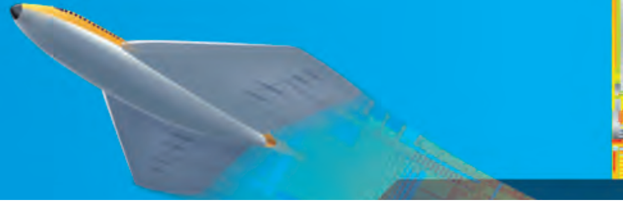

DE

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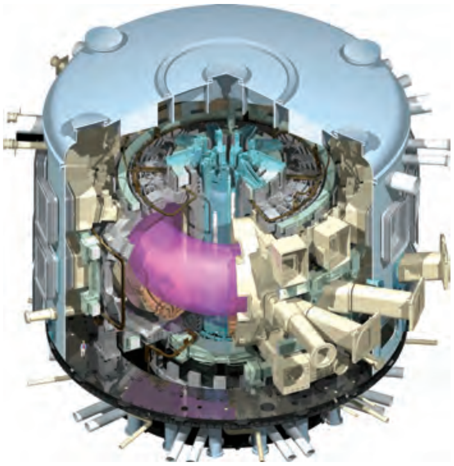
July 2012 / deskeng.com

VISUALIZE BETTER DESIGN

Real-time rendering immerses you in your designs.
P. 28

by Steve Robbins

Fusion Confusion



The ITER machine is based on the tokamak concept of magnetic plasma confinement, in which the fusion fuel is contained in a doughnut-shaped vessel. Image courtesy ITER Organization, iter.org.

Recently I found an article in Scientific American magazine (scientificamerican.com) called "Fusion's Missing Pieces" by Geoff Brumfiel. I have always been intrigued by fusion as a clean, unlimited energy source. A fusion reactor that can deliver more energy than it takes to power it is a world changing technology. But Geoff's article was interesting for more than just explaining how researchers are experimenting with fusion.

Clean Energy Gets Messy

In the design engineering world, the word "collaboration" is used all the time. Our editorial team is constantly in communication with companies, large and small, offering methods of collaboration from proprietary software to cloud-based social sites. Collaboration in engineering has become mainstream over the last decade, mainly because of advances in the speed of networks and the Internet, PLM, social networking and cloud computing enabling the sharing of large models and data globally.

Engineers should be allowed to design the fusion reactors, and politics should be kept out of it.

Politicians who seem to be making their decisions based on what benefits their countries are running ITER, the internationally funded project that has taken on a lead role in fusion experimentation to produce energy. There is no specific collaboration software for countries and politicians to use, so it's no wonder this project is moving so slowly and continues to double its costs, and then double them again.

Gyung-Su Lee, the current Chairman of the International Fusion Research Council of the ITER, is quoted as saying in the article "Fusion is seductive. It's like people searching for ways to make gold in the Middle Ages. It's the holy grail of energy research." And why wouldn't it be? Unlimited clean power based on an unlimited fuel supply: water. The ITER is not the only experimental fusion reactor device being used today, but it is the biggest and holds the greatest potential for creating energy and laying the groundwork for future reactors that will provide 10 times the energy needed to power it.

While unforeseen engineering problems continue to present themselves, my take from what I have learned recently is that the lack of structured communication, no collaboration efforts, and multi-governmental bureaucracy have led to massive problems in a critical experimental technology.

Progress Being Made

There are some breakthroughs in important areas, however. At NI Week I attended a session about the Max-Planck-Institute for Plasmaphysics (IPP) using Labview and multicore computing to control the magnetic field used to confine plasma in a torus in real time. The loop time on the control system was a correction every millisecond. (To view the video go to goo.gl/LOKV0.) But there is a lot of technology that will need to be solved before there is success in creating a reactor that will sustain fusion and create adequate usable energy. We will need new materials and new ways of creating superconductivity. But PLM and collaboration systems already exist.

Politicians Aren't Engineers

Parts and assemblies for the ITER fusion reactor are coming from seven different countries. If the critical decisions are made for political reasons, time and money are being wasted. Geoff illustrates in his article that India argued with the other members of the ITER on where a pipe should end. Engineers would put the pipe where it logically belonged and best fitted in the design. Building a fusion reactor is extremely complex but the probability of a successful outcome is high.

It might take a lot more years and a lot more money than projected, but one thing is very evident: The engineers should be allowed to design and build the fusion reactors, and politics should be kept out of it. This is too important to fail. DE

Steve Robbins *is the CEO of Level 5 Communications and executive editor of DE. Send comments about this subject to DE-Editors@deskeng.com.*

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Latest Project
Develop a test architecture for verification of wind turbine control systems
NI LabVIEW
LabVIEW makes me better because I can
SIMULATE
real-world systems

DE July 2012

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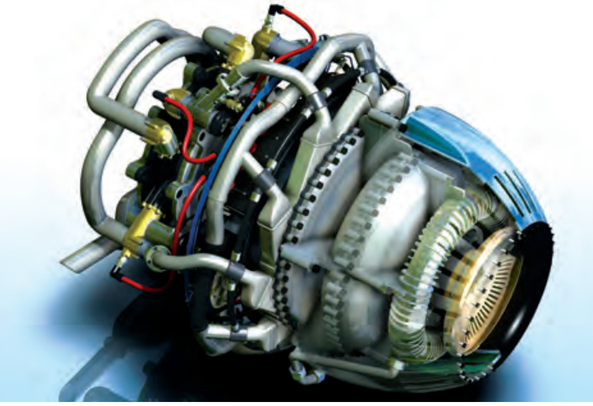

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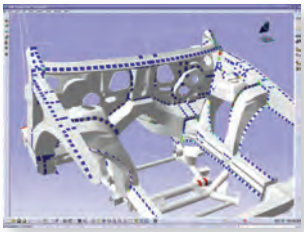
ON THE COVER: Integrated real-time rendering in CAD programs, like the IronCAD rendering shown here, can help engineers improve their designs and explain them to others.



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Freedom to Engineer

Engineering practice is changing dramatically. The workstation is leading the way.

BY PETER VARHOL

The field of design engineering has changed radically in just a few short years. Cost reductions and time-to-market pressures have required engineers to do more than simply meet requirements.They have to design a best-of-breed product, and do so in a timeframe that would be unheard of a decade ago.

Better engineering design software and simulation and analysis tools have played a large role in the ability of engineers to meet these challenges. But the foundation for these improvements has been the workstations themselves. Faster processors, more cores, more memory, and virtualization have all made a significant impact on engineering design practices, mostly by speeding up computation and rendering, and parallelizing selected work.

But one of the biggest changes on the horizon is the workstation form factor. Engineers have always used the traditional deskside or desktop workstation, a style that hasn't changed in 20 years. But the nature of work has changed dramatically in that time. Engineers used enclosed offices with large desks, and often had a drafting board or work table to spread out documents, diagrams, and illustrations.

These workspaces rarely exist any more. Many engineers, especially those who aren't also managers, see a small cubicle and smaller desk unit, with no work table and not a lot of room beyond that space. A desktop workstation takes up far too much space on a standard cubicle desk for the desk to be useful for other work, while a deskside box takes up valuable floor space.

Further, it's not just workspace considerations, but also the nature of the work itself. Engineers have more demands on their time and location than ever. It's not uncommon for engineers to join tiger teams for special projects, and may have to set up a workspace for a few months within another design group, or even within a conference room. The ability of the highest performance companies to quickly bring together ad hoc teams to respond to market needs is part of what makes them great.

Achieving a Flexible Workstation Form Factor

Due to the physics of computing and the demands of usable I/O, re-imagining the engineering workstation form factor is challenging, and no single solution is perfect. While laptops handle some of these emerging ways of doing engineering, their performance and expandability limitations prevent their widespread replacements as full-blown engineering workstations. Ideally, engineers can use the laptop form factor combined with an extra-large monitor and plenty of expansion ports.

Performance and display size and resolution are the two key requirements for most engineers. But because projects can vary widely, the ability to work with a lot of different peripherals became much more important than it was in the past.

These requirements led to the design and introduction of an entirely new form factor with the HP Z1 Workstation for engineers. At first glance, it looks like only a high-resolution display mounted on a stand, but inside the display case resides all of the computational and peripheral components expected in a purpose-built workstation.

The HP Z1 all-in-one workstation operates entirely within the space constraints required by today's engineering groups. On a desk, it is a straightforward 27-inch monitor, taking up no more room than what would be required for a standard display. Yet it is the entire computer, including processor, graphics subsystem with NVIDIA Quadro GPU, disks, memory, and expansion slots, all of which reside entirely within that package. While larger than a laptop, it offers full desktop performance. The wireless keyboard and mouse make the workspace still more streamlined, without the need to move wires around to clear a larger workspace.

Upgrading for future needs is also easy – the monitor case simply snaps open, and individual components, such as memory, disk drive, and graphics card, can easily slip in and out.

Engineers today and in the future need more options than a traditional desktop or deskside workstation. Those alternatives are emerging into the market. The HP Z1 Workstation, powered by the latest Intel® Xeon® processors, is a first initiative at defining the workstation form factor that is meaningful for engineers in today's work environments, and readily adaptable to future directions. Thanks to innovative approaches to understanding what it means to be an engineer today, new form factors will change the way we work. It's all about the freedom to engineer. **DE**

For more information on HP Solutions please go to www.hp.com/go/mcad or call 888-728-9985.

Screen image courtesy of Spracher Engineering.

by Kenneth Wong

Dell Debuts New Workstations with NVIDIA Maximus Dual-GPU Architecture

The old client-server computing model seems to be coming back, but with some new twists. The new Dell Precision T7600 tower workstation, part of the company's workstation lineup released in mid-April, features a PC-over-IP option, delivered via what Dell calls "a true zero-client communication solution." The idea is to let you keep the workstation in a server room elsewhere while you work with just a keyboard, a mouse and a display panel plugged into the client device, dubbed FX100.

The PC-over-IP device has no fan or driver, giving you a way to literally distance yourself from the heat and noise of a typical workstation. With audio/video input/out, FX100 gives you the option to connect to two displays. The client device communicates with the remote workstation through a PCIe remote access host card, housed in the host computer.

As for the workstation itself, T7600 is rack-mountable, designed for the Dell PowerEdge server rack. The chassis design gives you access to the hard drive from the front, with a quick-release.

"Designed for customers in data-intensive fields like video editing, who need to swap out hard drives easily, and military and research organizations, who need to store sensitive data in a secure location at the end of the day, it comes with up to four 3.5-in. hard drives or eight 2.5-in. hard drives," Dell says in a press release. At the same time, the company also rolled out T5600, T3600 and T1650 workstations.

Dell's new Precision workstations featuring NVIDIA Maximus Technology. From left are the T7600, T5600, T3600 and T1650.

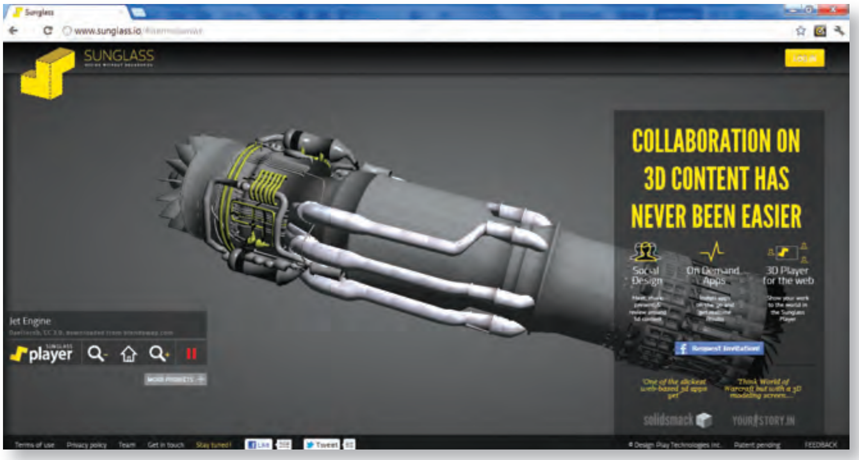
T7600 is distinguished by its multiple-GPU setup, comprised of a NVIDIA Quadro 6000 and two NVIDIA Tesla C2075. Similarly, the T5600 and T3600 also feature both Quadro and Tesla GPUs, housed within the same unit. The multiple-GPU setup represents NVIDIA's Maximus technology, which proposes the use of Quadro GPU for graphics-heavy interactive applications (such as 3D CAD modeling and rendering) and Tesla GPUs for multi-threaded HPC jobs (such as simulation and analysis).

In a typical PC, running a computing-intensive program, such as rendering software or finite element analysis software can consume all available processing power—effectively bringing interactive works to a crawl. NVIDIA's multiple-GPU setup is expected to remedy the bottleneck by dividing the jobs among additional computing cores available on the GPUs. (For more, see "NVIDIA Maximus Unveiled," *DE's* Virtual Desktop blog, Nov. 14, 2011.)

Rounding out the group is Dell's T1650, a new entry-level workstation that is certified for 2D/3D CAD and photo-editing applications.

Take a Look at Browser-based 3D Collaboration in Sunglass

Newcomer Sunglass (www.sunglass.io) is going where traditional CAD and product lifecycle management (PLM) vendors are reluctant to go: browser-based 3D collaboration. Running on WebGL (JAVA-based interactive 3D rendering inside browsers), Sunglass portal gives you the ability to upload a 3D model in a variety of formats (STL, DAE, OBJ, SolidWorks, Inventor, Creo, JT, IGES and STEP, just to name a few), then launch an interactive discussion using audio-video-text chat functions.



Browser-based collaboration platform Sunglass, currently in closed beta.

From a WebGL-supported browser, you can log into your project space, which is comprised of a collection of "stages." Each stage gives you a 3D environment into which you can drop a design. You may, in fact, use a single stage among several users to assemble a design by uploading multiple parts.

Once logged in, you have the option to move and resize uploaded designs. You may also add comments by dragging and dropping notes (think of it as attaching sticky notes with pushpins to specific areas of your model). There's also an online rendering option, which lets you render your design using remote CPUs. This approach leaves your local CPUs (the processors in your machine) untouched, so your own machine won't come to a crawl during the rendering session.

If you choose to share your design with the public, you can publish your design in a format viewable from a web page. An integrated link to Ponoko lets you print your design in 3D (provided you have an existing Ponoko account).

Sunglass envisions a mix of collaboration, annotation and crowd-sourcing as the future of design development. Its interface reflects this concept, with a link to a pay-per-use app store (currently listing meshing, finite element analysis, rendering and airflow apps) and community (currently still in development). At press time, the Sunglass team was also actively working on a mobile app. Sunglass itself is currently online, but the platform is in closed beta.

By bypassing the need to install and master a CAD program, browser-based collaboration tools like Sunglass could reach beyond traditional engineering and manufacturing sectors.

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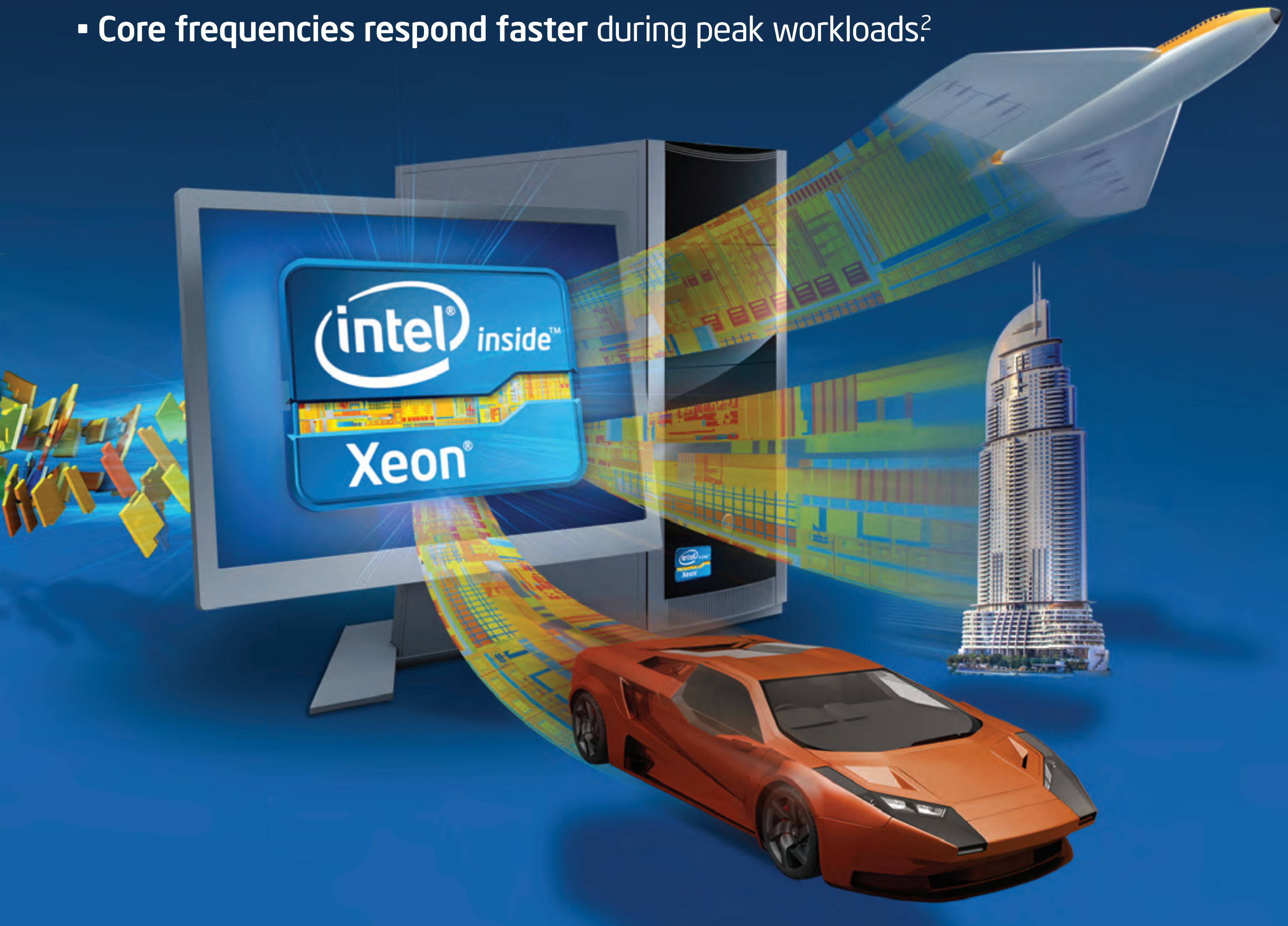

[1]Intel measurements of average time for an I/O device read to local system memory under idle conditions. Improvement compares Intel® Xeon® processor E5-2600 product family (230 ns) vs. Intel® Xeon® processor 5500 series (340 ns). Baseline Configuration: Green City system with two Intel® Xeon processor E5520 (2.26GHz, 4C), 12GB memory @ 1333, C-States Disabled, Turbo Disabled, SMT Disabled, Rubicon* PCIe* 2.0 x8. New Configuration: Meridian system with two Intel Xeon processor E5-2665 (C0 stepping, 2.4GHz, 8C), 32GB memory @1600 MHz, C-States Enabled, Turbo Enabled. The measurements were taken with a LeCroy* PCIe* protocol analyzer using Intel internal Rubicon (PCIe* 2.0) and Florin (PCIe* 3.0) test cards running under Windows* 2008 R2 w/SP1.

[2]Requires a system with Intel® Turbo Boost Technology capability. Intel Turbo Boost Technology 2.0 is the next generation of Turbo Boost Technology and is only available on select Intel® processors. Consult your PC manufacturer. Performance varies depending on hardware, software, and system configuration. For more information, visit http://www.intel.com/go/turbo.

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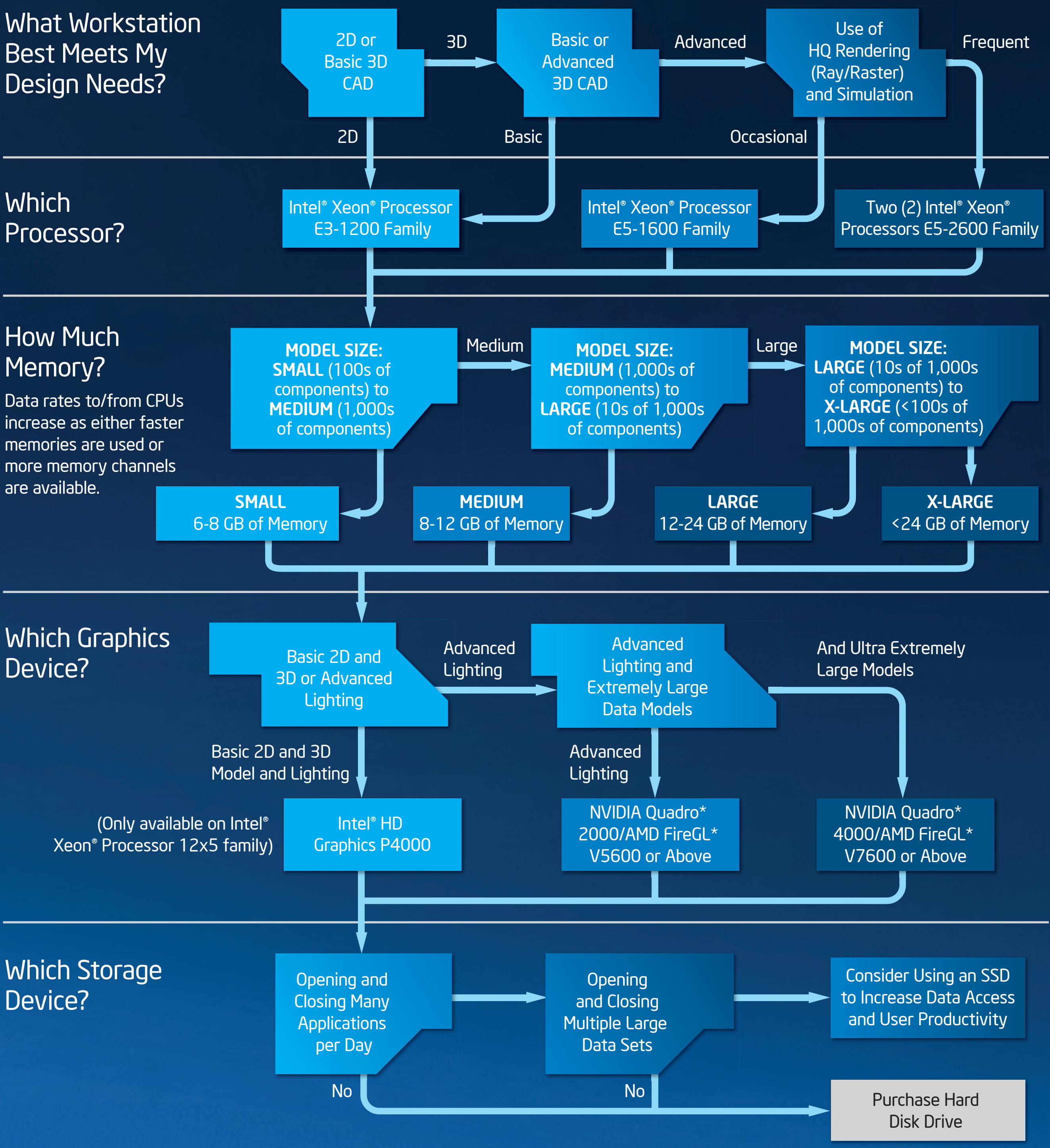

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by Kenneth Wong

Solid Edge Viewer and SolidWorks eDrawing, Coming to the iPad

SolidWorks eDrawings, now available for the iPad.

Solid Edge, part of Siemens PLM Software's Velocity Series, is getting the iPad treatment. It's getting a mobile viewer, set to appear by the time this issue reaches your mailbox. It's strictly a viewer that allows those who do not have Solid Edge software to receive and inspect 3D design files created in the software. The app will also display manufacturing information, such as dimensions, materials and suppliers. You'll be able to select and isolate subcomponents to hide or display. The demo version doesn't have a structure viewer or annotation tools, but such enhancements could be a natural progression of the app's future.

eDrawings, SolidWorks' desktop viewer, is also heading for the iPad, selling on the Apple App Store for $1.99. Like its desktop counterpart, eDrawings for the iPad gives you the ability to view, rotate and explode SolidWorks models. In addition to viewing eDrawings files published from SolidWorks, the app also lets you load and view native SolidWorks models, DWG files and DXF files. A floating pane lets you access the component tree in your assemblies, so you can use it to isolate and highlight subassemblies and parts. If your file is published with configurations (for example, an ink cartridge with or without handles), you may use the same pane to examine different configurations possible in the model. Unlike the desktop version, the iPad version doesn't offer tools for annotation, cross-sectioning and measurement. With limited functions, the iPad version is a simpler, lighter version compared to the desktop version.

Solid Edge Viewer mobile, coming to an iPad near you.

Filtering Big Data with Active Workspace

The past challenge for manufacturers was a lack of information, but the present challenge is the opposite. We have too much data, too much to review, too much to evaluate—too much to make sense of for decision making.

"'Big data technologies' describe a new generation of technologies to extract patterns and insights from a large volume of data," said Chuck Grindstaff, CEO and president of Siemens PLM Software, during his keynote to PLM Connection 2012 Conference attendees.

As revealed in the last several years, Siemens PLM Software has envisioned solving the big data problem with high-definition product lifecycle management (HD PLM), a way to visualize enterprise data and project data as layers of information on assembly models. (See "NX Goes HD," June 2010, Virtual Desktop blog.) Active Workspace, a product with a search-centric interface from Siemens PLM Software, is expected to fulfill the promise of HD PLM and bring it to a wider audience.

When you log into Active Workspace, the first thing you see is a search box. Upon performing a search, you can narrow down your search results through a series of logical filters and attributes—by release date, supplier, material, etc.

Active Workspace is an adjunct product to Siemens PLM Software's Teamcenter. It won't be offered to those who are not using Teamcenter. It is not, however, a plug-in to Teamcenter; it stands on its own as a desktop application. The program is an access point to delve into product databases, so it requires some connectivity and configuration tasks to set up (Siemens PLM Software plans to offer integration and consultation services on that front). It is built on open architecture, so it can be connected to databases beyond Teamcenter. Active Workspace uses Solr, an open-source search technology to query and index file attributes, which gives the application a way to swiftly return search results.

An integrated JT viewer serves as a way to display 3D data inside Active Workspace. Although it works as an access point to Teamcenter and NX data, Active Workspace runs as a separate application, allowing those who do not regularly interact with CAD and PLM systems to gain access to a greater volume of product lifecycle data. **DE**

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

Electronic 'Nose' Made from Conductive Composites

UK-based Peratech has developed an "electronic nose" using sensors made from a special composite material that can detect the presence of volatile organic compounds (VOCs). The ultra-thin, low-power sensors could potentially be integrated with mobile phones—or even into protective clothing.

Peratech's sensor is based on Quantum Tunneling Composite (QTC) technology, which is also used in pressure-sensitive touchscreens. The materials change resistance when force is applied. For the VOC sensor, the QTC is made of VOC-absorbing polymers spotted with the company's conductive metallic particles. The polymer content of the QTC swells when exposed to the gases (enabling electron flow), then recovers once the VOCs are no longer present.

Other potential applications include pressure switches on power tools, respiratory monitors and fabric keyboards.

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Amphibious Sea Lion Prototype Makes Waves

It's hard not to think of the James Bond theme song when you see a car capable of cruising on land and sea. Now for just $259,500, you can own the Sea Lion prototype and turn supervillains (or neighbors) green with envy.

Created by Mark Witt as an entry for the Amphibious World Speed Record Competition, the Sea Lion is made mainly of original parts. Designed using CAD and spreadsheet calculations, it was built using tungsten inert gas (TIG)-welded 5052 aluminum, with parts constructed from computer numerically controlled (CNC) plasma-burned pieces and CNC milling.

The Sea Lion has been designed to hit a top land speed of 180 mph. Water speeds of 60 mph should be possible with the right engine.

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Altaeros Energies' Inflatable Turbine Soars

Long before Don Quixote tilted at them, windmills have been producing energy. However, if the wind doesn't blow, or blows gently for too long, you don't get any power.

Massachusetts-based Altaeros Energies has devised a potential solution to this problem with an inflatable turbine. The company recently tested the idea with the help of a 35-ft. prototype of the Airborne Wind Turbine (AWT). The prototype was launched up to 350 ft. (more than twice the height of most ground-based turbines) with the help of a towable docking trailer.

With a successful test completed, the company will go back to work on designing AWTs that can reach 1,000 ft. to catch more powerful winds. According to the company, use of an AWT can reduce energy costs by up to 65%.

MORE → http://www.engineeringontheedge.com/?p=1640

Disney Touché Advances Gesture Recognition

Disney Research's Touché system lets everyday objects, such as a tabletop, doorknob or lamp, recognize how a user is touching it and react to the interaction. At its most basic, you could lock a door with a touch, turn off a lamp by tapping it or use your sofa as a remote.

Touché uses swept frequency capacitive sensing (SFCS) to perform these feats by monitoring data points. Not

only can something be either touching or not touching the interactive area, SFCS can recognize the manner in which something is being touched for different responses.

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iWalk Creates Bionic Foot

A company named iWalk is developing what it calls the first truly bionic prosthetic. The internally powered BiOM brings energy to the prosthesis with a high-tech foot and ankle that propel the user forward, rather than requiring the user to give energy to the prosthetic. This reversal of the norm for prosthetics should help to reduce the chronic lower back pain and joint degradation suffered by many amputees.

BiOM manages a better feel through the use of a modular lithium iron phosphate battery, biomimetic control firmware, a high-energy elastic spring actuator and a series of internal sensors. According to the company, the ability to produce a more natural-feeling gait reduces the energy required to use the prosthetic. **DE**

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3D Systems Releases ZPrinter 850 and ProJet 3500 Series

The ZPrinter 850 is the first ZPrinter to be released since 3D Systems acquired Z Corp. in January. According to the company, the ZPrinter 850 offers 390,000 colors from five print heads with a resolution of 600x540 dpi. It has a build envelope of 20x15x9 in. and offers a layer thickness of 0.0035 to 0.004 in.

The new system uses a high-performance composite material and an inkjet-sprayed binder to create layers. Finished products can be treated with resin to create sturdy, functional prototypes. 3D Systems says the ZPrinter 850 is its fastest printer yet, with a vertical build speed of 0.2 to 0.6 in./hour, amounting to approximately 42 baseball-sized prototypes per day.

In other 3D Systems news, the ProJet 3500 series uses the company's Multi-Jet Modeling and comes in three flavors, including the ProJet SD 3500, ProJet HD 3500 and the ProJet HD 3500Plus. All three systems use VisiJet UV curable acrylic plastics.

These plastics have been designed for different uses (and come in a number of colors), providing 3D printing options for prototyping and end use applications, direct casting and medical applications.

The HD and Plus models come with a five-year printer head warranty; the warranty is offered as an available option for the standard model. The HD build envelope offered by all three systems is 11.75x7.3x8 in., with a resolution of 375x375x790 dpi (xyz) and 32μ layers.

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Standardizing Additive Manufacturing Processes

Juggling the many different-but-similar terms additive manufacturing (AM) companies use to describe their technologies can be frustrating and confusing. It could even hurt acceptance of AM in general, slowing its growth. If someone is just beginning to look into AM for a business, there's a steep learning curve just related to the industry's vocabulary.

ASTM International, a standards group, wants to do something about it. Chaired by Terry Wohlers, the terminology subcommittee has boiled down the myriad AM process names into seven standardized terms. The terms are as follows:

- Vat Photopolymerization
- Material Jetting
- Binder Jetting
- Material Extrusion
- Powder Bed Fusion
- Sheet Lamination
- Directed Energy Deposition

For the definition of each term, as well as more information on the development of AM standards, visit Rapid Ready Technology via the link below.

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Matterport Develops Low-cost 3D Scanner

Still in development, the Matterport 3D scanner looks kind of like a Kinect with a hand grip. The first prototype was basically just that: a modified Kinect that could be waved around. Subsequent models have replaced the Kinect innards with Matterport-developed hardware.

According to the company, the Matterport 3D scanner has been designed to be less expensive and faster than the competition.

"We turn reality into 3D models, and our scanner is 20 times faster and 18 times cheaper than any other tool on the market," says Michael Beebe, Matterport co-founder, in a press release. "We are creating fundamentally new technology, like the steam engine or the car."

That math should put the Matterport scanner at under $2,000, which could make 3D scanning more attractive to small businesses and even some individual users.

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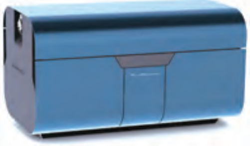
Blueprinter Preps for Launch



Denmark-based Blueprinter's 3D printer is set to launch sometime this year. Part of what makes this new system interesting is the process it uses to build objects. In place of a Fused Deposition Modeling (FDM)-like process or laser sintering, Blueprinter uses what it calls selective heat sintering (SHS).

SHS uses a thermal print head instead of a laser to fuse thermoplastic into the desired shape. According to the company, this process allows for a layer thickness of 0.1 mm and a print speed of 10 mm/hour. A potential drawback to this new contender in the 3D printing arena is that Blueprinter only offers a single color (white) for its builds.

The build envelope is 6.3x7.87x5.51 in., and objects created by the Blueprinter don't require support materials, instead being supported by the build material. The 3D printer will be priced at around $16,000. **DE**

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Dassault Systèmes DraftSight: Designed for All

BY JIM ROMEO

Aaron Kelly

To understand what Dassault Systèmes' DraftSight is all about, *DE* spoke with Aaron Kelly, senior director of the DraftSight brand. Here's how our conversation went:

DE: ***Can you describe some of the applications of DraftSight?***
AK: Two popular applications are for industrial equipment design, and for architecture and construction. A part, for example, may be designed with DraftSight and subsequently used by other applications to produce that part.

DE: ***What is the relationship between DraftSight and SolidWorks, and how do the two partner together?***
AK: DraftSight, like SolidWorks, is a Dassault Systèmes product. A key value that DraftSight delivers for SolidWorks is providing the opportunity to develop a relationship with 2D CAD users in hopes that when those users are ready to move to 3D, they will consider SolidWorks.

In addition, DraftSight fills a great need for many SolidWorks customers who need the ability to share DWG files and want access to a professional-grade CAD product to do so. Plus, SolidWorks customers can save money by choosing DraftSight over another 2D CAD option.

DE: ***You have cited examples on your website of how DraftSight is used by non-profits around the world. Do you have relationships with non-profits?***
AK: Not officially. But we are finding that many are finding out about us and using our product, and we are finding out about them.

DraftSight uses DWG files, and therefore may interface with many different software applications.

DE: ***Can you tell us more about how DraftSight was used by a non-governmental organization (NGO) in Papua New Guinea?***
AK: David Hall is a civil engineer on assignment for a New Zealand economic development agency. It is an organization similar to the American Peace Corps. Hall and his wife were assigned to a small province called West New Britain in Papua New Guinea. Most in the region live rurally and have no plumbing. Hall collaborated with a NGO called "Live and Learn."

Before leaving for Papua New Guinea, Hall searched the Internet for a convenient drawing program that would work on his Mac laptop, and he found DraftSight.

Hall used DraftSight to aid in the installation of basic water supply systems, to provide water in taps within the village and relieve the women and children of the daily chore of fetching water, often from miles away. He also used it to facilitate construction of ventilated "longdrop" toilets as a sanitary alternative to the current practice of using the bush or beaches as bathrooms.

DE: ***In your view, what are some things that DraftSight offers that may not be offered in higher-end, licensed software?***
AK: It allows access to a free, standalone, professional-grade product available to download at DraftSight.com. In enables open access to an active, online community where users can ask questions about the product and get answers from technical support reps, as well as other users.

It's downloadable from the web. It's only about 70MB. It is available in 14 languages, with English being the primary language. Other popular languages are French, German, Italian, Japanese, Brazilian and Portuguese.

DE: ***In your view, what do design engineers need in engineering design software nowadays? How do DraftSight and SolidWorks help provide this?***
AK: Users need compatibility to share files or collaborate across their company and business partners. They need software that is easy to use. They need software that is accurate. SolidWorks and DraftSight are compatible with many file types—and millions of people are using these two software products, so it is easy to find others that may have one or both of these products.

SolidWorks is an innovator in ease of use for 3D design, and DraftSight enables users to work in familiar 2D workflows. DraftSight and SolidWorks offer accurate drawings that can be shared with others.

DE: ***Do you see any trends in developing engineering design software?***
AK: I am not sure we will see a trend in software development of engineering software like DraftSight. It is an enabler for customers to shift their engineering software spending from 2D-focused software to 3D-focused software.

Looking at DraftSight as a DWG-file based system, though, we may see more emphasis on engineering CAD products using DWG files more. **DE**

Jim Romeo *is a freelance writer based in Chesapeake, VA. Send e-mail about this article to DE-Editors@deskeng.com.*

INFO → Dassault Systèmes: DraftSight.com

Scanning Success

An automotive accessories manufacturer finds Artec's M Model scanner optimizes its productivity.

Based in Russia, Nika Holding is a manufacturer of automotive accessories. The company has been in the automotive accessories market for about two years, engaged in production of floor mats for trunks and interiors. During this period, many leading automakers, such as Nissan, Skoda, Reno and Peugeot, have become clients.

Nika Holding produces mats based on a method that is impossible without scanning. Computer processing of the data ensures a perfect fit of a pattern to the automobile surface. After researching the market for existing technologies, the company tried the M Model scanner made by Artec.

Scanning the interior of an automobile is not easy because the space in a salon is rather tight and dark. Therefore, to obtain an acceptable result, about six scans are done from various angles.

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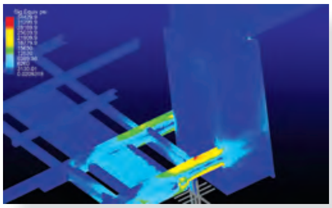
The Keys to Creation

New simulation software integrated with direct CAD saves weeks on analysis and reduces cost by 40%.



Heiner Philipp has worked as a mechanical engineering consultant for nearly 20 years since graduating from the University of Windsor with a bachelor's of science degree in engineering. His company, Southwinds Engineering Inc., is based in Flesherton, Ontario.

Phillipp has been a KeyCreator user since 1989, when he was first exposed to the software in college. Over the years, he has done a number of projects for Wilcox Bodies Ltd., a company that specializes in manufacturing custom service, utility, crane bodies, emergency rescue vehicles, tool boxes and diesel tanks made out of steel and aluminum. The company asked him to assist in making one of its products, a crane body for trucks, lighter, simpler and less expensive to build.

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Testing Electric Vehicle Batteries

How today's manufacturers prevent commercialization issues.

By Debbie Sniderman

While simulation is important to automakers commercializing hybrid-electric vehicles (HEVs) and plug-in electric vehicles (PEVs), industry leaders assert that physical battery testing is critical to avoid issues.

Manufacturers test batteries at multiple levels of complexity, from individual electrochemical cells, through modules, up to complete packs. Though most battery designs withstand a certain degree of abuse and will fail in predictable and controllable ways, manufacturers also perform highly specialized safety and abuse testing to minimize risks and comply with regulations (see "Types of Battery Tests," page 20).

Comprehensive Testing for Integration

Chrysler and its battery suppliers perform a wide range of functional, durability and reliability tests, says Steve Clark, senior manager in energy storage and high-voltage systems with Chrysler Group's electrified powertrain engineering organization. Chrysler focuses on tests related to integrating the battery into the complete vehicle system.

Clark says battery suppliers perform their own testing at the pack, module and cell levels. They outsource abuse-level tests to specialized facilities that have appropriate equipment to manage all potential test outcomes.

"Chrysler coordinates all levels of testing into a single, comprehensive test plan to meet the functional vehicle objectives," he says.

Several consortia and standards bodies, including the U.S. Advanced Battery Consortium LLC (USABC), the Society for Automotive Engineers (SAE), and the International Standards Organization (ISO), developed comprehensive test methods for HEV and PEV batteries. Chrysler and other auto manufacturers use their tests to characterize and validate their batteries.

Advanced automotive batteries used in HEVs and EVs contain a complex blend of advanced electrochemistry with electronic monitoring and controls.

"Battery packs are large, complex and expensive in the early stages of the technology's introduction," Clark says.

GM accelerates development and expedites production of HEVs, EVs and PEVs with hundreds of battery test channels and thermal chambers at their Global Battery Systems Lab.

"This degree of investment into a major vehicle subsystem sets the expectation that batteries operate acceptably over a vehicle's useful life. Rigorous and carefully planned testing is critical, and affords the automaker confidence in the design and technology it uses to create advanced energy-storage devices."

Setting Standards

In addition to developing test methods for battery systems in HEVs, PEVs and many other varieties, the USABC, whose members are Chrysler Group LLC, Ford Motor Co. and General Motors, also develops profiles, manuals, requirements and procedures for testing, measuring and data reporting.

It also participates with groups such as the SAE, ISO and the German Automakers Association (VDA) to develop battery standards such as package size, dimensions and tolerances. Ted Miller, who serves on USABC's management committee, says it is "helping the entire industry develop a set of tests and useful standards that can be relevant worldwide—not for a specific vehicle, but together as automakers."

Miller says battery testing is critical, and a key step in commercialization processes. The USABC performs collaborative battery testing for everything from performance, life and operating conditions, to actual costs. Some original equipment manufacturer (OEM) locations and a variety of national labs perform USABC tests.

Taking Temperature

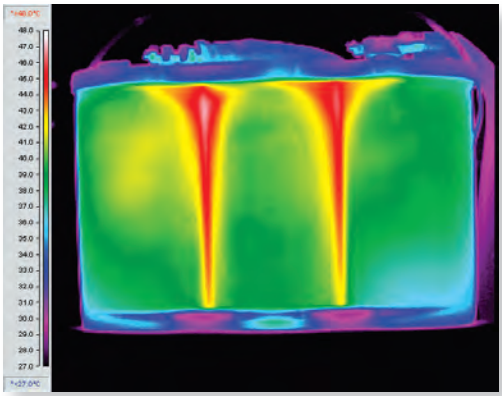
One such lab is the National Renewable Energy Laboratory (NREL), which provides thermal battery testing for all types of HEV, PEV and other batteries for many clients, including the USABC. Matt Keyser, who leads its laboratory operations for energy-storage and battery-testing labs, explained the need for infrared (IR) and calorimeter testing during vehicle commercialization.

Batteries operate efficiently when the temperature is uniform. IR testing takes IR images of a battery while running it through different drive or thermal cycles. Images can reveal if a portion of a cell, an entire cell, a module or a battery pack is hotter than another. Keyser says non-uniformities seen in IR thermal signatures can indicate areas of thermal concern. A region working harder than another can age differently, affecting the cycle length of the battery system under test. IR tests also look at the maximum temperature the cells attain.

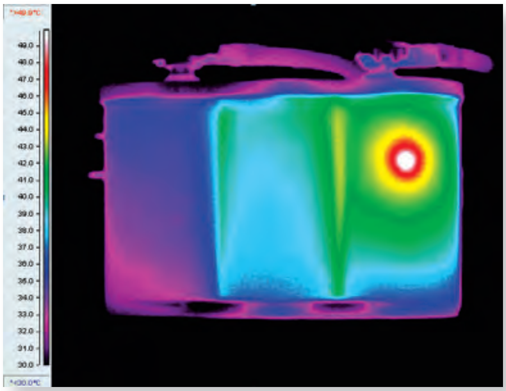
Calorimeter testing involves placing a battery in a controlled environment and determining how much heat it produces for various drive or thermal cycles. The calorimeter gives critical heat generation and efficiency data at various test temperatures, and can identify how changes to a battery

affect its performance. If a manufacturer modifies a battery with a new additive to help low-temperature performance, calorimeter testing can tell how the additive affects performance at high temperatures. “You can’t simulate that. You have to perform the testing,” Keyser says.

Calorimeter testing can also indicate the temperature that crystalline-phase changes occur inside the battery cells when cycled, because some phase changes are endothermic (consume heat). Testing helps establish critical operating parameters such as what state of charge to avoid cycling the battery so as not to crack anode or cathode materials. Combined



This IR image shows a typical heat signature.



This IR image shows internal damage or a “soft short” in a lead acid battery. The damage is not visible when inspecting the battery.

Types of Battery Tests

Functional electrical tests

- Characterize the battery’s electrical capacity as a function of discharge rate or charge state.
- Measure the delivery to, and removal of, energy from batteries.
- Require specialized assemblies of high-precision power supplies, loads and controls.

Functional environmental tests

- Expose batteries to various temperatures, humidity and contaminants to verify that they retain functionality.

Electrical durability and reliability tests

- In rechargeable batteries, focus on the number of charge-discharge cycles and total energy throughput the battery can sustain before losing a specified amount of its usable capacity.

Environmental and mechanical durability and reliability tests

- Evaluate the battery’s ability to withstand repeated exposure to environmental and mechanical stresses.
- Include vibration, mechanical and thermal-shock tests.

Safety and abuse tests

- Characterize battery cell, module and pack responses under extreme conditions.
- Abuse tests include crush, penetration (where a tester drives a sharp object into the battery), overcharge, over-discharge, short circuit, reversal and excessive heat.
- Safety tests include drop, bend and deform, intrusion and spike, turnover, fire and immersion.
- Require specialized facilities that test with reduced battery functionality and without electronic monitoring or controls that ensure safe operation.

calorimeter and IR imaging data provides information necessary to design the vehicle’s thermal management system.

“Models are effective, but their fidelity is limited,” Keyser explains. “It is difficult to simulate all pertinent parameters in a model and simulate real-world performance. There’s an obvious benefit to using test data with models to predict the behavior of battery systems in a vehicle.”

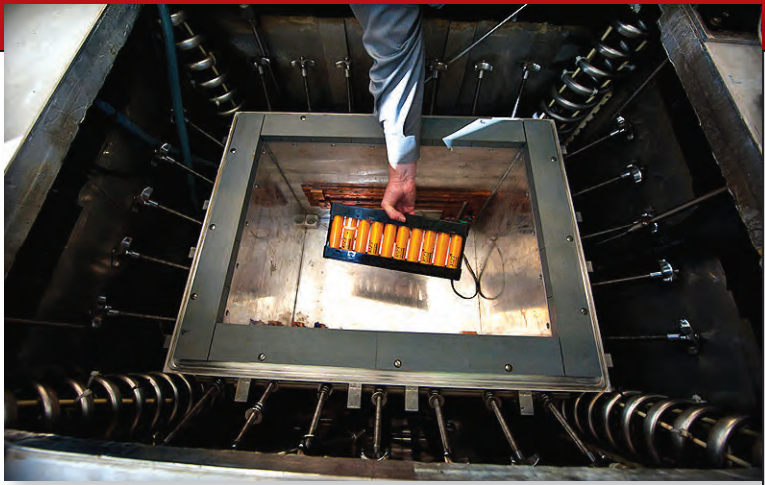
Critical Tests

Miller, also the manager of energy storage strategy and research at Ford Motor Co., says, “Ford has found that there is testing that has to be done. There’s always a need to at least perform targeted validation at stages, starting with the basic materials that go into a cell or a finished cell assembly, and extending to the modeling tools, models and expected performance of the entire system.

“When something breaks down at the electrode level on a cell, we remove one or two electrodes and test a half-cell configuration to make sure it delivers the expected performance,” he continues. “Then, we test many half cells coupled together to verify whether the effect is additive and we are getting results we predict."

Ford also performs critical mechanical tests for terminal durability and compressive stresses, because most batteries in a large array have some degree of compression.

"It is difficult to simulate durability," Miller says. "We can look at a single event, but when looking at long-term fatigue and wear-out factors, testing is quite important, since it doesn't have the same degree of predictability. Also, simulations don't always provide insight. You have to know what you're putting into the model to get good results from it. There's not always perfect information in the parameters included."



The Large Volume Battery Calorimeter in NREL's Energy Storage laboratory. The LVBC is the largest battery calorimeter in the world and can test cells, modules and sub-packs.

Because batteries are susceptible to corrosion, Miller says the entire industry performs humidity tests, placing batteries in high humidity conditions to validate that they are fully sealed from outside environments. Testing also verifies their designs are appropriate for the environment where they're used.

"Unknown air quality drawn from the cabin of a car may have impurities or moisture that could cause an issue, and sometimes galvanic reactions could occur. Corrosion or leakage is not easily simulated, so you have to test. Humidity testing is important and the place to catch it," he says. "We also complete many performance tests, which can lead to design changes, such as life-cycling and cycling under dynamic conditions."

By the time performance tests are run, Miller says, the vehicle has been in development for some time, so a design change "would be a surprise"—although the design could change if something wrong was discovered while testing a whole battery system.

"We probably created a simulation and smaller build-ups, and now have a full pack to test. We know the expected response. If battery performance is well below what's in simulation, testing could show potential issues with cell technology or cell connection designs," he says. "Perhaps the welded or bolted connection wasn't made to procedure, or if there's a design issue, a lighter-weight piece of copper was included than was needed, testing helps isolate the issues so we can modify it accordingly. Simulations may catch some materials issues, but not issues from a process standpoint. A torque setting may be wrong; we may assume a perfect joining procedure that didn't happen. Testing could be critical in those cases."

Testing Closer to the Road

SAKOR Technologies Inc. produces automated testing equipment for many major HEV and PEV manufacturers. Their test system combines a high voltage battery simulator, an AC motoring dynamometer, and an automated data acquisition and control system. It tests complete HEV drivelines or any vehicle sub-system, including emissions.

SAKOR's test system records a battery's functional responses to a variety of road load profiles. Manufacturers can test using simulations based on international standards or profiles recorded from real vehicles driven on closed test tracks. By simulating the vehicle's real dynamic responses, it can test the motor, inverter, transmission, charging system and battery, alone or in combination.

SAKOR President Randy Beattie says most customers perform HEV testing with battery simulators in the dynamometer cell. But physical battery testing is still necessary to validate designs, durability, and performance under continuously changing operational conditions, including different initial charge levels.

"Simulations can predict component performance and durability, but they can't be used exclusively for reporting energy efficiency, fuel economy or real-vehicle responses to the complex stresses and strains seen on a real course," he says.

SAKOR also performs emission testing for OEMs in specialty indoor test cells. Beattie says emission tests may also be required because some batteries can emit hazardous gases during normal operating or fault conditions, such as during a short or a large current surge. SAKOR validates the presence of hydrogen or other explosive gases in a test cell that must meet more stringent ventilation requirements than what a battery experiences stored in a vehicle. **DE**

Debbie Sniderman *is an engineer, writer and consultant in manufacturing and R&D. Contact her at VIVLLC.com.*

INFO ➜ National Renewable Energy Laboratory: NREL.gov

➜ SAKOR Technologies Inc.: SAKOR.com

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Battery Modeling

Progress has been made in understanding next-generation ba˜ ery energy sources, and the subsequent simulation technology that is now available to design engineers.

BY STEVE HARTRIDGE AND ROBERT SPOTNITZ

Automakers have introduced many new hybrid and fully electric vehicles over the last couple of years. It's now common for new vehicle announcements to have an obligatory "green" option—even for a high-performance Rolls Royce.

This need to offer fuel-efficient variants to potential purchasers has led to a massive increase in the so-called "electrification" of modern vehicles. This electrification normally takes the form of an electric motor/generator, power electronics and a battery energy source.

The recent trend for the inclusion of larger, more powerful batteries has provided an opportunity for lithium-ion chemistries to become the dominant energy source in such hybrid and electric vehicles. This is because lithium-ion batteries provide exceptionally high power and energy density. Lithium-ion batteries' growing popularity has also benefited from the longer-term trend for the acceptance of modeling and simulation techniques in the design of complex components, particularly passenger vehicles. Established automakers already have a taste for a healthy mix of simulation and traditional testing when designing vehicles, so the need for such a mix when including lithium-ion batteries in a design is necessary.

This presents the simulation industry with the challenge to provide battery models.

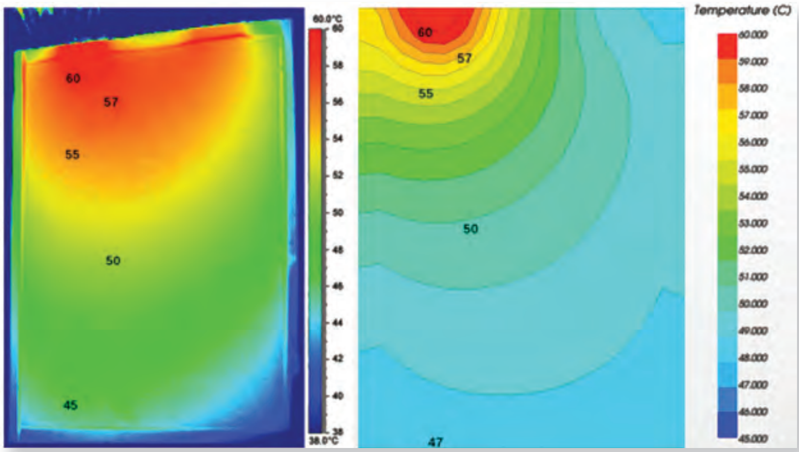

FIGURE 1: **Comparison of simulated results (right side), with previously reported IR temperature measurements[4].**

Anatomy of a Battery

At the heart of any lithium-ion cell are the anode (or negative) and cathode (or positive) active materials and electrolyte. The active materials are particulates that are mixed with binder and conductive additives and coated onto metal foils that serve as current collectors. The anode active material is usually graphite or carbon, though lithium titanate is also used. The material is usually coated on a copper foil to distribute the current from the negative post along the electrode.

The cathode active materials most commonly used in automotive applications are lithium iron phosphate (LFP) or lithium nickel manganese cobalt oxide (NMC), although lithium nickel cobalt aluminum oxide (NCA) is used, as well as lithium manganese oxide (LMO) when blended with NMC or NCA. The material is usually coated on an aluminum foil.

Both the anode and cathode active materials are "insertion" or "host" compounds, which designates that they are structured in such a way as to provide vacancies that lithium can fill. The process of lithium insertion or de-insertion is gentle, and does not damage the structure. This means the process is reversible, enabling long cycle life.

The electrolyte is usually lithium hexafluorophosphate salt dissolved in a mixture of linear and cyclic carbonates. Unfortunately, the electrolyte is flammable, which is a major safety concern in lithium-ion batteries. The electrolyte fills the interstitial space between the particulates as well as the porosity of a separator. The separator prevents electronic contact between the positive and negative electrodes while allowing ionic communication.

This completes the components required to create a simple electrochemical cell, the heart of all lithium-ion batteries. The lithium-ion cell is called a "rocking chair battery" because during operation, the lithium simply "rocks" between the positive and negative electrodes. During discharge, lithium de-inserts from the negative active material into the electrolyte and transports to the positive active material, where it inserts. The reverse process takes place during charge.

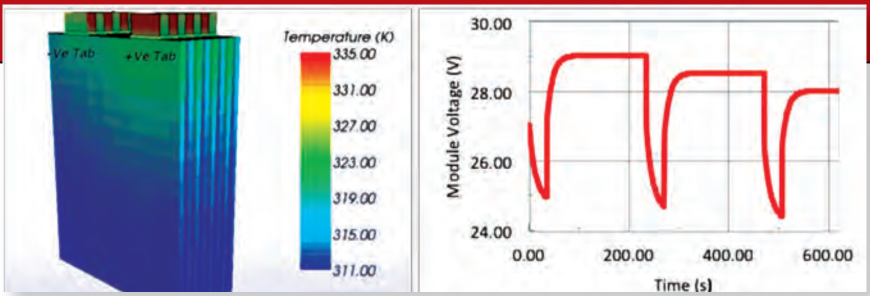

FIGURE 2: Simulation results for an eight-cell module; temperature is shown on the left and overall module response is shown on the right.

FIGURE 3: Lithium ion concentrations in a resolved 3D electrode model.

The challenge for battery modeling is to predict how the cell voltage, current, temperature, shape and other factors vary during use, based on the design and composition of the cell.

Data History

One of the first noted publications proposing a physics-based, mathematical model of a porous insertion electrode was by Atlung, West, and Jacobsen[1]. This paper, published in 1979 in the *Journal of the Electrochemical Society*, presented a model that predicted the energy available depending on the current required. However, it took until 1994 for this model to be extended to predict the performance of a complete cell consisting of dual porous insertion electrodes.

This model of a lithium-ion cell containing dual porous insertion electrodes, the "DUAL" model, was authored by Fuller, Doyle, and Newman[2]—and remains a milestone in lithium-ion cell models. This model identified five dependent variables, resolved across the two electrodes, to predict how the cathode and anode will perform within the electrochemical system. As well as the overall performance of the cell, this model provided insight into limiting factors of a given cell design.

As an example, a battery engineer could now visualize how the performance of a cell under very high current charging could be limited by the rate at which the lithium ions could diffuse into the anode material. Previously, a cell would be tested to understand that at a high rate its performance started to degrade. However, knowing how to *improve* the cell would largely be based on rules of thumb. Now, using the DUAL model, it was possible to understand the limiting factor within the cell—and thus adjust appropriate quantities to maximize a design, within given limits.

Since the release of this milestone paper, there have been many extensions, variants and sophistications to this model, to keep up with technology developments.

Although the DUAL model represented a step change in battery cell modeling fidelity, it does contain limitations that have become more apparent as lithium-ion cells have grown in size and capacity. In a small coin cell—something you might find in a wristwatch—it is reasonable to assume the whole of the cathode and anode are operating in the same conditions, both electric and thermal. However, in a larger, automotive-sized lithium-ion battery cell, this assumption is no longer valid. Therefore, a DUAL model has to be used in conjunction with solvers that can account for these variations.

Capturing Variations

One of the first publications that attempted to capture these effects, albeit for lead-acid cells, was by LaFollette and Harb[3]. Here the electrochemistry model was adjusted to allow a number of such models to work within an orthogonal grid, thereby capturing the variations along the length or height of the cell. This is the next advance in battery cell modeling that has now been successfully applied to automotive-grade batteries, allowing simulation to resolve the internal gradients within a cell. Figure 1 shows the results of a simulation of a 26Ah pouch type cell compared to an infrared image, reported by Damblanc[4]. Temperature is plotted in both cases—and it can be seen that by using this approach, good agreement can be achieved.

This advance moved battery modeling to three dimensions, allowing internal gradients to become visualized across the length and breadth of the cell. This same development can be transformed into a spiral structure, allowing the modeling of spiral cells as well as stack-type cells. Both stack and spiral designs are popular in larger-sized batteries.

Moreover, once such simulation architecture is created, then the single cell model can be replicated to create module and pack models. By tightly coupling the solution of both the electrochemistry and thermal environment, accurate simulations can be achieved. Figure 2 shows one such simulation, whereby a series of cells are arranged to create a module. This particular module experiences three pulsed discharges, and shows the subsequent temperature profile and electrical response.

This electrochemical simulation structure is now integrated in the 3D computer-aided engineering code, STAR-CCM+ by CD-adapco, to provide commercial users with the ability to simulate the behavior of standalone cells, modules, packs and systems. A typical model would also include the cell-to-cell electrical connections, which can contribute heat to the system, as well as liquid or air cooling, which controls the cells' temperature during operation.

What Lies Ahead

A new field of electrochemical modeling was initiated in 2005 by the work of Garcia et al.[6], who proposed a new approach simulating lithium-ion cells. This work did not use the volume-averaging approach used in the DUAL model, but instead resolved the microstructure of the electrode as a set of spherical particles. This approach provides the lithium-ion cell designer with a more realistic understanding of the diffusion processes during operation, and changes in particle shape and surface.

Figure 3 shows a section slice through a model, solving for the electrical current and the lithium diffusion, showing the anode and cathode particles. The particles are colored by the amount of lithium that has been absorbed, and it is clear there is non-uniform utilization of the active materials. The option for microstructural modeling is also available in the STAR-CCM+ software from CD-adapco, providing a tool for enhancing electrode design.

The most significant remaining challenge in the simulation of lithium-ion batteries is the prediction of the degradation, or "aging," of a cell as it is used. Aging refers to all the processes that affect the capacity and impedance of the battery, which are broadly characterized by two categories: calendar aging and cycle aging.

Calendar aging refers to the degradation of the cell because of internal processes that take place when the cell is left without being used. Models have been presented that show good agreement across a range of cells, and the significant process is thought to be the loss of active lithium into the solid-electrolyte interface (SEI) layer, which covers the active materials. The growth of the SEI reduces the amount of lithium that can be cycled—and also increases the internal resistance of the cell during operation. Ploehn et al.[7] published a general model for SEI growth, which is useful for simulation of calendar-aging effects.

Cycle aging remains a significant challenge for the simulation industry. Many projects are currently under way to quantify this effect. However, having an understanding of the internal thermal and electrochemical gradients will provide a framework to include breakthroughs when they happen.

For now, lithium-ion battery modeling remains a rapidly developing science. The future for simulation methods in this industry is bright, with tools available now that can provide engineering insight. There are also some significant challenges waiting for technical heroes to overcome—all in all, making this an exciting time for engineers in this area. DE

Steve Hartridge *is director of electric and hybrid vehicles for CD-adapco.* **Robert Spotnitz** *is president, Battery Design LLC. Contact them via de-editors@deskeng.com.*

Spurring on Tomorrow's Discoveries

Joint research projects, bringing together leaders in their respective fields, are the mechanism to move things forward. The U.S. Department of Energy is sponsoring a program of work to include lithium-ion cell modeling technology into industry-accepted CAE tools. CD-adapco is leading one such project, which includes Battery Design LLC, Johnson Controls Inc. and A123 Systems. It focuses on validating the methods discussed in this article.

This project is overseen by the National Renewable Energy Laboratory, a Golden, CO-based authority in battery modeling. For more information, visit nrel.gov.

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INFO ➜ Battery Design LLC: BatDesign.com

➜ **CD-adapco:** CD-adapco.com

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Charging Ahead

When it comes to ba˜ ery design innovation, it's all about the mathematics.

BY PAUL GOOSSENS

The field of energy storage is extremely active, with a constant stream of innovations being deployed to address major design challenges. At the heart of this activity is the commercial drive to increase energy density (energy stored per unit mass), extend battery life and improve overall charge/discharge efficiencies to reduce unit costs and enhance product reliability. But while great progress has been made in the last decade, certain industries still have a long way to go.

In particular, the electric vehicle industry is faced with major economic pressures to increase energy densities—and reduce costs—because at present, the cost-benefit arguments for the consumer to move from a conventional internal-combustion-engine-only vehicle to an electric or hybrid electric vehicle are marginal. According to several studies, the electric vehicle has not lived up to its promise economically because the cost-benefit model is extremely sensitive to two factors: the cost of energy storage and the cost of fossil fuel.

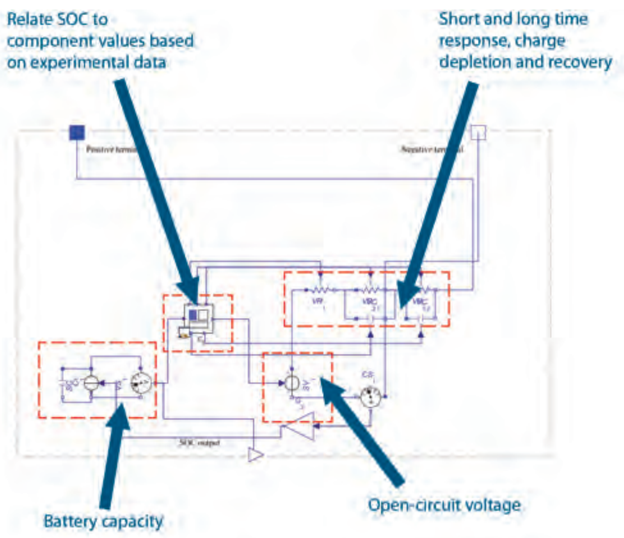
Since 9/11, the cost of crude oil has steadily increased from around \$20/barrel in 2001 to looking like it would break the \$100/barrel point in 2011, thus driving more investment into alternatives such as electric vehicles. However, the last year has actually seen a sharp decline in oil prices (with a brief spike during the Libyan uprising), demonstrating that relying on the oil price to drive this particular business model is untenable.

As Henry Lee, faculty co-chair of Energy Technology Innovation Policy research, Harvard Kennedy School, puts it: "The industry will need improvements in battery technology and reductions in battery costs for electric vehicles to meet their potential. Such improvements will require continued government support of battery research and development, and higher gasoline prices either through government action in the form of taxes or a cap-and-trade program or through the market."

Therefore, the race is on to produce better, lower-cost energy storage products (for the sake of brevity in the rest of this article, I'll call them "batteries"—but there are other forms of energy storage, such as hydrogen fuel cells and supercapacitors), as well as improvements in the circuitry and electromechanical components that generate power to charge them and draw power to drive the electric vehicle.

Back to Basics

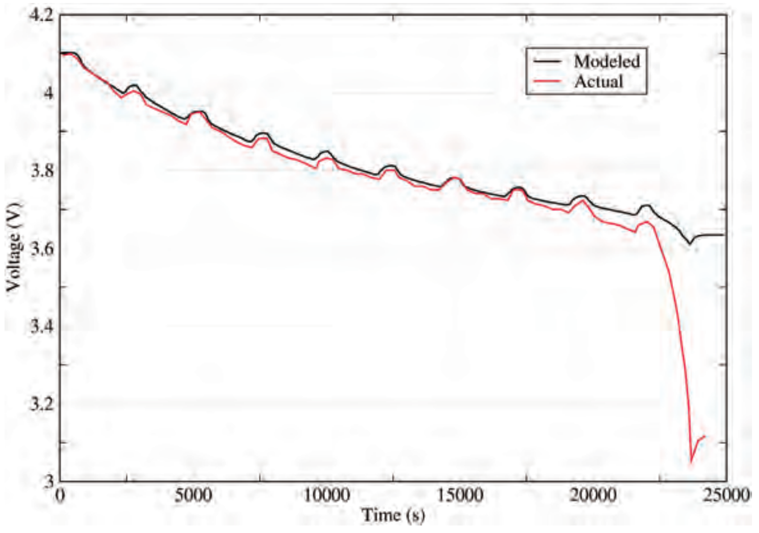
One major characteristic of this research is the need to get back to fundamental physical concepts when designing new batteries. To facilitate this, the industry is turning increasingly to math-based modeling techniques that allow engineers to accurately describe the behavior of the system—and the constraints on the system—in physical terms. These model equations are then used to develop, test and refine designs quickly, without building physical prototypes. Hence, having a good virtual model of the battery is essential so that both battery behavior and the physical interaction of the battery with all the other components are properly reflected in the model.



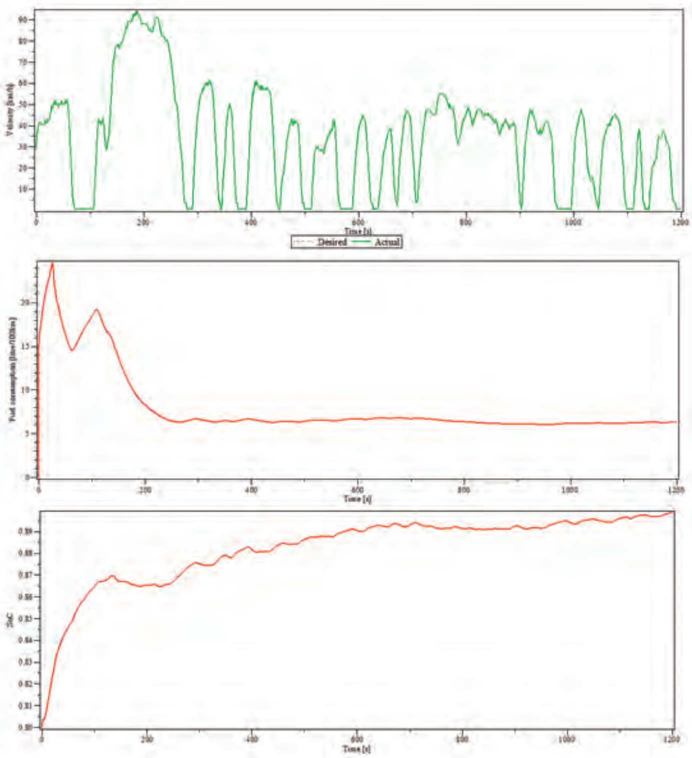
A circuit-based battery model.

Conversely, having a high-fidelity dynamic model of the rest of the vehicle that reflects the loading conditions that are applied to the battery during many different drive cycles and environmental conditions provides considerable insight into the two-way demands placed on both the battery and the rest of the vehicle. Because the battery plays such a vital role in the vehicle, capturing these interactions is essential to designing an efficient, effective electric vehicle.

In a recent case study, a research team at the University of Waterloo, Ontario, headed by Dr. John McPhee, the NSERC/Toyota/Maplesoft Industrial Research Chair for Mathematics-based Modeling and Design, developed high-fidelity models of hybrid-electric and electric vehicles, including the batteries as an aid to accelerating the design process. The team chose MapleSim, the multi-domain physical modeling and simula-



This example discharge model shows recovery charge when the load is disconnected. This matches experimental results very closely. *Test data courtesy A&D Technologies, Michigan.*



Results from full-vehicle HEV test using an urban drive cycle. The battery state-of-charge and fuel consumption are shown.

tion software from Maplesoft, because they have found the symbolic approach in MapleSim to be an effective way to develop simulation models of sufficient fidelity without sacrificing real-time performance for hardware-in-the-loop (HIL) testing—a critical part of the design and development process.

To illustrate the process, I'll focus on two of their projects: a battery electric vehicle (BEV) model and a hybrid electric vehicle (HEV) model.

BEV Model

Lithium-ion (and other lithium-chemistry) batteries are becoming popular for electric vehicles, as they are light and provide more power than other common types of batteries of the same size and weight. Batteries in vehicles are subject to periods of high current draw and recharge and large temperature variations, all of which can have a significant effect on the performance and lifespan of the batteries.

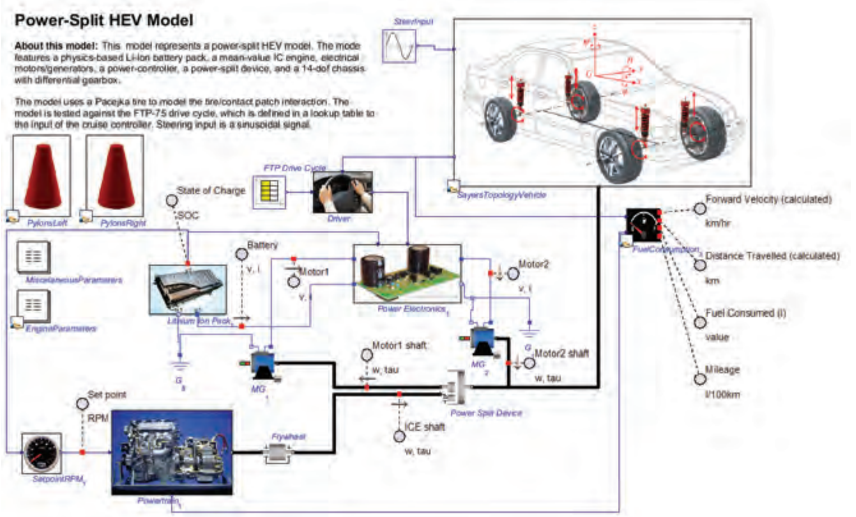
To capture these effects, McPhee's team needed a model of lithium-ion battery chemistry over a wide state-of-charge range, widely varying currents and various temperatures. Starting with the electric circuit battery model of Chen and Rincón-Mora, they implemented the components in MapleSim, using a custom function component to represent the non-linear relationship between the state of charge and the electrical components. They modified the battery equations to simulate a battery pack that is composed of series and parallel combinations of single cells.

Next, they developed a power controller model to connect the battery pack to a motor. They then incorporated a one-dimensional vehicle model into the model. The simple vehicle model drives on an inclined plane, which is in turn controlled by a terrain model. A drive cycle model was included to control the desired speed of the vehicle. The resulting differential equations, generated by MapleSim, were simplified symbolically and then simulated numerically.

A variety of driving conditions were simulated, such as hard and gentle acceleration and driving up and down hills. The results were physically consistent, and clearly demonstrated the tight coupling between the battery and the movement of the vehicle. This model will form the basis for a more comprehensive vehicle model, which will include a more sophisticated power controller and more complex motor, terrain and drive-cycle models.

HEV Model

The team also used MapleSim to develop a multidomain model of a series HEV, including an automatically generated optimized set of governing



The system equations for this multi-domain HEV model are generated automatically by MapleSim, and are accessible to the researchers for analysis and improvements to the design.

equations. The HEV model consists of a mean-value internal combustion engine (ICE), DC motors driven by a chemistry-based nickel-metal hydride (NiMH) battery pack, and a multibody vehicle model.

They chose a NiMH battery because of its widespread use in hybrid-electric vehicles. They used a chemistry-based modeling approach that captures the chemical and electrochemical processes inside the battery. With this modeling approach, they could modify the physical parameters of the battery as needed to meet their overall design requirements for the vehicle. They modeled the battery inside MapleSim by placing the governing equations of the battery processes directly inside MapleSim custom components.

MapleSim automatically generated an optimized set of governing equations for the entire HEV system, which combined mechanical, electrical, chemical and hydraulic domains. Simulations were then used to demonstrate the performance of the developed HEV system. Simulation results showed that the model is viable and the number of governing equations was significantly reduced, resulting in a computationally efficient system.

This HEV model can be used for design, control and prediction of vehicle handling performance under different driving scenarios. The model can also be used for sensitivity analysis, model reduction, and real-time applications such as HIL simulations.

So far, this approach has paid significant dividends for both projects.

"With the use of MapleSim, the development time of these models is significantly reduced, and the system representations are much closer to the physics of the actual systems," says McPhee. "We firmly believe that a math-based approach is the best—and quite possibly, the only feasible approach for tackling the design problems associated with complex systems such as electric and hybrid-electric vehicles."

Future Work: Power Electronics

As mentioned, developing a high-fidelity battery model is only part of the process. To model the loads being applied to the battery, it is connected to a range of electromechanical system models such as the internal combustion (IC) engine (in the case of a hybrid), power generation and motors. It's also connected to all the power electronic circuitry.

The next step in these projects is to consider the effects of the power electronics on the battery. Currently, these are simulated using "mean value" models, but work has begun on incorporating the three-phase switched networks in detail to investigate these effects.

MapleSim already has many built-in components, such as bipolar junction transistors (BJTs), diodes, metal-oxide-semiconductor field-effect transistor (MOSFET) and CMOS. In addition, there is a growing collection of power electronics sub-systems that have been submitted by research groups like McPhee's, such as pulse-width modulation (PWM) controllers, insulated gate bipolar transistor (IGBT) inverters and power amplifiers, to the Maplesoft Application Center.

Battery manufacturers in the automotive sector aren't the only ones dealing with the challenges from economic, environmental and governmental pressures. Manufacturers in the renewable energy sector and consumer electronics are facing the same challenges of delivering products that are economically attractive while fulfilling the environmental and legal demands placed on them.

Complex mathematical models of the products are becoming increasingly important—and increasingly complex. Fortunately, there are groups of researchers already engaged in modeling batteries at a detailed level, and these models are beginning to become available to help other engineers in their design work. DE

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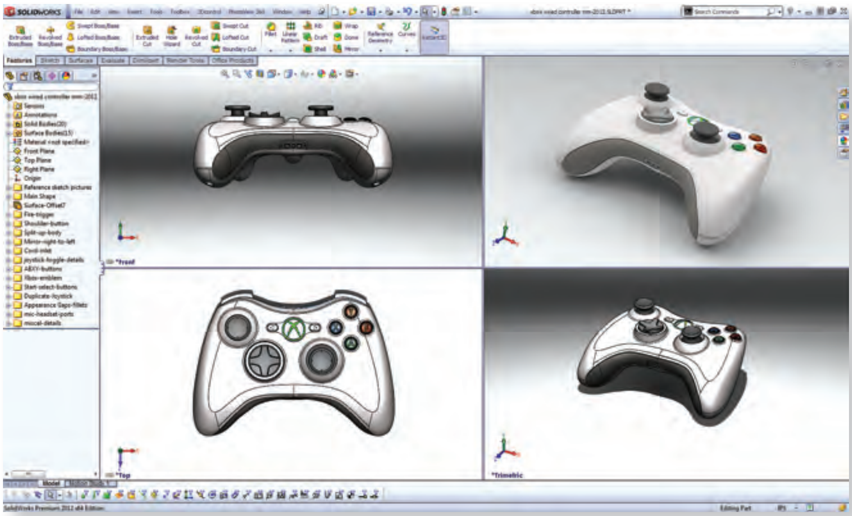
The Devil is in the Details

Balance realism and performance in a CAD modeling environment.

BY KENNETH WONG



When working in interactive mode, minimizing the size of the rendered viewport (top right view in this example, shown in SolidWorks 2012 with a four-viewport setup) gives you the ability to see the design in a realistic, shaded mode without a heavy burden on your CAD performance. A full-size rendered view, by contrast, could strain CPU and GPU resources, compromising your interactive CAD operations.

When working in a CAD program's modeling window, you usually have several display options. The simplest option provides you with basic geometric volumes and outlines. This Spartan option shows you the curvatures and edges of your design—and nothing else. As you turn on other details—such as hidden lines, shading, ground plain shadows, and reflections—the assembly in your modeling window begins to acquire more realism.

In a few CAD programs, you can turn on real-time ray-tracing in your interactive modeling window. With real-time ray-tracing, the term "photorealism" takes on new meanings, as the process uses complex algorithms to calculate light bounces to project shadows and reflections in a way that's consistent with how they would appear in the real world.

No doubt you've heard the saying "the devil is in the details." In CAD, with every detail you turn on, the devil exacts a tax in performance. Projecting shaded volumes, casting realistic shadows and showing reflections on surfaces consume a tremendous amount of computing power. The price you pay to be able to view your assembly in that mode is slower system response.

You'll notice a lag, for instance, in model rotation and geometry rebuild after an edit. In real-time ray-traced mode, whenever you make a change to your CAD model, your system must recalculate on the fly the interplays of lights, shadows and physics to re-render your on-screen view, down to the smallest details. With such heavy demands, an older or slower system will have a hard time keeping up with your commands, creating jerky animations and temporary pauses.

With multicore workstations equipped with powerful GPUs, many designers and engineers now have enough—not more than enough, but just enough—computing horsepower to visualize their design in progress in a realistic, photorealistic or ultrarealistic (ray-traced) mode. Even so, with large assemblies or complex parts, turning on ray-tracing while you're still heavily editing your design could put a burden on an average workstation. Until hardware becomes powerful enough to make the demands of rendering irrelevant, the best approach may be to balance the interactivity you desire against the realism you need.

The Tax You Pay for Shadows and Reflections

Among CAD software makers and users, the view on working in rendered mode or ray-traced mode is mixed. Some believe the performance penalty is too high; therefore, a more sensible approach is to perfect your design first, and then render it. Others believe the aesthetic appeal of a design is important enough that the interactive CAD modeling environment should offer a way to instantaneously render the design in progress.

Pete Lord, senior product manager for Autodesk's Design, Lifecycle and Simulation Product Group, observes that "Autodesk Inventor users use in-CAD rendering for quick images to support customer and design reviews, and to check appearance prior to sharing with graphics teams."

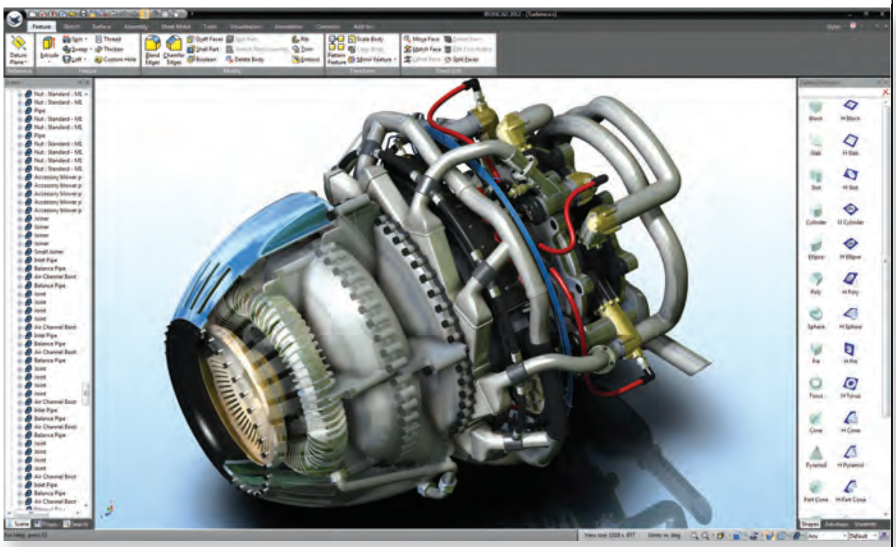
Paul Sagar, PTC's director of product management, points out that while important, photorealistic rendering is not as necessary as real-time rendering. "Users want to feel more immersed in their design and be able to see a product look more realistic."

Kris Kasprzak, Siemens PLM Software's director of marketing for Solid Edge (SE), reports that generally speaking, most users turn off details like shadows and reflections. "They want to be able to see the geometry, see an unobstructed view of the design," Kasprzak says. "The only time they go to what I call 'the pretty picture mode' is when they need to generate an image for a customer or a sales presentation."

Carry O'Connor, IronCAD's vice president of marketing, agrees. "The majority of design engineers don't use realistic or real-time rendering effects," O'Connor says. "But when they need to communicate the design, they may turn it on and send [a rendered image] off to whoever needs to preview that concept."

Xavier Melkonian, Dassault Systèmes' director, CATIA Creative Design, says interactive ray-tracing inside the modeling environment is important to CATIA users because "visualization must be part of the creative experience to have an efficient creative loop between the 3D shape creation and the visual result. But also because doing visualization outside of your 3D modeling environment requires a lot of data conversions and preparation, which is very costly and time consuming." ~

"Two to three years from now, when hardware can support modeling with real-time ray tracing, people might work in that mode, but only if it accentuates the modeling experience," predicts Mark Biasotti, SolidWorks' product manager. "They won't do it just because they want to look at material reflections and textures. Modeling is all about forms."



Integrated real-time rendering in IronCAD, shown here with shadow mapping, shadow planes, reflection planes, bloom effects and hemispheric lighting.

The advantage of working in a rendered or semi-rendered mode in the CAD modeling window is the ability to edit your design and see a photorealistic update instantaneously. If you're working in a fully rendered or ray-traced mode, exporting what you see in your modeling window as a common graphics file gives you a high-resolution, print-quality image. Therefore, you no longer need to initiate a rendering session to create a rendered image.

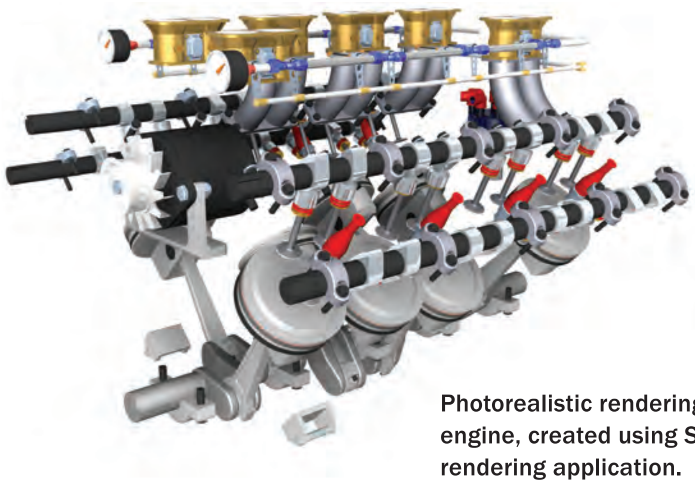
But the downside of working in a fully rendered, photorealistic mode is the increased computing demand, which affects how quickly your system can respond to your commands. In older, slower systems with insufficient processing power or memory, working in such a display mode is generally not recommended—or not possible at all.

Design and Render? Or Design First, Render Later?

Usually, if you're in the CAD modeling window, you're probably still refining your geometry. Therefore, you're more concerned with shapes and measurements, and less concerned with the visual appeal of your design. You won't, for instance, need to render a photorealistic view of your design each time you rotate to a new angle or add another hole.

This assumption remains true for the most part, for most CAD users. If you work with products that require constant attention to surfaces and curvatures—particularly, how they would look in the real world or how they interact with light—you may belong to a specialized discipline. This could be the case if you're designing, for example, high-end perfume bottles, costume jewelry or headlights in luxury vehicles.

To separate design and modeling operations from rendering operations, most CAD programs give you the option to render *outside* the modeling environment. That means when your design is at a stage where you're inclined to judge its aesthetic appeal or show a client an impressive image of your concept, you may invoke a rendering window—which usually appears in the foreground. This usually launches a rendering process that runs a few minutes (or a few hours, if you have an extremely complex scene to build, but a very slow machine) to



Photorealistic rendering of an engine, created using Solid Edge's rendering application.

generate an image of your design with lights, shadows, material textures and a background.

If you're running a system with limited computing horsepower and you need to, from time to time, check your design's aesthetic appeal or visualize it in a real-world setting (say, on a kitchen counter or a factory floor), you may be able to minimize the rendering operation's impact by reducing the preview window's size (the smaller the image, the fewer the pixels to calculate).

On the other hand, if your aim is to create a high-resolution still image, you have no choice but to relinquish a fair amount of computing power to the rendering process. While rendering is in progress, you may continue to refine your design, provided your system still has sufficient horsepower and memory left to support your normal CAD functions. Otherwise, your design operations may have to be suspended while rendering is in progress.

The other option is to export the file to a specialized CAD-friendly rendering program—like Luxion's Keyshot, Luxology's modo or Bunkspeed's SHOT—to create a glossy still image or animation sequence. Some rendering software developers have released CAD plug-ins. If there is one that supports your preferred CAD program, you can initiate the process from within your CAD modeling window, bypassing the need to export a file and open a new program.

Dedicated rendering software usually produces better results than what you would get from rendering in a CAD program itself. For a start, a specialized rendering program gives you more choices in materials and preloaded environments (prebuild backgrounds you can drop your objects into), more flexibility in camera placement, and more control over the scene itself (to adjust darkness, brightness, fading distance, etc.).

For CAD programs that don't have a built-in realistic display mode or rendering option, exporting to a renderer is the *only* option to get an aesthetically appealing image of your design. However, that's now a rarity, as almost all contemporary CAD programs give you at least some type of tools to produce a nice-looking (or semi-rendered) image from your program.

Common CAD Modelers' Approaches

With a robust software portfolio servicing the media and entertainment market, Autodesk offers you the option to work in real-time, ray-traced mode inside its mechanical modeler Autodesk Inventor. (Under View, along with visual styles, ground reflections and shadows, you'll find the option to enable ray tracing.) Working in this mode, you have the option to set your preference to Interactive, Good or Best. The Interactive option is configured to provide the best possible ray-traced visuals on screen without hampering your interactive CAD operations.

RapidRT, the rendering technology driving Autodesk Inventor's realistic display mode, is also found in Autodesk Revit (an architecture modeler) and Autodesk Showcase (a renderer program with a straightforward interface, included in many Autodesk suites as a standard component).

"RapidRT uses all available CPU cores on the system, and does not use the GPU," Lord says, noting that OGS, the other Autodesk technology for visualization, responsible for shaded modes, wireframe, illustration and watercolor-look "uses the GPU and can use the CPU for software rendering if necessary."

SolidWorks lets users launch a rendering session with PhotoView 360. It also offers the option to work with an integrated preview window, which effectively turns your modeling environment into a rendering preview window.

SolidWorks PhotoView is based on Luxology's CPU-based rendering technology (the company behind modo, a popular rendering and animation package). Whereas SolidWorks software itself only takes advantage of two CPU cores at the most in modeling operations, the PhotoView add-in can take advantage of additional CPU cores your machine can supply to cut down your rendering time.

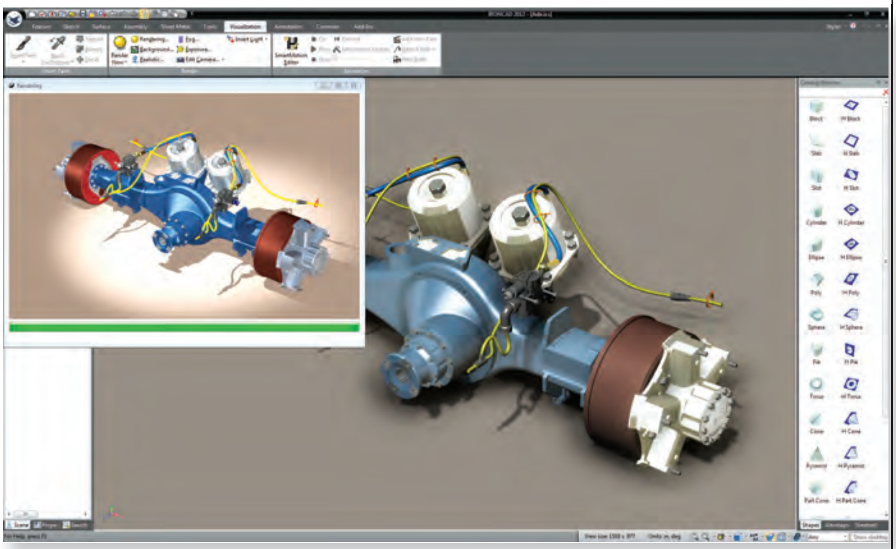
In IronCAD, you have the option to work in a realistic mode in real time, powered by Tech Soft 3D's HOOPS technology. Though not a ray-traced mode, the setting provides you with shaded volumes, reflections and shadows for enhanced realism in the interactive CAD modeling window. To obtain a ray-traced rendering of your design in IronCAD, you may launch a separate rendering window (with the shortcut CRTL + R). You may simultaneously launch more than one rendering window, in case you need to render the same design in multiple colors or from multiple angles.

"The realistic rendering [obtained through a separate program window] makes use of CPU cores. This is a multi-threaded operation, so it can take advantage of multiple cores," explains O'Connor. "The real-time realistic mode [which allows interactive work] makes use of both CPU and GPU."

Similarly, Siemens PLM Software's SE gives you the option to work interactively in an OpenGL-powered realistic mode. But to obtain a ray-traced rendering of your design, you'll need to invoke a rendering session (under the Explode, Render, Animate tab), which produces simple animations in addition to still images. SE's interactive realistic mode supports both CPU and GPU accelerations, according to Kasprzak.

In PTC Creo modeling products (Creo Direct and Creo Parametric), you can choose to work in OpenGL-accelerated mode, with shades and reflections turned on. However, this is not a ray-traced mode. In Creo Parametric, you have the option to produce ray-traced still images, but not to work interactively with CAD models. You may also use PTC's Creo Advanced Rendering Extension to produce ray-traced images. Ray-traced rendering in PTC Creo products are powered by mental ray from mental images, a division of NVIDIA.

Dassault Systèmes' CATIA V6 software suite employs the company's own technology and NVIDIA's CGfx shaders. Two years ago, the company introduced a new rendering tool called CATIA Live Rendering, based on NVIDIA's iray engine, to provide interactive ray-tracing and global illumination. iray takes advantage of both CPU and GPU cores. With CATIA Live rendering, the user can choose to use both CPU and GPU, only CPU or only GPU. As a legacy of of CATIA V5, Dassault Systèmes also provides the option to render in NVIDIA's mental ray.



For more sophisticated rendering, many CAD software programs offer rendering applications that can render still images with a preview window. The example shown here is in IronCAD.

"CATIA Live Rendering is totally embedded inside the modeling environment, which means that at any time a user can activate this visualization mode and see his product 'interactively' with ray-traced shadows and reflections and global illumination," says Dassault Systèmes' Melkonian.

If you prefer to work interactively in realistic or photorealistic visual settings, you should investigate whether your CAD software's rendering engine can benefit from additional CPUs or GPUs, then upgrade your hardware's processors and memory to accommodate such a workflow.

Dreaming of Ray-traced Interactivity

At the present, ray-traced interactivity—editing a detailed 3D model in ray-traced mode—is something of a luxury, simply because of the sheer power you need to preserve interactivity. Currently, designers and engineers occasionally turn on ray-tracing, but work in a less-ostentatious display style by default.

Next-generation workstations powered by Intel's many integrated cores (MIC) architecture or NVIDIA's Kepler architecture may change that. If the hardware provides so much computing power that rendering becomes an instantaneous (or near-instantaneous) process, they may work in ray-traced mode by default.

For now, though, shadows, reflections and textures still have a cost—payable in performance gain or loss. **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 ➜ **Autodesk:** Autodesk.com

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➜ **IronCAD:** IronCAD.com

➜ **NVIDIA:** NVIDIA.com

➜ **PTC:** PTC.com

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

➜ **SolidWorks:** SolidWorks.com

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Rendering with Character

Luxology greatly expands the options in its newest version of modo.

BY MARK CLARKSON

Luxology modo 601, the latest version of Luxology's polygon and subdivision surface modeler and renderer, is still relatively cheap—but the price is up from $995 to $1,195.

What do you get for that extra $200? A lot, actually, but all of the upgrades might not be useful for your work.

Character Animation

Let's get this one out of the way up front: Version 601 is modo's "character animation" release. If you do animated characters, this is the release of modo you've been waiting for, incorporating full 3D inverse kinematics (IK) and bones.

Think of a human figure. With forward kinematics, you rotate the shoulder, the elbow and the wrist to put the hand where you want it. With IK, you move the hand and the application calculates the rotation of the wrist, elbow and shoulder for you. IK is great for many animations, from robot arms to folding mechanisms.

Bones are just what they sound like. Put them inside of a "soft" body, and they control and distort the mesh. A human figure would have bones mimicking the human skeleton. Rotate them, and a joint bends. Primarily thought of as a character animation tool—which they are—bones are useful in animating other soft bodies, from hoses to curtains to what-have-you.

Dynamics & Volumes

modo 601 includes integrated dynamics simulation with recoil. Based on the Bullet Dynamics Engine, simulates both soft and rigid bodies. Soft bodies are good for capes, drapes and ropes.

As for rigid bodies, "drop" a handful of screws over a tabletop, and they will fall, collide, bounce and roll realistically. It's actually a neat way to create heaps and scatterings of objects without fussing about with individually placing dozens or hundreds of objects.

For more complex simulations, you can add triggers, forces and constraints, and springs and motors. modo now offers volumes, allowing you to create everything from infinite ground planes to ground fog to puffy clouds, to whole forests populated with 2D billboards of camera-facing trees. There are also viscous new "blobs" that can merge and separate—good for modeling, say, fluids pouring from a bottle.

Rounded Edge Rendering

So you don't do character animation or special effects. You don't need clouds or foggy rooms, and you're not interested in dynamics simulations. What's modo 601 got for you?

Let's start with rounded edge rendering. Imported meshes, especially low-resolution meshes, can look fake when rendered—owing mainly to their geometrically perfect edges. The same is true, of course, of meshes you create in modo.

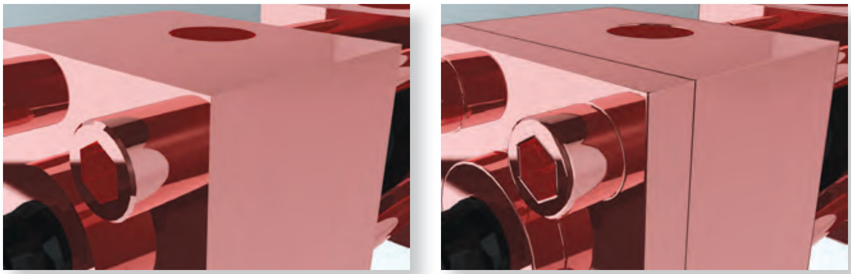
But Luxology has added "rounded edges" to 601's material options, providing beveled edges at render time without the effort and geometric overhead of actually beveling the edges. Rounding is definable by material, so you can give Chrome_1 a 1.2mm bevel, Chrome_2 a 2.0mm bevel, and Red_Plastic no bevel at all.

You will take a hit at render time, however. Renders took between 20% and 50% longer in my tests.

CAD Loaders

modo will import many standard file formats, including DXF, COLLADA and SolidWorks parts and assemblies, but control over the process is limited. If you work with a lot of imported CAD files, you'll probably want to consider Luxology's CAD loaders. They produce nice, smooth-shaded quad polygons, instead of the usual mess of triangles, and give you more control over the tessellation process.

Using the new camera clipping plane, as the camera approaches the object, it is progressively clipped away.



An imported SolidWorks assembly rendered without rounded edges (left) and with rounded edges (right).

The basic CAD loader ($495) imports Parasolid. The advanced CAD loader ($695) will also read IGES and STEP files. A little pricey, perhaps, given modo's $1,199 price tag, but they can pay for themselves quickly if you spend much time working with imported meshes.

Re-topology

Imported objects are often too dense for your needs. Even a simple box or cylinder can come in from CAD with hundreds of triangles. The "flow" of the mesh can also be off, with clusters of triangles creating undesirable bumps. modo 601 has a new workspace and dedicated set of tools for creating a new, low-resolution mesh from a high-resolution mesh.

To create your new model, place your high-density mesh in the background. Every time you lay down a point in the foreground, it snaps to the surface of the background mesh and adopts that surface's normal (which way is "up," for example). Drag out rows of polygons at once, and they all stick to the background mesh. The background mesh constraint was available in modo 501, but it had to be set for every tool you used. It is now built into the topology workflow.

I'd say that about 90% of your work can be done with the new Topology Pen, which allows you to drag out polygons to create a new mesh with truly astonishing speed and ease. If you do re-topology work, the new topology workflow alone is probably worth the upgrade price.

Custom Tools

One of modo's key features is the way it allows you to get into its "tool pipeline," combining different operations to create your own tools. Combine the Rotate tool with a linear falloff, and you've got a Bend tool. Combine them a different way, and you've got a Twist tool.

modo already has these tools, of course, but if you look under the hood, you'll see that this is exactly how they're built. You can then create your own tools that better suit your purposes and add them to the tool palette.

Camera Clipping & Render Booleans

modo 601 offers two new ways to produce easy cut-away views of your models: camera clipping planes and render Booleans.

With a camera clipping plane, as you move the camera through the scene, or leave the camera still and move the clipping plane, your objects are clipped away as the plane intersects them, revealing what's inside: the gears in your transmission or the electronic components inside your mouse. You can make objects immune to clipping on a per-material basis.

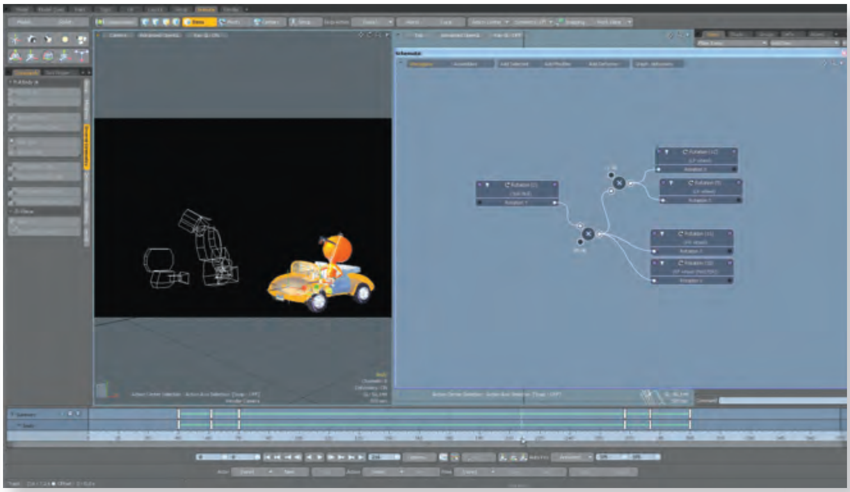
Render Booleans work similarly, except that they are animatable 3D objects—cylinders, cubes or spheres.

Rendering

Modo's renderer produces terrific, photoreal images and animations. The addition of a cel shader and cel edges material lets you create non-photoreal images now as well. You can choose from an assortment of standard camera backs and create custom lenses, complete with lens distortion and iris blade effects.

601's renderer provides you with a comprehensive set of statistics on each

The new recoil dynamics simulation. Three rigid balls and a soft donut fall into the scene from above.



modo's schematic view allows you to set up relationships between items. Here, one object drives the rotation of all the car's wheels.

render—from elapsed time to frame buffer memory to the number of refraction rays generated. You also get a good set of image post-processing controls for making adjustments to contrast, brightness, color cast, saturation and light bloom.

modo's renderer made big speed improvements with the last version. Unfortunately, it's apparently given some of them back with 601. My renders were consistently slower, with 601 taking 20% longer or more. I think it's time for Luxology to better leverage the power of all those GPUs sitting on my desktop.

Render Passes

The new render passes can really speed up your production pipeline. You can set up a scene to render out separate passes for each frame. Traditionally, in visual effects, you use this feature to render an object's color, reflections, shadows, etc., separately, so you can tweak them in post-processing. But with modo's implementation, you can set up separate render passes for almost anything.

Yes, you can render colors and reflections separately, but you can also render passes with completely different colors and different reflections. You can have a model with four different materials—say, red, blue, green and gloss black. Set up a different render pass for each material—and every render, or every frame of your animation, automatically produces four different images. You can have render passes for different lights, or different backgrounds. Any channel that can be changed can be included in a render pass.

Summing It up

I have skimmed the surface of new features, which also include new skin and hair shaders, particle generators and particle sculpting tools, tons of new deformers for both modeling and animation, a much-improved preview renderer, and a most welcome mesh cleanup tool. You can now paint interactively on any layer—bump maps, specularity maps, etc.

It's not a perfect upgrade. Some of the help isn't up to date, and I experienced my fair share of crashes and user-interface weirdness. But I find this to be an exciting upgrade, and am impressed by the new features modo brings with every new version. You can give modo 601 a try for free at Luxology.com/trymodo. **DE**

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

INFO → Luxology: Luxology.com

Buying an Engineering Workstation

Balancing processing power, memory, and other considerations for your most important engineering tool.

BY PETER VARHOL

Buying an engineering workstation used to be easy — you would get the fastest processor and most memory that your budget allowed. This would give you the fastest and most capable platform to do whatever you required, at least for the next couple of years.

It's much more complex today, because the projects you're working on are more complex and varied. You work differently than you did in the past, combining applications while also managing your own data and working on email. You're on a LAN, but you also have to consider other I/O such as USB, and you even have to be aware of your latency up to your cloud provider. You may also be making decisions about whether to run a particular job on your workstation, or dispatch it to a cluster.

And the Intel® Xeon®-based workstation has gained the power to do more of those projects. It's really a personal supercomputer, with multiple processors and cores, several levels of cache memory, a graphics processing subsystem, Turbo Boost, virtualization, and other technologies that support a sophisticated, highly capable workstation for a variety of engineering applications.

But today it's important to understand your software applications and workload, and how computing resources execute that workload. Different processor and memory configurations result in different performance levels, depending on the workload. Network, graphics, and cache memory all play into the equation.

And you also have to look at how your workflow may change if you have a more capable workstation. Rather than sending off simple simulations to a cluster, for example, you might be able to do them on a virtual machine in a workstation using Intel Xeon processors, or on a local workstation cluster. The best workstations today not only accelerate work and ultimately result in a better work product, but also change how we go about doing many established engineering activities.

For example, many engineers may get dual processor, six-core Intel Xeon systems for CAD and design rendering. While these are outstanding systems, the extra processor and associated cores do little to accelerate the performance of design and rendering.

However, configured with dual network interface cards and high-speed Ethernet networking, those extra cores can be used as a part of a workstation network whose power can be harnessed to run other engineering applications. Engineering processes can fundamentally change for the better with these and other technologies.

Steps to Buying Your Next Workstation

This trend means that engineers have to be educated in advances in computing technologies as well as how their applications utilize computing resources. Engineers also need the imagination to be able to find new ways of working with their systems to change how design, analysis, and other fundamental engineering activities are accomplished.

It can be a difficult transition for some engineers, but Intel makes it easy, through explanations of technology advancements, examples of typical configurations, and outreach to engineers on technical computing advances. Here's what you need to do to in order to make decisions about your next workstation:

- Assess your applications. Do they take advantage of parallelism, or would higher clock speeds give you better acceleration?
- Look at your workflow. Can the ability to drastically improve simulation times, or to run simulations locally in parallel with other work, change how you do your job?
- Check your budget. Few engineers have an unlimited budget for new workstations. What are parameters for spending over the system lifespan?
- Consider the alternatives. Large amounts of memory and cores, as well as fast networking, can support virtualization, letting you do multiple tasks simultaneously. How should the workstations of the future be configured to optimize engineering workflow?

Configure the workstation that best meets your needs and budget. And don't forget to change your processes to take advantage of your new capabilities.

Engineers can leverage Intel-based workstations in ways that couldn't be imagined only a few years ago. In future issues, we will explore how to best configure your workstation based on your applications and how you work as an engineer. DE

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

Power up
with Multiphysics Analyses

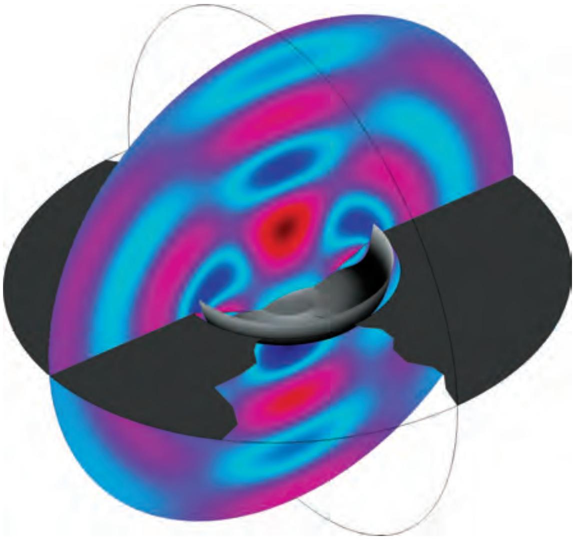
Add coupled physics to your design toolbox.

By Pamela J. W aterman

Fuel cells, human physiology, earthquake prediction, underwater explosions, or simply fluid-structure interactions—whatever complexity your daily projects throw your way, can your design afford to ignore multiphysics effects? If not, how well does your solution environment handle modeling and simulation of two or more interdependent physics effects?

It used to be that this topic was not for the faint of heart. Data, models and software from various engineering or scientific domains needed to be combined in a single environment, and managing the different mesh structures and data transfers was tricky. The push to create more design iterations in less time meant that multiphysics solutions involved a great deal of approximations and assumptions.

Over the past five years, however, both hardware and software offerings have advanced in ways that support solutions of more accurate, tightly coupled problems. While multiphysics takes prominence at COMSOL, ANSYS, ADINA and SIMULIA, software from such major analysis companies as Altair, Autodesk, CD-Adapco, ESI Group, LSTC, MSC Software and Siemens PLM also embrace coupled multiphysics solutions—though each with different subspecialties and approaches.



This titanium speaker cone, surrounded by air and set in an infi ite baffle, sh wcases the new acoustic-shell interaction user interface in COMSOL. The structural vibrations automatically act as a sound source, and the pressure force is coupled back to act on the shell. Applications for this type of simulation range from speakers to ship acoustics. *Image courtesy COMSOL.*

Bernt Nilsson, senior vice president of marketing at COMSOL, sees continued growth in this field as multiphysics analyses have become easier to conduct.

"Many low-level analysis operations have been made obsolete, such as the programming of material property subroutines, manually joining different mesh types and mesh elements, and the requirement for interfacing tools that shuffle data back and forth between specialized single-physics codes," he says.

These improvements have moved both major and minor multiphysics effects further upstream in the design process. *DE* has scoped out a baker's dozen of vendors in this field to learn how the power (and accuracy) of multiphysics simulations increasingly applies to today's applications—and when it may be overkill.

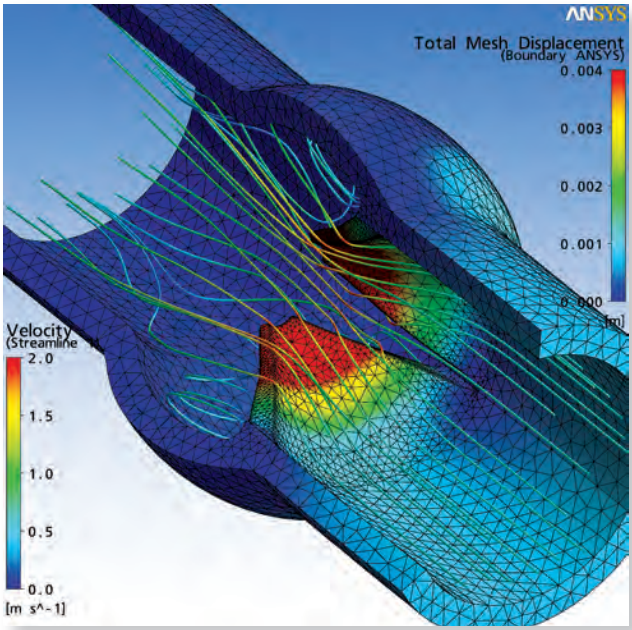
Better Resources, Easier Meshing

Vendors agree that compute power for tackling multiphysics problems has increased dramatically. As Bob Williams, Autodesk product marketing manager for simulation, puts it, "The rise of multiple CPUs, more powerful GPUs and even cloud-based simulation has made hardware resources a non-issue."

The multi-core architecture of microchips supports hybrid implementations of symmetric multi-processing (SMP) and massively parallel processing (MPP) solvers, enabling memory-demanding applications to take advantage of parallel architectures.

A second breakthrough is the widespread use of automated, adaptive meshing, making the task much less of a doctorate-level job. Time was when a solver for one physics type couldn't use the mesh created for the second domain—for example, the coarse mesh for a structure vs. the fine surface mesh at a fluid's boundary layer—but software across the board has made strides that reduce this issue to a lesser part of the simulation process.

"Good mapping tools should allow a seamless data transfer



ANSYS software analysis of fluid-structure multiphysics interaction in a biomedical valve, taking into account strongly coupled fluid flow and structural deformations. ***Image courtesy ANSYS.***

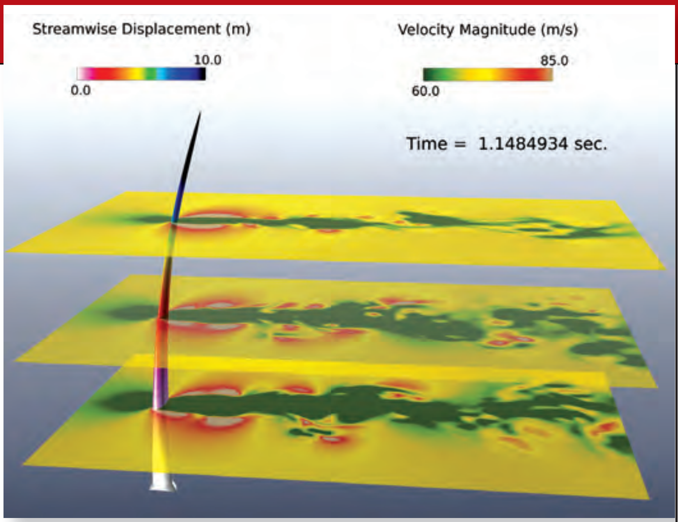
from one physics area to another, and automate the mapping between dissimilar meshes," says Pierre Thieffry, ANSYS product line manager for structural mechanics solutions. "Additional capabilities, such as scaling, unit changes and orientations to match point cloud data to the current model, are required."

In the past, users had to develop their own algorithms to do so. Now, as Williams adds, there's no need to know exactly what the mesh looks like ahead of time.

"Just worry about the initial state," he says. "The software looks at what's happening during the simulation and adjusts accordingly. The whole idea of the mesh needing to be the same (between domains) is gone."

Marc nonlinear analysis software from MSC Software has, for a long time, had automatic remeshing capabilities to analyze large-strain structural problems. MSC's senior product marketing manager, Srinivas Reddy, explains that this capability is highly beneficial when material gets distorted under high temperatures or strains in coupled analyses, or when motion and deformation in electrostatic/structural models displace the air surrounding the piece. The software also offloads users from needing to know where and when contacts will occur with automatic contact boundary detection, which is very beneficial in nonlinear analyses.

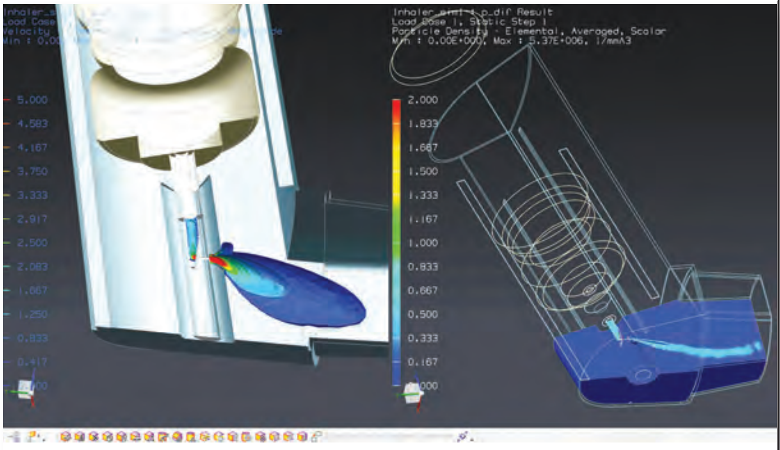
As if meshing between coarse and fine grids



A direct coupled fluid-structure interaction simulation of a 100m composite blade, using Altair HyperWorks for calculating turbine blade aeroelasticity. Displayed are flow features at different cut planes. ***Image courtesy Altair Engineering.***

wasn't enough of a challenge, meshing between structural (finite element, or FE) models and fluid (finite volume) models has traditionally been even harder. One solution comes from Altair, whose computational fluid dynamics (CFD) software, AcuSolve, is based on an exclusive FE approach that fully preserves all physical quantities. The gives the solution the advantage of being insensitive with respect to meshes, so coupling the two FE codes is straightforward. This simplifies, for example, solving a structure/heat-transfer/flow problem.

Coming from the CFD side of the industry, CD-adapco has developed an increasing number of meshing technologies specifically suited to certain structural geometry types. As Jean-Claude Ercollaneli, CD-adapco's senior vice president of product development, explains, "One example is our thin mesher, which automatically detects objects that are thin in nature," using sheet-

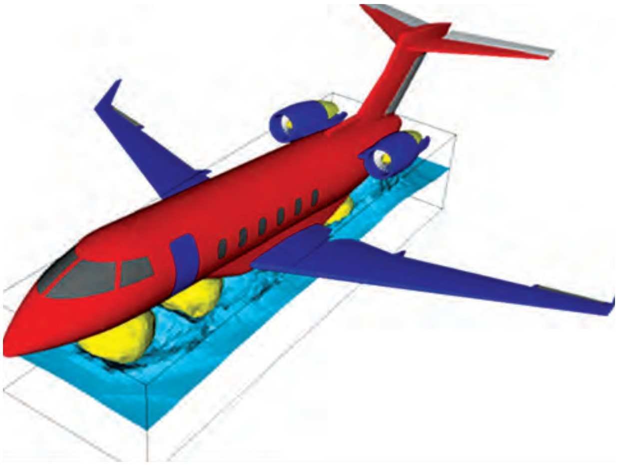


Multiphysics flow simulation of a medical inhaler, performed with NX CAE software from Siemens PLM Software. ***Image courtesy Siemens PLM Software.***

metal frames as an example. "Instead of trying to fill them with polyhedral elements, it creates extruded prisms," he says. "This means that to adequately capture thermal gradients through the thickness of the object, we don't require a high cell count."

Coupled vs. Deeply Coupled

Ultimately, analyzing a multiphysics problem is all about the equations. In COMSOL Multiphysics software, all the partial differential equations (PDEs) are combined in a single matrix



An aircraft crashworthiness simulation with fluid structure interaction performed with MSC Nastran Explicit Solver. External airbags are deployed to dampen the shock waves as a result of the aircraft impact on the water, and to act as a floating device to keep the structure above the water. As the shock wave from impact travels through the airbags and to the aircraft, the structural behavior (and possible failure) can be predicted. *Image courtesy MSC Software.*

Multiphysics Modeling, Step by Step

One way to gain insight into real-world effects is to start with a simple geometry, says Bernt Nilsson, senior vice president of marketing at COMSOL. Surprisingly, that can mean stepping back from today's 3D world.

"A 2D model is a good starting point," he explains. "The user can test out various geometrical and physical characteristics of the model, to really hone in on the important design challenges. Explore different boundary conditions, material properties, and mesh—that is an easy way to get insight in the problem. Because the geometry and mesh are simplified, it is really fast to solve and move on to the next hypothesis. When the user achieves a good description of the physics and participating parameters, he can take on the full problem, such as importing CAD geometry to verify and validate the design with COMSOL Multiphysics." — *PJW*

and solved simultaneously, converging to a single solution (mathematically, the most stable approach). Other packages generally address each physics environment separately, setting up two or more matrices to solve each set of PDEs independently, then passing the results from one matrix to another for closed-loop iteration.

Detlef Schneider, senior vice president for solver products at Altair, acknowledges that weakly coupled interaction seems less stable in theory. "But in practice, we have developed technologies that give us the stability of the strongly coupled code, without its drawbacks," he says. "Also, having a coupling strategy rather than integrating in one matrix allows you to implement third-party tools in the process."

Key issues for deciding among fully, strongly or weakly coupled solutions involve understanding several factors, including:

- how much the solution stability affects speed and accuracy;
- the level of influence or interaction actually taking place (is it one-way, two-way, weak or strong); and
- whether your company's current analysis package can handle your specific situation.

Regarding the last factor, not all multiphysics software addresses, for example, piezoelectric-mechanical interactions, but may be able to do so with a partnership package.

What considerations help users evaluate their choices? Thieffry offers this thought: "The key factor is how much the various disciplines are influencing each other. For a structure immersed in a fluid, if the structure is very flexible, it will impact the fluid flow as it deforms. If it is stiff, the flow around it won't change, as the structure will not deform much. For the latter, a simple sequential coupling is enough."

Ravi Shankar, director of simulation product marketing at Siemens PLM Software, voices a similar thought. "In many cases, there is much more calculation overhead in solving one large matrix vs. two smaller ones. Also, separate solvers can be more attractive because one solver cannot be specialized for all physics, and the features (properties) in FE modeling will not necessarily be common between models."

SIMULIA takes an open platform approach to working with other analysis packages. Karl D'Souza, SIMULIA lead for multiphysics, says that given the increasing complexity of product design today, innovation often requires the ability to explore and connect many disparate physical domains. So, Abaqus supports coupling various aspects of a workflow across multiple physics, as well as with outside software, using a consistent and scalable coupling paradigm. D'Souza adds that from a user perspective, multiphysics analysis would be easier if a fluid could be treated as just another material, so SIMULIA is also working on simplifying the user experience.

A hybrid approach also works for designers who depend on the NEi Software flavor of Nastran. They can call on Siemens FEMAP pre-processing software to set up solver-independent input for many of the standard multiphysics solvers. They then take the results back into NEi Nastran for structural analysis—

and lastly, add coupled convection and fluid flow analysis using the TMG Advanced Thermal module from MAYA HTT.

What Do You Really Need?

Adding multiphysics analysis can certainly improve designs, but good engineers learn when to use it and how much.

"I believe one of the biggest advances of the past few years is the awareness that multiphysics is a difficult subject that still presents large limitations in some areas, and that models have to be carefully designed to obtain realistic answers," says Livermore Software Technology Corp. (LSTC) scientist Facundo Del Pin. "Solving a monolithic system of linear equations that contains all the physics is definitely the most robust way, but sometimes it could be like using a sledgehammer to crack a nut."

Vipul Kinariwala, Cranes Software NISA product manager, sees a frequent need for working with two coupled fields such as EM-heat transfer, thermal-mechanical and fluid-structure, but not so much call for three-way combined physics.

"In the real world, you can get away with a lot even if you don't do a fully coupled [two-way] analysis," he says. "Take the two extreme conditions, apply them to your mechanical model and use your engineering knowledge and experience. For most cases, this is good enough."

In other words, don't do analysis for the sake of analysis.

Pushing New Limits

The multiphysics capabilities of these vendors continue to evolve to more accurately model coupled physics, whether applied to microfluidics, micro-electro-mechanical systems (MEMS) devices or rotating machinery. Check out Altair HyperWork's use of extended finite elements (X-FEM) (good for modeling windshield cracking) and CD-adapco's expansion of its CFD analysis capabilities into a full CAE tool. An example of the latter is the integration of discrete element modeling (DEM) into CD-adapco's STAR-CCM+ package. This combination lets users study solve both the fluid behavior and DEM fields of, for example, a "stream" of pills, corn kernels and even tumbling gummy bears in a manufacturing/processing environment.

Siemens PLM offers examples of acoustic structure modeling and smoke (multi-species dispersion) simulation. ESI Group has spent years working on fuel cell design capabilities in its CFD-ACE+ multiphysics suite, and COMSOL recently added a corrosion module to its primary analysis package.

MSC Software makes a strong case for the multiphysics power of MSC Nastran for modeling tire hydroplaning (involving nonlinear tire material, steel belts and a thin film of water). And ADINA Multiphysics can analyze the coupling between pore pressure and deformation of a porous material comprising bone, muscular tissue and fluids.

All this expanded power has convinced more engineers to apply multiphysics analysis to even more problems. A recent posting on LinkedIn's CFD Group asked for advice about simulating the heating, mass transfer and shrinkage of food cooking in a microwave oven—a task requiring a solution that handles a moving mesh. That designer is fortunate to have a wealth of choices for everyday multiphysics solutions; you may find it's time to join the crowd, too. DE

Dynamics of a re-entry vehicle impacting water at 30 ft./sec. The simulation consists of one structure (the capsule) and two fluids (air and water) whose interactions are captured in a single Abaqus FE model using the Coupled Eulerian-Lagrangian (CEL) technique to handle the highly discontinuous contact and free surface conditions. *Image courtesy SIMULIA.*

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 → **ADINA:** ADINA.com

→ **Altair:** Altair.com

→ **ANSYS:** ANSYS.com

→ **Autodesk Simulation:** Autodesk.com

→ **CD-adapco:** CD-adapco.com

→ **COMSOL:** COMSOL.com

→ **Cranes Software:** NISAsoftware.com

→ **ESI Group:** ESI-Group.com

→ **LSTC:** LSTC.com

→ **MAYA Heat Transfer Technologies:** MAYAhtt.com

→ **MSC Software:** MSCsoftware.com

→ **NEi Software:** NEiSoftware.com

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

→ **SIMULIA:** SIMULIA.com

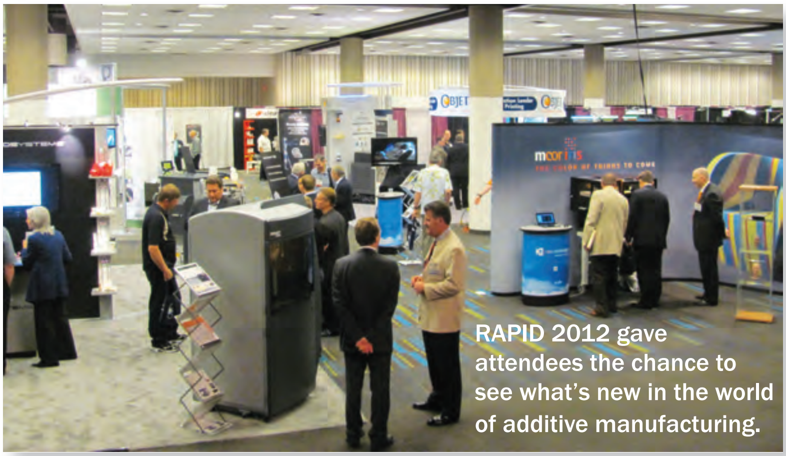
For more information on this topic, visit deskeng.com.

NAFEMS 2012 North America Conference

NAFEMS 2012, "Engineering Simulation: A 2020 Vision of the Future," takes place Sept. 11-12 in Washington, DC. Learn more at NAFEMS.org/events/nafems/2012/na2012.

A Look Back at RAPID 2012

BY JOHN NEWMAN



RAPID 2012 gave attendees the chance to see what's new in the world of additive manufacturing.

As 3D printing gathers steam, people familiar with the additive manufacturing (AM) industry and newcomers alike want to see the latest developments and talk with AM experts. To fill that desire for knowledge, the Society of Manufacturing Engineers (SME) holds RAPID, one of North America's largest AM conventions.

RAPID's place as the premiere AM event in North America is best summed up by the man responsible for *Wohlers Report*, the exhaustive yearly report on AM.

"RAPID has become the most important meeting place in North America for those involved with additive manufacturing," says Terry Wohlers, president, Wohlers Associates.

RAPID 2012 began quietly with a number of concurrent AM sessions, then kicked into gear with SME's Rapid Technologies & Additive Manufacturing (RTAM) Community Tech Groups program. The "Conference Kickoff" program featured a number of speakers, and was dedicated to highlighting AM innovations.

The field of 3D imaging was covered in broad strokes, covering topics such as industrial CT scanning, dental imaging (which is quickly becoming a field all its own), human body imaging (prosthetics, custom-fit clothes) and large-scale scanning. The Kinect received a brief mention as a commonly available 3D imaging tool, along with consumer photogrammetry (using digital cameras to produce 3D images).

Other topics of interest included AM-related medical applications, education, industry updates, a look at the European market, a concerted effort to standardize process terminology, and a materials overview. Following the RTAM program, RAPID switched into party mode with a 3D printed fashion show, sponsored by AM service bureau and industry consultant Materialise. RAPID attendees were also treated to a number of 3D printed creations, including hats by milliner Elvis Pompilio, necklaces by Daniel Widrig and some truly interesting accessories by Niccolo Casas.

The first keynote address for RAPID 2012 was presented by Paul Doe, chief designer for the Prodrive rally car program. Prodrive is a leading motor sport provider in Europe. Doe spoke about how 3D printing has changed the way Prodrive modifies automobiles.

For its rally car program, Prodrive begins with a brand-new Mini Countryman Cooper S. A typical rally car is vastly different than standard street vehicles, and by the time the Prodrive team is finished, nearly every part of the car has been replaced or modified in some way. Prototypes made using AM allow the work to be completed more quickly and cost effectively.

Following the keynote, the show floor opened its doors. Just under the tumult of conversation was the sound of multiple 3D printers humming away. Many industry manufacturers use RAPID as a venue to demonstrate their newest systems, and this year was no exception. Stratasys was showing off its new Fused Deposition Modeling printer, Mojo, and Objet had its newest polyjet offering, the Objet30 Pro, on display. The 3D Systems booth was busy with people looking for details about the new ProJet 3500 Series, ProJet 7000 Series and the recently revealed ZPrinter 850.

Mcor Technologies made its first appearance across the pond, showing off the Matrix 300 and announcing a new, full-color AM system to be released in the fourth quarter of 2012, the Iris. According to Mcor, the new printer was named after the goddess of the rainbow. For those unfamiliar with Mcor Technologies, the company uses standard office paper as its material of choice. The systems designed by Mcor lay down paper a sheet at a time, where it's cut before being attached to the next sheet by a water-based adhesive.

"We see full color as an essential offering to our customers," says Dr. Conor MacCormack, founder and CEO. "We think in color, so our 3D parts should be in color."

Other manufacturers represented at the conference were

ExOne and EnvisionTEC, along with a number of small business/hobbyist providers such as Fabbster and Delta Micro Factory. ExOne was showcasing its manufacturing-driven AM systems, including its resin-infused, sand mold casting S-Max. The S-Max has a whopping building envelope of 23x12x9.4 ft., and is intended for use in foundries and design facilities.

Keynote Revelations

The final day of RAPID began with a keynote speech by Wohlers. He began by informing the crowd that this was the 20th year of RAPID. The industry has changed quite a bit over the last two decades. According to Wohlers, since 1988, AM's compound annual growth rate (CAGR) has increased by 26.4%. Approximately 6,500 industrial AM systems were sold in 2011, and material sales to feed those systems added up to $327 million.

Another area of growth for AM is what Wohlers calls "personal 3D printers." According to Wohlers, any printer that costs under $5,000 is included in this category. Systems that fall into this category are produced by MakerBot and Solidoodle, along with the audience targeted by 3D Systems with its Cube. Hobbyists creating 3D printers using open-source systems, such as RepRap, are also included.

Wohlers says quantifying just how many personal 3D printer units have been sold is more difficult, partially because it's harder to track small start-up sales—and even harder to guess how many hobbyists are building their own printers. He estimates that around 23,265 personal 3D printers were sold in 2011, up from 5,978 in 2010.

Looking Ahead

AM goes hand-in-hand with 3D imaging and design. *Desktop Engineering* spoke with Geomagic CEO Ping Fu. Geomagic, provider of 3D imaging and metrology software, recently acquired Sensable, creator of haptics devices. Asked how the acquisition might affect Geomagic in the short term, Fu said that Sensable brings an improved workflow for design.

As an example, when working with a sculpt, the new workflow will allow a single sculpt to be rethought and virtually redesigned, rather than creating a resculpt. Fu also told *DE* she believes haptic feedback is the future of design. She said that adding touch to the process will bring a sense of "digital reality" to prototyping, as well as medical and engineering applications.

Dr. Conor MacCormack, founder and CEO of Mcor Technologies, introduces the Matrix 300.

DE was also able to sit down with Dr. Brent Stucker, professor of industrial engineering and Clark Chair of Computer Aided Engineering at University of Louisville, KY. Stucker is working with ASTM to produce standardized terminology for AM processes, materials and testing. Standardized process names would bring welcome clarity to what can be a confusing mix of process terminology. In place of the muddle of terms used by individual companies (it isn't difficult to find six different trademarked descriptions for what amounts to additive laser technology, for example), ASTM has created a list of standardized terminology to cover the spectrum of AM. See rapidreadytech.com/?p=1616 for the list of terms.

All of that is just a taste of what RAPID 2012 had to offer. In addition to the keynote programs, speakers covered a gamut of AM topics. These included Michael Mock of INUS Technology, who discussed 3D scanning, and Andreas Berkau of citim GmbH, who covered using AM as an alternative to aluminum casting. Next year is sure to be even bigger, given the recent focus on additive manufacturing by the U.S. government. Make sure to watch *DE* and its AM blog, Rapid Ready Tech (rapidreadytech.com), for details of RAPID 2013. **DE**

The fashion show was a hit with RAPID attendees.

John Newman *is a contributing editor for DE, and the lead writer on* DE's *Rapid Ready Technology blog at rapidreadytech.com.*

INFO → List of exhibitors for RAPID 2012: RAPID.sme.org/2012/Public/exhibitorlist.aspx?ID=567&sortMenu=103011

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

Geometric DFMPro

Design for manufacturability formalizes rules for designs so that, in theory at least, engineers will design parts that manufacturers can easily make.

BY MARK CLARKSON

Design for manufacturability (DFM), sometimes also known as design for manufacture, is a perfectly straightforward idea: Products should be designed so that they can be manufactured. Moreover, they should be designed so that they are as easy and inexpensive to manufacture as possible. For machined parts, for example, you need to be concerned with the material, with tool accessibility, and with the depth and shape of cavities and holes. Injection-molded parts need to slip easily out of their molds.

For anything other than the simplest parts and products, DFM can involve volumes of rules that can be hard to remember and time-consuming to check. Design reviews consume the time of experts. If a part fails design review, it heads back to the designer to be redesigned. This rework is expensive in terms of both time and money.

Enter DFM software such as DFMPro from Geometric Global. DFMPro is a DFM tool that runs within your CAD software: Creo Parametric (formerly Pro/ENGINEER), Dassault Systèmes SolidWorks and Siemens NX.

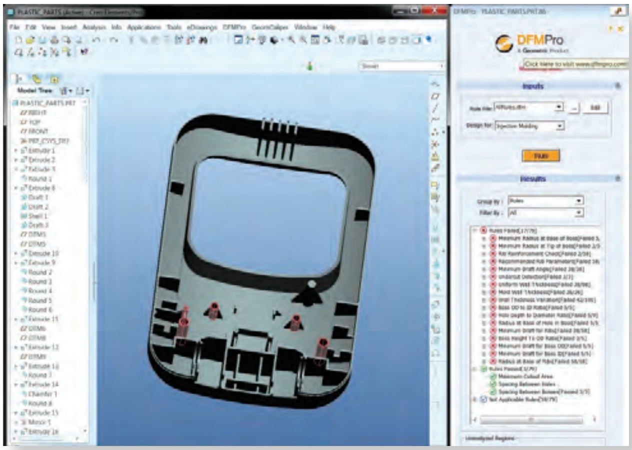
A Rules Referee

DFMPro acts something like a spell checker for your CAD designs, providing quick checking of copious design rules to improve the manufacturability of parts and assemblies, and to reduce their manufacturing cost. It comes out of the box with more than 100 configurable rules—pulled from various handbooks, guidelines and DFM experts. You can customize the application to add more.

DFMPro automatically recognizes key features from your CAD designs. You don't have to tell it where the ribs and bosses are; it will locate them on its own.

Run DFMPro and, after a few seconds or minutes, it returns a hierarchical, interactive list of your problem areas. You can see at a glance how many rules your design breaks, what those rules are, and where each instance of the problem is. You'll also get a list of all the rules your design passed, as well as those rules that don't apply to this design.

Click on a broken rule, and all instances of the problem are highlighted on your CAD model. Click on a problem, and you'll zoom in on that feature and receive a description of the issue.



DFMPro's Injection Molding module allows users to validate designs against standard direct-for-manufacturing practices.

The descriptions go way beyond "FAILURE: RULE 27." They give the design engineer actual useful information such as, "There is no fillet at the base of the boss, whereas it is recommended to have a fillet 0.25 times the nominal wall thickness of the part."

DFMPro will even explain the rules. It will tell you, for example, not just that your cavity doesn't have the minimum draft angle, but what draft angles are and why they are important, complete with illustrated examples and recommendations. This should actually help new design engineers to understand and implement proper design practices.

The Ability to Customize

The rules can be tweaked within the application's rule manager interface. Simply click a check box to enable or disable the checking of individual rules (deep holes, hole alignment, uniform wall thickness, etc.). You can also change the parameters for the rules, varying the minimum draft angle, or the preferred ratio of rib width to wall thickness. You can prioritize the rules by their "criticality," which runs from Insignificant to Critical. There's no scripting involved; everything happens in straightforward dialog boxes.

Not all rules will apply to every design, so sets of rules can be saved under unique file names. You can choose which ones to use at run time.

Four Modules

DFMPro's design checking comes in four distinct modules. When you run DFMPro, you select the module from a drop-down list:

- The **Injection Molding** module checks include minimum draft angle, minimum radius at the base and tip of bosses, wall thickness, maximum cutout area and undercuts.
- The **Sheet Metal** module checks for problems with distances between holes, bend and hem radii, slot and hole size, etc.
- The **Machining** module handles drilling, prismatic milling, and turning. It checks for problems such as deep holes, narrow slots, pockets with bottom chamfers and flat-bottomed holes.
- The **Assembly** module checks minimum clearances, both globally and between specific components, as well as issues such as alignment between holes and fastener projection.

The results of DFMPro's analysis can be exported and shared with others as eDrawings, XML documents or Microsoft Excel spreadsheets.

Parting Thoughts

DFMPro follows the trend of pushing more analytical technology—finite element analysis (FEA), for example—downstream to the design engineers, allowing them to check their work more thoroughly before passing it on down the pipeline. DFMPro allows design engineers to identify manufacturing problems early in the design and manufacturing process. The program is easy to learn and to use, and quickly provides interactive, easy-to-navigate feedback to the design engineer, spotlighting areas and features that are potentially difficult, expensive and impossible to manufacture.

DFMPro doesn't solve your design problems; it just highlights them. Still, it should significantly cut down your product design/redesign iterations and the amount of expert time you need to apply to design reviews. It's definitely worth a look. **DE**

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

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Virtually Assured Success

Version 11 of LMS Virtual.Lab to o˜ er integrated virtual product simulation.

BY VINCE ADAMS

There are numerous finite element (FE)-based multiphysics (MP) applications that couple domains such as heat transfer, stress and deflection, and fluid flow. However, many mechanical products—automobiles, agricultural vehicles, power tools, etc.—have coupled multi-domain MP attributes that extend into multi-body dynamics (MBD), vibratory responses, hydraulic or pneumatic systems, often with advanced controls. LMS provides an integrated suite that captures all these attributes.

To better understand this integration, consider an internal combustion engine (ICE). The quality of an engine isn't solely defined by its performance on a dynamometer. The engine is the primary source of sound and vibration for a car, a lawn mower or a chainsaw. The fuel consumption and emissions chemistry of the engine are some of the most examined and controlled attributes of any product in today's eco-challenged and energy-conscious global society. Traditional stress or fluid flow simulation provide little or no input on any of these coupled attributes. (See Figure 1.)

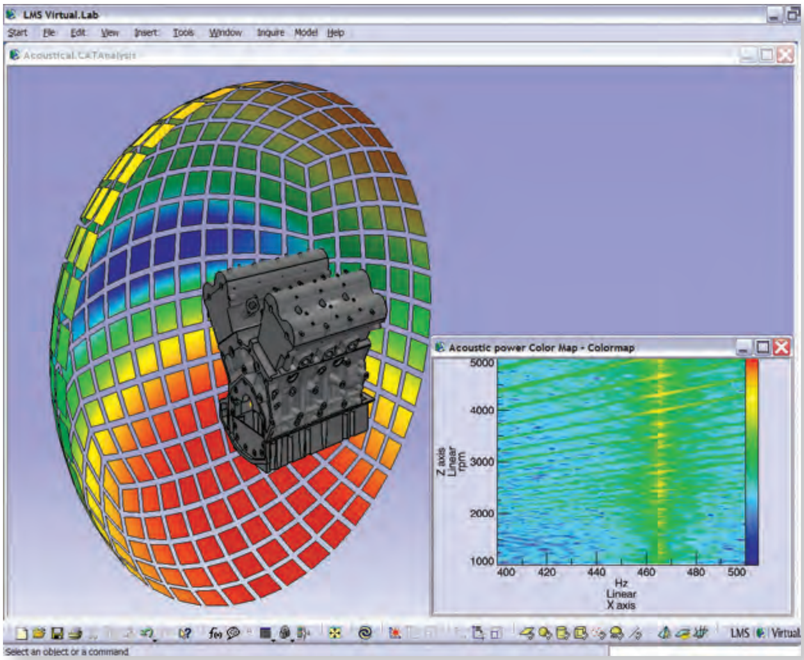

FIGURE 1: Sound Power radiation plot and color map for an engine run-up event.

Furthermore, these attributes are interdependent responses to rigid and flexible multi-body behavior, bearing fit and placement, component and assembly inertias, emissions pressure, fuel system transients—and increasingly, in electronic control strategies.

Each of these interactions can be captured in a single LMS Virtual.Lab model, leveraging system level models of fuel systems and controls from tools such as LMS Imagine.Lab or Simulink. LMS Virtual.Lab enables plant model development for real-time simulation across a variety of mechatronic systems.

LMS Virtual.Lab Solutions Architecture

LMS Virtual.Lab is a unified suite of tools that can integrate or operate independently. The products within the suite include LMS Virtual.Lab Motion, Acoustics, Durability, Noise and Vibration, Correlation, and Structures.

LMS Virtual.Lab is built off of a CAD solids-based user environment that allows geometry import from major CAD platforms, as well as native geometry construction. An integral optimization engine can incorporate solution attributes, as well as geometric parameters and dimensions. It has a model tree-based interface that should be familiar to engineers. LMS Virtual.Lab integrates other LMS products and technologies, such as LMS Imagine.Lab system models. The models are solved simultaneously for the faster response required by the real-time needs of hardware-in-the-loop (HiL).

LMS Virtual.Lab Motion

Evolving from the technology formerly known as LMS DADS, LMS Virtual.Lab Motion is an MBD solution for all types of mechanical systems. Motion has developed a feature tree-based modeling environment that is designed to improve the throughput for flexible body analysis. Flexible bodies in MBD use an FE representation that can deform naturally to the loading developed in the model, and compute stress/strain for downstream (or integrated, in the case of LMS) strength, vibration and fatigue decisions.

Version 10 introduced LMS Virtual.Lab Motion Time Waveform Replication (TWR), which is a technology for replacing simulated tire-ground interactions with measured loads acquired with wheel force transducers (WFTs). This is important for all vehicle manufacturers, but even more so for the off-road agricultural, lawncare and power sports markets. The variety of tires, and the unpredictable ground conditions, relegates simulation of these driving conditions to trend studies. However, the new Motion-TWR technology can produce realistic optimization of ride, handling and durability. (See Figure 2.)

LMS Virtual.Lab Version 11 will add a new product within Motion called LMS Virtual.Lab Composer, which allows customers to define product templates for faster new-product development. A set of templates will also be available for driving dynamics that LMS says combines its experience in this realm with algorithms and user interface design.

Version 11 will also see the first collaborative enhancements stemming from LMS' acquisition of SAMTECH, a CAE provider with advanced technology utilized by vertical industries such as aerospace and wind power. SAMTECH brings a non-linear flexible body technology, and integrated stress and modal solvers, to LMS Virtual.Lab Motion in the coming release.

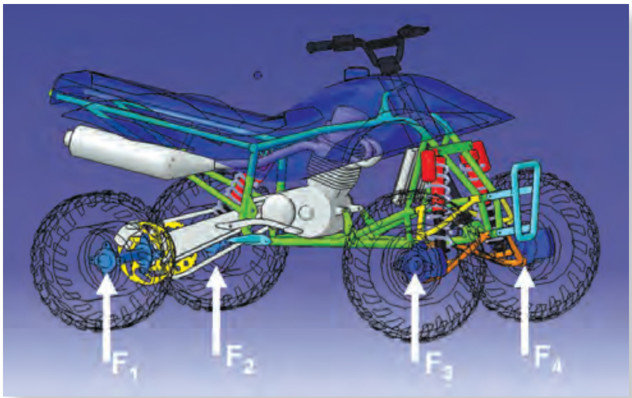

FIGURE 2: **LMS Virtual.Lab Motion TWR replaces tires with actual measured road loads.**

LMS Virtual.Lab Acoustics

LMS Virtual.Lab Acoustics expands on the benchmark acoustic simulation engine formerly known as LMS Sysnoise, with boundary element (BEM), finite element (FEM) and, as of Version 10, ray acoustics capabilities. Solver and technology improvements in FEM acoustics have yielded new capabilities. In Version 10, LMS introduced Automatically Matched Layer (AML) FEM, touted as next-generation Perfectly Matched Layer (PML) FEM, to increase the speed of FEM acoustics. (See Figure 3.)

In standard FEM acoustics, the fluid domain surrounding the noise-generating components needed to be a mesh of generally convex shape. An ellipsoid is common. This must be sized correctly for the frequency content of the radiating noise—often increasing the mesh size of the model to between 200% and 500% of the part being studied.

In recent years, PML reduced the mesh requirements of FEM acoustics by allowing a smaller fluid domain that just bounds the part in question with an outer layer of mesh with non-reflecting, "infinite" fluid properties. This still requires much manual meshing on the part of the engineer, however.

Now, AML from LMS automates the domain meshing process and removes the need to model the infinite property layer. This is applied automatically during the solve. LMS says this yields a 300% improvement in solution time over traditional FEM, and 100% over PML.

In Version 11, the SAMTECH integration also comes to the aid of acoustics by enabling fully coupled vibro-acoustic solutions. This is important for lightweight structures or radiation in heavy fluids.

Beyond that, an improved boundary condition for aero-acoustics, the Surface Dipole, has been added to speed up both BEM and FEM solutions in this domain. The ray acoustics capability has been beefed up to automatically convert surface vibrations into acoustic sources, for sound quality studies in cabins or other interior structures.

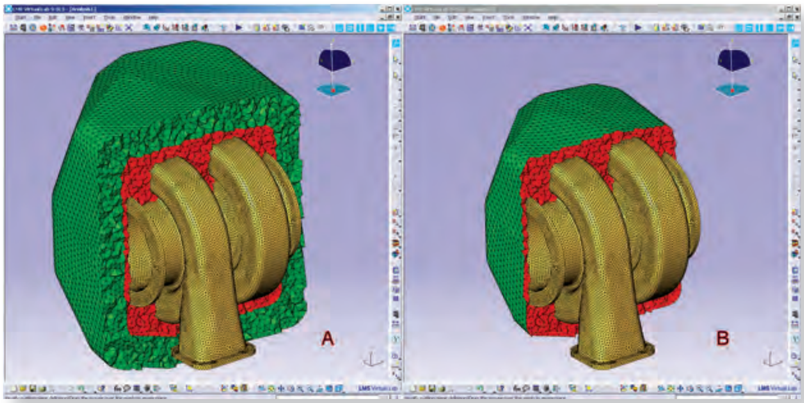

FIGURE 3: **AML technology (B) allows LMS Virtual.Lab Acoustics to achieve higher-frequency resolution with a smaller mesh compared to PML (A).**

LMS Virtual.Lab Durability

LMS Virtual.Lab Durability is an FE-based fatigue solver powered by the LMS FALANCS engine. LMS Virtual.Lab Durability has been benchmarked competitively in time-based, frequency or PSD-based, and thermal fatigue applications. On top of these fundamental event modes, LMS Virtual.Lab Durability provides a seam and spot-weld fatigue solver.

The seam weld solver receives major upgrades in Version 11, according to the company.

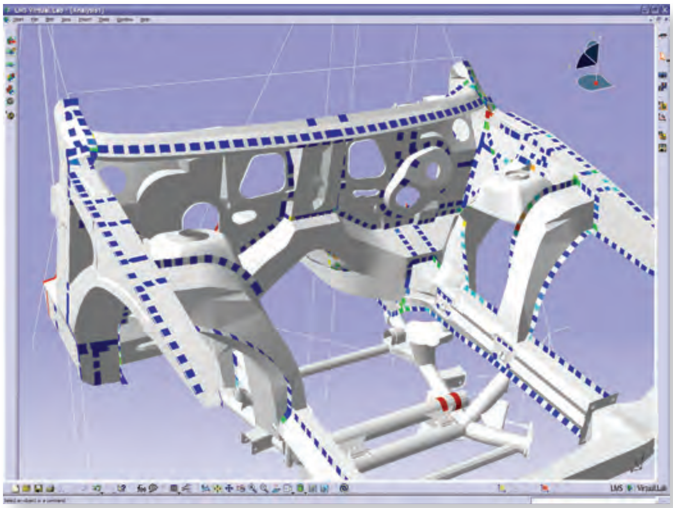

FIGURE 4: Seam welds are detected automatically in LMS Virtual.Lab Durability.

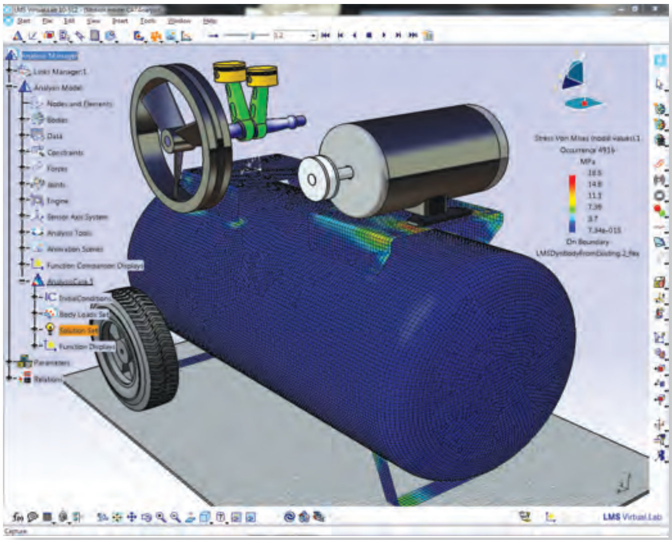

FIGURE 5: LMS Virtual.Lab simulation of a compressor, integrating engine motion, deformation, acoustics, fatigue and optimization computations.

These upgrades include expanded applicability to different weld types, and both thinner and thicker sheets. The utility to automatically identify welds in an FE mesh has been changed to offer speedups for large welded assemblies. This eliminates the need for engineers to model each seam weld connection manually. Welds detected can be solved with commonly accepted methodologies, from structural stress to notch stress methods, without needing to change the FE meshing. (See Figure 4.)

One of the most sweeping updates to LMS Virtual.Lab Durability is an extension of the shell element seam-weld techniques to solid element meshes. Automatic detection, property application, and notch stress analysis will be available to engineers without having to create special mesh interfaces with discretely modeled notches. LMS says this will make weld fatigue analysis much more accessible to engineers in different industries.

LMS Noise, Vibration and Correlation

LMS Noise & Vibration provides an environment for evaluating the vibratory paths and responses in complex mechanical assemblies, from automobiles to assembly equipment. This product also provides the tools for linking physical testing with the simulation world. This is offered in two primary ways:

1. Vibratory response simulation is heavily dependent upon the accuracy of the modal solutions of the underlying FE models. Correlating these models to modal testing, typically through impact testing, provides a basis for confidence in the final analysis. LMS Virtual.Lab provides a deep set of modal correlation tools to ensure your model maps to reality.

2. Vibration or acoustic simulations of complex systems often include many components whose dynamic response affects the results of interest, but aren't otherwise being evaluated. LMS Virtual.Lab Noise & Vibration allows engineers to substitute FE meshes of these parts with frequency response functions (FRFs) obtained through component testing. Using FRFs, along with LMS Imagine.Lab hydraulic, pneumatic or control models, permits engineers to use modeling representation efficiently.

Putting It All Together

LMS Virtual.Lab contains a suite of solutions for virtual product development. It is designed to integrate each of these technologies into a cohesive workflow.

Consider an all-terrain vehicle (ATV), where ride and handling must be optimized with durability, acoustics and driver vibration. An engine can be modeled in LMS Virtual.Lab Motion. The mount vibrations can propagate to the driver interfaces. The bearing loads can drive surface velocities for radiated acoustic calculations. The frequency-dependent stiffness can couple with frame and suspension models for ride and handling simulation, as well as frame durability predictions.

Frame and weld damage can be computed directly from duty-cycle events, using either actual tire-terrain interaction or TWR approximations to determine the impact handling improvements have on fatigue. Finally, various optimization algorithms can be applied across all these domains simultaneously in a single LMS Virtual.Lab database. DE

Vince Adams *is an account manager for LMS. He is also a long-time simulation educator, consultant and speaker. He has authored three books on finite element analysis and numerous magazine articles. Contact him via de-editors@deskeng.com.*

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Invisible GPUs are Coming

With NVIDIA's new Kepler architecture, graphics processing units move from the physical to the virtual world.

BY KENNETH WONG

NVIDIA CEO Jen-Hsun Huang at the GPU Technology Conference 2012, getting ready to demonstrate features in NVIDIA's Kepler architecture.

If you're a system administrator or IT manager, you have undoubtedly encountered invisible machines. Invisible machines, or virtual machines, have become a standard part of enterprise IT architecture. With hardware virtualization, a single workstation could become the host for several guests, or virtual machines. Each guest appears as an individual machine in the network; each performs and executes the designated user's commands as if it were an autonomous machine, running its own operating system. Spawned from the processing power, memory and storage capacity of a single machine, these pseudo-machines are, in reality, clusters of designated computing resources pretending to be machines.

With improvements in chip architecture from Intel and AMD, it became possible to virtualize the CPU about six years ago. This feature in modern CPUs allows several virtual machines to share the host machine's processing power, representing a giant leap in hardware virtualization.

But the graphics processing unit (GPU) remained locked out of the virtual world—until now.

NVIDIA CEO Jen-Hsun Huang broke the news to the crowd at the company's annual GPU Technology Conference (GTC). "I want to announce a GPU that we can all simultaneously share. Today, we're going to take the GPU into the cloud," he said. "For the first time, we've virtualized the GPU."

Made Possible by Kepler

By Huang's own admission, the GPU virtualization project took a good five years. Eliot Eshelman, senior technical account manager at Microway, explains the difficulty in making the GPU invisible: "Many typical office desktop systems have already been moved to the datacenter using virtualized desktop infrastructure (VDI). However, intensive GPU hardware acceleration used a driver model that required the OS to monopolize access to the device. It meant that, at best, one virtual machine had access the GPU hardware acceleration; in many cases, GPU hardware acceleration wasn't available to the virtual machines at all."

With NVIDIA's next-generation GPU architecture "Kepler," the NVIDIA VGX GPU Hypervisor (when integrated into the virtual machine manager) has a way to share a GPU among several users. According to NVIDIA, "In the case of VDI, it enables access to a single GPU from many virtual machines running on a single server, while also ensuring protected access of critical resources."

Huang declared, "Every virtual machine now gets to have a GPU to itself, just as it does a CPU to itself."

The other Kepler advantage, its energy efficiency, is also expected to appeal to data center operators.

Virtualization's Promise

Virtualization is driven by, among other things, convenience and cost efficiency. With fewer physical machines to acquire and manage, network administrators can control cost and streamline IT operations. With the proliferation of mobile devices in enterprise IT—described by some as the "bring-your-own-device," or BYOD movement—virtualization offers new promises. You could, for example, use an iPad to remotely interact with a virtual machine to run GPU-accelerated applications.

Sumit Dhawan, Citrix's general manager and vice president, attributes the increasing demand for VDI to, among other things, "the need for people to work and play from anywhere. Desktop virtualization is the perfect solution. People can bring in any device, and have the flexibility to work from anywhere."

One of the features of Kepler, according to NVIDIA, is Hyper-Q—the ability to communicate with multiple CPU cores simultaneously. The NVIDIA Kepler GPU family includes the GeForce GTX 680 GPU, targeted at media and entertainment, and the Tesla K10 and K20 accelerators, for HPC.

"A single Tesla K10 accelerator board features two GK104 Kepler GPUs that deliver an aggregate performance of 4.58 teraflops of peak single-precision floating point and 320GB per second memory bandwidth," according to NVIDIA. "[K20] delivers three times more double precision compared to Fermi architecture-based Tesla GPUs, and it supports the Hyper-Q and dynamic parallelism capabilities." Dynamic parallelism in Kepler lets the GPU dynamically spawn new work threads on its own without going back to the CPU.

The Performance Lynchpin

With virtualized IT setups, the speed of interconnects—the physical connectors or wireless connectors that allow client devices to communicate with the host machine—plays an important role in delivering acceptable or exceptional performance.

The difference between a virtual GPU's performance and a dedicated GPU's performance may also affect the type of applications you can choose to run. For instance, will running computer fluid dynamics (CFD) software on a virtual GPU from a remote client deliver the same performance as running it on a dedicated physical GPU in a workstation? It's a question that's difficult to answer until early adopters have gathered enough data. DE

Kenneth Wong *has been a regular contributor to the CAD industry press since 2000—first as an editor, later as a columnist and freelance writer for various publications. During his nine-year tenure, he has closely followed the migration from 2D to 3D, the growth of PLM, and the impact of globalization on manufacturing. Email him at kennethwong@deskeng.com or visit deskeng.com/virtual_desktop.*

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→ **Citrix Systems:** Citrix.com

→ **Intel:** Intel.com

→ **Microway:** Microway.com

→ **NVIDIA: NVIDIA.com**

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Intel's Phi Signals New Phase in HPC

Intel's next-generation chip based on the company's many-integrated core (MIC) architecture is about to become reality. Expected to ship by the end of 2012, Intel Xeon Phi is what the company has up to this point referred to only by the codename Knights Corner. With Phi, Intel leaps from multiple cores (two, four, six, or eight cores) to more than 50 cores in a single product. Marketed as a coprocessor, Phi is a departure from Intel's previous products, which are meant to be central or primary processing units. Phi and other MIC products will, in Intel's words, "complement the existing Intel Xeon processor E5-2600/4600 product families." As a coprocessor, Phi will take on highly parallel computing jobs, the territory of high performance computing (HPC).

Phi is outfitted to do battle where graphics accelerators (GPUs) have been aggressively campaigning for dominance. But the CPU maker's product may have one advantage its rivals don't—the x86 programming environment that's ready to accept codes written in C, C++, Fortran, and other common languages. Rival HPC products from NVIDIA, for instance, require mastering the GPU-specific CUDA programming environment. In a subtle jab at competing coprocessors, Intel declares its MIC architecture offers "more flexibility when implementing cluster solutions that are not available with alternative graphics accelerator-based technologies."

Some engineering software, such as ANSYS's simulation packages, are designed to take advantage of HPC clusters equipped with many processing cores, but adapting programs originally developed for the CPU to run on the GPU is not without challenges. A coprocessor with a simpler, easier programming environment can significantly lower the barrier to HPC and open up new possibilities.

The first Phi-powered test cluster is up and running and is delivering 118 TFLOPs of performance, according to Intel. But the first public evaluation of Phi's performance will be Stampede, a Petascale supercomputer in Texas Advanced Computing Center that's expected to go online in early 2013. For more on Intel Xeon Phi, read "Products based on Intel Many Integrated Core architecture scheduled for release this year" at deskeng.com/articles/aabfnk.htm).

A *Very* Affordable Workstation

The new entry-level Lenovo ThinkStation E30 won't break the bank.

By DaviD Cohn

Lenovo has once again taken the lead in producing one of the most affordable workstations with independent software vendor (ISV) certification. Aimed squarely at entry-level CAD users, the Lenovo ThinkStation E30 may not break any performance records, but it won't break the bank, either. While prices for the new E30 don't start quite as low as its E20 predecessor (see *DE*, February 2011), our evaluation unit was incredibly affordable—costing just $1,099 thanks to Lenovo's web discount.

The Lenovo ThinkStation E30 looks similar to last year's E20. Like other systems in the ThinkStation lineup, the E30 comes housed in a black case with a removable front handle that adds 2 in. to the height of the case, which measures 6.7x16.5x16.2 in. (WxDxH) overall. With a total weight of just 21 lbs., the handle makes it extremely easy to move this system, although there's also a metal lip on the rear of the case as a second lift point.

The top portion of the front panel provides two 5.25-in. drive bays, one of which contains a 16X DVD+/-RW dual-layer optical drive. Below these is a smaller 3.5-in. bay that houses an optional 25-in-1 media card reader. Below this, a sloping panel contains two USB ports, along with headphone and microphone jacks. Icons above these ports light up, making them easy to identify, even in low-light conditions. To the right of these ports is the main power button, along with lighted indicators for power and hard drive activity. A sculpted air intake with the ThinkStation logo fills the bottom portion of the front grill.

The rear panel provides six more USB ports, as well as a 9-pin serial port, RJ45 LAN port for the integrated Intel 82579 gigabit Ethernet, and microphone, audio line-in and audio line-out connectors. The rear panel also provides a VGA and a display port connector, both hidden beneath removable rubber covers. These ports are only functional on systems equipped with Intel processors with built-in HD graphics. There's also space for optional PS/2-style keyboard and mouse connectors, but these were not included in our review unit. FireWire and USB 3.0 are available as extra-cost add-ons.

inFo ➔ Lenovo: Lenovo.com/thinkstation

Lenovo ThinkStation E30

- **Price:** $1,099 as tested ($600 base price)
- **Size:** 6.7x16.5x16.2-in. (WxDxH, with handle) tower
- **Weight:** 21 lbs.
- **CPU:** one Intel Xeon E3-1230 (quad-core) 3.2GHz
- **Memory:** 4GB DDR3 SDRAM at 1333MHz
- **Graphics:** NVIDIA Quadro 600
- **hard Disk:** one Hitachi 500GB SATA 7,200 rpm drive
- **optical:** 16X DVD+/-RW Dual-Layer
- **audio:** onboard integrated high-definition audio (microphone, headphone, line-in, line-out and internal speaker)
- **network:** integrated Intel 82579 Gigabit Ethernet
- **other:** One 9-pin serial, six USB 2.0, 25-in-1 media card reader
- **Keyboard:** 104-key Lenovo USB keyboard
- **Pointing device:** USB optical roller wheel mouse

Modest Expansion Capabilities

To access the interior of the case, we had to remove two non-captive thumbscrews on the rear of the case and then press a small button to remove the side panel. Inside, the Lenovo-designed motherboard takes up about two-thirds of the interior, with all sockets, slots, and connections easily accessible. Lenovo offers processors ranging from the dual-core 3.1GHz Intel Core i3-2100 to the quad-core 3.5GHz Intel Xeon E3-1280. The single-socket motherboard in our evaluation unit housed a quad-core Intel Xeon E3-1230, a 3.2GHz CPU rated at 80 watts of thermal design power (TDP) with a maximum turbo speed of 3.6GHz and 8MB of Smart Cache. The motherboard also provides four dual in-line memory module (DIMM) sockets. Our evaluation unit came with 4GB installed as a single 4GB ECC 1333MHz memory module. The E30 can accommodate up to 32GB using 8GB DIMMs.

The motherboard provides just four expansion slots: one PCIe x16 graphics card slot, two PCI card slots and a PCIe x1 card slot. The graphics card slot in our system was filled with an entry-level NVIDIA Quadro 600 graphics accelerator equipped with 1GB of discrete graphics memory. Lenovo's other NVIDIA-only options range from the Quadro NVS300 to the Quadro 2000, as any boards larger than that would not fit inside the confines of the E30 case.

The Lenovo ThinkStation E30 has two 3.5-in. internal drive bays with quick-release acoustic dampening rails, one mounted just below the front panel in a novel cage that rotates 90° (after disconnecting the power and data cables) to allow easy access, and the second attached to the bottom of the case. For our review, Lenovo equipped the E30 with a single 500GB Hitachi 7,200 rpm SATA drive. Lenovo offers other 7,200 rpm SATA drives ranging from 250GB to 2TB, as well as 300GB and 600GB 10,000 rpm drives and a 160GB SSD drive, and systems equipped with two drives can be factory-configured in various redundant arrays of independent disks (RAIDs).

A 280-watt, 85% efficient auto-sensing power supply provides enough power to handle the system's relatively modest expansion options. The system was virtually silent during normal operations in spite of five fans—front, rear, CPU, graphics card and power supply—spinning inside.

Modest Performance

Lenovo pre-installed Windows 7 Professional 64-bit and also sent us a second hard drive with Windows XP 42-bit installed, so that we could repeat all of our benchmarks using that older operating system. The workstation also came with hyper-threading enabled so that our quad-core CPU appeared as eight separate processors. Equipped with fairly modest graphics and a mid-range CPU, we did not expect the ThinkStation E30 to set any records. And the E30 lived up to those expectations, turning in results measurably slower than those of other systems we've reviewed recently. But the numbers were definitely not disappointing. The ThinkStation's performance was approximately twice as fast as that of workstations from just three years ago—and nearly equal to that of modern systems costing much more.

On the SPECviewperf benchmark, NVIDIA Quadro 600 just couldn't match the performance of other systems we've reviewed recently, which came equipped with Quadro 2000 and Quadro 5000 GPUs. But the Quadro 2000 costs nearly three times that of the Quadro 600, and a Quadro 5000 would more than double the total cost of the entire ThinkStation E30 workstation (if one could be crammed into the case).

On the SPECapc SolidWorks benchmark, which is more of a real-world test (and breaks out graphics, CPU and I/O performance separately from the overall score), the E30 continued to lag behind other systems we've tested, thanks to its slower CPU and entry-level graphics. But again, the numbers were by no means disappointing; they would have placed the E30 near the top of the pack just a few years ago.

On the AutoCAD rendering test, which clearly shows the benefits of multiple CPU cores and hyper-threading, the ThinkStation E30 took just 71.75 seconds to complete the rendering. While that's nearly half a minute longer than the over-clocked BOXX 3970 Extreme workstation we reviewed in January, it's just 10 seconds slower than most of the other single-socket workstations we've tested recently, most of which cost twice as much.

Lenovo rounded out our evaluation unit with its standard 104-key USB keyboard and a USB optical wheel mouse. While Windows 7 came preloaded, Lenovo continues to support Windows XP and Red Hat Enterprise Linux 6. The system is backed by a three-year warranty on parts and labor onsite, with other warranty upgrade options available.

Although Lenovo lists a starting price of just $600, that's for an extremely basic system with no operating system. As configured, our evaluation unit priced out online at $1,513, but a web-based discount immediately dropped the total system cost to just $1,099. At that price, the Lenovo ThinkStation E30 is extremely affordable. While its performance won't set any records, its value may be too good to pass up. **DE**

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

Engineering Workstations Compared

		Lenovo E30 workstation (one 3.2GHz Intel Xeon E3-1230 quad-core CPU [3.6GHz turbo], NVIDIA Quadro 600, 4GB RAM)		**HP Z210** workstation (one 3.36GHz Intel Xeon E3-1245 quad-core CPU [3.7GHz turbo], NVIDIA Quadro 2000, 8GB RAM)		**BOXX 3DBOXX 3970 EXTREME** workstation (one 3.4GHz Intel Core i7-2600K quad-core CPU over-clocked to 4.5GHz, NVIDIA Quadro 4000, 8GB RAM)		**Dell Precision T1600** workstation (one 3.4GHz Intel Xeon E3-1270 quad-core CPU, NVIDIA Quadro 2000, 4GB RAM)		**@Xi Computer MTower** workstation (one 3.4GHz Intel Core i7 2600K quad-core CPU over-clocked to 4.1GHz, NVIDIA Quadro 5000, 16GB RAM)		**BOXX 3DBOXX 8550XTREME** workstation (two 3.33GHz Intel Xeon X5680 six-core CPUs over-clocked to 4.2GHz, NVIDIA Quadro 5000, 24GB RAM)		**Dell T5500** workstation (two 3.33GHz Intel Xeon X5680 six-core CPUs, NVIDIA Quadro 5000, 6GB RAM)	
Price as tested		$1,099		$2,269		$4,048		$1,875		$4,465		$11,396		$9,242	
Date tested		4/21/12		2/12/12		10/12/11		9/11/11		4/30/11		3/20/11		1/14/11	
Operating System		Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit	Windows XP	Windows 7 64-bit
SPECviewperf	higher														
3dsmax-04		79.01[1]	77.43[1]	80.67	79.46	n/a	99.03[1]	83.61	81.72	n/a	89.36	95.97	95.44[1]	76.05	78.72
catia-02		77.80[1]	77.68[1]	94.20	91.47	n/a	124.75[1]	96.38	93.28	n/a	121.7[1]	120.44	121.1[1]	98.48	100.25
ensight-03		48.20[1]	49.27[1]	75.78	73.57	n/a	109.56[1]	76.62	74.16	n/a	131.19[1]	132.41	130.13[1]	118.29	121.70
maya-02		156.64[1]	157.63[1]	291.17	270.83	n/a	399.43[1]	297.27	270.53	n/a	465.88	529.89	476.95[1]	490.95	435.44
proe-04		60.66[1]	60.79[1]	88.48	84.83	n/a	120.33[1]	89.24	85.86	n/a	128.25	113.84	113.24	92.19	90.61
SW-01		94.38[1]	94.68[1]	168.06	161.45	n/a	231.44[1]	169.31	160.61[1]	n/a	239.78	221.31	214.06	180.49	169.75
tcvis-01		34.25[1]	34.22[1]	56.41	54.43	n/a	79.05[1]	56.76	54.24	n/a	97.45	98.58	94.17	93.99	90.34
ugnx-01		29.01[1]	29.16[1]	43.41	42.49	n/a	65.91[1]	43.40	42.47	n/a	88.87[1]	89.32	86.90	89.31	87.95
SPECapc SolidWorks	lower														
Score	seconds	127.48[1]	n/a	110.91	n/a	n/a	n/a	106.63[1]	n/a	n/a	n/a	106.56[1]	n/a	146.86	n/a
Graphics	seconds	48.40[1]	n/a	35.71	n/a	n/a	n/a	34.24[1]	n/a	n/a	n/a	35.33[1]	n/a	58.42	n/a
CPU	seconds	27.90[1]	n/a	25.89	n/a	n/a	26.44[1]	25.05[1]	n/a	n/a	27.48[1]	25.99[1]	n/a	32.27	n/a
I/O	seconds	55.17[1]	n/a	50.74	n/a	n/a	47.01[1]	48.26[1]	n/a	n/a	49.48[1]	46.51[1]	n/a	60.76	n/a
SPECapc SolidWorks	higher														
Score	ratio	6.25[1]	n/a	7.92	n/a	n/a	n/a	8.04[1]	n/a	n/a	n/a	8.23[1]	n/a	5.32	n/a
Graphics	ratio	3.89[1]	n/a	5.78	n/a	n/a	n/a	5.74[1]	n/a	n/a	n/a	6.08[1]	n/a	3.23	n/a
CPU	ratio	11.57[1]	n/a	12.46	n/a	n/a	12.20[1]	12.88[1]	n/a	n/a	11.74[1]	12.61[1]	n/a	10.00	n/a
I/O	ratio	5.74[1]	n/a	6.24	n/a	n/a	6.73[1]	6.56[1]	n/a	n/a	6.40[1]	6.81[1]	n/a	5.21	n/a
Autodesk Render Test	lower														
Time	seconds	85.66[1]	71.75[1]	71.66[1]	62.33[1]	n/a	45.6[1]	82.2[1]	60.5[1]	n/a	49.8[1]	34.0[1]	19.0[1]	42.0[1]	28.0[1]

Numbers in blue indicate best recorded results. Numbers in red indicate worst recorded results. 1=Hyper-threading enabled.

MATLAB Communications System Toolbox: **Now GPU-enabled**

Predefined components get speed improvements via graphics processing units.

BY PETER VARHOL

MathWorks Inc. continues to expand its portfolio of NVIDIA graphics processing unit (GPU)-enabled software with the availability of GPU versions of its Communications System Toolbox components. This toolbox is used by designers building wireless communications handsets and base stations, and works at the physical level of the communications stack. It offers predefined algorithms for source coding, channel coding, interleaving, modulation, equalization, synchronization, and channel modeling.

These components are provided as MATLAB functions, MATLAB System objects and Simulink blocks, so they can be dropped into MATLAB or Simulink programs. They support fixed-point data arithmetic and C or HDL code generation, so once the design is validated, it can be converted to hardware or code.

According to Silvina Grad-Freilich, MATLAB senior manager, parallel computing marketing, the effort to port some of these components to run on GPUs represents the highest level of a three-tier strategy to enable MATLAB developers to take advantage of GPU computing power.

"We offer lower-level means of accessing GPU resources in MATLAB computations, such as the GPUArray instruction in the language," she says. "What we've done with the Communications Toolbox is to enable a higher level of abstraction and use."

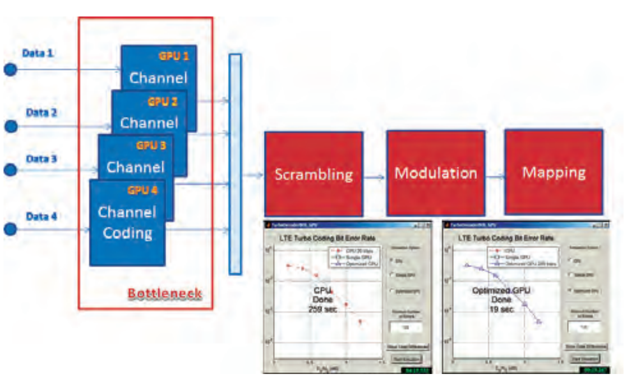
MathWorks has used this multi-level approach to deliver GPU capabilities and resultant performance increases across a wide range of the MATLAB language and product line. It enables design engineers to examine their design problems and select an approach that is appropriate for their efforts.

Faster Execution

MathWorks claims a significant performance increase for components utilizing the GPU.

"We did an analysis of how these algorithms worked," explains Ken Karnofsky, senior strategist for signal processing applications. He adds the analysis resulted in rewriting many different aspects of the algorithms.

What kind of performance increase is possible with GPU versions of these components? In some cases, it's up to15 times as much as the original implementation. While mileage may vary depending on the exact processors used and the application, it's clear that some functions can see large performance boost.



MATLAB Communications System Toolbox exploits GPUs and computational parallelism to accelerate throughput in communications system simulations.

These components are more than simply a recompile into the NVIDIA GPU architecture. According to Karnofsky, MATLAB engineers studied the Communications Toolbox code, then determined which algorithms would benefit from GPU execution—and how to re-implement them for GPU instructions and pipelines. They also considered how to best parallelize the computations so that they could also be executed on multiple GPUs.

Not all of the Communications Toolbox is GPU enabled; rather, there are about a dozen components that have been ported to the GPU. Karnofsky explains that the development team identified several "long poles" that would most benefit from GPU execution. It focused on highly computational algorithms in an attempt to get product designers the highest performance improvements immediately. The company will continue to convert these components as long as the performance improvement justifies it, Karnofsky says. **DE**

Contributing Editor **Peter Varhol** *covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at de-editors@deskeng.com.*

INFO ➜ The MathWorks Inc.: MathWorks.com

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Wills Wing's Leap of Faith

This hang glider manufacturer tries out CAM—and reaps some unexpected benefits.

BY MARK CLARKSON

Consider the modern hang glider, a flexible, triangular, two-lobed wing with the same area—around 150 sq. ft.—as a two-seater Cessna. Hanging beneath it: nothing but you.

"It's the only kind of flying where you feel like a bird," says hang gliding enthusiast Steve Pearson. "In hang gliding, the wings are yours. The control mechanism is really quite remarkable. Displacing your weight changes the flexibility of the membrane, and initiates a turn in a very complicated way that could only have evolved by iterative development over many, many years."

Pearson knows of what he speaks. He's not just a hang gliding enthusiast, he is also the chief designer and engineer at Wills Wing, considered to be the world's leading hang glider manufacturer. Well, truthfully, he's the only engineer—the company, which makes 650 gliders a year, only employs about 20 people.

The History of Hang Gliding

Hang gliders have been around in some form since at least the 1880s. What we think of as a modern hang glider—a triangular, two-lobed kite—was first flown in 1961. By 1976, the sport had really "taken off," with as many as 100 hang glider manufacturers. Many of them worked out of their garages and used materials ranging from plastic to bamboo. But there were, perhaps predictably, dozens of fatal accidents every year that influenced public perception of the sport.

"When we took over Wills in 1977," says Pearson, "the major manufacturers were developing air worthiness and stability standards, to provide some measure of safety. In the intervening years, hang gliders have evolved far past what most people conceive."

Although there are only a handful of manufacturers, today's hang gliders are sophisticated machines made from cutting-edge materials—lightweight, safe, maneuverable engineering marvels that can glide or race between thermals for hundreds of miles. Wills' hang gliders are made of 7075 seamless aluminum, carbon fiber and high-strength polyester film.

Safety in the sport has also soared: Fatalities have dropped well below one in 100,000 flights.

How Hard Can it Be?

Pearson has been using SolidWorks for his designs since 1995, but, until five years ago, the actual parts were built elsewhere. Wills Wing is situated in Orange County, CA, with access to plenty of machine shops.

"I have three different machine shops that I work with," says Pearson. "They each are really good at different types of projects. They also have different cost points. When I was designing components, I would typically design the component with [a particular] shop in mind."

And then came "the part that changed everything."

"I designed this part for machinist A," says Pearson. "For whatever reason, he couldn't make it. So I redesigned it for machinist B and, for whatever reason, that didn't work out. This part was a key component of a new product release, so the clock was ticking as I went through these redesigns."

Pearson ended up redesigning it for machinist C, who could make it. But the cost, delay and the end result still not being what he had in mind took Pearson to the boiling point: "At that point I thought, 'I'm just going to do this myself. How hard can it be?'"

Leap of Faith

"For a little company, deciding to buy a [computer numerical control] CNC machine, learn how to program it, and start making our own parts required a big leap of faith," says Pearson. "But once we made our first part, there was no looking back," he says. "Now, when I design a part, I design it the way I want it to be."

Wills initially purchased a standalone CAM application.

"I understood all the advantages of having integrated applications, but I was too cheap," Pearson admits. The standalone CAM application required Pearson to export designs from SolidWorks, import them into Rhino, and then export them again from Rhino to CAM.

"I knew I didn't have the associativity," he says. "If I changed something, I would have to do the whole process over again."

License for Success

Eventually, Pearson became frustrated with his standalone CAM application. When he saw the product release for HSMWorks, he followed up on it. The reseller gave him a 30-day trial license.

It wasn't quite love at first sight.

"My initial impression," says Pearson, "was that [HSMWorks] wasn't very powerful, because there weren't as many icons and buttons and widgets. I thought, what can I do with this? Where's all the stuff? But when you start working on a part, you realize that it's very intuitive. If you know SolidWorks, you know HSMWorks."

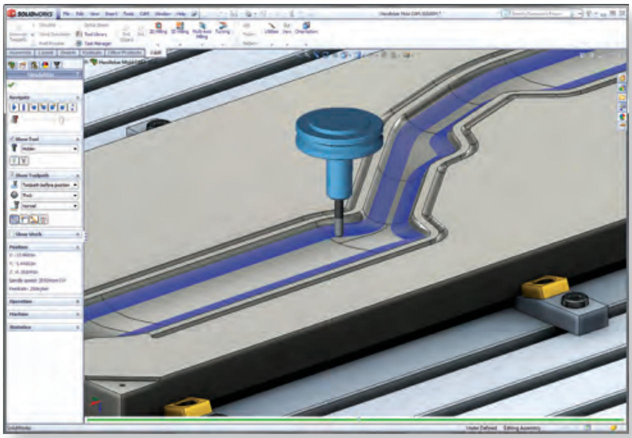
Pearson was particularly pleased with the post processor because he no longer has to modify his posts. He also likes how fast the program is at calculating paths: "I called the reseller three days later and said, 'Sign me up.'"

Unexpected Benefits

Wills has realized some unexpected benefits from bringing more of their manufacturing in-house, says Pearson. "There's a transaction cost with all of these parts that I hadn't considered. A machine shop may be able to manufacture the part, and the raw machining costs might be a little cheaper than [mine], but that's before you include the communications dealing with the outside vendors, and the lead times, and the quantity requirements.

"Typically, machine shops want to make parts in even numbers—100 or 500 or 1,000. I want to make 53, because I have 106 components that match with it in pairs."

This isn't just Pearson being contrary. With 13 different models, each with hundreds of parts, inventory management represents a big part of Wills' overhead.



Working on a handlebar in HSMWorks.

"Now I make just what I want, in the quantity I want," he says. "Our process has become much leaner, and the quality of our products is better. We don't have inspection issues with parts coming in, because they're inspected as they're made."

Pearson has found himself making entirely new things. In the age of social media, Wills wants to see photos and videos of people enjoying their products all over the Internet.

"Everybody's big on GoPro [cameras]," he says, "but there was no convenient way to mount one to our hardware. So I designed this little GoPro bracket that mounts on our hang glider. I made 50 of them, and just gave them away to people who I know are going to make great photos. If I couldn't just do it myself, I wouldn't bother."

Product Differentiator

Wills still sends some parts out for manufacture, especially large runs of common parts, says Pearson, but CAM and in-house manufacturing has been a major product differentiator for them.

"Having the capability to improve our product and make changes in-house has been a significant factor," he says. "Our competition doesn't have this capability. A lot of their components are cast, and they're structurally and cosmetically inferior. The customers recognize the difference." **DE**

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INFO ➜ Dassault Systèmes SolidWorks Corp: SolidWorks.com

➜ **HSMWorks:** HSMWorks.com

➜ **NEi Software:** NEnastran.com

➜ **Rhino:** Rhino3D.com

➜ **Wills Wing:** WillsWing.com

Breaking Down the Performance Wall

A mix of hardware, so˜ ware, and OS adjustments improve in SolidWorks performance as much as 5.5 times.

BY KENNETH WONG

At SolidWorks World 2012, in the introduction to their talk titled "Maximizing SolidWorks Performance," Adrian Fanjoy and Josh Altergott noted, "Performance is a perpetual problem. You're always going to be running into the performance wall at some point in time."

The phenomenon is familiar to most CAD users. Unable to cope with the complexity of an assembly or the demands of a modeling operation, the workstation comes to a crawl. That's when you know your CAD program has hit the proverbial wall. Understanding the performance wall was critical to Fanjoy and Altergott, technical services director and technical support manager of Computer Aided Technology Inc. (CATI), because it could help them answer the question their customers ask the most: "What should I buy or do to have the greatest impact?"

Just from experience, Fanjoy and Altergott have accumulated a few tricks on boosting CAD performance. But they wanted empirical data—incontrovertible, statistical, scientific data—to support what they knew intuitively. So, in a series of controlled tests, they tried to break the performance wall. They first created a large assembly out of problematic files that have been known to bring systems to their knees. Then, to establish a baseline, they ran a macro that executes a number of modeling tasks in SolidWorks on a typical CAD workstation. Afterward, they ran the same macro using alternate CPU, GPU, memory, hard drive, operating system, and SolidWorks configurations. In doing so, they were able to isolate and study the impact of each contributing factor.

Macro-Driven SolidWorks Tasks

To determine the best possible environment for SolidWorks, CATI researchers used a macro that ran the following SolidWorks tasks on a base system, then executed the same tasks using different CPU, GPU, memory, OS, and software configurations.

- Opens
- Rotations
- Modeling
- Rebuilds
- Switching Sheets
- Saves
- Closes

Fanjoy and Altergott discovered that, by adopting a mix of hardware, software, and OS adjustments, they could reduce a job that took 5 hours, 1 minute, and 35 seconds down to a mere 55 minutes, 19 seconds. In other words, if you adopt their recommendations, you could see as much as 5.5 times improvement in your SolidWorks performance.

Coyote Meets the Cluge

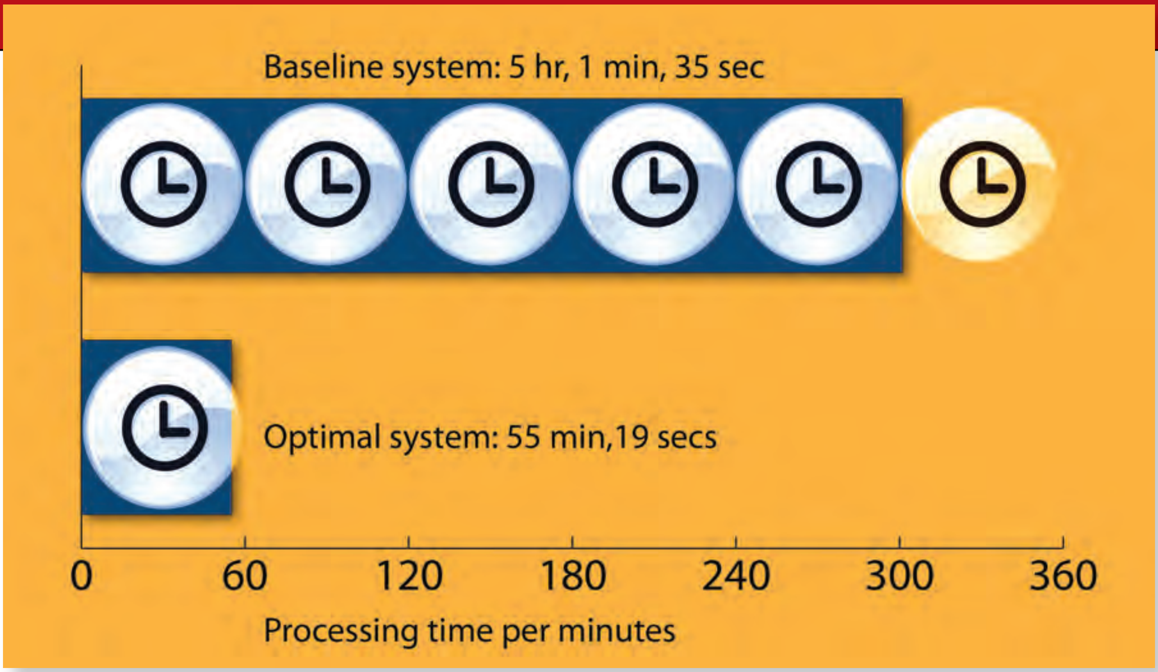
The centerpiece of CATI's research was a flexible, scalable system that could be easily configured to represent different environments, ranging from a standard system to an optimal system. For their purpose, testers were able to enlist BOXX Technologies' help. The company provided CATI with the 3DBOXX 8550 XTREME. The system supports up to two six-core Intel Xeon 5600 processors running at 3.4GHz (4.3GHz when overclocked).

"[BOXX's system] gave us a vast area, a great sandbox to play in, so we can make dramatic changes to our environment very easily," says Fanjoy.

To study the effects of different CPU configurations on SolidWorks performance, CATI gradually scaled up the CPU setup from 1 to 12 cores, and processor speed from 3.42GHz to 4.43GHz. The researchers also scaled up its memory from 8GB to 24GB. Similarly, they also swapped out standard hard drives with solid-state drives, experimented with different GPUs, and tweaked the OS and CAD configurations in-between tests.

The harsh, cruel treatment they planned to put the system through reminded the testers of Wile E. Coyote, the character who endured a variety of mistreatments in every episode of the Road Runner cartoon. Accordingly, CATI researchers nicknamed the test system Coyote.

The test dataset was an assembly file constructed out of several large SolidWorks files, reused with permission from CATI customers. They were selected from real-world data that has proven to cause performance problems. Humorously called the Cluge by testers, the consolidated assembly contains 6,637 total components, 5,862 parts, 775 subassemblies, 663 top-level



Research shows what hardware and software changes would reduce the time to complete a SolidWorks job.

mates, and 13,011 bodies. With such complexity, it was expected to push the limit of standard CAD workstations.

To establish a baseline, CATI testers first ran a macro that executes a series of modeling tasks on the test dataset, with the system configured to represent a standard CAD workstation: 1 Xeon processor with 2 cores, running at 3.46GHz, 8GB RAM, with most OS and CAD settings at default. This provided them with a baseline of 5 hours, 1 minute, and 35 seconds. The rest of the tests were designed to measure the deviation from the baseline produced by tweaks to the CPU, GPU, OS, and SolidWorks settings.

The Little Things That Make a Big Difference

By default, Windows OS uses a display option enhanced with simulated shadows, transparent program windows, and animations. That is especially true of later versions of Windows, such as Windows 7. Foregoing these aesthetic treatments (under the Visual Effects tab) could divert some of the computing power back to CAD performance. In CATI's tests, turning off these effects boosted SolidWorks performance by 8.5%.

Some of the add-ons in SolidWorks are by default turned on at installation. Even when not actively engaged, the add-ons demand some computing power and memory, which could otherwise be devoted to modeling operations. CATI recommends reviewing the add-ons and turning off those that you do not plan to use frequently.

You may further increase CAD performance by choosing a less demanding image quality in SolidWorks. The RealView and Shadows in Shaded Mode options are designed to display models in high-contrast photorealistic view, enhanced with shadows and reflections. While impressive to look at, such high-quality visuals may not be necessary in geometry editing, modeling, and day-to-day CAD operations. Choosing a simpler visual style could improve CAD performance by reducing the computing burden on the CPU.

In addition, CATI identified more than 20 performance-boosting adjustments you can make to SolidWorks' default system settings, ranging from disabling thumbnail graphics in the file explorer window and selecting draft quality for new views to reducing transparency in in-context assembly edits. Foregoing these niceties may mean giving up certain conveniences (such as the ability to graphically preview files in the explorer window), but the boost from the adjustment could add up to 9% performance increase.

The Heart of the Matter: CPU

Many CAD software programs, including SolidWorks, are primarily single-threaded, so increasing the CPU speed is one of the easiest ways to increase performance. Simply put, the faster the CPU speed, the more instructions it can process in a given amount of time. In CATI's tests, overclocking the CPU in the 3DBOXX 8550 XTREME from 3.42GHz to 4.29GHz bumped up the performance by 12%.

Overclocking, or tweaking the CPU to run at a speed faster than the manufacturer's specified speed, is not recommended for novices with limited system knowledge. Doing so increases the thermal output of the CPU; therefore, if done incorrectly, it could overheat the system and cause irreparable damage. BOXX is one of the few workstation providers who sell overclocked systems covered under warranty.

Though mostly single-threaded, SolidWorks does take advantage of multicore processors in certain areas, such as rendering, simulation, analysis, interference checking, and large-file retrieval. Even if SolidWorks is the only application running on the workstation, the software must still share resources with the OS. Furthermore, day-to-day operations require running more than just the CAD software. Therefore, according to Fanjoy, "If you want to run SolidWorks on two cores, you need to turn everything else off. And you're still going to be sharing some bandwidth with the operating system. If you're doing anything of any substantial size or complexity, I wouldn't recommend going with anything less than four cores."

Get the Whole Story

This article is supplemented by the white paper titled "Maximize SolidWorks Performance," which details CATI's tests, methodologies, findings, and recommended configurations. To download the free white paper, go to deskeng.com/whitepaper.

Multicore CPUs are shown to produce the greatest benefits in parallel-processing jobs, such as photo-realistic rendering. In CATI tests, the same rendering job that took more than 4 hours on four cores took just a little more than 1 hour when processed on 12 cores.

More Memory, Less Paging

When dealing with large assemblies, if the system doesn't have sufficient memory to accommodate the size of the active data, it will most likely use paging—borrowing available hard disk space to temporarily read and write data—to deal with the shortage. When this happens, the system tends to run slower.

The test data set, for example, requires at least 10GB of RAM. Any amount below 10GB was shown to trigger the paging — also known as swap — process, which led to system slowdown. In CATI's tests, bumping system RAM from 8GB to 24GB resulted in a whopping 54% improvement.

If paging does occur you'll want a fast hard drive to handle it. In CATI's tests, replacing the traditional spindle drive in the base system with a solid-state drive (SSD) increased SolidWorks performance by 47%. SSDs cost more than spindle drives, but they offer better speed at reading and writing data, which makes a difference in CAD performance.

Fix Top-Heavy Assemblies

Reducing top-level assembly mates—one of the best practices advocated by CAD users—also makes a difference in CAD performance, as CATI tests confirmed. Mating conditions that define the geometric relationships among subassembly components tend to take immense computing power to resolve and calculate. Consequently, loading a large assembly with hundreds of top-level mates could slow down the system. By contrast, nesting these mates at the subassembly level reduces the amount of calculating required at load time. In CATI tests, reducing top-level mates from 962 to 273 resulted in a 15% performance increase.

The Balancing Act

Some of the adjustments recommended by CATI, such as suspending visual effects in Windows OS and deactivating unused SolidWorks add-ons, cost nothing. Others, like upgrading CPU speed and memory or switching to SSDs, require additional investment. CATI's tests allow engineers to quantify the performance gains of those investments.

"It is also very important to remember that a computer system is just that—a system, and it should be treated as such," said Fanjoy. "What we have found in our efforts conducting these tests is that improvement of a modeling environment must be approached at a system level rather than a specific component level. All of the hardware, configuration, and modeling methodology options work in concert to establish the performance capabilities of a workstation." **DE**

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

Baseline vs. Optimal System

Baseline System
- Xeon processor with 2 cores, at 3.46GHz
- 8GB RAM
- SolidWorks 2012 SP1, default settings, some add-ons acti e
- Windows 7 64-bit OS, default display setting
- Operating system and files on same 200 RPM hard drive

Optimal System
- Xeon processor with 12 cores, at 4.29GHz
- 24GB RAM, SWAP 48GB
- SolidWorks 2012 SP1, optimized graphics settings, some add-ons deactivated
- Windows 7 64-bit OS, display settings to Best erformance
- OS on RAID 0 Intel Solid State Drive 520 series
- Files on OCZ RevoDrive with PCI-Express SSD
- NVIDIA Quadro series graphics card

INFO ➜ BOXX Technologies: boxx.com

➜ **Computer Aided Technology, Inc.:** cati.com

➜ **Intel:** intel.com

➜ **DS SolidWorks:** solidworks.com

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SPOTLIGHT

Directing your search to the companies that have what you need.

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.

All-in-One Workstation Built for CAD

HP's new HP Z1 leverages Intel Xeon CPUs and NVIDIA Quadro GPUs.

The case for an all-in-one workstation is obvious: You and your tiny desk are packed like sardines in tight cubicles. Your tower workstation and large monitor eat up all your workspace. The case against an all-in-one has merits: most are built for home or office usage, not engineering. In fact, "an all-in-one workstation built for CAD professionals" sounds like a paradox. But that's how HP describes its recently announced HP Z1 workstation, and I have to say this looks like the real enchilada. Let me add that it seems HP — which never did this sort of thing before — learned a lesson or two from some of the other all-in-one computers out there.

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Control Data from Prototype to Production

New product data sharing modules simplify ECAD design imports and sharing of bills of materials and build packages.

Data may be our prized asset, but it's often treated casually in the haste to get things done. Take when it comes time to build the actionable BOM (bills of materials). A lot of engineers arrive at that day with a spread-sheet that's just a columnar pile of parts, sketchy vendor details, and links to data sheets, component information, and pricing.

Arena Solutions, the SasS (Software as a Service) developer of cloud-based BOM and change management software, recently came out with PartsList to address this situation.

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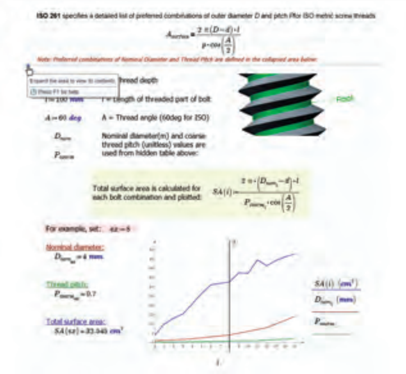

Mathcad Prime 2.0 Ships

PTC adds new capabilities and advanced functionality to its engineering calculation software.

Some of the features in Mathcad Prime 2.0 include a new symbolic mathematics engine, Open XML-based file format, a new equation editor based on order of operations and precedence, dynamic unit checking, and mixed units in matrices, tables, and plots. There's native 64-bit support, a new KNITRO multithreaded optimization solver for nonlinear optimization, and expanded integration with Microsoft Excel. Collapsible areas for organizing worksheets are back, and 3D scatter, curve, and surface plots now have unit support.

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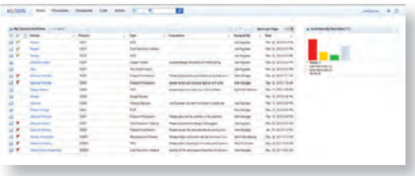

Manage Processes in the Cloud

Automation system simplifies processes throughout manufacturing enterprises.

Kenesto is a cloud-based system that allows users in all departments of a manufacturing enterprise to create processes and manage work easily. R&D has struggled for years to gain enterprise-wide acceptance of engineering-specific process systems like product lifecycle management (PLM). Kenesto seems to offer a new alternative to PLM.

The first thing Kenesto seems to do right is that it harnesses the concepts used by the least intimidating of all process management applications — e-mail. It empowers you to use e-mail to corral participants into your process plan, and it tracks everything.

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Tools of the Month

1

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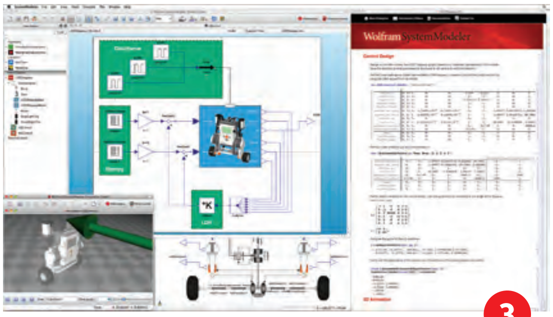

3

1 Omega's New Compact Thermal Imager

Omega's (omega.com) new line of compact thermal imagers is powered by FLIR. The OSXL-I series (FLIR I Series) is a point-and-shoot camera with a focus-free lens. This CE compliant product stores up to 5,000 jpeg images and has a thumbnail image gallery. According to the company, the 2.8-in. color LCD makes it easy to read images and temperature data to help find wasteful energy loss, locate moisture damage, document testing, detect energized equipment, and more. Prices start at $1,195.

Mentor Graphics' Flowmaster

Mentor Graphics (mentor.com) has announced its Flowmaster Power and Energy version for system level thermo-fluid simulation. This new product provides a two-phase solution modeling the phase change from liquid to vapor for steam generation or from vapor to liquid when steam is consumed. According to the company, this new capability is ideal for the power generation markets, accurately describing industry-specific components that must be developed to meet industry modeling requirements with faster and more accurate analysis.

2 Luxion's KeyShot 3.2

Luxion (keyshot.com) has released KeyShot 3.2 with updates to existing functionality and user interface improvements. Updates enhance speed, provide a cleaner interface, and make a handful of fixes so that creating 3D renderings and animations is even faster. KeyShot 3.2 now supports instant loading of materials, textures and environments. Material Templates can now be applied after a model has been imported while applying materials to the 3D model on import becomes even faster with the support of part names and wild cards. Additionally, the undo capabilities have been increased to provide the option to undo nearly every command.

CD-adapco's New iPad App

CD-adapco (cd-adapco.com) unveiled the company's new iPad app during the STAR Global Conference 2012. The first version of the app delivers exclusive product information, new features of the latest version, the ability to check Power-on-Demand usage and remaining credit, and CD-adapco news.

3 Wolfram Group's New Modeling Environment

Wolfram Group (wolfram.com) has released SystemModeler, a new high-fidelity modeling environment that uses versatile symbolic components and computation to drive design efficiency and innovation. The solution integrates with the Wolfram technology platform to enable modeling, analysis, and reporting, achieving a design optimization loop. **DE**

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Artec Eva 3D Scanner

Quick Capture

1 The Artec Eva 3D scanner captures up to 16 frames per second as 3D images. The frames are aligned in real time, according to the company, allowing users to see what areas of the object being scanned have been captured. Artec says Eva captures and processes up to 288,000 points per second with a resolution up to 0.5 mm and an accuracy up to 0.1 mm.

Hand-held Functionality

2 Weighing in at 1.9 lbs., the hand-held device can be used where it's needed. It can capture color information as well as motion. The scanner comes with Artec Studio software and the necessary cables.

Ease of Use

3 According to the company, Eva doesn't require long calibration procedures before beginning a scan. It does not need markers placed on the object before scanning, and because it does not use electromagnetic tracking, metal objects in the room don't affect its performance.

TECH SPECS

- 3D accuracy over distance: up to 0.15% over 100 cm.
- Texture resolution: 1.3 mp.
- Colors: 32 bpp.
- Light source: flash bulb (no laser).
- Linear field of view at closest range (height x width): 214 x 148 mm.
- Linear field of view at farthest range (height x width): 536 x 371 mm.
- Angular field of view (height x width): 30 x 21 in.
- Working distance: 0.4 to 1 m.
- Output formats: OBJ, PTX, STL, WRML, ASCII, AOP, CSV, PLY. Texture can be exported only in WRML and OBJ formats.
- Dimensions (height, depth, width): 261.5 x 158.2 x 63.7 mm.
- Weight: 0.85 kg.
- Compatibility: Windows Vista and Windows 7, 64 bit.
- Minimum computer requirements: Intel Core Quad, 4GB RAM, NVIDIA GeForce 9 series.

For more information, visit artec3d.com

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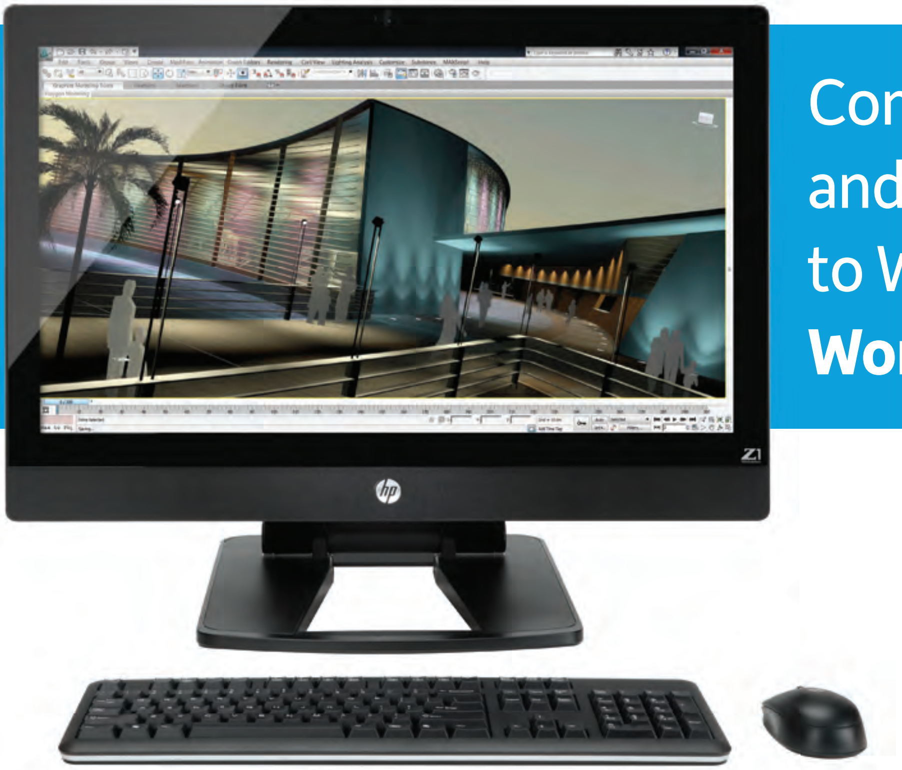

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