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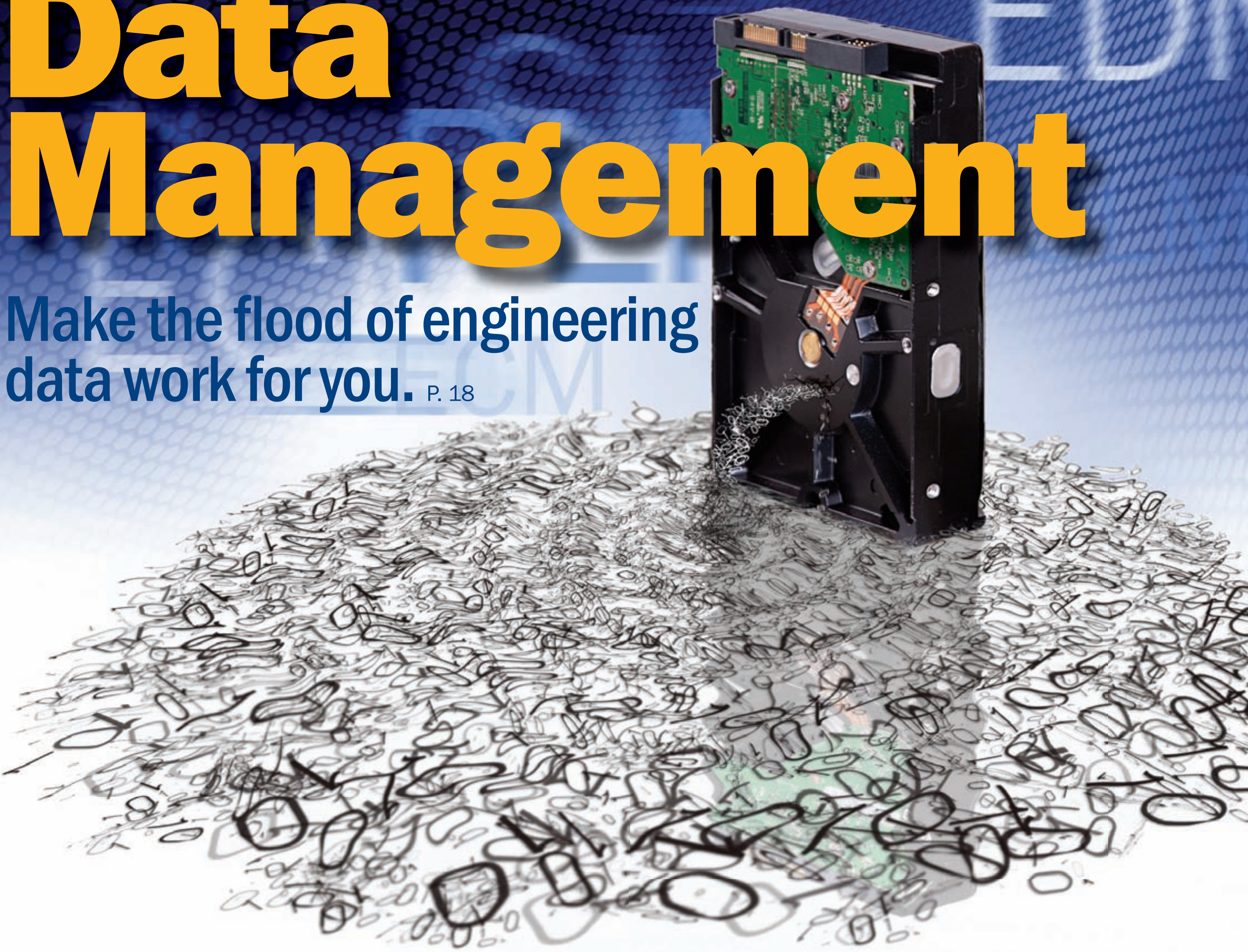
Data Management



by Jamie J. Gooch

More Data, More Problems

We've all heard of the beneficial role "big data" promises to play in our lives—from enabling more accurate simulation of weather patterns, saving lives that would otherwise be lost to Mother Nature's fury; to finding hidden patterns in disease management, which could unlock cures. Of course, less lofty goals are also being realized with big data. Proponents would have you believe that soon every business decision—from which product to design to how to sell it—will be based on aggregate consumer data from Google, Facebook, Amazon and the rest of our increasingly digital lives, and they may be right.

But all that data has to be stored and delivered from somewhere. There's an impulse to view data as ethereal bits of 1s and 0s floating in a white puffy cloud. It seems almost bucolic. The reality is quite different. Tens of thousands of worldwide data centers take up real space and inefficiently use large amounts of power even as they idle, waiting to respond to spikes in demand. All those servers need to be kept cool somehow. Diesel generators and banks of batteries are at the ready in case power is interrupted.

HP promises to reduce server energy use by 89% and cost by 77% with its Moonshot system.

According to the *New York Times* ("Power, Pollution and the Internet," Sept. 22, 2012) data centers use about 30 billion watts of electricity, which is about the output of 30 nuclear power plants, and only 6 to 12% of that power was going toward performing computations.

Search for Solutions

In Hong Kong, where the demand for space is high, the government is looking into building underground data centers, with the added benefit that subterranean caverns are naturally cool. Of course, it's not as simple as carrying some servers into a cave. Excavation, toxic mineral removal and lowered water tables would all impact the environment.

There are less drastic options for reducing data centers' energy usage, including better software to manage the peaks and valleys of demand, and marrying that to more efficient cooling systems. But more solutions are needed as demand for data continues to grow.

HP's Moonshot

HP says it has the answer. Last month, it launched its Moonshot servers, which the company says use 89% less energy, 80% less space and cost 77% less, compared to traditional x86 servers.

"With nearly 10 billion devices connected to the internet and predictions for exponential growth, we've reached a point where the space, power and cost demands of traditional technology are no longer sustainable," said Meg Whitman, president and chief executive officer of HP in a press statement. "HP Moonshot marks the beginning of a new style of IT that will change the infrastructure economics and lay the foundation for the next 20 billion devices."

Moonshot uses Intel Atom system-on-a-chip cards, the same chips used to power many portable phones and tablets. Processors from other companies will come later, each targeting a specific workload, according to the company.

The first HP ProLiant Moonshot server is available with the Intel Atom S1200 processor and supports web-hosting workloads. HP Moonshot 1500, a 4.3u server enclosure, is fully equipped with 45 Intel-based servers, one network switch and supporting components.

Each chassis shares traditional components including the fabric, HP Integrated Lights-Out (iLo) management, power supply and cooling fans. HP says these shared components reduce complexity as well as add to the reduction in energy use and space.

"Testing results show that with Moonshot servers we can expect to run hp.com with the energy equivalency of a dozen 60-watt light bulbs, which is a game changer," said John Hinshaw, executive vice president, Technology and Operations, HP in the Moonshot press statement.

While nearly every press release in my inbox promises to be a game changer, the Moonshot system is capable of shifting the infrastructure we rely on for our data needs, big and small.

I think Moonshot is an appropriate name. It represents a risk for HP, which released the first commercially successful x86 server and has been an x86 server market leader for the last 16 years. Now it seeks to shake up the market it sits atop. It's a good move. We're not going to need less data or want to waste more energy as the global cloud approaches a brontobyte — that's a one with 27 zeroes behind it. It won't happen overnight, but data centers now have an option to lower their hardware costs and energy usage. **DE**

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

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FOCUS ON DATA MANAGEMENT

ON THE COVER: Data leaks from a hard drive.
Image courtesy of Big Stock Photo.

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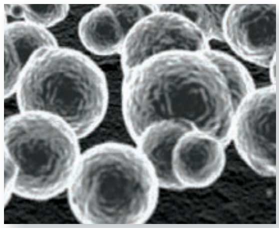

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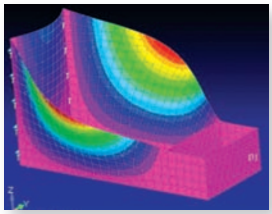

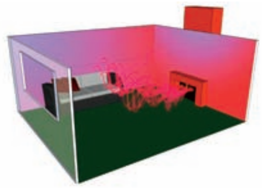

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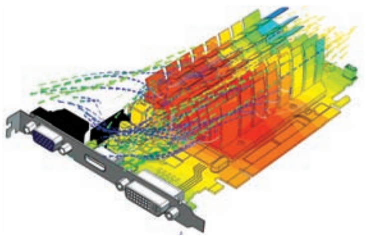

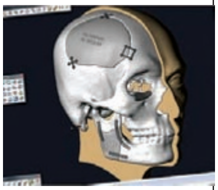

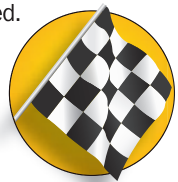

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by Kenneth Wong & Beth Stackpole

NVIDIA GTC 2013 Roundup

At NVIDIA GTC 2013, the company introduced the NVIDIA VCA, a GPU-accelerated hardware unit capable of supporting up to 16 concurrent users.

Mountain climbers know Piz Daint, measuring 9,700 ft., as part of Switzerland's snow-dusted Ortler Alps. Researchers and supercomputer nerds, however, know another Piz Daint—installed inside the Swiss National Supercomputing Center (abbreviated as CSCS in Swiss). Because supercomputers are used for, among other things, accurate weather prediction, the microclimates of the Piz Daint in the Alps could be computed on the Piz Daint at the CSCS.

The supercomputer is a Cray XC30 system. Its current performance is listed as 216 teraflops, according to Top500.org. But it's about to get faster, according to NVIDIA: When it's retrofitted with Kepler graphics processing units (GPUs), its speed will go up to 1 petaflop.

Remote Access

For those who need GPU acceleration on a more modest scale, NVIDIA CEO Jen-Hsun Huang unveiled a new product during his keynote address to the audience at the recent GPU Technology Conference (GTC). In NVIDIA's words, the NVIDIA Grid VCA (visual computing appliance) is "a powerful GPU-based system which runs complex applications such as those from Adobe, Autodesk and Dassault Systèmes, and sends their graphics output over the network to be displayed on a client computer."

With prices beginning at $24,900, the appliance—literally a box housing a set of GPUs—can support anywhere from eight to 16 users. The hardware can be configured with eight or 16 GPUs, enabling users to assign one GPU to each virtual machine. It could become a solution for businesses looking to provide virtual machines with powerful graphics, accessible remotely.

In the same keynote, Gian Paolo Bassi, SolidWorks' VP of R&D, joined NVIDIA's Huang on stage. Their joint demonstration showed SolidWorks mechanical modeling software running on a remote virtual machine, hosted on NVIDIA Grid VCA. With such a solution, Windows-based SolidWorks could be remotely delivered to engineers and designers on Mac OS, for example. Similarly, workstation-level performance could be delivered to lightweight mobile devices—provided the bandwidth is wide enough to accommodate the data traffic.

SolidWorks' parent company, Dassault Systèmes, has also done additional work to add GPU acceleration to its flagship high-end modeler, CATIA. The latest version, CATIA V6, includes CATIA Live Rendering, an interactive display mode that allows users to work with large assemblies in a fully rendered, ray-traced state. CATIA Live Rendering is powered by iray rendering technology from NVIDIA. In Maximus-class workstations, CATIA's rendering workload could be distributed on as many as three GPUs.

CAD over Cloud

A new breed of companies, like MAINFRAME2, which displayed its products at GTC, is emerging with an intriguing proposition. Suppose your company develops and markets 3D modeling software, traditionally sold as a program to install and run on a workstation. MAINFRAME2 can step in and provide you with the necessary hosting, IT setup, billing, analytics and load balancing capacity to offer your software as an on-demand, cloud-hosted solution.

According to the company, "MAINFRAME2-powered apps work on all PCs, Macs and even tablets. These apps are delivered as interactive streaming video and require minimal local resources." While Nikola Bozinovic, founder of MAINFRAME2, was not prepared to name names at press time, he did say he was in discussions with several major CAD developers.

The virtualization technology in NVIDIA's Kepler-brand GPUs and its new product Grid VCA point to a future where more users will log on to a virtual machine instead of a real machine. New companies like MAINFRAME2 are poised to harvest the trend, as the middlemen and middleware providers to turn popular software titles into Software-as-a-Service (SaaS) offerings.

—K. Wong

Autodesk and ANSYS Acquire Composite Simulation Software Providers

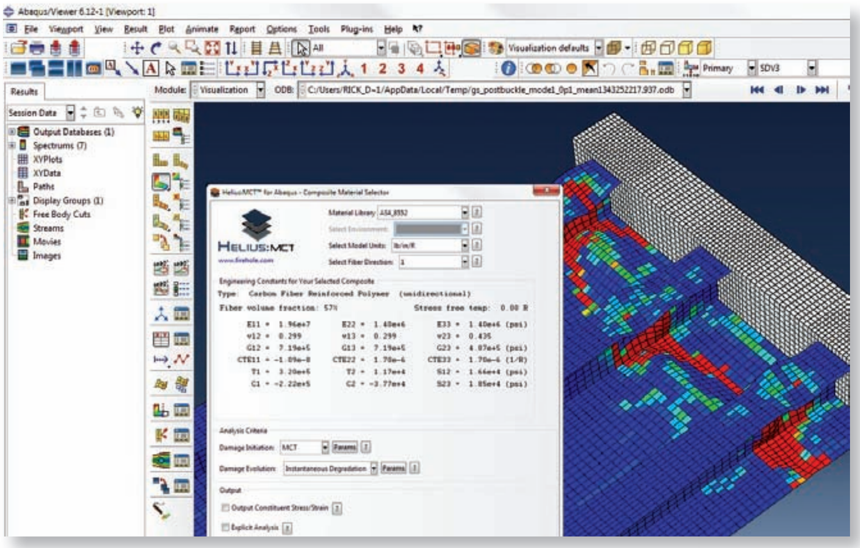
Dassault Systèmes offers composite simulation as part of its CATIA 3D Experience platform, and Siemens PLM Software made an aggressive play to address simulation of composite materials with its 2011 acquisition of Vistagy, which has a huge following in the aerospace sector. Now jumping into the fray is Autodesk and ANSYS.

Autodesk, which has already built out a pretty robust simulation software portfolio via its acquisitions of Algor (for finite element analysis, or FEA, capabilities), Blue Ridge Numerics (for computational fluid dynamics, or CFD, functionality), and MoldFlow (for injection-molding analysis).

Autodesk's latest target is Firehole Technologies, a privately held firm specializing in design and analysis software for composite materials. The firm's flagship product, Helius:MCT, delivers advanced capabilities for FEA of composite materials, taking a multiscale approach to evaluating progressive failure, damage tolerance and structural response of composite parts.

Adding composites simulation to the Autodesk simulation portfolio is critical now, as the usage of carbon fiber materials has escalated. This trend is being driven by companies' need to consider alternative materials to reduce weight, make products more energy-efficient, and increase safety.

"In the last 20 years, composites have gone from being an exotic material used by NASA to an everyday material now used in sporting goods equipment—and increasingly, by automotive [original equipment manufacturers]," says Ian Pendlebury, Autodesk's senior director of simulation products.



With its acquisition of Firehole Composites, Autodesk gains a family of composite materials simulation packages, including Helius:MCT, which runs as an extension to standard FEA solvers. *Image courtesy of Autodesk.*

With Firehole's product line, Autodesk will be able to offer composite engineers the ability to model layered woven and continuous fiber composites, an approach readily used in the aerospace and automotive industries, he explains.

ANSYS cited composites' popularity in a range of industries when announcing its acquisition of EVEN, based in Zurich, Switzerland.

"Because they combine light weight, high strength and outstanding flexibility, composites have become standard materials for manufacturing in a range of industries, including automotive, aerospace, energy, marine, motorsports and leisure. As a result, the use of composites has grown dramatically in the last decade," The company reported. "This popularity has fostered the need for new design, analysis and optimization technology. Since EVEN is a leader in composite simulation, this acquisition emphasizes the high priority ANSYS is giving to this emerging technology."

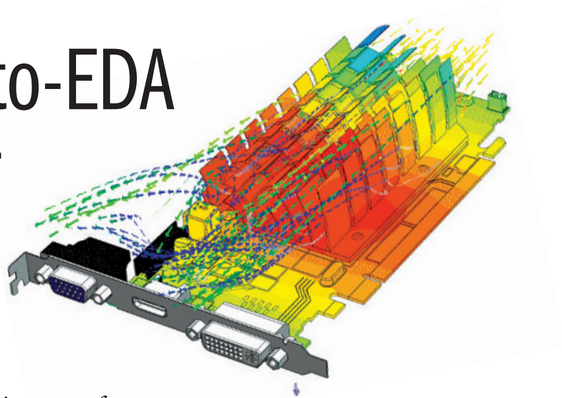
Oliver König, Marc Wintermantel, and Nino Zehnder founded EVEN in 2004, as an offshoot of their Ph.D. theses in the field of Structural Optimization at the Swiss Federal Institute of Technology in Zurich. The company is known for OpLyX software, an optimization platform compatible with widely adopted simulation software packages like CATIA, Abaqus, ANSYS, Nastran, and MATLAB. The software is deployed by Formula 1 design teams because, according to EVEN, "ComPoLyX provides advanced composite failure analysis including some unique algorithms that allow to calculate interlaminar shear and normal stresses out of standard layered-shell FEM-models."

The technology footprint of EVEN is found in ANSYSComposite PrepPost, tightly integrated with ANSYS Mechanical and ANSYS Mechanical APDL.

—B. Stackpole and K. Wong

by Kenneth Wong & Beth Stackpole

Mentor Builds an MCAD-to-EDA Bridge With FloTHERM XT



With FloTHERM XT, surface temperatures and 3D particle plots can help assess the effectiveness of a new heat sink design, which has curved geometry so it fits in an enclosure. *Image courtesy of Mentor Graphics.*

Mentor Graphics has combined the electronics cooling DNA from its FloTHERM thermal analysis software with the concurrent computational fluid dynamics (CFD) technology at the heart of its FloEFD product to deliver a new solution to let engineers work seamlessly with geometry created in both the mechanical CAD and EDA space.

Called FloTHERM XT, the software is designed to deliver electronics cooling simulation capabilities that can be leveraged throughout the design cycle, from concept through verification. The idea behind FloTHERM XT is to create bridges and optimized integration between mechanical design and EDA tools and workflows in the specific area of electronics cooling. The goal is to enable earlier virtual prototyping, a reduction in design iterations, and promoting more advanced "what-if" analysis, according to Eric Buergel, general manager of Mentor's Mechanical Analysis Division.

By optimizing the MDA/EDA workflows, FloTHERM XT dramatically shortens the design cycle because potential problems are caught far earlier, reducing the number of iterations, Buergel says. Moreover, because FloTHERM XT lets engineers work with geometry created in either the MDA or EDA world—and its user interface and solving engines take a lot of the complexity out of the meshing process—design engineers, not just CFD specialists, can take advantage of the capabilities. That means simulation is pushed further up in the design cycle, encouraging teams to explore more upfront scenarios to aid in product optimization.

"The goal is get a good product before you get to the first prototype," says John Isaac, director of market development for Mentor's Mechanical Analysis Division. "The bad approach is to depend on multiple prototypes to find flaws."

Mentor cites a number of market scenarios that highlight the need for an effective electronics cooling simulation approach. The faster speeds and higher density of smaller-factor printed circuit boards (PCBs) are increasing heat dissipation, driving a need for companies to explore new approaches to heat management. Based on data Mentor collected as part of its Technology Leadership Awards, the total area of PCBs has been reduced by 50%, while the number of components has surged by 350% between 1995 and 2012, resulting in a 7X increase in PCB density.

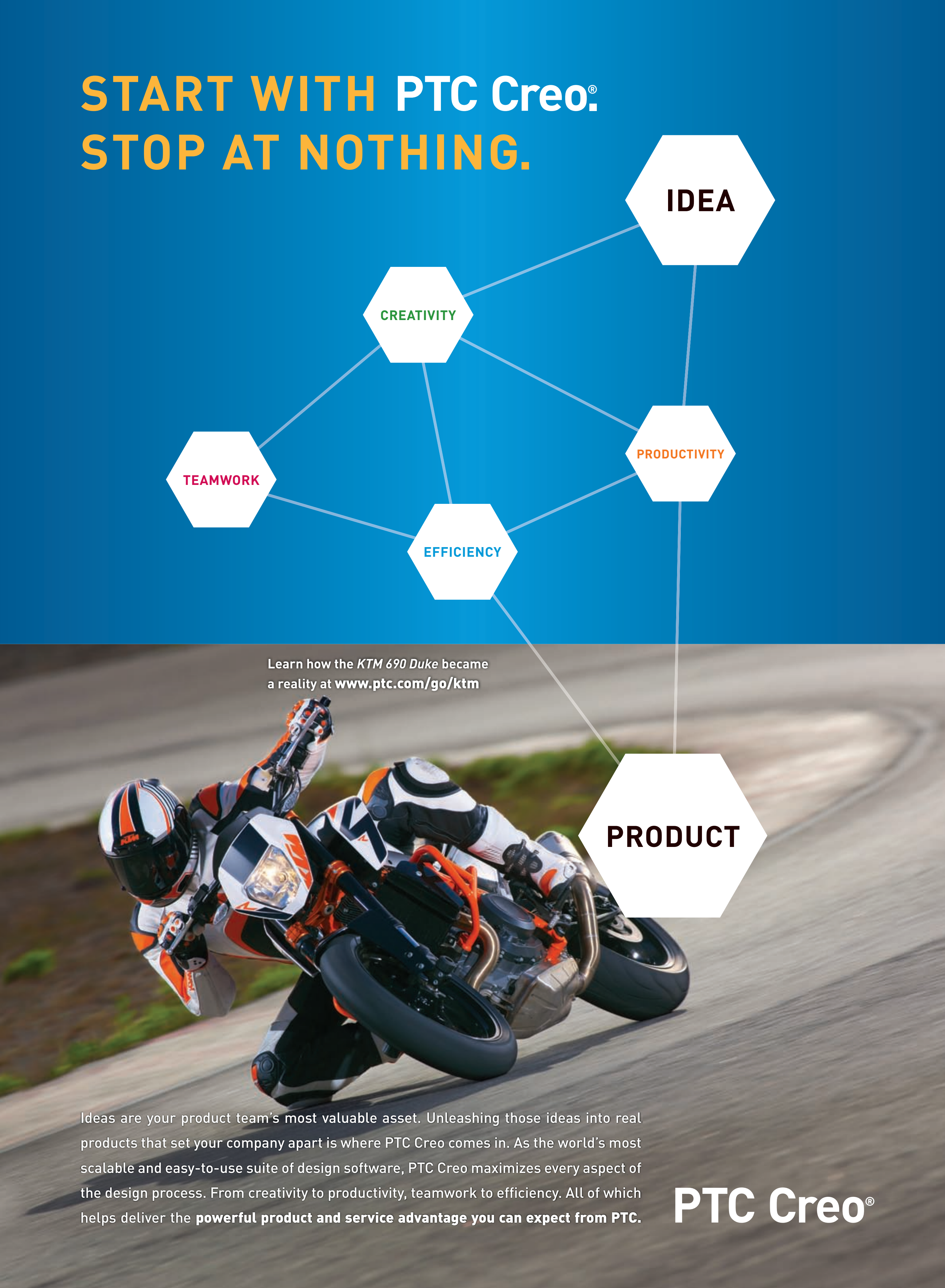
The complexity of geometry, driven by the smaller form factors of electronics devices and the influence of industrial design, is also compounding the design challenge. In a traditional electronics design flow, the MDA and EDA teams typically spend an inordinate amount of time importing data between systems, resulting in a lot of error-prone manual cleanup around data translation. FloTHERM XT addresses this issue in several ways, including enabling imported CAD geometries to work seamlessly with the tool's SmartPart library of models in addition to its automatic meshing capabilities, according to the company.

For Guy Wagner, director of electronic cooling solutions at Electronics Cooling Solutions Inc., a thermal analysis consulting firm, FloTHERM XT's capabilities have really streamlined the development process. For one thing, the software is able to handle thermal analysis on complex shapes, which wasn't possible in earlier versions of FloTHERM, Wagner says. In addition, being able to work directly on a SolidWorks model and have changes automatically reflected in FloTHERM XT without invention go a long way toward reducing his design cycle.

"The fact that you can bring MCAD geometry into FloTHERM XT and if you make a change in a part, it's automatically reflected in FloTHERM XT without having to do any imports, is the real timesaver," Wagner says. "It's just totally linked."

Between that capability and the software's simplicity around meshing, Wagner says he's able to turn client jobs around much faster: "This is the real value to the client, because I can get the job done at a lower cost and return results to him faster without going through a lot of the geometry imports that I had to do in the past."

—B. Stackpole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Lagoa Brings 3D Rendering to the Cloud

Those engineers chalking up the cloud to be a passing fancy or a platform that's ill-suited for professional-class design tools might want to reconsider.

In yet another example of a full-function engineering tool making its way to the latest software delivery model, startup Lagoa has just released a full 3D rendering and collaboration platform, entirely browser-based and running solely in the cloud.

Lagoa, which was just awarded a $1.6 million round of seed funding from such companies as 500 Startups, Atlas Venture, Real Ventures, and RHO Ventures, is the brainchild of a trio of partners, including Thiago Costa, the developer of the Logoa MultiPhysics desktop-based physics engine, Arno Zinke, with a Ph.D. in physically based rendering, and Dov Amihod, the company's chief technology officer.

Based on some of the work done for Lagoa MultiPhysics and influences from the gaming world, Costa and crew went to work on solving the speed issue that would result from trying to do sophisticated 3D rendering jobs in the cloud. The development of their own geometry kernel and coding system, in addition to advancements in data transmission technology were part of the secret sauce that went into Lagoa, which Costa says "makes rendering time super fast." Lagoa claims it feels even better and faster than what can be accomplished on a traditional desktop system.

The notion of putting 3D rendering in the cloud was born from the idea that installing, upgrading, and configuring traditional design tool software is just too complex and the server and IT infrastructure to run it far too costly, according to Costa, who came to that realization after the experience of commercializing Logoa MultiPhysics. "I realized it was a pain to ship desktop software and a lot of work to provide upgrades to people when you want to give them a new feature," he explains.

Lagoa provides full control over a wide variety of lighting like sphere, point, half dome, and anisoptropic dome. *Image Courtesy of Lagoa.*

Rendering First

The Lagoa team didn't feel the current state of technology was where it needed to be to offer users an optimum experience doing cloud-based multiphysics simulation, so they decided to start with 3D rendering capabilities first, and then address additional functionality later. "We decided to start with rendering and make it really interactive," Costa says. "With rendering, you don't have to download data for everything you do. The environment runs in the cloud and the rendering happens in the cloud and users only need to see the rendered image," he explains.

In addition to speed, precision and materials accuracy are the other top priorities for Lagoa. The team, led by co-founder Zinke, has put a lot of time in creating the most accurate materials from real life, paying close attention to volumetrics, so environmental reflections and refractions are applied to scenes as well as full control over lighting, including sphere, point, half dome, and anisoptropic dome.

Beyond 3D rendering functionality, collaboration is the other piece of Lagoa. Costa says multiple designers can simultaneously navigate, edit, and render on the same 3D scene, and clients or other partners can be invited into the collaboration, viewing changes on the fly. The system also addresses versioning concerns with automatic check out, versions, and backup.

While Lagoa may be among the first to put 3D rendering in the cloud, there are other services addressing the collaborative piece of the 3D design equation. Autodesk has been out in front with cloud-based design and collaboration tools, GradCAD is building an enterprise collaboration tool, and there's also the Sunglass collaboration platform and there are likely many more to come.

—B. Stackpole

Xeon or Core i7? Making the Right Workstation Choice

Choosing the right processor for your workstation needs doesn't have to be confusing. Here's a quick walkthrough on the key differences between the Intel i7 and Xeon processors.

BY DOUG BARNEY

No two engineers are built the same. Fortunately there are a range of PCs and workstations built to meet specific design needs, from basic CAD right up to highly refined simulations of complex products and exquisitely detailed renderings.

Sorting through the hardware choices isn't always easy. Perhaps the biggest decision is whether to go with the Intel Core i7 or Xeon family of processors.

Intel Xeon processors are built for professionals and while reliability is never really a question anymore, these processors, built on server technologies, offer users enhanced reliability and data integrity features that are not available on consumer-focused Core i7 based solutions. One of the biggest differences between the Core i7 and Xeon families is Error Correcting Code Memory (ECC) which is only found on Xeons.

ECC offers two huge advantages. First, ECC protects systems from crashes. In fact, ECC can trap some 99.9998% of errors, offering five 9s of protection.

Downtime costs money—besides lost productivity there can be the cost for IT to get the machine going. Dell argues that a single failure can take as long as 8 hours to recover from, when you look at the hours spent producing the data, the 3 hours it may take to get the system working again, and the hours it takes to redo the work.

Worse is the corruption of data. Some errors are apparent and the end user can make the correction. But some go undiscovered, resulting in design errors that impact the function and even the safety the end product.

Memory errors occur a lot more than you might think. Google did perhaps the most extensive study on the matter, and found there are some 3,751 correctable errors every year in each DIMM, errors ECC is designed to prevent.

And as the typical memory footprint continues to explode, these errors are becoming all the more common.

Other Xeon Advantages

Xeon and Core i7 processors tend to power very different machines. Xeon-based workstations tend to be far more expandable than their i7 counterparts, and come equipped with higher-end components, such as an enhanced I/O infrastructure designed to move large data sets, fast storage, and even larger more reliable power supplies. The Xeon family can accommodate multiple processors on the motherboard. At the center of a Xeon machine is often a second slot that can accommodate another Xeon processor. That provides up to 16 cores to churn away on highly parallel apps. And higher end systems can handle even more CPUs, resulting in even more cores.

More cores can speed some tasks such as raytracing. Tests found that by going from 4 cores to 16 cores, raytracing performance improved 3.5 times. If you do frequent rendering or simulation, Dell suggests dual Xeons, each with 6-8 cores.

Cores are just part of the story. Many Xeon processors come with their own graphics acceleration, such as the Intel HD P4000 Graphics line. For many apps, even high-end functions, the P4000 is just as effective as a dedicated third party GPU.

Other Xeon advantages include:

- A larger cache for Xeon processors vs. i7—Xeon's can accommodate up to 30M of cache, while i7s top out at 6-8M.
- More memory bandwidth.
- More overall memory capacity.
- Workstation software makers often optimize their wares for Xeon, so workloads are handled fast and safely, and certify software especially for Xeon. DE

Doug Barney *is a computer journalist with nearly 30 years of experience.*

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

Carbon Fiber Covers $4.6 Million Lamborghini

Automobili Lamborghini is celebrating its 50th anniversary in style with the debut of its new supercar, the Veneno—the fastest and rarest car the company has ever released.

It can reach speeds of 220 mph, sports a 12-cylinder, 6.5-litre engine, and a 7-speed Independent Shifting Rod (ISR) transmission. It can go from zero to 60 in less than three seconds.

The body is crafted from carbon fiber, a carbon fiber ring on the wheels delivers additional cooling air to the carbon-ceramic brakes. The bucket seats are made from a patented composite, while a woven carbon-fiber skin covers the cockpit, headliner and parts of the seats.

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Locust-based Robotic Vision Technology

Scientists from the United Kingdom's universities of Lincoln and Newcastle have replicated the way locusts use visual input to keep from flying into things. They have developed a computer-simulated model that could be used in advanced collision avoidance systems for vehicles and in other applications.

Why locusts? They process information using electrical and chemical signals while in flight, providing a fast, accurate warning system to help avoid collisions. The researchers developed a visually stimulated motor control (VSMC) that

converts visual information into motor commands based on the way the locust brain detects approaching objects.

Using the commands, a robot was able to avoid colliding with objects without the use of radar or infrared detection systems, which require a significant amount of processing power.

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DARPA Takes Fresh Look at Vertical Take-Off Plane

The Defense Advanced Research Projects Agency (DARPA) is planning to invest $150 million to develop a new vertical take-off and landing aircraft called the VTOL X-Plane. The project is the latest attempt to solve a long-standing engineering challenge: How to design an aircraft that can take off, land and hover like a helicopter, but that can fly at top speed once in the air.

With X-Plane, DARPA hopes to spur the industry to develop all-new designs that would result in a vehicle that could travel at more than 300 knots, with better hover and cruise efficiency than current helicopters.

"We have not made this easy. Strapping rockets onto the back of a helicopter is not the type of approach we're looking for," says DARPA Program Manager Ashish Bagai, Ph.D. "The engineering community is familiar with the numerous attempts in the past that have not worked. This time, rather than tweaking past designs, we are looking for true cross-pollinations of designs and technologies from the fixed-wing and rotary-wing worlds."

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Under Armour Developing Interactive Clothing

Under Armour is working on interactive, touch-sensitive clothing for athletes that monitors heart rate, speed, calories burned and other useful metrics, as well as keeping a record of past activities to help measure progress. All of that captured data is combined to produce a measurement of physical fitness that Under Armour is calling WILLpower.

Google is developing a similar idea for its Project Glass that uses a projector to create a virtual keyboard on your arm.

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Lockheed Martin Invests in Quantum Computing

Canadian quantum computing company D-Wave sold a quantum computer to Lockheed Martin back in 2011. It appears as though Lockheed was impressed with the result: The company has moved to commercialize the system and integrate the computer into its business operations.

Greg Tallant, Lockheed Martin program manager, says it is "ultimately a game changer for humanity."

While Lockheed Martin might be impressed, other scientists are still skeptical of D-Wave's system. The company has yet to produce data proving its computer is any faster than conventional binary systems. **MORE** ➜ engineeringontheedge.com/?p=4175

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Arcam Releases Arcam Q10

Arcam's new electron beam melting system (EBM), the Arcam Q10, uses an electron beam to melt powdered metals. Commonly used metals include titanium and cobalt-chrome. This new design is meant to replace the A1 for orthopedic manufacturing.

Arcam's newest system was designed to produce orthopedic implants, and so incorporates a layer verification camera system to monitor the 3000 W electron beam. The Q10 offers a 7.87 x 7.87 x 7.08 in. build envelope, and has a minimum beam diameter of 100µ.

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NASA Advances 3D Printing on the Moon

The European Space Agency (ESA) recently revealed a plan to construct a lunar base using additive manufacturing (AM), possibly following NASA's experiment with fueling a 3D printer with crushed moon rock. Now, NASA has released information about its own plan to build a lunar base with AM, with help from a multi-legged robot.

The robot, called ATHLETE (All-Terrain Hex-Legged Extra-Terrestrial Explorer), is being built by NASA's Jet Propulsion Lab (JPL), and has been in the testing phase for a number of years. It was designed specifically to explore the surface of the moon, and now may be refitted to add AM elements.

ATHLETE would use microwaves to sinter lunar soil, a process that eliminates the need for a binding agent, which NASA has dubbed SinterHab.

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Drag and Drop Searches

3D Industries (3DI) has received $350,000 in startup funding from the British government and an angel investor. That cash has been invested in a search engine named 3D Part Source, which has been designed for additive manufacturing. 3D Part Source is also available as an app.

Users drag a 3D design into the engine, and it spits out the names of companies that can provide the desired object. A keyword search is also available and can be modified by selecting the process and material you would prefer for your part. Searches can be limited by country, zip code or distance. Along with a general search, users can search catalogs of specific companies.

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Nano Scale 3D Printer

Nanoscribe is offering a 3D printer that is capable of building objects measured by the micron. The new Photonic Professional GT system uses laser lithography and two-photon polymerization to build sub-micrometer polymer structures. The build envelope of the Photonic Professional GT is limited to 100µ objects, but these can be fused together to create larger structures.

"A tremendous speed-up of the writing process is driven by an embedded ultra-high precision galvo technology, which laterally deflects the laser focus position by use of a galvanic mirror system. Thus, the fabrication of large area 3D micro- and nanostructures is now feasible in the shortest time," notes the Nanoscribe website. "In addition to rapid x-y-beam-scanning, a piezoelectric scanning stage provides ultra-precise x-y-z-movements of the substrate relative to the laser focus position ..."

The Photonic Professional GT is aimed at applications in the biotech field, finding use in building scaffolding for cell growth research.

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NAMII Awards $4.5 Million

The National Additive Manufacturing Innovation Institute and the National Center for Defense Manufacturing and Machining have selected seven projects to share $4.5 million in funding:

1. Maturation of Fused Depositing Modeling (FDM) Component Manufacturing
2. Qualification of Additive Manufacturing Processes and Procedures for Repurposing and Rejuvenation of Tooling
3. Sparse-Build Rapid Tooling by Fused Depositing Modeling (FDM) for Composite Manufacturing and Hydroforming
4. Fused Depositing Modeling (FDM) for Complex Composites Tooling
5. Maturation of High-Temperature Selective Laser Sintering (SLS) Technologies and Infrastructure
6. Thermal Imaging for Process Monitoring and Control of Additive Manufacturing
7. Rapid Qualification Methods for Powder Bed Direct Metal Additive Manufacturing Processes

NAMII will announce its next project call at RAPID 2013.

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Get Ready for RAPID 2013

RAPID showcases 3D printing and more June 10-13 in Pittsburgh.

Each year for more than 20 years, the RAPID Conference and Exposition has brought together the people, software, systems, materials and machinery used in rapid prototyping and additive manufacturing, including 3D imaging and 3D printing technologies. This year's event, to be held at the David L. Lawrence Convention Center in Pittsburgh, June 10-13, features 75 conference presentations and more than 30,000 sq. ft. of exhibits.

"The RAPID 2013 event schedule is designed to connect attendees and exhibitors with technologies and resources needed for businesses looking to remain competitive in a global marketplace and challenging economy," says Gary Mikola, business development manager for the Society of Manufacturing Engineers (SME), which produces the show.

Tours on Tap

Tours of five local additive manufacturing facilities will be conducted in conjunction with the conference.

On Monday, June 10, registrants can tour Bally Design, which is just a block away from the convention center. Bally specializes in product design and development, engineering, branding, corporate identity, and environmental design.

Attendees can also sign up for one of two tours on Thursday, June 13.

One tour includes ExOne and threeRivers3D, while the other visits the Human Engineering Research Laboratories at VA Pittsburgh and TechShop Pittsburgh.

At ExOne, attendees can see the company's 3D metal printing process from start to finish as well as its machine build lab.

While at threeRivers 3D, visitors will see how 3D scanners are manufactured, from the mechanical assembly of the scanner core, burn-in and on to final assembly/validation. A 3D scanning demonstration will also be given.

Human Engineering Research Laboratories at VA Pittsburgh's mission is to continuously improve the mobility and function of people with disabilities through advanced engineering in clinical research and medical rehabilitation. Part of that engineering includes final parts made with additive manufacturing.

TechShop is a community based workshop and prototyping studio with seven locations. TechShop Pittsburgh provides makers with 16,000 sq. ft. of workshops that include rapid prototyping and machining tools and equipment, as well as computers loaded with design software.

On-site Training and More

In addition to the tours, Monday's workshops will provide attendees with hands-on learning opportunities in four areas:

1. Fundamentals: Additive Manufacturing, is a workshop presented by Graham Tromans, G P Tromans Associates, that introduces additive manufacturing technologies and applications.
2. Fundamentals of 3D Scanning and 3D Modeling by Giles Gaskell, Wenzel America Ltd. provides an introduction to 3D scanning technologies, software and processes, followed by a demonstration of scanning devices.
3. The Metal Parts Using Additive Technologies workshop by Frank Medina, University of Texas at El Paso, gives an overview of additive processes used for creating metal parts—from casting metal parts from rapid prototyped patterns to direct metal fabrication using lasers, electron beams or ultrasonic energy.
4. The Fundamentals of RTV Mold-making and Polyurethane Casting workshop is presented by Bill Molitor, Innovative Polymers; Myra Bumgardner, Silicones, Inc.; and Terry McGinnis, BJB Enterprises. It focuses on using silicones to create molds and polyurethanes to create cast parts in silicone tooling.

In addition to the conference sessions and exposition, tours and workshops, keynote addresses will be presented by the National Additive Manufacturing Innovation Institute (NAMII), Disney Research, and industry consultant Terry Wohlers. Other activities include technical briefings, networking receptions, and the Additive Manufacturing Certificate review course and exam. DE

INFO ➜ RAPID 2013: sme.org/rapid

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by Anthony J. Lockwood 

Editor's Picks

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

IronCAD Design Collaboration Suite 2013 Released

COMPOSE module delivers 3D collaboration and configuration functionality.

IronCAD recently released the 2013 version of its Design Collaboration Suite. The IRONCAD 3D modeler deploys both the ACIS and Parasolid kernels, and you can use the strengths of both simultaneously. IRONCAD also offers you both parametric or explicit modeling. IRONCAD DRAFT is for 2D mechanical drafting. And INOVATE, which is a combination 3D concept design development and collaboration tool on steroids, lets you interrogate, modify, and communicate models or create photorealistic images or animations. The newest member of the suite, COMPOSE, lets you view/markup and manipulate models and assemblies in 3D.

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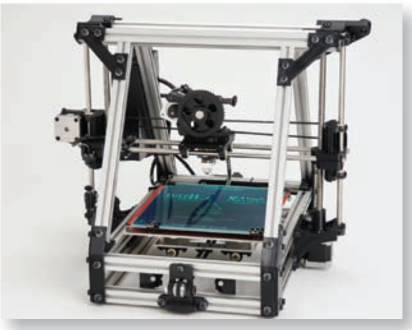

Customizable 3D Printer Has Open Architecture

Provides quieter printing than predecessor, improved power supply.

The LulzBot brand of Aleph Objects has released the AO-101, a low-cost, desktop prototype/short-run 3D printer. I mean low-cost. Pricing starts at $1,725. Better though, it's customizable: neither the hardware nor the software is forbidden territory for you to get into and modify, And, it fits pretty much anywhere, yet it still offers a respectable 7.9 x 7.5 x 3.9 in. print area and 0.0029 to 0.029 in. layer thickness. It's fast too, with a top-end speed of 7.9 in./sec.

The AO-101 is delivered ready to get printing. It comes with a toolkit, a step-by-step manual, 5 lbs. of ABS filament printing material, and three sizes of print nozzles.

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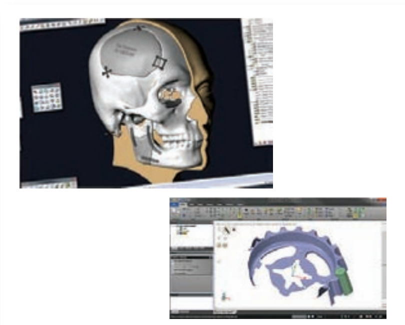

3D Scan-in-CAD Makes Sparks Fly At Geomagic

New tool for designing from scan data. Company also updates Geomagic Freeform Modeling as well as its scanning and metrology product lines.

Geomagic has released the 2013 versions of its 3D scanning and metrology software: Geomagic Qualify, Geomagic Qualify Probe, Geomagic Studio, and Geomagic Wrap. It also has updated Geomagic Freeform and debuts a new application called Geomagic Spark.

Geomagic Spark has game changer all over it thanks to live 3D Geomagic scanning technology interfaced with SpaceClaim's direct 3D CAD modeling technology. It also has assembly modeling and 2D drawing capabilities and can import and export MCAD-specific and industry-neutral file formats.

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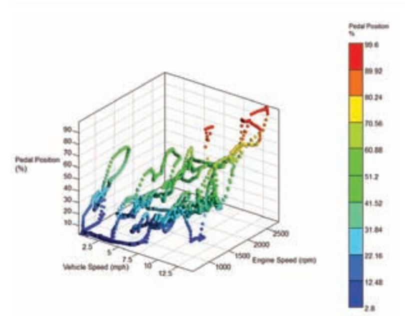

Fatigue and Durability CAE Tool Upgraded

nCode DesignLife 9.0 assesses thicker composite components, thicker welds.

nCode DesignLife works with and extends stress analysis results produced by such tools as ANSYS, Abaqus, and Nastran to provide you with fatigue life and durability prediction. It can correlate with physical test data, and is engineered to simulate real-world loading conditions by providing stress-life, strain-life, multi-axial, welds, shaker table, and similar fatigue and durability analyses. It's optimized for large model sizes, and it's user-friendly for new users yet configurable by experts.

The 9.0 version has just been released. It has new technologies for composites, welds, load reconstruction, multi-body dynamics, data visualization and more.

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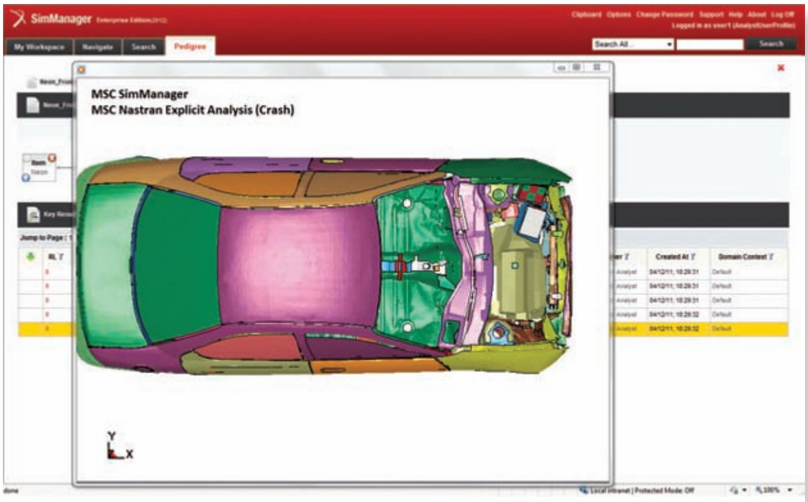
Lost in Simulation

Mixing data governance and standardized processes is the best antidote to a big-data headache.

BY KENNETH WONG

If you ask Frank Popielas, Dana Holding's senior manager for global CAE, to list the types of simulations he performs, you'd better grab a cup of coffee and sit down. It'll take him a while just to get through the primary ones: "structural simulation to look for stress spots, injection molding simulation for manufacturing process and part geometry optimization, gas flow and cooling flow analysis, steady state and transient conditions, thermal expansion and thermal distribution perspective …" and he goes on. This list covers just a fraction of the spectrum the Dana CAE team uses routinely to virtually develop and validate the functions and performance levels of the drivetrain, sealing and thermal management equipment designed and developed by the company.



An expanded view of the results from a crash test, part of MSC Software's SimManager software.

Marc Hertlein, BMW's project manager for simulation data and processes, has a similar list: "crash simulation, noise, vibration and harshness (NVH), driveline strength, pedestrian protection, head impact, exterior component, forming process, production process …" he begins.

Venkateswara Rao Pechetti works for Mando Softtech India, a Korean automotive component supplier. As executive engineering II of the company's CAE team, he, too, boasts his own list. "CAE FE-modeling for strength, NVH, durability, fatigue …" he starts.

Those who've witnessed the evolution of product lifecycle management (PLM) might see history repeating in the burgeoning simulation lifecycle management (SLM) market. Like PLM, SLM began as an attempt to clean up the data warehouses. In SLM's case, it's to sort and archive the mounds of data generated from repeated simulation so engineers can, when necessary, retrieve, refer to and consult past exercises for guidance.

Like PLM, SLM quickly ballooned into process management. The multidisciplinary approach—involving multiple experts investigating the design's fitness using multiple software packages from competing vendors—is adding complexity to the process. The repetitive nature of simulation—subjecting the same design to slightly different load variables to find the best option—increases the volume of data to sort afterward.

If simulation's big-data problem is exacerbated by insufficient process control, the solution is to turn the problem on its head. The experience of Dana's Popielas, BMW's Hertlein and Mando's Pechetti show that, with proper simulation protocols in place, the data either shrinks to a manageable size, or becomes intelligible for subsequent reuse.

What Exactly Are You Managing?

Keith Meintjes, Ph.D., practice manager for simulation and analysis at the analyst firm CIMdata, isn't wild about the term SLM because it sounds like a close relative to PLM. The two terms, in his view, are distinctly different.

"The problems for managing CAE data are very different than for managing CAD data," he points out. "SLM usually requires different business processes than the organization has already established in PLM."

For Meintjes, SLM is about doing the right simulation at the right time. "Process automation is important here in terms of simplifying the application of simulation, capturing IP and enabling uniform best practices (standard work)," he notes. "It's everything from using the right mesh and turbulence model to gaining understanding and support at the highest levels of engineering management that simulation is a strategic capability."

Trimming the Data

According to the estimate of BMW's Hertlein, the automaker produces roughly six petabytes (that's 6 million gigabytes) of simulation results yearly. His challenge, he says, is "to reduce it to one petabyte of relevant data."

It's also a race against time: Hertlein reveals that BMW is planning to double the amount of car projects for his group. So while he's looking for ways to trim the data to a manageable size, the volume of data generated is expected to grow.

Dana's Popielas points out that without proper simulation management, "you don't know what you have anymore. You won't know where the data came from. You're getting lost." Data output between 20GB and 25GB is normal for a single simulation job, he estimates.

"Do you really want to save everything? Most of the time, you don't," Popielas continues. "So you save the input stats—what you put into the simulation, how you went about it—and the end report."

Mando's Pechetti agrees. "It's really hard to differentiate/manage/retrieve the data, especially when there are small changes," he says.

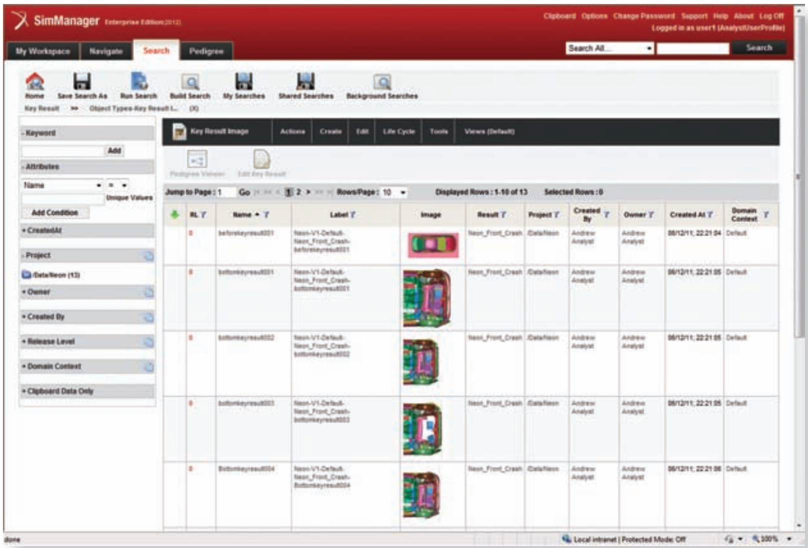
The minor differences in the CAD models or the incremental changes to the loads and pressures in simulation runs are not easily detectable by the naked eye. But in Mando's iterative workflow, multiple simulation runs with such minute changes are essential to find the best product configuration.

As each design is likely to change five to six times over the course of the project, Mando's data archival issues have become more complex. This can become a headache when the virtual simulation results have to be compared with physical test results. "To find the data, we'd go deep in to the project folders," Pechetti recalls. "I knew the data was there, but it took too much time, too many tries to find it."

Many managers overseeing simulation projects quickly come to realize it's not practical to maintain an ever-expanding database of simulation result files, let alone sorting them in a manner that's comprehensible for subsequent use. A more sensible approach is to create a virtual environment, essentially a browser-like interface, where users can browse and compare analysis jobs, along with their histories, input parameters and end results.

Standardizing Process

Setting up a simulation scenario means translating a real-world physical event—say, a car crash—into electromechanical forces, thermal loads, pressures and material attributes that can be computed mathematically. It's a specialty that takes time to develop, and most firms only have a handful of dedicated experts.



BMW uses MSC Software's SimManager software to manage simulation. Shown here is a series of simulation jobs managed in SimManager, along with thumbnail views of results.

"Simulation, never mind SLM, is a problem for smaller enterprises," says CIMdata's Meintjes. "They do not have IT departments to integrate all this stuff, and they do not have methods groups to figure out the 'how' of simulation."

BNW's Hertlein proposes a hypothetical scenario: "Just imagine that every engineer starts up his preprocessor and builds a simulation model in his own way. Is he using the most current geometry? Current materials? Does he follow the regulatory requirements? You won't know."

The repetitive nature of simulation points to the possibility of a template-driven approach. By reducing a complex simulation job into a predefined workflow with a series of variables that can be altered on demand, you can make it more accessible to the workforce. With such a process standardizing, the output and the history of simulation jobs become easier to manage.

If an automaker wants to market its vehicles in the U.S., for example, it would need to submit proof that the car meets the requirements of the Insurance Institute for Highway Safety. These requirements, Hertlein points out, should be part of the simulation template or workflow managed in an SLM tool. BMW uses MSC Software's SimManager.

For consistency in simulation, BMW uses what it describes as a "lead car"—a primary vehicle model for each of its brands. In individual simulation runs, the lead car is reconfigured with different components so it can stand in for a station wagon, a convertible or another model. But the primary model remains the same; therefore, so do many of the attributes inherited from it. This approach, made possible by SimManager, allows BMW to cut down on the size and complexity of its simulation jobs, Hertlein says.

Time Regained

Simulation is both compute- and time-intense. Complex simulation jobs can only run on high-performance computing (HPC) servers. Even when HPC equipment is involved, jobs still take hours, days and sometimes weeks to complete. Choreographing the job queue's ebbs and flows to match the drumbeat of milestones and deadlines is an art in itself.

Mando's Pechetti says now he can monitor his simulation jobs in Altair Engineering's Hyperworks Collaboration Tools. "I can assign jobs. I can monitor progress. I can see who's started and completed the job without approaching the candidate or his or her workstation," he says.

The variations within each project's simulation jobs are now managed in Hyperworks Collaboration Tools' version control safeguards. All projects are located in Mando's shared server, accessible to engineers and project managers located in different time zones around the world.

This keeps the time spent hunting for reports, inputs and histories to a minimum, Pechetti says. For each simulation run, Pechetti used to spend three to four hours just importing and verifying for the right data. Now, he puts this time to better use by doing quality assurance on the projects that have been completed.

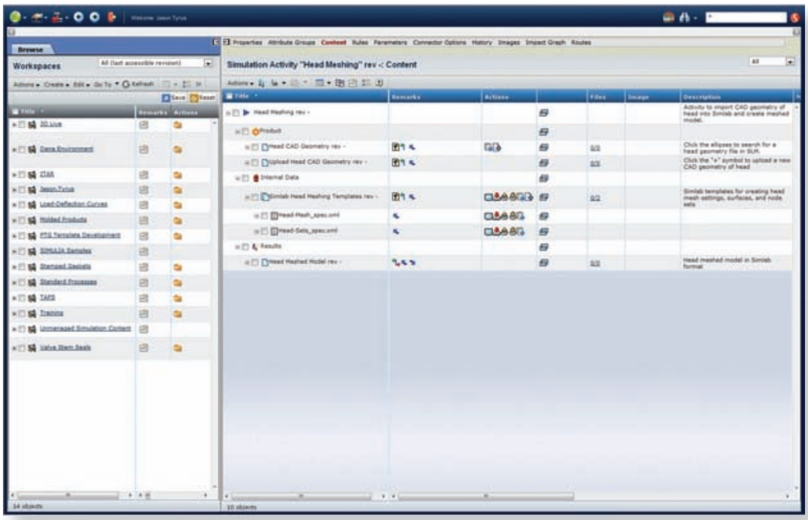
"Before we go into full-blown expansion of simulation into all engineering disciplines, we need to have tools to manage the data, the process, and the decision-making," notes Dana's Popielas. "We chose SLM from SIMULIA for that." SIMULIA, Dassault Systèmes' application for realistic simulation, offers a software product for managing simulation lifecycle. The product itself is dubbed SLM.

"Looking for information is where you can spend a significant amount of your time in simulation," Popielas adds. "We're easily saving 20% of that time by deploying SLM."

According to Popielas, Dana chose SIMULIA SLM because "the software is visually intuitive. It's in Dassault Systèmes' 3DLive environment. You don't have to spend a lot of time learning it. This helps a lot in getting adoption among users across all engineering disciplines."

PLM vs. SLM

Current SLM solutions are supplied by two primary groups: PLM vendors (for example, Dassault Systèmes) and simulation software vendors (for example, Altair Engineering and MSC Software). PLM vendors learned long ago that forcing customers to migrate to their own design software or those of their partners wouldn't work. Most manufacturers juggle multiple CAD systems, and prefer a PLM system that can accommodate a wide variety, including software



The simulation data management environment in Dassault Systèmes' SIMULIA, showing results, actions performed and remarks. The screenshot shows a project involving cylinder head preprocessing jobs at Dana Holdings. *Image courtesy of Dana Holdings.*

titles from the PLM vendor's rivals. SLM suppliers are now at a similar crossroads.

"The SLM and simulation software user base is very diversified," Popielas says. "That's why you need to have an open SLM environment to be able to communicate and link up with all the different applications seamlessly. This is also the reason why the end-user base is looking into initiatives to define exchange standards between simulation packages. Vendors are welcome to participate in those initiatives actively, and they do so."

BMW uses MSC Software's SimManager to manage simulation data, but the company also employs Dassault Systèmes' Abaqus Unified FEA software for vehicle safety simulations. Mando Softtech India uses Altair's HyperWorks Collaboration Tools to manage its simulation jobs, but it relies on both Altair's RADIOSS and Dassault Systèmes' Abaqus to perform simulation. SLM products, therefore, serve the user better if they're developed to accommodate simulation software from a variety of suppliers, including SLM software makers' rivals.

Some companies treat SLM as a big-data problem. Others contend that the bigger priority is to reduce complexity in the simulation process, to make it more accessible.

Meintjes cites two sets of companies as examples: "Tecplot (Chorus), VCollab and Altair Engineering (HiQube) for the big-data problem. Autodesk, ESI, ANSYS and MSC Software for democratization." He's not endorsing the companies named, he clarifies, but merely presenting examples of the different innovative approaches they have offer to tackle the problem of simulation usability.

Meintjes says he believes the answer is not to automate and cloak the experts' process for others to use: "It is to understand how others, like designers and field engineers, can be helped to get their work done."

Another conundrum for SLM vendors is satisfying both the extended enterprise and the workgroup requirements, as the need tends to grow from workgroup to enterprise. BMW, for example, began using SimManager at a department level first for NVH and crash tests only, before expanding it to other types of simulation.

"PLM vendors understand the enterprise; CAE vendors understand the workgroup. Neither, in my opinion, has yet bridged the chasm," Meintjes says.

Staying Small to be Competitive

Many might consider BMW one of the automotive manufacturing titans, but the company doesn't think of itself as such. "BMW is a small company compared to its competitors, but we're the most successful," Hertlein says.

At conferences, Hertlein has met his counterparts from rival carmakers, who seemed puzzled by BMW's approach. "Last year in Detroit, someone told me, 'If we have to increase our development process, we hire more people.' I told them, 'That's not what BMW does,'" he relates. "We're trying to streamline and effectively use our resources. SLM is a big part of the reason we're able to stay small and be as successful as we are." **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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➜ **BMW:** BMW.com

➜ **CIMdata:** CIMdata.com

➜ **Dana Holding Corp.:** Dana.com

➜ **Dassault Systèmes:** 3DS.com

➜ **ESI:** ESI.com

➜ **Mando Softtech India:** MandoSofttech.com

➜ **MSC Software Corp.:** MSCsoftware.com

➜ **Tecplot:** Tecplot.com

➜ **VCollab:** VCollab.com

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Vendors Try to 'Rightsize' PLM for Smaller Businesses

Making product lifecycle management more palatable to smaller businesses by simplifying configuration and leveraging the cloud.

BY BETH STACKPOLE

Increasing product complexity. The need to coordinate development processes across a globally-dispersed design team. Placing a greater emphasis on innovation and time-to-market agility. These challenges, once stumbling blocks for only the largest manufacturers, are now bearing down on small- to mid-size businesses (SMBs) as they seek to optimize product development organizations and engineering processes in an effort to gain a competitive edge.

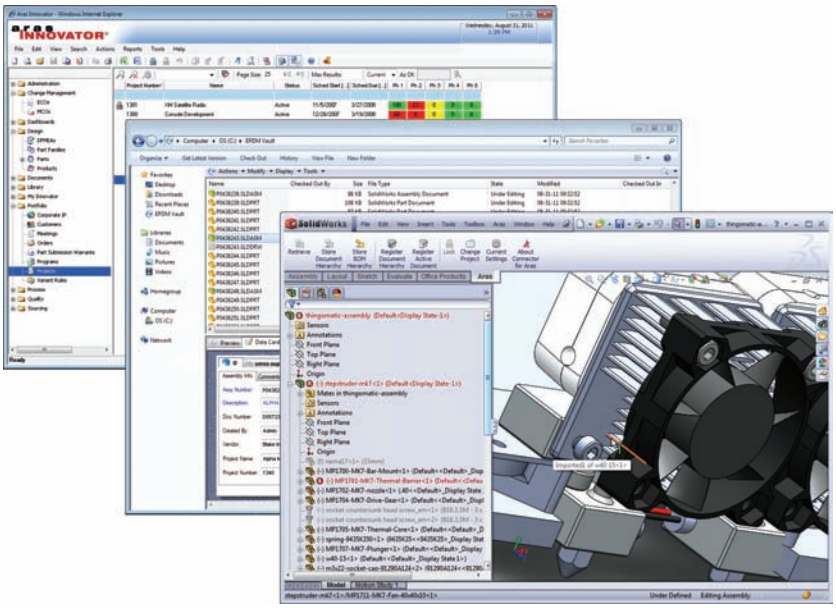
"Companies of all sizes have a pretty common theme in terms of increasing product complexity, process complexity and globalization," says Marc Lind, senior vice president of marketing for Aras.

With mechanical components only part of the overall product structure, today's greater reliance on electronics and software has both large and small shops struggling to coordinate design across multiple disciplines. Moreover, firm size no longer dictates supply chain and partner complexity. Whether a company has 20 people or 20,000 people, Lind says, there's a strong likelihood that some are spread across the globe.

For more than a decade, larger manufacturers have come to rely on product lifecycle management (PLM) to help deal with increasing design and manufacturing complexity, but the software tools have traditionally been expensive and difficult to deploy, keeping smaller companies at bay. PLM vendors have struggled to break into the SMB market, but their approaches—mostly scaled-down versions of enterprise offerings with key functionality removed—haven't convinced smaller companies that PLM is the right set of tools and processes to solve their product development pain points.

"SMBs have the same types of problems as larger companies, but the concept of PLM is frightening to them because it's been expensive, complicated, and they think it's going to slow them down," says Thane Hathaway, owner of EAC Product Development Solutions, a PTC value-added reseller and engineering consulting company.

That's starting to change as PLM vendors rethink their SMB strategies and embrace emerging technologies to make the tools more palatable to smaller customers. Some, like Autodesk, view the cloud as their ticket into the SMB space. Other longtime players, including PTC and Siemens PLM Software, are making core CAD data management and engineering change order functionality more approachable through support for commonly used systems like Microsoft SharePoint, new ease-of-use features, and out-of-the-box configurations. Newcomers like Vuuch and Kenesto are



Aras EPLM for SolidWorks EPDM is a scalable and secure business-ready solution aimed at driving cross-functional PLM processes throughout a company and its supply chain for global collaboration and coordination. ***Image courtesy of Aras Corp.***

radically rethinking the concept of PLM, moving away from simplifying traditional interpretations and toward promoting wholly new concepts around collaboration and engineering process workflows.

According to Tony Christian, director at industry analyst firm Cambashi, there are five forces driving the PLM market and making the technology more SMB-friendly:

- cloud;
- mobility;
- improved integration with complementary applications;
- social networking and new collaboration functions; and
- ease of use.

"Those five technology factors are all interdependent, and they are all areas in which PLM vendors are moving their solutions forward in quite an aggressive way," Christian says.

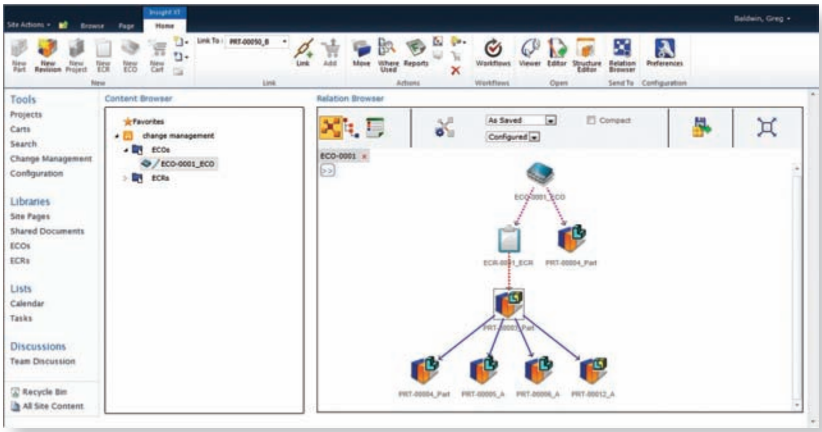
PLM Heads to the Cloud

Of all the vendors in the traditional design tool space, Autodesk is taking the most extreme approach to rightsizing PLM for SMB customers. Citing smaller companies' need for a PLM system that is easy to implement and maintain, and the requirement to keep costs in check, Autodesk has placed a bet on the cloud as the most effective delivery medium for SMB customers.

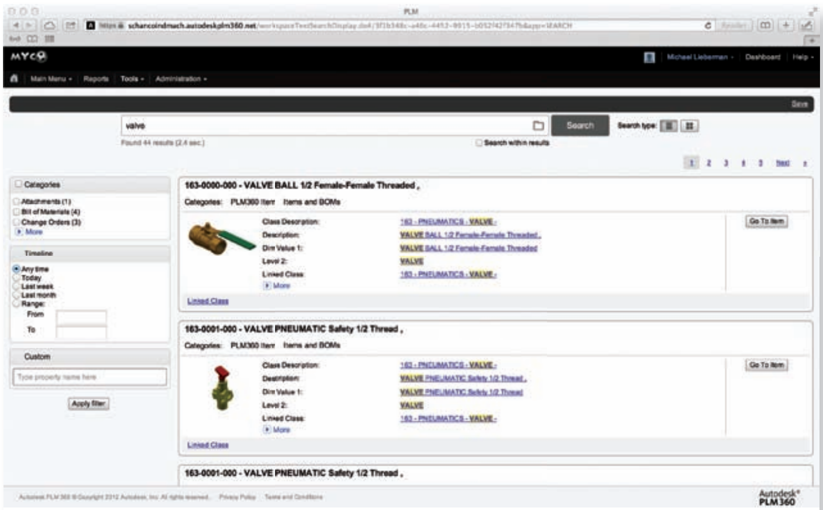
Omnify is courting SMBs with Empower PLM's flexible licensing plan, multiple deployment models and out-of-the box configuration. *Image courtesy of Omnify Software.*

The Autodesk PLM 360 offering neither requires customers to build out an expensive IT infrastructure to run PLM, nor requires on-site staff for ongoing support and maintenance. It emphasizes a workflow engine and capabilities such as program management, quality management, and supplier collaboration—as opposed to many SMB PLM systems, which target product data management (PDM).

"PLM is essentially a technology that allows manufacturers to solve and improve business process problems, and PDM is just part of that," explains Richard Blatcher, senior industry manager for manufacturing at Autodesk. Autodesk provides core PDM capabilities via its Vault offering, which remains



SolidEdge SP includes an out-of-the-box method to manage ECRs and ECOs. *Image courtesy of Siemens PLM Software.*



Leveraging its acquisition of Inforbix, Autodesk is adding a Google-like search function to PLM 360 to help users more easily find relevant product-related information. *Image courtesy of Autodesk .*

an on-premise application and is separate from PLM 360, although the two capabilities can be easily integrated, he says.

Without the broader set of PLM functionality, a tool doesn't solve the problem of facilitating communication and collaboration with all the stakeholders involved in product development, Blatcher contends. "If a system is used entirely within the engineering department, you're only involving 10% of the individuals and processes that need to be improved," he explains. "It's only solving a small piece of the picture, although it's an important one."

A new version of PLM 360 released in April builds on the accessibility theme by adding Google-like search capabilities to make it easier to find relevant, product-related information. There's also an App store, where users can tap into a catalog of predefined business processes and prepackaged applications.

For Memjet, a global leader in high-speed color printing technologies, PLM 360's cloud approach was the linchpin for making PLM a fit for its development challenges. Given time-to-market pressures, the company needed a better way to manage product information. It also had to establish faster and more flexible manufacturing processes, according to Jeff Bean, vice president of brand and communications at Memjet. The company's existing methods of using Wikis, email and FTP sites were increasingly becoming ineffective, but traditional PLM was too complex and couldn't effectively accommodate the company's dispersed team of developers and contract partners situated in the United States, Singapore and Australia.

"We needed a solution that wasn't tied to a particular office network or server, but allowed employees in multiple offices around the world to collaborate on bills of materials [BoM] and engineering change order [ECO] processes," he says. "PLM 360 allows us to bring all functions into one system. Users can now find information on parts and subsystems, access documentation attached to those parts, and manage the ECOs all from one system any where in the world."

Addressing PLM's Overhead Issue

Beyond the need for greater accessibility, the complexity and cost of configuring, deploying and maintaining a PLM system have been historical barriers for SMBs. Most traditional systems require an extensive infrastructure of servers and IT resources—not to mention an investment in consulting services to customize the implementation to match a company's business processes. That's according to Greg Dohrman, director of the data management group at ImaginIT Technologies, a RAND worldwide company.

"The overhead of PLM often outweighed the potential benefits that drove the project in the first place," Dohrman says, adding that many PLM tools support process workflows that are more in keeping with a larger company, fueling the complexity for SMBs.

As an example, consider ECO management—one of the primary functions a PLM tool can facilitate. A large company might have 30 pieces of information that need to be captured and routed to dozens of people to complete a process, whereas a smaller company might require only a handful of people and forms for the same task.

"It may take a big company 20 steps in the process to know what's going on to make the right decision," Dohrman explains. "Whereas in a smaller organization, you can obtain the same level of quality with a three-step process and fewer people involved. An SMB PLM tool needs to support all levels of process optimization, including making it as simple as it can be to support the need."

In this latest round of PLM for SMBs, vendors are taking that requirement to heart. Aras, for example, has designed its platform so users can customize everything from the data model to forms, templates and business rules without complex coding.

Omnify has pursued an out-of-the-box approach from the beginning, according to its CTO and President Chuck Cimalore, and continues to evolve it. This year, for example, the company is segmenting the Empower PLM platform to support vertical functionality so a system can be quickly deployed to support a quality or data management process without extensive configuration. Omnify is also exploring cloud delivery models for further ease of deployment, Cimalore says.

Mevion Medical, a longtime Empower user with just three IT staffers, says Omnify's approach, coupled with its efforts to support the cloud, made PLM a reality for its team.

"My job is to support the business, not build out IT," notes Ed Quinn, IT manager for Mevion, which manufacturers radiation therapy technology that advances the treatment of cancer. "I'm not looking to buy a big, honking back-end system and hire someone to keep it going."

PLM behemoths Siemens PLM Software and PTC agree that addressing the configuration and deployment hurdles around PLM is crucial to getting SMBs on board. Yet both companies believe the greatest need is around simplified PDM—with a clear path to scaling to other PLM functions if and when an SMB sees fit.

Many of Siemens PLM Software's SolidEdge customers have no formal data management in place. For this group, the company targets SolidEdge for SharePoint, a platform that leverages Microsoft SharePoint to manage materials such as CAD files, spreadsheets, Word documents and even visualizations, according to Bill McClure, vice president of product development. There are also workflows that extend SharePoint capabilities to handle ECOs.

"Many manufacturing companies already have SharePoint deployed, so there is ease of deployment and ease of administration," McClure says.

For smaller shops that need the full spread of PLM capabilities, Siemens PLM Software offers Teamcenter Rapid Start. This version of the platform can be installed on a single server, is based on Microsoft SQL Server, and is available with a variety of pre-configured workflows.

PTC, too, believes the primary value proposition of a right-sized PLM for smaller companies is simplified engineering data management—with a growth path to other PLM features over time. The company's PDM Essentials, released earlier this year (deskeng.com/virtual_desktop/?p=6744), takes aim at some of the barriers to entry by simplifying the installation and deployment process. It also packages everything in an out-of-the-box solution, including the Microsoft SQL Server database, and provides simple installation wizards to guide users through the set up, says Mike Distler, Windchill product marketing director at PTC.

Using Autodesk's PLM 360, Memjet's dispersed team of engineers was able to more effectively collaborate on the design of its unique "waterfall" style color printhead technology. ***Image courtesy of Memjet.***

The pricing model of PDM Essentials is also designed to help smaller shops digest PLM. As opposed to the named license model used in the traditional PLM world, where every user requires a full license, PTC—along with many of its competitors in this space—is offering a floating license, which can be shared among users. PDM Essentials is priced at $2,000 a seat for a floating license.

Beyond addressing the cost and complexity hurdles, PTC says it's essential a right-sized PLM tool provides a path to the future. In this case, users can easily transition to a full-featured PLM tool because PDM Essentials is built on the Windchill platform.

"We know that the small companies today are the big companies of tomorrow," Distler says. "With our approach, companies learn how to use one platform; they never have to migrate to another database, and they don't have to retrain users." **DE**

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INFO → Aras Corp.: Aras.com

→ **Autodesk:** Autodesk.com

→ **Cambashi:** Cambashi.com

→ **EAC Product Development Solutions:** EACpds.com

→ **ImaginIT Technologies:** ImaginIT.com

→ **Kenesto:** Kenesto.com

→ **Memjet:** Memjet.com

→ **Mevion Medical:** Mevion.com

→ **Microsoft:** Office.Microsoft.com

→ **Omnify:** Omnify.com

→ **PTC:** PTC.com

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

→ **Vuuch:** Vuuch.com

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Social PLM Model Gets a Reality Check

BY MARLEE ROSEN

Product lifecycle management (PLM) can provide the ability to boost development speed, enhance customer satisfaction, optimize operations, and create new revenue generation opportunities. However, several challenges have cropped up to complicate the process in recent years, including:

- Product designers and engineers managing their company's PLM are becoming increasingly mobile or distributed.
- An aging engineering workforce prompts the need to capture their knowledge and pass it on to younger engineers.
- The role of IT is expanding—thanks to social IT networking and collaboration tools deployed in other departments.

When you add to the mix the sophistication of today's product development processes, it is easy to see how teams can feel overwhelmed by the options to address these challenges, especially while dealing with security and being in compliance.

The innovation of collaboration tools, which historically began with email, teleconferencing, videoconferencing, instant messaging, LinkedIn, wikis, and other social forums are further progressing into next-generation collaboration dashboards. The idea is to provide companies with real-time visibility to product data and share information across planning, design, costing, sourcing, manufacturing and logistics.

There is no doubt that collaboration tools are quickly evolving and helping growing companies to create even better and more effective "virtual teams." The extended reach of these virtual teams have advanced as well, to include internal employees, a company's supply chain partners—vendors, outsourced services, distribution houses, consultants, integrators, distributors, etc.—and even customers, private-labeled partners and original equipment manufacturers (OEMs). This results in bringing together the right people at the right time, even when they are in different locations to deliver higher productivity, operation optimization and often more creativity in product designs and innovation. According to ARC Advisory Group, collaboration is driving better business performance because it enables teams to tackle business challenges more effectively, speeding up decision-making and transforming key activities like new product development.

Image courtesy of iStockphoto.

The Social Computing Era

The emergence of Web 2.0 capabilities has taken center stage in positioning widespread adoption of social computing—where individuals, at home or at work, can easily and simply engage with peers and colleagues. According to ARC Advisory Group, what we are witnessing is the convergence of social real-time collaboration and PLM across product development organizations in connecting the people and the products they develop to create communities that solve problems and develop product ideas.

There are PLM vendors along various points of the spectrum, from Dassault Systèmes promoting its Social 3DExperience platform to PTC and Autodesk with Social PLM to Omnify Software's Social Collaboration Portal.

In reality, the use of social media in product design still has a long way to go in terms of adoption. Companies are using social media as a low-cost way to broadcast a message, but not necessarily as a means of collecting customer input that can be turned into valuable information. Josh Bernoff, senior vice president, Idea Development at Forrester Research, puts it more bluntly: "We're several years into the social marketing boom, but still many executives are going about social strategy backward: picking technologies like Facebook or Twitter first instead of focusing on what they want to accomplish."

Omnify Software advocates conducting perception studies with customers to prioritize how its social dashboard could provide the most value. The firm went about identifying how users would want to communicate PLM data with suppliers, customers, manufacturing partners, and other external resources, and uncovered that customers want a web-based social platform that can allow for communicating product information in a secure environment that eliminates the need for partners to directly access their Omnify Empower system.

Omnify partnered with Sabisu, a social business platform provider that makes complex operational environments manageable. Their work together has yielded a social business portal that eliminates the use of emails and spreadsheets to share information with external resources, and instead provides the ability for these channels to access real-time information.

Social Networking Tools

Today there is even more sharing and shifting of power from marketers to customers where the manufacturer can't afford to ignore customer sentiments that are presented through the conversations going on in the social media sphere. According to ARC Advisory Group, soliciting these conversations, paying attention to the advice and integrating them into the product lifecycle, will save manufacturers marketing dollars.

The speed of product design into a life-cycle process is hastened through the addition of social technologies and the impact they can bring. Innovation management is a critical business process that is most effective when implemented as an end-to-end continuous process driven by a culture of innovation and enabled by technology. According to Michael Fauscette, group vice president, Software Business Solutions at IDC, "building a collaborative enterprise is about a lot more than just some new software tools, it's about fundamental changes to culture and behavior." There are four phases of innovation management: idea-source, develop, produce and feedback, built on new social technologies that are integrated across a business. Such an approach will help companies compete more effectively in the rapidly changing global, hyper-connected business environment we have today."

It's not a revelation to see PLM slowly adopting social habits, just like some other enterprise processes and tools. Manufacturing industries and engineers have been slower in adoption than marketers and media. Managing security and compliance continues to be one of main struggles. There are real risks to using social media, ranging from damaging the brand to exposing proprietary information to inviting lawsuits. Even the most responsible employees have lapses in judgment, make mistakes or behave emotionally.

Dealing with a confidential design comment in the office is one thing; if the comment or slip up on providing confidential product design details is made on a work-related social media account, then it's out there, and it most likely can't be retrieved. Most industry experts agree that without putting in place a social media policy for your enterprise, you may be inviting disaster. Companies need to spell out and be up front with the goals and parameters of its social media initiative. Otherwise they are not properly mitigating risk. It is important to predetermine who is allowed to use social media on behalf of the organization and what they're allowed to share. Bertrand Sicot, CEO of SolidWorks, understands that while people still have some insecurity about data sharing in the cloud, the general belief is that more and more people are growing more comfortable about using it: "Regardless of the platform, our customers are always ensuring their IP is protected." He continues, "there is a bigger concern when data residing outside their infrastructure is contemplated. We have seen a similar scenario with how unsure we were about conducting online banking just a few years back and now people have come to embrace it. We anticipate the same will happen in our industry. People in time will become more comfortable with the security put in place to protect their designs."

Social media and collaboration tools are changing how product development was once regarded. Gone are the days of the closed-door, experts-only approach to designing products. There is a new force made up of social-savvy mobile employees. PLM users have no choice but to expand, rethink implementation strategies, plans, and embrace the fundamental shifts in PLM enabling technologies and their use for collaboration.

Experts are concluding that the enterprises that seize the opportunities offered by these shifts in PLM software models enabled by social business tools—in particular, leveraging their mobile connected workforce will be in a better position to utilize new collaborative skills being brought to the workplace and will result in better engineered products. **DE**

Marlee Rosen *is an industry market researcher. She wrote this article on behalf of Omnify Software. Contact her via de-editors@deskeng.com.*

INFO ➜ Autodesk: Autodesk.com

➜ **Dassault Systèmes:** 3ds.com

➜ **Omnify Software:** Omnifysoft.com

➜ **PTC:** ptc.com

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Social Collaboration and Global Outsourcing

Sourcing advisory firm ISG reports that social media collaboration, mobility, cloud computing and big data are the key factors that have affected global outsourcing during 2012 and will reshape outsourcing in the long term. Companies will use collaboration tools to accelerate growth by using the skills and knowledge of suppliers, partners and customers in an "extended enterprise."

In her books, Patricia Seybold, a strategic business and technology consulting/research consultant, coined the process term for this as "Outside Innovation." PLM customers often outsource functions, whether engineering, manufacturing or logistics, to gain greater scale or reduce costs.

The Many Faces of Content Management

Product lifecycle management solutions work collaboratively with other solutions in today's dispersed work environment.

BY JIM ROMEO

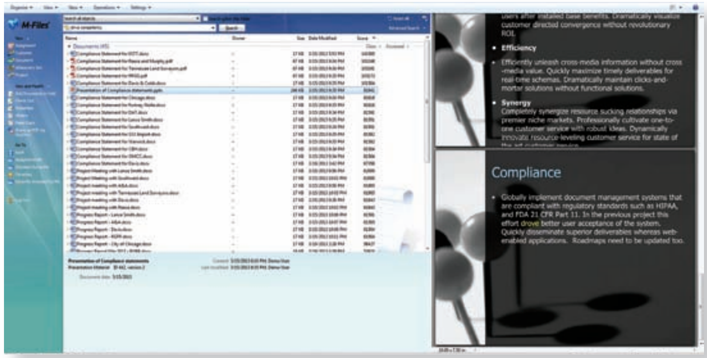
The Cannondale World Cycling Team uses bicycle parts made by SRAM LLC, a manufacturer of high-performance components for the cycling industry. SRAM is geographically dispersed with knowledge workers located throughout the globe, including Chicago, Asia and Europe. SRAM designers and engineers use PTC's Product Lifecycle Management (PLM) solution to manage various facets of their design process, from drawing production to sub-component design and material management.

PLM solutions are interconnected and interact with many other enterprise solutions. In some cases, such solutions are subsets of PLM, while others perform functions of data management, workflow and accountability, but have different names. Key solutions include product data management (PDM) software and enterprise content management (ECM) software. They enhance and, in some cases, replace PLM, but all have a common cause: manage workflow, provide accountability and controlled access, and provide centralized data management and control to build a better product or service.

Conjunctive Use

Greg Milliken, president of Dallas-based M-Files, explains that his company's suite of products offers specific solutions for documentation and quality process. They are focused as ECM solutions, often used in conjunction with PLM and PDM solutions. Milliken says M-Files products are particularly useful for companies where regulatory compliance is key, and where it is important to control the workflow, access and permissions of documentation.

M-Files' solution is used by different vertical markets to enable both front- and back-office functionality. For example, the product may be used in a data environment to manage CAD files, but may also be used as a repository to track and control accounts receivables, payables, requisitions, invoices and timekeeping records. An engineering firm, for example, could use it for accounting and personnel content management, as well as technical documentation management.



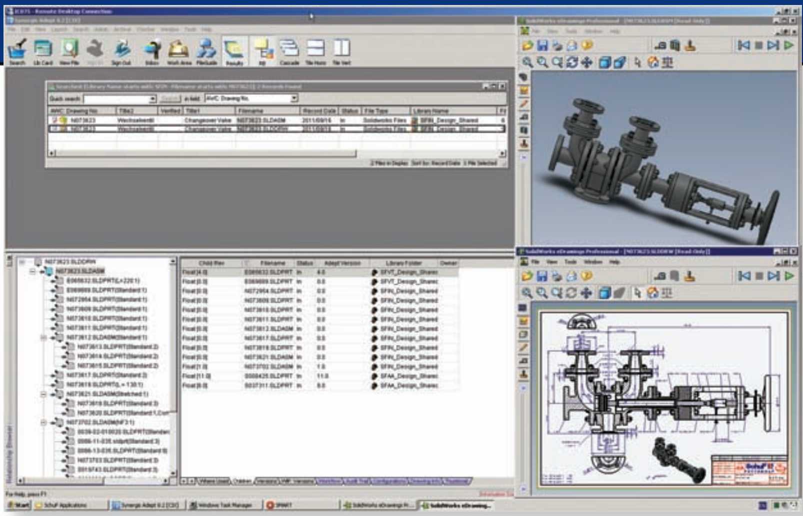
M-Files' software is often used to ensure regulatory compliance requirements are being met.

Case in Point

Booth & Associates is a consulting engineer that uses an M-Files document management solution. Previously, the firm relied on a simple electronic file procedure. An employee would check out a file (like one would do with a library book), save any changes, and then check the item back in. Problems would arise when several employees had the same document open—but only the last one would have his or her changes saved.

An ancillary problem was the management of Booth's AutoCAD and MicroStation drawings, as well as general office documents: They were dispersed over several office servers and on individual workstations. There was no organized central repository.

M-Files gave Booth engineers a more robust check-in and check-out capabilities on any file, whether it was from AutoCAD or MicroStation, or shared planning documents from common office applications. M-Files also allowed the company to use metadata. Precise database key terms identified every file inside a central file repository. Using metadata avoids version confusion, enables super-fast, comprehensive searches across an entire department, and brought in new management capabilities like document backup and history tracking.



SchuF Fettrolf creates parts in Germany, Ireland and the U.S. Each location collaborates with the other by maintaining their designs in an centrally accessible Synergis Adept location.

Document-centric

Milliken says that ECM is close to PLM and PDM, except that ECM isn't as product-centric as it is document-centric. Company customers use their product in conjunction with PLM or PDM. Others use ECM to manage all facets of product design, as well as back-office functions such as accounting, personnel and training.

The benefits of PDM sound much like the benefits of PLM and ECM, but they are project- and product-focused, and yield efficiencies to the collaborative efforts that normally characterize engineering design and services.

"Routing documents through a simple or complex process using email or paper-based processes is highly inefficient and prone to error," says Scott Lamond, vice president of Synergis Software in Quakertown, PA. Synergis offers a PDM solution. "When we rely on email, we are distributing uncontrolled document versions, often to multiple people—resulting in chaos and the potential for costly errors. There are now many versions of the truth instead of a single version of the truth. And there is no way for others to understand the status of the document's flow through the process, where it is and to whom it goes next. There is no built-in notification to others upon specific steps in the workflow, no time-based alerts to help alleviate bottlenecks, and no way to audit the trail of the entire process."

Communicate and Collaborate

"Collaboration is one of the most essential requirements within an engineering environment," Lamond points out. "It has a direct impact on a company's ability to innovate, design higher-quality products, get them to market faster, and with fewer resources. Collaboration occurs between design team members and across departments like manufacturing, procurement, quality and marketing. It also occurs with contractors, vendors and clients. These groups may be located across geographic locations and in different time zones."

Autodesk's Vault Solutions is a PDM product used by engineers for project and design teams. "PDM is focused on managing the day-to-day operations for engineering design and CAD data, facilitating collaboration and increasing efficiencies in the design process," says Richard Blatcher, senior manager for product and industry marketing for Autodesk in San Rafael, CA. "PLM, on the other hand, provides solutions to manage all product-related data and the business processes that encompass it. While the design process can be classified as a subset of this, PLM is focused on covering a broader set of processes to manage new product introduction, engineering, manufacturing, procurement, supplier management, quality and servicing."

Joy Mining Machinery uses Vault to improve collaboration and boost productivity for 400 engineers at 13 engineering sites on five continents. Joy is a producer of underground mining solutions for coal and other bedded materials, such as salt and potash.

Today's engineering design environments is characterized by massive amounts of information and data. The flow and control of such data can make an organization strong, efficient and improve their quality to them compete globally.

As for SRAM's bicycle component design team, they believe in the merit of PLM. Michael Johnson, SRAM's global PLM manager, touts their solution as "a single, integrated, digital environment for data that helps us identify and manage new product opportunities much more quickly than previously." **DE**

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

INFO → Autodesk: USA.Autodesk.com

→ Bentley Systems: Bentley.com/en-US/Products/MicroStation

→ Booth & Associates: Booth-Assoc.com

→ Cannondale World Cycling Team: Cannondale.com/pro_cycling

→ Joy Mining Machinery: Joy.com

→ M-Files: M-Files.com

→ Nexterra Systems Corp.: Nexterra.ca

→ PTC: PTC.com

→ SRAM LLC: SRAM.com

→ Synergis Software: SynergisSoftware.com

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Bright Outlook for Technical Applications

The outlook for technical applications remains broadly positive.

BY TONY CAMBASHI

As we progress through the second quarter of the new year, the market for CAD/CAE, product lifecycle management (PLM) and related applications—collectively, the "technical applications market"—seems to be relatively healthy. A major factor why is the widespread recognition that the technology industries are the ones that can generate sustainable growth.

In the Americas, Europe, the Middle East and Africa (EMEA), and the Asian-Pacific (APAC)—the overall markets show likely growth. From the technology side, with due acknowledgement to Porter's five forces framework for analyzing the attractiveness of target industries in the context of business strategy, we can apply the more tangible notion of "five technology forces" to the drivers that will shape the technical applications market this year.

During 2012, these "forces" became established as the main technology drivers for both the development activities of the application providers and the adoption strategies of user organizations. They are now embedded as the factors that, in 2013, will combine to deliver unprecedented access to design applications and new possibilities for designers to collaborate on new product development projects. As a result, 2013 looks set to be an exciting time for the industry.

Let's examine each force for its potential to change today's technical applications landscape.

1. The Cloud

First of all, the promise of the cloud is to remove a limited ability to invest in IT infrastructure as a barrier to access to applications. This promise can be extended to saying that the "simple applications for the small guys and the sophisticated applications for the large guys" paradigm can be broken.

Even if we disregard the tidal wave of hype that still surrounds the cloud, there is a lot of validity in the promise. In 2012, several major technical applications vendors stepped up their efforts to make their applications available in cloud-based environments—and we expect that, by the end of 2013, a substantial number of user organizations will be accessing the applications in this way.

Leading technical applications vendors are offering cloud-based deployments. For example:

- The Autodesk 360 environment already incorporates Fusion 360—a wide-ranging set of design technology that supports seamless design workflows. There's also PLM 360, the company's PLM system.
- Dassault Systèmes has promoted its commitment to cloud-based delivery of applications.
- PTC's Windchill PLM system can be hosted and managed using IBM Services.
- Siemens PLM announced in October the cloud-based deployment of Siemens' Teamcenter, with specific certifications for Microsoft's Windows Azure, IBM's SmartCloud Enterprise+, and Amazon Web Services.

2. Mobility

Mobility practically goes hand-in-hand with the cloud. So, in parallel with making applications cloud-based, several major vendors have made substantial progress in embracing mobile devices—either as access to the enterprise applications or in the form of reduced-scale (low-end) versions of applications that will run on mobile devices.

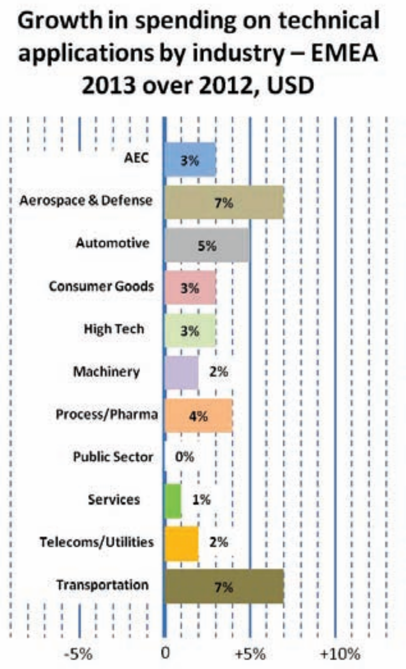
Here again, Autodesk has firmly set out its commitment to both aspects of making mobile applications readily available. In terms of reduced-scale applications designed to run on mobile devices, the company has reported approximately 100 million downloads of low-cost, mobile device-based software to-date.

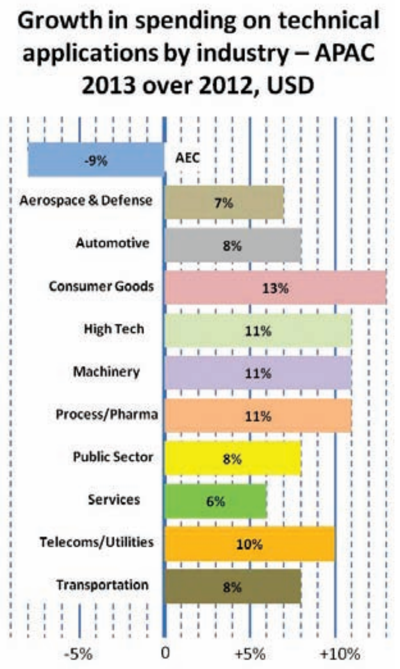
3. Social Networking

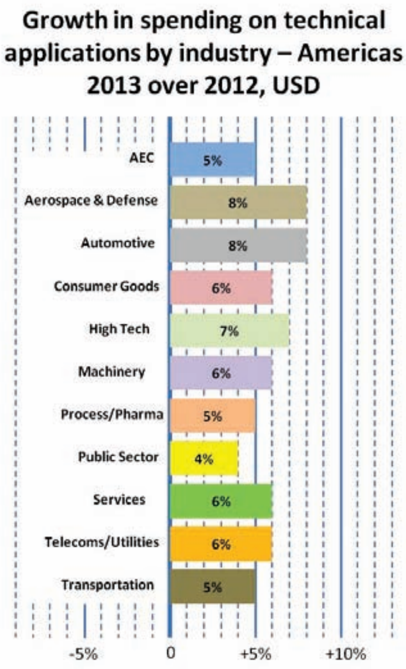
The increasing use of social networking technologies in all walks of life is being exploited to great effect to facilitate collaboration, whether in new product development projects or after-sale maintenance of products.

Of course, the tie-in to mobile devices is a vital aspect of this—for example, the ability for field personnel to access product information held in the PLM environment has been a major focus for Siemens PLM recently, and huge progress has been made in this area. A great example of the use of social networking in the design phase is the crowdsourcing approach to "recruiting" design input for projects.

For more on the expansion of social PLM, see page 26.







4. Integration

Advances in integration have come in a number of guises. Firstly, there has been substantial progress in integrating the individual applications that serve the different phases of the design and development workflow, from concept design all the way to manufacture.

The result is much better feedback from one phase to another, such as the impact back on the initial concept of simplifications suggested downstream to overcome manufacturing complexities. This reduces errors, timescales and costs.

In the PLM domain, the integration focus has been on bringing more of the product information within the scope of the PLM data management environment. The standout aspect of this is embedded software. Previously, software development was managed as a product in its own right and with its own lifecycle. As more physical products exploit embedded software, however, many PLM vendors are working to bring embedded software into the PLM environment. A good example of this is PTC's acquisition of software lifecycle management technology vendor MKS.

5. Ease of Use

Improved integration has led to many applications becoming much easier to use, thanks to mechanisms like common menu structures and higher automation of background tasks. This improves designers' ability to undertake a broader range of the tasks involved.

One notable example is the initial—and for simple products, perhaps entire—simulation and analysis activity. One example is Mentor Graphics' integration of its 1D (system-level) analysis technology and its 3D (component-level) technology.

When Forces Collide

The combination of the five forces is leading to rapid democratization of what were previously specialist tools. As we head toward the second half of 2013, the question of what needs to remain specialist and what can be done by the design all-rounder is a very hot topic.

A good example of this is simulation and analysis technology. There is no doubt that with the latest tools, engineering designers can take their simulations and analysis work to a new level; where that level is set before the need to involve a specialist arises is still an open question (and, of course, varies by industry), one that will attract a lot of attention in the coming months. Nevertheless, the death of the specialist, to borrow from the famous quotation, is greatly exaggerated. **DE**

Tony Christian *is director of the research analyst and consulting company Cambashi. Send e-mail about this article to de-editors@deskeng.com.*

INFO → **Amazon Web Services:** AWS.Amazon.com

→ **Autodesk:** USA.Autodesk.com

→ **Dassault Systèmes:** 3DS.com

→ **IBM Services:** IBM.com/technologyservices/us/en

→ **Mentor Graphics:** Mentor.com

→ **Microsoft:** WindowsAzure.com

→ **PTC:** PTC.com

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

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A New Space Race, Fueled by Simulation

GPU-accelerated simulation sped up Astrobotic's race to the moon.

BY KENNETH WONG

A rendering of Astrobotic's lunar rover robot, named Polaris. The robot's surface operations are carefully pre-planned to maintain unobstructed views of the sun for power and the Earth for communication. Astrobotic uses software-driven simulation to test out Polaris's autonomous electromechanical operations. ***Image courtesy of Astrobotic.***

In 1961, when John F. Kennedy publicly vowed to land a man on the moon and return him safely to the Earth within a decade, he spurred an era of space exploration. Seeing Russia launching Sputnik 1 satellite into space four years earlier probably also lit a fire under the American scientific community's feet. In 1969, six years after Kennedy's death, Neil Armstrong and Buzz Aldrin stepped out of Apollo 11, becoming the first humans to set foot on the moon.

Today, the $30 million Google Lunar X Prize (GLXP) is fueling a new era of space exploration, characterized by friendly competition among teams around the world. Past space endeavors were primarily funded by governments and national institutions. The GLXP, on the other hand, is designed to inspire privately funded groups. To win the prize, a team must safely land a robot on the surface of the moon, have that robot travel 500 meters over the lunar surface, and send video, images and data back to the Earth. Launched in 2007, GLXP started with 33 teams. Since then, some teams merged and others withdrew, reducing the pool to its current 23.

Among the remaining teams is Pittsburgh-based Astrobotic, an offshoot of Carnegie Mellon University's Robotics Institute. The firm relies heavily on software-driven simulation to perfect the electromechanical behaviors of its space robots. Though more cost-effective than physical testing, digital simulation is also a time-consuming process, especially when driven by slower, older systems. Furthermore, when a workstation is engaged in digital simulation, the intense computation hogs its memory and CPU resources. The system inevitably turns into what Astrobotic's CIO Jason Calaiaro calls a "dead node"—no longer available for anyone.

To win the GLXP, the remaining teams are racing against one another to be the first to pull off the mission. The contest, therefore, is also a race against time. For Astrobotic, speeding up simulation is the best strategy. But what else could the engineers possibly do when simulation programs were routinely exhausting the CPU power in their systems? The answer turned out to be GPU acceleration.

Go to the Moon for Less

A government-led moon landing endeavor today would cost about $800 million, estimates Calaiaro. "Our objective is to do that for an order of magnitude less," he reveals. "We've developed breakthrough technologies to do that."

The Astrobotic GLXP team is led by William "Red" Whittaker, Ph.D., CEO of the company. Whittaker's got quite a number of robotic missions under his belt. His past projects include Dante's volcano descent, Nomad's desert trek, Ambler's traverse of rock fields, Hyperion's sun synchronous navigation, and searching for meteorites in the Antarctic.

Astrobotic envisions executing the lunar mission with two robots: Lander and Rover. "Our Lander delivers 500 lb. to the surface of the moon," explains Calaiaro. "Our Rover departs our Lander once it touches the ground, and then explores that environment in high-definition videos and sends them back to Earth, just about in real-time." The first mission is set for 2015.

Astrobotic has constructed physical prototypes of its Lander and Rover robots. They are deployed from time to time to conduct physical tests. But to test the entire launch-to-landing process in the physical world—and repeat it many times until it's flawless—is impractical because of the time, cost and effort required.

As an alternative, the company relies primarily on software-driven simulation. It involves subjecting CAD models of the robots created in SolidWorks' mechanical design program to the anticipated stresses and loads in a virtual environment, using ANSYS and MathWorks' MATLAB software.

Going to the Moon from a Computer

Calaiaro refers to end-to-end, hardware-in-the-loop (HIL) simulation as "the Holy Grail of simulation."

"We'll simulate every detail of the spacecraft's environment, from the moment it departs the rocket to the moment it touches down on the surface of the moon," he adds. "The environmental part of that simulation—where the spacecraft is pointing, the location of the stars, where it is in a particular orbit around the moon, what the cameras are looking at—we'll simulate all of that. All of these are running either on engineers' machines or on a server."

The trouble was, when simulation was running at full speed, the three-year-old workstations at Astrobotic were completely consumed by the intensity of the jobs. Engineers and designers could no longer use these workstations for any other tasks—not even something as trivial as composing documents, checking emails or surfing the web. Some jobs could take as long as 10 hours, the equivalent of an engineers' entire workday.

Free White Paper

Astrobotic's experience with GPU-accelerated simulation is part of the white paper "Design and Simulate in Parallel," authored by the *DE* editors. In addition to the Astrobotic case study, it includes two additional case studies featuring Liquid Robotics and Briggs & Stratton.

Liquid Robotics, an ocean data services provider, used HP workstations and NVIDIA Maximus to speed development of its Wave Glider, a wave powered, autonomous marine robot designed to help address global climate change, national security, hurricane and tsunami warnings, and offshore energy and resource management. When Liquid Robotics began using ANSYS and MathWorks' MATLAB to simulate the Wave Glider's mechanisms it had designed with SolidWorks, its workstations slowed to a crawl.

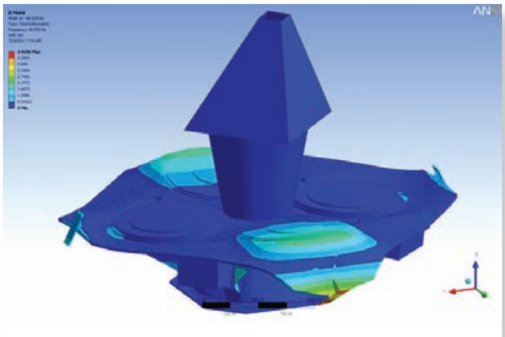
The company's engineers now use HP Z800 workstations with two CPUs and Maximus to speed their simulations. Six of the CPU cores plus an NVIDIA Tesla companion processor run CAE software, leaving the workstation's other six CPU cores, along with its Quadro GPU, to run SolidWorks and other design and office programs.

Likewise, Briggs & Stratton, a manufacturer of small engines, reduced its average simulation processing time by 30% using NVIDIA Maximus and HP workstations. The company uses PTC's Pro/ENGINEER Wildfire for equipment design. For studying the effects of the temperature on the product's mechanical components, engineers use Dassault Systèmes' SIMULIA Abaqus. And for analyzing the airflow, cooling, and combustion activities within the engine, they use ANSYS Fluent.

To learn more, download the free white paper at deskeng.com/maximus.html and listen to podcasts with key players at the Virtual Desktop blog, deskeng.com/virtual_desktop/?p=6983.

So Calaiaro and his team chose two methods to deal with the dead-node problem. Whenever possible, they simplified the simulation exercise to keep the processing time short. This was usually done by reducing the mesh count, or degrees of freedom (DOF) in the model, to half a million or less. They also resorted to scheduling jobs to occur after hours or over the weekend so they wouldn't interfere with the staff's day-to-day computing workload.

Both fixes came with drawbacks. Simplifying the job meant settling for an approximation rather than an accurate answer. Scheduling jobs to run overnight meant that, if a job had been incorrectly set up, the staff wouldn't find out until the next morning.



Simulation of Astrobotic's robots occurs primarily in a software-driven environment. Shown here are ANSYS simulation results of a module. With an enhanced GPU-powered HP Z800 workstation, Astrobotic expects to do something previously unthinkable: simulate the entire launch-to-landing sequence from a desktop system. *Image courtesy of Astrobotic.*

Then Astrobotic was introduced to GPU acceleration, courtesy of HP and NVIDIA. The company used a HP Z800 workstation, equipped with NVIDIA's dual-GPU Maximus architecture. With 12 Intel Xeon CPU cores, a NVIDIA Quadro GPU, and a NVIDIA Tesla GPU, the workstation was equipped with far more computing and visualization horsepower than to what Calaiaro and his engineers were accustomed. Perhaps most importantly, the system had sufficient power to facilitate a CAD program and a simulation program, both at the same time. The system didn't slow to a crawl when it was engaged in ANSYS simulation jobs; it remained active to perform other tasks. That was the beginning of the end of dead nodes.

GPU-Acceleration of Simulation

Standard workstations are equipped with a single GPU. The HP Z800 workstation with NVIDIA Maximus technology, on the other hand, has an additional GPU, a NVIDIA Tesla unit. The extra GPU becomes a dedicated parallel processor for compute-heavy simulation jobs.

To take advantage of GPU acceleration, the software must be written to parallelize computing jobs on the GPU. As it happens, Astrobotic's primary simulation software, ANSYS, is written to take advantage of GPU acceleration. When it announced GPU support for the first time in September 2010, ANSYS stated, "Performance benchmarks demonstrate that using the latest NVIDIA Tesla GPUs in conjunction with a quad-core processor can cut overall turnaround time in half on typical workloads, when compared to running solely on the quad-core processor. GPUs contain hundreds of cores and high potential for computational throughput, which can be leveraged to deliver significant speedups."

"The NVIDIA Maximus-powered system is like getting three people's worth of use on a single machine," observes Calaiaro. "This system is a beast. We haven't yet found anything it can't handle—even simultaneous CAD, analysis and additional number-crunching in remote rendering jobs."

With the new HP workstation, Calaiaro saw a significant speedup when running jobs involving 1.5 million DOF or more. "Now we can do complete analyses on our lander that runs 2 million to 3 million DOF, which means we can refine and test our models more completely and in less time," he notes.

To gain an even greater power boost, Astrobotic is also refining its own in-house software code to support GPU. In addition, Calaiaro is planning to augment his current Maximus setup with one more NVIDIA Tesla GPU. This would give the already-powerful workstation not one, but two NVIDIA Tesla GPUs, dedicated to simulation jobs. The setup would allow Calaiaro to do something previously unthinkable: Simulate the entire launch-to-landing sequence from a desktop system.

Design and Simulation, Side by Side

Previously, Astrobotic engineers employed a workflow that kept design and simulation in separate cycles because compute-intense simulation runs interfered with normal design work on workstations. But the new Maximus architecture is prompting engineers to rethink such a strategy.

"Analysis informs design," Calaiaro points out. "The ability to run analysis at will, not having to wait to do it at night, not having to schedule it for a particular time—that means you'll end up with a more informed design."

A workflow that facilitates design and simulation in parallel may not exactly be a new idea, but it certainly is "the way we should work," he adds. **DE**

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

INFO → ANSYS: ANSYS.com

→ **Astrobotic Technology:** Astrobotic.com

→ **Dassault Systèmes:** SolidWorks.com

→ **HP:** HP.com

→ **Intel:** Intel.com

→ **MathWorks:** MathWorks.com

→ **NVIDIA:** NVIDIA.com

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Advertorial /// ESTECO

Multidisciplinary **Collaboration** Made Easy

Orchestrating industrial expertise through the web with ESTECO solutions.

Engineering design often involves multiple disciplines and requires coupled analysis to evaluate the overall performance, taking into account interdisciplinary trade-offs. As traditional simulation tools are not devised to solve specific problems coming from different domains, Multidisciplinary Design Optimization (MDO) comes in assistance to the architecture of coupled engineering processes. However, as product design becomes more and more complex, a shift toward a distributed and collaborative paradigm is required. Simulation Workflow Management (SWM) proposes a solution that is able to support the integration of distributed simulation models, enhancing multidisciplinary team collaboration.

With this in mind, ESTECO has developed a system that captures, organizes and orchestrates engineering processes and simulation data ranging from the definition to the execution of the simulation workflow. The new web-based enterprise application, SOMO, offered with the MDO platform modeFRONTIER, enables the management of not only multidisciplinary simulation workflows but also inter-organizational ones.

Let's take as an example Airworks Engineering, a multidisciplinary company for mechanical engineering that was facing the challenge of improving efficiency in conversion of wind energy into electrical power. To optimize the design of the whole assembly of a wind power unit rotor, Airworks' experts in structural performance analysis joined forces with the specialists in CAD and CFD at the University of Trieste, Italy. The latter prepared the parametric CAD model and set up CFD simulations, while Airworks took care of aerodynamic calculations of the wind rotor blade. The optimization analysis was performed by using ESTECO technologies, allowing the geographically dispersed, inter-organizational multidisciplinary team to use different CAE tools, including proprietary codes. The outstanding result was a wind turbine design with a power coefficient and an annual energy production increase of 1.26% and 0.47%, respectively.

Simulation data and engineering knowledge were effectively managed through ESTECO's web Simulation Workflow Management System, meeting unmatched results thanks to the collaborative environment.

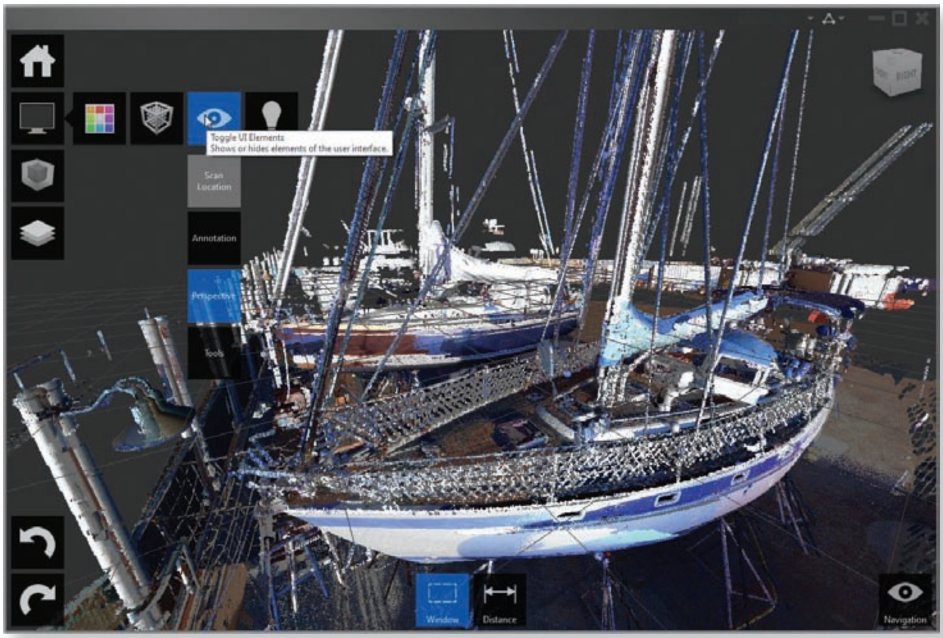
INFO → ESTECO: esteco.com

AutoCAD: Improving *Your Design Workflow*

Connectivity empowers a host of new features and functions in AutoCAD 2014.

BY DAVID COHN

A new release of AutoCAD has become a rite of spring, and for this, its 28th major release of the world's most popular CAD program, Autodesk, has once again provided customers with a host of improvements. For the past several years, the company's focus has shifted from empowering standalone individuals to leveraging the power of the cloud, social and mobile computing. With AutoCAD 2014, users can work more seamlessly across platforms, collaborate with other project stakeholders, and access their drawings wherever they go. And a linchpin of that capability is the Autodesk 360 cloud service.



The new Autodesk ReCap program lets users create and manipulate point cloud project files before attaching them to AutoCAD drawings.

Upon launching AutoCAD 2014, users are once again greeted by a Welcome Screen featuring three panels: Work (tools for creating new drawings and opening existing files), Learn (links to video-based training), and Extend (connections to the Autodesk Exchange app store, Autodesk 360, and social media sites including Facebook and Twitter). Although you can certainly use AutoCAD 2014 as a standalone application, users will want a full-time Internet connection to take advantage of all the new connectivity tools—and will likely remain logged into their Autodesk 360 account whenever they're using AutoCAD 2014.

Even Better Command Line Tools

One of those new connectivity tools is the ability to do Internet searches directly at AutoCAD's ubiquitous Command line. Many longtime users continue to access commands by typing. While the Command line saw some significant changes in the last release, its transformation in AutoCAD 2014 is just short of miraculous: The Command line in AutoCAD 2014 now supports AutoCorrect. If you mistype a command, instead of responding with "Unknown command," the program autocorrects to the most relevant and valid AutoCAD command. For example, if you accidently type TABEL, the TABLE command is automatically launched.

The AutoComplete command entry feature, introduced in AutoCAD 2013, has been enhanced in AutoCAD 2014 to support mid-string search. So now, if you type SETTINGS, the suggestion list displays all commands containing the word SETTINGS anywhere within it, not just at the beginning. Commands in the suggestion list are initially displayed in the order of their usage based on general customer data. But as you continue to use AutoCAD, the order of commands in the suggestion list adapts to your specific behavior.

The Command line in AutoCAD 2014 also has a built-in synonym list. If you type a word, the program returns a command if a match is found in the synonym list. For example, if you type SYMBOL, AutoCAD finds the INSERT command; or type ROUND and AutoCAD finds the FILLET command. And like most things in AutoCAD, you can customize both the AutoCorrect and Synonym lists using the Edit Alias tool on the Manage ribbon.

When you move the cursor over a command name or system variable in the Command line suggestion list, two small icons appear so that you can immediately search for more information in the Help system or on the Internet.

You can also use the Command line to access layers, blocks, hatch patterns, text styles, dimension styles, and so on. For example, if you type DOOR and the current drawing contains a block definition with the name DOOR, you can quickly insert it right from the suggestion list.

To make the suggestion list easier to navigate, system variables and other content are organized into expandable categories. You can expand a category to see the results, or press the TAB key to cycle through each category. You can also customize the behavior of the Command line itself, enabling or disabling various features, changing the suggestion list delay, and adjusting the input search options. Most of the new Command line functionality is also available when using dynamic input.

Improved File Management

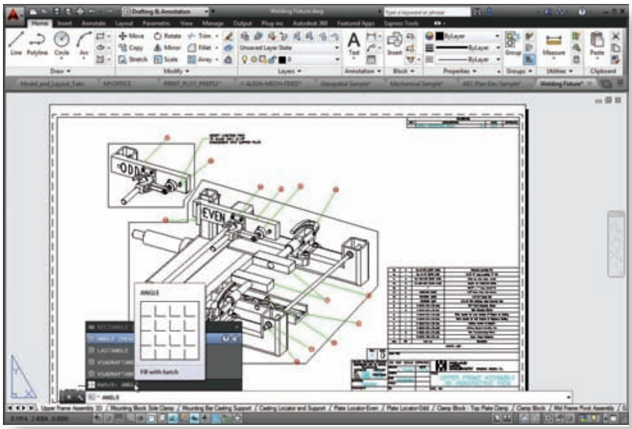
While the enhancements to the Command line only become apparent when you type, the new drawing file tabs will probably be the first new features you'll notice when you start using AutoCAD 2014. The drawing file tabs appear as a bar across the top of the drawing area. Because they do take up some space that could otherwise be used to display drawings, the drawing file tabs can be toggled on and off. When enabled, you see a tab for each open drawing, and can easily switch between drawings by simply clicking on a tab.

The tabs initially display in the order in which drawings were opened, but you can drag and drop tabs to change their order. If there is not enough room for all of the file tabs to display across the drawing area, an overflow menu at the right end of the file tabs bar provides access to the additional files.

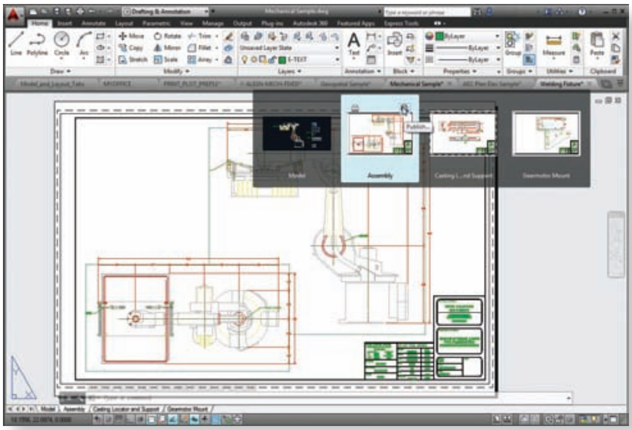
A lock icon on a tab indicates that a particular drawing was opened in read-only mode, while an asterisk on the tab indicates that the drawing has been modified since it was last saved. When you move the cursor over a tab, you see preview images of the model and layouts, and if you move the cursor over one of those previews, the corresponding model or layout temporarily fills the drawing area. Plot and Publish tools are also available above each preview image, or you can click on one of the previews to immediately switch to that specific model or layout. You can also right-click on a tab to access tools to create, open, save and close files, including the ability to close all open files except the one on which you right-clicked.

Connecting with Colleagues

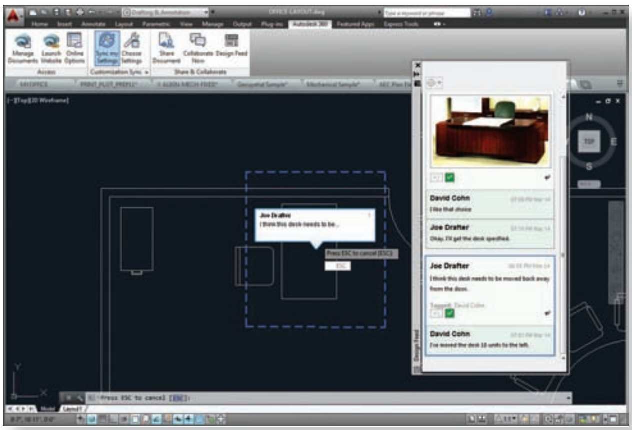
If a big focus of AutoCAD 2014 is connectivity, the centerpiece of that connectivity is Autodesk 360. The Autodesk 360 cloud-based service is both a secure, web-based central repository for your drawings and system settings, and an



The Command line now includes auto-correction, synonym lookup, and mid-string auto-completion. You can even preview hatch patterns and blocks directly at the Command line.



Drawing file tabs make it easier to switch among open drawings, preview model or layout tabs, and even see which drawings have been changed since last saved.



Design Feed enables users to have a virtual conversation with other team members; it also tracks messages and images tagged to the drawing.

online hub for collaborating with colleagues and leveraging cloud-based compute power for creating renderings, performing analysis and leveraging point cloud data.

New in AutoCAD 2014 is Design Feed, an environment in which you can have a virtual conversation with other team members, regardless of their location. Design Feed appears in the form of a new palette when you click the new Design Feed tool on the Autodesk 360 ribbon.

You can use tools in the Design Feed palette to create messages to other team members, and associate those messages with an area or point within the drawing. You can also include images and tag multiple colleagues. Once you post a Design Feed message, it is saved to your Autodesk 360 account along with the drawing, and the people that you tagged receive an email message alerting them of your post. They can then view the drawing and associated posts and reply to those posts using their copy of AutoCAD 2014, AutoCAD WS via any web browser, or the AutoCAD WS app on a mobile device. They can even make changes to the drawing if you've granted them permission to do so. Design Feed works wherever you are, and comments sync within seconds.

Connecting with the World

In this latest release, Autodesk has added some of the tools found in AutoCAD Map 3D and Civil 3D to AutoCAD itself. The new geographic location tools in AutoCAD 2014 enable you to import map data into drawing files so that you can see your design within the context of its location. If you render the model, it will automatically have the correct sun angle. If you insert geo-referenced images or blocks into a geo-referenced drawing, they are automatically placed in the correct location and at the proper scale. This enables multiple users to work separately on portions of the same design, such as a housing project, with the guarantee that everything will match when the entire project is assembled. If you have a GPS-enabled device on your computer, you can see your current position in the drawing and mark positions as you walk around.

To add the geographic location to a drawing, you simply click the new Set Location tool on the Insert ribbon. You can set the location using the Autodesk Maps Service or by selecting a KML or KMZ file. To use the Maps Service, however, you must be logged into your Autodesk 360 account.

When you specify the geographic location using a map, you can simply click on the map or search for an address or latitude and longitude. Maps can be displayed as an aerial photo, a road map, or a hybrid of both. When you find the correct location, you drop a marker to select it, automatically applying the corresponding latitude, longitude and time zone. Once placed, you can adjust the elevation, latitude and longitude as needed.

Once a map has been applied to the drawing, it is always displayed below the drawing geometry. You can then trace over the map to identify features on the site. The map can be changed between aerial and road map views, or toggled off completely as needed. Additional tools enable you to mark positions in the drawing and add text to describe those positions.

Capturing Reality

The ability to attach and display point clouds was first added to AutoCAD 2011. While the tools in AutoCAD itself have not changed all that much, Autodesk has included a new program called Autodesk ReCap as part of the AutoCAD 2014 release. ReCap is a separate application that enables you to create a point cloud project file (RCP) that references multiple indexed scan files (RCS). Those scan files can come from laser scanners, or even from a series of digital photos that you upload to the ReCap Photo online service.

After selecting the files to import, ReCap lets you adjust import settings that affect the size and appearance of the point cloud. The imported files are displayed in ReCap and can be modified before attaching the point cloud file to your AutoCAD drawing. For example, you can use tools to crop the point cloud to isolate a specific volume within the scene. After attaching a point cloud to an AutoCAD drawing, additional tools become available in AutoCAD that let you further adjust the point cloud. You can then use the point cloud to show existing conditions, or as the basis for constructing AutoCAD geometry.

Other Enhancements

Of course, like any release of AutoCAD, users will find a host of other, smaller enhancements designed to improve common tasks. For example, layers now use natural ordered sort, so that layers named 1, 4, 25, 6, 2 and 10 are sorted as 1, 2, 4, 6, 10 and 25 instead of 1, 10, 2, 25, 4 and 6. There's also a new Merge option in the Layer Manager palette that enables you to select one or more layers in the layer list, merge the objects from those layers onto a different layer, and then purge the selected layers from the drawing.

Layers and linetypes from externally referenced drawings are no longer displayed in the linetype list of the ribbon or Properties palette, because you can't control them from there. But externally referenced layers still appear in the ribbon and Layer Properties manager, so you can control their visibility. You can also now easily change the xref attachment type between Attach and Overlay, and change the path of selected xrefs between Absolute and Relative.

Rounding out the list of new features are several very welcome drawing enhancements. For example, you can now draw arcs in either the default counter-clockwise direction or clockwise by pressing the CTRL key. The command for creating single-line text now retains the most recent justification setting. When adding hatch or gradient fills, the program retains the most recent method for selecting objects to hatch (pick internal point or select objects). And when adding baseline or continued dimensions, AutoCAD can use either the current dimension style or the style of the selected dimension.

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 includes AutoCAD Raster Design, SketchBook Designer, Showcase and Mudbox for just $330 more than the cost of AutoCAD alone. The Professional suite adds 3ds Max to the mix, while the Ultimate suite adds Alias Design as well.

This time around, virtually all of the new features in AutoCAD 2014, including the intelligent command line improvements, live maps, Design Feed, drawing file tabs and Autodesk 360 connectivity, have also been included in AutoCAD LT 2014, the company's lower-cost 2D-only alternative to AutoCAD.

Both AutoCAD and AutoCAD LT 2014 began shipping in late March, with the Design Suites following suit in April. AutoCAD 2014 supports Windows XP, Windows 7 and Windows 8 (including support for touch-enabled devices), but Autodesk has dropped support for Vista. AutoCAD 2014 also includes several new features to help improve software security, and prevent loading and running of unauthorized or malicious AutoLISP and VBA applications.

All told, Autodesk has once again done a great job improving its flagship product, making AutoCAD 2014 another very compelling release. **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. His latest CADLearning eBook, AutoCAD 2014 New Features and Enhancements—Revealed! can be purchased on the Apple iBookstore. You can contact him via email at david@dscohn.com or visit his website at DSCohn.com.*

INFO → Autodesk: Autodesk.com

AutoCAD 2014

- **Full system:** $4,195
- **Annual subscription:** $545
- **Upgrade from AutoCAD 2008-2013:** $2,935

AutoCAD LT 2014

- **New:** $1,200
- **Annual subscription:** $180
- **Upgrade from AutoCAD LT 2008-2013:** $840

SYSTEM REQUIREMENTS

- **Operating system:** Windows 8, Windows 7 or Windows XP (SP3 or later); 64-bit or 32-bit
- **CPU:** Intel Pentium 4 or AMD Athlon dual-core (3.0GZ or greater recommended for Windows 8 or Windows 7; 1.6GHz or greater for Windows XP)
- **Memory:** 2GB RAM, 4GB 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 7.0 or later web browser

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

Get an Education in Simulation

The 14th NAFEMS World Congress takes place June 9-12 in Salzburg, Austria.

The 2013 NAFEMS World Congress in Salzburg, Austria will be the largest one yet. More than 260 presentations across eight tracks and two conferences will take place over June 9-12, 2013.

Every other year, NAFEMS, an international association for the engineering modeling, analysis and simulation community, hosts a World Congress that focuses on simulation. This year, the 14th such event will feature more than 260 presentations, several training courses and panel discussions, and an exhibition. Attendees include software vendors, engineers, analysts and academic institutions.

Keynotes Announced

The keynote presenters for NAFEMS World Congress are indicative of the Congress' global perspective, and match this year's "World of Simulation" theme:

- Ralph Sundermeier -Volkswagen, Germany
- Koichi Ohtomi -Toshiba, Japan
- Harald Hasselblad -Volvo, Sweden
- Grant Steven- University of Sydney, Australia
- Steven Sirman- Tata Steel Automotive, UK
- Frank Popielas- Dana Corporation, USA
- Jérôme Buffe- Thales Alenia Space, France

"We are delighted that the some of the world's leading minds in analysis and simulation have agreed to speak at the Congress and share their knowledge and expertise with delegates," said Tim Morris, NAFEMS CEO. "Their combination of technical expertise,academic knowledge and industry experience ensures delegates an unrivalled insight into the use of analysis and simulation today, and developments for the future."

Simulation Process & Data Management

This year, the Congress will incorporate the 1st International Conference on Simulation Process & Data Management (SPDM). The new event will allow all those with an interest to take part in an independent, international forum dedicated to SPDM.

Over the past three years, NAFEMS has held a series of dedicated conferences on the topic of SPDM in both Europe and North America. Their popularity gave rise to the idea of a conference dedicated to SPDM, which will run alongside the NAFEMS World Congress in 2013.

When registered, all delegates will have access to both the SPDM Conference as well as the World Congress. The tracks for the SPDM conference will be scheduled in such a way that delegates can also take part in the World Congress keynote sessions without missing out, and similarly, NAFEMS World Congress delegates can take part in the SPDM agenda. The co-location of both shows will provide a larger exhibition area, including a specific section dedicated to SPDM.

Book Training Courses in Advance

As part of the NAFEMS World Congress 2013, attendees will have access to many training courses being held over the course of the Congress. These courses will be taught by NAFEMS tutors, including *Desktop Engineering* Contributing Editor Tony Abbey. Attendees must reserve their place for the courses in advance by registering at nafems.org/congress.

A preliminary agenda is available on the NAFEMS site, which includes more information on the following training courses:

- Structural Optimization in FE Analysis
- Composite FE Analysis
- Fatigue & Fracture Mechanics in FE Analysis
- Dynamic FE Analysis
- Introduction to SPDM
- Introduction to Business Value from Simulation Data Management
- Non-linear FE Analysis
- Practical CFD
- Practical Modeling of Joints and Connections
- Elements of Turbulence Modeling
- FEA for Managers

INFO ➜ NAFEMS World Congress: nafems.org/congress

➜ SPDM International Conference: nafems.org/congress/spdm/

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

The **Costs** of the Cloud

As more engineers leverage high-performance computing, the true costs of a cloud-based model remain a mystery to many managers.

BY FRANK J. OHLHORST

The last thing an engineer wants to hear are terms like TCO (total cost of ownership) and ROI (return on investment), especially when those terms are applied to technology solutions. Simply put, what most engineers want are the resources to do their jobs effectively, quickly and accurately.

However, those resources can be quite expensive. Their costs put not only a project at risk, but the company as well. What is the most cost-effective way to balance effectiveness and expense? Many firms are finding their answer these days in one of two camps: high-performance computing (HPC) cloud-based solutions (HPC as a Service) and in-house implementations.

Which specific solution is right for your company comes down to the math, what delivers value, what enhances productivity and what garners results in the most economical way. To quantify those factors, it takes some research.

On-site or in the Cloud?

Making sense of the value of HPC solutions provided by cloud service providers can be a complex undertaking. After all, the billing mechanisms can be multifaceted, including charges for provisioning, CPU time, support services and so on. Yet, at first glance, the initial costs can be quite attractive.

Barbara Hutchings, director of Partner Relations and HPC Strategy at ANSYS, offers some sage advice: "One of the first things to consider is the total costs of a solution; you have to look at software, hardware, support and administrative costs. Only when armed with that information, can you make a comparison between an onsite solution and cloud-based solution costs." That proves to be an important point, because many potential adopters of cloud-based HPC experience "sticker shock" once they see how much HPC compute cycles cost per hour.

Hutchings also points out that "pay-as-you-go HPC cloud services can be very expensive for steady state processing." In other words, the cloud proves to be a viable entity for projects that require temporary scale-up capabilities, or bursts of processing activity. Organizations that have a steady flow of HPC work may be better served by internal resources, because burst processing and scale on demand are not necessary requirements for operation.

However, that business model may be an exception to the rule, with most engineering firms having to scale up on a project-by-project basis and assign resources to handle bursts of activity.

Cloud-based Benefits

While much hype surrounds the cloud, there are both tangible and intangible benefits offered by outsourcing HPC. HPC system managers can leverage those benefits and extend the ROI of HPC operations. The primary benefits include:

- Scale to better support application and job needs with automated workload-optimized node OS provisioning.
- Provide simplified self-service access for a broader set of users, which also reduces management and training costs.
- Accelerate collaboration or funding by extending HPC resources to community partners without their own HPC systems.
- Enable pay-for-use with show-back and chargeback reporting for actual resource usage by user, group, project or account.
- Support using commercial HPC service providers for surge and peak load requirements to accelerate results.
- Enable higher cloud-based efficiency without the cost and disruption of ripping and replacing existing systems.

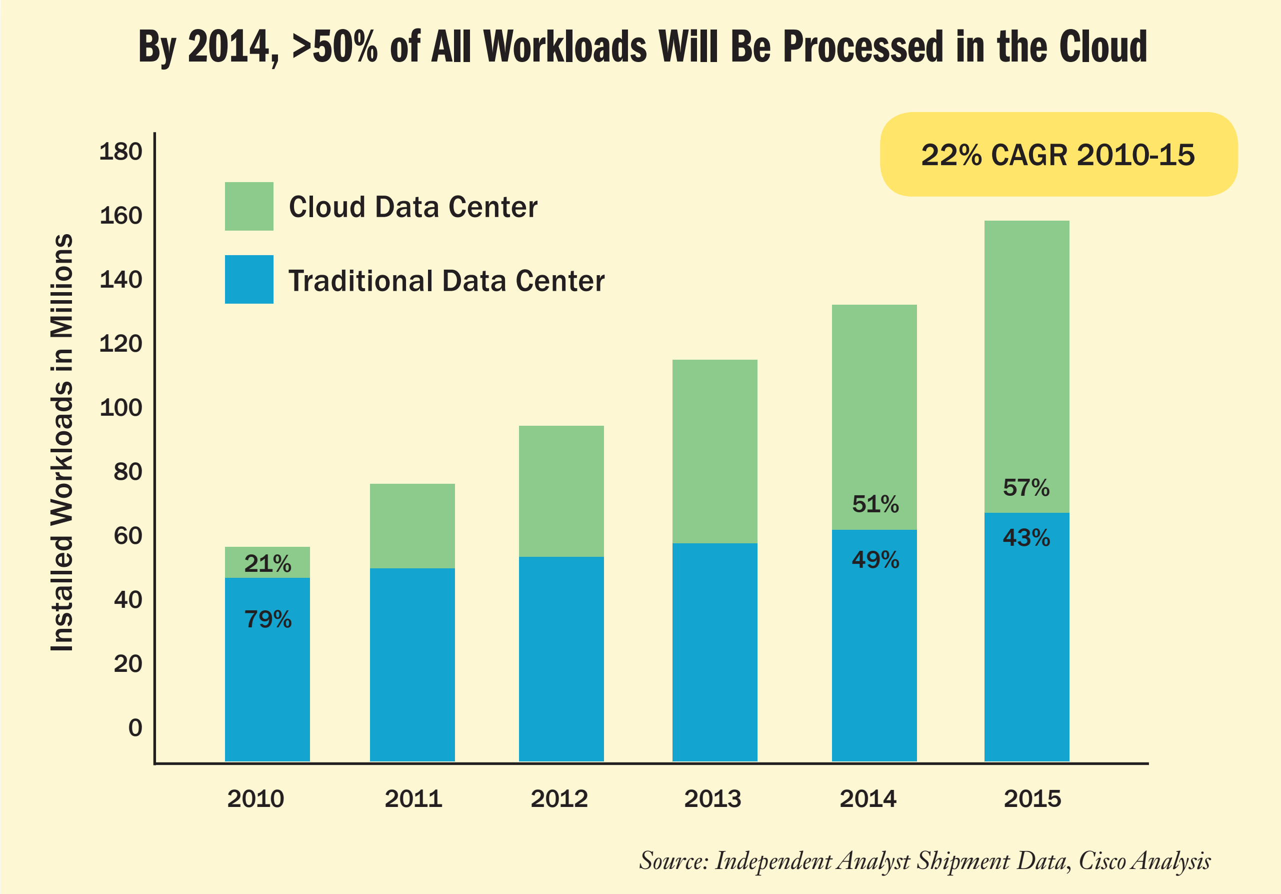
These benefits help cloud-based HPC deliver appreciable ROI and make hosted offerings viable for a multitude of businesses. However, cloud-based HPC services are not without their challenges as well, perhaps diminishing some of the luster of HPC cloud services. Those challenges include:

- The costing/pricing model, which is still evolving from the traditional supercomputing approach of grants and quotas toward the pay-as-you-go model typical of cloud-based services.
- The submission model, which is undergoing an evolutionary change from job queuing and reservations toward on-demand virtual machine provisioning and deployment.
- Moving data in and out of the cloud, which can be costly and result in data lock-in.
- Security, regulatory compliance, and various abilities (performance, availability, business continuity, service-level agreements, and so on).

However, as more and more vendors get involved in providing hosted HPC solutions in the cloud, many of those challenges may simply disappear.

Determining Value

The hosted HPC market is in a state of flux, with more providers coming on the scene and competition creating pricing models that are only bound to get less expensive with time. Although that situation makes it difficult to calculate ROI and TCO, it surely does point those calculations toward more affordable results.



Nonetheless, much the same can be said about on-premise deployments as well—workstations and servers continue to become more powerful, and prices continue to drop. What's more, supporting technologies, such as storage and high speed networking, are also increasing in capacity and speed as prices drop.

With that in mind, it becomes increasingly difficult to pick one solution over the other—yet, that is the very task that IT managers and those in charge of budgets must consider. Adding further confusion to the process is the fact that both technologies may be about to experience disruptive enhancements. The cloud is poised to gain speed and added flexibility with the arrival of software-defined networks (SDN), while on-premise equipment is bound to be affected by developments in nonvolatile memory and optical networking technologies. That brings added angst when designing "future proofing" into an HPC solution, ultimately affecting value.

The Choice is Yours

Ultimately, it will be the needs of the business and its projects that will determine which is a better fit for an organization. For example, if continuous scale change is part of the operating norm, the cloud may prove to be a better fit. However, if a business operates in a steady state fashion, with predictable loads, an on-premise solution may be the better way to go.

Another factor that can sway the argument include the speed of provisioning. If a project has a normal, planned scale-out, in-house resources may be appropriate. However, if projects are deemed critical, the instantaneous provision capabilities of the cloud may prove beneficial. Considerations such as IT staffing levels, in-house expertise and administrative chores all have an impact on determining what works better for a given situation.

It comes down to the fact that one technology may not be better than another, but more of a choice based upon which is more appropriate for a business model. As Hutchings notes, "a usage-based model may be the best fit for smaller, less frequent projects, which may not fall under an organization's core competencies, and ultimately duty cycles may be the key determining factor."

Hutchings also warns that "the cloud is not a single process or an isolated technology, and it has implications for a broad range of technologies, so HPC in the cloud may be part of a much bigger cloud-enablement scenario."

With that in mind, IT may have to research the benefits of the cloud beyond just solving an HPC problem, and perhaps shift more services into the cloud, to bring overall operational expenses down. DE

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Simplifying Intelligent Systems Design

Intel hopes to make the "Internet of Things" participation easier for developers with its new tools and software.

BY RANDY FRANK

According to IDC, the Internet of Things (IoT) could consist of 15 billion intelligent connected devices by 2015 ("Worldwide Intelligent Systems 2011–2015 Forecast: The Next Big Opportunity"). The machine-to-machine (M2M) connectivity of the IoT requires extensive communications and computing technology.

"This is the whole spectrum of devices, from microcontrollers and sensors all the way up to data center devices," says Ryan Brown, marketing director, Intelligent Systems Group, Intel.

Hardware is one of the pieces of the staggeringly larger puzzle. The other part is 35 trillion gigabytes of data. "Making the best advantage of that data in a connected world will drive new solutions," predicts Brown.

As an advanced manufacturer of integrated circuits, Intel plans to be part of creating these new solutions. To date, it has developed two approaches to help developers: Intelligent Systems Framework (ISF) and the Intel System Studio. The tools and software available from these programs make it easier for design engineers to go to market with smart devices.

ISF Overview

Recognizing many of the design engineers who are familiar with Intel products are not experts at embedded system design, Intel developed ISF as a how-to guide for configuring smart devices. According to Brown, ISF is about having connected, secured and managed systems. Simple connectivity, especially at the expected scale, without management and security creates problems.

"There is nothing worse than untrusted data, because you are making decisions upon it," notes Brown.

Connectivity, security and management requirements have been Internet issues for users for many years. Unlike user-driven enterprise and consumer designs, however, machine-drive embedded designs have quite different problems.

"As you move into this embedded space, it becomes very fragmented—in many cases proprietary, depending on whose equipment you bought in the last 20 years," Brown says. "We saw an opportunity to start putting together a framework of basic capabilities your solutions should have in them to be able to connect to this new world order, this Internet of Things."

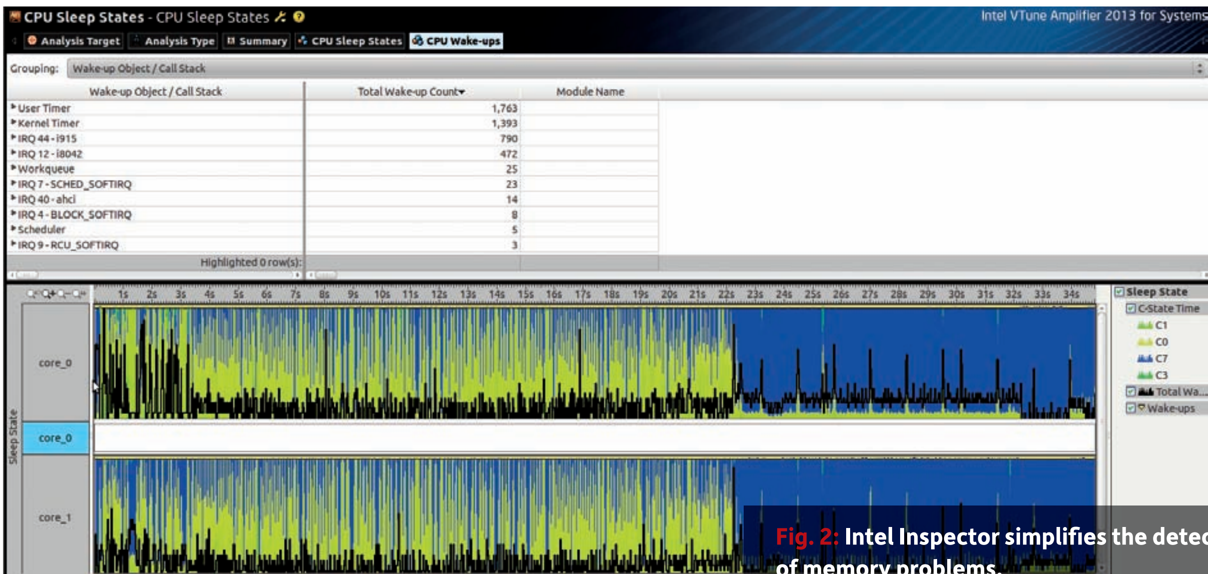

Fig. 2: Intel Inspector simplifies the detection of memory problems.

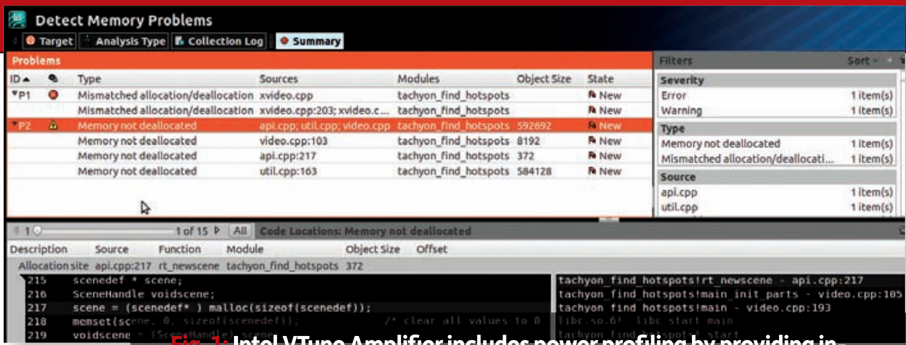

Fig. 1: Intel VTune Amplifier includes power profiling by providing in-depth, SOC-wide visibility of events and analysis of CPU and GPU activities.

Partnering with several companies, Intel introduced the first revision of ISF in September 2012, and since then it has been bringing an ecosystem together. Delivering a solution that is easy to integrate and poised for a long useful life requires more than one company to bring all the disparate pieces together.

Today, Intel and its partners have more than 50 products shipping for industrial, automotive, retail, entertainment and technology applications based on ISF 1.0.

Integrating Intel System Studio

With the framework in place, Intel's next step addresses the major concerns of developers. As noted in VDC Research's "Strategic Insights 2012: Embedded Software & Tools Market," the most important factor in the development of products in the embedded space is product quality. Device system performance, time-to-market, engineering productivity, development cost and power requirements are among the other Top 10 factors.

UBM Electronics' "2012 Embedded Market Survey" lists debugging tools, schedule and programming tools as three of the Top 5 items that designers would like to change to improve their embedded design activities.

Addressing these concerns, the Intel System Studio provides deep system-level insights into power, reliability and performance to help accelerate time-to-market of Intel architecture-based embedded and mobile systems, says Peter Horn, an embedded software strategist at Intel. Debuggers, analyzers, compilers and libraries deliver the insight and system capabilities. A few examples demonstrate the capabilities of the Intel System Studio.

"For time-to-market, we added optimized building blocks, like encoder-decoder libraries and debuggers that provide both high-level language debugging capabilities and full hardware insight to speed up development," says Horn.

"The biggest help for a developer is if you provide him code that he can use 1:1 directly," he adds. The building blocks and libraries in the Intel System Studio target this approach. "The content of these libraries goes far beyond what I have seen in other tool chains," Horn says.

For example, full encoder-decoder signal processing capabilities address mathematical algorithms such as Fast Fourier transforms (FFTs) from proven and optimized code.

Debugging delivers part of the system-level insight. Intel's JTAG debugger is a high-level language debugger for C++ language. It offers views for the peripheral registers in all the peripheral intellectual property (IP) blocks on the system on a chip (SOC). Besides standard debugging, it provides visibility to thousands of registers—as well as the capability to modify the values. The bit-field editor in the debugger shows the content of these bit fields in a human-readable way.

The debugger also contains the manual to provide information when the developer needs it. System Visible Event Nexus technology (SVEN), a software technology and application programming interface (API) in the Intel Debugger, provides a method of transmitting events from any operating system context, driver and firmware.

In addition to the Intel debugger, a second GNU Debugger (GDB) optimized for Intel architecture provides information—including application defect analysis and the ability to determine thread errors as part of the debug process.

Intel VTune Amplifier and Intel Inspector are analyzers in the Intel System Studio. On-chip counters read by the Intel VTune Amplifier show the number of cache methods to help designers determine the optimum performance and power balance in a system. This tool identifies wake-up causes, timers triggered by application, and interrupts mapped to hardware interrupt level, and displays CPU core frequencies and events that wake up the processor at the source code level (see Fig. 1).

The Intel Inspector analyzer identifies memory and threading coding defects, including memory leaks, invalid access, plus data races and deadlocks. It supports remote data collection, debugger breakpoints, and break on selected errors (see Fig. 2).

Connecting the M2M Dots

The Intel System Studio provides deep system-level insight to the underlying silicon device, as well as the operating system.

It does so to aid "efficient development, debugging, performance and power optimization of the embedded system," says Horn. "The debuggers are able to display all SOC elements, and our analyzers utilize counters of the system to provide accurate performance and power analysis." **DE**

Add these capabilities to ISF, and developers may have a new way to expand the IOT.

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

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Is AM Ready for Standards?

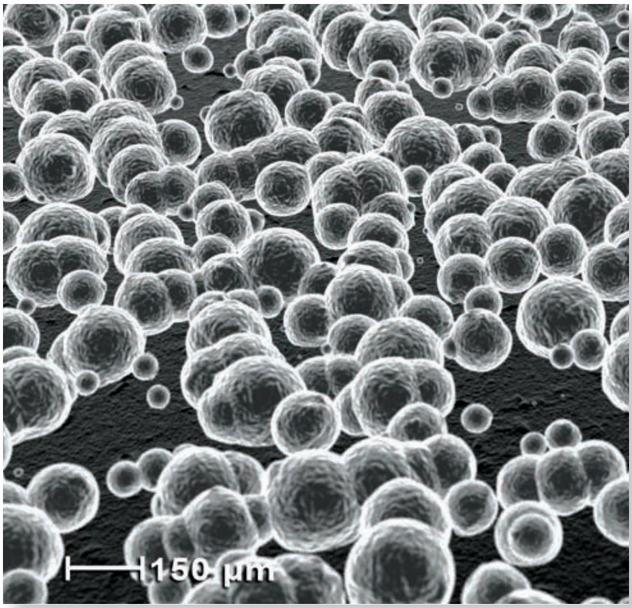
It takes some time for an industry to mature to the point where standards become relevant. That time may be coming soon for additive manufacturing.

BY MARK CLARKSON

When it comes to additive manufacturing (AM), there really aren't many standards in place. That's not especially surprising, given that the entire field is only something like 25 years old. Compared to technologies like casting, milling or even injection molding—which dates to the Civil War era—AM is just a baby.

In fact, until recently, there hasn't been a pressing need for AM standards. For some segments of the market, the capability to print solid objects is so new and so exciting that, especially at the relatively inexpensive end of the spectrum, people just don't care that much about standards.

"Is the lack of standards impeding our business in any way? No," asserts Jeff Moe, president of LulzBot, which produces sub-$2,000 desktop 3D printers. "It hasn't been a pressing issue. From a business perspective—getting our units out there—the lack of standards hasn't been a problem. A lot of our customers are engineers and architects, and none of them have been asking about standards."



Artist's rendering of microscopic view of metal powder particles with an approximate diameter of 150 micrometers (µm). *Renderings copyright Mark Clarkson.*

Any Material You Want, As Long As It's UV-curable Resin

"Standards are less important for the design end of the market because the bulk of today's technologies are very different in their capabilities," says Fred Fischer, director of business development for Stratasys. "The output is so different that it's relatively easy for someone to make a decision based on that."

Fischer uses shopping for a new camera as an example. "If Brand A cameras give you color, and Brand B cameras give you black and white, then it's easy to make that decision," he explains. "Do you need color? That's where our industry is now."

If you need metal parts, for example, stereolithography (SLA) isn't an option. If you need transparency, metal laser sintering won't work. If you need parts 3 ft. wide, you can't print them with a PolyJet. The physical characteristics of your part—size, material, strength, surface finish, isotropism—will greatly determine which process you're going to use.

"As the industry continues to mature and the technologies become more like one another, then standards will become increasingly important," predicts Fischer.

You're camera shopping again. This time, all the cameras take color photos, but each manufacturer specifies its capabilities differently. One gives resolution in megapixels, another gives the diagonal dimension of the sensor. Frustration and confusion ensue.

Standards solve the problem, but only if we can believe them.

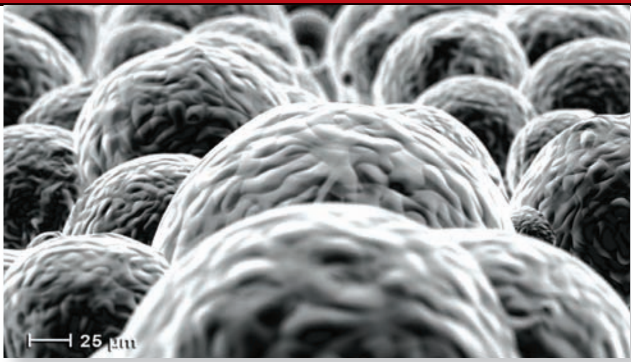
"As you move into functional prototyping or using additive technologies for manufacturing applications," says Fischer, "the requirement for consistent output becomes critical. If I'm an engineer and I choose a material based upon a material spec sheet, I want the parts I make to come within reasonable proximity of my expectations—not just for the initial part, but on an ongoing basis, from part to part and from system to system.

"Standards help engineers increase their confidence level, and they increase the comprehensiveness of the documentation and data that's available to help make those decisions," he continues.

Great. So where are those standards?

ASTM Committee

"The fact that there has been no concerted effort to develop additive manufacturing standards until 2009 is telling," says Pat Picariello, ASTM International's director of developmental operations. "No one's going to invest the time, the effort and the intellectual capital it takes to develop consensus standards … unless there's some return on investment for them."



Artist's rendering of microscopic view of metal powder particles with an approximate diameter of 150 micrometers (µm). *Renderings copyright Mark Clarkson.*

But in 2009, ASTM International (formerly the American Society for Testing and Materials), started technical committee F42 to define AM standards. ASTM is an organization that facilitates the development and delivery of international voluntary consensus standards. It is similar to ISO, but with members representing themselves or organizations rather than countries.

"That there exists an ASTM technical committee on AM speaks to the fact that a good chunk of that industry has decided that standards were [needed]," says Picariello. "That committee wouldn't exist otherwise. ASTM doesn't decide that 'Today is the day we're going to start developing standards for a given subject area.' It's only the stakeholders, those with a material interest in the topic, who tell us the time's right and that they'd like ASTM to work with them."

The membership of F42 consists of more than 150 individuals and organizations from 13 countries, says Picariello. "The membership of any ASTM activity is intended to be a microcosm of the industry it represents. In the case of F42, we have instrument manufacturers, component manufacturers, material suppliers, academicians, different federal entities, and [consultants.] Each of these individuals, representing one organization or another, works to develop the documents that they decide are relevant at any particular time."

ISO Committee

There is also an International Organization for Standardization (ISO) AM technical committee: TC 261. TC 261 is even younger than F42, but it has an identical scope and structure—and about an 80% overlap in membership.

"Nobody wants conflicting standards," says Picariello. "There is an agreement between ASTM International and ISO to work in a collaborative way to develop standards for AM. It sets forth different mechanisms to marry the ISO process to the ASTM process, which will result in a jointly branded ASTM/ISO standard.

"This is the first agreement of its sort between ASTM and ISO," he adds. "It's really going to enable the standards development in this area to move at a much more accelerated and collaborative pace."

Voluntary Servitude

The lack of standards doesn't mean that, say, aerospace companies aren't using AM.

"All the prime aerospace contractors have internal process specifications for AM of some kind," says Shane Collins, business development director of Oxford Performance Materials. "But it's proprietary to that company, and quite often they see it as a competitive advantage. They may not even want to let on that they're using AM, let alone help write a standard that could help their competitors get to where they are."

However reluctantly, additive manufacturers are waking up to the need for standards to facilitate everyday transactions between buyers and sellers. Even so, AM standards aren't exactly developing at breakneck speed.

"It's really hard to get worldwide consensus on anything," Collins quips.

At press time, ASTM F42 has published five standards to date: two on terminology, one on a new file format, and two for very specific manufacturing processes.

It's important to note that participation in the ASTM or ISO technical committees is entirely voluntary—it's not a paying job.

"It takes the commitment of people who have day jobs to write these standards," says Collins. "These people usually already have a full plate, especially the talented people who we need to dedicate time to this."

Supply and Demand

Despite all difficulties, the consensus remains that having AM standards in place is only a matter of time.

"All of your Tier 1 guys have written their own standards," says Collins, "and they've coddled their supply chain for additive so far. But we're getting to the point where their supply chain is going to be several steps removed. When their supplier's supplier's supplier starts supplying additive parts, and they lose track of the fact that the part was made additively, and now it's become a part of a larger assembly—that will be an OMG moment.

"That's when the problems will appear, and they'll recognize the need for standards." **DE**

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

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Dynamic Analysis

The major building block of any dynamic analyses is an understanding of the important resonant frequencies and corresponding mode shapes.

BY TONY ABBEY

Editor's Note: Tony Abbey teaches the NAFEMS FEA Intro class in the UK and US. Contact tony.abbey@nafems.org for details.

After 35 years, I still find dynamic analysis to be a "buzz," if you will excuse the pun. There are so many uncertainties in dynamic analysis, dependent on the way that the mass distribution, the stiffness distribution, loading forms and constraint forms all interact. The results of an analysis are often a surprise, and always need checking.

Natural Frequencies and Mode Shapes

The natural frequencies of any structure are special frequency values where the interchange between kinetic energy and stored energy occurs most readily. A simple suspended mass on a spring has a single natural frequency, say 134 Hertz (Hz). Hertz units are in cycles per second.

The stored energy is a maximum in the spring when pulled away from the datum position before release. After release, the kinetic energy builds up as speed increases. It is at maximum when the mass is traveling fastest as it passes through the datum position. At this snapshot in time, there is no stretch in the spring, so stored energy is zero.

Beyond the datum, the spring stiffness opposes motion—and the stored energy builds up, speed drops and kinetic energy falls. The spring comes to rest at full stretch, with maximum stored energy. That is half a cycle of motion completed. The whole process is repeated indefinitely if no damping is present.

The readiness of the structure to "flip-flop" between energy modes is what makes the natural frequencies so important. It means the structure will respond to an external excitation most aggressively at these values.

For a more complex spring mass system, with three springs and three masses suspended, the model now has three degrees of freedom (DOF). We will find three possible natural frequencies of increasing value. For a large model with 100,000 DOF, theoretically there are 100,000 natural frequencies. Luckily, most structures only have significant response at the lowest modes.

Associated with each natural frequency is a mode shape. Imagine the mode shape as a frame from a high-speed video or the "frozen" image seen by a strobe light, set just at the natural frequency. This is a deflected shape that is unique to that particular frequency. This uniqueness, or "orthogonality," is also a very special property and we use it a lot in dynamics.

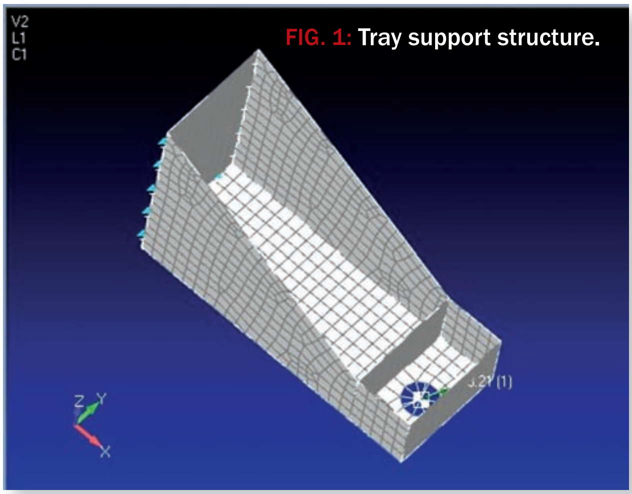

FIG. 1: Tray support structure.

The structure shown in Fig. 1 is a simple cantilevered tray. It supports a piece of equipment modeled as a lumped mass connected to the base of the tray with a rigid, spider-type element.

The first eight natural frequencies of the tray are shown in Fig. 2. There are approximately 5,000 DOF in this model, but mode 5,000 is of no interest to us as it is some random perturbation of the structure, rather like Brownian motion.

Mode	Freq(Hz)
1	108.4
2	129.8
3	430.0
4	1596.0
5	1804.0
6	3482.0
7	3551
8	4219

FIG. 2: The first eight natural frequencies of the tray.

Associated with each frequency is its mode shape, and the first four for the tray are shown in Figs. 3 through 6. It is important to identify what the mode shapes represent and to describe them clearly. If we just refer to "Mode 2, 129.8 Hz," we have no way of comparing it to test or other analyses. Its physical

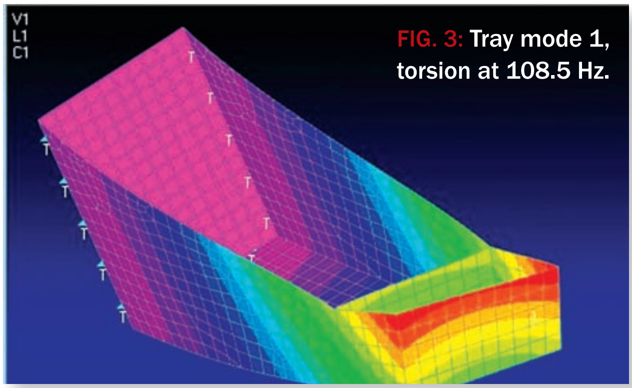

FIG. 3: Tray mode 1, torsion at 108.5 Hz.

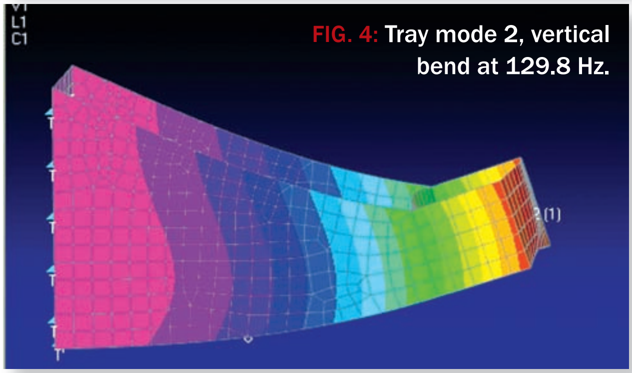

FIG. 4: Tray mode 2, vertical bend at 129.8 Hz.

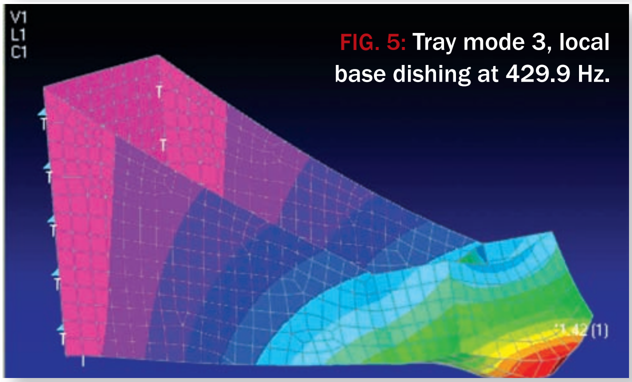

FIG. 5: Tray mode 3, local base dishing at 429.9 Hz.

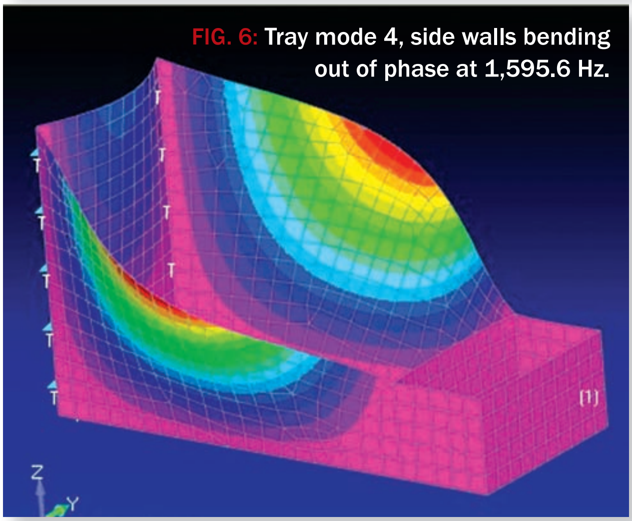

FIG. 6: Tray mode 4, side walls bending out of phase at 1,595.6 Hz.

meaning gets lost in any report. The modes are described in the figures. You can make up your own terminology, as long as it is consistent and gets across the physical shape.

The higher-frequency modes are shown in Fig. 7.

What modes are important? That usually depends on the frequency range of the excitation forces. If the tray is connected to a solid bulkhead that is being vibrated up to 850 Hz, all modes up to that value should be included. However, mode shapes tend to interact—and we may find that the natural frequencies above the 850 Hz cut-off play a role as well.

Notice Mode 4 at 1,596 Hz (Fig. 4). We don't hit this mode at resonance in our excitation range, but there may be some influence at 850 Hz. We really don't know until we do a full response investigation, so a safety factor of one-and-a-half to two times the highest frequency is used. If we use a safety factor of two on 850 Hz, then Mode 4 at 1,596 Hz would be considered.

If the excitation is a force-impacting, rather than a steady driving frequency, it becomes more difficult to assess important modes. For example, a sharp triangular load shape through time has a lot of high-frequency content (remember the Fourier series from college days?).

However, a modal survey such as we have carried out provides great physical insight into the potential nature of any dynamic response of the tray.

Building Blocks

It is vital to carry out a modal survey as shown on any structural model before we carry out a dynamic analysis involving some type of external excitation. Whether we shake it or hit it, a structure will respond by combining the mode shapes together through time, or across frequency.

In our tray, we can see major modes associated with whole structure motion at 1 and 2; local dishing of the payload region at 3 and a local wall mode at 4. Higher-order wall modes occur at Modes 5 and 6, and whole-structure torsional modes occur at 7 and 8. This should give us a good, intuitive feel for response to any type of input.

Internally, in the solution of dynamic response finite element analysis (FEA), there are two approaches possible:

1. Modal method reuses the data from the mode shapes in a previous normal modes analysis step.

2. Direct method calculates the responses using overall system matrices, without needing a normal modes step.

When using a direct method, there is a temptation to ignore the need to do a modal survey because the calculation process doesn't need it. This is a very dangerous practice, because without a modal survey you are "shooting blind" in any response analysis, with no way of knowing whether the model is showing the correct modal behavior. So please treat this as a two-step analysis: Run a normal modes analysis to carry out a modal survey, then do a direct response analysis as required.

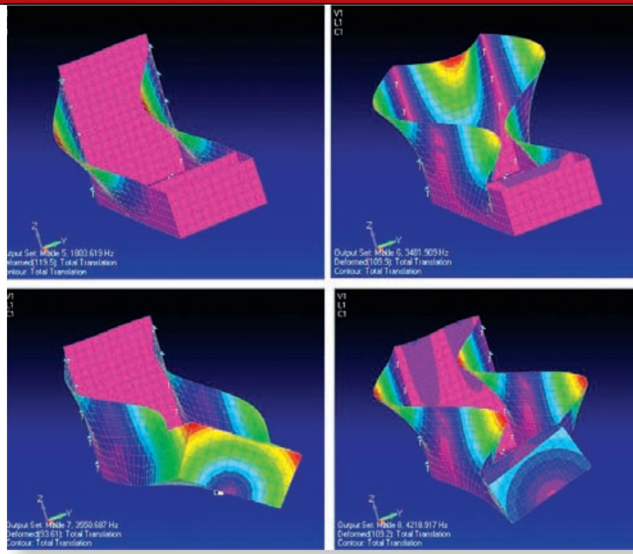

FIG. 7: Modes 5 - 8, above frequency range of interest.

We will discuss the pros and cons of modal and direct methods in a future article. The key thing to remember for now is that both are tools in the toolbox, and you can use both to build confidence in the results.

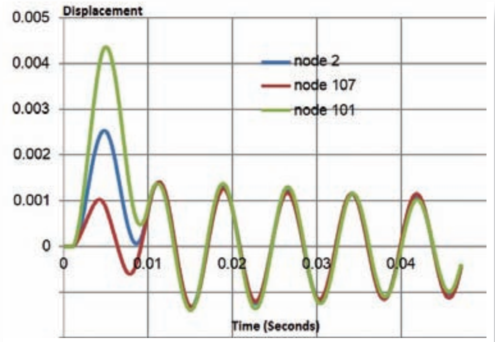

FIG. 8: Time history of payload and corners in z.

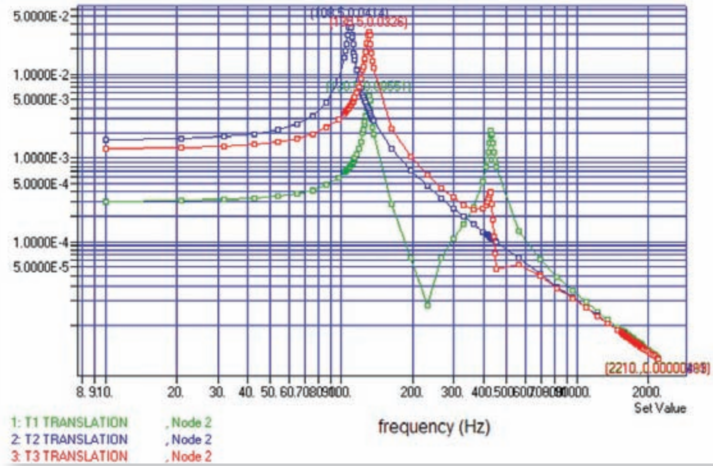

FIG. 9: Frequency response of the tray at payload position.

Time-based Response

Once we have understood the inherent modal characteristics of a structure, we can carry out a time-based (transient) analysis. The loading is applied through time, and we calculate the response through time. Fig. 8 shows the vertical response through time of the payload mass and two corners of the tray. A rectangular pulse was applied for 0.01 seconds at the payload. The orientation of the load was at 45° to the vertical.

The response during loading is shown; notice the spread of values as a torsional response is seen initially. When the load is removed, we see a steady wave form. It has a dominant frequency and is slowly decaying. We can measure the peak-to-peak values to give a time period.

The inverse is the frequency, so we can check against the natural frequencies of the structure. We are looking for confirmation of the frequency and corresponding mode shape. If it all ties up, we build confidence in the model.

The decay rate is proportional to the damping we model in the system. Damping is a complicated subject, and we will explore it in more detail in a future article. However, most damping is modeled using a viscous (velocity-dependent) simulation. By using successive peaks, we can check the damping level defined.

It is best to check a large model by using xy plots at key positions as shown. Only then do we perhaps need to do a full animation of the model. A full animation takes up a large amount of data storage, and a very large model can defeat a post processor's capabilities. These may be "nice to have"—but xy plots and frozen time plots can usually tell a full story.

Frequency-based Response

An alternative to a time-based solution is a frequency-based solution. A typical application would be a structure connected to a bulkhead or similar base structure, which is being shaken across a frequency range. This does not represent one physical event, but represents an exploration of the structural behavior across a range of possible steady-state responses.

A shaker table is a good analogy: We mount the structure on the table and vibrate at 10 Hz. We ignore the start-up motion, and concentrate instead on the peak displacement, acceleration, stresses, etc., at the steady-state response. We then increase the frequency to, say, 20 Hz—and wait until the system settles down and measure the peak steady-state responses.

Alternatively, we can imagine a point load introduced to the tip of a beam via a "stinger." The stinger oscillates at a set frequency, and when the system settles to steady state, we measure the peak beam response. We change the frequency and repeat the process. Similar external excitations can be set up on more-complex structures.

Fig. 9 shows the displacement response of the payload point on the tray when the payload is driven at a range of input frequencies. The response in x, y and z is shown. From this, we can see the influence of each of the modes we investigated earlier, and we would check that the payload directional response ties up with the survey.

We can plot a similar figure for acceleration response, and we can use these in the design assessment. For example, if the driving input at the payload is 200 Hz, this means the response is low—nicely between peaks. The y (lateral) direction response is dominant at 108.5 Hz Mode 1 torsional response. The z (vertical) response is less severe, at 129.8 Hz vertical bending Mode 2. This information could be used to check fragility of the payload.

This has been a very short introduction of a very broad subject. The main emphasis is on the importance of the calculation of natural frequencies and modes' shapes of a structure. These are inherent characteristics of any real structure. Any time- or frequency-based response analysis is dependent on how accurately these are represented. To aid our understanding and build confidence in any dynamic analysis, a full modal survey should be carried out.

A time-based transient solution is the most intuitive type of dynamic loading, and represents a specific loading case. A frequency-based solution, on the other hand, is usually a search across a potential applied loading range for the most damaging steady-state loading. DE

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When 3D is Not Needed

How 0D and 1D simulation can achieve large-scale design space exploration.

BY SERDAR UCKUN

Imagine generating 1,000 design alternatives for a new rocket engine and analyzing the performance and behavior of these designs in parallel, using virtually unlimited computing resources in the cloud. This is the promise of design space exploration. In fact, this is the vision articulated by Carl Bass, CEO of Autodesk, in a keynote address at Autodesk University in November 2012 (Bass 2012).

Simulating and analyzing a vast space allows designers to:

- isolate and eliminate inferior designs;
- search for and identify promising optimal designs;
- verify designs with respect to system requirements;
- identify design tradeoffs to maximize performance; and
- move to detailed designs with proven system models.

Today's simulation and analysis (S&A) tools allow engineers to study and verify system properties and visualize the thermal, structural, electromagnetic and other physical properties without having to build a physical prototype. We can crash simulated cars into walls, perform stage separation in simulated rockets, and fly virtual aircraft with remarkable precision and accuracy. But for the most part, engineers only run a handful of designs through the S&A process because of the tool costs and the time it takes to create models. Furthermore, verification and certification of system designs is often done using actual hardware—a rather costly and time-consuming endeavor.

It doesn't have to be that way. In the semiconductor industry, new chip designs are routinely optimized and verified using computer models and simulations, using a process known as "correct by construction" design (Sangiovanni-Vincentelli 2003). Achievement of a similar capability has been the Holy Grail of complex cyber-electromechanical systems design for the last couple of decades.

Arguably, it is much harder to do correct-by-construction design for systems that directly interact with an uncertain external world. On the other hand, computing power is ever-increasing. In theory, simulation capabilities should become more affordable and readily available.

And with that, a compelling vision emerges: Could true design space exploration finally take place without having to create physical prototypes?

Achieving Design Space Exploration

The reality is that sophisticated S&A tools are only available to a privileged few. The majority of model-based engineering analyses use complex methods such as computational fluid dynamics (CFD), finite element analysis (FEA), and multi-body dynamics (MBD). These tools require a 2D or 3D design configuration as the starting point for grid generation.

Imagine what's required to generate one 3D design for a passenger car, and multiply it by 1,000 design alternatives. Even if we were to only use conceptual CAD models, it would require extraordinary computing power and data storage—not to mention simulation and design expertise.

And so, even with the movement to bring more cloud-based S&A tools to market, 3D thinking will still result in very few designs being extensively explored, thanks to their complexity.

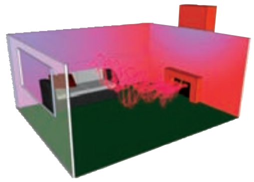
So, what is the alternative? The key is to free ourselves from the constraints and commitments imposed by precise 3D configurations. Detailed low-dimensional models of system behavior can provide valuable insights into system performance and function. And once an appropriate high-fidelity, low-dimensional model has been found to perform well, it can easily be augmented with appropriate 3D details.

Breaking Down the Walls

Let's look at this in the context of a familiar example: heating a living room. Imagine a fireplace on one side of the room, an open window on the other side, and a cold winter day outside.

A 3D CFD model would be the most detailed model of the thermal characteristics of the room. We could use such a model to study heating irregularities within the room, or to better understand thermal flux. A typical CFD model of the room would divide the space into a 3D mesh, and then use a set of partial differential equations (PDE) to evolve the temperature (and possibly humidity, airflow and other factors) in each segment of the mesh as a function of time. To produce meaningful results, the CFD model would require knowledge of the precise geometry of the room, including furniture placement, other impediments to heat flow (such as columns), and the thermal characteristics of the objects in the room.

A 2D model of the room would follow the same principles as a 3D model. To simplify modeling and simulation, we could use a 2D grid that divides a 2D cutaway of the room into individual cells, and a set of PDE models to define the heat transfer between the cells. We might ignore the width of the room and simply model heat transfer along the length (fireplace to window) and height (floor to ceiling) axes. By eliminating one dimension, one could achieve significant computational speedup in exchange for some loss in precision.



Properties of 0D, 1D and 3D Models

	0D	1D	3D
Behavior	System dynamics as a function of time	System dynamics as a function of time and one dimension	System dynamics as a function of time and space
Type of model	Lumped parameter ordinary differential equations or differential-algebraic equations	Ordinary differential equations or differential-algebraic equations	Partial differential equations
Inputs	Component-connectivity model; component behavior models; context	Component-connectivity model; component behavior models; context	3D CAD configuration; material properties; context
Critical expertise	Model abstraction	Model abstraction	Grid generation
Typical use	Component sizing; design space exploration; preliminary verification of performance and function	Component sizing; design space exploration; preliminary verification of performance and function	Detailed analysis and verification of performance, risks, and failure modes
Common tools	MATLAB/Simulink, Modelica, C, Java, Excel	MATLAB/Simulink, Modelica, C, Java, Excel	Various open and proprietary CFD and FEA solvers

Both 2D and 3D models are based on PDEs, which are difficult to solve. By contrast, 0D and 1D models could be based on ordinary differential equations (ODEs) or differential-algebraic equations (DAEs) that are easier to solve. A 1D model of the same room would define heat transfer along the length axis of the room (from fireplace to window), while a 0D model would assume that the temperature is uniform across the entire room (commonly referred to as a lumped parameter model) at any given time.

A significant advantage of 0D/1D modeling is that one does not need precise 3D geometry to develop lower-dimensional models. While lower-dimensional models do not provide the same level of precision as detailed spatial models, they can be used during earlier stages of design (prior to conceptual or detailed CAD) for the purpose of design space exploration.

A vast space of system configurations may be generated rapidly by using a component model library and by composing end-to-end system models from these components. For instance, we could easily generate and analyze 1,000 alternatives by choosing from 10 window sizes, 10 fireplace models and 10 different-sized rooms. In this particular case, a 1D model of heat transfer could be used quite effectively to determine the proper fireplace size to meet certain room-heating requirements. Once the sizing study is completed using a 1D model, the designer can incorporate the appropriate fireplace into the 3D design of the room.

In other applications, the insights gained from 1D analysis may help constrain the 3D configuration options. For instance, performance analysis of an electric powertrain might place constraints on the size of the vehicle under consideration.

A Final Word about Model Fidelity

It's true that 1D models do not have the same level of fidelity as 3D models, and it's often not be possible to study all pertinent behavior using a 1D model alone. However, the goal of space exploration design is to eliminate inferior designs from consideration so that detailed S&A efforts may be spent on the most promising designs. By using high-fidelity surrogate models in less than three dimensions, we achieve substantial performance gains in the overall design process without sacrificing final product quality. Simply put, three dimensions are sometimes just too many. **DE**

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AM Yields Better Product Results

Testing with additive manufacturing prototypes helps ensure a better design.

The latest development in thermal imaging cameras from FLIR Systems is a small, sleek camera for boaters to use as a nighttime vision aid. The camera functions as a fixed seeing eye.

"Navigating at night and actually seeing what is in front of you helps boaters, firefighters, the Coast Guard," explains Marcel Tremblay, director of mechanical engineering at FLIR. "GPS tells you where the boat is, and radar will detect what is far in front, but the camera actually shows you what is there. The camera is like your own eyes in the daytime."

The camera has found appreciation among boat captains in particular, says Tremblay: "Many captains are on the water, driving $2 million boats at times, and now they have something akin to a car's headlights—only better. It significantly decreases stress for them."

The camera's unit development, however, might be the greatest stress reliever for both user and maker. By using additive manufacturing (AM), the team at FLIR was able to inexpensively test the product before it was finalized for tooling and injection molding. Thanks to product testing early in the manufacturing process, the team succeeded in preventing the product from wearing down later in its life, and was able to better protect the thermal imaging camera from the boating environment.

Tremblay says FLIR never releases a production of a plastic tool without doing a stereolithography (SLA) prototype first.

The SLA process allows complex, involved prototypes to be built fast via preprogrammed computers, ultraviolet (UV) lasers, and liquid resins. FLIR uses service bureau Solid Concepts' SLA technology to not only work out design intentions, but to test predicted weaknesses—essentially troubleshooting years in advance of any foreseeable problems. The multipurpose resin used for FLIR's MD-Series camera units was SC 4500.

"For the MD-Series, we did water, precision of alignment and vibration testing," Tremblay says. "The great thing about SLA plastics is that they are strong enough to endure vibration testing to a certain point. So, we put the SLA prototype unit on the boat.

"By testing with the more fragile SLA unit, we can get an excellent idea of where the part might break down the road. Then we reinforce it in the problem areas, thereby avoiding the breakage early on and giving the product longer life. **DE**

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Cool Technology

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The greeting over the front door at Cryogenic Equipment Services (CES) reads: "*We love the cold*." In addition to making the equipment used to produce ice cream cakes, frozen pizzas and heat and-serve entrees, CES is a leading manufacturer of cryogenic freezers for pharmaceutical and metal treatment applications.

CES' work requires large-assembly design and production, and sheet-metal design and fabrication solutions Until 2007, the company used 2D design tools. However, as demand for custom-designed systems, shorter lead times and greater accuracy grew, so did the company's need for a 3D development platform.

Since implementing SolidWorks Professional software, CES has cut the time from initial design through final production in half. In addition to realizing productivity gains in sheet-metal design and fabrication, the manufacturer has experienced improvements in developing large assemblies and resolving potential clearance issues. **DE**

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Advertising Index

Commentary  by David Vaughn

Big-picture Simulation is a Matter of Perspective

CAE fashions come and go. If you read or listen to software marketing these days, it would seem that multiphysics (MP) simulation is all the rage. Similarly, the word multidisciplinary is making a big comeback as a buzzword in the CAE business.

In fact, the coupling of various physics models—whether it was fluid flow, heat transfer, particle flow, sprays, chemical reactions or even structural stress and deflections—is not new.

It's Not About Multiple Physics or Disciplines

We talk with our customers a lot about their "grand challenges." What is it that keeps them up at night thinking, "if I could just _________, that would be a real game changer in my business"? Regardless of which industry they come from, their answers are often quite similar: The majority of these discussions relate to evaluating the performance of an entire system.

The grand challenge is putting everything together, simulating the whole system.

For example, a jet engine manufacturer might talk about being able to evaluate the performance of an engine, or the performance of certain components during engine operation. Of course, this could be done with flight testing, but that would require manufacturing a prototype engine in addition to everything else that goes along with testing. The cost and time scales of flight testing do not permit it to affect engine design; rather, it is usually the last phase of engine development that merely validates the safety and performance of the near-final engine design.

But now imagine those engineers have access to a full set of flight test-like data for every design candidate, and this data could be had for a small fraction of the time and cost of a flight test program. This would transform the way business is done in that industry, and have a significant impact on the bottom line.

The obvious solution is simulation. Certainly, CAE analysis is prevalent in traditional engine design, but the grand challenge is putting everything together, simulating the whole system with all its moving parts and complicated physics.

Indeed, this would require CAE software that incorporates multiple physics models and provides data to multiple disciplines, but it is a matter of perspective. You see, the engineering management doesn't say, "we need to simulate multiple physics," nor do they say, "we need to analyze several disciplines." Their goal is to have a virtual flight test program. And in terms of simulation, this equates to a simulation of the full engine system.

Simulating Systems

You might think of simulating systems this way: It's seeing the "big picture" using simulation. This big-picture approach can be seen in our products, such as electro-chemistry (for battery simulation), electro-magnification, aero-vibro-acoustics, icing, casting, chemistry, combustion, discrete element modeling and many more. Each of these capabilities and features are implemented with the vision of simulating full systems, rather than merely coupling physics models to analyze individual components.

An important point in this concept is using the appropriate fidelity for each model within the simulation. It's like the old saying, "when you go through life as a hammer, everything looks like a nail." In terms of this discussion, if you approach it from a finite element analysis (FEA) perspective, for example, you might tend toward modeling the entire system using FEA methods (I could have just as easily said computational fluid dynamics, 1-D, etc.). But the efficient simulation of a complex system must incorporate models at different levels of fidelity in addition to multiple physics/disciplines.

Words can be tricky. Their meaning often depends entirely on one's perspective. But whether you call it simulating systems, multidisciplinary, MP, tightly coupled, loosely coupled, co-simulation, etc., the key is combining technology innovation with customer partnerships to solve real-world engineering problems through simulation. **DE**

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