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TECHNOLOGY FOR DESIGN ENGINEERING

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FOCUS ON: Technologies for SMBs P.24

Virtual Reality Gets Real

Engineers take advantage of advances in virtual immersion technologies.

by Jamie J. Gooch

Technologies for SMBs

Large enterprises are in the spotlight when it comes to technology's role in driving the economy. From Ford to Google, big businesses certainly make large investments in technology that can save them time and enable innovation, and so are rightly courted by software and hardware vendors. But small businesses are just as important drivers of innovation, especially in the design engineering space.

More than half of the U.S. working population is employed by one of the country's 28 million small businesses with fewer than 500 employees, according to the U.S. Small Business Administration (SBA). In fact, SBA says small businesses account for more than 99% of all U.S. businesses, and they produce about half of the private nonfarm gross domestic product. Tailoring technology investments to benefit small- and medium-sized businesses (SMBs) is vital to the economy, and vital to many technology vendors who are rushing to meet the demand.

The independent mindset of many SMBs can hamper growth.

SMBs' technology expectations are high. Brother International Corporation, in partnership with SCORE, an organization that mentors small businesses, recently released results from a survey of 500 U.S. businesses with fewer than 100 employees. The survey showed that 72% of respondents expect new technologies to offer a bigger return on their investment than new employees in 2014. Almost half (49%) of the Brother Small Business survey respondents put investing in technology tools at the top of their 2014 priorities. The problem is understanding which technologies to choose. The survey indicates 63% of respondents frequently feel overwhelmed with the number of technologies available to run their businesses.

A Big Business History

The confusion surrounding SMB technology options is understandable. Not long ago, there were technologies that sat squarely in the realm of large enterprises: product lifecycle management, advanced simulation software, enterprise resource planning and more. They often required a significant investment in software licensing and high-performance computing hardware that was out of reach for most SMBs.

But now those technologies are widely available thanks to strides vendors have made in making them more accessible and the greater availability of affordable computing power — from desktop workstations that can handle demanding software, to clusters of cheap workstations, to Cloud services. As technology in general has gotten smaller, mobile and more affordable, SMBs have the potential to reap significant benefits. Today's technology makes it possible for one person to afford a workstation capable of running advanced design and simulation software, burst to the Cloud as needed, 3D print prototypes at his desk or at a rapid prototyping service provider, and collaborate with clients or even market and sell the product himself online. He can optimize designs, track data from hundreds of iterations and improve a product faster than some large corporations can get an idea out of committee.

Service and Support

That's the possibility, but the reality is that many SMBs are slow to adopt new technologies. The SBA notes that small businesses have created 65% of net new jobs since 1995, but 22 million of the 28 million U.S. small businesses are nonemployers. That means there are a lot of one-person operations out there, trying to keep up with technology and run a business.

An SMB's size is one of its greatest assets. It provides the agility needed to quickly capitalize on new trends. But size can also be an SMB's greatest weakness. Small business owners and employees wear many hats. The design engineer is often also the software support specialist, computer repairman, website administrator and technology procurement manager. As Jason Lopes, lead systems engineer with special effects company Legacy Effects, said during his RAPID 2014 keynote: "If it plugs into a wall, I'm responsible for it."

Unlike SMBs who are overwhelmed by technology, Lopes relies heavily on service providers, collaborates online with other small businesses to find the expertise he needs, and leans on hardware and software vendors for support. In short, he is able to scale up quickly to incorporate the use of the latest and greatest technologies.

The can-do attitude and independent mindset that led to the formation of many small businesses can hamper their growth. Technology allows SMBs to do more than ever, but they don't have to do it all alone. DE

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

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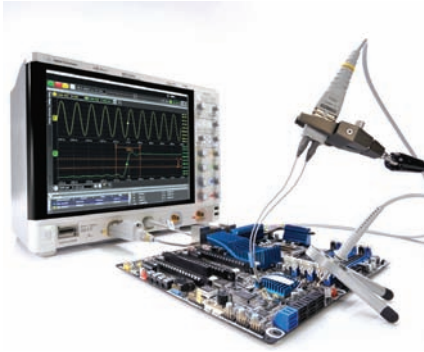
Virtual Reality: A Powerful Engineering Tool

ON THE COVER: Virtual reality enables engineers to interact with products virtually to resolve manufacturing and serviceability issues upfront in the design process. *IC.IDO image courtesy of ESI.*

TEST



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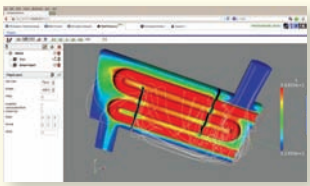
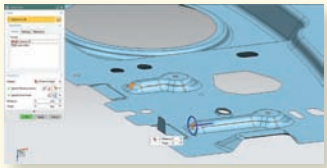
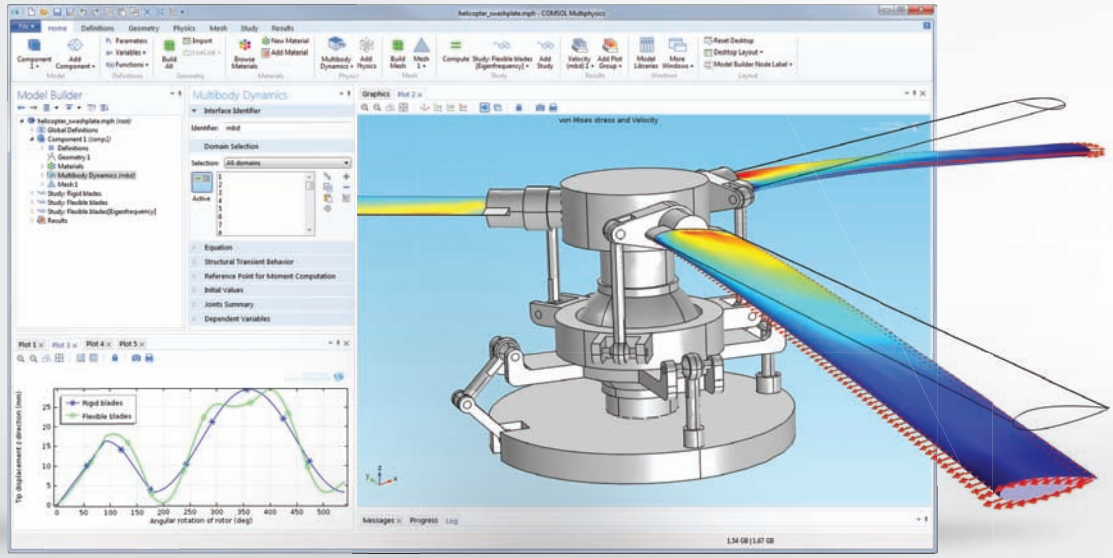




MULTIBODY DYNAMICS: A swashplate mechanism is used to control the orientation of helicopter rotor blades.



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BPA WORLDWIDE

The **Smart Money** Is on a Workstation Refresh

With the rapid-fire pace of technology change today, working on a three-year-old workstation is akin to driving a decade-plus clunker—it gets you to your destination, but likely with some major hiccups along the way.

A three-year old workstation might be capable of running the latest versions of CAD or CAE software, but it's hardly optimized to exploit the tools to their fullest capacity. In fact, an old workstation can be the bottleneck to modern, analysis-led engineering workflows. Older workstations are based on past-generation processor and bus technologies, which have since been updated with new instruction sets and micro architectures that streamline how data is handled. That means a three-year-old workstation based on a 3GHz processor is not the equivalent of a workstation built with a comparable 3GHz processor today.

High-performance workstations based on the latest Intel Xeon processor E5-2600 v2 product family can execute more instructions per second, allowing them to run CAE and CAD software faster. As a result, engineering teams outfitted with the latest workstation models are able to explore a greater number of design concepts up to three times faster and for less money. The ability to conduct more simulation studies means engineering teams can reduce the number of physical prototypes required while arriving at the optimal product design much more quickly.

Beyond the Need for Speed

There's more to a workstation upgrade than building the case for a high-octane processor, however. Configuring a next-generation workstation today is all about balance, blending the right mix of processor, graphics cards, memory, and storage to create the best experience for CAD and simulation workflows. Workstations that are three years old or later won't necessarily support the other modern-day components that work together to deliver productivity advances at less cost.

Consider this scenario: Buying one or two frequencies down from the premier CPU clock speed or opting for a less expensive graphics card can generate savings that can be redirected toward additional memory or SSD drives, which can have a greater overall impact on boosting productivity. For example, an investment in twice the memory capacity of the largest CAD model can deliver a performance increase of up to 2X on that model for less money than opting for a workstation based on the highest end CPU.

Trading off graphics horsepower for additional SSD storage can deliver similar performance benefits, again at less expense. Entry-level GPUs are sufficient for most CAD users' needs; in fact, informal testing by CATi, a SolidWorks reseller, found the performance difference between a $150 entry-level graphics card and $1,500 high-end model to be just 6% during the course of an average workday by a typical engineering user.

The Software Side of Performance

Also essential to a workstation refresh is running the latest versions of CAD or simulation software fully optimized to exploit the new hardware capabilities, from multiple cores to microarchitectures and faster bus technologies. Consider the example of SolidWorks Simulation 2014 running on an updated workstation with multiple cores. Based on testing by SolidWorks and Intel, multicore support delivered a 2X speed boost to FFEPlus operations. Moreover, because the Large Problem Direct Sparse Solver is much faster than the Direct Sparse Solver for problems with millions of degrees of freedoms (DOFs), solution time for a chassis simulation with 3,360,485 DOFs performed in minutes as opposed to hours.

Holding off an engineering workstation upgrade solely because of the expense of new hardware is short sighted and misguided in terms of total savings. The dollar value associated with the business advantages of effective simulation-based design workflows—specifically, greater exploration of more designs in much shorter timeframes—will universally outweigh any initial investment in new hardware.

To configure your ideal workstation, go to www.intel.com/content/www/us/en/workstations/workstation-configurator-tool.html.

Balance is the Key to the Optimal Workstation

It takes more than an ultra fast processor to ensure the best performance for an engineering workstation. Rather, the optimal approach is to create a balanced system based on these four components to ensure the best possible experience.

- **Processors:** Choose a processor that is almost as fast as is possible without opting for top-of-the-line performance.
- **Memory:** Spec the system with memory equal to or better than two times your largest CAD model.
- **Storage:** Opt for solid state drives (SSD) whenever possible to get high impact performance.
- **Graphics:** Invest what is needed for your applications and workload and do not defer to the top-of-the-line card if not required.

The Numbers Tell the Story

70% The percentage of product lifecycle costs associated with design, according to experts. A properly speced workstation enables simulation-based workflows, which allows for the investigation and testing of more ideas in less time to find the optimal design.

20% The number of best-in-class companies pursuing robust design strategies, including widespread use of simulation, that were better able to meet product launch dates and hit product revenue, cost, and quality targets. *Source: Aberdeen Group*

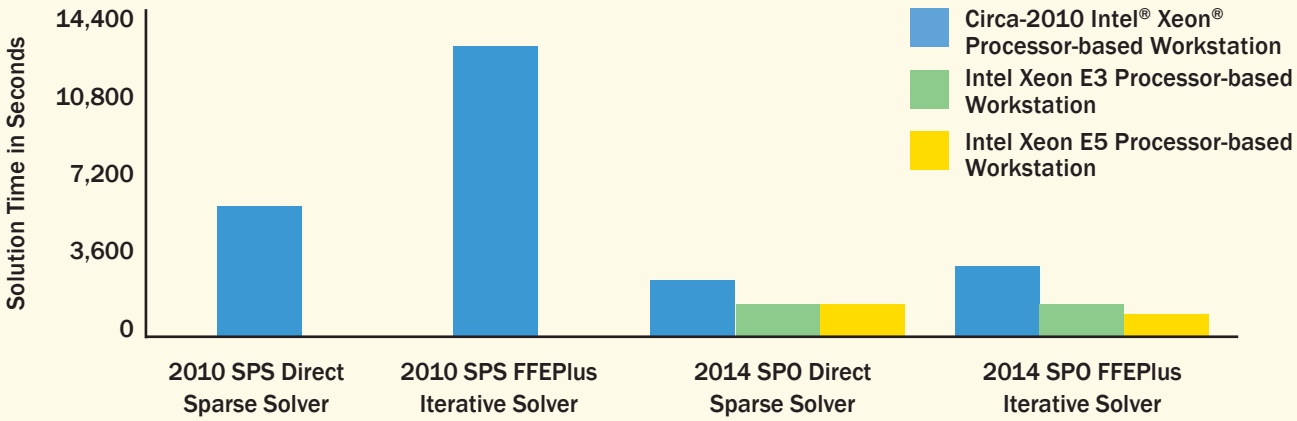
4 The number of weeks it typically takes for an engineering workstation upgrade to pay for itself via time savings.

4.71 The number of times the new Intel Xeon processor E5 completed multiple, concurrent electronic design automation (EDA) application workloads faster than a workstation based on the older Intel Xeon processor 5400 series.

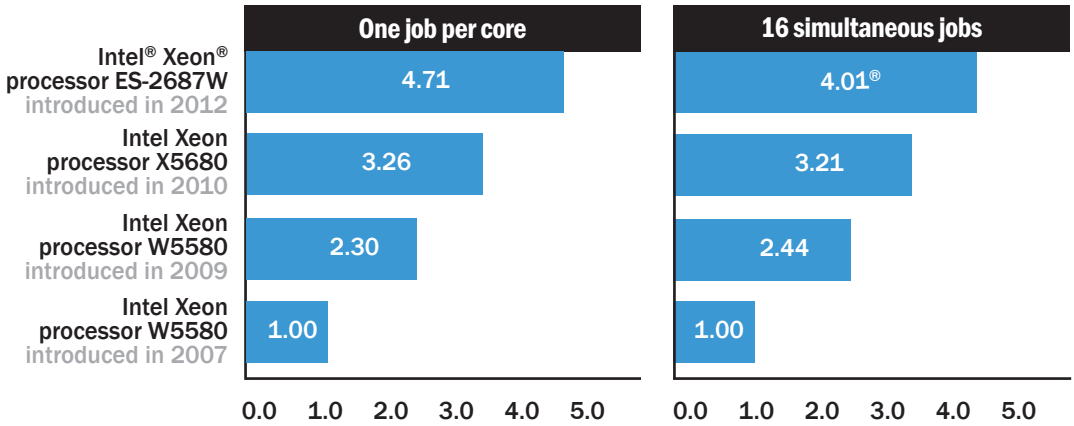
3.5X The performance running ANSYS Mechanical v14 for structural linear or nonlinear analysis when upgrading an entry-level Xeon E3-1280 v3 workstation to a state-of-the-art system based on a 2S Intel Xeon E5-2687W v2.

Benchmarking the New Simulation Desktop

In benchmark testing, SolidWorks Simulation 2014 ran nearly 80% faster in key simulations on workstations based on state-of-the-art Intel Xeon processors compared to models equipped with 2010 Intel Xeon technology.



Newer Xeon=4X+ Faster Performance



Relative performance of dual-socket workstations running multiple front-end and back-end electronic design automation applications. Based on Intel IT tests applying two different usage approaches, one job per core and 16 simultaneous jobs. Intel internal measurements, January 2012.

by Kenneth Wong

NVIDIA Launches GRID-powered Remote Desktop for Test

Is it feasible to run professional-grade software using a remote, or virtual, desktop? It's a scenario that many have proposed as the way of the future, driven in part by the software consumers' comfort with Software-as-a-Service (SaaS) and in part by the potential cost reduction in eliminating physical hardware. In May, NVIDIA launched GRID, an online service that lets you test it yourself at NVIDIA.com/object/trygrid.html.

To run the test drive, you need to register and download a thin client (a 10MB launch file). After that, you can log in to get 24-hour access to a remote desktop, hosted in a GPU-accelerated GRID server. The sample desktop is preloaded with AutoCAD, SolidWorks eDrawings, Siemens Teamcenter, Google Earth and PowerPoint, among other programs and a few multimedia files.

NVIDIA offers the GRID test drive to let you experience a GPU-accelerated remote desktop.

Putting GRID to the Test

I ran the test using a home user's ordinary DSL connection. Interactive programs — like eDrawings, AutoCAD, Siemens Teamcenter and Google Earth — ran as they normally would on a local machine. With large models, zooming, panning and rotating could cause stutters on underpowered machines. In the GRID-powered virtual desktop, all worked seamlessly.

In multimedia content playback, the HD movie sample provided by NVIDIA and a clip featuring Dawn, the company's brand icon, did exhibit some noticeable choppiness and low frame rates, however.

In previous virtualization exercises, companies managed to successfully duplicate the operations of the CPU in the cloud. Virtualizing the GPU remained a stumbling block, until NVIDIA's Kepler architecture made it possible. That means programs that rely heavily on the graphics processor to let you interact with pixel-dense visuals and 3D models (typical of CAD programs with photorealistic display options) can now be virtualized and hosted in the cloud without a compromise in graphics performance.

As demonstrated in NVIDIA's test, the virtual or remote desktop experience now includes GPU acceleration.

Desktop as a Service

Some vendors, such as VMWare, an NDIVIA partner and a leader in virtualization, are laying the groundwork to deliver Desktop-as-a-Service (DaaS) — remote machines you can use when needed and pay for access per duration. VMWare's product, Horizon DaaS, lets you rent and use remote Windows desktops hosted in the cloud, just as you would with any other SaaS products.

Whereas SaaS gives you on-demand software, DaaS gives you access to the equivalent of a personal workstation's processing power, hosted in the cloud.

The emergence of the cloud-hosted computing trend opens up new options previously unavailable to small and midsize businesses that need access to powerful workstation-grade desktops to run engineering software, but don't have the budget to acquire and maintain them perpetually. For a video report, visit deskeng.com/virtual_desktop/?p=8779.

— K. Wong

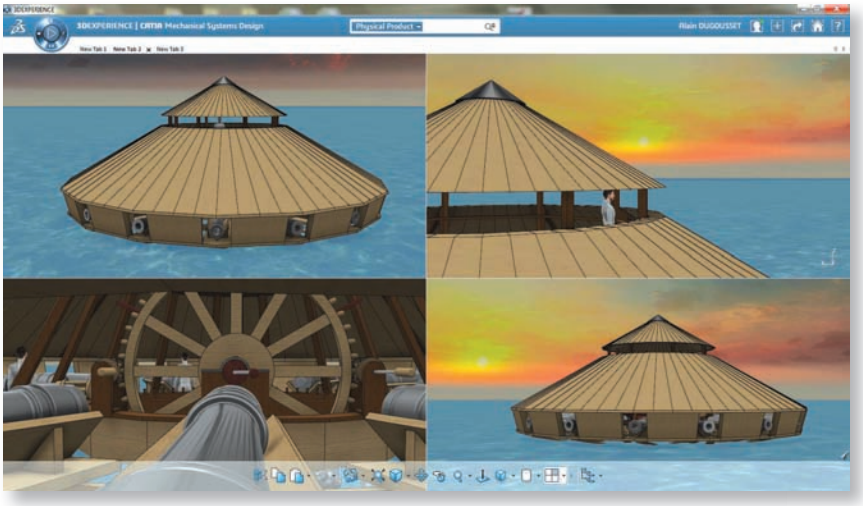
by Kenneth Wong

The Da Vinci Codex, Decoded in 3D

Leonardo Da Vinci, remembered for his artistic masterpiece "Mona Lisa," also left behind quite a lot of engineering drawings that were never realized or tested. They're preserved in his sketchbook, known as "The Codex Arundel" (now digitized and archived online at the British Library's site).

Many of his ideas — like his mechanical wings, flying ships and war engines — would have required hundreds of carpenters and craftsmen to properly prototype and test. Suppose he could travel in time and gain access to the type of 3D CAD programs designers and engineers use today for concept exploration. What might he have done with it? How would his ideas look as digital prototypes?

Alain Dugousset, Thibault Waltzer and Antonio Perez have a pretty good idea. As participants and the Top 3 winners of the Da Vinci 3D 2014 contest (January-April 2014, sponsored by HP and AMD, organized by Dassault Systèmes), they each chose a codex — a concept sketch of Da Vinci — and reproduced it in great detail in 3D. They went so far as to test the assemblies and mechanism in physically accurate simulations to see whether their versions would operate without clashes and collisions.



To create a battleship based on Leonardo Da Vinci's sketches, Alain Dugousset combined sectional views of a ship and a tank in 3D. ***Image courtesy of Alain Dugousset.***

The Master's Missing Pieces

Dugousset has spent time both in Paris and Firenze, where Da Vinci's artworks was part of the cultural landscape.

"As a mechanical engineer, Da Vinci is a kind of master for me," he says. "Moreover, his capability to associate art and science is really amazing."

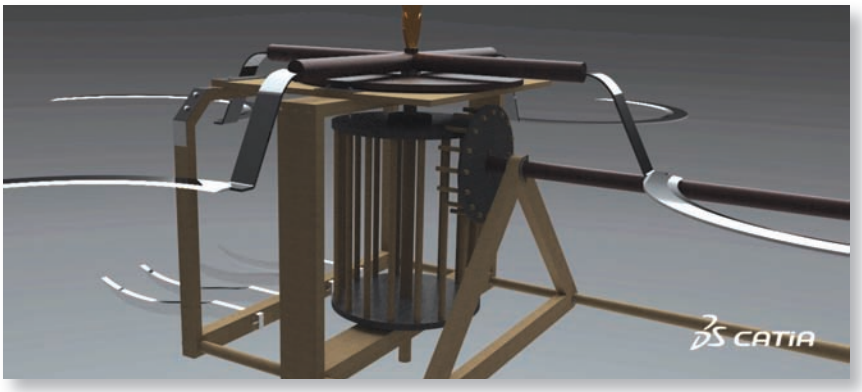
Dugousset knew most people have seen, and many have also attempted to recreate, famous pieces like the flying machine, the tank and the automated car. So he went in search of a lesser-known concept.

"Looking at the Piazza della Scala documents provided for the contest, I found a top view of a kind of military ship — I call it the Leonardo Battleship," he says, noting that while it has two other sectional views, "the third dimension of this machine seems to be missing."

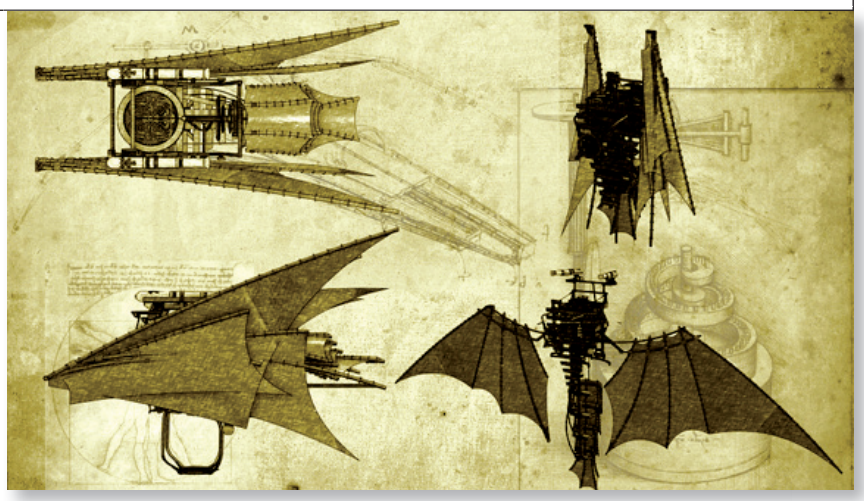
To solve this problem, Dugousset had to take some artistic liberties.

"I decided to merge these drawings with the one for a tank to create the third dimension," he recalls. In doing so, he faced a new issue: "Driving a tank is something simple, but what about a cylindrical ship?" Without any helm visible in the original drawings, he was left to press his imagination into service.

"My first idea was to work on the two main gears inside the ship, which can be seen on the most detailed drawing," he says. "It seems there's a starting wheel only on one side, but it seems to me it's impossible to have the ship maneuvered by two separate gears with two different speeds. In fact, if those two gears are not linked together, during the starting operation, the ship will not go forward … That why I have developed another mechanism to maneuver the ship, using other information visible on Da Vinci's drawings."



Antonio Perez's scythe-equipped war machine, based on Da Vinci's sketches. ***Image courtesy of Antonio Perez.***



Thibault Waltzer created the plane-pack, inspired by Da Vinci's sketch of a mechanical wing and flying apparatus. ***Image courtesy of Thibault Waltzer.***

Dugousset used Dassault's 3DEXPERIENCE platform (CATIA is part of it) to create his digital mockup of the Leonardo Battleship. The virtual environment — the 3D landscape that makes up the backdrop in his presentation video — was sculpted in 3DVIA Studio. For comparison and perspective, he went ahead and included another ship, a virtual model of the BB-62 New Jersey.

Designing for New Heights

Waltzer, on the other hand, chose Da Vinci's flying machine because of its fame and because "it's a nice challenge to revisit. I wanted to design something totally different from Da Vinci's models, but also pay tribute to Da Vinci with a complex mechanical model. As I like the wing-suit, I created a Da Vinci's-style plane pack."

Waltzer used Dassault's CATIA to design the shape and kinematics of the system. Because he wanted to adhere to the mechanical practices available during the Renaissance for authenticity, he notes, "The biggest challenge was to create a complex, functional mechanism while respecting the technology and the materials of Da Vinci's time."

Questions of Scale

The third winner, Perez, says he was impressed with the concept of Da Vinci's scythe chariot and its transmission design: "It's a war machine used for ground combat. It combines the concept of a conventional war chariot and the scythe blades that are very effective in rotational motion."

Perez used Dassault's CATIA to model, simulate and render his design. Unlike in a contemporary engineering project, Da Vinci's blueprint for the idea didn't come with dimensions or measurements. So, Perez points out, "I had to guess the dimensions of every part, which took several iterations be accurate."

The size and scale of the battleship is too ambitious for Dugousset to translate into a physical prototype, so today he has to be satisfied with a 3D-printed scale model.

Waltzer may have to do some additional work before he can 3D-print his winged plane pack. "The complexity and the size of my different parts aren't compatible with the 3D-printing technology," he said. "So I think the biggest challenge to print my model is the different conductivities and the strength of materials."

Perez, too, is looking into 3D-printing his model in a smaller scale. A full-scale version, he suspects, would be difficult to assemble, as "there are around 60 parts that need to be glued, bolted, or fastened."

For archived images and videos from the contest, visit 3Dvia.com/madein3d/davinci.

— K. Wong

Rescale Adds Siemens PLM Software as a Partner

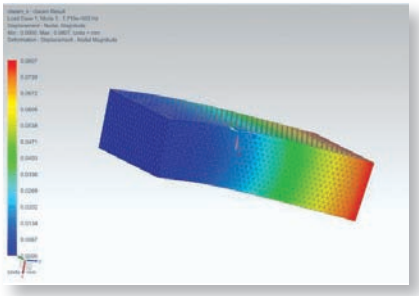
San Francisco-based Rescale, which specializes in providing on-demand computing platform (a mix of middleware and hardware), has just added one more name to its growing list of partners. The new addition, Siemens PLM Software, rounds out a partner list that already includes household names in simulation, like ANSYS, MSC Software, CD-adapco and Dassault Systèmes.

"Because Rescale hosts such a wide range of simulation software, it's not uncommon for one company or customer to run many different solvers — even competing ones," says Ilea Graedel, Rescale's business development manager. "Many of our customers have several departments using Rescale, including aerodynamics, structural, thermal, acoustics, etc. Each team may use different simulation software depending on the application, so having them accessible in one location really cuts down on the time and energy required to burst capacity into the cloud."

Rescale belongs to the emerging Platform-as-a-Service (PaaS) or Infrastructure-as-a-Service (IaaS) vendor community. The company targets specifically those who rely heavily on simulation and digital prototyping to develop, test and verify their products. With its partnership with Siemens, Rescale now lets you run Siemens' flagship simulation product NX Nastran on Rescale's remote computing resources.

If additional NX Nastran licenses are needed (to speed up the job by distributing it on more cores), Rescale can negotiate and deliver them. Rescale's own cluster management and job management software gives users the ability to save a simulation loop like a template, preserved for reuse by others.

— *K. Wong*



Running a stress analysis on a rectangular beam using NX Nastran on Rescale's on-demand hardware platform, part of a tutorial that highlights the Rescale-Siemens partnership. *Image courtesy of Rescale and Siemens PLM Software.*

A New Geometric Kernel from Russia

Russian software firm Ascon Group is turning its eyes toward the North American market. It predicts its geometry kernel C3D — developed to power CAD, CAM and CAE products — will be the entry ticket. At COFES 2014 in Scottsdale, AZ, in April, Oleg Zykov, product director for C3D, came to test the waters with a tech briefing.

"C3D is a parametric constraint manager, mesh generator, converter, modeler and solver," he explains. "It solves in both 2D and 3D. It's just as good as Parasolid, ACIS or other kernels. We're a leader in the Russian market."

The kernel can be used to develop CAD programs to run in Windows, Linux and Mac OS. It's the core of Ascon Group's CAD product, KOMPAS-3D. It's also embedded in other products like LEDAS Geometry Comparison, for identifying the geometric differences in 3D models; ESPRIT Extra CAD, the CAD-modeling module for ESPRIT CAM software; and BAZIS, a furniture-design CAD program.

C3D Labs, the division that manages the kernel, currently has 10 customers (companies that have built products based on C3D technology), supported by a staff of 15. "As we expand, we will add more people," notes Zykov.

Because most major U.S. CAD vendors have been operating for some time, they have all chosen specific kernels as their partners. How would C3D break into that tight-knit group, governed by existing relationships? Zykov says there's an untapped market among those who have been using open source kernels (like Open CASCADE) because they find commercial kernels unaffordable, or startups that may want to build something from scratch. He described C3D has the advantage of "royalty-free licensing, flexible licensing, and low-cost, special rates for startups."

— *K. Wong*

Google Designs Self-Driving Vehicle Prototype

Google has released the first prototypes for its self-driving car project, an initiative to improve car safety and efficiency. The company says it is confident that its technology can help decrease the number of lives lost each year in traffic accidents.

The prototype and car design is simplistic, allowing for two passengers to fit comfortably in the vehicle. It includes room for some personal belongings, start and stop buttons and a screen that displays the route. There's no need for steering wheel or acceleration and brake pedals. To maintain safety, Google has capped the vehicle's speeds at 25 miles per hour.

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Students Revolutionize SCUBA Technology

Two freshmen from NYU's Polytechnic School of Engineering have won funding to advance their research on how to harness solid forms of oxygen and nitrogen. The students, Patrick Nave and Patrick Gumusoglu, hope to use this technology to create a replacement for the compressed-gas tanks typically used by sport SCUBA divers.

Presently named "Solid Air," this technology could also be used by firefighters and supplemental oxygen users nationwide.

"Standard chemical reactions are involved, and our system would be a great deal lighter, smaller and cheaper than those used now," Gumusoglu says,

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BlackBerry's Project Ion for Internet of Things

BlackBerry has launched a series of initiatives, titled Project Ion, to connect businesses, people, devices and machines. The project is part of BlackBerry's plan to offer end-to-end solutions for the Internet of Things (IoT).

Project Ion will center around developing a host of IoT resources, including:

- A secure public application platform powered by QNX technology that supports a new generation of IoT applications that access large amounts of data from multiple sources.
- Facilitation of an IoT ecosystem containing partners, carriers and application developers wanting to collaborate.
- Strategic partnerships, such as the Industrial Internet Consortium, a non-profit organization that looks to drive standards-based technology for industry, academia and government.

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SoftBank To Start Selling Personal Robots

Japan's SoftBank Corp says it will start shipping human-like robots named Pepper for personal use by February of 2015. The prototypes were recently deployed. They were developed in collaboration with the French company Aldebaran.

Pepper, according to SoftBank's CEO Masayoshi Son, will be capable of learning and expressing emotions and serve as babysitters, nurses, emergency medical workers or friends. "People describe others as being robots because they have no emotions, no heart. For the first time in human history, we're giving a robot a heart, emotions," Son said.

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Control VR Makes Virtual Reality More Hands On

While technologies like Google Glass and Facebook's Oculus Rift are bringing the populace into augmented and virtual realities, one thing is missing — the user's arms and hands. One California-based company called Control VR is working to ensure that when someone goes into virtual reality, it's as realistic as possible.

The device the company is creating is a glove-like system that fits over one's arms and shoulders to sense bodily movements before translating them into virtual reality.

The system includes a set of sensors — originally designed for military use — that has three accelerometers, gyroscopes and magnetometers. This technology produces a position signal, which is then fed back to a processor and calculated. the company's technology creates a major distinction between Control VR and other virtual reality devices because it doesn't require the use of an external camera to map the user's location.

The company recently completed a successful Kickstarter campaign.

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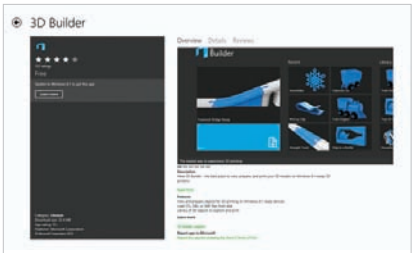
Plug-And-Play 3D Printing from Microsoft Windows

If Microsoft could have its way, printing objects with 3D printers from Windows PCs would be as simple as printing from a common 2D inkjet printer. The company wants people to think of 3D printing not as a complicated process accessible only to the experts. It wants 3D printers to become plug-and-play devices.



But there are some barriers to widespread adoption, namely in preparing a model before it can be 3D printed. That's where Microsoft sees an opportunity to play a role. Accordingly, the company struck a partnership with Netfab to launch a cloud-hosted model-repair service. Simply dubbed Model Repair Service, the Microsoft-Netfab portal lets you upload your model, automatically analyze and fix the geometry to make it print-ready, then return the repaired model.

In Windows 8.1, Microsoft's free 3D Builder app is expected to further promote the idea of plug-and-play 3D printing. It offers direct links to downloadable 3D models, ready for print.

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3D Printing is a $3 Billion Industry and Growing

Regardless of the ups and downs additive manufacturing (AM) might experience on the stock market, the industry as a whole is extremely healthy. As more businesses find ways to benefit from the flexibility offered by 3D printing, demand continues to increase.

Wohlers Associates backs up the idea of a vibrant 3D printing market in its latest report. The *Wohlers Report 2014* claims the market for 3D printing, consisting of all products and services worldwide grew to $3.07 billion last year. This represents an annual growth rate (CAGR) of 34.9%, which is the highest in 17 years.

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Autodesk to Enter the 3D Printing Market

Autodesk is preparing to make the jump from software provider to hardware provider with the upcoming release of its own AM system as part of its new 3D printing platform named Spark. The new open software aims to make the AM process easier than ever, including integrating new materials into the process.

Autodesk, which is providing its Spark APIs and an SDK to the public, opted for the open source route because it says that is the best way to spark innovation in a market that has huge potential, but is still evolving.

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SuperDraco Thruster

When SpaceX's Dragon orbital spacecraft takes its first crewed flights (possibly next year), it will be equipped with a new rocket engine that includes an 3D printed combustion chamber made of Inconel created by an EOS direct metal laser sintering (DMLS) machine.

The new engine has roughly 200 times the power of its predecessor, and will provide attitude control for the Dragon capsule in orbit and during re-entry. It can also carry the capsule to safety during a launch accident. It can also help bring the Dragon capsule back to spaceport under its own power and provides precision landing capabilities. Each engine produces 16,000 lbs. of thrust, and can be restarted multiple times.

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Lockheed Martin Pushes the Boundaries of AM

Lockheed Martin is using additive manufacturing as part of design project to make more efficient use of space while increasing a satellite's payload. Because the process would require testing many assembly configurations and producing several simulations to validate the various design changes, the Lockheed team was interested in alternative approaches to traditional manufacturing methods — particularly around the design and function of the satellite's giant fuel tanks.

The tanks — one measuring 6.75 x 3.8 x 3.8 ft. and the second at 3.8 x 3.8 x 3.8 ft. — would take over six months to produce to the tune of around $250,000 with traditional machining and CNC (computer numerically controlled) methods. That was not a realistic timetable given the deadlines Lockheed was facing and because of the high costs.

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RAPID 2014 Comes of Age

While introducing a keynote speaker at RAPID 2014 last month, SME President Michael F. Molnar joked that, after 21 years, the rapid prototyping and manufacturing event could finally buy a drink. It was an appropriate analogy as one of the event's biggest segments, 3D printing, has matured to the point of being accepted by many of the companies that attended The Big M, a manufacturing conference co-located with RAPID 2014 for the first time this year in Detroit.

In fact, the RAPID side of the exhibition hall was more crowded than The Big M side, as attendees crowded booths filled with 3D printers, 3D scanners, metrology equipment, computer-aided manufacturing machines and materials.

"The caliber of company names on the badges of people visiting our booth has been really impressive this year," said David Burns, president and chief operating officer of ExOne. He said big industry is now showing a keen interest in additive manufacturing.

Manufacturing Muscle

The Big M co-location and the Detroit venue may have contributed to the spirit of the event. Many of the presentations and announcements at RAPID 2014 focused on the role advanced manufacturing has to play in boosting the profile of manufacturing in America.

For example, during the opening keynote, U.S. Secretary of Commerce Penny Pritzker announced the M.Lab21 initiative between SME and 3D Systems to enhance high school industrial arts and vocational education classes. The program will offer starter kits intended to transform shop classes and incorporate additive manufacturing into curriculums.

"We need the public and private sectors to work together now more than ever to focus our investments on areas with the highest potential for growth," said Secretary Pritzker. "Our objective (at the White House Office of Manufacturing Policy) is to break down the silos across the government and encourage meaningful public-private partnerships at every level to move American manufacturing forward."

Talking Trends

Terry Wohlers' data seemed to support the hypothesis that industry has latched onto 3D printing. Wohlers is principal consultant and president of Wohlers Associates, which produces an annual report on the state of the additive manufacturing industry.

He opened the final day of the conference by pointing out trends he over the past year. According to the *2014 Wohlers Report*, sales of 3D printers capable of producing metal parts increased almost 76% vs. 2012. That growth is primarily coming from the medical, dental and aerospace industries.

In the past, materials were often blamed for the seemingly slow uptake of 3D printing by industry, but many RAPID 2014 exhibitors had solutions on display:

- Stratasys officially launched three new flexible 72-color palettes, composed of its rubber-like (TangoPlus) material and combinations of rigid opaque (VeroCyan, VeroMagenta and VeroYellow) materials, as well as three flexible 68-color palettes, built with rubber-like (TangoBlackPlus) and combinations of the same rigid opaque (Vero) colors. The new palettes are extensions to its range of flexible and rigid material options for the Objet500 Connex3 Color Multi-material 3D Printer.
- ExOne had its new Inconel alloy 625 on hand in its booth. The nickel-based alloy is the first single metal alloy for 3D printing industrial applications to achieve more than 99% density using its binder jetting technology, according to the company. The ExOne Material Applications Laboratory qualified the material for ExOne's M-Flex and X1-Lab 3D printers.
- Mcor, known for using paper as the raw material for its 3D printers, announced FLEX, a finishing option for users of the company's IRIS and Matrix 3D printers that allows them to produce pliable models that are water resistant.
- Fenner Drives' new NinjaFlex materials received rave reviews from open-source, fused-deposition-based 3D printer manufacturers on the show floor. The thermoplastic elastomer has high elasticity, giving users another option for flexible prints.
- Autodesk is also looking to material innovation as part of its entry into the 3D printing market (see announcement on previous page). As part of its open source initiative, the company says it will share some of its research so others can create materials that will work on its 3D printers.

RAPID 2014 keynoter Jason Lopes from special effects studio Legacy Effects explained how he used Stratasys Objet Connex multi-material 3D printing to create the new RoboCop suit.

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INFO → 3D Systems: 3Dsystems.com

→ **Autodesk:** Autodesk.com

→ **ExOne:** ExOne.com

→ **Fenner Drives:** fennerdrives.com

→ **Mcor Technologies:** mcortechnologies.com

→ **Wohlers Associates:** wohlersassociates.com

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Virtual Reality: A Powerful Engineering Tool

Not just for gamers, 3D immersion offers new perspectives for design success.

BY PAMELA J. WATERMAN

IC.IDO's Virtual Reality (VR) technology enables customers to present, manipulate and exchange product information virtually. *Image courtesy of ESI Group.*

Add a little bit of *Iron Man*, a little *Star Trek* and a lot of *Matrix*, and the combination will give you some idea of working in a perfect virtual reality (VR) environment. Though we're not quite there, hardware and software developers have worked the details for decades and gotten us surprisingly close (fortunately minus the red and blue pills). Imagine a world that isn't physical — yet you can walk through it, observe the walls or scenery go by, reach out and touch a button, chair or wall, and see everything react in real time. Immersive VR spaces are here today, created through a combination of high-definition projectors, head-mounted displays, polarized glasses, wireless tracking technology, computer graphics and more, all coordinated to work in unison and present realistic, user-interactive experiences.

Across the board, it's clear that the people involved in VR systems are passionate about the technology and building on achievements in gaming, entertainment and simulator training. Automotive, architectural and healthcare programs use immersion tools to uncover problems and verify solutions. The benefits are thoroughly tangible: for example, in 2013 Ford Motor Co. used its Immersion Laboratory to verify more than 135,000 details on 193 virtual vehicle prototypes prior to building prototypes; that's in one year alone.

Although describing 3D virtual environments on a flat piece of paper seems incongruent, here are some personal perspectives (and 2D images) that might convince you of VR's possibilities.

Creating Virtual Reality

Starting in the 1960s, the technology behind flight simulators, displays, video games, computer input devices (the mouse, tracking gloves and cameras) and Hollywood effects cross-pollinated to support the emergence of VR environments. More recently, developments in high-performance computing (HPC) added the processing power that makes real-time responses possible.

Jason Jerald, founder and president of NextGen Interactions, has the big picture on VR immersion technology, having worked in computer graphics and 3D interfaces for more than 20 years.

"Virtual reality is getting a lot of press

The Sensics XSight panoramic HMD for single-viewer virtual-reality immersion with 1920x1200 pixels per eye, tiled OLEDs and 123° field of view. *Image courtesy of Sensics.*

and the media has really latched onto it, but it's been around a long time," he says. "It's primarily been for visualization purposes — such as for design reviews, to make sure things look right or are in reach."

But Jerald admits that for engineering applications, such as putting together components to make sure they fit, "we have a ways to go."

Currently, VR configurations, whether for gamers or engineers, take two basic approaches, each with its own appeal. On one side are permanent or portable computer-assisted virtual environment (CAVE) systems, where one or more users, immersed in a 180° or 360° display, wear polarized glasses and stand, sit or walk within a partially or fully enclosed space. Tracking technology on the lead person governs the changing views and interactions.

On the other side are head-mounted display (HMD) systems worn by a single individual, who sees perhaps an 80° 3D view delivered as separate near-to-the-eye images. Again, the user interacts with the scene by wearing infrared or electromagnetic devices that work with a tracking system to capture head and hand motions.

Top-of-the-Line Immersion Experiences

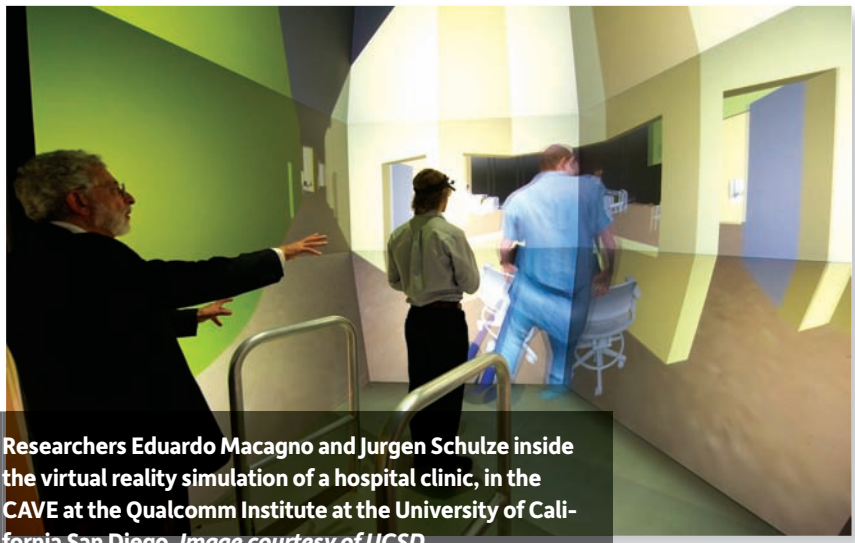
Tom DeFanti is the director of visualization at the Qualcomm Institute (QI), a facility that houses several generations of CAVEs at the University of California San Diego (UCSD). His name appears in just about any description of these systems, which is no surprise since he created the first such VR environments in the early 1990s while founding the Electronic Visualization Lab (EVL) at the University of Illinois-Chicago. Officially, the name CAVE is a trademark of the University of Illinois, but its variations are used everywhere.

A CAVE's visuals are rear-projected onto multiple large screens or displayed on groups of LCD panels. When the configuration includes three or more walls, floor and/or ceiling, even a small space offers the illusion of much greater volume. UCSD's StarCAVE is pentagon-shaped, with upper screens that tilt inward; 34 projectors combine to create the stereo visuals.

In listing what comprises a useful and affordable do-it-yourself VR system, DeFanti says, "It should involve a tracked real-time 3D stereo image with a screen large enough that you feel immersed and not see the edges as a dominant part of the image." One can do this with single units or arrays of HDTVs and UHDTVs you can buy at an electronics retailer, he adds, noting that while good head/hand tracking can run about $10,000, "cheaper means are coming along. Kinect systems and their clones are becoming useful

Qualcomm Institute (QI) Director of Visualization Tom DeFanti, one of the pioneers of CAVE VR environments, immersed in a simulation of the QI building at the University of California San Diego. *Image courtesy of UCSD.*

Nine degree-of-freedom VI-DriveSim immersive virtual-reality vehicle test platform. It is based on MSC Adams multibody dynamics simulation software from MSC Software. *Image courtesy of VI-grade.*



Researchers Eduardo Macagno and Jurgen Schulze inside the virtual reality simulation of a hospital clinic, in the CAVE at the Qualcomm Institute at the University of California San Diego. *Image courtesy of UCSD.*

for controls, but not so much for head-tracking." (*Editor's Note: See calit2.net/newsroom/article.php?id=2273 for a view of the newest UCSD CAVE incarnation called WAVE, comprising 35 LCD panels lining a horizontal semi-cylinder.*)

One of the primary users of the UCSD StarCAVE for design evaluation purposes has been Eve Edelstein, a research professor recently appointed to the University of Arizona. Edelstein brings a diverse background in architecture, anthropology and neuroscience to programs that observe how humans respond to their environment, whether natural or man-made.

In one of Edelstein's projects, the StarCAVE was set up to visualize part of a hospital under construction, specifically a nurse's station with views to two patient rooms: "We brought in actual sound recordings of ambient noises plus a doctor reciting a medical order." She says that participants in the VR scenario could not distinguish the spoken words, proving the need to change the layout and even to use building materials with different acoustical properties (which were then simulated and approved).

3D Modeling VR

Another VR-related development that could help the engineering world is Sixense's new 3D modeling system MakeVR. You have to see a demo to understand how this approach to mechanical design, based on virtual manipulation, is so different from standard CAD packages. Building on the company's electromagnetic STEM VR control system, MakeVR lets you pull, grab, twist, spin, cut, splice, resize and duplicate geometric and freeform objects — all to create 3D parts without any knowledge of traditional CAD. Think of it as virtual modeling compound at your fingertips. Check out YouTube.com/watch?v=FXMnnTwtER4.

— *PJW*

High-fidelity VR systems already exist in such corporations as Caterpillar, General Motors and Ford Motor Co. At Ford, a CAVE Immersion Laboratory contains several VR setups with different goals. Elizabeth Baron, a VR and Advanced Visualization specialist, says the goal of their lab is to give designers and engineers a cross-disciplinary approach to what customers would see if they sat in the vehicle.

"Instead of doing engineering by PowerPoint or spreadsheets, we're all looking at the same thing," Baron adds. "It's a great tool to get designers, engineers and ergonomics people to understand the same thing at the same time."

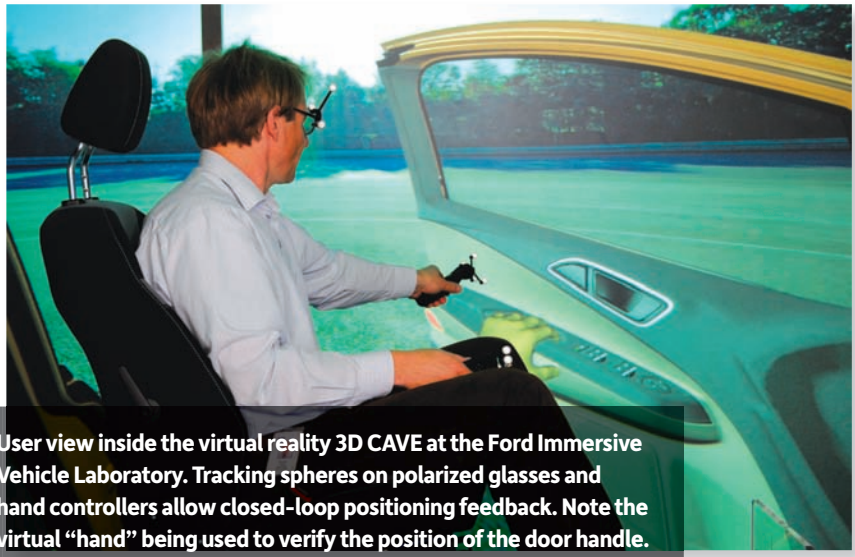
Begun in 2006, Ford's Dearborn, MI, Immersion Lab now contains three types of VR experiences: the CAVE that helps the team perform studies on driver visibility and ergonomics; a Virtual Space "powerwall" recently upgraded to a 4K (4096x2160 resolution) display for 3D model review; and a Programmable Vehicle Model viewed using HMD equipment. The company has just opened a second such lab in Australia, and has satellite viewing centers in five other countries, supporting international design collaboration.

Ford Immersive Vehicle Laboratory, with Elizabeth Baron, Virtual Reality and Advanced Visualization technical specialist. ***Image courtesy of Ford Motor Co.***

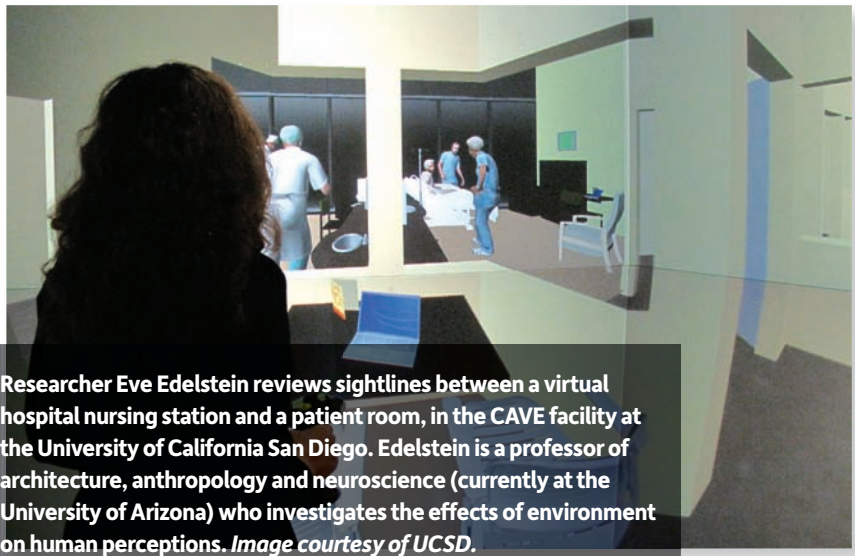
Head-mount VR Systems

The second VR interaction mode is through HMD technology. Far less expensive than CAVE systems, HMDs combine stereo, near-to-eye displays with

Virtual reality headset in use at the Ford Immersive Vehicle Laboratory. *Image courtesy of Ford Motor Co.*



User view inside the virtual reality 3D CAVE at the Ford Immersive Vehicle Laboratory. Tracking spheres on polarized glasses and hand controllers allow closed-loop positioning feedback. Note the virtual "hand" being used to verify the position of the door handle. *Image courtesy of Ford Motor Co.*



Researcher Eve Edelstein reviews sightlines between a virtual hospital nursing station and a patient room, in the CAVE facility at the University of California San Diego. Edelstein is a professor of architecture, anthropology and neuroscience (currently at the University of Arizona) who investigates the effects of environment on human perceptions. *Image courtesy of UCSD.*

real-time tracking systems. Important factors include resolution, color depth, field of view and brightness. The closed-loop visual and audio functions immerse wearers in their own highly interactive spaces: moving the physical controllers in one's hands triggers a corresponding action in the virtual world. However, it's a single-user system, meaning no one else in the room sees any part of the VR view.

Ford's Immersion Lab uses HMDs in its Programmable Vehicle Models (PVM). These comprise a physical seat and steering wheel mock-up set to the dimensions of a given design. IR tracking spheres on the HMD and gloves let users touch and feel the wheel, shift, seat and other interior elements for ergonomic evaluation.

Until recently, the PVM field of view (FOV) was 50° to 80°. Since October, Ford has been evaluating one of the hottest items in the VR world, the 105° FOV Oculus Rift, an HMD unit plus developer kit first offered on Kickstarter. The company was recently acquired by Facebook, unleashing hundreds of online speculations about adding VR to social media interactions. But for the engineering world, a favorable point is its operation with PCs.

Sony's Project Morpheus HMD (in development for PlayStation use) may also be a contender. It has a polished visor-style look and feel compared to the current ski-goggle appearance of Oculus Rift. It's also slimmer, since much of the processing is done in a separate box that sits between the headset and the PS4. The PS4 operation makes it unavailable for engineering VR applications, but perhaps demand will drive expansion to a more open source.

Two high-end, highly experienced HMD manufacturers are NVIS and Sensics. NIVS is a 30-year-old company whose clients include Honda, BMW, Boeing, MIT and Walt Disney. Its HMDs support such advanced options as eye-tracking (knowing where you are looking) and motion-tracking (with three or six degree-of-freedom configurations). Sensics, a panoramic HMD company, has a broad range of products that offer ultra-wide FOV and high resolution based on flat-panel, OLED or tiled OLED displays.

Bringing in the Experts

A number of commercial companies can help you create a VR visualization solution. ESI Group markets the IC.IDO solution specifically for the engineering market.

"For a VR system, there are three components: first, the hardware, from projectors to computers to tracking systems; second, the software (that we make) that tells all the hardware what to do so everything is correctly scaled and behaving in unison; and third, the operators who build up the scenarios to study different engineering problems," says Ryan Bruce, ESI Group's business development manager.

IC.IDO software scales from use on desktop PCs to CAVE immersion systems. It can handle massive data sets and collaborate among multiple locations, but a major strength is that it is based on a real-time physics engine to respond to your actions. For example, Bruce offers, "If I'm (virtually) trying to replace an alternator, I can pull the bolts out, grab and pull it. If there's an electrical cable connected to it, the (virtual) cable will show you're stretching it too much."

Other companies offer both specialized and broad options to create various VR systems. Mechdyne, an international consulting firm in the visual information business, licensed the original CAVE technology and name from DeFanti's EVL facility. It built upon that to develop flat, curved, CAVE and portable immersion systems with multiple interaction options. Virtalis is another VR system developer; its ActiveCUBE, ActiveWALL, ActiveMOVE and ActiveSPACE variously include options for portability, full immersion, HMD use and remote participation.

Always Room for Improvement

NextGen Interactions' Jerald says HMD systems are getting better at dealing with "simulator sickness"; CAVEs tend to have fewer problems with this since latency is less of an issue. Another challenge is using curved, seamless display walls. These improve realism — in fact, people tend to walk into them — but the images are harder to align.

There's no question about the demand for such technology to enhance today's design and visualization tools, and developments in MEMS sensors and computational algorithms will continue to expand VR capabilities. As QI's DeFanti concludes, "Design engineers would love to see their designs from every angle, in super detail, and in stereo 3D from their precise perspective. It just makes a simulation so much better." DE

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

RESOURCES:

- **IEEE Conference on Virtual Reality:** IEEEvr.org/2014
- **ESI Group: Interactive Virtual Reality Seminars:** ESI-Group.com/company/events
- **Michael Abrash, Oculus Chief Scientist, speech: "*What VR Could, Should, and Almost Certainly Will be within Two Years.*" Steam Dev Days 2014:** YouTube.com/watch?v=G-2dQoeqVVo

INFO ➜ **ESI Group:** ESI-Group.com

➜ **Ford Motor Co.:** Corporate.Ford.com

➜ **Mechdyne:** Mechdyne.com

➜ **NextGen Interactions:** NextGenInteractions.com

➜ **NVIS:** NVISInc.com

➜ **Oculus:** OculusVR.com

➜ **Sensics:** Sensics.com

➜ **Sixense:** Sixense.com

➜ **Sony:** Sony.com

➜ **University of Arizona:** RC.Arizona.edu

➜ **University of California San Diego:** CALIT2.net

➜ **University of Illinois Chicago:** EVL.UIC.edu

➜ **VI-grade:** VI-grade.com

➜ **Virtalis:** Virtalis.com

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

VI-DriveSim Combines Physical Simulators & VR

Vehicle dynamics experts from MSC Software have formed a spin-off company called VI-grade. One of their products brings the automotive test track into the office via VI-DriveSim, an immersive driver-in-the-loop package built around Adams software.

The static version gives the seated user a force-feedback steering system, plus real-time imagery of proving grounds or racetracks. An optional Driver in Motion platform mounts the entire hexapod system on a tripod that itself slides on a horizontal baseplate. This dynamic combination provides a full nine degrees-of-freedom dynamic movement, including a realistic yaw effect, for a full sensory immersion experience.

— PJW

Close-ups of mounting system hardware for VI-grade's VI-DriveSim nine-degree-of-freedom vehicle-handling simulator. *Image courtesy of VI-grade.*

HPC Options, Part 2

CAD Value and Performance are Not Mutually Exclusive

CAD relies on high-performance systems to meet the productivity levels engineers need to remain competitive.

BY FRANK J. OHLHORST

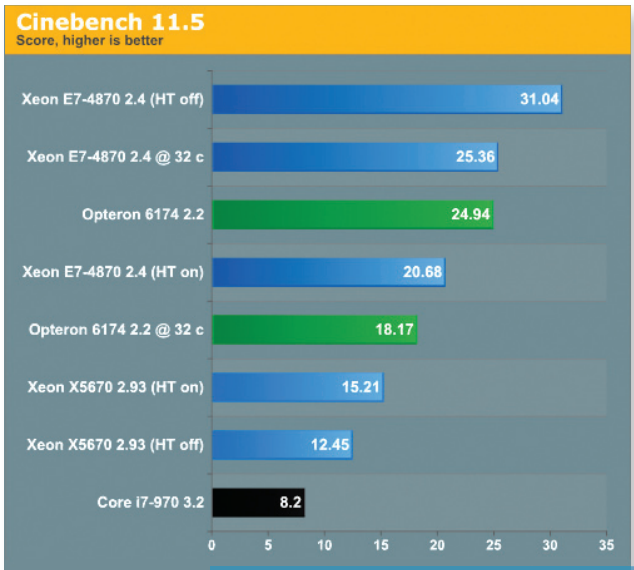
There was a time when only the most complex projects required dedicated CAD workstations. As the use of CAD has proliferated to range from performing simple design chores for basic projects to creating entire system designs, however, engineers have come to wonder how much productivity relies on the hardware in use.

In other words, the situation with CAD has become one where humans put forth the ideas and machines make the designs possible. It's a seismic shift from the days of design tables, vellum and multi-colored pens. That said, it becomes obvious how important technology has become in the CAD equation — where poorly performing systems can delay, if not hamper the design process, and high-performance computing (HPC) has become the rule of the day.

Speed comes at a price, and price ultimately affects a project's profitability. Is it worth spending thousands for a few percentage points of performance increase? Such questions leaves design engineers with a complex problem that requires making the correct hardware choices — without breaking the bank. Some engineers will go out and purchase a typical PC, hoping that a few high-performance goodies will provide enough power for the task at hand. Sometimes that works; other times it results in a miserable failure. On the other hand, some engineers will purchase a very expensive, high-end workstation for the task at hand, and then discover that they are not using many of the high-performance capabilities offered.

What's more, in the HPC world there is a diverse ecosystem of requirements that are often dictated by the applications being used. Simulation applications require different types of processing power than CAD or CAM uses, and in many cases what makes one application perform well may hinder another.

The trick here is to understand what types of components and add-ons offer the best performance increases for an application, while still keeping things affordable. It all comes down to making the right choices.



For graphics-intensive work, like rendering, Xeon processors take the lead.

Do You Really Need a Workstation?

When it comes to working with CAD software, a common question arises: Can't I just use a high-end business PC for CAD? Workstations are a different class of machine than a typical PC, at least from a design and reliability point of view.

"Workstations tend to be more fault-tolerant than PCs, often using ECC RAM, as well as different class of processor, such as Intel's Xeon," explains Wes Shimanek, workstation product manager at Intel. "Workstations are also designed

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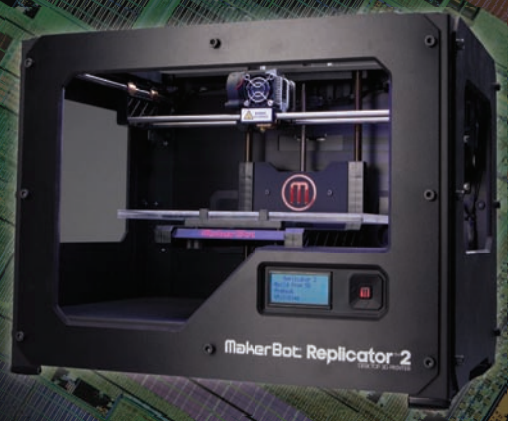

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for expansion, as well as 24/7 use, and incorporate better cooling. They also offer improved serviceability over a PC."

From an architecture standpoint, the Xeon and Core i7 processors are more alike than they are different. However, there are some key differences. For example, the more-expensive Xeon processors offer larger caches, more cores and the ability to access 512GB of RAM. Xeon processors also tend to run cooler than Core processors, and are designed for high utilization in 24/7 environments.

On the other hand, Core i7 CPUs offer performance similar to top-of-the-line Xeons; the drawback is that they are limited when it comes to expandability (64GB max). What's more, Xeon CPUs are designed to work in multi-CPU environments, whereas a HPC may have two or more CPUs, each with multiple cores, able to run multithreaded applications more efficiently and quickly.

It all comes down to a starting point. If you're choosing a workstation, the Xeon processor will be the foundation and then the choice becomes how many Xeons you want or need. With a PC, on the other hand, you can choose an AMD CPU or a Core i7, i5 or i3 as a CPU, but you are limiting the expansion options available right from the outset. For most CAD work, expansion is a critical concern: As workloads increase and projects grow more complex, the ability to add CPUs, memory or storage becomes important.

All told, though, expansion is just one of the considerations in choosing a workstation. Greg Weir, director of Precision Workstation Product and ISV Marketing at Dell, notes that it is important that CAD users select an independent software vendor (ISV)-certified workstation to help ensure that the applications they depend upon run smoothly, right out of the box. ISV-certified hardware, he adds, "comes with supported drivers to help eliminate issues and increase performance after the point of sale. This intense level of testing and development between an OEM and the ISV only comes with workstations."

Video Card Options

Another element that feeds the workstation vs. the PC argument is one of video processing power, especially in the form of graphics processing unit (GPU) selection. There are intrinsic differences in what GPUs are used for in a system. For example, CAD requires the speedy rendering of images and objects on one or more screens, while simulation work uses the multiple thread capabilities of GPUs to process algorithms and mathematical calculations to create a simulation.

Nevertheless, there are GPUs that are optimized for professional graphics-intensive applications, such as design rendering. Choosing the correct one can make all the difference between a high-performance CAD workstation and a slow PC.

Both NVIDIA and AMD offer professional caliber GPUs designed for CAD work in their respective Quadro and FirePro product lines. GPUs come in a variety of flavors for desktop, as well as mobile form factors. For workstations and PCs, there are typically five categories of add-in cards, with the first category being 2D GPUs. Professional 2D cards can manage some 3D processing, but are not optimized for regular or intensive 3D applications. They generally aren't well suited for CAD use. CAD work requires 3D GPUs, which fall into the other four categories as defined by Jon Peddie Research: entry level (under $350), midrange ($350 to $1,000), high-end ($1,000 to $1,500), and finally, ultra high-end ($1500+).

"Most CAD professionals will want to select a GPU that matches the performance and capabilities of the rest of the system — choosing an entry-level GPU for an entry-level workstation, for example," explains NVIDIA Vertical Marketing GM Andrew Cresci. "However, there are exceptions. Some CAD applications can better leverage high-end GPUs, thus improving overall performance."

Weir notes that Dell does "some of the selection work for you, offering a subset of GPUs that best match the capabilities of the workstation selected." Of course, Dell, isn't the only OEM to do that: HP and many other workstation OEMs are happy to configure systems for their customers.

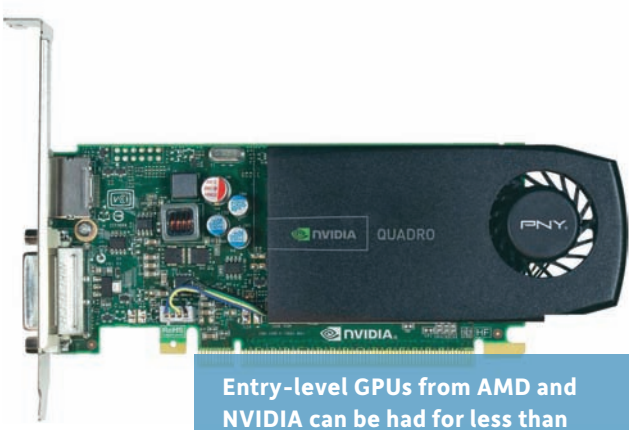
Another important GPU consideration comes in the form of future-proofing a system. Most graphics cards use PCI Express x16 slots in a workstation. Graphics cards can be installed in open slots at the factory when ordering a system, or later on as an upgrade. Upgrading an existing system with the latest-generation GPU can provide a cost-effective performance boost kick, if rendering becomes a bottleneck.

Most workstations today are equipped with at least two PCI Express x16 slots, able to accommodate multiple GPU cards. This an important consideration for upgrading systems, because technologies from NVIDIA (SLI) and AMD (CrossFire) allow the pairing of two cards rendering alternate frames to boost performance.

Multiple GPU cards also support multiple high-resolution displays, which is a proven technique for increasing productivity. Engineers who have used two or more displays will likely never settle for a single display in the future. However, multiple GPU cards are not always a necessity for multiple monitors. NVIDIA's Quadro with nView and Mosaic technology can support two displays across most of the product line. A single high-end AMD FirePro V7900, with its Eyefinity technology, can handle as many as four monitors.

More Memory Makes Sense

Naturally, there is much more to a workstation than just CPUs and GPUs. A complete ecosystem of components makes up the internal workings of the typical workstation, with each and every component affecting price and performance. Two subsystems that have a great impact on both



Entry-level GPUs from AMD and NVIDIA can be had for less than $150.

Ultra high-end GPUs from graphics card manufacturers can retail for as much as $4,000.

price and performance are storage technologies and system memory (or RAM).

RAM size and speed can have a significant impact on performance depending upon the application. Finding the optimal configuration often proves to be more of an art than a practice. Obviously faster is better, and for the most part systems today use DDR3 1333-MHz RAM. DDR3 is third-generation, dual-data rate memory technology, running at 1333-MHz, which is the speed of most of Intel's current platforms.

As for the amount of memory, a general rule of thumb is to start with the minimum recommendation for the primary application and add additional memory based upon anticipated loads. In cases where engineers are working with large CAD files, more memory, which allows the entire design file to be loaded into RAM, significantly accelerates performance.

Another consideration comes in the form of Error Correcting Code (ECC) memory, which allows single-bit memory errors to be detected and corrected. Today's Xeon processors offer integrated ECC support. For those configuring workstations, future memory expansion should also be considered. In other words, there should be empty or available dual in-line memory module (DIMM) slots to add more memory at a later date.

SSDs' Price Worth the Added Speed and Reliability

As far as storage is concerned, traditional workstations' hard-disk drives (HDDs) in a 3.5-in. form factor seem to still reign supreme, at least from a storage size and cost argument. HDDs are starting to become one of the primary bottlenecks in workstations today, however, with access speeds and data rates delaying how quickly data can be loaded into system memory. With price-per-gigabyte ratios falling rapidly, traditional spindles are proving to be cost-effective for large storage chores, where speed is not paramount. For HDDs, there are two interfaces available today:

- SATA interface drives are less expensive, but are limited to 7,200 rpm, which affects throughput.
- SA-SCSI drives can spin as fast as 15,000 rpm; they can deliver more data in less time, but at roughly double the cost.

Choosing a SATA or SA-SCSI drive often means making a choice between economy and performance. There are other options available today.

Solid-state drives (SSDs), which offer performance levels far beyond any physical, spinning media-based HDD, are a prime example. An SSD stores data in solid-state memory (SRAM) instead of on hard disk platters. Speed is just one advantage to this higher-priced option, however: SSDs have no moving parts, meaning they are more reliable and generate less heat and noise.

Selecting a PC or workstation for performing CAD work is no simple matter, especially when one is trying to garner the biggest bang for the buck. What's more, CPUs, GPUs, RAM and storage are only the beginning of a list of components that affect performance and value. Other capabilities, such as networking, connectivity and expansion, all play a role is configuring what one may consider the "ideal" CAD system.

Keep your options open for the future when deciding on a new CAD workstation. Expansion options should abound when buying a workstation. CAD models are getting more complex, and rendering and simulation tasks are needed more and more often. Don't risk painting yourself into a performance corner. DE

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

INFO → **AMD:** AMD.com

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→ **HP:** HP.com

→ **Intel:** Intel.com

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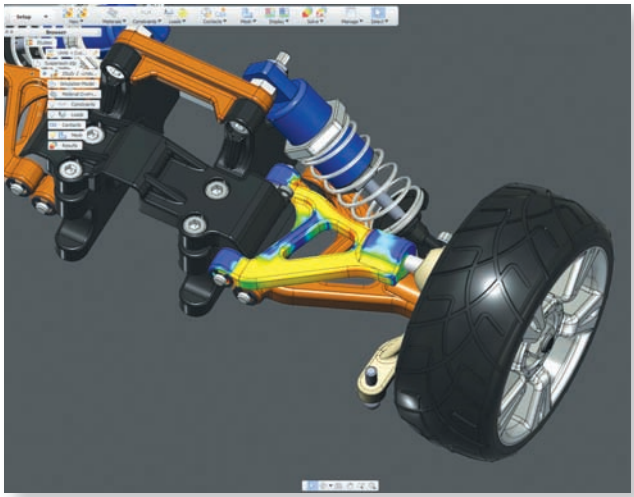
A Map to the Cloud(s)

There are many routes to take, depending upon your compute needs.

BY KENNETH WONG



Autodesk Simulation running on a 600MB thick client augmented with remote computing resources. The hybrid approach takes advantage of local and cloud computing.

There's a parable about a group of blind men who set out to learn what an elephant looks like. Each man, touching a part of the animal, came to a different conclusion. The one who felt the tusk was convinced the elephant looked like a plowshare. Another concluded, after feeling a leg, that it looked like a pillar. The one who happened to pull on the tail argued it looked like a pestle. So they argued endlessly, each backing his theory with his own experience.

Discussions about the cloud could be a bit like that. Many freely use the generic word "cloud" to describe a specific implementation: remote hardware, browser-based software, public servers, private servers, thin clients, thick clients, virtualization and so on. Some are fierce opponents; some are early adopters. Others sit on the fence. Whichever camp you may belong to, it's important to recognize that the cloud — the massive creature that each of us may find impossible to wrap our arms around — exists in various permutations.

Software as a Service

The classic software-as-a-service (SaaS) offerings usually run from a browser or a thin client. They rely minimally on the processing power of your own machine; they delegate the lion's share of the computing to remote servers equipped with far more cores than a typical personal computer. SaaS vendors tend to offer pay-as-you-go or subscription licensing, usually calculated per user, per month.

To remain profitable with smaller, incremental payments, SaaS vendors must rely on a larger user base. Therefore, they put in considerable efforts to do what some argue is impossible: Make simulation easy enough for average engineers and designers.

SimScale from SimScale GmbH, headquartered in Munich, exhibits the classic SaaS characteristics. It lets you run structural mechanics, fluid and thermodynamics from a browser — no download, no installation. It includes a setup environment to define the scenario (say, oxygen in water flowing through a T-junction), the solver and post-processing environment to review the outcome. The simplified user interface offers you a way to set up a scenario without overwhelming you with too many options.

CFDCalc, developed and maintained by Altair, lives as an online computational fluid dynamics (CFD) solution, an easy tool to simulate activities related to heat sinks, SMX mixers (used in chemical mixing), and simple pipes. A general CFD package lets you simulate a wide range of flow behaviors. By contrast, CFDCalc singled out three types of common CFD scenarios, built templates, and placed them in the cloud. It points to another business model — one that reduces a specific simulation job into a set of wizards, inputs and equations that can be completed online, like an Excel spreadsheet with embedded formulas. (Potentially, more calculators could be created and hosted by users, either in the private or public cloud.)

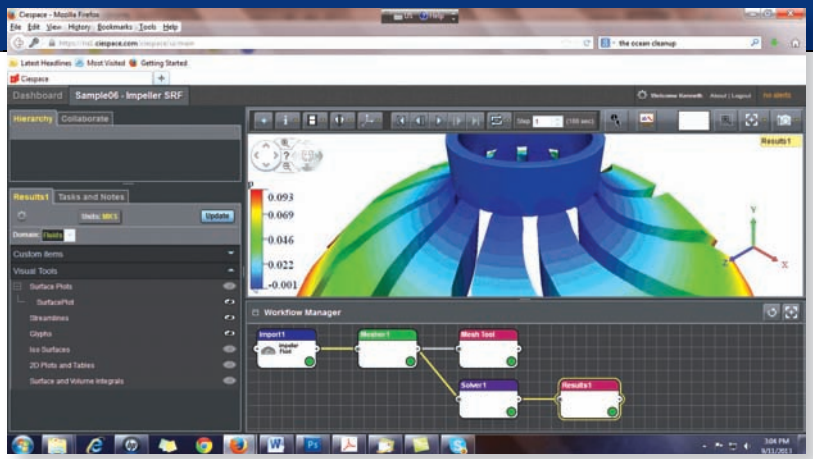
"Historically, high-end multi-physics simulation has had many barriers to entry," says Bill Clark, executive VP of worldwide sales, CD-adapco. "Typically, the required combination of domain knowledge, simulation expertise, and access to adequate compute resource made high-end simulations challenging at best."

Clark adds that in the past, companies would hire people with doctoral degrees to satisfy the first two requirements, and invest considerable resources to maintain a high-performance computing (HPC) system to satisfy the last requirement. But today, he says, "a wide range of users leverage our software and new licensing models to facilitate the use of shared hardware."

With the SaaS model, you bypass the need to acquire and maintain on-premise HPC or powerful multi-core machines. The monthly, pay-as-you-go fee structure works better for businesses with less-predictable or less-consistent workflows. For instance, if your project needs heavy use of simulation in the early phase, but light in later phases (or the other way around), SaaS allows you to adjust your seat count to match the workload.

Platform for Hire

In June 2013, Ciespace in Santa Clara, CA, launched version 1.0 of its browser-based CFD solution. Announcing it to the press at the time, the company's then-CEO Kevin Kerns said, "Over the next five years, we believe there will be a major paradigm shift in how people consume engineering design and simulation technology." For its solver, Ciespace uses OpenFOAM, an open source software package developed by ESI Group, distributed by the OpenFOAM Foundation.



Sanjay Choudhry, the company's CTO, says the primary purpose of Ciespace's SaaS CFD offering was "not necessarily to make a business out of that. It was to have enough users and customers to validate the platform's robustness and performance, as well as validate the pricing and value proposition for the users. Now that this phase is underway, our platform strategy kicks in."

Part of that strategy, Choudhry continues, is going to independent software vendors (ISVs) and getting their applications in the SaaS mode "so that they can focus on their core competence. In fact, the entire platform is cloud-neutral, and it can even be used by product manufacturing companies to make their proprietary solvers, meshers, etc., available enterprise-wide."

CieSpace is seeking OEM partners who might want to license CieSpace's platform to offer their traditionally desktop programs as SaaS-style offerings.

For example, if you have CFD software initially developed for the desktop or HPC environment, and you're having a difficult time figuring out how to transform your product into SaaS, Ciespace will offer you its existing, tested infrastructure as the readymade backbone to do just that. The company has already demonstrated successful completion of proof-of-concept for end-to-end vertical applications using different physics types with different backend architectures, and workflow requirements is possible in one to two weeks, Choudhry says.

Suppose a company has made a name for itself with its flagship product, Acme CAE. What would happen to its existing revenue stream if it starts offering on-demand versions? Would its current customers stop renewing their Acme CAE desktop licenses and switch instead to Acme SaaS CAE? That's a common dilemma for traditional simulation vendors considering the SaaS market.

"That's a mistaken notion," Choudhry says. "One only has to look at the other business software domains where various SaaS companies have only increased the size of the market, not taken away from their existing market. The engineering domain is no different, and there are untapped markets."

He offers as an example the vastly ignored segment of price-sensitive small and midsize businesses (SMBs) that don't need the full functionality of conventional offerings and vertical industry segments: "Even as SaaS has brought prices down, the knowledge required for simulation can remain a barrier to rapid adoption for these smaller businesses," Choudhry says. "Vertical solutions as well as templates that can be cloned and replayed provide the answers to that problem. With a customizable SaaS application, you can make the product so simple that everything happens behind the scenes."

Flexible Licensing Paves the Way

"Our first foray into the cloud was introducing new licensing," says CD-adapco's Clark. "We target small and midsized companies through a licensing scheme that allows per-use payment."

This model, referred to as Power-on-Demand, was introduced in 2011. The license grants users the ability to launch as many concurrent jobs as needed on unlimited cores, and charges only for the wall clock time utilized per job. In 2012 and 2013, CD-adapco delivered 2.5 million and 7.3 million hours of Power-on-Demand, respectively, to its customers, Clark says.

The new licensing method was introduced to service companies that maintain their own HPC hardware. "Now the licensing is used by an increasing number of customers who don't maintain their own hardware," Clark says. That was the precursor to CD-adapco's partnership with Rescale, which sells access to on-demand HPC platform for simulation software users.

Hardware as a Service

Some refer to it as infrastructure-as-a-service (IaaS); others as platform-as-a-service (PaaS). Whatever the terminology, IaaS and PaaS vendors typically give you remote access to their own HPC resources. Such offerings are ideal for businesses that have in-house simulation experts and the necessary software, but don't have the servers needed to run the software as a distributed computing job. An in-house expert with a professional workstation can set up and process simulation jobs, but the hardware at his or her disposal may not be powerful enough to finish the jobs in a reasonable time. In that case, additional hardware from IaaS or PaaS vendors can augment the user's existing hardware.

Rescale offers simulation software users access to customizable, on-demand HPC resources. Its partner network encompasses well-known simulation software developers like Dassault Systèmes SIMULIA, CD-adapco, ANSYS, MSC Software, Siemens PLM Software and Convergent Science. Rescale provides access to both additional software licenses and hardware so they can run simulations using familiar commercial, open-source and even proprietary software. And because these programs often have different compute requirements, Rescale users can customize computing resources for each job, making bursting into the cloud even easier for multiple types of simulations.

With the latest improvement in virtualization, some vendors have begun introducing desktop-as-a-service, or DaaS — virtual machines you can "rent" for the duration of your need. Whereas IaaS or PaaS vendors like Rescale target businesses that need an on-demand HPC, DaaS aims to serve individual users who want access to a powerful machine, but don't necessarily want to own or maintain it. With this model, your in-house simulation experts don't necessarily need to have a dedicated workstation on the premises. Instead, they may ac-

Simulation as a Service

For businesses that have no in-house expert or on-premises high-performance computing (HPC) hardware, and don't plan to invest in either, simulation consultants offer a way out. In this case, SaaS is not exactly software as a service, but simulation as a service — delivered on-demand for a fee.

Need to find the best packaging layout inside an electronics enclosure? To simulate a wind-tunnel test to reduce drag on a racecar? To safely cut 10% of the materials from your airplane wing's structural support? You provide the CAD model and the parameters, and explain the problem to the consultants. In return, you receive a report, usually accompanied by multimedia presentations, recommendations and collaboration throughout the process to ensure design guidance and ideas exchanged fit within your product constraints.

With this approach, the headache of securing the necessary hardware, setting up the computational fluid dynamics (CFD) or finite element analysis (FEA) job, running it, and making sense of the results is not yours. It's the consultant's.

"The cloud is a viable option — if you know how to use the software," observes Jason Pfeiffer, who spearheaded IMAGINiT's CFD consulting group and now serves as the division's director. "I've found that many companies — small and midsized companies in particular — don't have people trained to be proficient in CFD. People come to us when they have a design problem, and want to tap into our expertise for the solution. Their HPC needs or the hardware they have at their disposal never really comes up."

— K.W.

cess the virtual workstation remotely — from home, from an airport lounge, or from a Wi-Fi-equipped café, for example — using a low-cost machine or a lightweight tablet to set up, process and monitor the simulation jobs.

DaaS is now available from VMware (under the Horizon DaaS brand), as well as from dinCloud, Cisco Systems and a few others. Major hardware makers who currently focus on selling physical machines may soon get into the business of renting virtual machines. The Achilles' heel in DaaS, however, may be the bandwidth required for interactive experience.

"SaaS for CFD is a relatively recent phenomenon," notes CD-adapco's Clark. "When we build a model, there are literally millions of polygons, hundreds of GBs of data that need to get transported [through the network]." That presents a data-transfer challenge SaaS tools don't have to wrestle with in, say, customer relationship management (CRM) or enterprise resource management (ERP).

An Integrated Approach

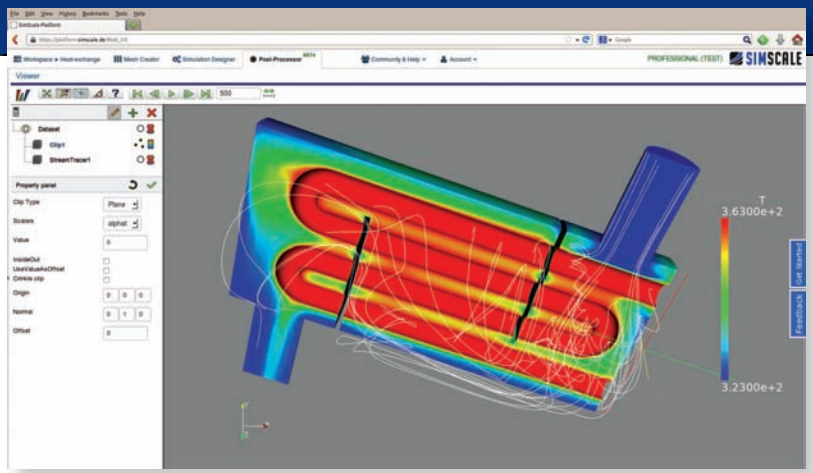
At approximately 600MB, Autodesk Simulation 360's client isn't exactly thin. But once installed, you get access to a direct editor (Autodesk Fusion 360), along with a preprocessor environment to set up mechanical simulation, cloud-hosted storage, and a postprocessor environment to review your results. The processor — the stage where you initiate the number-crunching to solve your scenario — is directly linked to a remote server, so the computing burden can be offloaded to a remote server maintained by Autodesk, not your local machine's CPUs. It's an example of the hybrid model — software that straddles both your local desktop and the cloud.

With this setup, the simulation software user must still be provided with a robust machine to run the thick client (unlike the SaaS model that lets you get away with a lightweight machine or a tablet); however, the enterprise saves cost by bypassing the need for onsite HPC. Instead, it relies on the software's built-in access to remote computing resources.

Simulation Expertise Not Included

Whether you're considering SaaS, IaaS, PaaS or hybrid products, the importance of simulation expertise and domain knowledge shouldn't be underestimated. It's not something you'll find in the cloud solution; therefore, you must develop it in-house or acquire it through consultants. CD-adapco's Clark touts the ease of use in modern simulation software and the flexibility afforded through cloud computing that have advanced the prevalence of simulation. But he warns that "the need for specific domain knowledge is a barrier that will not soon be overcome."

SaaS products that target non-experts are suitable for designers and engineers. They're meant for those who want to ensure their geometry — the shape of their design — is within the realm of optimal performance. Such tools let you see by approximations that your product, as designed, has a reasonable chance at surviving the anticipated stresses, frictions, corrosions and collision.



Running on a standard browser, SimScale's CFD program is an example of the browser-based SaaS-style simulation.

But it's usually not within the purview of conceptual designers to seek additional opportunities to shave off materials without jeopardizing durability, or perform additional calculations to prevent failure under a specific set of criteria. Such simulation tasks are usually left to experts or advanced software users entrusted with internal HPC resources. They are, therefore, more likely the ones to migrate to PaaS or IaaS.

The obstacles one must overcome, such as privacy concerns, compliance and cost, differ depending on the chosen path to the cloud. The next time someone gushes over the cloud or raises vehement objections, before adding your voice to the confusion, you should ask, "Which cloud?" DE

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

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➜ **Autodesk Simulation:** Autodesk.com/products/sim-360/overview

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➜ **IMAGINiT:** IMAGINiT.com

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➜ **Rescale:** Rescale.com

➜ **SimScale GmbH:** SimScale.de

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Simplifying FEA Models Using Planar Symmetry

This classic simplification method can help create faster simulations and analysis.

BY TONY ABBEY

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

Advances in finite element analysis (FEA) software solution efficiency, computing hardware power and available storage have meant a dramatic increase in the size or scope of the FEA models we can run. The size is reflected in the number of elements, or mesh density, we can use in a model. The scope is reflected in the type of analysis we are running. There is a trend to run more advanced analyses that include greater realism in the simulation of the physics involved.

The advanced analyses, such as non-linear, fracture mechanics and others, are more demanding in terms of computing resources — and there may come a point where a fully modeled component takes unacceptably long run times. At that point, we can look to some of the earliest forms of model simplification techniques to reduce the element count, and to allow us to run complex analyses within the resource budget.

I can remember more than 20 years ago hearing declarations that these methods were obsolete now that we have "modern" computing power. However, they have stood the test of time and I still use them today in many projects. Let's take a look at one of these methods, planar symmetry (we will cover other simplification methods in future articles).

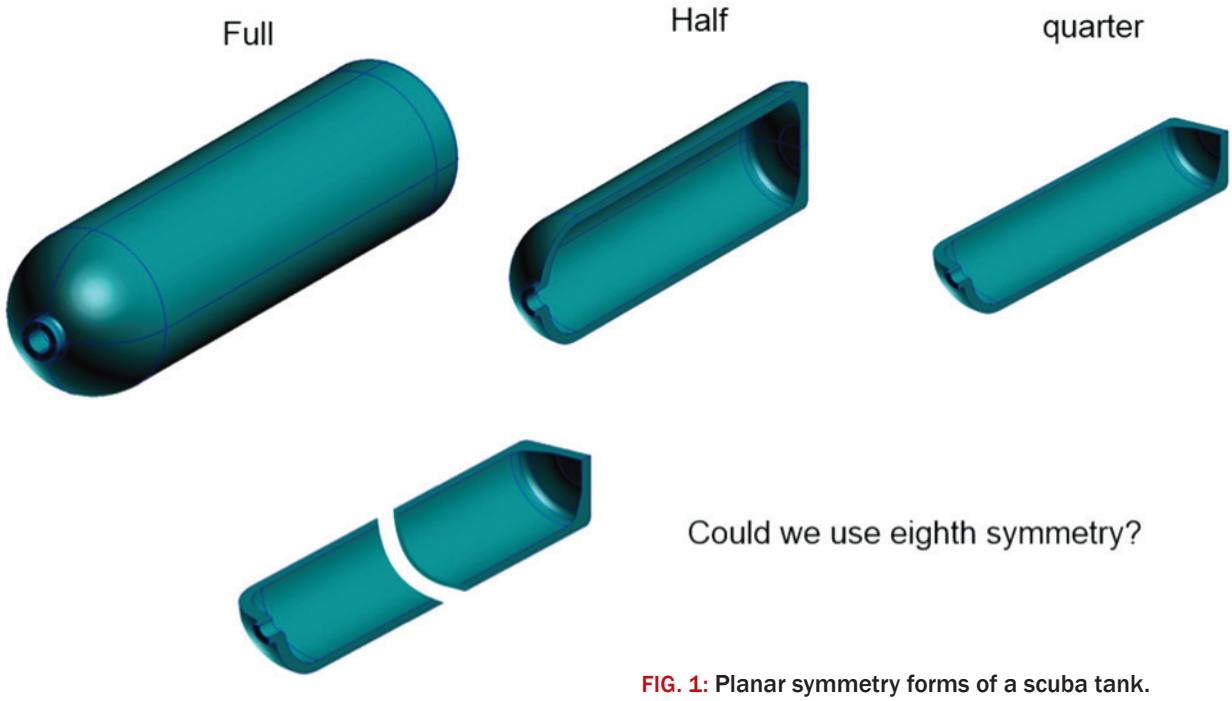

FIG. 1: Planar symmetry forms of a scuba tank.

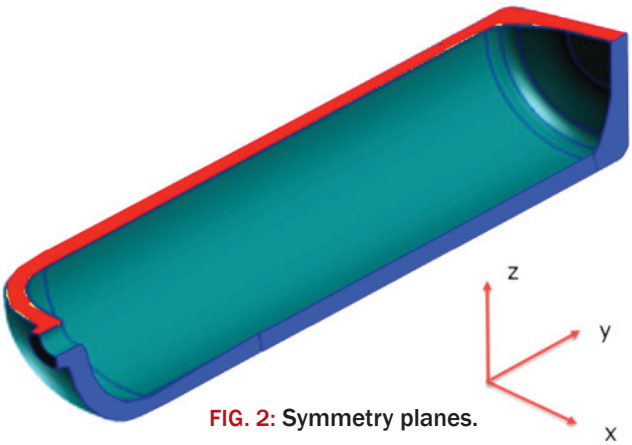

FIG. 2: Symmetry planes.

Planar Symmetry

Fig. 1 shows a scuba tank that is modeled in full, and then various forms of planar symmetry. We know that the cost of solution time is approximately proportional to n^2, where n is the number of degrees of freedom (DOF). Thus, the motivation in going to half or quarter symmetry is to achieve a cost-savings factor of 4 or 16. If a nonlinear analysis is going to be reduced from 16 hours to 1 hour, then that is significant.

There are some rules associated with selecting planar symmetry — the geometry, material, loading and boundary conditions all have to exhibit symmetry.

Considering the half-symmetry scuba tank case, the geometry is clearly symmetric. If we held the real half-structure on a glass mirror plane, then the real and virtual halves would form a full representation of the whole. If we were creating the full model in CAD or an FEA preprocessor, this would probably be part of our strategy. The quarter symmetry is equally obvious.

A question arises: Why not slice further? Usually we stop at quarter or eighth symmetry simply because the main global coordinate system naturally forms these cutting planes. We can slice further, but we that would fall into sector symmetry — or in the limit, axi-symmetry.

The one-eighth symmetry shown in Fig. 1 looks curious, and violates our requirement for true geometric planar symmetry. However, it is a good example of how we can "push" symmetry. The motivation would be a cost savings of 64 on the full model.

One-eighth Modeling

If our objective is to investigate the details of each end of the scuba tank, the nozzle region and the flat-bottomed end, then we could run two models of one-eighth symmetry each.

		Tx	Ty	Tz	Rx	Ry	Rz
Red	xy plane	free	free	fixed	fixed	fixed	free
Blue	zy plane	fixed	free	free	free	fixed	fixed

FIG. 3: Symmetry boundary conditions for a quarter scuba tank model.

One model would be a double-nozzle scuba tank; one would be a double flat-ended tank.

At first glance, this doesn't make much sense. However, the stresses in the two ends are independent of each other and stabilize along the wall of the tank between the two ends, because they are far enough away from each other to allow the stresses to diffuse.

Put another way, the stresses at the center slice are the same in both eighth-symmetry models. The net savings is a factor of 32 if we run two models. Each investigates the relevant region in detail. Our main problem is going to be convincing the certification authority, client or lead engineer that this makes sense. The factor of 32 can be applied toward a much finer mesh, or more incremental steps in a non-linear analysis.

If the parallel wall section were very short, we could not use this one-eighth symmetry plane, as the stiffness at each end would interact and the stresses would be dependent on the specific combined geometry.

One other convenient aspect of eighth symmetry is that no external constraint other than the symmetry constraints is required. This is often an advantage in structures that are in balance under applied loading and do not require a "skyhook" to hold them. A full FEA model would be awkward to constrain, however, without introducing unwanted load paths. How would you hold the scuba tank full model without introducing unrealistic constraint reactions? We will come back to that in a future article on minimum constraints.

Load Considerations

Other requirements for symmetry include loading. Pressure loading is conveniently planar symmetric in all our cases. However, if we put an external load on one side of the wall only, perhaps from a handling operation, this destroys the symmetry. A half-symmetric model would imply an equal and opposite load; quarter symmetric would imply four loads at 90°, and so on.

There are ways to deal with this using symmetry and anti-symmetry boundary condition models, but superimposing them though the process is awkward and error-prone. Some solvers can set up and combine results automatically, but in the absence of this functionality I would avoid this approach.

The constraints also have to be symmetric, so if this were a heat exchanger, for example, and one wall was supported locally, the opposite symmetric wall would have to have the same support feature.

Material symmetry is usually only a problem when considering composites. If this was a helical filament wound pressure tank, then strictly speaking we have a herringbone disjoint pattern in each angle ply across the symmetry plane. This can be overcome by assuming a smeared equivalent stiffness.

This last point illustrates how we can "cheat" a little when using symmetry. If there is a handle on one side of the scuba tank, for example, and we decide it is not structurally significant, we can either assume a fake extra handle about the mirror plane, or just leave the handle off the model. Features that are not quite truly symmetric can be adjusted to make them symmetric, as long as the effective stiffness and key local stresses are not affected.

Enforcing Planar Symmetry

Symmetry conditions are enforced through the definition of correct boundary conditions, which make the structure respond across the boundary as if a "virtual" structure was there and complies with the response of the full structure. In Fig. 2, the red cut boundary face is in the xy plane. The coordinate system or the model can be moved to achieve this.

Imagine the cut surface placed against a mirror face. If we slide our real model in x, will the virtual model follow properly? Yes, it will. If we slide the real model in y, will the virtual model follow? Again, the answer is yes. Now consider moving the real model in z, away from the mirror plane. What will the virtual model do? It will split away from the real model — literally cracking it in half. Thus, we cannot allow a displacement across the boundary condition in z.

Now, onto the rotations. Can we rotate about x? No, this will dip one end into the mirror plane, and pull one end out, destroying our combined real and virtual image. The same argument is made for rotation about y. If we rotate about z, though, the real and virtual rotate together in the mirror plane and simulate the half model well.

In this manner, we are building a table of fixed and free constraints. The full table is shown in Fig. 3. Also included are the constraints for the blue cut face, which lets you

check for the correct sense.

One thing to notice about Fig. 3 is that for each cut surface, the translations and rotations are opposites. This is a nice tip for that Monday morning feeling — focus on the translations, and just put in the opposite for the rotations.

Two comments are often made here:

1. "The preprocessor does all this. We just fill in a radio box." That's fine, but we need to know how and why this all works. Also, it's wise to double-check the sense of those radio buttons — some are filled in pre-processors meaning "fixed," while others are filled meaning "free." There is no universal standard across the industry.
2. "We don't need to worry about the rotational constraints." This usually arises from folks who only ever create solid-mesh models. It is vital to have the rotations dealt with properly, however, if beams or shell elements are used.

Where to Avoid Symmetry

If all our symmetry requirements are met, it is tempting to use this approach in either a normal modes analysis or buckling analysis. In both cases, the full structure will respond with a set of symmetric and anti-symmetric mode shapes. We will only capture the symmetric mode shapes, which are just a subset of the full physical response.

For example, the half symmetry of the scuba tank will allow an extensional (stretching mode) in y, and both a dilatational and a bending mode in the zy plane. The bending in the xy plane and the first torsional mode are eliminated. Similar subsets of higher-order modes are also eliminated.

Any dynamic response analysis done using these modes is doomed to failure.

Linear buckling will follow a similar incomplete pattern: Non-linear buckling will inhibit free migration from symmetric to non-symmetric, or vice versa.

Simplification of FEA models using planar symmetry is a powerful tool that's still relevant in today's analysis environment. With some ingenuity, a wide range of models can benefit from the method. DE

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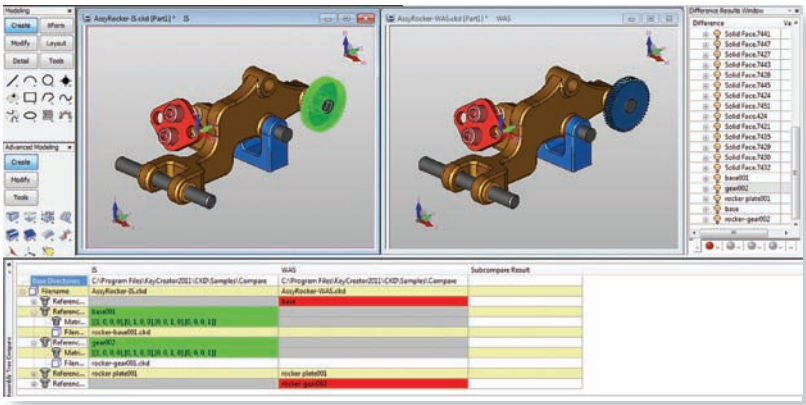
The CAD Interoperability Monster Still Lurks

Validation tools may o˜ er a way to tame it.

BY KENNETH WONG

In November 1999, CADENCE, a trade publication devoted to CAD and product lifecycle management (PLM), published its annual list of Editors' Choice award winners. In the lineup was 3D Model Server, a web-based model conversion and healing service run by Spatial Inc. Using this portal, you could upload a CAD file in one format and translate it into another format. The product fell into the application service provider (ASP) category. Today, 3D Model Server would have been described as Software-as-a-Service (SaaS) or cloud-hosted.



With the Kubotek Validation Tool, you might discover unintended changes — in this case, a fillet change — as a result of translating a CAD file. The top window displays an overlay to help see the difference in better context. ***Image courtesy of Kubotek.***

At the time, home users accessed the Internet via external modems delivering 56K/sec top speed (and bragged about it). Spatial was taking a chance on the CAD users' willingness to embrace web-based services with its new offering, because it recognized the enormity of the problem it could tackle.

CADENCE Editor-in-Chief Arnie Williams praised 3D Model Server as one of the "trend-setting technologies that will have a profound effect upon the engineering automation industries." Spatial wrote, "This service is critical to the manufacturing and engineering industries which, to this point, have struggled to maintain interoperability throughout the manufacturing supply chain."

Spatial, now part of Dassault Systèmes, continues to develop and license its modeling kernel to major CAD software vendors. But both CADENCE and 3D Model Server have become extinct. Only ghostly remnants of the editorial recognition and the product still remain online, as archived press releases. However, interoperability — the struggle associated with managing and reconciling different CAD programs and formats — is still an issue today.

Paul Brown, Siemens PLM Software's senior marketing director, said interoperability is "not a dead horse. The horse is very much alive. It's a horse that'll continue to live for a long time." For manufacturing, the use of multiple CAD programs is a fact of life. It's like a chronic condition: You can't get rid of it, but you can manage it. Some believe setting up quality control protocols at the point of conversion and translation may be the best approach.

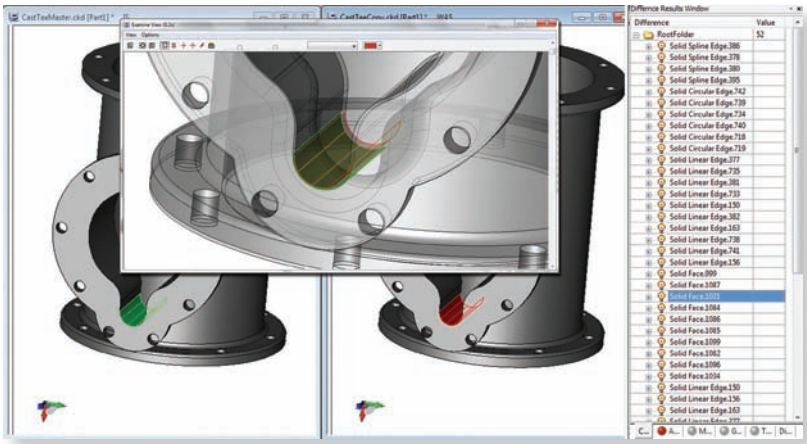
What is the Root Cause?

The root cause of interoperability is in the different ways CAD programs generate and edit geometry.

"We have a feature called a hole," Brown explains, noting that rival company PTC also has a feature called a hole. "The semantics are the same, but the way we draw it, track it and manage the edges is very different from others. Primitive shapes like blocks and cylinders are probably OK [in format conversion], but where you get into trouble is with complex features like blends, rounded edges and freeform shapes."

Consequently, when you convert one CAD file into another format you'd need to work in — say, from CATIA to NX or SolidWorks to Inventor — the resulting geometry may include flaws and imperfections, like gaps, unclosed

edges and inverted surfaces. Scott Sweeney, VP of marketing at Kubotek, says, "If they can't fix them, they'll redraw from scratch" — a clue to the kind of CAD rework that adds hours, if not days, to the design cycle.



KeyCreator Direct CAD uncovers a change in an assembly when comparing two versions of a design. Image courtesy of Kubotek.

Why Consolidation is Not Always Feasible

By virtue of their far-reaching influence, top-tier manufacturers like Airbus, Boeing, GM and Lockheed Martin are well positioned to dictate the formats delivered by their suppliers. After all, they're the ones offering the contracts and writing the checks. Some manufacturers may dangle a larger paycheck as incentive to obtain the digital design in the format they prefer.

"I've seen it done," says Brown. "The client may say, 'If you give me native NX data, I'll give you more money, but if in neutral or other format, less money.'"

"But most people aren't Airbus or Boeing," notes Jim Brown, founder and president of Tech-Clarity, an independent analyst firm. So the interoperability problem travels downstream, to Tier II, Tier III or lower-level suppliers. "From the top, you've got big clients saying, 'You must supply models in this format.' At the bottom, you've got suppliers sending you their work in neutral formats or their own CAD formats. So anybody who's not a top-tier original equipment manufacturer is going to have to deal with it."

In the Tech-Clarity white paper "Consolidating CAD: The Benefits of a Unified CAD Strategy," Jim Brown wrote, "CAD consolidation and standardization have multiple benefits. The first that most think about is cost … More strategic advantages include improved design reuse, collaboration and sharing best practices." He also acknowledges, "There may be reasons that may prevent companies from fully consolidating their CAD solutions, such as customer mandates to use specific tools. In these cases, a multi-CAD environment is required and must be supported."

Even if a manufacturer has managed, against great odds, to consolidate and standardize on a single CAD program, Jim Brown points out, "You're just one acquisition or one new customer away from being back in the multi-CAD environment."

Coping Mechanisms and Side Effects

The emergence of neutral formats — STL, STEP and IGES, to name but a few — has helped reduce the headache, to an extent. "Lightweight data is very important," says Siemens' Paul Brown. "It's valid if someone is just designing in the context of the data. Let's say, you've got to design a part that fits inside another piece, you can use the lightweight data."

Tech-Clarity's Jim Brown agrees. "You can pull the file into your program using JT," he offers, referring to a lightweight format created by Siemens, "or some other neutral format. That gives you the geometry, but what if you need to modify it?"

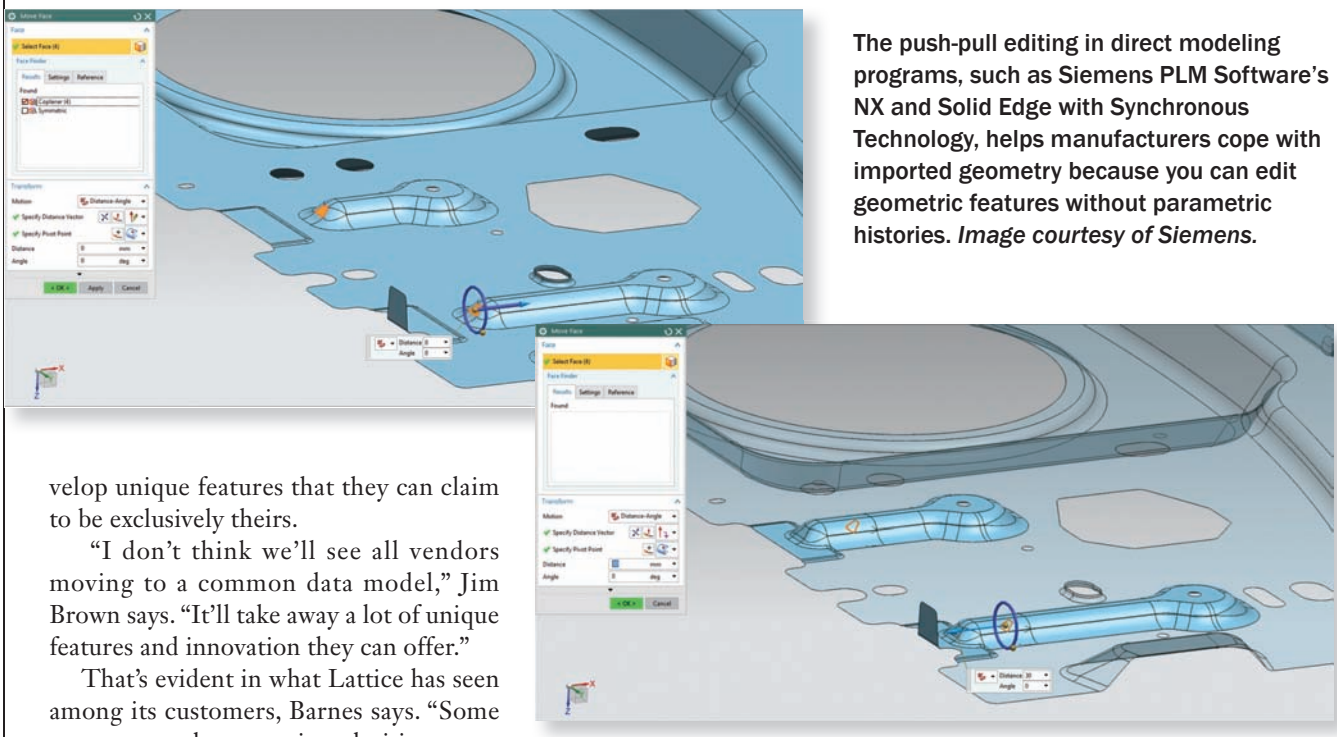
Choosing to work with a neutral format or a lightweight format also means giving up some or all of the part's geometry construction history — its parametric formula. The development of direct-editing programs like KeyCreator, SpaceClaim, Autodesk Inventor Fusion, Siemens NX and Solid Edge with Synchronous Technology allows you to edit parts without history.

The vendors' willingness to grant access to their libraries (often in exchange for licensing fees or royalties) also helps.

"Vendors like Lattice or providers have some kind of capability to read others' formats," notes Bill Barnes, general manager of Lattice Technology. "They license libraries to do that. So you've got an NX file, you want to bring Inventor parts into it, or something like that, we've got these scenarios covered."

Tech-Clarity's Jim Brown reports that being able to take a file from someone else's program and read it in your program has evolved for the better over time, but a critical problem remains: "The hardest part is the round trip — being able to make changes and sending it back to the original author. That's a long way from being solved."

Getting all vendors to migrate to a common data model — the same formula for geometry creation and editing — is highly unlikely. After all, they're fierce competitors. But there's something else that gets in the way. The differences in their modeling formulas also give them the ability to de-



The push-pull editing in direct modeling programs, such as Siemens PLM Software's NX and Solid Edge with Synchronous Technology, helps manufacturers cope with imported geometry because you can edit geometric features without parametric histories. *Image courtesy of Siemens.*

velop unique features that they can claim to be exclusively theirs.

"I don't think we'll see all vendors moving to a common data model," Jim Brown says. "It'll take away a lot of unique features and innovation they can offer."

That's evident in what Lattice has seen among its customers, Barnes says. "Some customers make a conscious decision to use different tools for different parts," he observes. "One part may be designed with CATIA, another may be with Pro/ENGINEER [rebranded as PTC Creo] or Autodesk Inventor."

New Dimension to Old Problem

Barnes points out that the old interoperability problem now has a new dimension: interdisciplinary interoperability. "The problem has shifted," he continues. "As we bring more 3D into downstream usage, we begin to run into interdisciplinary interoperability. You now need to bring electronic CAD (ECAD) and mechanical CAD (MCAD) together, for instance."

One of Lattice's clients, for example, ran up against this issue when the company was producing assembly instruction and maintenance manuals. "They had to bring in not only their CAD data for machines, which happens to be in SolidWorks format, but also their wire harnesses and electrical boxes in 2D ECAD formats," Barnes explains. The customer in question uses Zuken E3, a program that lets you design wire harnesses as 2D layouts but also work in 3D, to consolidate MCAD and ECAD. Electronic CAD software maker Zuken is also an investor in Lattice.

Quality Assurance in Conversion

One way to rein in the interoperability issues is to establish good quality control protocols during conversion.

"Check the models before you send them out to make sure the edges and the solids are valid, that there's no gap," advises Siemens' Paul Brown. "If you don't, you're just pushing your problem down the line. Someone else will have to deal with the rubbish you sent. Invest in model-checking software to make sure what you're sending is a valid model."

Barnes agrees, adding, "If companies are concerned with QA (quality assurance) in data transfer, there are validation tools they should look at."

Lattice's translation technology is developed in partnership with Elysium, with a line of product targeting CAD translation and repair. The product's name alone — CAD-doctor — is a clear indication that it specializes in healing imperfections. The same product also exists as a plug-in for NX, Siemens' flagship CAD product.

Another product in the same class comes from Kubotek, best known for its history-free modeler KeyCreator. In late 2011, the company launched KeyCreator Compare, a new product specifically designed to compare and identify the differences among similar CAD files. (Think of it as the 3D CAD equivalent of Microsoft Word's module for text-document comparison.)

"Companies use KeyCreator Compare to validate that the translation is accurate," explains Kubotek's Sweeney. "We have a high tolerance modeler, and we have libraries to read native formats. We have been asked to validate translations between not just different CAD programs, but between different versions of the same CAD program — CATIA V5 R25 and R26."

Kubotek also offers Kubotek Validation Tool, described as a product that performs "a mathematical comparison between two similar or different CAD models to ensure data integrity is maintained during a translation or data migration process." It's an ideal tool to "ensure that CAD transla-

tions have not adversely affected the files or models being translated," Sweeney says.

Coexistence for the Long Haul

During Kubotek's webinars, Sweeney often polls the attendees to get a snapshot of their CAD setup. "We learn that they have seats of all the CAD software that people are sending them, and they're supporting all these systems, training them and keeping the software updated," he reveals.

Lattice's Barnes also testifies to a similar discovery. "The typical environment with larger customers is, they have a primary CAD tool, but also smaller numbers of seats of other CAD programs that they often receive," he says.

Juggling multiple CAD programs may seem unavoidable in contract manufacturing, especially among those who work with multiple suppliers and subcontractors. Some may find relief in a CAD system that serves as the primary translator, provided it comes with robust features for reading and writing native CAD files from other programs.

"Many contract manufacturers have reduced their training, maintenance and software costs and saved valuable production time by using KeyCreator Direct CAD as their sole MCAD package for opening, editing and comparing customer files to prepare for manufacturing operations," notes Sweeney.

Many software vendors recognize they should make a concerted effort to help users cope with the headaches of a multi-CAD environment. After all, their own collective welfare is inseparably linked to it.

As Siemens' Paul Brown concludes, competing CAD vendors have to coexist: "It's not in anyone's interest for any one of us to make it really difficult for our customers to move data around." DE

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INFO ➜ **Elysium:** Elysium-Global.com

➜ **Kubotek:** Kubotek3D.com

➜ **Lattice Technology:** Lattice3D.com

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

➜ **Spatial Corp.:** Spatial.com

➜ **Tech-Clarity:** Tech-Clarity.com

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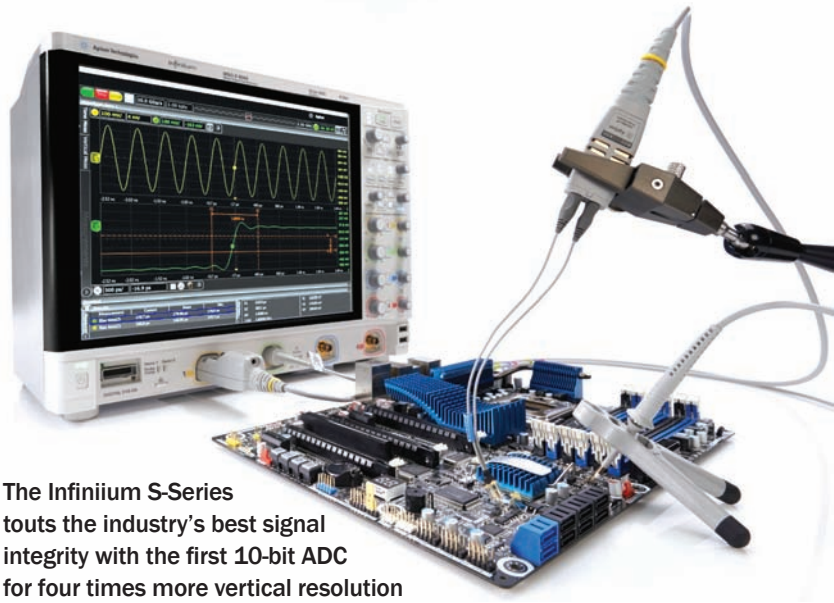
Today's Oscilloscopes Wear Multiple Hats

Oscilloscopes are morphing into multi-domain instruments that tout modern-day user interfaces — complete with touch and support for gestures.

BY BETH STACKPOLE

Oscilloscopes are continuing their march to embrace modern technologies with the current focus on integrating multiple domains into a single instrument, new usability capabilities and the never-ending quest for higher bandwidth and signal clarity.

While general-purpose oscilloscopes remain a staple of the engineering workbench, the growing complexity of electronics devices, the proliferation of wireless capabilities into all kinds of products and the more stringent requirements around power efficiency are all upping the ante for additional functionality to be used in conjunction with the base oscilloscope in a more efficient fashion. In addition, the general trend toward high-speed input/output connections like PCI Express and USB is driving demand for higher-speed oscilloscope capabilities — along with faster throughput.



The Infiniium S-Series touts the industry's best signal integrity with the first 10-bit ADC for four times more vertical resolution than traditional 8-bit scopes, as well as a low-noise front. ***Image courtesy of Agilent Technologies.***

As a result of these trends, we're seeing the rise of the multi-domain instrument, with leading oscilloscope vendors — including National Instruments, Agilent, Tektronix, Pico Technologies and others — integrating more functionality as part of a single device, according to Prathima Bommakanti, an industry analyst with Frost & Sullivan.

"Users prefer to use the same instrument for different applications in their workflow," Bommakanti says, adding that spectrum analyzers, logic analyzers, function generators and other capabilities are becoming standard on the core oscilloscope. "Users have a need for different capabilities, but they are requesting one box for testing."

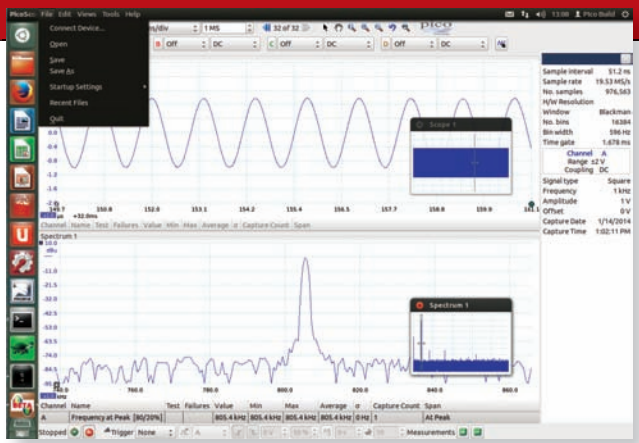
While demand for multi-domain oscilloscopes is on the rise, there is still demand for the standalone, general-purpose oscilloscope, Bommakanti says. Frost & Sullivan projects the market for oscilloscopes of all kinds to be $1.15 billion for 2013, up slightly from the $1.1 billion in 2012. The firm is anticipating continued growth for the category, projecting a calculated annual growth rate (CAGR) of 7.2% from 2012 to 2019.

All-in-one Device

National Instruments is the latest company to put its spin on the concept of a multi-domain testing device with its introduction of VirtualBench, which integrates five instruments into an all-in-one device. VirtualBench, which is based on NI's software-based approach to test and measurement, incorporates a mixed-signal oscilloscope, function generator, digital multi-meter, programmable PC power supply and digital I/O. The system interacts with users through software applications running on a PC or iPad.

Unlike NI's previous oscilloscope offerings, which played in the automated test space for validation after an electronics product or circuit board was produced, VirtualBench is the company's first offering aimed at early-stage design and as a go-to test tool for the engineer's workbench. "We like to think of it as a Swiss Army knife — it's there on the bench and engineers can pull it out and do whatever they need to do," explains Chris Delvizis, NI's senior product manager.

In addition to taking up minimal space on a desktop or



Pico Technologies' PicoScope software, now available for Windows and soon to be offered on Linux, delivers an oscilloscope, spectrum analyzer and signal/waveform generator all in one. ***Image courtesy of Pico Technology.***

benchtop, VirtualBench simplifies instrument configuration through NI's software approach. This latest offering sports a user interface (UI) that mimics some of the touch and gesturing conventions popularized by consumer electronics devices, Delvizis says. "The big change here is that some of the modern UI patterns have really evolved, and we're trying to take advantage of them to provide an experience that's as good as all the knobs and [physical] instrument controls, but better," he adds. "Another key benefit is being able to use the PC or mobile device, which lets us take advantage of all of the technology already built into those products."

VirtualBench's $1,999 price tag — and the fact it takes up limited desktop space — makes this type of instrument more accessible. It also opens up new possibilities for how engineers can utilize benchtop instruments, says Russell Stanphill, electronics advisor at TechShop, a maker community and workspace.

"The nice thing is that this is an out-of-the-box experience — you turn it on and the screen turns into the instruments on your device, whether it's a laptop or an iPad," he explains. "It's a winner because of the amount of functionality, the affordability of that functionality, and fact that it packages everything I need into one box." VirtualBench's integration with LabVIEW is another plus, Stanphill says, as it facilitates the ability to do repetitive measurements or characterization of a design.

Tektronix has been focused on multi-domain, mixed-signal oscilloscopes for the last few years. It's part of its product development charter, which is all about helping engineers find the answers to problems in seconds instead of days or weeks, according to Gina Bonini, the company's technical marketing manager. For example, given the rise of wireless radio capabilities in embedded systems, Tektronix was the first to pair an oscilloscope with a spectrum analyzer — in recognition that its customers needed a better way to coordinate testing among domains.

Tektronix research showed that more than 25% of oscilloscope users employ a spectrum analyzer multiple times per week, and more than 40% of embedded design projects include some form of wireless capability; hence the impetus to pair the two instruments together.

"Previously, engineers had an oscilloscope and a spectrum analyzer, and nowhere were they connected," she explains. "What that means in the world of wireless radio is that customers were not able to do basic timing measurements between time and frequency domains, which is a really key measurement that needs to happen. We've integrated the most common instrument used side-by-side with an oscilloscope into the oscilloscope itself, and that's huge in terms of convenience and cost savings."

While the MDO4000 Mixed Domain Oscilloscope series broke ground in this arena, Tektronix followed up in February with the release of the MDO3000. The new series has slightly less functionality — but with a price tag starting at $3,350, it's targeted to the mainstream portion of this market. The MDO3000 includes a spectrum analyzer, logic analyzer, protocol analyzer, arbitrary function generator and digital voltmeter, but it has been designed so users can add or customize other functionality at a later date. For example, they can implement performance upgrades for input frequency, or

National Instruments' VirtualBench combines five instruments in a single device, and interacts with users via software that runs on PCs or an iPad. ***Image courtesy of National Instruments.***

functional upgrades such as the addition of digital channels or protocol analysis, among other capabilities.

The MDO3000 features two or four analog input channels, with bandwidth ranging from 100 MHz to 1 GHz, 16 digital channels (optional), and one RF input channel. Other notable features include an optional integrated 50 MHz AFG functionality with eight times the arbitrary waveform record length; more than 280,000 waveforms per second capture rate displayed on a digital phosphor display for easily finding infrequent anomalies in a signal; and more than 125 available trigger combinations.

Speeds and Feeds

In addition to integrating multiple domains, oscilloscope vendors have been on a tear to push the bandwidth and signal integrity of their offerings. "The race has been on to develop oscilloscopes that have more bandwidth than their predecessors, are wider to support more channels, and are deeper so they have more memory, so engineers can look back in time and see where the problem lies," explains Trevor Smith, business development manager, test and measurement for Pico Technology. "The faster, wider, deeper and better resolution electronics engineers have, the better visibility they have to the problem they're working on so they can design a fix."

Pico's sweet spot is around the "deeper" part of the race, pushing the boundaries of onboard memory to allow engineers the flexibility to dig deep into the data to find the problem. The company's mainstream offering, the PicoScope 4824, is an 8-channel, high resolution, deep memory compact scope supporting 12-bit vertical resolution, bandwidth of 20 MHz, a fast sampling rate of 80 MS/s, and 256 MS buffer memory. The PicoScope 6000 offers ultra deep memory with up to 2 GSample buffer memory compared to industry standards, which are around 20 MSamples.

"Say, for example, you needed to look at a 60 Hz mains signal over a long period (minutes or hours) and capture the entire waveform to guarantee that you will record each and every transient or dropout, with good resolution, that might occur in that time," Smith explains. "Twenty samples per waveform might be good enough resolution, so one minute of capture would require 20 x 60 x 60 = 72,000 sample points. Most scopes today can do that. But an hour would require 20 x 60 x 60 for a total of 4.32 million samples, and a day would require over 100 million samples. Very few scopes have that buffer memory, but PicoScope does."

For its part in the race, Agilent Technologies recently introduced a pair of oscilloscopes — one the company intends to set new standards around price/performance, and the other putting measurement accuracy in its sights.

The Infiniium S-Series tackles the issue of signal integrity for bandwidths up to 8 GHz via a new low-noise front end and a fast, 10-bit analog to digital converter (ADC) that has four times the vertical resolution for precise viewing of signal detail compared with traditional scopes that offer an 8-bit ADC, according to Richard Markley, product planner at Agilent. The series, designed for validation and compliance of already-built devices, includes bandwidths from 500 MHz to 8 GHz with four-channel digital storage (DSO) models and 16-digital-channel mixed signal (MSO) models.

To ensure the scope stays responsive in all operating modes, the S-Series comes with application-specific measurement software fueled by a motherboard stocked with 8GB of RAM, along with a solid-state drive (SSD) for increased reliability. There's also a 15-in. multi-touch capacitive display for optimal visualization. Pricing for the series ranges from $17,500 to $73,000, depending on the configuration.

Agilent's second offering is the InfiniiVision 6000 X-Series, which delivers 6 GHz of bandwidth at a price point starting at $29,500 — which Markley says is less than half the price of competitors' models with comparable bandwidth. The scope family also ups the ante for integration of other domains, incorporating an oscilloscope, logic analyzer (MSO), protocol analyzer, dual-channel WaveGen function/arbitrary waveform generator, digital voltmeter, and a 10-digit counter totalizer. This model is designed to handle the debugging and troubleshooting process as part of early design, Markley says.

This lineup includes two- and four-channel DSO and MSO models with 16 digital channels and with bandwidths from 1 GHz to 6 GHz at 20-GS/s sample rates; the InfiniiVision 6000 X-Series small size (15 lbs. and about 6 in. long) are about one-third the size of similar bandwidth scopes, setting a new standard in portability, he explains. Pricing for the InfiniiVision 6000 X-Series ranges from $14,900 to $42,500, depending on the configuration and options.

Following in the footsteps of the InfiniiVision 4000, the 6000 X-Series has a capacitive touchscreen and incorporates many of the capabilities users are accustomed to with their smartphones and tablets. "It's got all the things you've come to associated with tablets and smartphones, but it goes beyond just telling the scope you want to pinch and zoom," Markley says.

All of these developments spell one thing for engineers: Options to match the oscilloscope to the need. "Customers who've used spectrum analyzers before can [choose to] not use oscilloscopes; there are oscilloscopes of any bandwidth; and there's a convergence between oscilloscopes and other analyzers," Frost & Sullivan's Bommakanti concludes. "It's all about choice." DE

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INFO ➜ **Agilent Technologies:** Agilent.com

➜ **Frost & Sullivan:** Frost.com

➜ **National Instruments:** NI.com

➜ **Pico Technology:** Picotech.com

➜ **TechShop:** TechShop.ws

➜ **Tektronix:** Tek.com

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Making It Even Better

HP updates the first all-in-one workstation to release the HP Z1 G2.

BY DAVID COHN

In early January, HP unveiled the second generation of the world's first and only all-in-one workstation, the HP Z1 G2. When we reviewed the original Z1 (*DE*, August 2012), we raved about its design and performance. With the next-generation Z1 again aimed squarely at CAD and graphic arts, we were anxious to set it up and put it through its paces.

Like the original, the HP Z1 G2 combines a sleek design with workstation performance in a package that outwardly consists of little more than a 27-in. display and keyboard. But while the monitor houses the entire system, swapping out components is easy thanks to the Z1's innovative tool-less chassis.

New Touch Capability

The Z1 G2 workstation arrived in a large, flat box, similar to what you would receive if you bought a new flat-screen display. Once out of the box, however, the stand's hinge releases and unfolds at the press of a button so that it can be swiveled into an upright position. Also in the box were a 104-key wireless keyboard and wireless mouse. The receiver for the keyboard and mouse were already installed in the system's internal USB port. All we needed to do was extend the stand, plug in the power and turn it on.

Outwardly, the new Z1 G2 workstation looks nearly identical to the original Z1. With its stand fully extended, the system is about 23 in. tall. The display measures 25.75x17.75 in., but at 3.5 in. thick, it is a bit deeper than a standard LCD display. The 16x13-in. base is a bit larger than the base of a typical monitor as well, contributing to the overall 47-lb. weight of the system.

The 27-in. in-plane switching (IPS) white LED backlit LCD in the Z1 G2 also looked quite similar to the one in the original Z1, which is to say that it provided one of the best-looking images we've ever seen. With a 16:9 aspect ratio and native 2560x1400 resolution, the monitor is big, bright and crystal clear. But this time around, HP offers two options: a non-glare panel, similar to a conventional LCD, and an edge-to-edge glass panel.

Our evaluation unit came with the glass panel, which includes one of the enhancements over the original Z1 — touch, specifically Windows 8-compliant, 10-finger capacitive multi-touch. Although the touch capability adds $400 to the system price, it is a nice addition, particularly when you consider that you can fold the system into a more horizontal position so that it functions much like a tablet.

Thunderbolt Option

Like the Z1, when seated comfortably in front of the Z1 G2, all you see is the monitor. But its other components are readily available. An HD webcam is centered above the monitor. A white LED lights up when the camera is active, and a dial on the top edge lets you adjust the camera angle. A pair of digital microphones is hidden to either side of the camera; two pairs of cone speakers below the display provide great sound.

Along the right side of the panel (from top to bottom) are a power button, hard drive activity light, a slot load optical drive and eject button, a two-in-one media card reader, two USB 3.0 ports (one of which is also a battery charging port), and headphone and microphone jacks. Our evaluation unit came with a Blu-ray Disc writer, an option that added $235 to the system cost. A more conventional DVD-RW drive is also available for $150.

But the other big addition to the HP Z1 G2 is an optional Thunderbolt 2 module. This $235 add-on takes the place of the optical drive, and provides a pair of Thunderbolt ports for connecting external devices. For those unfamiliar, Thunderbolt is a hardware interface originally developed by Intel. It first showed up on Apple's 2011 MacBook Pro. A single Thunderbolt port supports up to six Thunderbolt devices via hubs or daisy chains. With full-duplex I/O speeds of 10 GB/sec, Thunderbolt delivers up to four times the bandwidth of USB 3.0. It is fast becoming a requirement for digital content creators, particularly filmmakers working with 4K video.

A serial number pull-out card is the only protrusion on the left side. Across the rear of the panel, positioned more conveniently than in the original Z1,

the Z1 G2 provides a subwoofer connector, audio line-out and line-in jacks, a DisplayPort connector, power cord connector, four USB 2.0 ports, an optical S/PDIF audio port and an RJ-45 network jack. There is also a slot for a cable lock in the lower-left corner of the case and a handle centered across the top.

The DisplayPort is actually a bi-directional port, so it can be used to enable the Z1 G2 to power a second monitor — or allow the Z1 G2 LCD to serve as the display for a separate workstation.

Updated CPUs

Internally, the Z1 G2 is laid out much like the original Z1. With the system folded down and locked into a horizontal position, a pair of latches unlocks the LCD panel. Once freed, the entire panel hinges open. With the open lid supported by a single hydraulic shock absorber, you have full access to an amazingly well organized interior.

Once open, swapping out components is extremely simple. HP's familiar green touch-points indicate where to grab and release components. Users can easily swap out the 400-watt, 90% efficient power supply, graphics card, hard drives, optical drive and cooling fan assembly. Blind mate connectors ensure that everything hooks up correctly.

There are also two miniPCIe full-length slots and one PCIe Gen3 x16 MXM slot. An Intel dual-band 802.11ac wireless LAN and Bluetooth 4 combo card comes standard on the Z1 G2, so if you don't want to see a network cable hanging off the back of your system, you can go wireless.

The choice of CPUs HP offers in the Z1 G2 is also a big step up from the original Z1. The Z1 we reviewed in 2012 used Sandy Bridge processors. But the Z1 G2 we received came equipped with a fourth-generation Haswell CPU, specifically an Intel Xeon E3-1280v3 processor. This 3.4GHz quad-core CPU with a 4.0GHz maximum turbo frequency is the fastest available for the Z1 G2.

Other, less-expensive options include the dual-core i3-4130, the quad-core i5-4570 (which lacks Hyper-Threading Technology), and two somewhat slower quad-core Xeon CPUs. However, potential customers may want to consider these options, because the E3-1280v3 adds $975 to the base system price.

A base Z1 G2, starting at $1,999, lacks touch capability and relies on the Intel HD Graphics built into the Core i3-4130 CPU. At that starting price, you also get just 4GB of non-ECC memory, a 500GB 7,200 rpm drive, and a DVD-RW optical drive.

For more demanding users, HP offers four NVIDIA Quadro graphic board options: the K610M, K2100M, K3100M

Single-Socket Workstations Compared

		HP Z1 G2 workstation (one 3.6GHz Intel Xeon E3-1280 v3 quad-core CPU, NVIDIA Quadro K4100M, 16GB RAM)	HP Z230 workstation (one 3.4GHz Intel Xeon E3-1245 v3 quad-core CPU, NVIDIA Quadro K2000, 8GB RAM)	Lenovo E32 SFF workstation (one 3.4GHz Intel Xeon E3-1240 v3 quad-core CPU, NVIDIA Quadro K600, 8GB RAM)	BOXX 3DBOXX W4150 XTREME workstation (one 3.5GHz Intel Core i7-4770K quad-core CPU over-clocked to 4.3GHz, NVIDIA Quadro K4000, 16GB RAM)	Ciara Kronos 800S workstation (one 3.5GHz Intel Core i7-2700K quad-core CPU over-clocked to 5.0GHz, NVIDIA Quadro K5000, 16GB RAM)	Lenovo E31 SFF workstation (one 3.3GHz Intel E3-1230 quad-core CPU, NVIDIA Quadro 400, 8GB RAM)
Price as tested		$5,918	$2,706	$1,479	$4,273	$5,714	$1,093
Date tested		5/3/14	11/24/13	11/10/13	7/31/13	5/31/13	12/29/12
Operating System		Windows 8.1	Windows 7	Windows 7	Windows 7	Windows 7	Windows 7
SPECviewperf 12	Higher						
catia-04		42.23	n/a	n/a	n/a	n/a	n/a
creo-04		30.82	n/a	n/a	n/a	n/a	n/a
energy-01		1.74	n/a	n/a	n/a	n/a	n/a
maya-04		33.79	n/a	n/a	n/a	n/a	n/a
medical-01		10.34	n/a	n/a	n/a	n/a	n/a
showcase-01		21.12	n/a	n/a	n/a	n/a	n/a
snx-02		40.37	n/a	n/a	n/a	n/a	n/a
sw-03		38.66	n/a	n/a	n/a	n/a	n/a
SPECviewperf 11	Higher						
catia-03		63.80	46.17	25.14	72.37	96.39	18.15
ensight-04		61.56	29.32	15.47	49.20	83.26	11.08
lightwave-01		82.76	87.98	75.52	100.78	103.15	46.79
maya-03		128.09	92.05	51.32	131.31	153.01	40.36
proe-5		17.18	20.25	15.61	24.74	22.87	10.29
sw-02		67.75	57.31	41.99	78.27	84.51	31.54
tcvis-02		58.99	38.78	23.74	55.73	77.82	16.53
snx-01		65.58	34.09	19.56	53.95	83.21	13.45
SPECapc SolidWorks 2013	Higher						
Graphics Composite		5.67	4.38	3.14	5.25	3.89	n/a
RealView Graphics Composite		6.16	4.69	3.09	5.38	4.1	n/a
Shadows Composite		6.13	4.68	2.96	5.36	4.1	n/a
Ambient Occlusion Composite		8.48	5.81	2.90	5.63	8.37	n/a
Shaded Mode Composite		5.55	4.75	3.25	5.12	3.79	n/a
Shaded With Edges Mode Composite		5.79	4.04	3.02	5.38	3.98	n/a
RealView Disabled Composite		4.08	3.35	3.31	4.74	3.15	n/a
CPU Composite		3.12	4.15	4.27	4.07	4.92	n/a
Autodesk Render Test	Lower						
Time	Seconds	45.00	49.00	48.66	42.00	58.33	64.00

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

and K4100M. All four are really mobile graphics processing units (GPUs), but are custom-mounted for the Z1. Our evaluation unit came with the top-of-the-line Quadro K4100M, with 1,152 compute unified device architecture (CUDA) cores and 4GB of dedicated GDDR5 memory — an option that added an additional $900 to the system cost.

The Z1 G2 can support up to 32GB of ECC memory in four easily accessible memory sockets. Our evaluation unit came with 16GB of RAM installed as two 8GB DDR3 ECC memory modules.

Storage options are improved in the Z1 G2. The drive bay is yet another of those removable components, a special caddy that supports either a single 3.5-in. drive or a pair of 2.5-in. devices, with a redundant array of independent disks (RAID) 0 or 1 available for dual-drive configurations. HP offers 3.5-in. 7,200 rpm drives ranging from 500GB to 3TB, as well as 10,000 rpm drives of 500GB or 1TB. But our system came with a 256GB mSATA-3 solid-state drive (SSD) as the boot drive, along with a 512GB SATA SSD — a combination that added a whopping $1,465 to the cost of the system.

Great Performance

Of course, it doesn't matter how good a system looks if it doesn't perform. Once we were done poking around inside the system, we closed the lid — the hydraulic shock absorber ensures that the LCD panel closes slowly and safely, locking with a satisfying click. We then powered the workstation back up again, and loaded our suite of benchmarks.

On SPECviewperf version 11, the HP Z1 G2 outperformed every other single-socket workstation we've tested in the past two years, except for those with over-clocked CPUs. SPEC has recently released SPECviewperf version 12, and the Z1 G2 is the second system on which we have run the new benchmark. We are including the results of this new test, and will eventually switch over to reporting just the SPECviewperf v12 results once we have enough systems to compare.

The results on the SPECapc SolidWorks 2013 test were excellent, with the HP Z1 G2 outperforming most of the other workstations we've tested on the graphics components of the test, though it fell behind on the CPU composite portion.

On the AutoCAD rendering test, a multi-threaded test on which faster systems with more CPU cores have an advantage, the HP Z1 G2 did well. It completed the rendering in 45 seconds, faster than all but the over-clocked systems.

The Price of Style

Our system came with Windows 8.1 Professional 64-bit. HP also offers Windows 7 as well as several versions of Linux. HP backs the Z1 G2 with a standard three-year warranty that covers parts, labor and support. Four- and five-year warranties are also available. Like other HP workstations, the Z1 G2 is fully independent software vendor (ISV)-certified for most CAD/CAM/CAE/DCC software.

We fell in love with the original Z1, so it is understandable that we became equally attached to the new Z1 G2. Budget-conscious buyers can purchase a base-level Z1 G2 for $1,999 — an attractive price when you consider that you're getting both a workstation and a high-end 27-in. IPS display. But the system we tested was anything but affordable. With nearly every top-of-the-line option available, our Z1 G2 priced out at $7,397, making it the most expensive single-socket workstation we've ever tested. Even with a 20% online discount, the price was still $5,918. We kept reminding ourselves that the price included a monitor.

And yet, it is still difficult to put a price on style. The Z1 G2 remains unique in the industry — a powerful all-in-one workstation sure to be the envy of those who walk into your office. And you could buy a Z1 G2 for thousands less by opting for a less-expensive graphics board and more conventional hard drives.

I wanted a Z1 the first time I saw one. Now I want a Z1 G2 on my desk, and I suspect many design firms are likely to feel the same way, in spite of its price. The Z1 G2 continues to set the mark for style and cutting-edge technology. DE

David Cohn *has been using AutoCAD for more than 25 years and is the author of more than a dozen books on the subject. He's the technical publishing manager at 4D Technologies, a contributing editor to* Desktop Engineering, *and also does consulting and technical writing from his home in Bellingham, WA. You can contact him via email at david@dscohn.com or visit his website at DSCohn.com.*

INFO → HP: HP.com

→ More Online: Watch a video HP created to unveil the Z1 G2: Youtube.com/watch?v=zleyDsxyRGw

HP Workstation Z1 G2

- **Price:** $5,918 as tested ($1,999 base price)
- **Size:** 26x20.8x16.5 in. (WxHxD) all-in-one
- **Weight:** 47 lbs.
- **CPU:** Intel Xeon E3-1280v3 3.6GHz quad-core with 8MB cache
- **Memory:** 16GB (32GB max) DDR3 1600MHz ECC
- **Graphics:** NVIDIA Quadro K4100M with 4GB GDDR5
- **Hard Disk:** 256GB mSATA SSD, 512GB SATA SSD
- **Optical:** Slot load Blu-ray Disc writer
- **Audio:** High-definition audio, dual-cone speakers, SRS Premium Sound
- **Video:** HD webcam
- **Network:** Integrated Intel I217LM PCIe Gigabit controller, Integrated Intel dual-band 802.11ac wireless LAN, Bluetooth 4.0
- **Drive bays:** Two internal 2.5-in. or one internal 3.5-in., one external 5.25-in. bay
- **Ports (side):** Two USB 3.0, Media Card reader, one headphone, one microphone/line-in
- **Ports (rear):** One DisplayPort, four USB 2.0, one RJ-45 to integrated LAN, one subwoofer output, one optical S/PDIF output, one audio line-in, one audio line-out
- **Ports (internal):** One USB 2.0 Type A on rear IO board, two internal on 9-pin header
- **Keyboard:** 104-key HP wireless keyboard
- **Pointing device:** Two-button optical HP wireless scroll mouse

Digital Training

Engineering students get digital access to simulation and design software training materials.

Faculty at Purdue University and Western Washington University faced a dilemma — how were their respective departments going to keep up with teaching techniques to reflect today's engineering workforce? More specifically, two professors wanted to change how they taught CATIA and Pro/ENGINEER.

With the ASCENT Center for Technical Knowledge, each program developed a curriculum that provided custom, relevant content in an easy-to-access format.

To learn the software, students had to purchase physical textbooks. Aside from being expensive, professors felt that these books provided a finite amount of information and were not always current with the software.

"Students in our programs benefit from our state-of-the-art labs. Unfortunately the software they work with evolves very quickly and physical textbooks have a hard time keeping up," explains Nathan Hartman, assistant department head and associate professor of the Computer Graphics Technology program at Purdue.

In Washington State, Associate Professor and Manufacturing Engineering CAD/CAM Option Coordinator Derek Yip-Hoi felt the same way, but also was concerned about the environmental impact of textbooks. By going 100% digital, the program could reduce its carbon footprint.

Digital Solutions

ASCENT offered two customized solutions for each university. Western Washington implemented eBooks and Purdue selected the ProductivityNOW portal.

The ProductivityNOW portal is a self-serve, online resource that allows students to access ASCENT's courseware content. It includes hands-on exercises and video demonstrations to assist students learning software features. It is also interactive, allowing students to obtain and add tips, techniques and review frequently asked questions about the program. After Hartman had chosen the program, it took about 48 hours to set up the entire portal, and he was immediately able to start using it in his courses.

On the West Coast, Yip-Hoi discovered ASCENT eBooks during a demonstration at an engineering educators' tradeshow. He then discussed options with ASCENT to develop a bundling of eBooks that students purchased through the campus bookstore.

With a bundling, students only needed to purchase one item for the course, instead of multiple manuals and guides. And even though most students didn't have CATIA on their laptops, they could download the eBooks to a mobile device, laptop or tablet to access when convenient. Furthermore, students could still access the information after the course had ended.

The Results

Hartman and Yip-Hoi have noticed significant benefits from implementing ASCENT's learning tools. Overall, they include a more convenient format, faster access to information, as well as useful teaching aids to accelerate learning.

The information is more up-to-date than traditional methods because ASCENT works to update materials as the software itself evolves in the industry. It is also easily accessible anytime, anywhere, since the platforms are web-based and available for mobile devices.

With ProductivityNOW, students can access course materials at their own pace and availability. Hartman has also observed that while using the portal, his students are using CAD software in unrelated classes. This may illustrate that students are able to learn faster and have a higher degree of confidence about their engineering software when learning about it at their own pace, he says.

With the eBooks, the platforms included advanced features for more detailed note taking of the course material. "There are some really nice features that ASCENT's eBooks offer that paper-based courseware simply can't," says Yip-Hoi. "Searching for topics using the 'table of contents' pane is much faster and instantly takes students to the section on which they want to work. Students can 'bookmark' pages for rapid access to topics that are referenced often, make notes, highlight text for future reference and more. Notes and highlights can also be shared with other users."

Not only did both solutions provide benefits for the professors, they had a positive effect on the larger campus community. At WWU, the bookstore only orders an eBook bundle when a student registers for a class. This way, managers are not left guessing about how many books to order, or left with excess inventory at the end of the semester. In working with ASCENT, both schools were able to develop cutting-edge technical education software that helped multiple groups in the university community, from the students to professors and even the bookstore. DE

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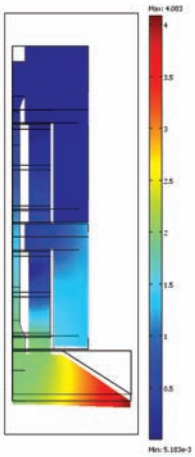
Making Smart Materials Smarter With Multiphysics

How does a company design a product with a material that exhibits certain characteristics only when exposed to a specific environment?

BY ALEXANDRA FOLEY



Materials that demonstrate different responses to varying external stimuli are known as "smart materials," and their discovery has led to the creation of products that perform on a whole new level. For example, magnetostrictive materials are engineered smart materials that change shape when exposed to a magnetic field. They have proven crucial for the production of transducers, sensors and other high-powered electrical devices.

Engineers at ETREMA Products Inc. design devices using magnetostrictive materials for defense and other industry applications including sensors, loudspeakers, actuators, SONAR and energy harvesting devices. The properties of magnetostrictive materials make designing these devices a challenge.

Simulation of Magnetostrictive Transducers

Researchers at ETREMA have found that multiphysics simulation can be used to accurately represent the material properties and complex physics interactions within such devices, facilitating the production of the next generation of smart products. To accurately model magnetostrictive transducers, ETREMA uses COMSOL Multiphysics. Their simulations include permanent magnets and coils, the magnetic fields created by these coils, stress and modal analyses of structural mechanics components, as well as heat transfer in the device to mitigate heat generated by eddy currents and hysteresis. Fully coupled models are used to evaluate the overall electro-mechanical characteristics of these transducers.

"When we first began to expand our engineering process to model such devices, our modeling techniques consisted of a system of disjointed methods that included hand calculations, equivalent circuits, and single-physics modeling," says Julie Slaughter, senior engineer at ETREMA. "However, our decision to move toward a devices and systems approach coincided with the advent of multiphysics finite element analysis and we adopted COMSOL as our modeling tool for systems-based modeling. This greatly improved our understanding of transducers and their design."

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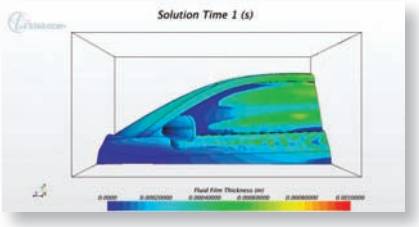
SPOTLIGHT

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.



CD-adapco Updates STAR-CCM+ CFD System

Version 9.02 includes volume rendering and new Dispersed Multiphase model.

One new feature of STAR-CCM+ Version 9.02 is volume rendering. You probably know this visualization technique from medical imaging or some Pixar movie. It's new to CFD simulation, thanks in part to advancements with graphics cards, workstations, cloud hardware in general and parallel processing.

Volume rendering can provide a more realistic view of what's going on inside. To do this, it uses a set of volume elements with opacity, color and lighting attributes applied to each element. Controlled yet adaptive resampling methods handle the computational loads.

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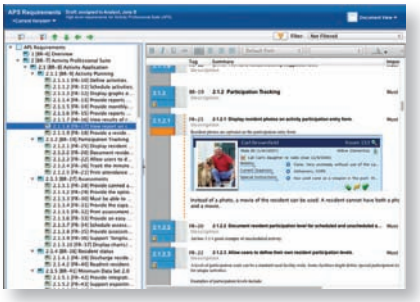

Seapine TestTrack 2014 Released

Update focuses on useability and new Seapine Cloud service.

For centralized test case management, TestTrack provides tools for creating, organizing, executing, measuring and reporting on both manual and automated product testing. It can track everything relevant to a test, such as test case details, test steps, variants and emails.

The new 2014 version of TestTrack brings a couple of new features that will interest new and existing users. Current users will be interested to know that version 2014 replaces the three previous web clients with a single interface and it has new search filtering capabilities.

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Dell Announces New M2800 Mobile Workstation

Released this spring, workstation includes 15.6 in. display, Intel processor.

Like Dell workstations and mobile units in general, the M2800 is configurable to meet your needs. CPU options, according to Dell, include fourth-generation Intel Core i5 and Intel Core i7 processors, which are dual-core and quad-core, respectively. The unit uses the AMD FirePro W4170M professional-level graphics card, which is equipped with 2GB of dedicated GDDR5 video memory. System memory can go up to 16GB, and can accommodate up to 1TB of storage.

Other features include external multi-monitor support and docking compatibility.

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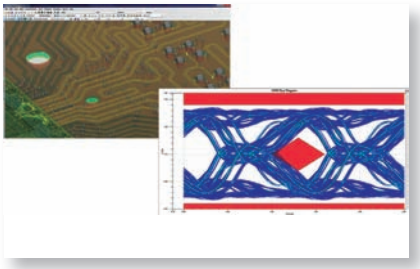

Electromagnetic Suite Simulates PCB and IC Designs

SIwave from ANSYS is a 3D platform for power and signal integrity.

SIwave is intended to help you evaluate an entire design from package to board, including the coupling effects between traces, packages and boards.

The core of the SIwave suite is a hybrid field finite element EM solver engine that provides frequency and time-domain analyses using your IC or PCB design's geometry. SIwave directly imports layout data from major ECAD package outfits like Mentor Graphics and Zuken, meaning that SIwave extracts frequency-dependent circuit models of signal nets and power distribution networks with the physical dimensions and characteristics of your design.

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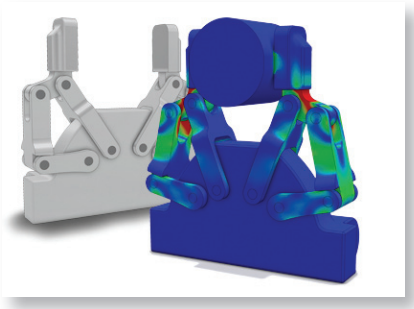

SolidWorks Application for 3DEXPERIENCE Announced

SolidWorks Mechanical Concepts provides tools for MCAD.

At its core, SolidWorks Mechanical Conceptual is a conceptual modeling environment that complements your SolidWorks MCAD system. It provides a suite of conceptual design tools, deploys a unified modeling environment and provides direct editing tools that, in Dassault's words, offer the benefits of parametric and history-free modeling.

A neat feature of this application is called Sketch Motion. This gives you the ability to evaluate concepts for fit and function using trace paths and area sweeps for early stage concept validation.

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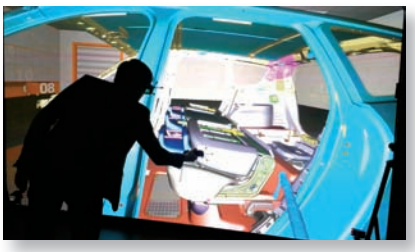

Immersive Environment for Manufacturing Updated

IC.IDO version 10 includes modules for realistic lighting and process planning.

ESI Group has announced version 10 of IC.IDO, its immersive virtual reality solution tuned for engineering and manufacturing. IC.IDO combines stereographic visualization hardware and what ESI calls IC.IDO Visual Decision Platform Software that enables you to virtually and interactively engineer, build, service and present assemblies and designs. IC. IDO gives you the ability to unify high-end visualization and real-time simulation of product behavior in or near its actual size.

Version 10 of IC.IDO is enhanced with two new modules: IDO.Illuminate and IDO.Process.

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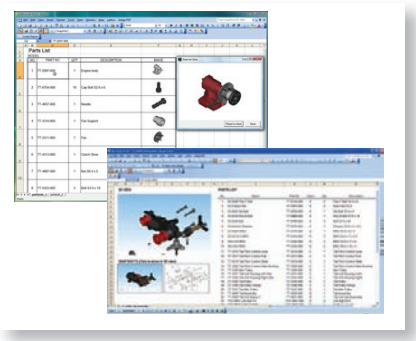

Create 3D Interactive Spreadsheets

Lattice3D Reporter plug-in updated to version 7.1.

Lattice3D Reporter works from inside of Excel. It lets you create Excel spreadsheets with embedded interactive 3D XVL models. XVL technology, developed by Lattice, has the algorithms that let you compress 3D models from pretty much any CAD system into a highly accurate yet lightweight 3D file.

In version 7.1, you can create 3D interactive PDFs of your XVL-extended spreadsheets that can be viewed and used by anyone with Adobe Reader.

Lattice3D Reporter can also work as a stand-alone system in addition to integrating with your ERP and PLM systems.

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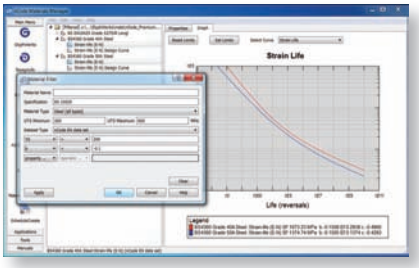

Premium Materials Database Launched

Database from HBM-nCode has 72 materials including steel, aluminum alloys.

The first release of the Premium Materials Database in nCode 10 provides fatigue-centric property data on 72 materials, and the company says it plans to add 20 to 30 materials to the database each year. This initial release offers a set of fatigue properties for commonly used steels and aluminum alloys. The database identifies materials according to international standards like ISO and DIN whenever possible. The database also provides statistical estimates of scatter, which will help you assess reliability and certainty of survival percentages.

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A Very Compelling Release

AutoCAD 2015's new look is much more than skin deep.

BY DAVID COHN

The latest update to AutoCAD is the 29th major release of the world's most popular CAD program. You would think that after all these years, there would be little left to change. But somehow, Autodesk has once again found ways to improve upon its venerable flagship product. While some of those changes may at first seem merely cosmetic, the depth and breadth of improvements and new features combine to make AutoCAD 2015 one of the most significant updates in years.

First impressions are important. So every few years, Autodesk modifies what happens when you first load AutoCAD. This time, the change is truly an improvement: When you first start AutoCAD 2015, instead of a Welcome dialog, you are greeted by the New tab. You also see this tab when there are no drawings open, and you can easily switch to the New tab at any time.

The New tab contains two sliding content frames: Learn and Create. The Create frame is displayed by default and serves as a launch pad where you can access sample files, recent files, templates, product updates and the online community. The frame is divided into three columns:

1 The Get Started column lets you quickly begin a new drawing from a default template or from a list of available drawing templates, open an existing drawing or sheet set, get more templates online and explore sample drawings.

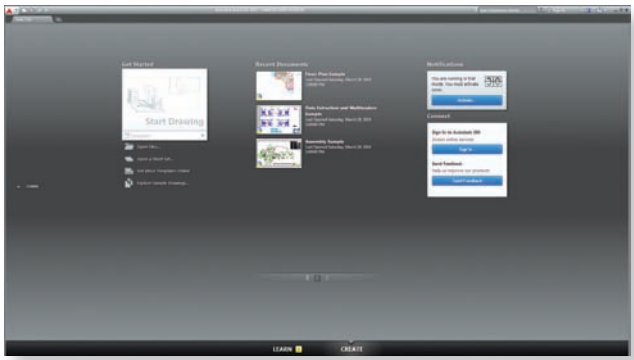
2 In the Recent Documents column, you can view and open your recent drawings, choose how these drawings are displayed, and pin drawings to ensure that they remain in the list.

3 The Connect column provides links to sign into your Autodesk 360 account and send feedback to Autodesk.

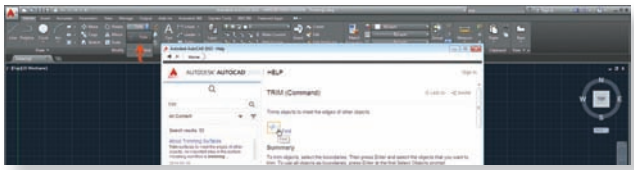
The Learn frame provides tools to help you learn AutoCAD 2015, and includes links to getting-started videos and online resources.

More Responsive Interface

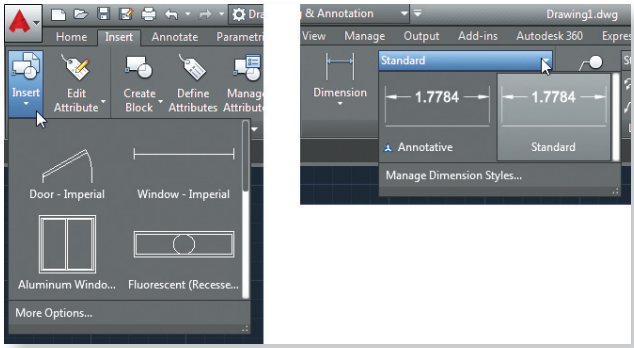
The Help system, always a great way to learn how to use new features, now includes a new way to help users locate the relevant tool within AutoCAD's interface. Once you have located information in the Help system, you can click to display an animated arrow that points you to the appropriate tool in the AutoCAD ribbon. If the tool is not accessible from the current workspace, or is located in a hidden tab or



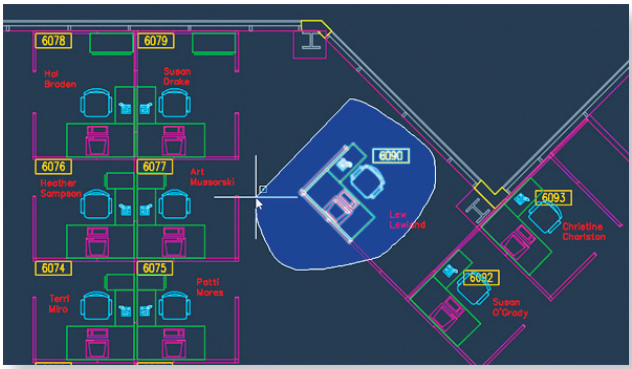
The New tab consolidates file access tasks to one easily accessible central location, reducing the number of steps needed to open existing drawings or start new ones.



When using Help, an animated arrow now points you directly to the specific tool in the AutoCAD ribbon. AutoCAD 2015 also sports a new, dark-themed interface designed to reduce eyestrain.



Galleries make it easier to insert blocks and manage styles for controlling text, dimensions, multi-leaders and tables.



With the new lasso selection, you can click and drag around or through objects to select them.

panel, a tooltip tells you exactly where to find the tool.

The program also sports a modern, dark-themed interface that the company claims helps to reduce eyestrain. It is quite easy to switch to a more traditional light theme, however, if you prefer. But it's not just the colors that are new. The entire bottom of the program window has been reorganized. The tools in the Status bar have been consolidated into a single area located in the lower right, while the Model and Layout tabs have been moved into the lower left. This opens up more space to work on drawings.

Only the most-often used tools appear on the Status bar, which is now easily customizable. Status bar tooltips are also more informative, so you can see at a glance the status of each tool. And instead of having to right-click on Status bar buttons to access additional controls, many of the tools now include flyout buttons. When clicked, these menus remain open until you close them.

For example, when you open the Object Snap menu, instead of closing after you toggle a single running object snap mode, the menu remains open until you click somewhere else in the interface, so you can make multiple changes.

The Layout tabs to the left of the Status bar have also been significantly enhanced. A new "+" icon lets you quickly add new layouts. When you move the cursor over a layout tab, a tooltip displays the layout name in addition to a preview image. And if your drawing includes more layouts than space allows, an overflow menu provides easy access to those additional layouts.

The ribbon has also been updated to include galleries for inserting blocks and selecting predefined styles for controlling text, dimensions, multi-leaders and tables. For example, you now see exactly what blocks look like before you insert them into your drawing, and you can insert them directly from the gallery rather than having to use the Insert dialog.

More Intuitive Graphic Previews

Under the hood, AutoCAD 2015 features a completely new accelerated graphics system that includes automatic anti-aliasing and improved visual feedback. For example, when moving objects, the selected objects are displayed in their original position with a faded deletion effect instead of as dashed lines. You also see actual color, linetype and lineweight as you create or edit objects. When you select objects to modify, their color changes and they appear thicker, helping you see exactly which objects are part of the selection set.

One particularly exciting new feature is the lasso selection. In AutoCAD 2015, you can click the cursor in a blank area of the drawing, then drag around objects to create a lasso window, crossing or fence selection.

AutoCAD 2015 also enables you to preview the results of trim, extend, lengthen, break and match properties operations prior to actually selecting the objects and completing the command. For example, when trimming objects, you can pass the cursor over the object you want to trim, the segment to be removed is dimly displayed, and a cursor badge indicates that it will be deleted.

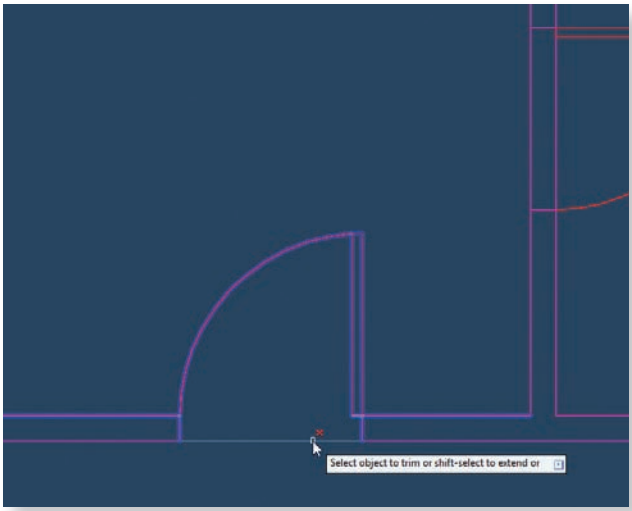
Similarly, when you pass the cursor over an object to be extended, it is temporarily extended so you can preview the results. Similar previews display when breaking or lengthening objects.

The cursor itself is also now more informative, displaying badges to reflect the operation being performed. For example, a rotate badge appears when rotating objects, a move badge when moving objects, and so on.

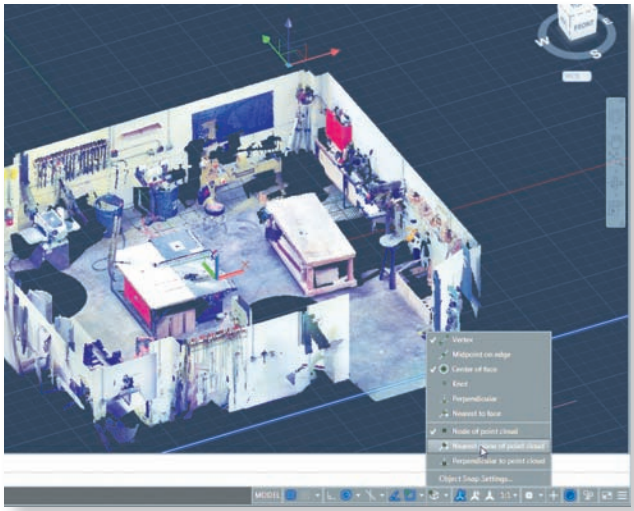
Improved Text and Dimensions

Model space viewports have been around in AutoCAD for years with little change. But now, these viewports are suddenly much easier to use. In AutoCAD 2015, after creating multiple viewports in model space, a bright blue boundary clearly identifies the active viewport, and you can easily resize any viewport by dragging the horizontal or vertical viewport boundaries. New "+" icons on the viewport boundaries also let you easily add more viewports by simply clicking and dragging, rather than having to use dialog boxes. You can also hold the CTRL key while dragging a viewport boundary to split it into two model space viewports, or join viewports by dragging a boundary to the edge.

Engineering drawings often include a lot of annotations, and AutoCAD has had text capabilities that rivaled those of full-fledged word processors. But AutoCAD 2015 improves upon previous offerings quite a bit. The updated multi-line text editor environment provides better visibility and control, and offers much more intuitive tools for resizing columns — allowing you to adjust both the height and width individually or simultaneously. The program can now automatically apply bullets or numbering, and correct text when you press the SHIFT key while Caps Lock is enabled. There are also new subscript and superscript tools, improved autostacking capabilities for fractions and tolerances, and vastly improved tools for controlling paragraph tabs.



When editing objects using commands such as trim and extend, you now see the results of operations before completing the command.



AutoCAD 2015 adds tools that make it easier to work with point clouds, including new cropping and object snap capabilities.

The text editor also includes a new Match Properties tool, so you can apply properties between selected text within a multi-line text object. This works for all multi-line objects, including dimensions and tables. And a new text alignment tool enables you to quickly align and adjust the spacing of text and attributes.

Dimensioning capabilities have also been improved. Now, when placing dimensions, existing dimension extension lines are ignored to prevent you from inadvertently snapping to them while attempting to pick nearby geometry. And when creating continued or baseline dimensions, the new dimension automatically inherits both the layer and the dimension style of the dimension that is being continued or used as a baseline.

Improved Geographic Location Tools

AutoCAD 2014 added some terrific geographic location tools, but those tools had several limitations. Most of those limits are now eliminated. Although you still need to be signed into your Autodesk 360 account to access Online Map Data, if you are not signed in or choose not to use the online data, you can still use the Geographic Location tool to enter latitude and longitude. When you do use the online map data, the Geographic Location tool has been streamlined to guide you through the process of specifying a geographic location.

Once you have attached geographic data, map resolution improves as you zoom in — and you can now capture map data. Captured map data is embedded into the drawing so it can be viewed and plotted, even when you turn off online maps or have no Internet access. You can even select embedded map data and use grips to move, resize and rotate the image boundary.

When you change the image boundary, AutoCAD automatically re-queries the online map data and updates the image accordingly. New slider bars let you adjust the brightness, contrast and fading of the map image, so you can more easily see relevant AutoCAD geometry.

Making Point Cloud Data Usable

Another exciting new feature in AutoCAD 2014 was a revamped set of tools for working with point clouds. Those tools have also been significantly enhanced in AutoCAD 2015, including an updated version of Autodesk's ReCap point cloud manipulation software. With these new tools, Autodesk has dropped the ability to attach point clouds saved in the PCG and ISD format, but if you open a drawing to which those older point cloud files are attached, they will still display and you can select and modify their properties.

The new point cloud capabilities include an option for using geographic location data if it is available within the new RCP and RCS point cloud files. Once attached, you can control the point size and level of detail and better visualize cloud-based data. More intuitive tools make it easier to crop point clouds, and you can switch views — say, from a plan to an elevation view — and continue to refine the cropping boundary.

The biggest point cloud enhancement is a new set of point cloud object snaps that make it feasible to create actual AutoCAD geometry based on point clouds. If the point cloud includes segmentation data, you can snap to the nearest point on planar segments or perpendicular to planar segments, and use the UCS tool to align the user coordinate system to a plane in a point cloud.

Other Enhancements

A major addition to the 2014 product is the new Design Feed environment, which allows users to carry on a virtual conversation with other team members. Although the Design Feed tools work largely as they did in the previous release, you can now choose to save data locally rather than in your cloud-based Autodesk 360 account. That way, anyone with an Autodesk 360 account who also has access to your server can access the Design Feed data associated with each drawing. If you subsequently use AutoCAD's eTransmit, Archive or DWG Convert tools, you can choose whether Design Feed data is retained or removed from the drawings.

AutoCAD 2015 also uses a new Autodesk Translation Framework (ATF) when importing model data from other formats such as CATIA V4 and V5, Pro Engineer, SolidWorks, Parasolid, JT, NX, STEP, Rhino and IGES. ATG supports importing meshes and curves, as well as object colors and layers.

Rounding out the new AutoCAD 2015 release are enhanced customization tools, a new Autodesk Application Manager that helps you stay current with the latest updates for all Autodesk applications and suites, and a performance reporting tool that can analyze and troubleshoot any performance issues you may encounter while using the software.

Autodesk continues to place increased emphasis on its suites, which provide some pretty good deals. For example, in addition to AutoCAD itself, the AutoCAD Design Suite Standard edition includes AutoCAD Raster Design, Showcase and Mudbox for just $330 more than the cost of AutoCAD alone. The Professional Suite adds 3ds Max, while the Ultimate Suite also includes Alias Design. Note that SketchBook Designer is no longer included in any of the suites.

Most of the new features in AutoCAD 2015, including the interface enhancements, text and dimensioning improvements, and updates to map data and Design Feed, are also included in AutoCAD LT 2015, the company's lower-cost, 2D-only alternative to AutoCAD.

Both AutoCAD and AutoCAD LT 2015 began shipping in late March; the Design Suites followed in April. AutoCAD 2015 supports Windows 7 and Windows 8 only (no more support for Windows XP), and is available in both 32- and 64-bit versions.

Once again, Autodesk has done an amazing job of improving its flagship product. With truly significant performance and graphic improvements and a host of new features, most users will want to upgrade to AutoCAD 2015. DE

David Cohn *has been using AutoCAD for more than 25 years, and is the author of more than a dozen books on the subject. He's the technical publishing manager at 4D Technologies, a contributing editor to Desktop Engineering, and also does consulting and technical writing from his home in Bellingham, WA. Watch for his latest CADLearning eBooks on AutoCAD 2015 on the Apple iBookstore, at Amazon, and on the CADLearning website. You can contact him via email at david@dscohn.com or visit his website at DSCohn.com.*

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AutoCAD 2015

- **Full system:** $4,195
- **Annual subscription:** $2,100
- **Upgrade from AutoCAD 2009-2014:** $2,935

AutoCAD LT 2015

- **New:** $1,200
- **Annual subscription:** $360
- **Upgrade from AutoCAD LT 2009-2014:** $840

SYSTEM REQUIREMENTS

- **Operating System:** Windows 8 or Windows 7; 64-bit or 32-bit
- **CPU:** Intel Pentium 4 or AMD Athlon dual-core (3.0GHz or greater recommended)
- **Memory:** 2GB RAM, 8GB recommended
- **Disk space:** 6GB free disk space for installation (4GB for AutoCAD LT)
- **Video:** 1024x768 VGA with true color minimum (1600x1050 recommended)
- **Other:** Microsoft Internet Explorer 9.0 or later web browser

Advertising Index

Commentary

by Bernie Rosenthal

Meet Fuel Mandates with CFD

The regulatory landscape for automobile emissions continues to evolve. In February, the European Commission endorsed new, substantially lower target emissions for carbon dioxide (CO_2) emissions from motor vehicles. In March, the U.S. Environmental Protection Agency (EPA) also announced new, tighter fuel emissions standards to help curb greenhouse gas emissions.

For today's engine and automobile manufacturers, designing engines that meet mandates for cleaner fuel standards is a growing challenge. While regulatory agencies require cleaner burning engines, the market demands more powerful motor vehicles with improved fuel economy. To streamline the design of high-efficiency, low-emissions engines, computational fluid dynamics (CFD) simulations allow engine designers to visualize and test fuel and ignition behaviors within a virtual combustion chamber, using software instead of costly physical prototyping. Virtual prototyping using CFD gives engine manufacturers a faster way to design cleaner, more efficient engines by simulating ignition and fuel dynamics.

To ensure simulations can predict fuel effects requires an understanding of fuel chemistry.

To ensure that simulations can accurately predict real-life pollutant emissions from internal combustion engines requires CFD simulation tools that accurately account for chemical kinetics. Combustion performance is one of the key areas of design optimization in the automotive development process, and at the heart of combustion is chemistry. Understanding and accurately predicting the effects of fuel chemistry in a combustion system is critical to developing competitive real-world engines with superior performance and lower emissions.

Improving Accuracy

Motor fuels are very complex. Not only do they vary by seasonal formulation (for instance, in the U.S. summer-grade gasoline contains less butane than winter formulations), fuels differ by region: Diesel fuel used in the U.S. has different properties than diesel fuel used in Europe. In addition to fuels composed of hydrocarbons, there are non-carbon-based alternative fuels such as ethanol and bio-diesel. To add to the complexity, certain chemical species in fuels contribute more to emissions than others, underlining the need for multi-component, chemically precise fuel models for accurate modeling.

To improve the predictive accuracy of combustion simulation, the Model Fuels Consortium, a 20-member group that included leaders in energy and engine manufacturing, pioneered the use of "surrogate modeling." With this process, complex fuel chemistry could be represented by a reduced number of well-characterized molecular models and reactions selected to accurately simulate specific behaviors such as pollutant-emission production. The consortium, which included Toyota, GM and Volkswagen, among other global automakers, identified 56 fully validated fuel components comprised of more than 4,000 chemical species. These findings were compiled in the Model Fuels Library, a database of detailed chemical mechanisms for use in combustion simulations.

Getting to the Root of Soot

Soot emissions are particularly difficult to predict with conventional CFD simulations. Soot formation involves multiple complex chemical interactions combined with physical interactions that take place in an engine. Engine operating conditions such as combustion pressure, temperature, fuel-air equivalence ratio, quantity of exhaust gas recirculation (EGR), and boost level can all affect the formation of soot. And once a soot particle is formed, it can grow and combine with other soot particles through agglomeration, or it can oxidize. Because of the many factors that can combine to give rise to soot, it is difficult to represent with simple modeling tools and single-component, severely reduced fuel models used in most conventional CFD packages.

To ensure that simulations can accurately predict real-life fuel effects requires more than just the use of complex algorithms to describe the physics and thermodynamic behavior of combustion; they also require a detailed understanding of fuel chemistry.

The FORTÉ CFD Package by Reaction Design, now part of ANSYS, provides engine designers with tools to create CFD combustion simulations. Fuel components derived from the Model Fuel Library help simulate combustion for a variety of new or existing fuel blends, and foresee what emissions will occur for a wide range of operating conditions. Multi-component fuel surrogate models also help predict where and when soot will form in the combustion chamber under varying factors.

By using accurate fuel models based on precise chemistry, engineers can increase the predictive quality of combustion simulations — helping them more quickly and effectively meet strict regulatory guidelines, and create advanced clean engine and fuel technologies. DE

Rosenthal *is general manager of Reaction Design for ANSYS. Send e-mail about this article to DE-Editors@deskeng.com.*

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