by Steve Robbins

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Sincerely,

Steve Robbins, Executive Editor

Desktop Engineering

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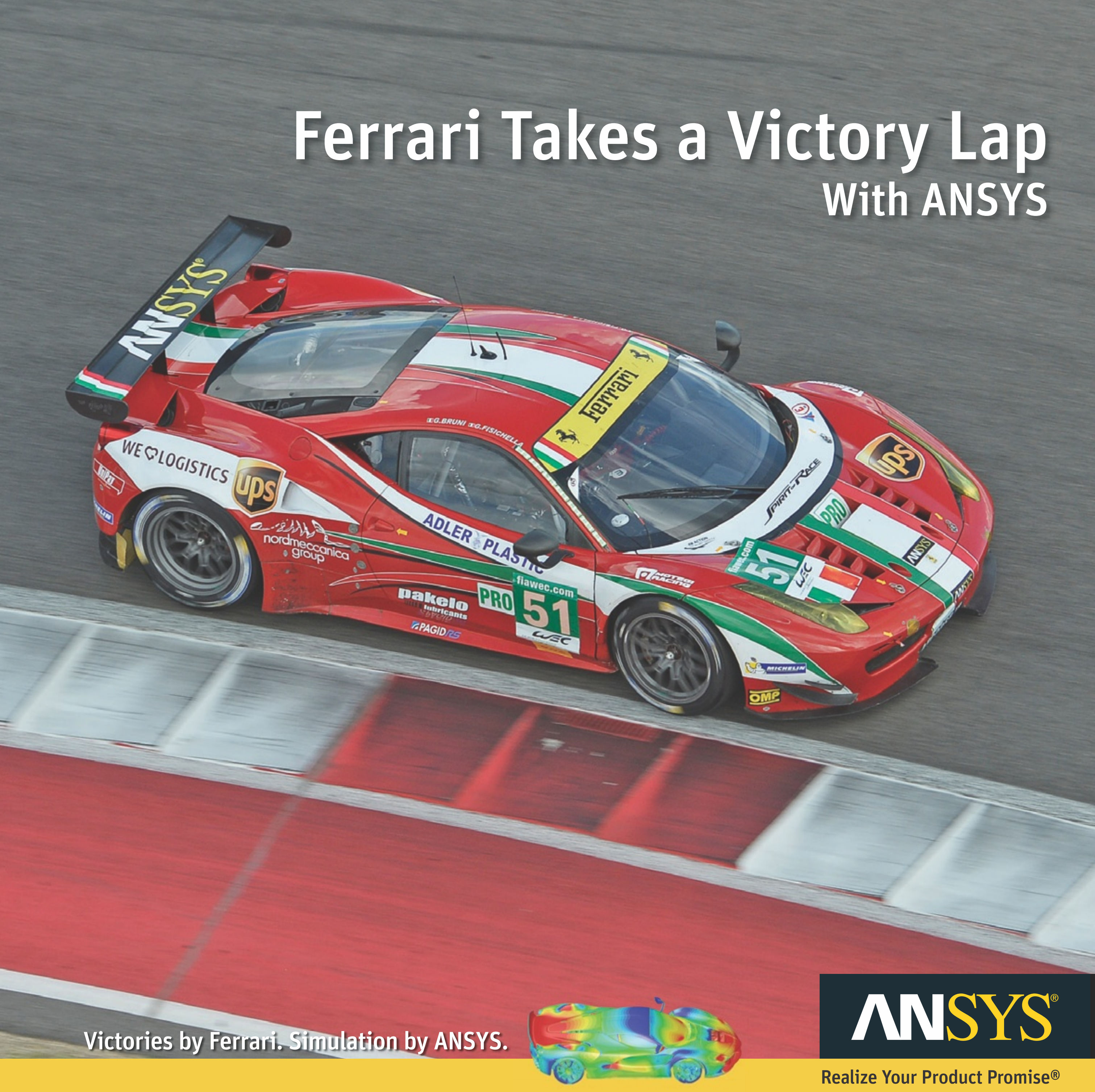
TECHNOLOGY FOR DESIGN ENGINEERING

March 2014 / deskeng.com

FOCUS ON: CAD to CAE

SIMULATION & OPTIMIZATION



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Degrees of Freedom

by Jamie J. Gooch

Cars Get Connected

Your car may soon be talking behind your back ... to the car about to rear-end you. Last month, the U.S. Department of Transportation's (DOT's) National Highway Traffic Safety Administration (NHTSA) announced its intention to mandate that future vehicles be able to communicate with one another. Similarly, European standards organizations have agreed on specifications for the Cooperative Intelligence Transport Systems that will form the basis of connected car technology in Europe.

"Vehicle-to-vehicle (V2V) technology represents the next generation of auto safety improvements, building on the life-saving achievements we've already seen with safety belts and air bags," said U.S. Transportation Secretary Anthony Foxx when announcing the program. "By helping drivers avoid crashes, this technology will play a key role in improving the way people get where they need to go, while ensuring that the U.S. remains the leader in the global automotive industry."

Could cars flow like emails down the highway? Why not?

The idea is that your car would use a customized Wi-Fi protocol, 802.11p, to warn you of an imminent collision in time for you to avoid it. Need to know if you have time to pass that garbage truck on a two-lane road? Whether that sports car speeding toward the intersection is going to stop before he hits you? If someone is about to turn left in front of you? The DOT says V2V communications can make you aware of such situations while the other vehicle is still hundreds of yards away, even if they cannot be seen.

The connected vehicles would not just communicate with vehicles next to each other, they would connect with vehicles miles away as well as with traffic systems in a huge mesh.

Tests Positive

In August 2012, DOT launched a test program called the Safety Pilot model deployment in Ann Arbor, MI. More than 2,800 vehicles from different manufacturers were deployed in the largest road test of V2V technology to date. Both factory-embedded types of devices and aftermarket safety systems that were brought into the vehicle were tested.

The tests were so successful that NHTSA estimates 80% of crashes involving non-impaired drivers could be addressed by V2V technology. It expects a fourth of all vehicles will be connected by 2020. Likewise, the European Commission expects the technology to begin implementation in 2015.

Just the Beginning

The possibilities for vehicle-to-vehicle communications and its companion technology, vehicle-to-infrastructure (V2I), are easy to imagine. Privacy watchdogs are already envisioning a day when your car could be stopped remotely, when its every move could be tracked and controlled. It begs the question: Who is really driving your car?

The government is well aware of the public's unease. Its official press release states:

"The information sent between vehicles does not identify those vehicles, but merely contains basic safety data. In fact, the system as contemplated contains several layers of security and privacy protection to ensure that vehicles can rely on messages sent from other vehicles, and that a vehicle or group of vehicles would be identifiable through defined procedures only if there is a need to fix a safety problem."

Somehow, I don't think that will be enough to allay everyone's concerns. Still, privacy issues have not been enough to stop other connecting technologies — from Facebook to the Cloud — and I don't think it will be a roadblock (sorry) to connected vehicles. There are just too many potential benefits.

For example, pair V2V tech with strides made by Google and others in self-driving cars, and it doesn't take a fortune teller to see the writing on the wall. Combining sensors that allow cars to "see" what's around them with the Wi-Fi that enables them to "speak" to one another sounds like science fiction, but the technology is here. Could cars flow like email messages sent from point A to point B down a true information superhighway with little to no user intervention? Why not?

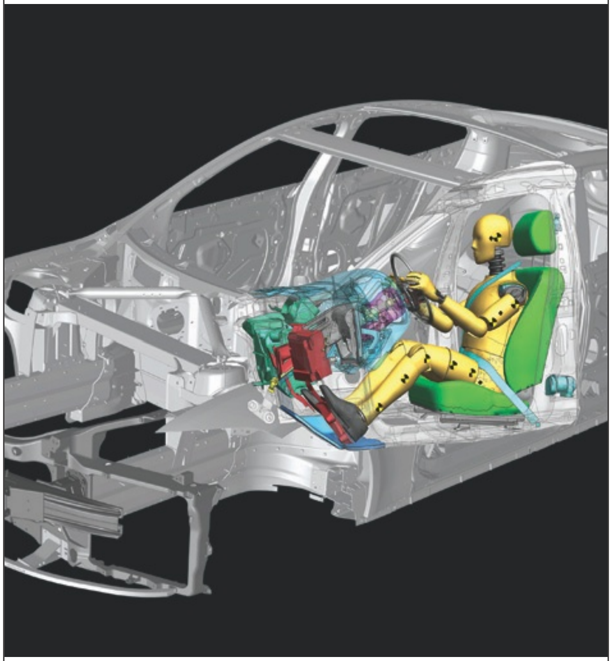
Well, for one reason, an email — 42-year-old technology — I sent the other day never reached its destination. It will be quite sometime before I would be comfortable leaving the driving to technology, and I'm an early technology adopter. For connected cars to reach their full potential will require years of public awareness building, foolproof implementations and layers upon layers of safeguards.

But it's not an all-or-nothing situation. V2V communication is just the beginning of a long journey, and design engineers are behind the wheel. **DE**

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

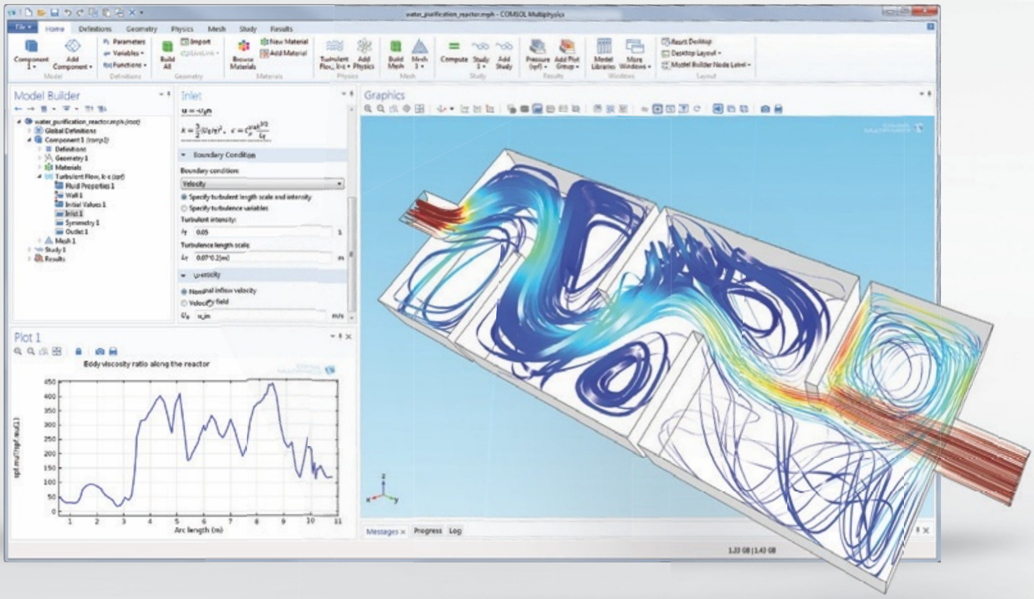
DE March 2014

VOLUME 19/ISSUE 7



ON THE COVER: Innovation in the automotive industry is driven by simulation and optimization technologies.
Images courtesy of Tesla Motors and Arup/Oasys LS-DYNA.

WATER PURIFICATION: Model of a 6 m long ozone reactor. Simulation results give an overview of the turbulent flow field and allow estimation on residence time of chemical species.



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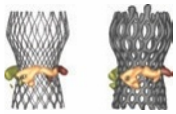

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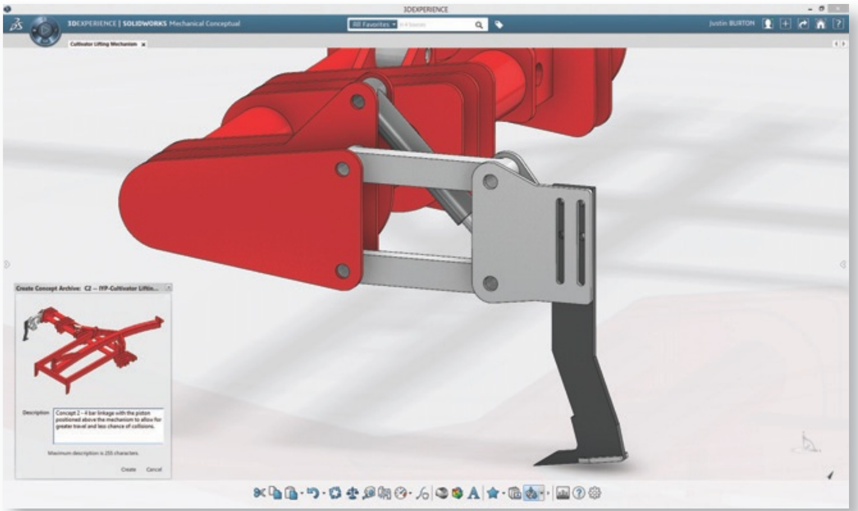
by Kenneth Wong & Beth Stackpole

SolidWorks Launches New Products, Moves Toward Subscription Model

Most attendees at SolidWorks 2014 knew they might bear witness to the birth of a brand-new product. The industry press had tipped them off a full year ago with tidbits about Mechanical Conceptual (MC), a new product SolidWorks was developing. But the company had another surprise in store: MC has a cousin called Industrial Conceptual (IC). MC is designed to let you quickly sketch, animate and sculpt classic mechanical components; IC is expected to let you produce organic shapes and complex surfaces with a minimum learning curve.

In a departure from the traditional SolidWorks licensing model, MC goes on sale in April under subscription for $249 a month. IC is expected to enter Lighthouse phase (the post-beta phase) with select customers this summer, with no date set yet for public release. Thus, with two new products and a decisive step toward on-demand licensing, SolidWorks marks the beginning of a new era.



Predictive motion and 3D components derived from 2D sketches in Mechanical Conceptual.

More Search, Less History

Those familiar with SolidWorks will be struck by the absence of a history tree in MC's interface. Aaron Kelly, the company's VP of user experience and portfolio management, notes that it "is still there, but it's not in your face. You don't need to go there to make changes."

The modeling operations occur mostly through dragging and pushing faces. Kelly doesn't object to "direct editing" as a description, but points out that the company took a different approach.

"What we really wanted to deliver was something instinctive," he says. "If you want something to change size, you can make it happen. You shouldn't have to invoke a CAD command."

SolidWorks CEO Bertrand Sicot reveals that MC is built on Convergence Geometric Modeler (CGM) and Constraint Design Solver (CDS), technologies from SolidWorks' parent company, Dassault Systèmes. CGM is also the technology for Dassault's higher-end product CATIA.

MC has a single modeling environment for sketching, simulation (in 2D sketches), component design and assembly design. At every stage, the product anticipates the input and offers a dialog box; thus, the onscreen menus are kept at a minimum. The enterprise search engine Exalead, a Dassault Systèmes product, appears as an integrated search box to find and locate files and documents.

The social pane adds Facebook-like tools for locating collaborators, monitoring discussion threads and activity feeds related to certain files. The program also lets you import community content from 3D Content Central and other sources.

Half in Cloud, Half on Desktop

With a thick client augmented by online collaboration and data storage functions, MC straddles both the desktop and the cloud. Cloud storage is an inherent part of the product because it's the best way to facilitate Google Docs-style simultaneous viewing and editing among multiple project team members, Kelly says. Some Dassault Systèmes products, like CATIA, can be installed in the private cloud. MC, by contrast, is explicitly designed for a multi-tenant, public cloud setup.

MC will be distributed through all Dassault Systèmes channels. In the initial launch, MC subscription requires at least a one-year commitment, Kelly says. At $249 a month, that works out to $2,988 a year. But the requirement may relax over time, leading to quarterly and month-to-month subscriptions, according to Kelly. Sicot notes, "We're all going to learn from this [subscription pricing]. And we'll adjust if needed."

A handful of SolidWorks rivals — Siemens PLM Software and Autodesk, most notably — have begun exploring the rental model. If the MC subscription proves successful and popular, Sicot may

Continued on page 10 ...

... *Continued from page 8*

consider a similar plan for SolidWorks.

"Why not? I'm very open," he continues. "Today you can buy SolidWorks or lease it. Basically you pay monthly, depending on your financial arrangement. But there are customers who say, 'Today, my business visibility is not so good.' Later, they may say, 'Now I need more than the 10 seats I have. But six months later, I won't need them.' They need flexibility. We haven't decided on [SolidWorks subscription], but it's something on the table."

IC: For the Industrial Artist

The teaser of Industrial Conceptual (IC) at SolidWorks World 2014 showed a product that lets you poke, pinch and push on objects to quickly sculpt shapes. (Think shapes possible in Autodesk Alias or Maya.) No release date is published yet, but Kelly says the product will be deployed at select customer sites in production environment this summer, as a Lighthouse program.

Sicot assured attendees that the R&D efforts for the two new products wouldn't detract from the company's dedication to its classic CAD brand. "The proof is in the pudding," he said. "Every year, we deliver a robust release."

Sicot also revealed he'd added R&D staff in the company to reflect the increased effort. "We have two teams now: One dedicated to the existing product line and another working in parallel on the new products."

Direct modelers like SpaceClaim, Solid Edge with Synchronous Technology, Autodesk Inventor Fusion, and PTC Creo have, each in their own way, served the conceptual design phase. MC has not yet been market-tested, but it appears to have the right attributes for concept creation and exploration. If MC offers seamless — and problem-free — data exchange between itself and SolidWorks and other Dassault Systèmes products, its appeal as a concept modeler increases many times over.

At about $3,000 a year, MC's debut cost is almost the same as a detailed CAD program. For some, it may be a reasonable investment. But for smaller design shops and manufacturers with inconsistent workloads and projects, MC is an attractive proposition if it comes with the option to subscribe or cancel at any time.

— K. Wong

Aras Innovator 10 Focuses on Scalability and Usability

Describing the new Aras Innovator 10 as a major product lifecycle management (PLM) platform enhancement, Aras CEO Peter Schroer says the idea was to clean up and lean out the server code to hit some high scalability numbers — all while making the software feel comfortable and accessible to a broader range of non-CAD users.

"PLM is finally leaving the drafting department," he quips. "You have people from finance, the supply chain, manufacturing and quality all wanting to access the same product information — not only in a read-only way, but also contributing to it."

With mobile devices increasingly put to use on the factory floor and on the road, Schroer admits Aras was inundated with user requests to enhance Innovator's scalability to accommodate additional users. Specifically, he cites an automotive original equipment manufacturer (OEM) customer looking to extend Aras PLM to 100,000 concurrent users.

"We're not talking 100,000 design engineers, we're talking PLM users all over the corporation," Schroer adds.

With those kind of increases in mind, Innovator 10 has been revamped to scale from 100 users to more than 100,000 concurrent users on Microsoft SQL Server 2012, giving companies of all sizes a solid platform for steadily building out PLM use, according to the company. At the same time, the Aras software engineering team put a lot of muscle into tightening up the code for greater efficiency and performance on standard hardware configurations, Schroer says.

"We fully profiled the software to understand how to make it run better at that performance," he explains. "We are fully ready to teach people how to run PLM with over 100,000 users."

The other major thrust of Innovator 10 is improved usability, ushered in through a modern, roles-based HTML 5 web interface with an Office 13-style design. As opposed to many PLM programs that are bill of materials (BOM)-centric, Innovator 10's interface is designed to feel comfortable to non-CAD users, a critical attribute for pushing PLM out to partners and users throughout a global supply chain.

With the Innovator 10 platform solidly underway, Schroer said Aras will spend the rest of 2014 focusing on rolling out new business applications that will extend the core platform. For example, the company announced new 3D visualization capabilities that will be available inside Innovator, and Schroer says Aras is working on a secure social application that would let engineers collaborate, just as they might on social networks like Facebook, but with a higher level of security.

Companies with an active Aras subscription will receive a free upgrade to Innovator 10 (and subsequent releases), regardless of the amount of customization in the current deployment, the company says.

— B. Stackpole

by Kenneth Wong & Beth Stackpole

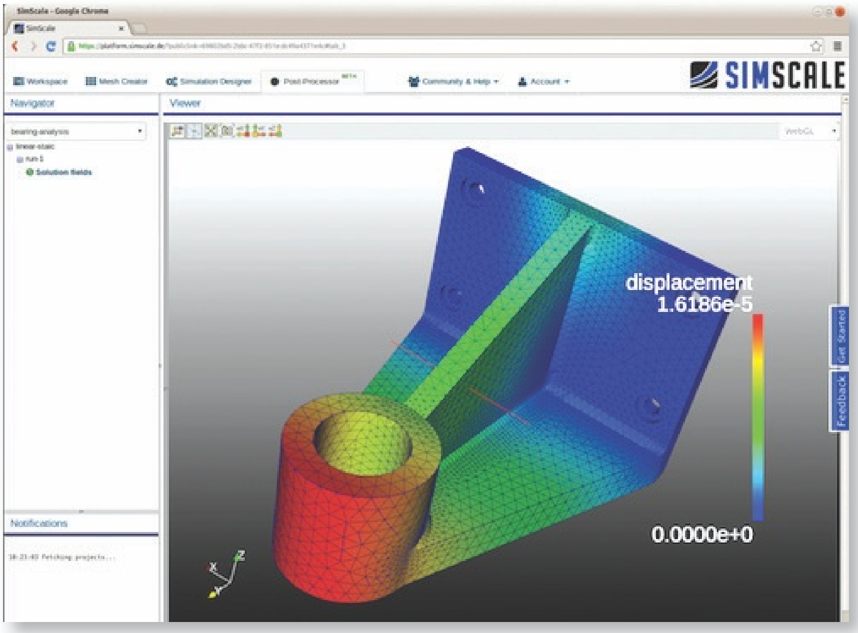
GrabCAD, SimScale Challenge Promotes Cloud-based Design

GrabCAD and SimScale are teaming up on a design challenge that encourages participants to show off their CAD and simulation prowess by designing a rear underrun protection device (RUPD) for trucks. The project represents the joint efforts of two upstarts with a common vision for how cloud-based 3D design and collaboration tools can radically transform how engineering teams work together, to produce more robust and innovative products.

As 2014 began, GrabCAD, a three-year-old 3D content-exchange community, just logged its 1 millionth user — and is currently home to more then 370,000 shared CAD files. Last year, the company turned its attention to cloud-hosted collaboration and file-sharing, introducing its GrabCAD Workbench offering.

SimScale, for its part, makes modeling and simulation tools available as an on-demand, cloud-based service. The platform, available via a standard web browser, delivers simulation capabilities in the areas of structural mechanics, fluid dynamics, thermodynamics and acoustics, along with CAD preparation, meshing and post-processing functionality. With its cloud-based approach and no need for costly and hard-to-administer hardware and software, SimScale aims to bring simulation to a broader swath of users in much the same vein as what GrabCAD is trying to do for CAD collaboration.

"There's definitely a parallel vision behind the idea for GrabCAD and SimScale that new web technology — specifically 3D capabilities in a browser and the cloud — creates new opportunities for engineers to do their work much faster and easier," explains David Heiny, head of product at SimScale.



Armed with a standard Web browser and Internet connection, users can set up a range of simulations on the SimScale platform. ***Image courtesy of SimScale.***

"Engineering is a team sport, but the reality is most tools and processes are not built that way," says Rob Stevens, GrabCAD's VP of sales and marketing. "The cloud enables team behavior in a way that we couldn't do when things were isolated and hard to move around. It makes it easy for engineers to work together and collaborate."

Once a user signs on to SimScale, they upload a CAD model and can tap into all of the platform's simulation capabilities, from meshing to setting up boundary conditions, to running the actual analysis studies using finite element analysis (FEA), computational fluid dynamics (CFD), or other solvers. The analysis happens on a remote system, Heiny says, and users can take advantage of the platform's post-processing tools to visualize the results — or download them directly to their own desktop for use with their own post-processing tools if that's their preference.

With the sponsored competition, SimScale is hoping to introduce its vision of a cloud-based simulation service to the GrabCAD audience while soliciting feedback on the platform. Participants will be tasked with designing a RUPD, which sits on the rear end of a truck to help increase traffic safety by preventing a colliding car from running under the truck.

The RUPD, which will be judged by the SimScale team, will be measured on weight and stiffness. The SimScale platform comes into play by helping participants validate the performance of their design; participants can use SimScale's free basic offering, and there are video and documented tutorials to help people get started. Organizers plan to announce the winners on March 19.

— B. Stackpole

The Economics of New Design Workflows

An article in The *Wall Street Journal* shed some light on the high-tech secret that is helping Ford Motor Co. conceive and test designs much more cheaply and quickly.

Advances in simulation software and investments in computing power are empowering Ford engineers with new workflows that let them conceive and test more ideas in a fraction of the time and for significantly less cost than previously possible. By accelerating the art of ideation, Ford has moved from months to days and from millions of dollars to several thousand dollars just with the design of a simple cylinder head. Extrapolate those savings out to the thousands of engine parts and countless components in any one vehicle and it's no wonder Ford is riding high.

Not only is Ford creating, testing, and modifying more ideas faster than ever before, the new workflow helps Ford trade up adequate designs for optimal designs that can reduce manufacturing costs, diminish warranty costs, and increase product quality.

But what about a company that doesn't have the resources on par with an industry behemoth like Ford? Can they ignore these workflows because they think technology is out of reach? Of course not. Companies of all sizes can benefit from introducing simulation earlier in the design workflow, and the technology to do so is accessible and affordable even for smaller organizations.

The Time Factor

A white paper published by Intel and SolidWorks (goo.gl/ZwZjnu) showcases how a smaller company in the automotive supply chain is getting mileage out of new simulation-led design workflows. Dr. Steve Jia, chief engineer at Litens Automotive Group, a designer and manufacturer of engi-

neered power transmission systems and components, said the fast solver capabilities of SolidWorks Simulation Premium software helps engineers solve full-assembly contact analysis problem in a few hours.

For less than $10,000 per system, Litens Automotive employs workstations configured with two Intel Xeon processor E5-2687W CPUs (3.10 GHz), 8 cores, a 20MB cache with four Intel® SSDs and 64GB RAM.

Some simple math proves the economics of Litens Automotive's new simulation-led design workflows, especially if an organization has hardware or software that is three years old or more. Say an average engineer makes around $100,000 annually or approximately $1,900 a week. A workstation capable of handling design simulation will require an investment of under $10,000. Given a typical lifespan of three years, that means upgrading to the latest workstation and simulation software will cost a company between $40 and $60 per week—roughly just 3% of an engineer's annual salary.

There's plenty to be gained from that relatively modest investment. According to testing by SolidWorks and Intel, using SolidWorks Simulation 2014 on workstations with multiple cores can deliver a 2X speed boost to FFEPlus operations. In addition, with multi-core support, the Large Problem Direct Sparse Solver is much faster than the Direct Sparse Solver for problems with millions of degrees of freedoms (DOFs) resulting in solution time for a chassis simulation with 3,360,485 DOFs now at minutes as opposed to hours.

By upgrading outdated technology and adopting new workflows, companies of all sizes can do what Ford and Litens Automotive already are: Shaving millions off development costs while shrinking the time from opportunity to new product introduction.

Now that's an economic argument that can't be beat.

Next Steps

- Develop new workflows that make simulation an integral part of the concept design process.
- Encourage engineers to explore up to five ideas a day instead of one.
- Provide plenty of training to acclimate engineers to simulation-based design.
- Consider a refresh if your hardware and simulation software is more than three years old.
- Check out the easy to use system configuration tool created by SolidWorks and Intel: goo.gl/6lhmGJl.

Nissan Unveils Tiny Combustion Engine

This summer, the Nissan ZEOD RC will become the first entry at the 24 Hours of Le Mans event to run a one-hour lap of the Circuit de la Sarthe using nothing but electrical power. Equally impressive, though, is the new Nissan DIG-T R 1.5 liter turbo engine that will kick in once the electrical-only portion of the run is completed.

The 500x400x–200mm, 440-hp combustion engine weighs about 88 lb.

"Our engine team has done a truly remarkable job with the internal combustion engine," said Darren Cox, Nissan's Global Motorsport director. "We knew the electric component of the Nissan ZEOD RC was certainly going to turn heads at Le Mans, but our combined zero emission on demand electric/petrol powerplant is quite a stunning piece of engineering."

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Engineering Students Provide Helping Hand

Bioengineering students from Rice University's George R. Brown School of Engineering developed a robotic arm to help a teenager overcome his physical limitations.

Seventeen-year-old Dee Faught has brittle bone disease, which makes it challenging to perform everyday tasks without risking injury. The solution the engineering students came up with is manipulated using a PlayStation controller. The arm is fitted to his motorized wheelchair, and acts as a sort of remote-control crane.

The R-ARM won the school's Design Showcase and Competition last year. It cost about $800 to make.

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DARPA Seeks Self-destructing Electronics

The U.S. Defense Advanced Research Projects Agency (DARPA) hopes to roll out battery technology that can self-destruct on command. The agency recently awarded a $4.7 million contract to SRI International to develop a transient power supply that can be triggered to vanish.

The contract is part of the DARPA Vanishing Programmable Resources (VAPR) program, which hopes to develop electronic components that can decompose when they are no longer needed. These "vanishing" electronics could self-destruct once the equipment is no longer in use or under the control of U.S. forces.

This type of "limited device persistence" could be programmed into the devices, triggered remotely, adjusted in real-time, or (as mentioned above) be sensitive to environmental elements.

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Bendable Glass Resists Shattering

Researchers at McGill University's department of mechanical engineering have come up with a way to potentially create shatterproof glass for computer screens and other applications. In a recent article in *Nature Communications*, they report on their work with glass that is pre-cracked using lasers. This creates fissures that are then filled with polyurethane to create a new kind of glass that bends on impact. Their inspiration: mollusks.

According to Professor Francois Barthelat, the interior of mollusk shells are coated with nacre (mother-of-pearl), which is structured kind of like small interlocking toy bricks. Using the nacre as a model, the team used lasers to engrave a network of 3D micro-cracks in glass slides. They were able to increase the durability of the slides by up to 200 times.

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Flexible Nanowire Sensors Could Monitor Strain and Pressure

New "stretchy" sensors built on nanowire conductors could potentially be embedded in clothing, or on human skin and other surfaces to track strain and pressure, or provide touch-based functionality in new form factors.

North Carolina State University researchers created the sensors using technology developed by team leader Yong Zhu. Zhu made elastic conductors from carbon nanotubes by pouring a liquid polymer over silver nanowires on a silicon plate, and then peeling the form off of the silicon.

The new sensor can be stretched to 150% of its original length.

The sensor can monitor capacitance, including changes caused by pushing, pulling or touching the conductors. So far, the researchers have used the sensors to monitor thumb movement and knee movements. They also developed an array of sensors to map pressure distribution. The sensors exhibited a response time of 40 milliseconds, and could monitor strain and pressure in real time.

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Print Multiple Materials in Multiple Colors

Stratasys launched the next generation of its Objet500 Connex line of 3D printers: The Objet500 Connex3 Color Multi-material 3D printer combines colors with multi-material 3D printing.

Previous 3D printers, notably from 3D Systems' ZPrinter line and Mcor's line of paper-based 3D printers, have been capable of 3D printing in multiple colors. Stratasys' own line of Objet printers have been capable of producing 3D

prints in multiple materials. However, the Connex3 is the first 3D printer to combine both in what the company calls "virtually unlimited combinations of rigid, flexible and transparent color materials, as well as color digital materials" in a single print run.

Similar to a 2D inkjet printer, three color materials — VeroCyan, VeroMagenta and VeroYellow — are combined to produce hundreds of colors. These color materials join Stratasys' range of PolyJet photopolymer materials, including digital, rigid, rubber-like, transparent and high-temperature versions.

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Photoshop Now Supports 3D Printing

Adobe has added 3D printing support to Photoshop Creative Cloud (CC). Not only does Photoshop now allow users to work with 3D images, it also directly supports a number of 3D printers — including the MakerBot Replicator and 3D Systems' Cube, along with built-in service bureau access in the form of Shapeways.

Photoshop CC automatically configures material support (or scaffolding) for prints where necessary, repairs models that aren't watertight, and even provides an image prior to printing consistent with the final product, taking into account materials used. The program also allows users to convert 2D images into 3D images through extrude, twist and pinch tools.

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Arcam Q20 Targets Aerospace Industry

The narrative for additive manufacturing (AM) in 2014 seems to be centered around a change from prototyping to end-use products. One industry that is showing interest in AM-built parts is aerospace.

While nearly any metal AM system can be turned to production of aerospace parts, a few companies are building 3D printers specifically with aerospace in mind. Arcam, for example, is looking to tap into the aerospace market with its Q20 Electron Beam Melting (EBM) system.

The Arcam Q20 is essentially a scaled-up version of the Q10, which was designed for orthopedic manufacturing. Both systems use the same EB gun, but the Q20 offers a larger build envelope at 350x380mm (Ø/H). The larger build envelope not only allows users to generate bigger parts, but also to build more parts simultaneously.

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FSL Kickstarts a Desktop SL System

Full Spectrum Laser (FSL) is the first to challenge Formlabs in the desktop stereolithography space with its Pegasus Touch. Much like the FORM 1, FSL's system owes its existence to Kickstarter.

Formlabs had no trouble meeting (and surpassing) its Kickstarter goal, and FSL has had similar success. With a little over a week remaining on the clock at press time, the Pegasus Touch had already surpassed its funding goal by more than $400,000. It seems as though people are very interested in getting their hands on desktop SL — although it might not hurt that the Kickstarter special promised a Pegasus Touch for a mere $2,000.

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Mark One Offers Carbon Fiber AM

Gregory Mark, co-owner of Aeromotions, a company dedicated to building racecar wings, noticed the lack of material options available for more modestly priced additive manufacturing (AM) systems — and decided to do something about it. He founded MarkForged, with the intention of designing a 3D printer that could build in carbon fiber. The Mark One is the result of that ambition.

Mark named his process "Composite Filament Fabrication," but it still remains essentially a material extrusion printer. Materials get fed into the system and are pushed out through a dual quick-change extruder head to form the desired shape. In the case of the Mark One, potential materials include carbon fiber, nylon, fiberglass, and regular polylactic acid (PLA).

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FISHER/UNITECH to Offer New Objet500 Connex3

FISHER/UNITECH, a reseller of Stratasys 3D printers, will be offering the Objet500 Connex3 as part of its design series.

The Objet500 Connex3, unveiled at SolidWorks World in January, is the only 3D printer that is able to create products from multiple materials and colors. The three-material jetting technology allows complex prototypes from a selection of more than 180 material options.

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Wisconsin Metal Parts Adds Fiber Laser Services

Wisconsin Metal Parts is now offering fiber laser cutting services to its capabilities. One of only three metal parts producers in Wisconsin with in-house fiber laser services, the device will be used to cut stainless steel, brass, copper and other metals. The company plans to use a TRUMPF TruLaser 5030 fiber unit.

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xLM Solutions Joins Aras Partner Program

xLM Solutions, a product lifecycle management (PLM) consulting and systems integration firm, has joined Aras' partner program. xLM provides lifecycle management and IT services that include requirements analysis, migration planning, solution implementation, customization and systems integration. According to a company press release, xLM will help provide expertise and consulting for companies currently using SmarTeam and other legacy PLM products in switching to Aras Innovator's PLM platform and suite.

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Level 3 Inspection Offering Field 3D Scanning Services

Level 3 Inspection LLC, a provider of computer aided inspection and 3D scanning dimensional layouts, will now digitize clients' components anywhere in North America. This service has been developed to allow clients to ship larger files in a safer manner. According to a company press release, Level 3 Inspection has developed a mobile 3D scanning system that is capable of digitizing any object to an accuracy of .001" or better. The scan creates a SmartScan file, which is then processed at the company headquarters for whatever a client's needs may be.

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Dana Opens Tech Center in India

Dana Holding Corp. has dedicated a new 90,000 sq.-ft. technology center in Prune, India. According to a company press release, this center will be home to original equipment manufacturers in the light-vehicle, commercial-vehicle and off-highway markets in India.

Housing more than 240 engineers, the new center is devoted to the research, design and development and testing of drivetrain, sealing and thermal-management products. The new lab will also include the latest testing equipment for axles, transmissions, materials, noise, vibration and harshness (NVH), prototyping, inspections and machining. Some of Dana's clients include Caterpillar India, Deere and Co., Ford Motor and Mahindra & Mahindra.

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New Composite Prototyping Center

The Long Island Forum for Technology (LIFT) will install a GERBERcutter and laser ply layup system from Gerber Technology and its subsidiary, Virtek Vision, in its new Composite Protoyping Center (CPC). These systems will be available to manufacturers looking to develop protoypes containing composite materials.

In the CPC, Gerber will install a GERBERcutter DCS 2500 computer-controlled, static cutting system and a Virtek LaserEdge system that uses laser templates to guide operators.

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Find Help Fast

Desktop Engineering has created the Engineering Services Directory—a compilation of companies that can help you throughout engineering process, from concept design to testing, and everything in-between.

Available online at deskeng.com/services and in an annual print edition in May, our directory gives you access to more than 100 companies and counting that specialize in CAD modeling, design analysis, industrial design services, IT, product testing, rapid prototyping/reverse engineering and educational services.

The directory gives you the opportunity to contact companies that will be available to support your day-to-day or long-term engineering needs, allowing you to optimize cost and time in all stages of design.

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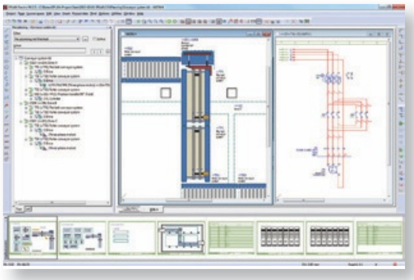
Editor's Picks

by Anthony J. Lockwood

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



EPLAN Version 2.3 Released

Integrates pre-planning and detail engineering to improve data consistency.

The EPLAN portfolio offers a number of toolsets—EPLAN Electric P8; EPLAN Harness proD, 3D software for cable harnesses; and EPLAN Pro Panel. Version 2.3 integrates the pre-planning and detail engineering project phases and offers a number of enhancements focusing on standardization, automation, and consistency. These include new page scaling, integrated management of discontinued parts, project-wide table based editing of macro boxes, extended navigator display options, and new search functions for settings. EPLAN Platform creates a uniform project-planning environment.

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DAQ Device Supports Android and Windows Mobile Devices

Multifunction BTH-1208LS for wireless data acquisition.

The BTH-1208LS comes with virtual instrumentation software for acquiring and displaying data and generating analog signals as well as a utility for installing, calibrating, and testing. For Windows users, there's also a Universal Library. It supports Visual Studio and Visual Studio .NET programming. Drivers for the DASYLab data acquisition, graphics, control, and analysis software as well as the NI LabVIEW measurement and control system design software from National Instruments accompany the BTH-1208LS. It is available in a standard version and a board-only version.

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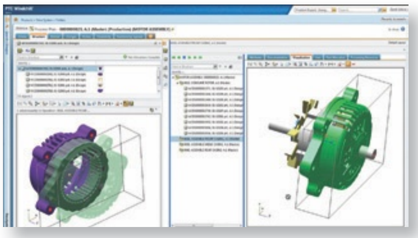

PTC Expands Windchill Regulatory Compliance Capabilities

Latest release reduces effort needed to comply with new FDA and SEC regulations.

Version 10.2 of PTC Windchill provides end users with out-of-the-box templates for new CAD documents in Autodesk Inventor, AutoCAD, and SolidWorks. Its document management capabilities have been expanded within the Microsoft Windows and Microsoft Office environments, and users can upload any CAD content in any condition to the server workspace. Users can also visually interrogate data relationships and visually construct process plans. New system administration capabilities include simplified and automated PTC Windchill support within a cluster environment.

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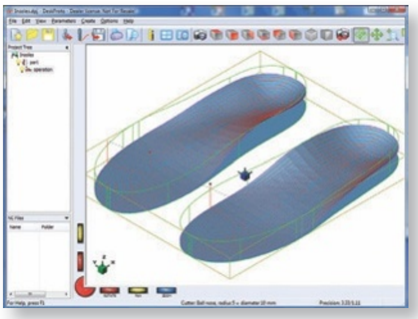

3D CAM for Milling and Rapid Prototyping Update

DeskProto 6.1 for non-machinists includes a new offset strategy.

Just out in version 6.1, DeskProto provides the tools for 3D machining of the geometry from an STL file, simple 2D machining of a drawing from a DXF file, and machining of a picture from a bitmap file (GIF, JPG, and BMP). It calculates CNC toolpaths and writes the NC program. Depending on your version of DeskProto, you can do 3- and even 4- and 5-axis CNC milling. DeskProto uses wizards that can help new users get up to speed, and the settings are available for experienced CAM users to work with. Even with complex geometries, calculations are said to be fast.

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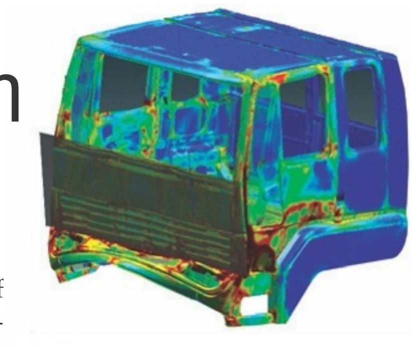
Heavy Duty Mass Reduction

Process shown to reduce heavy-duty vehicle mass by 35% and development costs by 40%.



For heavy-duty vehicles, like trucks and buses, mass reduction strategies with consistent durability performance are naturally central concerns for OEMs and their suppliers.

Much like the automotive industry, the heavy-duty vehicle industry is facing numerous challenges today. The product design and development process includes multi-dimensional issues, which often contradict each other. A central challenge is the need for cost and mass reduction, while continuing to meet all new and existing requirements for quality and performance. The cost reduction objective is challenged by a few factors, including aggressive fuel economy, emissions standards and many other factors.

Engineering Technology Associates, Inc. (ETA) has found a way to address these challenges head-on, leveraging new technology and high performance computing. First applied to automotive body structures on a variety of passenger vehicle projects (full-system and subsystem), including WorldAutoSteel's FutureSteelVehicle, it has developed an engineering process based on design optimization. The service was dubbed the Accelerated Concept to Product (ACP) Process®.

For the development of a vehicle structure, the methodology offers four key benefits, including a demonstrated capability to reduce product development costs by 35% to 40%, reduce product mass by 25% to 35% and more, improve product performance (stiffness, durability, NVH and crash/safety), as well as improve fuel efficiency based on the mass reduction results.

Considering the market's sensitivity to rising fuel costs and increasingly stringent emissions regulations, the mass reduction capabilities offered by the ACP Process™ present real cost-saving value and even greater fuel efficiency.

The ACP Process™ is a performance-driven, holistic product development method, based on design optimization. It is applied to full-systems, sub-systems and components alike. A variety of software including CAD design, CAE analysis and optimization tools are used to generate the optimal design solution.

One key enabler is the use of *3G Optimization™*, which is the careful consideration of the shape of the main body (skeleton) of a structure with regard to its material and material properties. 3G Optimization™ is incorporated to find the optimal shape (geometry), material types and properties (Grades & Gauges), based on available manufacturing processes, while maintaining performance of the full-system.

One other key enabler in the ACP Process™ is ETA's proprietary software, Virtual Proving Ground (eta/VPG®). VPG is a software tool used primarily for performance evaluation for a variety of load cases. The simulations are created in a dynamic non-linear environment, using real-time boundary conditions consistent with common test environments.

Using VPG, the team creates a variety of chassis, suspension, vehicle body structure, truck-bus/road interaction, seat/restraint system and E66 rollover event simulations. The resulting designs are more robust with a higher level of durability performance, promoting a longer fatigue life and ultimately less warranty issues down the road.

School Bus Subsystem Redesign

On a school bus program, ETA engineers were tasked with reducing the overall weight and complexity of a current design for different variants of school buses. ACP Process™ was applied to a bus full-system and several decoupled sub-systems.

In one portion of this project, the team developed a body structure design for a subsystem, decoupled from the bus full-system, with the goal of cost reduction and improved fatigue and safety performance. The redesign was focused on the body structure of one existing section.

To begin, legacy data was used to allocate requirements for the subsystems. Each component was redesigned based on *3G Optimization*™ for maximum efficiency and design performance, while meeting all design targets. Concurrently, the team focused on cost reduction in terms of process, labor and mass.

As a result of the efficacy of the *3G Optimization*™, the redesigned section was a much higher performing structure. Using part consolidation, the team was able to reduce the number of parts in the section by half (from 64 components to 32 components). The reduction of components resulted in a 35% overall weight reduction and significant labor and joining cost reductions. The potential cost savings for this sub-system alone was estimated at $500 to $700 per bus.

The final step in the process was to incorporate the redesigned sub-system into the full vehicle system and perform a full system evaluation for pilot testing and prototyping. Upon completion of prototyping, testing, validation and production, the team found that the overall system design performance was maintained, in terms of safety and durability performance.

For more information contact ETA

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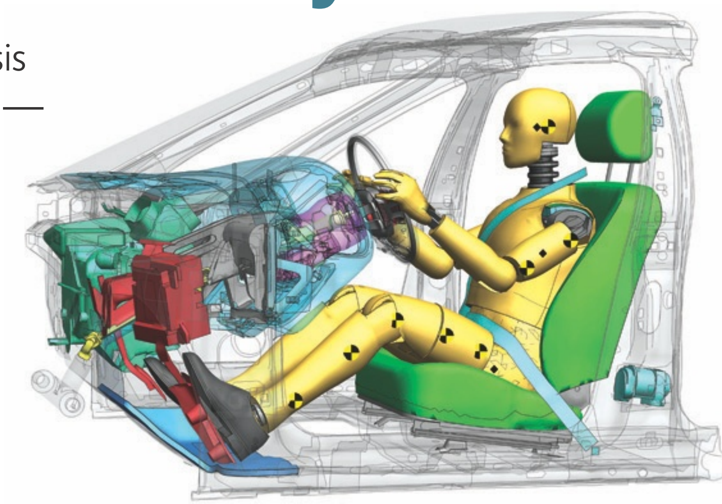
Structural FEA in the Automotive Industry

A look at some of the finite element analysis technologies involved in creating a vehicle — and the simulation methods involved.

BY TONY ABBEY

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



Crash dummy model.
Image courtesy of Arup/Oasys LS-DYNA.

The overarching objective of all automotive manufacturers is to move predictive simulation to the early design stage. The benefits of influencing design earlier, reducing the number of design cycles and eliminating much physical testing are well understood. Target project timescales from concept to prototype definition are very aggressive within the industry, with timescales of the order of 18 months being discussed. Considering the trend to extend the range of vehicles to give a broad product portfolio, this is an extraordinary achievement.

Vehicle crash analysis is probably the most well known simulation in automotive design, and indeed is seen as the role model for other disciplines within the industry. Here, the emphasis is now on prediction of vehicle response to validate design strategies and permit change well before available physical test articles. Most other simulation processes are also now being used earlier in the design loop. However, current simulation technology limitations imply a traditional forensic and redesign process in some areas. In such cases, advanced research and collaboration with academic institutions is the way forward.

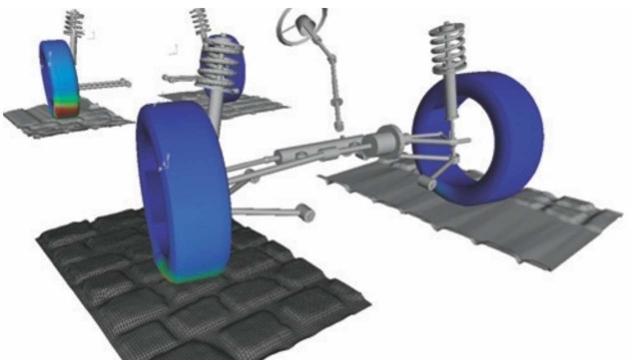
Last two vehicles in a multiple-vehicle crash simulation.
Image courtesy of Arup/Oasys LS-DYNA.

Crash Simulation

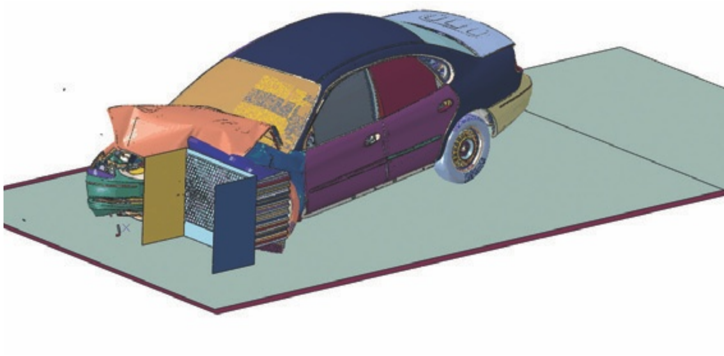
The requirement for a crash simulation is regulated through specific accident scenarios and safety targets. The objective of vehicle crash design is to allow energy absorption to take place throughout the vehicle. Instead of designing a civilian armored vehicle, where all is swept before it, the vehicle is designed to progressively crumple at even modest impact levels.

Every component in the chain of events is designed to crumple, crush or in some way absorb energy. Modeling requires sufficient mesh fidelity and accurate material strain rate behavior to provide realistic responses, as components evolve in the overall design.

Finite element analysis (FEA) of vehicle crash uses explicit analysis (described in "Impact, Drop and Crash Testing and Analysis," *Desktop Engineering*, August 2013). The size and complexity of crash models have now reached the stage where sophisticated pre- and post-processing is required. For example, an engineer must identify and visualize response of the hundreds of components in the vehicle assembly during impact — using transparency, section cutting, dissection, etc. Physical test result videos are overlaid on simulation animation for correlation. Graphical plots of force, displacement or



MotionSolve vehicle model.
Image courtesy of Altair.



Crash model.
Image courtesy of Dassault Systèmes SIMULIA and NCAC.

acceleration against time are spawned interactively from key points to compare against test data.

Crash test dummy simulation is now a mature area within vehicle crash analysis. Specific models include gender, age and percentile range of height, weight, etc., and provide standardization and repeatability. Dummy-based prediction is a simplification of real-world response of occupants in a crash, of course, and there is research to move beyond this. But it's a difficult and challenging area from many perspectives.

Automatic seat belt draping, pre-tensioning and body interaction with the seat typify the sophistication of these simulations. Airbag simulation, with the great variation of installation sites and shapes, is essential in crash modeling. The gas dynamics inside the airbag are coupled to the structural response of the bag, typically within the explicit solver. Advanced sensor technology — in door-mounted side bags, for example — drives structural simulation to couple with system simulation.

Remarkably, despite the levels of technology used to provide defensive systems for the occupants, one of the most challenging aspects is the refusal of many to use them. U.S. regulations require full test and simulation of unbelted and out-of-position occupants to ensure no accidental injury from the safety systems and overall occupant containment within the vehicle.

Global Modeling Strategy

A single-model strategy allowing common usage across a range of disciplines is appealing. Benefits include centralized and standardized idealization and meshing. This brings big productivity gains — although it is generally limited to disciplines that share idealization requirements.

A full body crash model matches the high fidelity required for body acoustic analysis. However, acoustic analysis is an implicit FE-based solution, where the computer resources required are a square law on size, rather than the linear scaling of the explicit FE method. In many cases, the full implicit model is run using "super-element" or "sub-structuring" techniques, which require sophisticated management.

Tires, brakes, engine, transmission and exhaust systems all require different levels of model fidelity and simulation methodologies. Disciplines can include traditional implicit and explicit FEA, durability, multi-body dynamics, computational fluid dynamics (CFD), thermal, combustion, integrated system simulation and so on. To derive a common model database able to plug-and-play these various disciplines would indeed be very challenging.

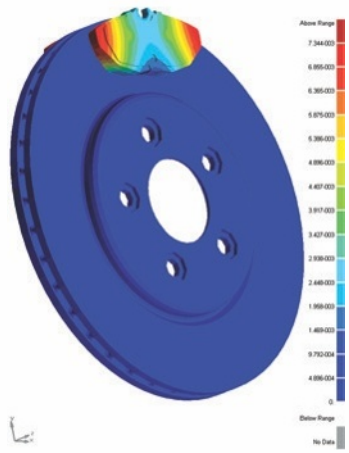
An alternative approach is to develop a full-system model that can use cross-discipline or multi-physics (MP) methods by linking disparate simulation inputs and outputs. This reflects the increasing trend for the vehicles to be "smart" systems that provide the required performance through complex and linked mechanical and electronic systems.

Brake Modeling

Brake design and simulation aims to avoid failure under thermal or structural loading. The challenges start with material modeling; the makeup and properties of a typical brake pad are complex, and may be subject to quite significant variation across production batches.

A stochastic approach to modeling is increasingly important in automotive analysis, and this is a typical example. Understanding the implication of extremes and compensating for them avoids the odd rogue system — with its accompanying reliability and warranty issues.

Other brake analysis targets dynamic interaction causing brake squeal, judder and groan. Dynamic analysis of brake squeal traditionally used complex eigenvalue analysis, using a stationary disk on an isolated axle. Simulation now includes rotating disks and caliper action in the context of full vehicle response. Multi-body dynamics using rigid body simulation of the vehicle is linked to the flex-



Brake analysis with MSC Marc. *Image courtesy of MSC Software.*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Powertrain durability model.
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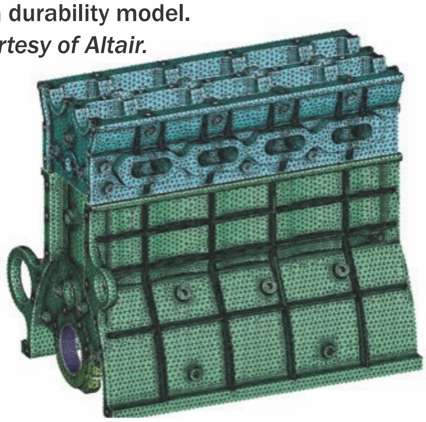

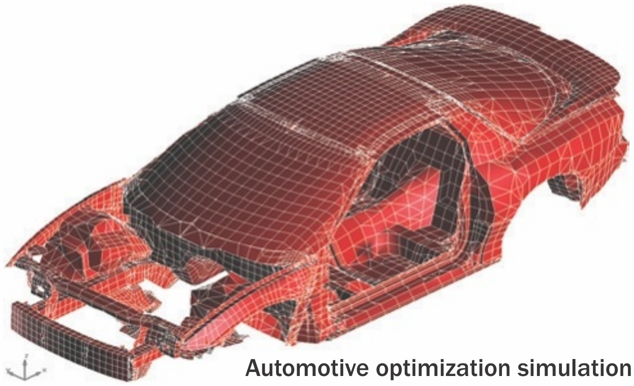

Automotive optimization simulation.
Image courtesy of MSC Software.

ible body dynamics of the brake system. Further inputs, such as an anti-lock braking system (ABS), can be included through the high-level system modeling approach.

Simulation of brake heating and cooling now typically includes thermal and CFD analysis of rotating, rather than simplified stationary models.

Tire Modeling

The performance and response of the road tires dominates much of the automotive simulation methods such as noise, vibration and harshness (NVH), handling and ride. These are all directly related to how the tire will respond — and clearly form a vital part of the chain, from road to vehicle component.

Tire modeling has progressed from simplistic doughnut- or spoke-type models that modeled basic stiffness parameters. Current simulation technology is attempting to model the tire under a wide range of operating conditions, including sideways or lateral shearing, and rolling actions with resultant heavy distortion of the tire, partial lift-off and other scenarios typical in the real world.

The tire is a complex assembly of advanced material components. Many of the ingredients are hyper-elastic in nature, meaning they respond differently in tension, compression and shear. That means a great deal of careful tuning with test analysis correlation to make sure the fundamental response is well modeled.

Other challenges include bond-line failures, heavy distortion and localized heating. The influence of the pressure inside the tire walls requires coupled fluid and structural modeling. In addition, the dynamic interaction between the rim and tire is important.

Tire analysis also has to be conducted in the context of the overall vehicle response — and, as with brakes, multi-body dynamics links structural and system models.

Of course, automotive manufacturers are not in the business of manufacturing and designing tires. There may be many tire options across the range of vehicles a manufacturer offers. The emphasis on tire modeling for development lies with the tire manufacturer, but commercial confidentiality limits how much model information can be shared. The full burden on modeling the tire in the context of the vehicle safety and performance lies with the vehicle manufacturer.

NVH Concerns

NVH embraces many vehicle components and physical disciplines. One of the major areas here is the study of the acoustic response of the vehicle. There are several sources of noise within the vehicle — the tires, transmission, power plant, external airflow, etc. These inputs are transmitted through to the body and, of particular concern, to the glass window surfaces.

Acoustic analyses are carried out to determine the interior noise levels that the occupants will experience. This requires coupling the structural model of the vehicle to a CFD model of the internal volume, and tracing the acoustic transmission path. Sound-absorbing features such as seats, carpeting and acoustic liners are all modeled within this environment.

Much of the noise is characterized by high-frequency content. This becomes a very demanding analysis, as a large number of modes are required with high fidelity of mesh to capture the short wavelengths of the structural response.

Engine and Powertrain

Other vital areas to simulate include the engine and powertrain components. Each demands its own variety of disciplines to fully understand the real-world physics — and hence, how to simulate and improve design.

For example, the engine is a complex assembly of static and moving parts that are taking in air and fuel, producing exhaust products and delivering power to the transmission. Overall dynamic and thermal modeling of the response of the engine is important.

In addition, detailed assessment is required in many areas such as the stresses within the piston, cylinder head and valves during each power cycle. This involves a multi-discipline approach involving thermal, combustion, structural and fluid dynamics interactions.

An initial analysis of engine components such as the piston and connecting rod may take "frozen" positions with pressure and inertia forces in a pseudo-static balance. More sophisticated, full transient analysis can add dynamic and thermal effects.

Predicting dynamic interaction is a key requirement in many systems throughout the engine and powertrain. The transmission of power through torque converters, etc., requires careful attention to avoid damaging dynamic magnification or resonant frequency excitation. The exhaust system must be designed so that inadvertent dynamic coupling between engine block and body mounting does not create unpleasant vibrations.

Durability Issues

Durability of vehicle components is essential to provide a long service life and minimize warranty claims. Successful implementation of durability analysis using fatigue and fracture mechanics analyses requires a thorough understanding of the characteristics of the material, the component and also of the loading scenarios.

The magnitude and sequence of loading on components is vital in fatigue analysis. The history of suspension, steering systems and drivetrain is difficult to assess. We, the drivers, are the huge uncertainty in the loop — with no such thing as a "typical" operating envelope.

Compare a rental car subjected to a history of abusive and aggressive driving (in the engineering sense) with a one-owner commuter vehicle. The challenge is to embrace all these situations. Interesting future developments include on-board fatigue monitoring and "weak links," which will safely demonstrate a component is overloaded by sensors or permanent deformation, but can be easily replaced.

What is clear from talking to automotive manufacturers is that goals are moving beyond the minimum requirements of safety, handling and acceptable driver comfort. An ever-increasingly competitive market means manufacturers strive to deliver a quality of experience that will excite the customer.

Simulation is playing an ever-stronger role in making this achievable. Traditional disciplines such as crash are getting more sophisticated, and new disciplines such as MP, multi-body dynamics and full-system modeling are developing important roles. **DE**

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

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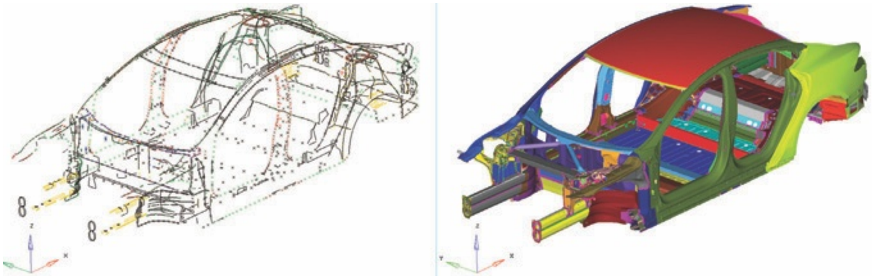
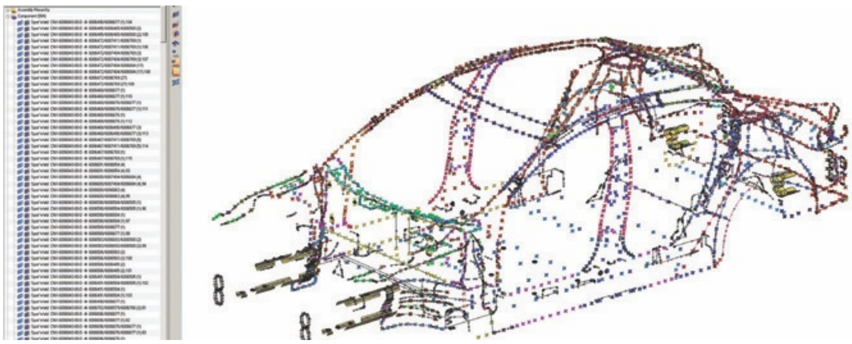
Tesla Breaks the Simulation Bottleneck

Automating CAE connector creation in HyperMesh helped optimize Tesla's design cycle.

BY BETH STACKPOLE



The Model S employs more than 300 fixings, including bolts, rivets, adhesives and welds. *Images courtesy of Tesla Motors.*



When the CAD file is imported into HyperMesh, all specification connections are contained in the component title. This information is used to fully automate the CAE connection creation.

When you're building something as high-stakes as an electric car and your company is as high profile as Tesla Motors, time is of the essence for getting a high-quality production vehicle out the door, especially when you're looking to be the innovator in a pioneering market.

While there was plenty of opportunity for large-scale process improvement to optimize its development cycle, the Tesla simulation team got significant mileage out of a relatively small change to its finite element analysis (FEA) model preparation procedures. By automating how it handles the connector portion of its CAE model, the simulation team was able to shave days off its design process — and redirect that time to more in-depth analysis studies.

"The big pressure is getting the product out to the market as soon as possible and trying to improve quality," says Singai Krishnamoorthi, technical specialist and staff engineer at Tesla. "Cutting off two to three days of the design cycle doesn't sound like that much. But Tesla runs a tight schedule, and when you're aiming to get a car out in one-and-a-half years, every single day counts."

Founded in 2003 by serial entrepreneur Elon Musk — the man behind such well-known ventures as PayPal and SpaceX — Tesla's development efforts have grabbed worldwide attention. The company's mission is to launch mass-marketed electric vehicles designed to capture the fancy of buyers unimpressed with the quality and performance of first-generation electric car offerings.

Tesla comes at the electric car market with a three-pronged strategy. In 2006, it introduced a high-end, high performance sports car called the Roadster to establish that electric cars were viable and, more importantly, had sex appeal. Six years later, it released the Model S sedan — which, at a base price of about $50,000, was half the price of the Roadster. The third phase is to produce a mass-market, affordable electric vehicle for mainstream buyers at about a $35,000 price point. It's a milestone that Musk recently said was still about three years away.

In the interim, the company is selling a notable number of its higher-priced models. Since the Roadster officially hit the streets in 2008, there have been more than 2,300 sold, and the automaker recently revealed that it had taken orders for 6,900 Model S sedans in the last quarter of 2013 — a 25% spike over the previous quarter.

Connector Conundrum

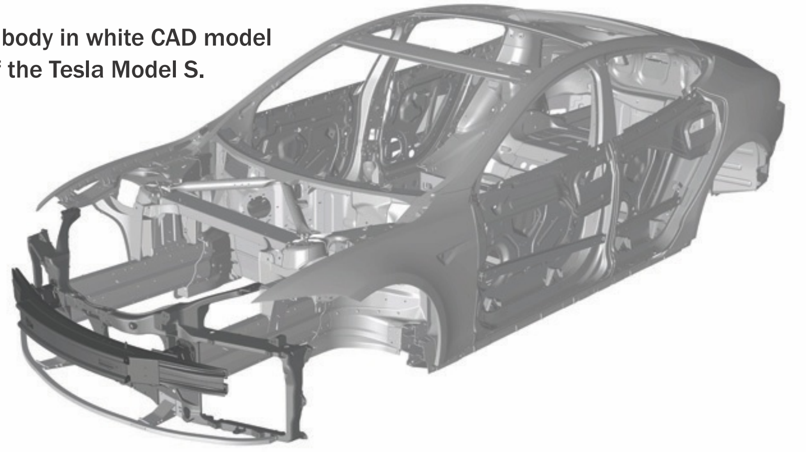
With so much attention lavished on Tesla's business plan and engineering efforts in the areas of sleek aerodynamic design, electric powertrain, and battery strategy, an optimization effort focused on connectors might seem rather mundane. But there are more than 300 different fixings and more than 6,000 welds points on the Model S sedan, which competes with luxury brands like BMW and Lexus. Among the different connector types are welds, bolts, rivets, adhesives and MIG welds.

When preparing a CAD model of the Model S to be meshed for simulation, the most time-consuming task is to recreate the connectors, Krishnamoorthi says. "Creating a mesh of 350 body and white panels can be done within a couple of hours using batch meshing as long as the CAD is clean," he adds. "The bottleneck is putting everything together and making sure we're not missing out on any spot welds, rivets or bolts."

Tesla CAE engineers were concerned about overlooking a metal inert gas (MIG) weld or adhesive because of the way connectors were traditionally handled as part of building and updating the CAD model. While the 3D models included a representation of the various connectors, there wasn't always enough detail in the CAD file to determine what type of connector was used, let alone any of its mechanical properties or what panels it was connecting.

"There were different ways to make connections, whether through a bolt, a screw or a MIG weld, but they were all represented in CAD the same way — as a line or surface or point — and they didn't tell you much about the weld," explains Ben DiMiero, applications engineer at Altair, a CAE vendor who worked with the Tesla simulation group on the CAD connector automation project.

Typically, the connector information was exported as a standard text file, which specified all of the coordinates for connectors, the various types, and what specific panels it was being used to connect. It was up to the CAE engineer to use the data to manually recreate the connections in the CAE model. The process proved to be both laborious and an ineffi-

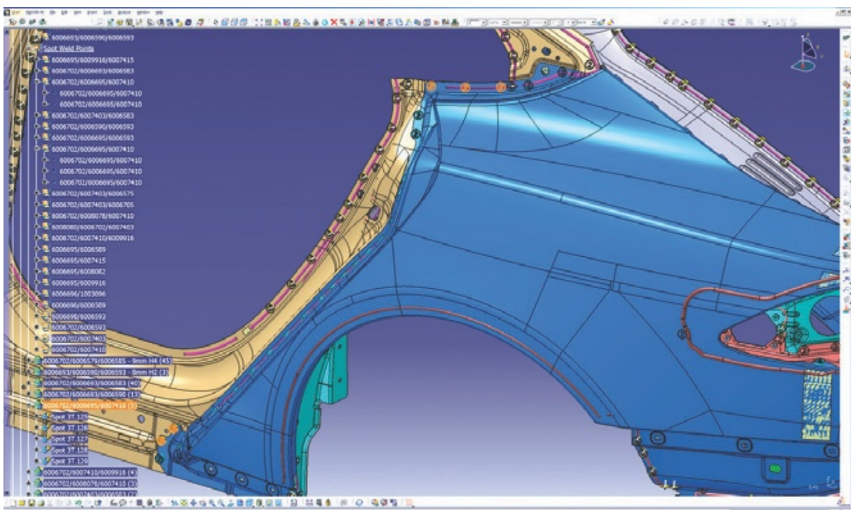


A body in white CAD model of the Tesla Model S.

cient use of the engineer's time.

Working with Altair's DiMiero, the Tesla simulation team decided that a more effective approach was to keep all of the detailed connector information in the CAD file, which in Tesla's case was Dassault Systèmes' CATIA. Tesla's Cory Ostrow led the effort to create a connector (CNX) CAD structure, putting tags on the connector entities to maintain consistency in naming and tree structure so the data could easily be extracted with a search string. Paul Hamrick created the CNX data merge tool, which creates an Excel file that depicts such CATIA geometric entities as where they reside in the overall CATIA tree as well as the connection type, among other attributes. Jenny Wu created an Excel macro that is used to mark all relevant geometric entities in the Excel spreadsheet that need to be exported in one sweep, based on the search string given by the design engineer. The last piece was a HyperMesh TCL script, which imports the updated CATIA files created by the CNX Data Merge tool into HyperMesh. The Tcl script also creates all the CAE connection elements for the various weld types, and highlights which connectors failed to be created.

The end result eliminated the manual labor and reduced the model creation process by a couple of days. Typically, all body in white pressed panels can be batch meshed in a half-day,



To facilitate automation, the team created a CNX CAD structure using consistent naming and a tree structure to ensure the relevant connector data could be extracted.

Tesla Optimizes Designs for Pedestrian Impact

Altair's HyperStudy is finding a new role at Tesla, aiding in the design group's efforts to meet legal pedestrian impact requirements and the New Car Assessment Program (NCAP).

The NCAP test represents a pedestrian being hit by a vehicle traveling at 40 KPH with the goal being to minimize injury to the head, upper, and lower leg. The allowable injury threshold is a moving target, forcing manufacturers to come up with innovative ways — including pop-up hoods or airbags — to meet the requirements without sacrificing the vehicle's styling.

Using HyperStudy, Tesla is evaluating a range of solutions to better understand and find solutions to the problem, according to Singai Krishnamoorthi, staff engineer. "The most important thing is not to restrict the creativity of the stylist," he explains. We're trying to give them guidance so they can find ways of solving and still optimize the design."

While conventional wisdom puts the ideal head acceleration curve to meet the requirements to be a square pulse, giving a stop distance of 83mm for a head injury criterion (HIC) target of 650, the HyperStudy analysis helped prove otherwise. Malcolm Burges, a Tesla engineering manager, came up with a theoretical optimum curve that delivered a stop distance of 68mm, which is 22% better than the widely touted square acceleration curve.

Using HyperStudy, the team was able to prove the theoretical curve was the optimum acceleration curve as opposed to the square pulse, despite the fact it is more difficult to engineer.

"HyperStudy let us challenge conventional wisdom and optimize a design that was outside of conventional assumptions," Krishnamoorthi says. "This approach was also used for the lower leg impact as well."

—B. Stackpole

but the connections can take as long as two to three days, Krishnamoorthi explains. This becomes a significant time saver because the analysis team frequently recreates the CAE model in response to design changes.

"Because we have to respond to design changes very quickly, we can't say, 'give us a few weeks to build a model,'" he says. "We actually wanted to give people an answer in a very short time."

While the actual development of the scripts and macros was straightforward, the bigger challenge was coming up with a solution that didn't drastically affect how engineers worked with CATIA or HyperMesh, Krishnamoorthi says: "We didn't want to tell the CAD users they were going to have to spend an extra 20 minutes modifying the way they worked. We had to come up with a process that would have the least amount of impact, yet was very robust and not prone to mistakes and errors."

For example, Tesla design engineers had historically used random names to define a weld or a connector type in the CAD file. Once the connector automation program was launched, the engineers were instructed to use a specific set of terms, so the scripts could filter out what was needed to create the actual connections in the model. "One designer might specify something as a 'MIG weld line'; another might call it a 'MIG weld curve'; and yet another might just specify 'curve,'" Krishnamoorthi offers as an example. "We asked them to stay consistent with naming and where the data is placed in CATIA. That way, we can extract it very efficiently."

While the HyperMesh script has certainly made a dent in the CAE model creation process, the more important benefit of the automation initiative has been redirecting that time to allow the Tesla CAE engineers to do more in-depth analysis.

"Because we saved time building the model, we could spend more time looking at the results and making sure the designs were optimized," Krishnamoorthi concludes. **DE**

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

INFO → **Altair Engineering:** Altair.com

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→ **Tesla Motors:** TeslaMotors.com

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Closing the CAD/CAE Gap

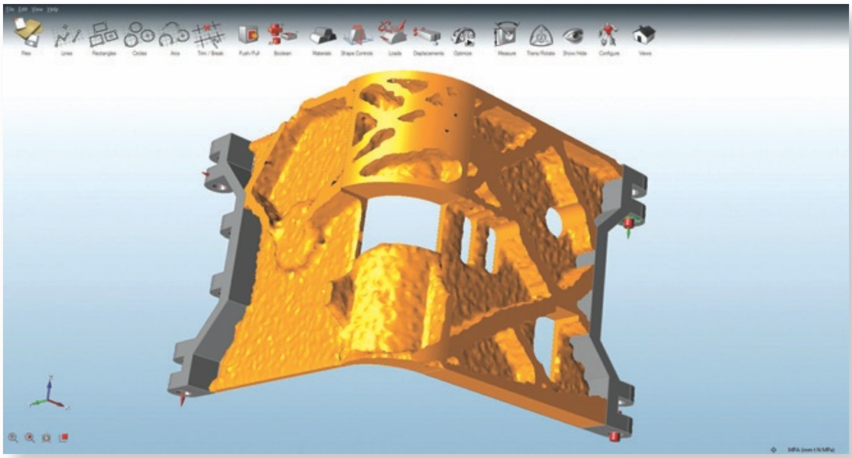
Can your company improve workflow with designer-led analysis?

BY PAMELA J. WATERMAN

Fifteen years ago or so, mechanical designers began working with improved CAD software and PC hardware to perform basic finite element analysis (FEA). The goal was shortening product development time, but there was valid concern about putting such tools in the hands of non-experts. Garbage in meant garbage out (GIGO), so designs were mostly still "thrown over the wall" to the analysts, then sent back with changes.

The process was inefficient, of course. In some cases, by the time analysts finished months of work, market forces had pushed the designers to make other changes.

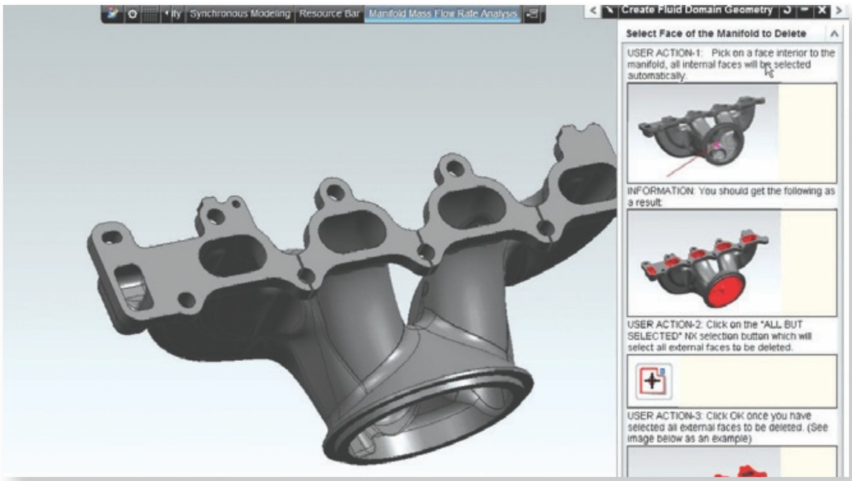
Today, both CAD and CAE software offerings include a range of simulation capabilities, and many designers are degreed engineers who do a good job performing stress and yield strength analyses. But the GIGO concept still holds — and because compressing design cycles is more important than ever, software developers are finding ways to bring even more reliable capabilities into the CAD/CAE workflow.



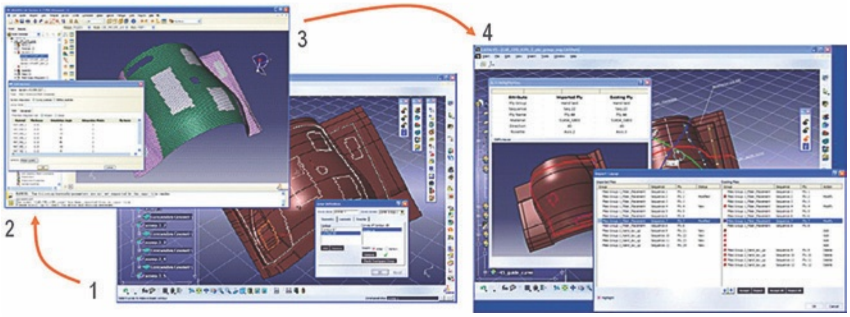
Possible internal structure of an aircraft door hinge, conceptualized and analyzed in solidThinking Inspire software prior to detailed CAD work. *Image courtesy of solidThinking.*

Switching Roles

Just how big is this workflow shift? At the 2012 NX CAE Symposium hosted by Siemens PLM Software, Northrop Grumman's Dave Fowler gave a presentation on "Structural Analysis Tools Modernization" (available as a PDF download at http://sie.ag/1evU2Pk). Speaking to the growing role of analysis and simulation in the design process, he pointed out that, whereas there used to be six designers for every analyst, the ratio is flipping to 1.2 people doing simulation for every person strictly doing design. This is huge: It means every designer is also doing simulation — and not always with analyst support.



Step-by-step simulation workflow for designer use, built with NX CAE. The interface includes built-in help documentation so the designer is guided to perform the correct tasks: extract the fluid domain in the exhaust manifold, mesh it and then perform a flow analysis. The designer simply picks on various parts of the model, as shown in the documentation pictures. *Image courtesy of Siemens PLM Software.*



SIMULIA aerospace component example of a workflow for integrating simulation with CAD for composites: designer creates initial layup in CATIA; analyst applies loads and boundary conditions in Abaqus/CAE and runs simulation; then results go back to designer for update in CATIA. *Image courtesy of Dassault Systèmes.*

Such a large role reversal has an equally large ripple effect, as both groups have different skill sets. Ravi Shankar, director of global simulation product marketing at Siemens PLM Software, says this means we have to figure out how to support designers as they take on simulation tasks.

"We must make a toolset such that collaboration between the designer and the analyst is easier," he says. "One way is with a common platform, with applications that can scale from simple to high-end analysis, such as the NX CAE simulation environment."

In support of the designer-as-occasional user, NX offers customizable user interfaces (roles), automated scripts (wizards), improved ease-of-use, and solutions data management. For a white paper on this subject, visit http://sie.ag/LNbuUW.

"Simplified analysis was very much the rage, 10 or 15 years ago," agrees Dale Berry, senior director, Dassault Systèmes SIMULIA User Experience. "Software vendors were pushing it, but now companies no longer need to have the value of simulation proven to them. Expert simulation has been and is so successful, our customers are pulling us to bring it across the enterprise."

The challenge is making simulation an activity not trapped in an expert group, but extending among groups across the company. Berry notes, "You're not going to give [SIMULIA's non-linear expert analysis tool] Abaqus to a designer, but he needs access to Abaqus technology to solve things like, when does it break, how long does it last, how much lighter can I make it before it's going to break?"

To provide such functions, SIMULIA is building these technologies within Dassault Systèmes' 3DEXPERIENCE collaborative platform in such a way that the designer can execute tasks and methods that are pre-determined.

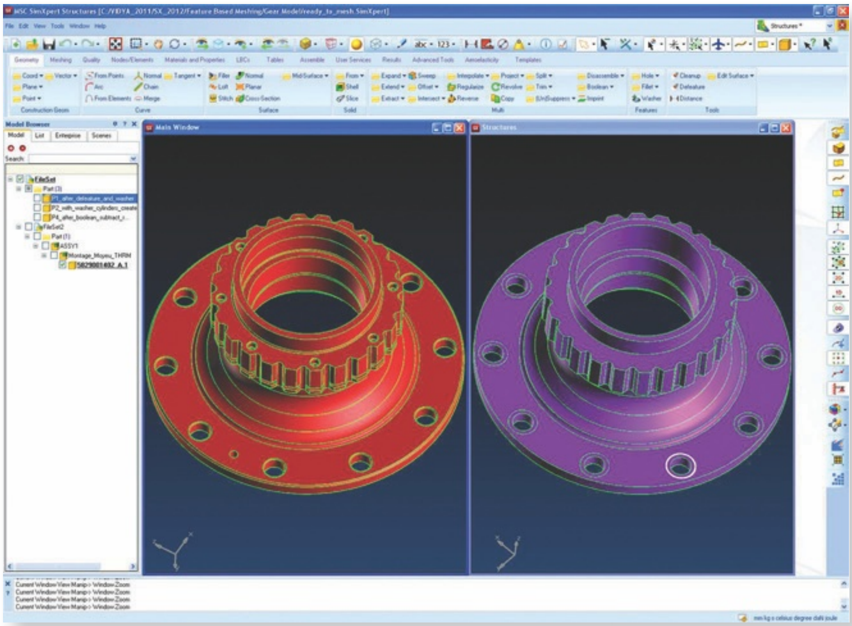
"He might have a menu pull-down that says 'flexibility,' depending on the type of tasks he needs to solve and requirements his product has," Berry offers as an example. "Those methods may be using Abaqus technology, but are predefined by the expert."

If the designer runs into trouble, the 3DEXPERIENCE platform allows the expert to come in remotely, open up the files, take a look at the analysis as well as the design, and help the designer figure out what's happening. This approach makes the expert even more valuable — ensuring all the designers in a company are using the method properly.

Berry notes that this subject is very timely: In May, the SIMULIA customer conference will feature a prominent airframe manufacturer speaking on simulation collaboration.

Other Creative Options

Allowing designers access to simulation technology in a way that fits their environment is crucial. In addition, developers must acknowledge the demanding



MSC Software's SimXpert Structures tool, showing the user interface for meshing a gear. *Image courtesy of MSC Software.*

realities of typical job requirements.

For example, besides having CAD skills, designers must understand manufacturing strategies, follow procedures to release parts, and interact with suppliers. As David Mason, VP of Global Automotive at Altair, says, "adding CAE is another barrier. It adds another thing to their plate while shrinking the design cycle, giving them less time and more to do."

Although automating tasks has helped, he says having the designer do analysis is not necessarily a huge time-saver. To gain that benefit, Altair offers Inspire from its subsidiary company, solidThinking — software that in a way puts simulation before design. More than just a geometry-creation tool, Inspire includes traditional structural simulations for identifying load paths and checking whether a design will support the required load values.

"That's going to give you a much bigger impact for time reduction, because your analysis is going to confirm that you have good geometry," explains Jason Napolitano, solidThinking's executive vice president, global sales. It also leaves more time to optimize the details. In terms of workflow, most designers take the output of Inspire and use it to do detailed design work in their own CAD software. Customers are asking for Inspire to support smooth surfaces, plus more-detailed geometry and simulations. Napolitano says the product's approach is already a radical change for the industry.

Another way that high-capability analysis companies are supporting designer-simulation efforts is by moving away from pure FEA language. Pierre Thieffry, ANSYS product manager, structural mechanics, observes that advanced analysis tools are easier for designers to understand when the software uses such terms as *forces* and *pressures*, rather than "constraints on a node." This simplification is a key concept behind the ANSYS Workbench environment, supporting the company's vision of "Simulation Driven Product Development."

"When a designer sees CAD-integrated tools, they look familiar; the designer can navigate much easier now than 10 years ago," Thieffry says. With Workbench, he adds, experts can customize the tools and write process guidelines that show exactly what needs to be done on a given type of part. This is right in line with the trends in the aerospace and turbine industry, where he sees CAD designers doing more of the repetitive work on basic parts made of steel, aluminum and titanium, while dedicated analysts handle complex and innovative tasks involving composite materials and coupled physics.

Powerful Templates

Going back at least to 2001, MSC Software has worked to streamline and improve design workflow, starting with embedding complex solver technology in CATIA (now at V5). Offering direct access to Nastran and Adams analysis tools seemed logical, but designers still had difficulty setting up simulations and understanding the results.

"The MSC CATIA solution morphed into a solution for degreed engineers rather than designers," explains Leslie Bodnar, senior director, global marketing. "Since then, we've gone more toward helping customers do [simulation] with CAE templates that help automate certain tasks. That seems to be a better way of moving simulation earlier in the design process."

Specifically, MSC Software uses templates in its SimXpert product to define a workflow, for several strong reasons listed by Shekhar Kanetkar, MSC Software manager, field support. Consistency is No. 1.

"If you give a problem to 10 engineers," says Kanetkar, "we joke and say you can get 12 answers. Two will do it two times because they wonder whether they did it the right way (depending on materials and experienced assumptions)."

Other benefits to template use include:

- automation — speeding up such labor-intensive tasks as fuselage or wing analysis
- efficiency — a wizard guides a non-expert through the process
- expertise — capturing the wisdom of experienced CAE users (it's what Kanetkar calls "engineering acumen")

Even the experts use templates to maintain consistency, for themselves and for globally separated groups working on a common project.

Bridging CAD and CAE Experts

Autodesk brings a different perspective to enhancing the CAD/CAE connection, starting with its history of pure CAD rather than analysis. Adding Inventor Professional to its AutoCAD software line gave its customers their first opportunity to do linear stress analyses within their 3D CAD environment. Over the past decade, the company expanded its simulation capabilities with the acquisition of analysis products from Moldflow, Algor and Blue Ridge Numerics, using them to create its Simulation Suite of targeted applications.

"Making simulation available to the masses is a good thing," says Luke Mihelcic, Autodesk's cloud marketing manager, noting that the analyst receives a design that needs fewer iterations. "But adding simulation capabilities to CAD tools creates a certain level of responsibility. The challenge is, how does a designer interpret simulation results?"

His company's response has been establishing a User Experience Group whose tutorials explain what a simulation run means. For example, when values for yield exceed a certain limit for a given material, the tutorial makes the connection of "this means the yield-strength has been exceeded," and discusses safety factors.

24/7 Analysis

Although the phrase "global economy" may seem both overused and a given, a recurring theme in the CAD/CAE discussion is designer access anytime, anywhere. SIMULIA calls its approach the 3DEXPERIENCE Platform, comprising collaboration, cloud deployment, mobile access and managed access. Autodesk offers a line of cloud-based "360" simulation products, plus mobile apps for general design-direction feedback.

"You can no longer think of design and simulation as completely independent activities," says Siemens' Shankar. "What we're trying to achieve is quality engineering, and that includes both how the product will look and how it will function."

But as Autodesk's Mihelcic adds, "Things don't have to be hard to be accurate." **DE**

Contributing Editor **Pamela Waterman**, *DE's simulation expert, is an electrical engineer and freelance technical*

INFO → **Altair:** Altair.com

→ **ANSYS:** ANSYS.com

→ **Autodesk:** Autodesk.com

→ **Dassault Systèmes:** 3DS.com

→ **MSC Software:** MSCSoftware.com

→ **Northrop Grumman Corp.:** NorthropGrumman.com

→ **Siemens PLM Solutions:** Siemens.com/plm

→ **SIMULIA:** SIMULIA.com

→ **solidThinking:** solidThinking.com

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CAM Heads to the Cloud

Sold as a subscription, Autodesk CAM 360 challenges long-held notions.

BY KENNETH WONG

Shaun Mymudes, COO of SolidCAM, compares computer-aided manufacturing (CAM) to a religion.

"It's something you have to devote yourself to if you want to do it well," he says. "On our staff, we don't have any application engineers who are not machinists. Every single one of them knows how to run a [computer numerically controlled, or CNC] machine, knows how to program."

And that makes Mymudes skeptical of Autodesk's latest initiative to, as the company says, "[break] down the barriers of traditional CAD/CAM" with a blend of software-driven machining and cloud-hosted collaboration, delivered in subscription-style pricing beginning at $75 a month.

Can Autodesk, with all its commercial outreach and muscle, bring software-driven manufacturing — what some see as a specialized practice — to the masses through its Autodesk CAM 360 offerings? Some analysts believe they can.

Market Pulse

Jeanné Naysmith, analyst firm CIMdata's manufacturing practice manager, points to Autodesk's 2012 acquisition of HSMWorks — and its February acquisition of Delcam — as proof of its commitment to CAM. With the cloud brand Autodesk 360, Naysmith adds, "I believe they're creating a digital prototyping platform, spanning from design to the making of the design using both additive technology [with 3D printers] and subtractive technology [CAM]. They're attempting to cover the whole gamut."

According to Stan Przybylinski, CIMdata's VP of research, the CAM market accounted for about 10% of the $10.8 billion revenues generated by the overall CAD/CAM/CAE market in 2012.

Autodesk CAM 360 offerings, derived from the HSMWorks acquisition, is rooted in the idea that "you may want to collaborate in the cloud with the very people who'll help you make or manufacture that design," he adds.

Most CAM software vendors offer plug-ins to popular CAD packages in addition to standalone titles. Mastercam, for instance, offers Mastercam for SolidWorks. BobCAD-CAM offers BobCAM for SolidWorks. As a certified Gold Partner of SolidWorks, SolidCAM offers single-window integration with SolidWorks CAD software.

CAM vendors have to ensure their software interacts with popular CAD file formats, as the automatic machine-code generation relies heavily on CAD geometry. With a major CAD package (Autodesk Inventor) in its portfolio, Autodesk has the advantage to build tight links between its CAD and CAM products.

What's in the Subscription?

Immediately after the announcement of CAM 360 last December at Autodesk University in Las Vegas, more than 500 people signed up for access to the beta software, according to Anthony Graves, product manager at Autodesk. The beta software is currently deployed by some users as a free technology preview. Autodesk plans to officially offer it as a commercial product sometime this year, but no specific date was available at press time.

Autodesk CAM 360 Express, comprising the functions currently offered for free under HSMXpress for SolidWorks and Inventor HSM Express, will remain a free product. When released, CAM 360 will be offered at $75 (basic) to $150 (pro) per month, based on a 12-month contract. Autodesk also plans to offer quarterly and pay-as-you-go, month-to-month subscriptions.

SolidCAM's Mymudes compares the software rental model to his own rented car: "I never really cozied up to that car, because I knew at one point I'd have to give it back," he quips. "I think people are the same way with CAM systems. They're not easy to learn, no matter what system. Autodesk may succeed in making certain modules simple enough, but when you get into advanced geometry, it cannot be simplified."

"One of the barriers to entry for CAM is the initial software licensing cost," counters CIMdata's Naysmith. "With these prices that undercut traditional purchase costs, Autodesk is making CAM more easily accessible."

What Would You Share in the Cloud?

Autodesk's Graves says he expects that CAM 360 users will have the ability to upload, store and share 3D CAD models, quality documentations, testing documentations, photos and videos. The advantage of the cloud-hosted environment, he notes, is the ability to invite others to view the archived files online, to get instant notifications of the edits and changes executed by team members, and to collaborate on milling/machining strategies in virtual meetings online.

Jayson Kramer, owner of the southern California-based NexGenCAM West and Precision Programming Services Inc., recently signed on to become an HSMWorks reseller.

"In the old days, some of my customers, whom I've never met in person, would send me their CAD files," he says, noting how he'd just program the machining routine and send back the code, along with some pictures to show the tooling and cutting operations. But with cloud collaboration, he adds, he's "able to do online meetings to discuss things like different fixture op-

Autodesk CAM 360, based on HSMWorks technology, is now in beta phase. The company plans to offer it on subscription in the near future.

tions, or talk to my customer about issues with his model."

SolidCAM's Mymudes, however, cautions that some complex, larger files could present problems for uploading and working in online: "Sometimes they present a challenge even working on them locally [on your own workstation], let alone over the web."

Kramer routinely uses secure FTP to exchange large files with his customers. Such exchanges for his CAM-related consulting business may now occur in Autodesk CAM 360's integrated cloud storage and collaboration interface.

As CIMdata's Naysmith observes, "there are very few designs that escape the need to be modified once a particular manufacturing method is chosen. Anything that eases the obstacles to collaboration between the designer and the manufacturer increases the overall efficiency of the process of moving a design from concept to reality."

Resellers' Role

As this article goes to press, the distribution strategy for CAM 360 was under development. "We're still determining how that's going to happen," Graves admits. "We're still working out a lot of things, but we want to keep everyone relevant."

As part of the Autodesk 360 family of products, CAM 360 may be promoted and sold primarily online, but that doesn't mean resellers won't have a role in its commerce. One strategy under consideration, Graves revealed, "is to streamline the purchasing process by leveraging Autodesk's e-commerce tools. This enables users to have immediate access to the A360 services while maintaining the relationship between the reseller and the end-user."

NexGenCAM's Kramer points out that "for resellers like me, the [subscription] gives a steady recurring income, as opposed to the lump sum amount I'd make in sales."

Traditionally, CAM software resellers have served as the front line of support for the software. Similarly, with CAM 360, resellers may be involved in what Graves describes as "premium support and services — project- or application-specific support."

Some may wonder how Autodesk can offer quality technical support at the price point CAM 360 is listed. SolidCAM's Mymudes cites the makeup of his own staff as proof of the critical nature of technical support. "We have 30 people," he says. "Out of those 30, we only have seven salespeople and three administrative. The rest — 20 of them — are involved in some kind of support."

Autodesk's Graves counters that his resellers had consistently been providing robust support for free versions of the software HSMXpress for SolidWorks and Inventor HSM Express, which include 2D and 2.5D CNC operations. Autodesk plans to uphold the same practice, he says.

"We look at everybody as a user, whether they're on the free version or the paid version," he continues. "The support they get for the free product should set their expectation for the paid version. Why should they expect less when they start giving us money?"

A Benefit Even to Competitors

Mymudes recalls how, just a few years ago, SolidCAM was a four-person operation. Since he's taken over as COO, he says the business has consistently grown 50%, with the exception of one recession-plagued year.

"Most of our growth comes from replacing other CAM systems," he reports. "That's not easy in this market, especially because people are extremely loyal to their CAM systems."

CIMdata's Naysmith contends that what Autodesk is doing is bound to benefit the overall CAM sector, including its rivals. "It expands the market more than it hurts those already in it," he concludes. "It will attract people who would otherwise never use any CAM products." **DE**

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

INFO ➜ Autodesk CAM 360: cam.autodesk.com/cam.php

➜ **BobCAD-CAM:** BobCAD.com

➜ **Dassault Systèmes:** 3DS.com

➜ **Delcam:** Delcam.com

➜ **CIMdata:** CIMdata.com

➜ **Mastercam:** Mastercam.com

➜ **NexGenCAM West:** NexGenCAM.com

➜ **Precision Programming Services Inc.:** PPCADCAM.com

➜ **SolidCAM:** SolidCAM.com

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Big Complications in a Small Package

Stent simulation requires training to develop engineering skills and workflows. Software providers are stepping in to provide it to their medical customers.

BY JAMIE J. GOOCH

Imagine designing a flat structure — the thinner, the better — that can be inserted into a pipeline from afar, and then be expanded into a tube-shaped scaffold that will support the pipeline's deteriorating walls. Now imagine that those walls are constantly moving, requiring the scaffold to compress and expand again and again.

Such form, fit and functionality requirements would be a challenge for any engineer. But when the pipeline is an artery, the scaffold a tiny stent, and the engineer a medical researcher — the complications multiply.

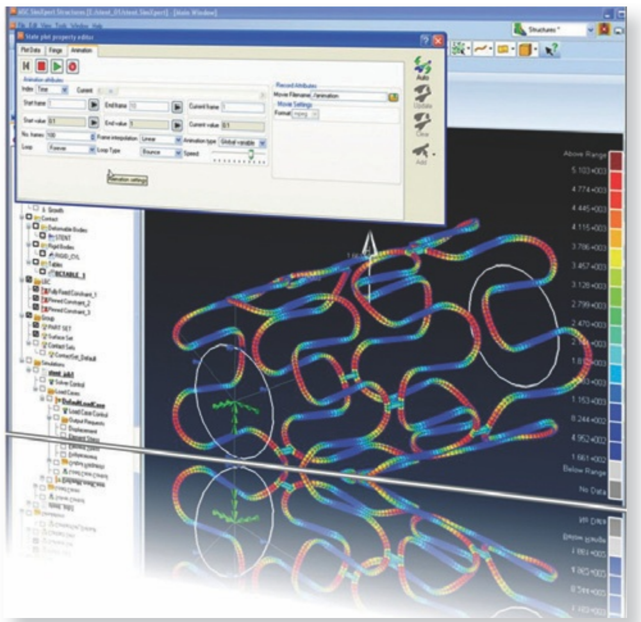
Talking the Talk

Consider the challenge faced by Shannon Gott, a Ph.D. candidate at the University of California, Riverside. Gott is researching a new type of stent that she expects to cause less damage to artery wall linings, which can cause tissue to build up. That buildup, called restenosis, narrows the artery, defeating the purpose of the stent. The other big risk is thrombosis, or blood clotting, sometimes tied to drug-eluting stents that release therapeutic agents to reduce restenosis.

"We're trying to address some of the problems that stents currently have by nanopatterning the surface of stents to get the desired cell response from vascular cells, and promote healing that way," she said at the Siemens PLM Software NX CAE Symposium last year. "Because we're trying to nanopattern the surface, we need to develop and refine titanium micromachining techniques, and we're coming up with a new planar design."

Restenoisis, thrombosis, therapeutic agents, nanopatterning? The language barrier alone between medical terms and simulation terms — such as oscillating stress vs. mean stress, contact non-linearity or even computational fluid dynamics (CFD) — can be a barrier to innovation.

Gott received a helping hand from Andrew Jabola, an application engineer at software reseller and service provider Saratech who, in his own words, "analyzed and correlated current planar stent designs against physical test data, and optimized future designs using FEA (finite element analysis)" capabilities in Siemens NX computer-aided engineering software.



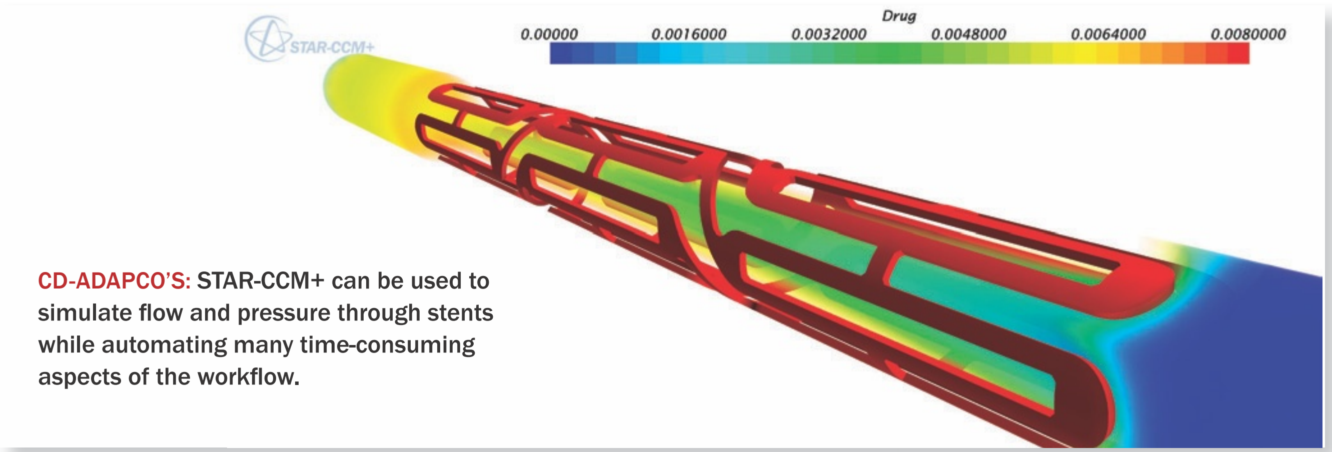
MSC'S SimXpert (shown here) integrates multi-discipline analysis capabilities that can be used to simulate stents from pre- to post-processing .

That need for a translator between the medical and simulation analysis fields, not just of industry jargon but of specialized knowledge, is an opportunity for many engineering service providers, software resellers and developers.

"I think that's part of the reason my position was created: to have someone who can learn the language of biomedical folks," says Kristian Debus, director of Life Sciences at CD-adapco. "My task is to get into the biomedical community, plus to internally educate our own people."

Multiple Paths to Innovation

Debus says many CD-adapco customers he works with know the biomedical side, but not the engineering side. His challenge is to get everyone up to speed using CD-adapco's



CD-ADAPCO'S: STAR-CCM+ can be used to simulate flow and pressure through stents while automating many time-consuming aspects of the workflow.

STAR-CCM+ analysis environment. The company provides in-house, on-site and on-demand training, as well as service contracts where analysts will perform the simulation for the client.

"In a service contract, our goal is to transfer the information and knowledge to them, then sell them a software license so they can do it themselves — with the help of a dedicated support engineer they can call on as needed," he adds.

For example, professors Alan Edelman, Ph.D., and Caroline O'Brien Ph.D., at the Massachusetts Institute of Technology (MIT) have mechanical and biomedical engineers on their research team. At the Edelman Lab, they are working to determine how tissue responds to implanted devices, including stents, and how their design influences that response.

"Within our current work, we integrate computational modeling with state-of-the-art intravascular imaging to extract real-world flow domains," Edelman explains. "The simulation of the flow fields in these image-derived geometries is notoriously difficult, however ... such a simulation has been made possible through CD-adapco."

For other customers who don't have the diverse staffing resources available at MIT, that hand-off to independent analysis is still possible. Simulation software is becoming easier to use and the necessary simulations are better understood, according to Derek Barkey, senior manager of Consulting at MSC Software.

"What used to be a fairly complex analysis is now actually pretty routine," he says. Still, many of MSC's life sciences customers would rather leave the analysis to the experts.

"Usually they have no idea about the simulation work," he says. "It's not a core competency they want to develop. Usually they're pretty well acquainted with FDA (U.S. Food and Drug Administration) requirements and have read their guidelines and know what needs to be done."

On the flip side, software developers and engineering service providers also train engineers in the specifics of stents. For example, Dassault Systèmes SIMULIA is offering "Modeling Stents Using Abaqus," a two-day course designed to help engineers create geometry for modeling stents; choose the proper element type; perform static, implicit and explicit dynamics analyses; and more. The course is next being offered May 29-30 in Warwick, RI.

Opportunities Abound

While life sciences researchers are accustomed to long lead times associated with decade-long clinical trials and the peer review process, they are often surprised by the time it takes to set up and run a simulation, Debus says. The need for an efficient workflow and the computing horsepower required for complex simulation runs are the primary speed bumps.

"You can do lot on desktop these days, but our prime customers are on clusters," he says. "Big models require horsepower. Others are using low-level simulation, but to go really deep takes an investment in hardware and manpower."

Biomedical researchers aren't like automotive and aerospace customers, he adds. They don't always have the system in place to support the hardware and software they need.

An example can be found at MIT, where integration with Simpleware Ltd.'s ScanIP image processing software was causing a bottleneck. Edelman says the staff at CD-adapco facilitated a collaboration "to create an efficient workflow taking intravascular images through to flow simulation."

As the stent research landscape shows, the software training, hardware selection and design cycle optimization needs of the life sciences community present many opportunities for service providers. The key to taking advantage of those opportunities is in ensuring you have the necessary expertise in the specifics of various biomedical fields, not just in various engineering disciplines. **DE**

Jamie Gooch *is managing editor of Desktop Engineering. Contact him via jgooch@deskeng.com.*

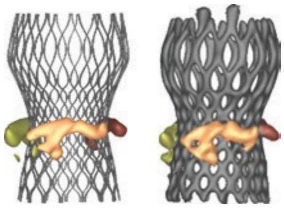
INFO → **CD-adapco:** CD-adapco.com

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

→ **MSC Software:** MSCSoftware.com

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

→ **Simpleware Ltd.:** Simpleware.com



Looking Deep into Heart Valve Replacement

FEops uses SIMULIA solutions to provide realistic simulation of transcatheter heart-valve procedure planning and design.

The heart is often compared to a pump, facilitating the flow of blood between its upper and lower chambers. The heart's valves, which open and close with each beat, regulate the pressure and course of blood throughout the body. Unfortunately, according to the American Heart Association, more than 5 million Americans are diagnosed with heart valve disease each year. It can occur in any single valve or a combination of all four, but disease of the aortic and mitral valves is most common.

According to the University of Maryland Medical Center, up to 1.5 million people in the U.S. suffer from aortic valve disease. The aortic valve controls the movement of oxygenated blood from the left ventricle into the aorta, the main artery leading to the rest of the body. Without an aortic valve replacement (AVR), 50% of aortic valve disease sufferers will not survive more than an average of two years after the onset of symptoms.

For patients deemed too old or ill to undergo AVR through traditional open-heart surgery, transcatheter aortic valve implantation (TAVI) is a growing alternative approach. It involves inserting a catheter, usually through the femoral artery in the thigh, which is then threaded into the heart, where it inserts a replacement valve inside the native (original) one. This replacement valve is mounted upon a dedicated endovascular prosthesis or stent.

FEops, a spinoff from the IBiTech-bioMMeda group at Ghent University in Belgium, developed its patent-pending TAVIguide technology — which aims at improving the design, planning, safety and efficacy of TAVI products and procedures. TAVIguide uses pre-operative images, gathered from an individual's computed tomography scans, to create digital 3D anatomically correct finite element models of patients' aortic roots by combining Abaqus FEA software from SIMULIA, the Dassault Systèmes 3DEXPERIENCE application, with proprietary software.

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Another Price/Performance Champ

HP's newest entry-level workstation, the HP Z230, delivers great performance at an attractive price point.

BY DAVID COHN

We recently received the new HP Z230 workstation, the successor to the Z220 and the original Z210 that we reviewed in April 2012. First announced last summer at SIGGRAPH, we got our initial glimpse of the Z230 at an HP workstation event in New York, when the company unveiled several additional systems in HP's highly rated Z-series workstation line.

Like its predecessor, the HPZ230 is available as both a tower and a small form factor (SFF) workstation. At 6.7x17.4x15.7 in., the Z230 tower that we received is 17% smaller than the Z220 that it replaces, and the SFF version is 57% smaller than the tower. Both new Z230 systems are aimed at mainstream users in markets such as mechanical CAD, media and entertainment, healthcare, finance, government, education, geospatial and architecture, engineering and construction (AEC).

While the HP Z230 bears a striking resemblance to the rest of the Z-series line, its 4U rack mountable chassis offers several new features. For example, although there are two 5.25-in. drive bays with front panel access, the topmost bay in our evaluation unit was set up with an optional handle and dual SFF drive adapter, a $30 add-on. This front panel recess, along with a recessed power supply ledge on the rear of the case — similar to handles on higher-end Z-series workstations — makes it easy to lift and move the Z230.

Below the handle are a conventional 5.25-in. drive bay and an additional 5.25x5/8-in. slim bay housing a tray-loading 16X SuperMulti DVD+/-RW optical drive. Below this, the now-familiar Z-series vertical fins conceal the air intake and internal speaker. A power button, four USB ports (two USB 3.0 and two USB 2.0, one of which can charge an attached device), and headphone and microphone jacks occupy a narrow vertical panel down the right side.

INFO ➜ HP: HP.com

HP Workstation Z230

- **Price:** $2,706 as tested ($1,025 base price)
- **Size:** 6.7x17.4x15.7-in. (WxDxH) tower
- **Weight:** 23 lbs.
- **CPU:** Intel Xeon E3-1245 V3 3.4GHz quad-core with 4MB L2 cache
- **Memory:** 8GB (32GB max) DDR3 1600MHz
- **Graphics:** NVIDIA Quadro K2000 w/1GB GDDR5
- **Hard Disk:** Seagate Barracuda 1TB 7,200 rpm SATA
- **Optical:** 16X SATA dual-layer SuperMulti LightScribe DVD+/-RW
- **Audio:** high-definition integrated Realtek ALC221 audio
- **Network:** integrated Intel I217LM Gigabit LAN
- **Drive Bays:** two external 5.25-in. bays, one slim optical drive bay, two internal 3.5-in. bays, one 2.5-in. internal drive bay
- **Ports (front):** two USB 3.0, two USB 2.0 (one charging), one microphone in, one headphone out
- **Ports (rear):** wo USB 3.0, four USB 2.0, one audio out, one audio-in, one microphone in, two PS/2, one RJ-45 to integrated LAN, one DVI-I, two DisplayPorts
- **Keyboard:** 104-key HP keyboard
- **Pointing device:** ttwo-button optical HP scroll mouse

The new HP Z230 workstation is available in a small form factor or in the tower configuration we reviewed. Equipped with a choice of next-generation Intel Xeon E3 or Intel Core processors, our evaluation unit turned in excellent test results, making this new HP system another price/performance leader.

LEFT: The interior of the HP Z230 workstation is well organized, with ample room for expansion — including a dedicated 2.5-in. internal bay that in our evaluation unit held a 64GB solid-state drive disk cache module.

The rear panel adds four more USB 2.0 ports, two additional USB 3.0 ports, PS/2 mouse and keyboard connectors, an RJ-45 jack for the integrated Intel I217LM Gigabit LAN, and audio-in, audio-out, and microphone jacks for the integrated Realtek ALC221 audio. There is also a single DVI-I and two DisplayPort connectors for the integrated Intel graphics.

Impeccable Design

Removing the left-side panel on the tool-less chassis reveals a spacious, well-organized interior. Below the external drive bays are two 3.5-in. drive bays and a 2.5-in. bay. The base Z230 configuration comes with a 500GB hard drive, but in our case, one of the 3.5-in. bays contained a Seagate Barracuda 1TB 7,200 rpm SATA drive with 32MB cache — an option that added just $40 to the overall system cost. Other 7,200 rpm drives of up to 3TB, as well as 10K rpm drives up to 1TB capacity and solid-state drives (SSDs) ranging from 120 to 240GB are also available; the system also supports redundant arrays of independent disks (RAIDs). The dedicated 2.5-in. internal bay in our evaluation unit held an optional 64GB SSD Intel SRT disk cache module, a $250 add-on.

Both the SFF and tower versions of the HP Z230 use next-generation Intel processors. HP offers a total of 13 different processors from which to choose, ranging from dual-core Pentium and Core i3 CPUs to quad-core i5, i7 and Xeon processors. The base configuration Z230 comes with a 3.2GHz Xeon CPU, but our evaluation unit came with a faster 3.4GHz Xeon E3-1245 V3 quad-core CPU, with 8MB of cache and integrated Intel HD Graphics P4600 — adding $150 to the system cost. This Haswell processor has a thermal design power (TDP) rating of 84 watts, a maximum turbo-boost frequency of 3.8GHz, and supports Hyper-Threading.

Although the base Z230 configuration comes with just 4GB of RAM — using a pair of 2GB dual in-line memory modules, or DIMMs — our system included 8GB of 1,600MHz DDR3 ECC memory, installed as two 4GB DIMMs. This option adds $120 to the base price. The Z230 supports up to 32GB of RAM. Power is provided by a 400-watt, 92% efficient power supply; our system was Energy Star rated.

The HP motherboard, based on an Intel C226 chipset, includes five expansion slots: two PCIe x16 graphics slots, one PCIe x4, one PCIe x1, and a full-length PCI slot. This is less expansion than was offered in the older Z210 and Z220 systems, but it results from changes made by Intel. One of the graphics slots was filled with an NVIDIA Quadro K2000 graphics accelerator with 2GB of dedicated GDDR5 memory and 384 compute unified device architecture (CUDA) cores.

While the base Z230 configuration relies on integrated Intel HD graphics, anyone running 3D CAD applications will likely prefer a discrete graphics card. HP offers 14 different boards from which to choose, ranging from entry-level 2D boards from NVIDIA to 3D boards from both AMD and NVIDIA. At $574, the mid-range NVIDIA Quadro K2000 adds considerable cost to this system, but its performance is likely worth the price for most *DE* readers.

Excellent Performance

Because our system came with both integrated Intel graphics and a discrete graphics card, we had hoped to test the Z230 both with and without the NVIDIA Quadro K2000 GPU, to

Single-Socket Workstations Compared		HP Z230 workstation (one 3.4GHz Intel Xeon E3-1245 v3 quad-core CPU, NVIDIA Quadro K2000, 8GB RAM)	Lenovo E32 SSF workstation (one 3.4GHz Intel Xeon E3-1240 v3 quad-core CPU, NVIDIA Quadro K600, 8GB RAM)	BOXX 3DBOXX W4150 XTREME workstation (one 3.5GHz Intel Core i7-4770K quad-core CPU over-clocked to 4.3GHz, NVIDIA Quadro K4000, 16GB RAM)	Ciara Kronos 800S workstation (one 3.5GHz Intel Core i7-2700K quad-core CPU over-clocked to 5.0GHz, NVIDIA Quadro K5000, 16GB RAM)	Lenovo E31 SFF workstation (one 3.3GHz Intel E3-1230 quad-core CPU, NVIDIA Quadro 400, 8GB RAM)	Lenovo S30 workstation (one 3.6GHz Intel Xeon E5-1620 quad-core CPU, NVIDIA Quadro 4000, 8GB RAM)
Price as tested		$2,706	$1,479	$4,273	$5,714	$1,093	$2,614
Date tested		11/24/13	11/10/13	7/31/13	5/31/13	12/29/12	8/18/12
Operating System		Windows 7	Windows 7	Windows 7	Windows 7	Windows 7	Windows 7
SPECview 11	higher						
catia-03		46.17	25.14	72.37	96.39	18.15	48.21
ensight-04		29.32	15.47	49.20	83.26	11.08	32.18
lightwave-01		87.98	75.52	100.78	103.15	46.79	64.47
maya-03		92.05	51.32	131.31	153.01	40.36	84.50
proe-5		20.25	15.61	24.74	22.87	10.29	11.93
sw-02		57.31	41.99	78.27	84.51	31.54	53.53
tcvis-02		38.78	23.74	55.73	77.82	16.53	37.66
snx-01		34.09	19.56	53.95	83.21	13.45	33.87
SPECapc SolidWorks 2013	Higher						
Graphics Composite		4.38	3.14	5.25	3.89	n/a	n/a
RealView Graphics Composite		4.69	3.09	5.38	4.1	n/a	n/a
Shadows Composite		4.68	2.96	5.36	4.1	n/a	n/a
Ambient Occlusion Composite		5.81	2.9	5.63	8.37	n/a	n/a
Shaded Mode Composite		4.75	3.25	5.12	3.79	n/a	n/a
Shaded With Edges Mode Composite		4.04	3.02	5.38	3.98	n/a	n/a
RealView Disabled Composite		3.35	3.31	4.74	3.15	n/a	n/a
CPU Composite		4.15	4.27	4.07	4.92	n/a	n/a
Autodesk Render Test	Lower						
Time	Seconds	49.00	48.66	42.00	58.33	64.00	63.80
Battery Test	Higher						
Time	Hours:min	n/a	n/a	n/a	n/a	n/a	n/a

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

determine whether the latest Intel HD P4600 graphics was up to the task of running 3D CAD and modeling applications. But the Intel HD graphics does not support the SolidWorks RealView feature needed to run SPECapc benchmark for SolidWorks, and we encountered errors when trying to run the SPECviewperf benchmark using only the integrated graphics. Those errors only affect the synthetic benchmarks, however. We had no problem running SolidWorks, AutoCAD or a host of other CAD applications using just the integrated Intel HD graphics.

Using the discrete NVIDIA graphics board, the HP Z230 delivered excellent results. While it certainly didn't set any records, its scores on all eight datasets were squarely in the middle of the pack.

On the SolidWorks 2013 benchmark, which is more of a real-world test, the HP Z230 did quite well — particularly for a system costing half that of the best-performing single-CPU systems we have tested to date.

On the AutoCAD rendering test, which is multithreaded and therefore shows the benefits of multiple CPU cores, the HP workstation took an average of just 49.0 seconds to complete the rendering. That places it in a dead heat as one of the best-performing single-socket systems with a standard (not over-clocked) CPU we have tested to date.

As usual, HP rounds out the Z230 with its excellent 104-key USB keyboard and two-button optical scroll mouse. It backs the system with a limited three-year warranty on parts and label, which includes next-day service Monday through Friday and 24/7 phone support. You can extend the warranty to four years for $29 more, or five years for $89.

Z230 prices start at $1,025, which gets you just 4GB of memory and integrated Intel HD graphics. As configured, our evaluation priced out at $2,706. If you don't plan to use the integrated graphics, you could opt for the otherwise-identical Intel Xeon E3-1240 V3 processor, which costs $50 less. To sweeten the deal even more, at presstime, HP has a coupon code that can save 20% on the Z230 workstation during checkout when purchasing online.

As was true of its predecessor, the HP Z230 may very well be the best balance of price/performance currently available. **DE**

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

IT-free **HPC** Appliances

Pre-configured clusters try to take the high-performance computing middle ground.

BY KENNETH WONG

Late last year, when *DE* ran a survey on high-performance computing (HPC) adoption on behalf of IBM Platform Computing, participants cited a lack of budget (47%) and a lack of skilled IT personnel to manage the cluster (31%) as the top two barriers. The phenomenon prompted some software vendors and hardware partners to deliver a packaged solution: HPC in a box, preconfigured for simulation.

The specialized appliances target workgroups primarily, but they could also be a way to deal with peak demands in enterprises. Self-contained and portable, they can be managed independently from the company network. Some rest under a desk, with no need to be housed in a temperature-controlled server room.

Because the goal of the hardware is to reduce reliance on IT, many of these appliances come preloaded with simulation and job management software. They're an attractive option for simulation-dependent businesses that don't want to invest in full-scale data centers, but aren't prepared to work exclusively with Software-as-a-Service (SaaS) either. For those caught in the tug of war between in-house servers and the cloud, plug-and-play simulation hardware might just be their safe harbor.

Revival after a Faltered Start

In 2010, ANSYS, Dezineforce, Dell and Microsoft came together to create what was described as a "turnkey HPC simulation appliance." The idea was to deliver a mini-HPC server from Dell — preloaded with simulation software from ANSYS and management tools from Dezineforce and Microsoft. Then in early 2012, with little or no warning, Dezineforce closed up shop and disappeared. The ANSYS HPC appliance faded away.

But Wim Slagter, ANSYS' lead product manager, has revealed that the appliance is about to come back.

"We're targeting midsized companies that still rely on workstations, while HPC clusters would enable them to significantly decrease their time to solution," he adds. "We revived the HPC appliance initiative with IBM in the middle of last year, but I should say it's right now at a very early stage."

In January, Lenovo, which purchased IBM's PC business in 2004, announced its intent to acquire IBM's x86 server business. The nature of the ANSYS-IBM HPC offerings may change after the acquisition. Barbara Hutchings, ANSYS' director of strategic partnership, notes, "When the Lenovo-IBM transection is completed, ANSYS looks forward to continuing the HPC appliance offerings with the new business entity as its partner."

Part of the HPC value proposition is to empower engineers to run more simulation, more often. But that proposition makes sense only if the software licensing policy allows users to take advantage of the added computing power. Current simulation software licensing models often draw ire from users — partly because of their complexity and partly because the cost increases significantly when users deploy the software on more powerful hardware (that is, running the software on more processing cores).

"With the HPC appliance, we also introduced HPC licensing to make [entry-level HPC clusters] more attractive," says Slagter. The new licensing, he adds, "rewards volume HPC processing for entry-level 32- and 64-core clusters within a single workgroup sharing the same location."

The clusters ANSYS offers in partnership with IBM tend to be larger, comprising hundreds of cores. ANSYS is considering other original equipment manufacturers like BOXX Technologies and Dell, which market smaller clusters. They remove IT dependency because "they need no special cooling, no special outlet, and they're designed to be on desktop environments," Slagter says.

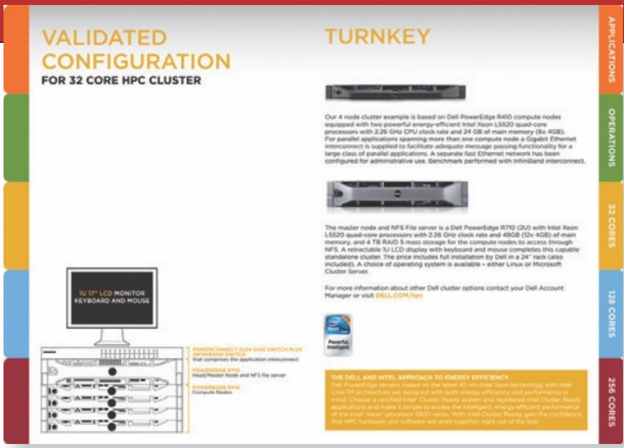
A Box with Unlimited Runs

Last September, Altair, widely known for its HyperWorks engineering software suite, unveiled what it described as a "private cloud" solution. Developed in partnership with hardware maker SGI, HyperWorks Unlimited is supplied as rented hardware. It's designed "to run pre- and post-processors 'out of the box' within the customer's own location, and is completely managed and supported by Altair," the company announced.

The "Unlimited" in its name refers to "unlimited use of all Altair software, including HyperWorks applications and PBS Works workload management tools," according to Altair. Ravi Kunju, VP of strategy and business development at Altair, notes that many of the smaller clients don't have the IT expertise to manage HPC, "especially Linux clusters. And even if they can find the experts, they're expensive."

So what does "out-of-the-box" mean? Kunju explains: "In the case of the first customer, within one hour after we rolled the appliance into their data center and uncrated it, they were running a large-scale simulation job on it."

Kunju says he'd seen both interest and adoption of the appliance among Altair customers, but prefers to keep the statistics private. He also revealed an insight into the purchasing behavior he'd witnessed. "In companies, there's the software renewal cycle, and the hardware refresh cycle," he reports. "In most cases, if we propose the appliance [to the buyer] when these two cycles coincide, we get a higher rate of success."



An ANSYS brochure, detailing a 32-core turnkey cluster.

One Foot in Sea, One on Shore

Not every simulation software vendor is jumping into the HPC appliance business, however. "We're in the business of supplying world-class software, and we're not in the business of selling hardware," says David Vaughn, CD-adapco's VP of worldwide marketing. "We have partners who have a lot more experience building hardware, and we work very closely with them."

Vaughn adds he believes it's more important to offer "flexible licensing options for the private cloud."

For ANSYS, though, the HPC hardware and the cloud are not mutually exclusive. While it is reviving its HPC appliance initiative, ANSYS is also inking partnerships for pay-per-usage models from companies like Sweden's Gridcore, France's Bull, and U.S. firms such as Rescale, R-Systems and Penguin Computing. The two-pronged approach lets ANSYS customers maintain mini-HPC clusters for in-house use, but also turn to PaaS vendors when they need additional computing power.

In addition to the HyperWorks Unlimited Appliance, Altair offers the HyperWorks On-Demand program, where users may buy additional compute power to address peak workload. According to Altair, in its pay-per-usage model, "customers purchase a pool of HyperWorks Units (HWUs), which are used to gain access to the extensive suite of Altair's software and HyperWorks Partners' products ... allowing the same HWUs to access the HPC infrastructure in the cloud."

For established businesses with predictable, consistent workloads, in-house data centers and HPC servers seem to offer the best bang for the buck. But for small- and mid-sized businesses, a mix of smaller HPC hardware and pay-as-you-go solutions may be the better alternative, as the dual approach gives them access to in-house HPC with low IT overhead, and on-demand computer power to address unexpected workloads. **DE**

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

INFO → **Altair:** Altair.com

→ **ANSYS:** ANSYS.com

→ **BOXX Technologies:** BOXXTech.com

→ **Bull:** Bull.com

→ **CD-adapco:** CD-adapco.com

→ **Dell:** Dell.com

→ **Gridcore:** Gompute.com

→ **IBM Platform Computing:** IBM.com

→ **Lenovo:** Lenovo.com

→ **Microsoft:** Microsoft.com

→ **Penguin Computing:** Penguincomputing.com

→ **R-Systems:** Rsystemsinc.com

→ **Rescale:** Rescale.com

→ **SGI:** SGI.com

ADVERTISING INDEX

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by P. Kelly Senecal, Ph.D.

Shifting the Paradigm of CFD

If you run computational fluid dynamics (CFD) simulations, I'm guessing your workflow goes something like this: You make a mesh, run the calculation, look at the results, and then wonder whether the results would change if the mesh were modified. With project deadlines looming, it is impractical to consider recreating the mesh to examine how the solution would differ with resolution.

Does this sound familiar? If so, you may be at the mercy of the mesh.

My first experience making a complicated mesh was in graduate school. I remember spending hours, days, even weeks structuring cells such that the overall mesh conformed to the strict rules of the CFD solver. When I finally finished, I felt an enormous sense of accomplishment — and relief. With this relief, however, came big uncertainty: Did I have resolution in the correct places? Was I anywhere near the point of grid convergence? Admittedly, I didn't know the answer to these questions. I was at the mercy of the mesh.

How do we escape being held at the mercy of the mesh?

There's a school of thought that it's necessary to be this way, that making a mesh by hand is essential to achieving an accurate solution. Think about that for a moment. If you know where the mesh resolution should go ahead of time, then you must already know what the flow solution looks like. But if you already know what the solution looks like, why do you need to run the simulation?

The truth is that guessing where resolution should go ahead of time is quite challenging, even impossible for most cases. In a 2004 Stanford workshop, Professor Wagdi Habashi of McGill University stated that to achieve mesh independence, we "cannot let the user decide where to generate and concentrate points." He also indicated that "a mesh that is good for a flow condition can be shown not to be as good for a different condition, for the same geometry." (*Author's Note: For more details on Habashi's presentation, do an online search for the phrase "meshing by guessing."*)

My graduate school meshes took a long time to generate and had no guarantee that they would correctly resolve the flow for the cases that I threw at them. Unfortunately, similar meshes still show up today, particularly in the combustion community.

Breaking Free

How do we escape being held at the mercy of the mesh? We stop making meshes. New technologies make it easier than ever to simulate complicated flows with CFD.

For example, mesh-free methods remove the requirement of connecting points to represent a simulated volume. One of the oldest mesh-free methods, smoothed-particle hydrodynamics (SPH), predicts a flow field by calculating the motion of a set of particles. In some cases, mesh-free methods have been successfully applied, but fortunately it's also now possible to use the concept of a traditional mesh without having to make it ahead of time. This is what I refer to here as "automated meshing."

Automated meshing means different things to different people. Some automatic mesh generators literally cut corners and sacrifice accuracy for gains in efficiency. Other approaches aren't really fully automated or suffer from conservation issues. Such techniques may be adequate for running quick and dirty CFD, but the automated meshing to which I'm referring represents the geometry exactly, is truly automated, and conserves perfectly.

This is accomplished by intimately connecting the mesh and the flow solver. The connection is so tight, the solver actually creates the mesh at runtime. Just imagine how much time you would save if you didn't have to create meshes!

As if that wasn't enough, runtime grid generation typically gives you a better mesh than what you would have gridded by hand. This is made possible through a process called adaptive mesh refinement (AMR), in which the mesh responds to feedback from the flow. As a result, the mesh is optimal at every time-step, in every portion of the flow domain.

Runtime mesh generation with AMR is a fundamental change in how CFD is done — a paradigm shift that has been successfully used in applications ranging from internal combustion engines to curveballs, from gas turbines to wind turbines. It's a shift that is giving engineers more time to focus on the task at hand. DE

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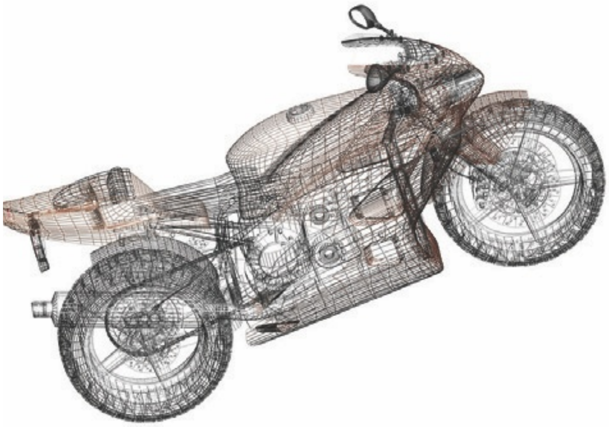

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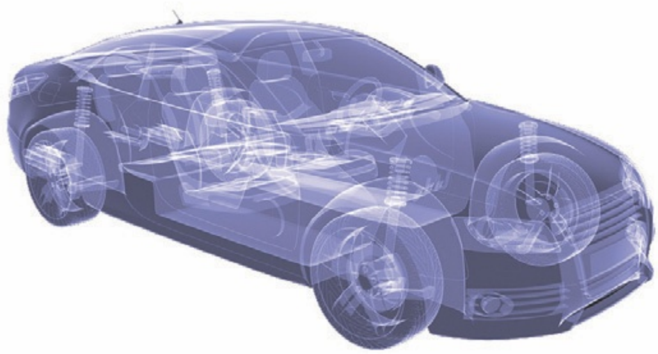

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