshes and distributes those to different layers. I do both operations all the time.

I'm even happier to see color-coding available on all layers — meshes, lights, image maps, etc. You can also drag-select the visibility of layers, turning whole swaths on and off easily. That's something that's previously been a real pain in modo.

modo has rearranged its workspaces, from a little to a lot. The modeling workspace looks familiar, while the new animation workspace is nearly unrecognizable and somewhat overwhelming. A single, horizontal palette holds virtually every control you'll need for animation.



Creating a replicator array of engine nacelles. Note that modo's layers can now be color-coded.



The new pop-up Layout Switcher replaces the layout tabs in previous versions.

Too Much for the Likes of Us?

The impressive improvements are mostly in animation, particles and simulation. I'm guessing that very few of us are doing particle simulations and character animation. The improved graph editor and Python support are definite pluses, but do you need sculptable particles that interact with soft cloth? Many of us are using modo for hard surface modeling, and for importing and rendering mechanical designs from other applications. Sexy new features tend to be of less interest.

And the price, of course, goes up. 701 retails for $1,495, up from $1,199 for 601. I'm not saying it's not worth the price — it definitely is — but I wonder if it isn't time to think about splitting off that extra-fine modeling and rendering engine and making it available for the kind of money older, more limited versions of modo commanded.

See for yourself. Give modo a free try at Luxology.com/trymodo/. **DE**

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INFO ➔ Luxology: Luxology.com

modo 701

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Metrology *Meets* Meteorology

Reverse engineering enhances data integrity while saving time and materials at NASA.

BY CATHY HAYAT

The ROMER Absolute Arm is used to scan the accreted ice on the leading edge of an aircraft wing model.

Air travel has long been considered the safest form of transportation. Statistically speaking, the average American is safer in an airplane than an automobile. Though reassuring, the industry is relentlessly pursuing ways to improve air travel safety.

One such improvement is the continued research to further understand ice buildup and how it affects aerodynamics. The aerospace industry has focused on understanding ice accretion because it causes a reshaping of the aircraft's wings or tail. When this occurs, there is the danger of aerodynamic stall.

The point at which a stall takes place involves the contour of the airfoil. A small amount of ice build-up, as slight as the roughness of sandpaper, will affect the way air flows over the upper surface. This reduces lift and increases drag to the point of which a stall becomes imminent.

According to the Aircraft Icing Research Alliance (AIRA), a cooperative association comprised of European, Canadian and U.S. government agencies, icing is the most critical natural hazard affecting the safe operation of aircraft in the Northern Hemisphere. Though aircraft routinely operate in icing environments, the dynamics of icing are still not fully understood. Areas of concern include atmospheric conditions that lead to aircraft icing, the variability of icing conditions and aircraft performance in icing conditions.

Another area of concern is the capability to simulate ice accretions and their aerodynamic effects to forecast equipment' behavior. It is this concern that has benefitted from the introduction of metrology tools to simplify reverse engineering of ice shapes.

Studying the Ice

Engineers in the Icing Branch at NASA's Glenn Research Center in Cleveland have been studying the mechanics of ice buildup since the 1940s. In the past 20 years, the team's objective was to document 3D features of the wing and tail shapes with a laser scanner. They hoped to use a solution that was starting to find its way into mainstream industry to capture the data. Their plan was to develop methods for evaluating and simulating the growth of ice on aircraft surfaces, the effects ice may have on the behavior of aircraft in flight, and the behavior of ice protection and detection systems.

Unfortunately, the researchers could not find a system that performed to their requirements. This was partly because the available hardware did not have the capability to capture the finer nuances of the ice shapes. It was also because available software could not capture the scan data and generate a CAD model with an adequate amount of detail.

Undaunted, the team continued to pursue the concept of ice forecasting. They learned that it is an extremely complicated process, because the physics of icing are not well documented nor understood. If the team could not rely on a digital solution, they needed to find a manual one, even if the results could not be quantified. Their short-term solution was to produce castings that recreated the features of ice shapes.

To create the castings, the team accreted ice on the wing or tail section's leading edge. After the ice is acquired, the leading edge is installed in a mold box. Room Temperature Vulcanizing (RTV) silicone that cures below freezing temperatures is poured into the box and left overnight to cure. A polyurethane casting resin is poured into the mold to accurately duplicate the ice shape. The casts are then used in qualitative analysis by attaching them to wing models and testing them in flight or in a wind tunnel to measure how much performance degradation they cause.

At the team's disposal is NASA's Icing Research Tunnel (IRT) at Glenn. The IRT is one of the world's largest refrigerated wind tunnels, with a 6x9x20 ft. test section, and the capability to generate airspeeds of more than 400 mph.

Implementing Metrology

NASA has been tasked with creating software to help predict ice growth. These efforts are aimed at the development of design and analysis tools that can aid aircraft manufacturers,

A researcher uses the ROMER Absolute Arm to capture the finer details of the ice shapes.

subsystem manufacturers, certification authorities, the military and other government agencies in assessing the behavior of aircraft systems in an icing environment.

To do so, the researchers revisited the subject of acquiring quantitative data using non-contact laser scanning. They believed technology had finally caught up with their requirements, after thoroughly evaluating several laser scanning systems by testing them in the wind tunnel with actual ice.

In the end, the team decided a portable coordinate measuring machine (CMM), specifically a Romer Absolute Arm with integrated laser scanner, was the solution that best fit their needs. The stiff carbon fiber construction eliminates the need for temperature compensation because, for this application, it is routinely used in an environment where temperatures range from 0° to 28°F. Using equipment that is thermally stable also prevents the system from locking up when temperatures rapidly change.

Using the new equipment, the team changed their procedure. After accreting ice, a researcher brings the portable CMM and computer into the wind tunnel. The ice is painted with a custom titanium dioxide fast-evaporating paint. While maintaining temperatures of 0° to 30°F, the operator scans the ice using a slow, smooth motion.

"One factor that we did not want to compromise was the ergonomics of the system, especially in such a challenging environment," notes Sam Lee, a research engineer with a Glenn contractor. "If the scanner starts to feel heavy, the researcher's hands would tremble, which negatively influences the data."

The scanning process takes approximately 15 to 20 minutes, and requires an overlap between individual scan passes. However, the researchers needed to avoid scanning the same area multiple times, which can add unwanted noise to the acquired data. The difficulty in scanning the shapes is ensuring all the small gaps within them are measured. When the scan is complete, the researchers have between a 0.5 to 1.0GB data file. They are able to scan up to seven ice shapes during a day of testing, because of the time it takes to initially accrete the ice.

Although the specifications of the portable CMM boast far better accuracies, this was not a primary concern for NASA because the tolerances the team needs to achieve are between four and five thousandths of an inch. The importance of the work is not the absolute accuracy, but in capturing the finer details of the ice shapes. In this application, the laser scanner's resolution of 0.046 mm between points allows them to document those details.

The mold and casting method provides excellent results; however, the process is extremely tedious and time-consuming. One of the biggest benefits when reverse engineering with a laser scanner is the savings on time and materials.

"The process of making molds and castings is very labor-intensive," Lee adds. "To make one cast shape takes a couple of days in terms of man-hours. Now, it takes a couple of hours to scan and process the ice shape."

Although the savings are a definite benefit, faster data acquisition is the most important gain. Using quantifiable data in their computer models further refines the program's accuracy.

The Next Step

At press time, the researchers are comparing the scan data vs. the mold and casting method in preliminary studies. To compare the two side by side, several ice shapes were scanned, as well as reproduced with the mold and cast method. A 3D rapid prototype machine recreated the shapes using the scan data.

The team is testing both shapes in an aerodynamic wind tunnel to discover whether the outcome is identical. At this point, the results for straight wings are similar, as researchers have recorded similar penalties created by both sets of ice shapes. They base their findings on the amount of lift and drag observed. If the results continue to be similar, laser scanning has the potential to replace the mold and casting method used for more than 20 years to capture aerodynamically relevant features of ice shapes.

"Based on preliminary testing, we have been getting very similar results," Lee reports. "Additionally, the casting method has an inherent flaw: It tends to make the ice shape rougher due to the small air bubbles that get trapped in the mold. So the molds we create are a little rougher than the actual ice."

Comparison testing recently concluded, and at press time NASA was preparing to publish the results. At present, there are several wind tunnels owned and operated by companies in the aerospace industry. While these researchers continue to use metrology to enhance ice forecasting software, others in the aerospace industry may discover new uses for the methods and techniques pioneered by NASA. DE

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INFO ➜ **Aircraft Icing Research Alliance:** IcingAlliance.org

➜ **Glenn Research Center:** NASA.gov/glenn

➜ **Hexagon Metrology:** hexagonmetrology.us

➜ **Romer:** Romer.com

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Capturing the Crown

BOXX Technologies' new dual-CPU 3DBOXX 8980 XTREME proves to be the fastest (and most expensive) system we've ever tested.

BY DAVID COHN

It's been a while since we last reviewed a workstation from BOXX Technologies (*DE*, January 2012). The Austin, Texas-based company has been building computers since 1996, and its systems have consistently proven to be the fastest commercially available. So it's no surprise that we were excited when the latest BOXX workstation arrived, the 3DBOXX 8980 XTREME.

While all of the company's 3DBOXX systems come housed in custom-designed aluminum chassis, the 8980 XTREME features a new design. In spite of the changes, the front panel remains similar to past systems. A single front drive bay houses a Plextor 20X dual-layer DVD+/-RW optical drive. Below this is a panel containing four USB ports, but now two of those ports support USB 3.0. That panel also provides headphone and microphone jacks, a round power button and bright-white LED power indicator, a blue hard drive activity light, and a small reset button.

The rear panel offers four additional UBS 2.0 ports, two more USB 3.0 ports, two RJ45 network connections, and a 15-pin VGA port for the Intel CPU's integrated graphics. There are also five audio connectors, plus an optical in/out connector.

Room for Expansion

Removing the right side panel reveals a spacious, well-organized interior. In addition to the single drive bay with front panel access, there are also eight internal drive bays. In our evaluation unit, one of those bays contained an Intel 240GB SATA solid-state drive (SSD) as the boot drive and a 7,200rpm Seagate Constellation 2TB drive for data, leaving plenty of room to add more storage.

A Seasonic 1,250-watt 80 Plus Gold power supply provides more than enough power for any expansion needs. Power cables are already routed to all of the remaining drive bays, and the system came with an ample supply of additional cables.

The 3DBOXX 8980 XTREME is built around a Super Micro Computer X9DAX-iF motherboard and Intel C602 chipset. Two CPU sockets support Intel Xeon E5-2600-series processors with Intel QuickPath Interconnect links, but all BOXX 8980 XTREME workstations come with a pair of over-clocked eight-core Intel E5-2687W CPUs. Those processors are hidden beneath closed-loop liquid cooling units, each with its own 4-in. fan mounted on the rear of the drive bay. A third fan cools the interior of the case.

The motherboard also provides four memory arrays with four sockets each, for a total of 16 240-pin dual in-line memory module (DIMM) sockets. The base model 8980 XTREME comes with 32GB of 1600MHz DDR3 registered ECC memory, and BOXX over-clocks the memory to 1980MHz. But our evaluation unit had double that amount, installed as eight 8GB DIMMs and adding $846 to the base price. BOXX currently offers configu-

INFO → BOXX Technologies: BOXXTech.com

3DBOXX 8980 XTREME

- **Price:** $13,454 as tested ($10,029 base price)
- **Size:** 6.825 x 24.65 x 17.815 in. (WxDxH) tower, weight: 34.5 lb.
- **CPU:** two Intel Xeon E5-2687W (8 core) 3.33GHz (over-clocked to 4+ GHz in turbo mode)
- **Memory:** 64GB DDR3 ECC at 1600MHz (up to 512GB)
- **Graphics:** NVIDIA Quadro K5000
- **Hard Disk:** Intel 240GB SATA SSD, Seagate Constellation 2TB SATA 7,200 rpm drive (eight internal drive bays)
- **Optical:** Plextor 20X DVD+/-RW Dual-Layer
- **Audio:** onboard, integrated high-definition audio
- **Network:** integrated 10/100/1000 LAN with two RJ45 sockets
- **Other** two USB 2.0 and two USB 3.0 on front panel; four USB 2.0 and two USB 3.0 on rear panel; integrated VGA video port

rations with up to 256GB of memory, although the system can support a maximum of 512GB of RAM using 32GB DIMMs.

Although the motherboard extends beneath the power supply, BOXX has made it easy to access hidden areas. We simply had to remove two screws to swing the power supply out of the way.

Optimum over-clocking

In its stock configuration, the Xeon processor has a maximum turbo boost frequency of 3.8GHz while maintaining a maximum thermal design power (TDP) of 150 watts. BOXX then increases performance by over-clocking the CPUs. The system goes through a startup sequence during which it self-calibrates for over-clocking. When we first turned the system on, it started and stopped several times before finally booting Windows 7. Once it was up and running, we found our processors over-clocked to 3.3GHz, yielding a maximum turbo boost frequency of just over 4GHz.

The Super Micro motherboard also provides a pair of PCI-E 3.0 x16 graphics slots. While the base configuration comes with an NVIDIA Quadro K2000 graphics card with 2GB of onboard RAM, our evaluation unit was equipped with a Quadro K5000 with 4GB of video memory. BOXX offers other graphics options, ranging from a Quadro K600 to the Quadro 6000G — as well as AMD FirePro boards ranging from the W5000 to the W9000. If you opt to go with NVIDIA GPUs, the second graphics slot can be equipped with a second matching Quadro board or an NVIDIA Tesla K20.

The motherboard also provides four PCI-E 3.0 x8 slots and a PCI-E 2.0 x4 expansion slot, as well as dual-channel gigabit Ethernet ports.

New Performance Champion

Based on our past experience, we had high expectations for this BOXX workstation — and the 3DBOXX 8980 XTREME definitely lived up to those expectations. On the SPECviewperf test, which focuses solely on graphics performance, the 8980 didn't just surpass every workstation we've ever tested; many of its scores were 1.5 times faster than its nearest dual-CPU competitor and more than 2.5 times faster than the best single-CPU system.

On the SPECapc SolidWorks benchmark, we can't make any comparisons. The SolidWorks 2005 benchmark we had been using is quite old. We've now switched to the new SolidWorks 2013 benchmark. Judging from the performance we experienced when actually running SolidWorks and other CAD software, the 8980 XTREME should power through even the most extreme CAD, CAE and DCC tasks with ease.

On the AutoCAD rendering test, which shows the advantages of CPU speed, multiple CPU cores and hyper-threading, the 3DBOXX 8980 XTREME completed the rendering in 38 seconds. While that's not a record (the 3DBOXX 8550 XTREME, with the equivalent of 24 cores running at 4.2GHz, completed the task in just 19 seconds) it is the fastest result we've seen since.

It's difficult to make an over-clocked system silent because of all the cooling required. Still, the 3DBOXX 8980 XTREME was very quiet and its fan noise would likely fade into the background.

BOXX Technologies backs the system with a one-year premium support warranty, with 24/7 telephone support and next-business-day onsite service, followed by two additional years of standard warranty service. Premium support can be extended at the time of purchase for an additional charge.

Needless to say, this much power comes with a very hefty price tag. The 3DBOXX 8980 XTREME carries a base cost of $10,029, which gets you two CPUs, 32GB of RAM, an NVIDIA Quadro K2000, a 500GB 7200rpm hard drive, optical drive, OS, keyboard and mouse. As configured, our evaluation unit priced out at $13,454, making this BOXX workstation the most expensive system we've ever tested. But, for those who need the absolute fastest performance available, the 3DBOXX 8980 XTREME is now the king of the hill. DE

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Workstations Compared

Workstations Compared		Dual-Socket Workstations		Single-Socket Workstations		
		BOXX 8980 XTREME workstation (two 3.1GHz Intel E5-2687W eight-core CPUs over-clocked to 3.82GHz, NVIDIA Quadro K5000, 64GB RAM)	**HP Z820** workstation (two 3.1GHz Intel Xeon E5-2687W eight-core CPU, NVIDIA Quadro 5000, 32GB RAM)	**Lenovo E31 SFF** workstation (one 3.3GHz Intel E3-1230 quad-core CPU [3.7GHz turbo], NVIDIA Quadro 400, 8GB RAM)	**Lenovo S30** workstation (one 3.6GHz Intel Xeon E5-1620 quad-core CPU [3.8GHz turbo], NVIDIA Quadro 4000, 8GB RAM)	**HP Z1** workstation (one 3.5GHz Intel Xeon E3-1280 quad-core CPU [3.9GHz turbo], NVIDIA Quadro 4000M, 16GB RAM)
Price as tested		$13,454	$9,984	$1,093	$2,614	$5,625
Date tested		5/9/13	7/16/12	12/29/12	8/18/12	6/29/12
Operating System		Windows 7	Windows 7	Windows 7		
SPECview 11	higher					
catia-03		78.01	51.69	18.15	48.21	39.46
ensight-04		80.25	44.13	11.08	32.18	26.19
lightwave-01		77.07	59.02	46.79	64.47	60.76
maya-03		125.16	101.67	40.36	84.50	78.65
proe-5		16.14	11.72	10.29	11/93	12.69
sw-02		67.16	57.48	31.54	53.53	47.24
tcvis-02		71.58	44.52	16.53	37.66	30.79
snx-01		81.35	44.86	13.25	33.87	27.70
SPECapc SolidWorks 2013	Higher					
Graphics Composite		2.69	2.15	n/a	n/a	n/a
RealView Graphics Composite		2.86	2.37	n/a	n/a	n/a
Shadows Composite		2.86	2.36	n/a	n/a	n/a
Ambient Occlusion Composite		6.26	5.19	n/a	n/a	n/a
Shaded Mode Composite		2.62	2.27	n/a	n/a	n/a
Shaded With Edges Mode Composite		2.77	2.03	n/a	n/a	n/a
RealView Disabled Composite		2.11	1.45	n/a	n/a	n/a
CPU Composite		4.84	4.50	n/a	n/a	n/a
Autodesk Render Test	Lower					
Time	Seconds	38.00	41.00	64.00	63.80	87.92

Numbers in blue indicate best recorded results. Numbers in red indicate worst recorded results.
Results are shown separately for single- and dual-socket workstations.

RAPID Expansion

The RAPID Conference and Exhibition grows with the additive manufacturing industry.

BY JAMIE J. GOOCH

In recent years, 3D printing has been hailed by many media outlets as a harbinger of a manufacturing revolution that will usher in a custom-built world. That's a lot to live up to.

While acknowledging that the news reports are a few decades late, the keynote speakers who opened RAPID 2013 on June 11 in Pittsburgh didn't exactly disagree with those claims.

"It is truly vital to engage in advanced manufacturing opportunities," said Brett Lambert, deputy assistant secretary of defense for Manufacturing and Industrial Base Policy, U.S. Department of Defense. "The world has changed and is changing as we gather here today."

Michael F. Molnar, chief manufacturing officer, National Institute of Standards and Technology (NIST), agreed with Lambert, saying the country needs to focus on advanced manufacturing techniques, including 3D printing. The National Additive Manufacturing Innovation Institute (NAMII) is one way to sharpen that focus. Molnar said NAMII and three new institutes for manufacturing innovation that will be founded this year, are trying to bridge the gap between research and commercialization.

Edward Morris, director of NAMII, said the institute envisions widespread adoption of additive manufacturing as increasing U.S. competitiveness, revealing new and better products and manufacturing techniques, and spinning off new companies with highly skilled workers.

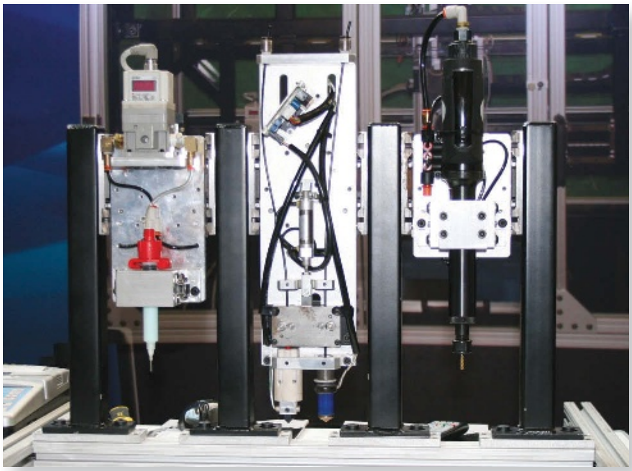
Even after more than 20 years, there was a feeling at the show that additive manufacturing has just scratched the surface of its potential. Initial attendance figures showed 2,700 people, including exhibitors from nearly 100 companies, traveled to the conference this year. That's up from less than 1,500 attendees last year.

Exhibitors Optimistic

The show floor backed up those early numbers with crowded aisles and busy exhibitors. Conor and Deirdre MacCormack from Mcor Technologies said their business continues to expand, especially after launching a deal with Staples Printing Systems Division to launch a new 3D printing service called "Staples Easy 3D," online via the office store. The booths at Stratasys, 3D Systems, Envisiontec, EOS and others were likewise packed with attendees getting a close-up look at different additive manufacturing and scanning technologies.

The increased media attention (up 100% from last year according to consultant Terry Wohlers) has brought the benefits of rapid prototyping and custom manufacturing to light to many new people, but it's still just getting started. **DE**

Mcor Technologies' founder and CEO, Conor MacCormack shows *DE*'s Contributing Editor Pam Waterman how the company's IRIS 3D printer uses paper, ink and water-based adhesive to create color models.



The National Nanotechnology Manufacturing Center displayed its Multi Proto Lab that it says is capable of 3D printing, precision milling, extrusion deposition and more in one machine by using different components.

Jamie Gooch *is managing editor of Desktop Engineering. Send e-mails about this article to jgooch@deskeng.com.*

INFO → RAPID Conference and Exhibition: rapid.sme.org/

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

Commentary  by Nicholas M. Veikos

Do You Have a Simulation Plan?

The notion that early simulation can provide significant benefits to product development has been proven. The question that many small- and medium-sized businesses (SMBs) are asking is, "Will it work for us?"

Companies use simulation software with mixed results. Some achieve resounding success and serve as exemplars for the industry. Others fail miserably, vowing never to sway from the build-and-test philosophy. In most cases, the differences lie in planning and commitment to execution.

Sometimes planning can be overwhelming when applied to something broad and abstract, so my suggestion is to plan using a well-defined application. If possible, pick a product that is currently in production, but is due for a major redesign. The advantage to this approach is that you will likely be able to answer questions like:

- How many prototypes did we need?
- What design modifications could we not implement because we ran out of time?
- What were the major warranty items in the field?

Don't Go for Broke

I recommend against developing your first simulation plan for a high-profile or "bet-the-company" project. The risk is simply too high and the atmosphere too stressful. You must be able to show significant benefits, but look to do it within a relatively stable environment.

No training is OK ... if you don't mind ruinous failure.

With historical information in hand, you can begin to survey how simulation would improve your process. It may be wise to find an experienced engineering consultant to entrust with this step. He or she will be able to work with you to analyze each step in the design process to provide a quantitative and realistic assessment of how simulation can help, what resources it will require, and the expected benefits. He or she will also be able to give an objective opinion of which pieces can be done effectively internally, and which would benefit from expert help from the outside. A good consultant will also be able to identify areas where simulation may not be a practical option.

At the completion of the survey, you may be convinced that simulation is a no-brainer, but don't fool yourself into thinking you have a plan. You have data, but still need to connect the dots, both for yourself and your management.

Case in Point

Let's say, for example, that you have identified that your organization will benefit most from a combination of some basic simulation early on to help choose a design direction, followed by more detailed simulation to capture all the physics, minimize prototypes and ensure a robust product. The overall plan for this scenario must consider the following:

- How much simulation will be done internally? If your team has little or no experience, it can probably handle the initial design iterations, but the detailed simulation may be best handled by an expert consultant. As internal skills improve, your team will be able to take on more of the simulation work. A good partner will share what he or she has done to help your engineers learn. Stay away from those who want to keep all they do under wraps, and refuse to share knowledge or models.
- Who will perform the simulation? The latest buzzwords are "democratization of simulation." While simulation can be used by a wide spectrum of engineers, you want the first adopters in your organization to be the cream of the crop. Train these people first — they will succeed, and so will your plan. Promote geniocracy (a government of geniuses) for now; democracy can come later.
- Which simulation software will you implement? The keys here are to ensure it is easy for non-experts to learn and use; has the functionality that you need today, but is scalable to what you will need in the future; and is supported by engineers who use it to solve real problems. Note that the cost of the software is a small fraction of the implementation cost and the overall benefit, so don't get hung up on this aspect.
- How much training is required? Customized training, geared to your project, is best. It will make everyone productive immediately. Generic training is better than none at all. No training is OK ... if you don't mind ruinous failure.
- How much new hardware is required? Work with IT to determine cost and lead time for modern hardware.

Develop a budget and schedule. Verify that the required return on investment is there, the risks are mitigated, and the project will be completed with time to spare. Otherwise, your conversation with management is going to be uncomfortable.

Different implementation scenarios will require different plans, but the basics are similar. And like all plans, execution is paramount. But that is a story for another day. DE

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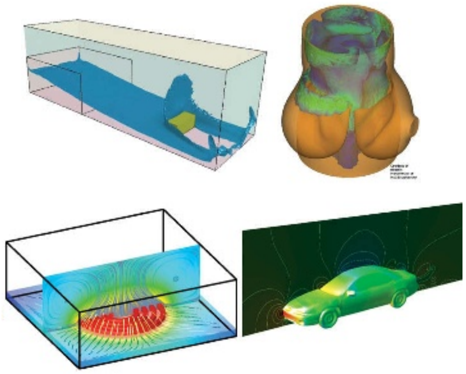
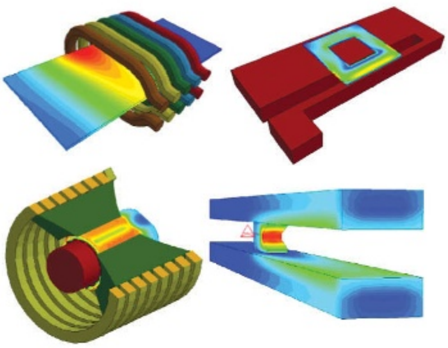
LS-DYNA R7

Three New Solvers for Multiphysic Purposes

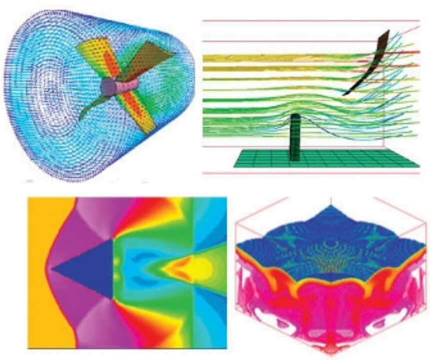
- **Incompressible CFD (ICFD)**
- **Electromagnetics (EM)**
- **CESE / Compressible CFD and Chemistry**



Incompressible CFD: The incompressible flow solver is based on state of the art Finite Element technology applied to fluid mechanics. It is fully coupled with the solid mechanics solver. This coupling permits robust FSI analysis via either an explicit technique when the FSI is weak, or using an implicit coupling when the FSI coupling is strong. In addition to being able to handle free surface flows, there is also a bi-phasic flow capability that involves modeling using a conservative level-set interface tracking technique. Basic turbulence models are also supported. This solver is the first in LS-DYNA to make use of a new volume mesher that takes nice surface meshes bounding the fluid domain as input.



The Electromagnetism Solver: solves the Maxwell equations in the Eddy current (induction-diffusion) approximation. This is suitable for cases where the propagation of electromagnetic waves in air (or vacuum) can be considered as instantaneous. Therefore, the wave propagation is not solved. The main applications are magnetic metal forming or welding, induced heating, and so forth. The EM module allows the introduction of a source of electrical current into solid conductors and the computation of the associated magnetic field, electric field, as well as induced currents.



CESE/ Compressible CFD: The CESE solver is a compressible flow solver based upon the Conservation Element/Solution Element (CE/SE) method, originally proposed by Dr. Chang in NASA Glenn Research Center. This method is a novel numerical framework for conservation laws. It has many non-traditional features, including a unified treatment of space and time, the introduction of conservation element (CE) and solution element (SE), and a novel shock capturing strategy without using a Riemann solver.

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