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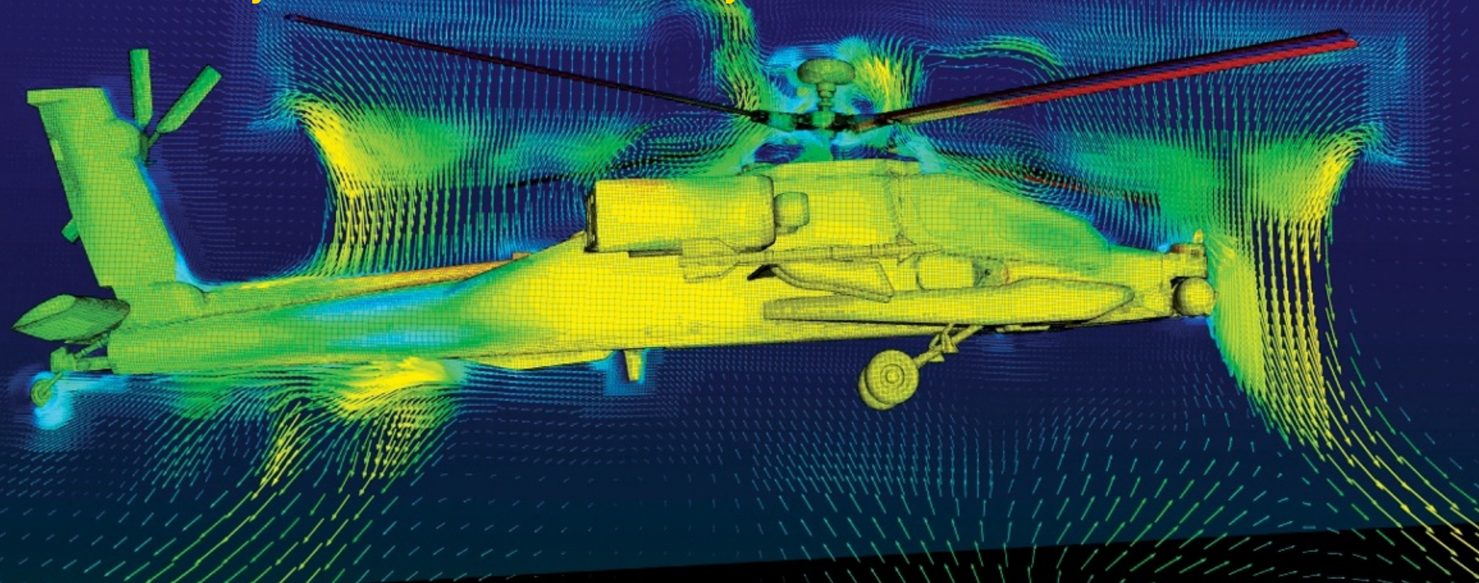
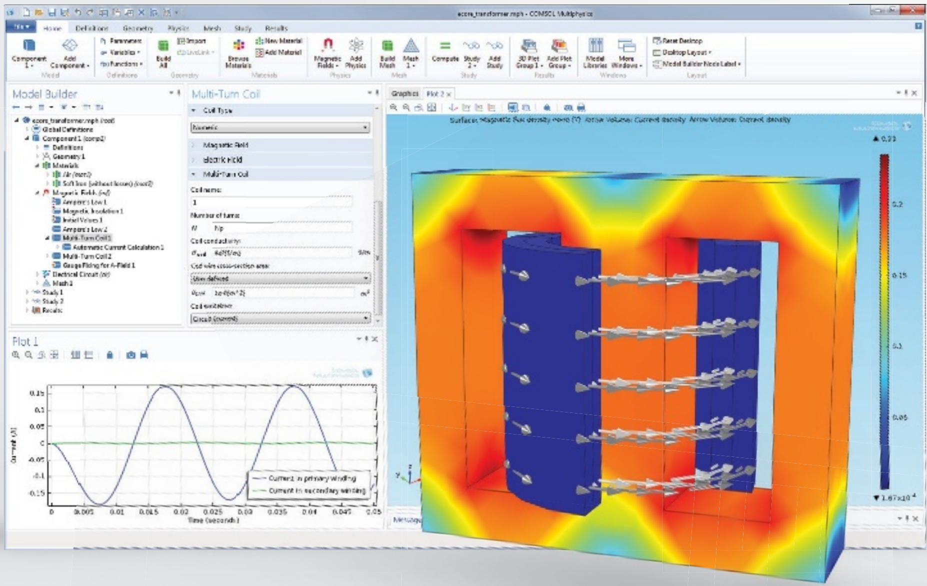
Special Issue: Data Management

The Simulation Data Drag

Aerospace engineers look for ways to make system-level simulation fly. P.18





by Jamie J. Gooch

Don’t Dismiss Data Duties

It’s a new year, full of the promise of doing things better than the year before. Take a moment to look at 2014 with an optimistic eye before succumbing to the harsh pressures of reality. This could be the year you organize and optimize all of your tasks into a streamlined thing of beauty that lets you work smarter, not harder. This could be the year you lead the charge to an efficient data management platform for your entire department — let’s make it your entire company — saving your bosses so much money that you get that raise/promotion/new workstation/software license you deserve.

Or, this could be another year of struggling in vain to keep up with increasingly complicated designs and simulations that require more information to be stored, accessed, updated, and exchanged with more people. Unfortunately, that’s the potential reality faced by many design engineers who are already overworked without what they see as the added chore of data management.

Take an active role in data management decisions before they are decided for you.

Alter Your Reality

Chances are, someone has taken a look at the hodgepodge of data floating around your company — concepts, CAD models, test results, analyses, market intelligence, renderings — and decided to implement a way to organize it all. If a data management platform is already in place, you’re that much closer to an optimized workflow. If everyone in your company is using the data management system properly — whether it’s product data management, document management, product lifecycle management, or any other companywide platform for organizing and sharing data — you’re way ahead of the game.

If not, why not? The “this is the way we’ve always done it crowd” is often responsible via small acts of civil disobedience: refusing to check in files, not working on shared drives, not annotating designs with information that is useful to other departments, and generally trying to maintain the status quo. The root cause of their attitude may have merit: A poorly implemented data management platform can easily cause more workflow headaches than it solves.

That’s why it’s so important to get involved in the process. Data management touches every aspect of a company, from the CEO to the guys delivering the finished product. Without a strong voice from the design engineering corner, it’s more likely that decisions will be made that will either hinder your workflow, force (or at least tempt) you to defy the data management system, or both.

Get Involved

Implementing a data management platform is an opportunity for design engineers to help ensure the design cycle is adequately supported without being overly burdened. Whether your company has a data management taskforce, committee, or just a few guys wondering how to improve efficiencies over lunch, make sure they consider:

- What are the objectives of the data management platform, and how do design engineers fit into that objective?
- How much time is spent managing data vs. producing, simulating, analyzing and testing designs? How does that compare to the efficiencies lost without a data management platform?
- Will new hardware be needed? Creating a central repository of data means that data needs to be stored, backed up and those backups backed up. Are your current storage and networking solutions up to the task?
- Will the system support the way you work, or force you into a rigid workflow? If it’s the latter, is that something you and your colleagues can embrace?
- Will the data management platform support customization? If so, how will that affect updates, maintenance and support?
- Once the data is collected, how will it be used? Knowing and sharing the big picture can go a long way toward making sure everyone complies with new routines that will build a more complete repository.
- How is the data secured? Are security measures robust without hindering the use of the data management platform?
- How will the company get everyone — from executives on down — to support and use the data management platform?

Properly implemented, supported and maintained, data management can drastically reduce design cycle times, reduce frustrations associated with engineering change orders, and ultimately improve your company’s time to market. Without the right guidance, those benefits can disappear.

The need for data management isn’t going away. It’s only going to increase. You can take the lead or you can take your chances. DE

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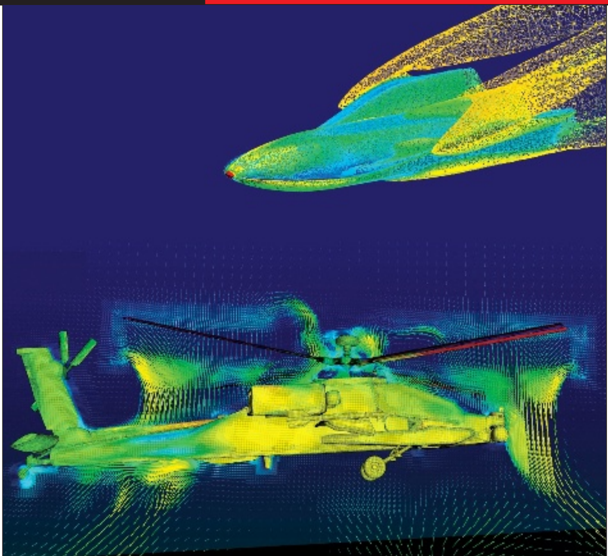

ON THE COVER: The aerospace industry is at the forefront of system-level simulation and data management. *Images courtesy of Escape Dynamics (top) and CD-adapco.*

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by Kenneth Wong & Beth Stackpole

Autodesk CAM 360 Promises CAM Revival

Autodesk's aggressive pursuit of CAM technologies began with its 2012 acquisition of HSMWorks; it continues in the purchase of Delcam (pending at press time). HSMWorks is known for, among other things, ease of use and tight integration with SolidWorks, a mechanical CAD modeler from Autodesk's rival Dassault Systèmes.

Speaking to the press at the December Autodesk University conference in Las Vegas, Brenda Discher, Autodesk's vice president of strategy and marketing, noted that "the common gossip was, we're going to build a HSMWorks product for Inventor and then kill off HSMWorks for SolidWorks. Well, only part of that was true."

The company *did* develop Autodesk Inventor HSM Express, a counterpart to the free HSMXpress for SolidWorks. Last July, Inventor HSM Express became a beta product. Both the Express edition for Inventor and Xpress for SolidWorks are limited to 2.5-axis milling operations. They serve as gateway products to let users get a taste of the software's ease of use. Higher-end operations (3-axis, 5-axis and so on) require a commercial license.

Collaborative CNC

Autodesk CAM 360, launched at Autodesk University, is the latest addition to the company's CAM portfolio. It's expected to become available in 2014. The company is pitching Autodesk CAM 360 as the all-in-one bundle that combines computer numerically controlled (CNC) programming, simulation and design "with real-time collaboration and online project and data management."

Whereas Autodesk Inventor HSM is designed to work in conjunction with parametric modeler Autodesk Inventor, Autodesk CAM 360 includes Autodesk Fusion, the company's 3D direct modeler. The CAD-CAM linkage in these products promises to cut down on the steps and time required to move from 3D design to tool-path generation.

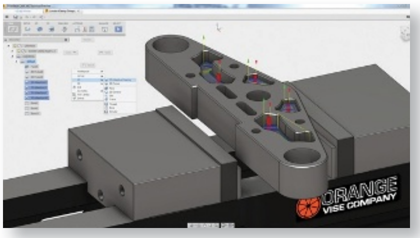
With Autodesk CAM 360's cloud-hosted collaboration with social media-inspired functions, the company takes a gamble on its vision of how the next generation would want to work. For those comfortable within the social media environment, this style of project management is a natural evolution in data management. But skeptics wonder how users might feel about storing their intellectual data — specifically, the 3D design files — in the cloud.

Exploring the Rental Business

At the Autodesk University conference, just a few feet away from the Autodesk CAM exhibit area, Shaun Mymudes, COO of SolidCAM America, delighted in observing the increased foot traffic to CAM vendors' booths, including his. "Most people think of CAM as something they need to buy into — need to invest in and learn — so they may be reluctant to treat it as monthly rental," Mymudes remarked.

On one hand, Autodesk's renewed interest in CAM is bound to spur its biggest competitors to take a closer look at other CAM software developers for possible partnerships or mergers. On the other hand, the company's Software-as-a-Service (SaaS)-style pricing for Autodesk CAM 360 — roughly \$75 to \$150 per user per month — threatens to undercut the standard sales model.

"If you have to pay \$100 per month, in two years you would have paid for the cost of our 2.5D milling product," Mymudes points out. For some CAM software vendors, he adds, competing with Autodesk may mean bolstering the type of value-added support and services.



Autodesk CAM 360, launched at Autodesk University 2013, adds cloud-hosted project management and collaboration features to CAM workflow.

"We have nearly as many support people as we do salespeople," he says. "For us, support is No. 1. You have to wonder: What kind of support would you get at \$100 per month? Will you get to talk to someone with 30 years of experience?"

CAM Continues to Grow

For prototypes with complex geometry, 3D printers offer the advantage of cost and speed. But for prototypes that must mimic the manufactured parts' strength and durability in lab tests and stress tests, milling machines that can cut metal still serve as the best choice. And the rise of personal desktop milling machines is expected to attract hobbyists who have previously stayed away from CAM because of the high initial cost. (For more, read "*A New Look at Subtractive Manufacturing*," September and October 2013.)

Autodesk has proven to have the organizational muscle to push certain professional products to the consumer and prosumer markets. CAM software makers — even those competing with Autodesk CAM 360 — stand to benefit from Autodesk's outreach campaigns.

— K. Wong

Taking the Cloud Back to the Enterprise

Speaking at the November 3DEXPERIENCE Customer FORUM in Las Vegas, Dassault Systèmes president and CEO Bernard Charlès said, "ENOVIA is no more a platform. It's a collection of apps." He also described V6 as "no more a platform. It's the architecture.

"Two years ago, we asked ourselves where we should be in 2021," Charlès explained. "Every 10 years, we try to reformulate where we want to be and why we want to be there ..."

He concluded that today's economy is driven not by products, but by experiences: "Welcome to the world of experiences: 3DEXPERIENCE," he said.

Two critical components of the 3DEXPERIENCE would be the web and the cloud. Early this year, Dassault will launch cloud-powered, V6-based products. During his luncheon meeting with the press, Charlès further clarified that the new solutions "will be on Dassault's cloud, but augmented with Amazon elasticity in the back end." In other words, if more computing capacity is necessary, Dassault will tap into the Amazon cloud to deliver scalability.

Charlès didn't get into the details about how the change might affect licensing, but he suggests no hiccups should be expected. He sees the app-driven, cloud-hosted setup as the foundation for the new crop of engineers who have come of age with the World of Warcraft and iPhone app store.

"Everything we have today is becoming a collection of applications," he declared. Consequently, he envisioned that purchasing software — Dassault's solutions included — should be "like going on the app store and provisioning apps."

Charlès said lighthouse customers are already using 3DEXPERIENCE solutions — an entire portfolio delivered in the cloud as a series of CATIA, DELMIA and SIMULIA apps. It would be up to Dassault to ensure that the software's performance is consistent, whether the customer is accessing the product from Singapore, China or California.

Dassault's move is similar to the app-driven strategy PTC began pursuing a few years ago, marked by the switch to the Creo brand. The adoption of Apple's piecemeal sales model among enterprise software vendors that historically relied on hefty maintenance fees and upfront costs is the sign of the times. Part of the 3DEXPERIENCE Dassault plans to deliver must be the low-commitment, low-cost, low maintenance, use-it-when-you-need-it experience smartphones give us daily.

— K. Wong

PTC Tunes PLM for Conflict Minerals Compliance

Amid an already-complex regulatory landscape, manufacturers will soon be facing yet another compliance directive — one that requires them to investigate the sources of certain materials for origination in the war-torn region of the Democratic Republic of the Congo.

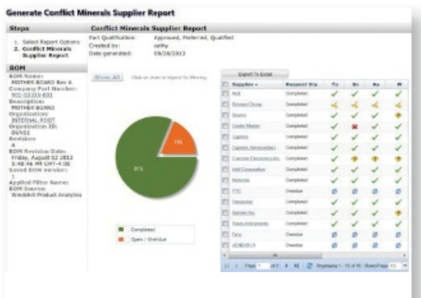
As part of the 2010 Dodd-Frank Act, companies listed on the U.S. stock exchanges have until May 14, 2014, to comply with a directive to investigate whether the sources of tin, tantalum, tungsten and gold used in their products are from the region in question, and thus are considered so-called "conflict minerals."

The compliance requirements are applicable to the entire supply chain, which means hundreds of thousands of component suppliers also need to have systems and processes in place to orchestrate compliance with the forthcoming conflict mineral regulations.

Siemens PLM Software is touting its Teamcenter Substance Compliance tool as a way to help companies deal with the new conflict minerals legislation. Oracle is also talking up capabilities in its Agile PLM Version 9.3.2 as a framework for compliance.

The new PTC Materials Compliance Solution, available as a managed service, is designed to give manufacturers a fast deployment option that will allow them to systematically access and report on the status of conflict minerals within their product lines and across their supply chains. PTC will install, operate and maintain all the software and related infrastructure to support the solution, freeing up internal IT groups to focus on other initiatives.

"For many companies, there's an urgency around this topic now — and maybe they didn't plan for the IT



PTC's Materials Compliance Solution enables manufacturers to identify and report on 3TG minerals in the supply chain. ***Image courtesy of PTC.***

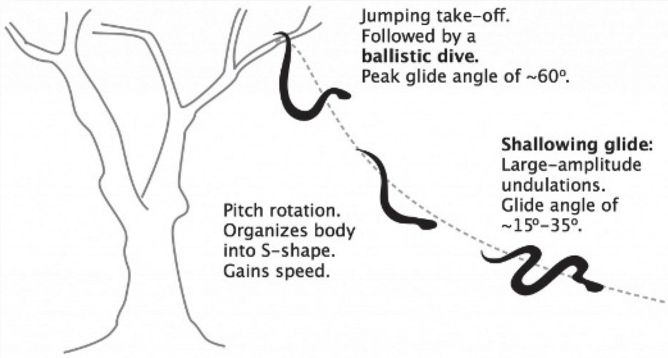
resources to go and tackle this issue," notes Howard Heppelmann, PTC's general manager, Supply Chain Management Segment. "This is really about enabling companies to quickly adopt and start using a solution that has some time sensitivity to it."

— B. Stackpole

by Kenneth Wong & Beth Stackpole

Simulating Football Stadiums & Flying Snakes

What do one of the windiest professional football stadiums and a rare breed of flying snake have in common? They both offer some important takeaways for engineers looking to promote simulation studies far earlier in the design process.



ABOVE: Sketch of the gliding behavior of a flying snake. *Image courtesy of Lorena Barba Group.*

RIGHT: A model of Heinz Field was created so that a CFD analysis could be conducted using Autodesk's Project Falcon's 3D visualization capabilities. *Image courtesy of Autodesk.*

CFD for Kickoff

Known for killer winds that blow into the stadium and across the field in a variety of crazy patterns, the Pittsburgh Steelers' Heinz Field is notoriously hard on kickers. Autodesk, with an assist from Penn State University student and Autodesk summer intern Matt Wilson, decided to apply the company's technology to explore whether there was any scientific evidence to support the league's long-standing complaints about the challenging kick-off environment.

Using Autodesk's suite of simulation tools, Wilson modeled the stadium as well as the location's airflow patterns. He began by using Autodesk's handheld ForceEffect Flow iPad app to do a simple 2D flow of the stadium and to determine whether there was any foundation for a potential problem, according to John Twerdok, Autodesk's senior business line manager. Once the 2D model illustrated there was just cause to pursue deeper exploration, Wilson created a full 3D macro model of the stadium and the flow. He finalized his experiment with a full 3D computational fluid dynamics (CFD) analysis, which incorporated Heinz Field's weather data.

For this last step, Wilson employed Project Falcon, Autodesk's cloud-based CFD prototype service. At press time, Project Falcon was being prepared for release as a production-ready offering called Design Flows.

More than solving any engineering issue in the construction of Heinz Stadium, Twerdok says, the exercise was a look at how to apply simulation tools.

"This was really a lesson in the progression of how to use the tools," he adds. "It's best to start with the simplest tool out there, and then if you see a problem, create the more progressive and complex models and invest more time in the simulation."

Yet that's not how most engineering departments attack the problem. "A very coarse simulation done early in the process could have more impact than doing a more detailed one at the end."

GPU for Flying Snakes

Lorena Barba, Ph.D., associate professor of mechanical and aerospace engineering at George Washington University in Washington, is using graphics processing unit (GPU)-powered wind tunnel simulation to understand one of nature's mysterious creatures: Chrysopelea. The snakes launch themselves into the air from tall tree branches and gliding down with graceful, undulating movements. But how does a snake, without the wingspans of birds, create lift and sustain it?

Barba's collaborator, Jake Socha, Ph.D., an assistant professor of engineering science and mechanics at Virginia Tech, has been studying the very same creatures. To measure the forces, he and his team have conducted a wind tunnel test that employs a 3D-printed cross-section of the snake's body.

"They also used DPIV to visualize the flow," says Barba, referring to digital particle image velocimetry. "That gives you some idea of the lift and drag, but it's not possible to get details of the flow because the resolution is not as fine."

Barba and her researchers decided to migrate to computer simulation to see whether it produces the same characteristics of the DPIV, and to explain the bump in the snake's lift they've observed.

On a workstation with a single NVIDIA Tesla GPU, average jobs run approximately eight to 10 hours. The shortest runs are about two hours; the longest runs take up to three days.

Currently, Barba has students working on parallelizing the code for snake-glide simulation. That would allow them to take advantage of the GPU's parallel-processing architecture — a prelude to running a full 3D simulation of the snake's flight pattern.

— B. Stackpole and K. Wong

3D Systems Unleashes a Flood of 3D Printers

When 3D Systems first started on its acquisitions spree, there were whispers wondering whether the company could successfully integrate so many different corporate cultures into a meaningful whole. If 3D Systems' display of additive manufacturing (AM) might at EuroMold is anything to judge by, it seems as though the company's strategy of expansion by acquisition is working.

EuroMold saw the release of five AM systems. The ProJet 4500 offers high-resolution, full-color plastic prints, while the ProJet 5500X advances 3D Systems' dedication to multi-material composites printing. The ProX 300 is a direct metal laser sintering (DMLS) industrial AM system; the ProX 500 SLS is an industrial selective laser sintering (SLS) system, and the ProX 950 SLA is an industrial stereolithography (SL) AM system with a massive 59x30x22-in. build envelope.

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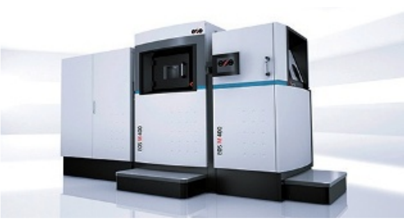
EOS Unveils Two Systems

EOS has announced two new industrial 3D printers. The EOS P 396 works with plastic material, and the EOS M 400 builds in metal. According to the company, the EOS P 396 offers improvements over older additive manufacturing (AM) systems by increasing material efficiency by up to 30%. Secondary processing times have been reduced, thanks to a new point pyrometer and a low-wearing, high-speed recoater.

The EOS M 400 offers a modular AM solution with both set-up and process stations, and an automated unpacking station to be launched later this year.



The modular concept incorporates an exchangeable frame — including components and residual powder — that may be moved, following the build process, from the process station to the unpacking station. As an industrial AM system, the build envelope allows for prints as large as 15.8 cu. in.

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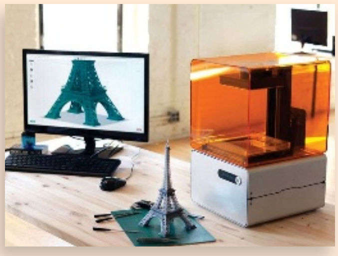
Formlabs: From Kickstarter to Launch



Crowdfunding site Kickstarter is a godsend for inventors and small businesses to find startup capital to bring their ideas to life, and Formlabs is a great example of a successful Kickstarter campaign leading to a rapidly growing business.

Unlike many additive manufacturing (AM) systems found on Kickstarter, Formlabs' FORM 1 offered something new: stereolithography (SL) printing in a desktop package. Tech junkies who follow Kickstarter developments were apparently as interested as we were, and Formlabs destroyed its $100,000 with a total of nearly $3 million pledged.

Now, a little over a year later, Formlabs has fulfilled its Kickstarter agreements, shipping out more than 1,000 3D printers to customers in more than 30 countries. While fulfilling its promises might seem routine for most businesses, a number of Kickstarter ventures have run into trouble once manufacturing begins. That the FORM 1 has gone out, and in such numbers, may speak to the company's potential.

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New USC Process Reduces AM Time

Researchers at the University of Southern California (USC) Viterbi School of Engineering have developed a process for AM that has the potential to reduce the time for a print from hours to minutes.

The process uses a digital micromirror device, light source and lens to project an image into photocurable resin. The resin hardens in thin layers in the shape of the image projected, slowly building an entire object. Because mask projection targets entire areas simultaneously, rather than single points as is the case in laser-based AM, the build time of objects is reduced.

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Rolls Royce Looks to AM for Jet Engine Parts

The civil aerospace division of Rolls Royce is devising ways of using 3D printing to build various jet engine parts.

Like other aerospace companies, Rolls Royce is interested in additive manufacturing for its capability to

build complex parts more quickly, with less material waste, and from lighter materials. Along with providing lighter parts, access to AM could save the company money on storage: Instead of attempting to carry every conceivable part required to build or repair jet engines, some necessary components could be stored digitally and printed out upon demand.

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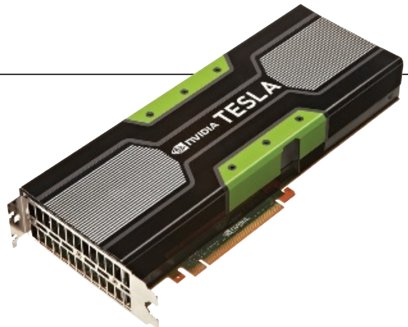

NVIDIA, IBM Target Big Data for the Enterprise

Graphics processing unit (GPU) accelerator technology is about to arrive in the corporate data center: NVIDIA and IBM plan to collaborate on GPU-accelerated versions of IBM's enterprise software applications on IBM Power Systems.

IBM Power Systems will support applications developed with the NVIDIA compute unified device architecture (CUDA) programming model, and IBM will make its Rational software development tools available to supercomputing developers. The companies also plan to integrate the joint processing capabilities of Tesla GPUs with IBM POWER processors, creating opportunities for supercomputing hardware to be used in different applications.

IBM is targeting applications like business intelligence, predictive analytics and risk analytics for improvement through GPU-accelerated technology. NVIDIA expects to benefit from the IBM endorsement and access to the company's sales and marketing muscle.

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High-tech Naval Destroyer

The U.S. Navy has launched its new Zumwalt destroyer. It can sail with a crew that's about half the size required for current destroyers, while its Total Ship Computing Environment (TSCE) controls all of the vessel's systems. The computer

systems on board are designed in modular enclosures so that components can be removed and replaced as technology changes. It generates enough electricity to potentially power future weapons systems (like railguns and lasers). It's also the first U.S. warship to use electric propulsion.

The Zumwalt's shape helps conceal its size to radar, even though at 610 ft. long, it's the largest destroyer ever built.

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OpenACC Implemented Linux Compiler to Debut

Mentor Graphics and the Oak Ridge Leadership Computing Facility are collaborating to integrate the OpenACC standard into the open-source GCC compiler suite. OpenACC is an application program interface that allows programmers to provide directives to the compiler to identify what code to offload to the GPU accelerator.

According to Mentor, because GCC is the default compiler on most Linux distributions, the integration could expand access to the language and "facilitate the development and testing of OpenACC applications on smaller systems, such as workstations and clusters." Mentor and the OpenACC group hope this can help move accelerator use out of the science niche and into additional applications and markets.

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Solar Power for Sensors

Alta Devices claims it has come up with a solar solution that can provide plenty of power to the types of small, wireless sensors that are becoming more ubiquitous in electronic devices — all while taking up a relatively small footprint.

Alta says it has designed small, flexible solar cells that can produce five times more energy via indoor light than other solar technologies. That means wireless sensors using the cells can be physically smaller and retain power, even in fairly low-light environments.

The Alta Device cells are based on gallium arsenide, and claim a conversion efficiency of 28.8%.

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Rotorcraft Breaks Mu-1 Barrier

Carter Aviation's slowed rotor/compound (SR/C) prototype broke the Mu-1 speed and efficiency barrier during a test flight late in 2013. The aircraft combines the speed of an airplane with the vertical takeoff and landing (VTOL) features of a traditional helicopter.

"Mu" is used to express the rotor tip advance ratio of a rotorcraft. At Mu-1, rotor drag almost disappears and the aircraft's efficiency improves significantly, compared to a helicopter. According to Carter: "By being able to safely slow the rotor in flight, the technology allows for forward speeds as high as 500 mph, the cruise speed of some business jets, without the tip speed of the advancing blade going over Mach 9."

The company says the prototype flew for 49 seconds at Mu-1 and above, and flew above Mu .96 for more than seven minutes. Conventional helicopters usually fly at Mu 0.3.

Flying at Mu-1 makes flight unstable, a factor Carter overcame by offloading lift from the rotor to the wing and slowing the rotor in forward flight. .

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PLM Tackles Complex Industrial Machine Design

Amid pressure to innovate, industrial machine manufacturers are turning to product lifecycle management to reduce design complexity and facilitate time-to-market.

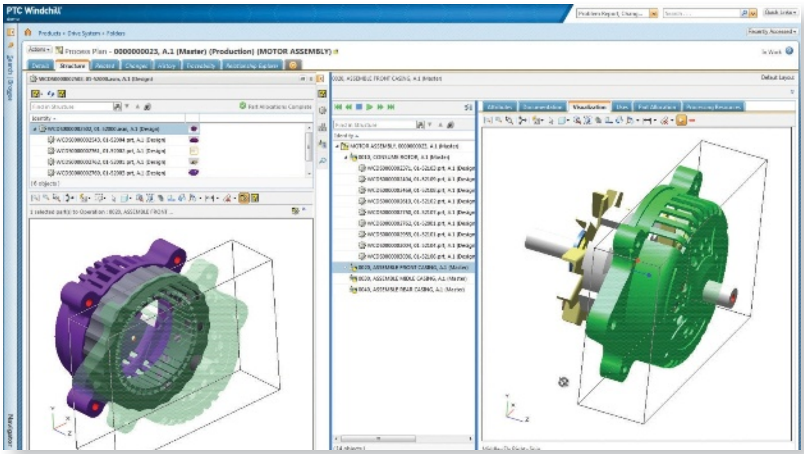
BY BETH STACKPOLE

Whether we're talking about the much-hyped Boeing 787 jetliner or the latest luxury roadster from BMW, product lifecycle management (PLM) has had a starring role in nearly every major product rollout in the automotive and aerospace sectors for the better part of a decade. Yet PLM has only been a bit player in the effort to engineer industrial machinery — a scenario experts say is changing thanks to a greater emphasis on software and configurable systems.

Defined as those plant floor robotic arms, automated conveyors, and packaging systems that hum along to produce everything from the latest in electronics gear to food and beverage items, industrial equipment has blossomed into a $400 billion-plus global industry that shows little sign of slowing down. The machines are complex products involving thousands of subassemblies and a mix of electronic, mechanical and software components. While offered in base configurations, most industrial equipment is highly customized to meet specific requirements. And with multimillion-dollar price tags, the machinery constitutes a major capital expense, which assures it a lengthy lifetime of work in the field.

If you've noticed the similarities between industrial equipment design and that of aircraft and other complex systems, you'd be right on target. With these similarities come comparable design challenges for manufacturers in this space, including the pressure to innovate, keep quality and performance standards high, deal with complex bill of material (BOM) structures, and deliver a high level of support from installation all the way through the entirety of a product's lifecycle.

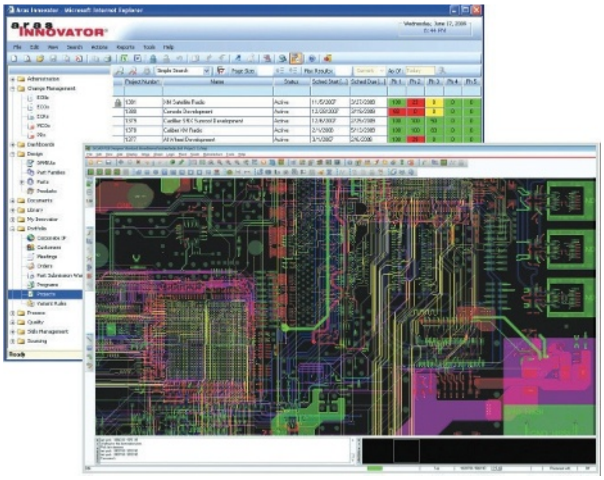
It's been well documented that PLM, with its promise of a one-version-of-the-truth repository for all things product related, has vastly helped aerospace and automotive companies manage much of the complexity related to product development — all while pushing the boundaries of innovation. Industrial equipment companies have been slower on the PLM adoption curve, experts say, in part because they lack the budgets of larger aerospace and automotive giants. But it's also because many are still immersed in the traditional engineering culture of functional silos and over-the-wall, iterative development cycles.



PTC Windchill 10.2 allows manufacturing engineers to visually construct process plans. *Image courtesy of PTC.*

Even that has started to change, with companies in the industrial machinery space coming face-to-face with demand for increasingly smarter and highly configurable products.

"Companies in this sector have reached an inflection point, where they need to look at their engineering processes and determine how to manage the entire process in a manner that's not as disconnected as it today," explains Rahul Garg, senior director, machinery industry for Siemens PLM Software. "They have the mechanical design tools in place — and maybe even



With Aras Innovator, companies can manage MCAD, ECAD and PCB data in the same system. *Image courtesy of Aras.*

the CAD data management tools — but they can now leverage the business value that PLM can provide them."

CIMdata, a consultancy that keeps a finger on the pulse on the PLM market, is already seeing signs that the process is becoming entrenched in the industrial equipment sector. In its most recent annual market analysis, the research company estimated that global spending on collaborative product definition management (what it dubs cPDM and a core component of PLM) in the industrial machinery segment exceeded $1.5 billion in 2010. It's forecasted to grow at an 11% compounded annual growth rate over the next five years.

Software-driven Design Complexity

PLM is finally taking off in this market for a variety of reasons, but by far the biggest one is increasing design complexity, according to Stan Przybylinski, CIMdata's vice president of research. PLM has evolved to help manufacturers deal with much of the complexity beyond pure CAD data management — for example, managing requirements across the functional areas of mechanical, electrical and software, and integrating ECAD and software data as part of a broader, systems engineering-oriented design process.

"Software has grown in importance, but the ability to support the development [of the software systems] and integrate with the other elements of the product is complicated," Przybylinski says. "The tools are really only just now emerging to help people model some of this interaction."

Most of the major PLM vendors have taken steps to address the mechatronics aspects of product design, adding new modules and capabilities for managing the software and elec-

Aras PLM helps Breton handle the complexity around designing custom-configured equipment, including this system used to machine metal and stone. *Image courtesy of Breton S.p.a.*

Breton's industrial machines are use to cut and mill stone, including granite kitchen countertops. *Image courtesy of Breton S.p.a.*

trical components of an engineering effort. PTC, for example, in 2011 acquired MKS, the maker of the Integrity suite of requirements management, software configuration management, and application lifecycle management software. The acquisition and subsequent integration of Integrity and Windchill PLM have resulted in the Systems Requirements and Validation solutions, notes Tom Shoemaker, PTC's vice president of PLM marketing. These deliver traceability across all the functional domains involved in product development, including so-called "smarter" industrial machines that are more reliant on controls, sensors and software to drive their intelligence and automation.

"With the need to be 'smart' comes increased complexity of systems, whether it's material handling or robotics," Shoemaker says. "That means engineers now have to make sure that the mechanical design efforts stay in lockstep with the electrical design, which stays in lockstep with the software design effort, and the whole thing is treated as a collective system."

This notion of systems engineering is certainly nothing new. While leaders in the automotive and aerospace sectors are continually talking up the practice, industrial machine companies have been in the trenches with systems engineering for some time, notes Paul Brown, senior marketing director for Siemens PLM Software.

"Auto and aerospace companies talk about systems engineering, but in machinery, they've been doing systems engineering and no one talks about it," Brown says.

To address the systems engineering requirements of the industrial machinery and other industry sectors, Siemens has released Mechatronics Concept Designer, a platform for machine design. It allows users to trace customer requirements all the way through to a finished design, and enables mechanical, electrical and automation functions to develop and collaborate in parallel.

Thomas Strigl, Ph.D., is helping his clients adopt Mechatronics Concept Designer to connect all the various constituents involved into the design process with one tool. He's CEO of ISILOG, which works with industrial machine companies on production planning.

"It doesn't mean the electrical or automation guys need to work inside of NX or Mechatronics Concept designer, but they can get access to the detailed design to use for testing and developing the right automation," Strigl explains.

The big advantage to this is working as an integrated team, Strigl says. For example, if an additional sensor was required, the mechanical designers could make the hole required to house the sensor in the same design, without having to import and export data or prepare models for testing.

The Configuration Challenge

While software is raising the bar on design complexity, so is the need for custom configuration. Most industrial equipment manufacturers build special-purpose machines that are highly configured for specific plant environments. Rather than start each product design from scratch, companies in this space are striving to create an internal catalog of standard parts modules, which can then be reused and reconfigured to meet an individual customer's specification, explains Peter Schroer, president of PLM maker Aras.

"They try to have a standard catalog, but what they are really shipping out the back door is different every time," he explains. Without a full PLM system to manage the product data, there can be real problems when years later, a customer wants a second, identical machine, but the design has changed or there are new suppliers for key parts. "The customer doesn't want something new; they want something exactly the same because it's predictable," Schroer says. "It's a very difficult problem for most PDM systems to solve."

Aras PLM has been architected with complex processes and BOMs in mind, Schroer says. The system employs technology for building a BOM by customer order, aiding in custom configuration, and Aras is invested in adding more application lifecycle management functionality to the PLM platform to address the rising software requirements, he says.

Claudio Saurin, product development director at Breton S.p.a., an Italian company that manufactures industrial equipment for machining stone, says his company has been able to streamline its design processes, removing waste and shrinking development cycles, via its use of Aras PLM. Previously, the company used a collection of systems to manage the product data, which was far less efficient, he explains.

"We would have a set of documentation comprised of drawings stored in a PDM system, documents in a file system, email in an email system, and our BOM data stored in SAP so the system was not holistic," Saurin says. "It was a very demanding effort."

While PLM technology provides the platform on which to integrate all the design data, it's really more about process change and getting engineers to adapt to cross-functional integrated workflows. Today, most mechanical engineers are using CAD to model what's relevant to their part of the project, but they need to change their mindset to do work that could be useful to the electrical engineering department or the software group and vice versa, Strigl says. So, for example, if they're modeling an axis, they should be looking at the kinematics definition of the machine.

"That's not often done by the mechanical team, and that's the challenge," Strigl concludes. "It means reorganizing processes and taking on a bit more." **DE**

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➜ **Breton S.p.a.:** Breton.it

➜ **CIMdata:** CIMdata.com

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➜ **PTC:** PTC.com

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Visualization Confronts the Digital Data Monster

System-level simulation awakens the specter of big data.

BY KENNETH WONG

A rendering of Escape Dynamics' concept design for a launch vehicle. The company aims to develop the first single-stage-to-orbit reusable vehicle. *Image courtesy of Escape Dynamics.*

How big is the problem of big data in simulation? I posed that question to Sanjay Angadi, a senior product manager of ANSYS. He replied, "I've heard people say, 'Every time I open a large model, I should go make coffee.' Others joke, 'I'll click Open on Friday and come back on Monday.'"

The problem is especially prevalent in aerospace. Colorado-based Escape Dynamics aspires to develop the first single-stage-to-orbit reusable vehicle. Dmitriy Tseliakhovich, Ph.D., the company's co-founder, CEO and CTO, explains that the big data in aerospace "often corresponds to large number of degrees of freedom and large number of system components that need to be simulated and optimized. This leads to a demand for a large number of simulation runs and the ability to analyze, store and share data."

One way to bypass the problem is to tackle your design in piecemeal, to analyze it at the more manageable subassembly or part level. For a time, that was a perfectly legitimate solution. But more recently, manufacturers have begun to consider system-level simulation — even more ambitious than mechatronics in scope and scale — as the ideal approach.

Leo Kilfoy, MSC Software's general manager for engineering lifecycle management, observes that nearly all aerospace original equipment manufacturers (OEMs) practice system-level simulation. But because of the typical level of complexity in any aerospace vehicle, he says, "it is impossible to build such a vehicle without system-level simulation."

The new approach advocates the treatment of all related parts as a whole. Therefore, it forces engineers to once more confront the digital data monster. How do you load, display, share and collaborate on gigabytes of simulation results — preferably without involuntary coffee breaks? It's a conundrum that some are solving with a mix of remote visualization, lightweight file formats, and cloud streaming.

HPC is the Visualization Engine

"Before you can look at the results, even getting the model into the simulation program is a huge hurdle," notes David Vaughn, vice president of worldwide marketing at simulation software maker CD-adapco. "That's where the simulation software's secret sauce — in STAR-CCM+'s case, the meshing and surface-wrapping methods — makes a difference." (*Editor's Note: For more, read "The Ongoing Quest to Cure CAD-to-CAE Data Exchange Headache," December 2013.*)

In post-processing, Vaughn says, both employing a client-server architecture and enabling the use of distributed parallel processing improve display performance. For viewing simulation results, CD-adapco offers STAR-VIEW+, a free desktop application that lets you view and interact with simulation results.

With large data sets, the general practice is to keep the data in the cloud (private or public), then let users access it through the CAE program itself or a free viewer like STAR-CCM+ client. This method offers the advantage of high-performance computing (HPC)

— usually far superior to a typical desktop. The visuals, therefore, can be rendered on the back end before they're transmitted to the client app for display.

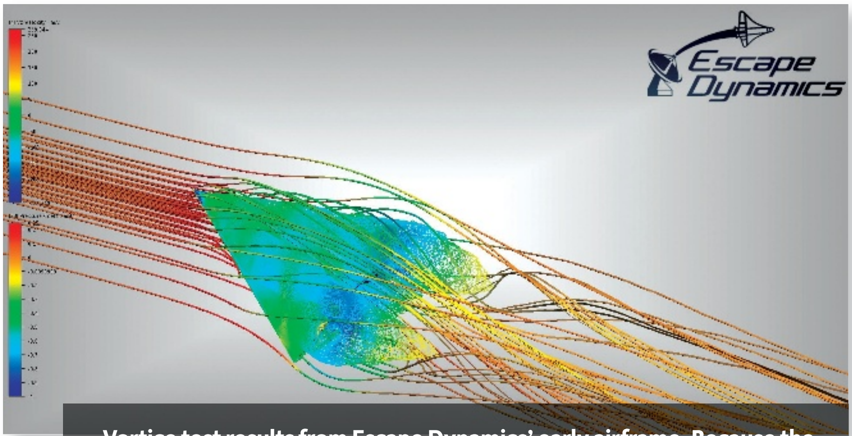
"A good example is visualizing the streamlines," says Vaughn, referring to the indication of the flow direction of heat, air or fluid. Although the solver has done its calculation to simulate the scenario, "there's still a numerical process required to display the streamlines with all the densities and pressures," he adds. "It's helpful to do that on the more powerful servers with distributed memory."

Escape Dynamics uses Autodesk Simulation CFD and Simulation Mechanical to design and optimize the airframe of the vehicle, the engine and many other subsystems. "These tasks involve multiple people," says Tseliakhovich. "We use a wide range of data visualization tools to analyze the results of virtual wind tunnel simulations, and benefited significantly from the new features of Autodesk Simulation CFD. The ability to visualize forces, pressure volumes, iso-surfaces and flow lines is exceptionally useful in the design process."

Because the airframe is expected to house multiple subsystems inside (avionics, payloads, engine, etc.), small changes in the shape of the airframe have an impact on every other subsystem. For visualization, "the ideal scenario would be to enable continuous iteration and optimization process when the designer can evaluate changes across the entire system," Tseliakhovich says. "This would clearly require both server-side simulations and server-side rendering of the resulting data."

Keep the Data Where It's Produced

ANSYS' Angadi noticed that the most advanced customers sought relief from big data problems through a mixture of lightweight data formats, provisioning powerful CAE desktops dedicated for CAE/computational fluid dynamics (CFD), and remote desktop clients.



Vortice test results from Escape Dynamics' early airframe. Because the airframe is expected to house multiple subsystems inside (avionics, payloads, engine, etc.), small changes in its shape can have an impact on every other subsystem. ***Image courtesy of Escape Dynamics.***

Each has its own drawbacks — so a blend of the three, he says, seems to be the right approach.

"By definition, lightweight data is meant to be a supplement to post-processing tools, not a replacement," he continues. "Today, lightweight formats work well for remote interactive interrogation of surface data, but large-volume data (CFD) still poses some challenges. With file transfer, the challenge is to minimize the bandwidth requirements. With remote desktops, we discovered that anything more than a hundredth millisecond's delay could be bothersome to users."

According to Angadi, customers prefer to keep the data where it's produced: on the HPC server. Keeping the simulation results physically close to the processors also cuts down on the data traffic. Advanced simulation and analysis programs are usually designed for client-server setup. Therefore, handling post-processing graphics on the HPC server offers similar advantages in visualizing the results. For those who need to view simulation results remotely, ANSYS offers integration to a lightweight viewer from VCollab as part of its collaborative simulation toolset.

Phillip Greene, SIMULIA's R&D director for simulation visualization applications, notes that his firm's Multi-Physics Results application, built on the 3DEXPERIENCE platform, utilizes a client-server architecture. "This architecture enables the data processing to be achieved in parallel, and the processing can be performed within the compute environment, where the large-result files are produced and reside," he explains. "Performing data processing on the compute server negates any requirement to copy or move datasets to be accessible for visualization."

With this approach, Greene points out, the software's ability to deliver reasonable performance on slow networks is an advantage. The app accomplishes this by "only sending the necessary data to update the display, and to perform graphics manipulations on the local client," according to Greene.

PLM-integrated Viewer

In 2010, PTC decided to break up its all-encompassing Pro/ENGINEER into smaller, modular programs branded as PTC Creo apps. In its current lineup, PTC Creo View serves as the company's offering for enterprise-wide 3D data viewer.

"Today, you can publish simulation results [from PTC Creo Simulate] in the PTC Creo format and distribute it to the company," reports Brian Thompson, PTC's vice president of product management, CAD segment. But companies are liable to use and manage simulation results produced in a variety of programs, including some from PTC's rivals.

Julie Blake, PTC's corporate communications manager for North America, clarifies: "Simulation data files are proprietary for each simulation application. However, simulation results can be saved in standard file formats. If Windchill users are storing the simulation results in Windchill, they should be viewable with Creo View without any conversion. Storing the results in Windchill is a much more common use case, given the very large size of the data files."

PTC Creo View is usually used for interacting with 3D CAD models without installing the authoring CAD programs. According to PTC, Creo View can handle massive assemblies, such as ships, airplanes or automobiles. It has proven itself with customer datasets with millions of polygons, and can handle up to 1 billion in interactive mode with good performance.

For manufacturers who use PTC Windchill to manage their engineering data, Creo View offers tight integration with the data-management system. The viewer is available as a desktop program, browser-based app or mobile app.

Subsystem View vs. System View

In aerospace, users prefer to have the option to visualize the entire system. But that doesn't necessarily mean it's something routinely done. By definition, system-level visuals involve too much data. If an engineer is trying to troubleshoot something in an analysis program, he or she will most likely analyze only the subcomponents that contribute to the problem. For example, electrical wiring information can safely be omitted when doing an airflow study of the outer surface.

"What I can tell you, based on what I've seen is, customers use many different methodologies based on the analysis type," says ANSYS' Angadi.

"Common global and local modeling approaches include modeling subsections and substructures. But even so, at the subsystem level, the visualization challenges for post-processing and pre-processing are significant."

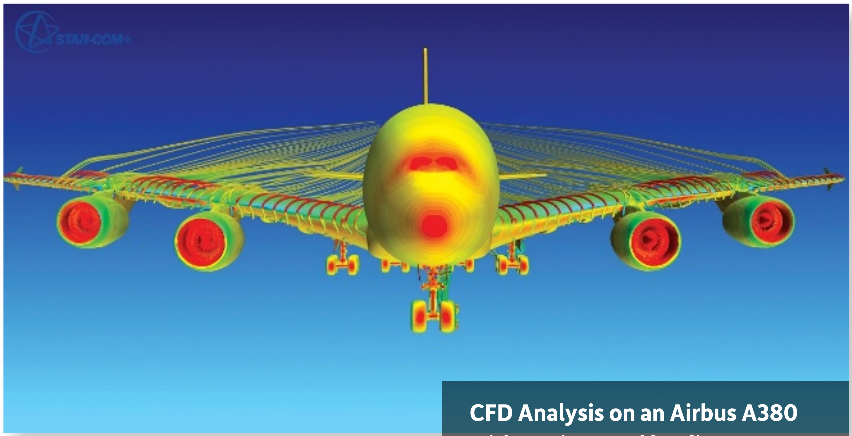
Although a system-level view is not always required, it's important that engineers are able to see how different input parameters are related to the subsystem under study. Escape Dynamics' Tseliakhovich offers this example: "A change in wing geometry might cause a significant change in mechanical stresses experienced by the airframe. This is where large-scale multiphysics simulations and the ability to do server-side data management would be extremely helpful."

CD-adapco's Vaughn notes that generally speaking, however, "you need to have a tightly integrated organization to do" system-level simulation. Even among many Tier I suppliers and leading aerospace manufacturers, "tightly integrated" remains a work in progress or a vision to strive for — not yet a reality.

True Cloud Apps for Mass Consumption

Storing large data sets on engineers' local machines is hardly an option, and most CAE code's client-server setup demands cloud integration. But whether you choose private cloud (essentially an internal server or intranet) or public cloud (such as Amazon Web Services) may depend upon your firm's size and IT capacity.

"Larger organizations typically have the infrastructure in place to fully support their software and hardware installations, and the desire to maintain full control of their data," explains SIMULIA's Greene. "Smaller organizations can see the benefits of a public cloud, which can provide access to extensive compute resources and can provide excellent configuration control to assure that their software solutions are running in an optimal fashion." The Multi-Physics Results app is available for both public or private cloud deployment.



CFD Analysis on an Airbus A380 with engines and landing gear.

For engineers and designers already equipped with powerful desktops and advanced CAE software, visualizing CAE simulation results is well within their capacity. But the desire to share these results with non-engineers in collaborative projects — for example, sharing the heat-flow results of an aircraft model with public relations and marketing teams — demands lightweight viewers that can be installed on mobile devices and consumer PCs.

"Our ideal situation would be to keep the data in the cloud in a compressed format, and be able to give access to the data to the engineers who need it," says Escape Dynamics' Tseliakhovich. "Today, this functionality is limited, but with the work currently pursued by Autodesk, this challenge is going to be addressed in the very near future."

MSC Software's Kilfoy points out that SimManager, his company's simulation process and data management system, employs multiple approaches for sharing engineering data in a secure collaborative environment: Web-based dashboards that provide the ability to drill down to specific information; rich-3D lightweight models, CAE results viewing, and post-processing viewable in a browser; and a strong application programming interface (API) to support access from client applications, including mobile devices.

If such a solution is not available, project team members may have to rely on JPG screenshots, 3D PDFs and AVI clips to communicate their findings. These media help to a point, but offer no interactivity. You won't, for instance, be able to choose different types of stress results from a dropdown window in a movie file, or rotate a still image to inspect the results from another angle.

Because the tendency to host the source files and outcomes of simulation in the cloud (private and public) is already well-established, a cloud-hosted simulation data viewing and sharing solution seems like the most convenient approach. And as SIMULIA's Greene points out, Software-as-a-Service (SaaS) is relatively easy to use, "with a user interface targeting the non-experts and literally no maintenance by the end users." **DE**

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

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Improve Interoperability

The Global Product Data Interoperability Summit aims to drive standards adoption in aerospace, automotive and other industries.

BY RANDY FRANK

With a theme of "Enabling Productivity with Common Data Streams," the Global Product Data Interoperability Summit (GPDIS) 2013 focused on data exchange tools, manufacturing and quality systems, data exchange/product lifecycle management (PLM), and service-oriented architecture (SOA)/cloud. A sample or two from each track provides an idea of the changes that are occurring in these areas.

PLM Interoperability

In late 2012, Siemens' JT data format was accepted as the first International Organization for Standardization (ISO) international standard for viewing and sharing lightweight 3D product information. Explained in ISO IS14306, the format provides corporations and software vendors the ability to leverage JT in PLM workflow and software applications. In his presentation, "PLM at ATK," Jon Jarrett, a director at ATK, shared the success ATK has experienced with the new standard.

"Using JT as an exchange mechanism has been a big differentiator for us," he says. Jarrett explains that the JT format delivery has been preferred when working with customers in space, defense and commercial applications; it has helped identify standard parts used across corporate organizations and government agencies. (*See Fig. 1.*)

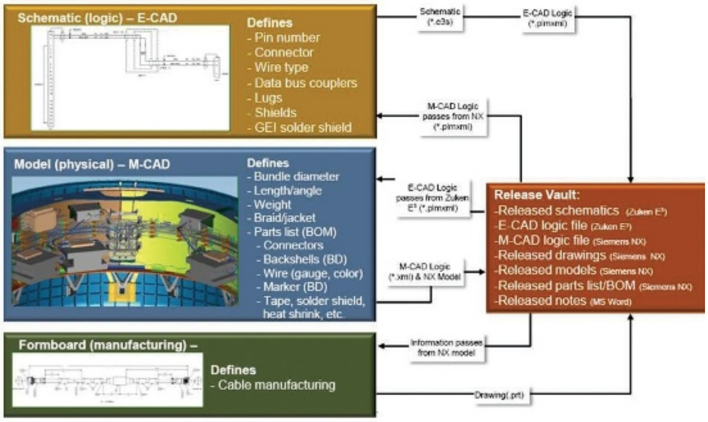


FIG. 1: Logic models in ECAD, physical models in MCAD and manufacturing requirements provide inputs and get information from the release vault.

For example, using 3D models delivered in JT and a standard parts management process, interoperability results from NASA's SLS booster program include:

- requiring almost 16 fewer cable modelers for the selective laser sintering (SLS) booster design;
- reducing the number of designers needed for delivery of the SLS booster model design by about 40% because of reuse; and
- reducing the SLS preliminary design review (PDR) schedule by about nine months.

A New Standard?

Rather than reporting on the success of a recently established standard, Rainer Romatka, Ph.D., of The Boeing Co. wants to establish a new standard. In his presentation "Generic Configuration Management for Engineering Data," he proposes that the industry establish an "Industry Standard for a Federated, Generic Configuration Management (FGCM)." (*See Fig. 2.*)

With a goal of storing, exchanging, integrating and providing traceability across the infrastructure, data does not have to be changed for export or import with this proposed standard, so that users can establish workflows that span multiple repositories. However, different models, purchasing agreements, different fidelity of the models and other real-world aspects can all lead to variations in the end requirements.

"I don't think we'll ever get to a point where one vendor can provide all the tools that we need for the job," Romatka points out. "They use different types of data representations because the problems are different."

In the system he proposes, one model needs to know the impact of a change in another model that is related to the change requiring extensive tracking capability. To accomplish this, the configuration management system needs to know the structure of the data a user wants to store in it.

When implemented, the FGCM would provide repository access through a standards-based interface, as well as interoperability of implementations by different vendors.

Data Exchange Standards for Interoperability

Because digital data is used in many different ways throughout a business in a product's lifecycle, the transition to a standardized model-centric approach for structured digital data is required.

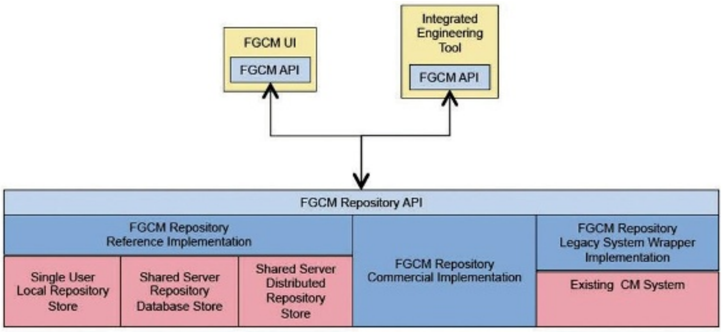


FIG. 2:The FGCM architecture includes an application programming interface for a user interface (UI) and integrated engineering tool.

Rick Zuray, technical principal at The Boeing Co., addressed these issues in "LOTAR: Managing a Model-based Enterprise."

The ease of storing digital data has created new challenges and increased complexity for data that needs to be archived. Length of storage, data ownership and operational requirements on the system are a few key aspects driven by information requirements, as are business results; repository retention period, format and processes; and systems in the enterprise.

The standards-based solution is Long-term Archiving and Retrieval (LOTAR), established in January 2003 by the LOTAR International Consortium. The working group is sponsored under a hosting organization consisting of the Aerospace Industries Association (AIA), PDES Inc., Aerospace & Defense Industries of Europe – Standardization (ASD-STAN) and ProSTEP iViP. (*See Fig. 3.*)

Using the data in one form and storing it in another format is a simplified way to describe LOTAR. With the goal of a standard by this month, suppliers participating in the ISO and LOTAR teams have made significant contributions to the process — providing ideas and critiques as the specs are developed.

"We've found that it's easier to get a standard out faster that way, if you get the vendors involved more up front instead of getting a standard out there and saying 'You need to support this,'" says Zuray.

Suppliers start working on implementation before the standard is finalized to demonstrate feasibility; they can propose alternatives if some aspects are problematic.

Data Exchange Tools for Interoperability

In his presentation "Multi-user Interoperable CAx Tools," C. Greg Jensen, Ph.D., from Brigham Young University (BYU), explained how BYU-developed multi-user adaptations of NX and CATIA, called NX Connect and CATIA Connect, allow multiple designers to simultaneously contribute to the same part or assembly model.

"The design process does not really have to be serial," explains Jensen. A side-by-side comparison with students collaborating vs. a single student working alone yielded about a two-thirds reduction in required time for a simulated project. This can translate into a time savings of weeks, or even months in a real program — and get a product to market much sooner.

With impressive results from his efforts, Jensen says he is looking forward to the next phases of research. Working with a consortium of prime defense contractors, BYU plans on developing a CAx application- and data-neutral architecture for use in multi-user CAx.

Global organizations communicate using English as a common language. "They all speak English, but not the same English," observes Roland Maranzana, Ph.D., of 3DSemantix. As a result, he says, a text-based description can have many different meanings.

In his presentation, "3D Mining for Part and Information Reuse in a PLM Context," Maranzana proposes to address the limitations and problems with traditional text-based searches with a 3D-based search engine for engineering. With this approach, mechanical components can be visually searched with 3DSemantix 3DPartFinder.

For CAD systems, 3DPartFinder V4 can be used with: CATIA V5, NX 7 or 8, PTC Pro-E and Creo, SolidWorks 2012-2014, Autodesk Inventor 2013-2014, and Solid Edge ST4, ST5.

PLM In-depth

Although one may think of interoperability as making sense only for large companies, small companies can still derive several benefits from the concept. John Loo of VMH International (VMHI) addressed this opportunity in his presentation, "The Potential Impact of Cloud-based PLM on Small Supplier Quality Process."

Loo notes that while small suppliers have faster response, less overhead and more flexibility on pricing, they are often challenged by capital/cash flow constraints, capacity constraints and infrastructure issues. Cloud computing with virtual machines (VMs) — and the ability to add and delete resources as required — makes it an attractive tool that can provide a solution, including software-as-a-service (SaaS).

Loo states that cloud-based PLM offers small companies many advantages, including:

- paying only for what you use, when you use it;
- tracking costs at a granular level;
- reducing staffing and facility costs; and
- expanding easily.

As a CAD/CAM/PLM software value-added reseller, focused on small and medium-sized business, VMHI developed a cloud computing architecture with client platforms, including browser-based and thick clients. It also offers integrations with: Siemens CAD (NX 8, 8.5; SolidEdge ST5), Teamcenter Visualization tools, Microsoft Office, and Cortona 3D.

Applied across different business applications, Loo says the results include excellent reliability and VM performance with very good network performance — "all things considered."

"Cloud-based PLM obviously is not a panacea," Loo quips, adding that it does, however, offer advantages to small business and others. These include:

- The option of implementing PLM at a reduced cost.

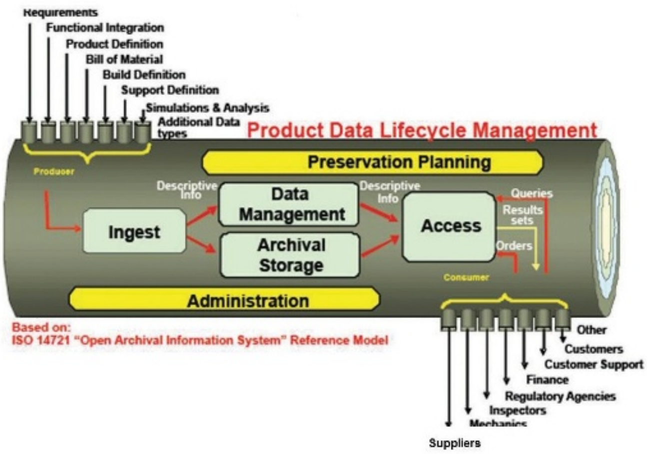


FIG. 3: The LOTAR data management pipeline receives various inputs from a producer—and outputs from a customer.

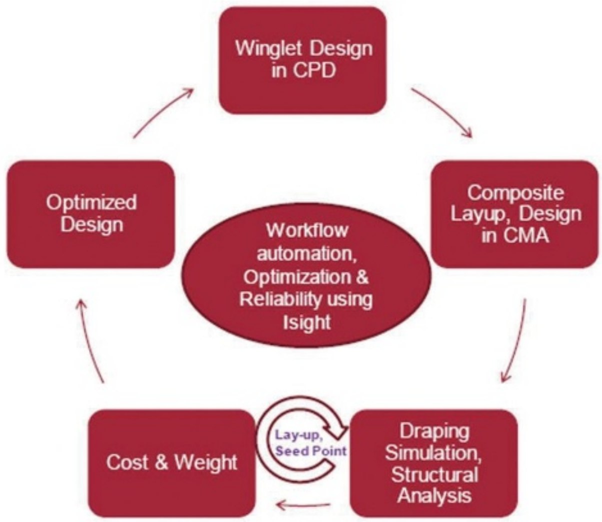


FIG. 4: The composite workflow analysis uses Isight for workflow automation, optimization and reliability.

• The potential for more SaaS offerings and reduced pricing, thanks to competition and technology advances.

To obtain these advantages, successful PLM implementations still require careful planning, allocation of sufficient resources, and management support, he says.

Data Exchange/PLM

Composite materials allow designers to achieve considerable design improvements, but they require more thorough analysis than traditional materials. In their presentation "Achieve a Robust and Manufacturable Composite Design," Mahesh Turaga, Ph.D., and Bill Brothers from Dassault Systèmes used a bent wing design for an airplane to show how analysis of 74,613 variable possibilities for analysis could be reduced and managed.

Using a variety of seed points, the point of first application point for a composite ply, the analysis employed gradient, direct and exploratory techniques with cost and weight comparisons to determine the acceptable reliable, robust design. Alternative drapings, the process of applying a flat sheet material to a mold surface, were part of the analysis.

The analysis used Dassault's Isight in an integrated process that automatically drives variables across tools and manages results. The evaluation involved the exchange of data through five separate data management software segments. *(See Fig. 4.)*

The base design used 16 plies, took two weeks to achieve and had a deflection of 5.9 in. vs. a design goal of less than 5 in. and max strain of 30.9 lb., versus a design goal of less than 30 lb. In contrast, the optimized design used 10 plies, took about 2 minutes and delivered deflection of 4.1 in. and max strain of 26.8 lb. — meeting design goals in these areas and others.

The final presentation in the Data Exchange/PLM track was "Collaborate to Innovate with Engineering Virtual Desktop Infrastructure (eVDI)." Nicholas Holian and Rob Link of Hewlett-Packard showed how to address today's issue of achieving security, speed of design from idea to manufacturing, and collaboration across an expansive ecosystem — all while overcoming obstacles that appeared within the last 15 years.

HP engineers had the goal of creating a centralized engineering environment, "putting all the pieces of product development engineering into a single ecosystem, and they are all interconnected together," explains Holian.

The solution, evaluated in HP ecosystem, used a centralized engineering environment and several services. The result, eVDI, is a globally accessible information platform for engineering virtualized 3D visualization. **DE**

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

INFO ➜ ***Presentations are accessible without requiring a password at*** GPDISonline.com/schedule.html

➜ **3DSemantix:** 3DPartFinder.com

➜ **Aerospace & Defense Industries of Europe – Standardization:** ASD-Europe.org

➜ **Aerospace Industries Association:** AIA-Aerospace.org

➜ **ATK:** ATK.com

➜ **The Boeing Co.:** Boening.com

➜ **Brigham Young University:** BYU.edu

➜ **Dassault Systèmes:** 3DS.com

➜ **Hewlett-Packard:** HP.com

➜ **LOTAR International Consortium:** LOTAR-International.org

➜ **PDES Inc.:** PDESInc.com

➜ **ProSTEP iViP:** ProSTEP.org

➜ **Siemens:** Siemens.com

➜ **VMH International:** VMHInternational.com

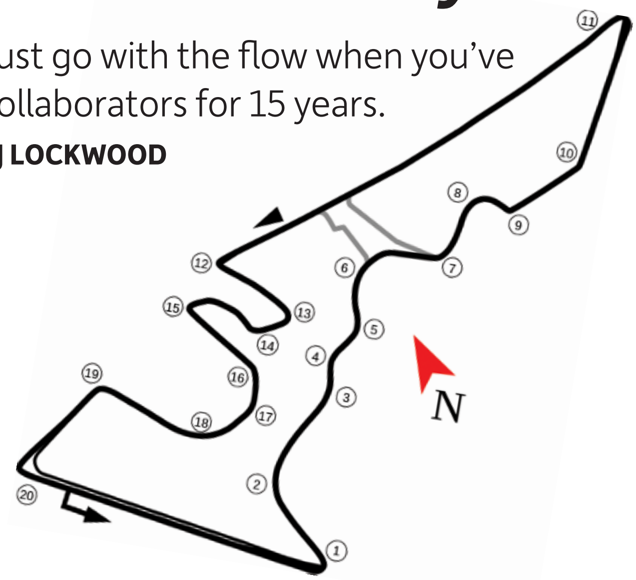
CFD Helps AF Corse *Cruise to Victory*

You never just go with the flow when you've been fast collaborators for 15 years.

BY ANTHONY J LOCKWOOD

Auto racing R&D never stops. From each physical experience, you learn something that will help you improve your design for the next season, and the seasons after that. Deadlines are tight. You need to go with a design straight to a physical event. And that means your simulations must be as fast, accurate and true to your target as possible.

I recently had a chat with two engineers from the Italian racing team AF Corse, a Ferrari Corse Clienti (client racing) partner. These guys work on improving the durability of Ferrari's GT racecars. Simulation serves a vital role in their efforts. Or, as one of the engineers put it, they simulate the car's systems as much as possible because it gives them the power to act on a problem immediately.



The track at Circuit of The Americas has some nasty curves. ***Image created by Francesco Betti Sorbelli and courtesy of Creative Commons.***

Performance for Endurance

GT, from the Italian meaning gran turismo (grand tourer), racecars are performance or luxury cars, usually coupes. They're tweaked to be very fast, and are able to maintain their performance over long distances. I met the AF Corse engineers in the paddock at Circuit of The Americas in Austin, TX, during a break in their preparations for the fifth round of the Fédération Internationale de l'Automobile World Endurance Championship (FIA WEC) championship series. Austin was the U.S. stop in this series of 6-hour endurance races, held worldwide.

Circuit of The Americas is a new, multipurpose race complex that can handle all classes of racing, including the Formula 1 United States Grand Prix. It is the first purpose-built Grand Prix facility in the U.S. Its 3.4-mile circuit track has four straightaways, 20 curves, and a 133-ft. elevation change.

Ferrari uses a variety of ANSYS computational fluid dynamics (CFD) and finite element analysis (FEA) tools for jobs ranging from suspension systems to brake cooling systems and full-body dynamics. Ferrari doesn't talk much about how it uses ANSYS software, since they consider it to be a strategic tool used for proprietary work. It was, however, mentioned during the course of our conversation that ANSYS FEA helped engineers optimize a part in Ferrari's rear suspension system. The part had been cracking in less than 6,000 km of use. With its new ANSYS optimization, the part has now been running for more than 10,000 km — with no sign of cracking yet.

AF Corse uses ANSYS to fine-tune the designs it gets from Ferrari. Three key assignments and one key need of ANSYS CFD were the subjects of our discussion:

1. Predict the down force on the car to ensure it will stick on the road when negotiating curves at racing speeds.
2. Design and optimize the brake cooling system.
3. Optimize the design of the side mirrors.
4. Do it quickly.

Going with the Flow

The brake cooling and side mirror design optimization jobs are tightly related, almost inseparable. Both projects had been ongoing for 10 years, according to the AF Corse engineers.

The brake cooling system assembly is a highly complex device. It consists of a pair of parallel air intakes and outtakes, front and rear, on both sides of the car. The basic idea is to scoop air from the outside, funnel it around the brakes for cooling, and direct it out and away from the car — all without interfering with the downward force or messing up the aerodynamic flows around the car.

This sounds simple enough, if you don't have to design it. Now add in the complication that the Ferrari has a rear-mounted engine. As originally designed, the airflow around the side-view mirrors interfered with engine cooling and misshaped the car's aerodynamic form.

Using ANSYS CFD software, AF Corse engineers were able to optimize the car's side-view mirrors so that they maintained the car's aerodynamic form without disturbing the airflow supplying the rear engine, yet still feeding diverted air into the rear brake cooling inlets.

But that was even less simple than it sounds.

The brake cooling system job, coupled with the side-view mirror redesign and analysis, turned out to be a vast, computationally intensive multiphysics (MP) analysis undertaking. The key to turning the page on this 10-year-old project was that ANSYS CFD solutions such as Fluent, as well as other ANSYS software, are inherently high-performance computing (HPC)-ready.

HPC provided the engineers with the raw horsepower they needed to fully use ANSYS, and parallel processing to explore quickly and solve accurately hundreds of possible cooling system designs without comprising meshes or details. That meant that the engineers were able to analyze the front and rear brake cooling systems and the side-view mirrors, both as individual subsystems and as constituent components within the entire brake cooling assembly. The level of design detail they leveraged could not have been achieved with a typical engineering workstation and still earn the tag "quickly."

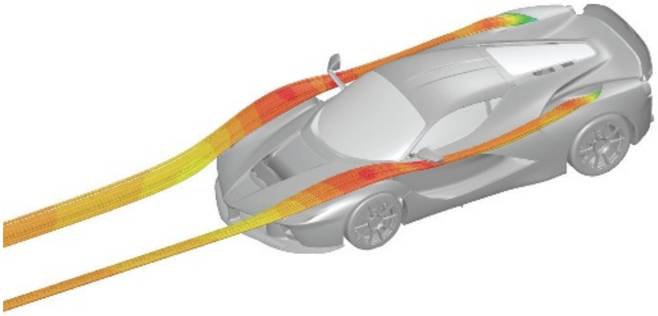
Fast Collaborators

Ferrari has worked with ANSYS CFD and FEA solutions to optimize key components of its GT category racecars for more than 15 years. In that time, ANSYS has become an official Ferrari GT Championships Sponsor Partner. It's a mutually beneficial relationship. Ferrari provides feedback and suggestions for functions they need, and ANSYS develops the code. Eventually, these new features and functions work their way to ANSYS users.

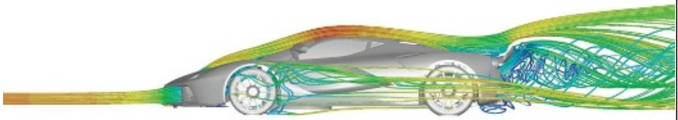
In a sense, the physical tests that validate all of the AF Corse simulations happen on the track. So, I asked one of the engineers how the ANSYS-Ferrari relationship was really working out for them. He responded that "the more you use these tools, the more you want to use them."

The results make it obvious to see why: AF Corse Ferrari 458 Italia #51, already the champs in the FIA WEC (GTE Pro category) series, took the 2013 series lead in Austin — and went on to be the threepeat champs with a win in Bahrain in December. **DE**

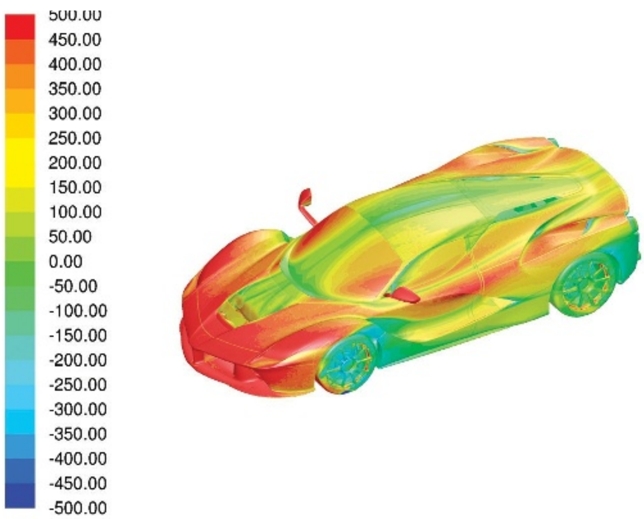
Anthony J. Lockwood *is Editor-at-Large for* Desktop Engineering. *He may be contacted via DE-Editors@deskeng.com. Editor's note: ANSYS Corp. paid for Tony Lockwood's hotel room in Austin for his meeting with AF Corse engineers. Desktop Engineering covered all other expenses. No additional considerations were offered by ANSYS, and ANSYS did not attempt to influence the content of this article.*



Pathlines show the predicted airflow around the Ferrari's side-view mirrors being directed into the rear brake cooling system. *Image courtesy of ANSYS Corp.*



An ANSYS simulation of the airflow around the left side of the Ferrari 458 Italia #51 GT racecar. *Image courtesy of ANSYS Corp.*



A view of the total surface pressure. *Image courtesy of ANSYS Corp.*

INFO → AF Corse: AFCorse.it

→ **ANSYS Corp.:** ANSYS.com

→ **Circuit of The Americas:** CircuitOfTheAmericas.com

→ **Fédération Internationale de l'Automobile World Endurance Championship:** FIAWEC.com

→ **Ferrari Corse Clienti Division:** CorseClienti.Ferrari.com

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PART 1

Accuracy and Checking in FEA

The final accuracy of the results reported in a finite element analysis model depends on many factors. Let's take a look at how errors can occur — and how to avoid them.

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.

In the finite element analysis (FEA) process, checking is done at every stage. Before the analysis even starts, we need to get all our material data, dimensions, masses, loading definitions and other data clearly organized.

Obtaining accurate and validated data can take a surprisingly long time. Start the project report early, and include this information as it becomes available. I have written reports at the last minute, and found the wrong material properties used in the model. There is no choice, then, but to re-run the analysis — with a strong possibility that all results will have changed.

In the pre-processing stage, we mesh the model. We apply loads and boundary conditions, material properties, etc. We can do many checks here. The first check during meshing is to assess element quality; distorted element shapes are our biggest enemy.

What do we mean by "quality," and why is this important? In the calculation of the overall structural stiffness, each element is evaluated numerically. The accuracy of the element stiffness — and hence, the accuracy of the whole model — depends on how well this element evaluation is carried out.

Good and poor quality meshes are shown in Fig. 1. We can see by eye that one mesh is inferior, but applying more formal checking is better practice. Fig. 2 shows a typical checking element criterion plot (using aspect ratio), highlighting the poor mesh.

A large number of element checking formats are available. One of the best catch-all methods is element aspect ratio. If this is set to a high number, such as 10, it will trap all of the rogue elements that are often created in a mesh. This includes sliver-type element shapes, or collapsed elements, where the mesher has become confused by poor geometry or tolerance errors. Fig. 3 shows a typical aspect ratio definition of longest over shortest length. A word of caution here: The pre-processor definition may be different from the solver definition, which is the important version.

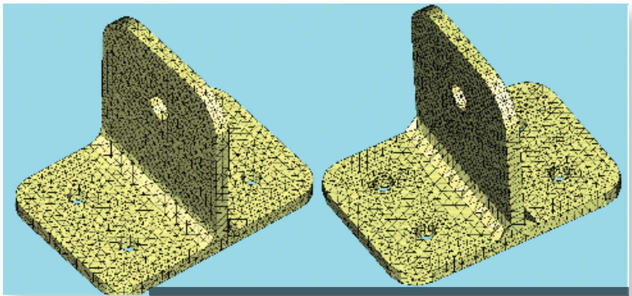

FIG. 1: Good- and poor-quality meshes.

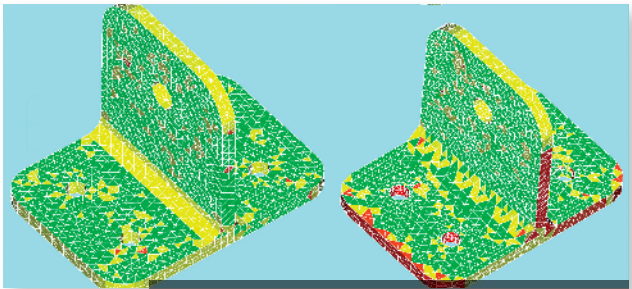

FIG. 2: Element aspect ratio check plots.

General Performance

Once we have removed obviously bad elements, we can check the general performance of the mesher. Many meshers are able to show mesh quality interactively. This is extremely useful, as it helps guide us toward improvements in the mesh. If we are meshing 3D elements, it is important that we are checking the shape of elements in the interior of the geom-

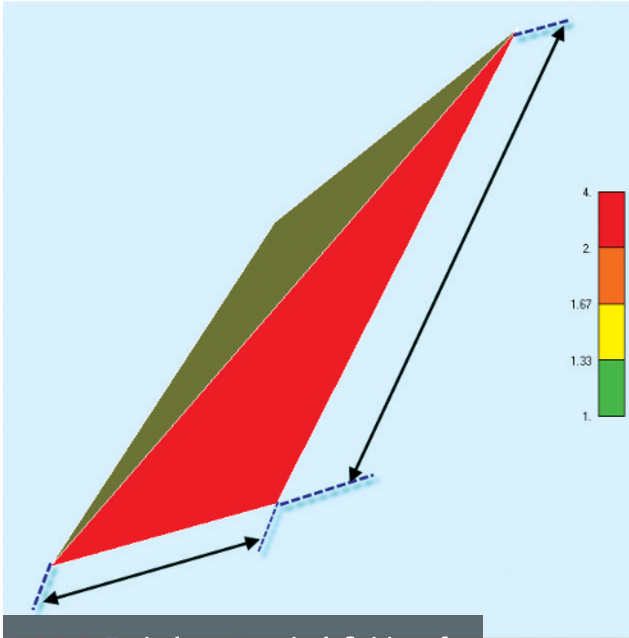

FIG. 3: Typical aspect ratio definition of a 3D tetrahedral element.

etry. Fig. 4 shows a typical case where the mesh looks fine on the outside, but is very poor inside. Splitting the mesh apart visually is the only way to see this.

Some meshers enhance our ability to check inside the mesh by providing a slider bar to control which elements we see. Setting an aspect ratio value will only show elements that are above that threshold. Fig. 5 shows a typical example. Grouping or color-coding these elements are another powerful tool to help us identify and improve the mesh.

Jacobian Calculations

Perhaps the most powerful element checking format is the Jacobian. Unfortunately, it is also the most difficult to interpret and expensive to calculate. Each element forms a Jacobian matrix during the evaluation of its stiffness matrix. This is, therefore, a direct representation of how numerically accurate the element is.

All geometric factors play a part in this. With a large model, the cost of emulating the Jacobian calculations in the preprocessor can become prohibitive.

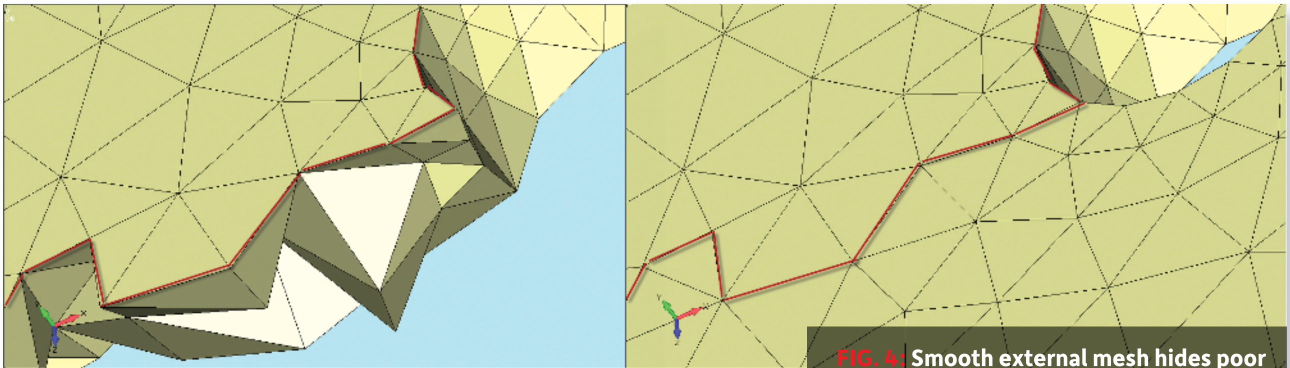

FIG. 4: Smooth external mesh hides poor internal mesh. Split line is shown.

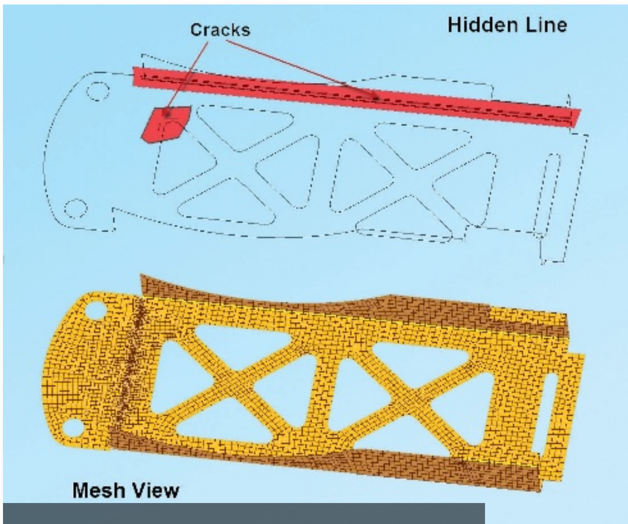

FIG. 5: Highest criteria set on the left, lowest on the right.

It is important to understand that this is an emulation, not the actual solver calculation. You may find controls such as “approximate” or “accurate” calculation options. The evaluation may just use faces of 3D elements. It is important to experiment with controlled mesh distortions to evaluate for yourself just how effective the “approximate” calculations are compared to the resultant analytical values.

The fundamental question is: *What is a good Jacobian value?* Unfortunately, it is not possible to define that in a general sense. The value is definition-, element type-, dimensional- and solver-specific. The best way to approach this, then, is to experiment and calibrate mesh distortions yourself, to build a good baseline. Fig. 6 shows a typical study.

Model Cracks

Cracks in a mesh occur where adjacent elements are not properly connected. Reasons include differences between

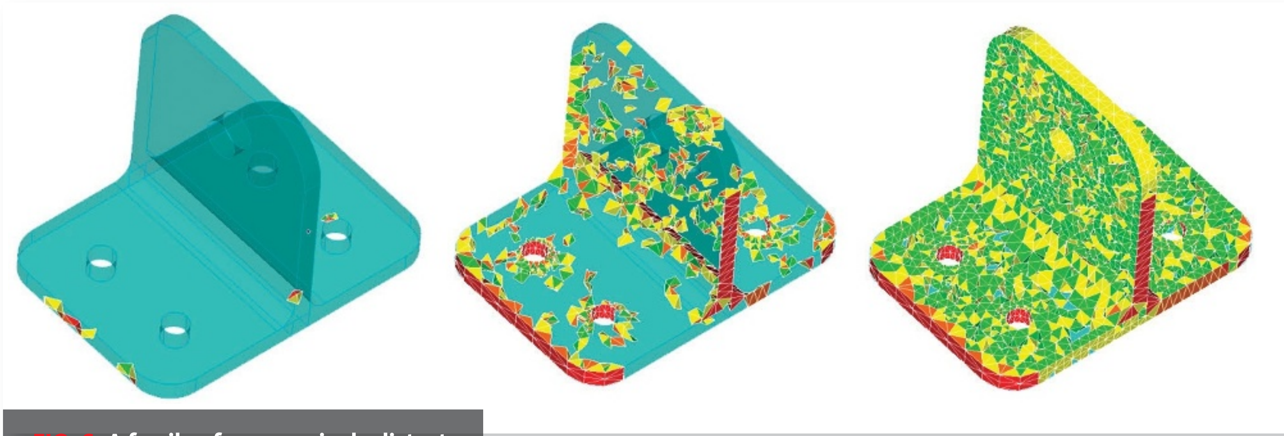

FIG. 6: A family of progressively distorted tetrahedral elements, with Jacobian checks.

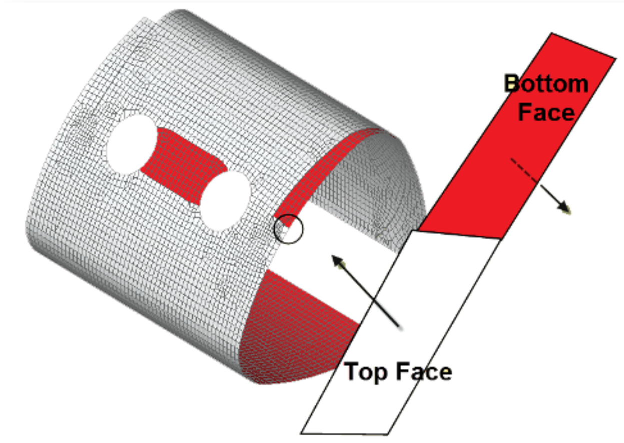

FIG. 7: Full mesh view and free edge hidden line view, showing cracks.

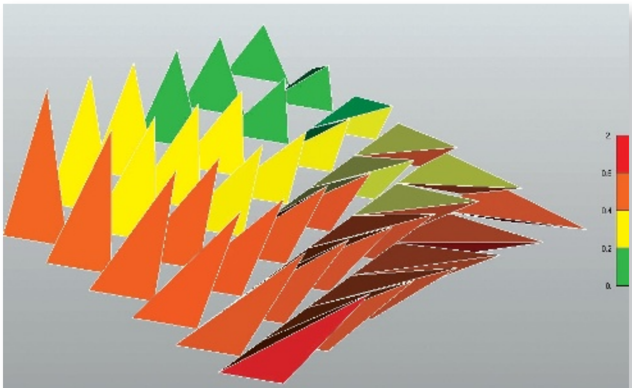

FIG. 8: Element normal with back faces painted red. Notice the errors in pressure load directions.

tolerances in the CAD model and FEA models, and mismatched element mesh densities between adjacent surfaces or volumes. Most meshers will refuse to collapse an element, so awkward junctions of element shapes may resist attempts to join up nodes that are very close to each other.

It is important to preview cracks as the meshing occurs. Most meshes will allow snapping between free edge or free face view and normal view. Fig. 7 shows a typical mesh with a variety of cracks that need to be fixed.

Element Normals

Each 2D element (or face in a 3D element) has a normal or perpendicular direction. The element normal is used to define several important characteristics in the analysis. The most obvious is the direction to apply a pressure load in a 2D element.

A typical convention uses the pressure direction running into the element, against the element normal. This is shown in Fig. 8. The resultant normal for each geometry face is somewhat arbitrary when meshing the typical complex 2D geometry found in a component. If we want to apply consistent pressure loading, it is important to check the sense of the normal — and hence, the pressure load — and if necessary, reverse the sense. We can plot the element normal as a vector, but for a complex model, this ends up looking somewhat like a porcupine!

A better way is to paint the back faces of elements with a distinct color. This is shown in Fig. 8, where pressure loading is clearly shown to be in error and the correction can be made.

The other important use of an element normal in a 2D element is to define the top and bottom surfaces. A bending moment applied to the element will result in tension and compression surface stresses. Consistent element normals are required to get the correct post-processing stress distributions.

Finally, element normals are also used to define offsets, and stacking orientation in composite layups. Mixing up normals will cause random errors in all of these.

Load Balance

It is important to make sure that we have the loading defined correctly. Some loading forms are straightforward, with just a few isolated loads. However, the loading can get quite complex with distributed pressure loading, body inertia loading, etc. In all cases, we want to check the magnitude and resultant line of action of the loading against our specification. We can check visually, using the preprocessor graphics to make sure the distribution of the loading is correct.

Many preprocessors provide a load balance check tool to make sure that we have calibrated the load properly. For example, inaccuracies between geometric area or volume and subsequent mesh area and volume will cause loading errors. We can adjust the loading to match the specification. The definitive check on load balance will occur after the solution, and we will look at that later.

Boundary Conditions

Setting up the correct boundary conditions is also vital for successful analysis. Again, these can be very simple, or complex with local coordinate systems and specific degrees of freedom (DOF) components defined. Throughout 2014 in *DE*, we will look at various advanced checks using supplementary analyses, production analysis and post-processing.

In the preprocessor, we can focus on the graphical representation of the constraints. It is a good idea to thoroughly review the constraints at this stage to make sure that nothing has been missed or applied in error. When using automated setup options such as symmetry, I strongly recommend double-checking that you understand and agree with how these options have been setup. Similarly, local coordinate systems are very powerful to describe realistic constraint systems, but they are also very error-prone, as shown in Fig. 9.

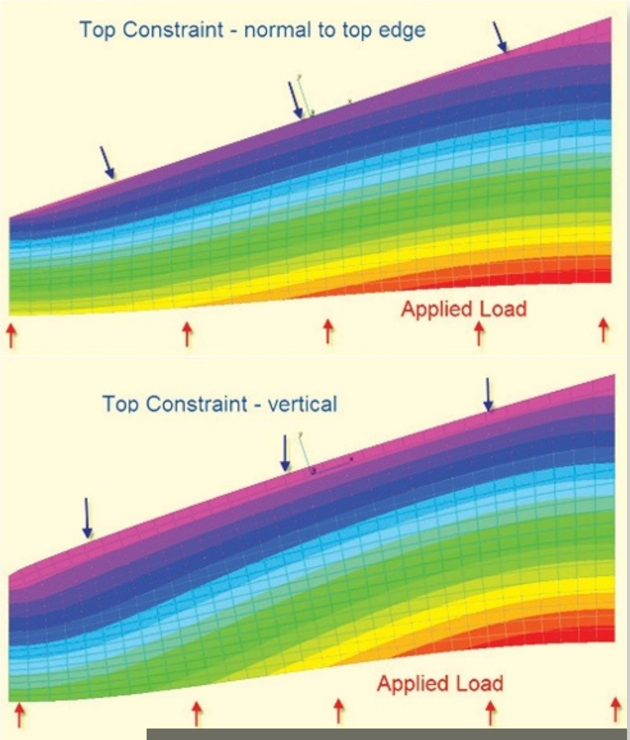

FIG. 9: Constraint is applied in the wrong coordinate system in the lower model.

Physical, Material and Mass Properties

Checking physical properties, such as shell element thickness and beam cross-sections and material operatives, is largely a matter of housekeeping. But again, we usually have a full set of graphical and tabular options in the preprocessor to help us here. Color-coded mesh plots of property and material distribution are an extremely useful checking option — and also good practice to include in the report.

Beam and shell element idealization features, such as cross-section visualization, orientation vectors and offsets can be checked visually in the preprocessor. This is extremely powerful; spare a thought for engineers of 20 years ago who would be staring at a screen full of lines, trying to check these aspects. I always worried about "Friday afternoon models," where human nature meant that the error level was probably quite high!

If we are using mass in an analysis, for static inertia loading or dynamic analysis, it is vital that we check the mass distribution. Again, most preprocessors have great tools to help us check this out before we commit to an analysis. Most components will have mass properties stated in the specification, and we can check against these.

It is important to include the mass moments of inertia as well as the mass. If we are using lumped mass idealizations for components, this becomes very important. A common error is to just include the translational mass.

The physical analogy is a large block of steel on ice, which resists a push at its center gravity. However, if we push on an edge, it will spin rapidly, as it has no rotational inertia resistance.

In FEA, there is a lot of checking to do! However, if a consistent and rigorous approach is taken, it will improve the likelihood of creating accurate models — and will also give checkers and reviewers a great deal of confidence. **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.*

Getting in Gear

Companies are finding innovative ways to deal with the complexity of automotive systems.

BY RANDY FRANK

Massive information transmission, storage and processing, often called big data, starts with more sensor data in control systems. With sensors providing the input, National Instruments (NI) uses the term "Big Analog Data" to describe the changes occurring to control systems.

"We say that it is analog, because the data that we are collecting comes from the physical world and it's going to be all types of different signals," says Stephanie Orci, a product manager and member of NI's Big Analog Data team. Big Analog Data does not, however, mean the data stays in analog form.

"One of the key differentiators between our big data and others is that it has to be digitized in some way," says Orci. "We have to take it and convert it from that analog signal — usually to some digital format that we can read off a computer."

In automobiles, powertrain control is an excellent example of Big Analog Data. Increasing complexity in vehicle engine management systems is more than a cliché. Today's automotive engineers at vehicle original equipment manufacturers (OEMs) and Tier I suppliers have to approach the data collection and validation process differently than they have in the recent past, to deal with the added complexity, tougher regulations and increased customer expectations while continuing to meet deadlines.

Engine management systems have used several sensor inputs and increasingly powerful microcontrollers (MCUs) and digital signal processors (DSPs) to control solenoids, motors, heaters and other actuators to obtain lower emissions and higher fuel economy. With today's regulations — and those that are expected to be required within the next few years — cranking down the emission and fuel consumption increases the challenges to system designers.

No End to Global Regulations

In the U.S., the Corporate Average Fuel Economy (CAFE) requirement for 2016 average fuel efficiency is 35.5 mpg, or roughly 250 grams of carbon dioxide (CO_2) per mile. This level increases to 54.5 mpg by 2025. Other regions of the world specify higher efficiency requirements in terms of grams of CO_2/kilometer. From 2000 to 2025, the U.S. reduction of CO_2 emissions is dramatic, but not as low as other regions (*see Fig. 1*).

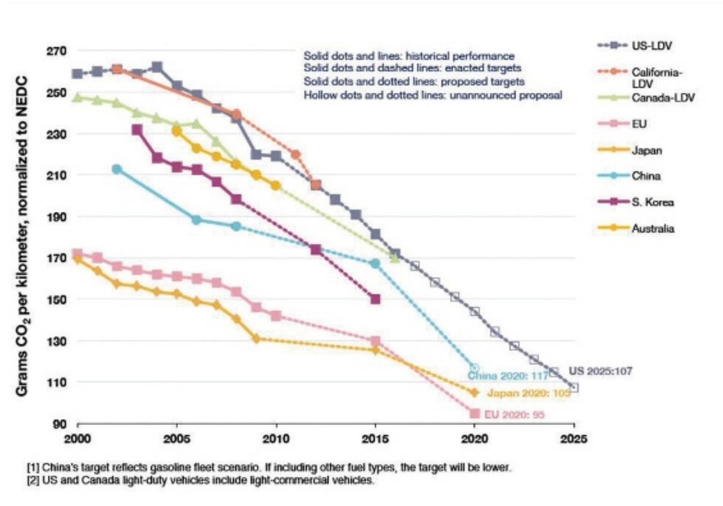

FIG. 1: Historical and current or proposed standards fleet CO_2 emissions performance shows continuous improvement, and indicates the level of increasing complexity required to make these improvements. ***Image courtesy of the International Council of Clean Transportation.***

Traditional improvements to reduce CO_2 by reducing weight, rolling resistance and improving aerodynamic properties can only go so far, however. Electronics in powertrain control provides added capability, to achieve aggressive improvements and reduce the grams of CO_2/mile.

Carmakers Respond

In North America, General Motors has a number of centers that specialize in simulation, modeling and verification technology for powertrain applications, including those in Pontiac, Milford and Warren, MI.

"One specific area we anticipate continuing to grow is simulation, and our efforts to move from Road to Lab to Math (RLM)," says Radu Theyyunni, engineering group manager for powertrain system design and computational fluid dynamics (CFD) analysis at General Motors. "We see our high-speed computing environment increasing in capability and capacity, and terabyte

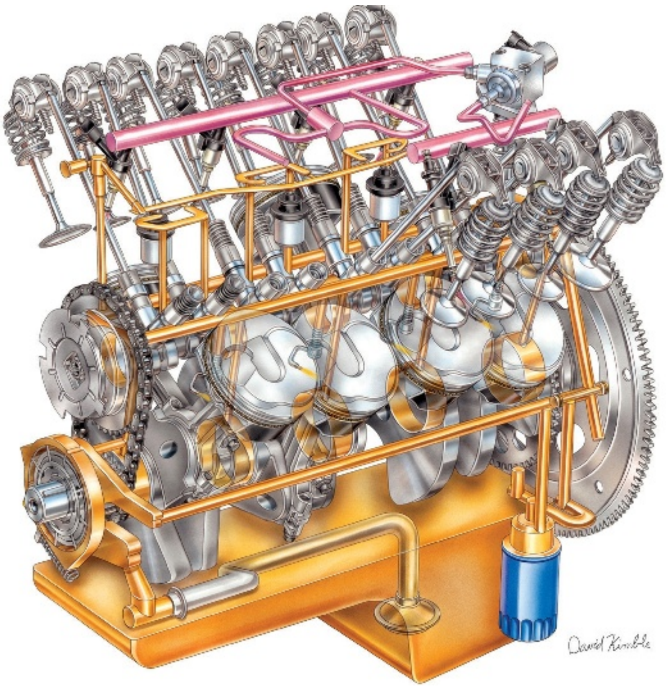

FIG. 2: In GM's 5.3L engine, cylinder deactivation works seamlessly through controlled oil pressure to shut off four of eight cylinders in light load conditions to save customers fuel. This lubrication system operates in conjunction with direct injection and continuously variable valve timing, which are all monitored by an advanced and reliable powertrain control system. *Image courtesy of General Motors.*

data management is something we will need to deal with on an ongoing basis."

GM is handling the increased complexity of data management in a few fundamental ways.

"One key initiative is that more 'technology' and up-integration is occurring to accommodate additional I/O in parallel with reducing packaging space," says Larry Hallman, director of powertrain global controls and software. "GM Powertrain Controls is developing a totally new generation of development tools — build, change, configuration management and variation control — to deal with the increasing complexity of the electronics, controls and software space."

The all-new 5.3L Small Block V-8 lubrication system and fuel system shown in Fig. 2, for example, is used in the Chevrolet Silverado and GMC Sierra pickup trucks. These highly developed systems could not have been created without the state-of-the-art development tools.

Suppliers Respond

New system hardware and/or combinations of hardware require more computing performance, and add significant complexity to powertrain control. Here are just a few of the techniques that are being pursued to reduce emissions and improve fuel economy to meet global regulations:

- internal combustion plus electric power;
- direct injection;
- advanced knock detection, which could include the use of a pressure sensor in each cylinder;
- cylinder deactivation;
- stop/start;
- cylinder-by-cylinder control;
- electrohydraulic instead of mechanical variable valve timing (VVT);
- higher number of gears in automatic transmissions with current-controlled solenoids; and
- dual-clutch transmissions.

To keep vehicles as affordable as possible, only the techniques that are absolutely necessary must be used. Richard Soja, automotive system on a chip (SOC) systems engineer at Freescale Semiconductor, deals with the requirements for these systems at carmakers and Tier I suppliers.

"They are all being used to reduce fuel consumption and improve emissions," he says. "Complexity and cost determine to what extent any feature is implemented."

To cope with any added system requirements, the amount of embedded memory in powertrain processors is continuously increasing.

"It's 8MB flash now, but growing to 16 to 24 in the next decade," Soja predicts, noting that the same situation occurs for the performance of powertrain processors: "It's 300 MHz now, growing to 500 to 1,000 MHz in next decade."

Freescale Semiconductor's recently released Qorivva MPC5777M Power Architecture Microprocessor Control Unit (MCU) is a quad-core device targeting high-end powertrain applications that meets next-generation advanced engine control, functional safety and security requirements. It has 8MB of flash, operates at 300 MHz, and can connect to several vehicle networks. With this capability available today, system designers are embracing advanced tools for development.

"More and more model-based tools are required to model the physics of internal combustion and produce auto-generated code," explains Soja.

Toolmakers Respond

NI tools are used in powertrain research, and its engineers frequently work closely with researchers. A recent project with Oak Ridge National Laboratory (ORNL) exemplifies how these tools are used.

ORNL researchers wanted to experiment with various lean burn catalysts to evaluate their impact on reducing CO_2 emissions. Unlike a traditional gasoline engine control that uses a three-way catalyst, a lean burn strategy is much more complicated.

To determine how the production controller operated, the research team monitored all of the signals going into and out of the controller. For any research effort that occurs outside of an OEM or its electronic control unit (ECU) supplier, this

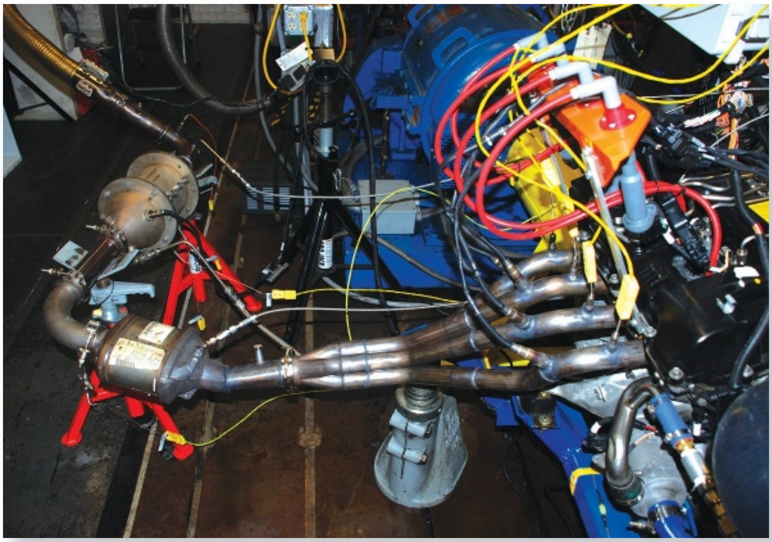

FIG. 3: The Oak Ridge National Laboratory's test engine and catalytic converter had numerous temperature measurements, in addition to those in the powertrain control. *Image courtesy of National Instruments.*

FIG. 4: Researchers built a data mining application in LabView to obtain the mean value of the collected data. *Image courtesy of National Instruments.*

would be a common approach to getting around the lack of direct knowledge regarding the ECU's code.

"If you are not the OEM, you have to do this every time," explains Matt Viele, Ph.D., principal architect of the NI Powertrain Controls Group.

Over two weeks of chassis dynamometer time, the test setup collected a third of a terabyte of data (*see Fig. 4*).

"The most complicated was cylinder pressure, where we read the pressure, we know the engine position and we can calculate a lot of functions based on that," Viele says.

Next- and same-cycle cylinder-based control are both fast-response and data-intensive control techniques that are being evaluated.

"In next-cycle control, we are going to look at cylinder pressure, and we are going to do calculations," Viele says, offering burn location or effective pressure as examples. "We will then have those ready for the next cylinder event."

Lean burn operation increases the need for this type of control.

"If you're running close to the lean stability limit, then you want to know that — to adjust your fuel timing for the next cycle," says Viele.

Next-cycle control is something that NI has been able to do in research boards for years, but it is starting to be used in production controllers by some carmakers as well.

Same-cycle control using NI's field-programmable gate array (FPGA) is able to provide very fast feedback from one injection pulse to the next, and adjust injection timing even sooner.

"There is not a whole lot of control authority because physical systems take some time," explains Viele. "Our computations are sufficiently fast, so that we can monitor in-cylinder pressure, do some math and adjust the back end of injection pulses in the same cycle."

Same-cycle control can avoid a misfire when the cylinder is running too lean, and save a test cycle before it is too late by taking the appropriate action immediately. With the FPGA in its compact reconfigurable I/O (CompactRIO), engineers can change the code in a few hours.

Viele admits the same type of thing could be accomplished in volume-production hardware with a dedicated digital signal processor (DSP) or in a multi-core processor with a dedicated core, but "it is a lot of work."

Low-volume, high-cost vehicles such as off-road construction equipment can take (and have taken) the FPGA from lab into production. High-volume vehicles use a similar approach in R&D for researchers to make recommendations for production, but then employ tools appropriate for the type of hardware used in the production ECU. With the challenges that are ahead, more analog data will drive the need for even more comprehensive development tools. **DE**

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

INFO ➜ Freescale Semiconductor: Freescale.com

➜ **General Motors:** GM.com

➜ **National Instruments:** NI.com

➜ **Oak Ridge National Laboratory:** ORNL.gov

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Health Care Turns to 3D Printing

Additive manufacturing gets personal with pre-surgical models — and gets a regulatory thumbs-up.

BY KENNETH WONG

Sheku Kamara, director of the Rapid Prototyping Consortium at the Milwaukee School of Engineering, says he believes additive manufacturing (AM) — better known as 3D printing in mainstream discussions — is "made for the medical industry."

Whereas traditional manufacturing methods are ideal for high-volume production of parts with standard geometric features, AM can produce one-of-a-kind models of complex organic shapes in low volume. The growing use of pre-surgical models — 3D-printed physical replicas of the cross-sections that must go under the knife — is a relatively new trend made possible by AM's ability to speedily produce single units for one-time use, custom-built from the CT scans of target patients.

The Consortium's rapid prototyping hardware setup includes iPro8000, SLA-3500 and Sinterstation 2500plus from 3D Systems; Fortus eT from Stratasys; and Spectrum Z510 from 3D Systems (previously a Z Corp brand, acquired by 3D Systems). Its members are industry-leading names in the medical sector: Johnson & Johnson, Baxter Healthcare, and Zoetis (formerly Pfizer Animal Health), to name but a few.

By Kamara's conservative estimate, more than 50% of the Consortium members own and operate their own rapid-prototyping facilities, deploying inexpensive concept-model printers to high-end machines. But the interest, R&D activities and technology acquisitions only began to pick up in the last four or five years, he notes. The insiders aren't publicizing what they're doing with AM because, he says, "it's a competitive advantage for them."

When Ablation Frontiers, a medical device company, urgently needed several hundred Ablation tools for a trade show, it turned to RedEye to produce them in additive manufacturing.

More Info Online

- A New Look at Subtractive Prototyping: deskeng.com/articles/aabmcy.htm
- Additive Manufacturing: A Body of Work: deskeng.com/articles/aabjpe.htm
- From Classical Mechanics to Biomechanics: deskeng.com/articles/aabkmn.htm

Who Gets the Bill?

In automotive and aerospace sectors, manufacturers are increasingly relying on digital mockups and simulation software to circumvent the cost of building and crashing physical prototypes for safety tests. But in the medical sector, tangible 3D-printed models are giving surgeons and physicians an option they'd never had before: the ability to practice and plan computer-guided surgery on a mockup of their patient's anatomy.

In October 2013, DePuy Synthes CMF (craniomaxillofacial), a division of Johnson & Johnson, launched a new offering called TRUMATCH CMF. It's a pre-operation planning service for facial reconstruction, orthognathic surgery, distraction and cranial reconstruction. Much of it is powered by AM, according to the company. As the press release explains: "A digital file is translated into a physical object by a 3D

In the development of a new device to treat benign prostatic hyperplasia (left), Kablooe Design needed seven to 10 design iterations for testing. The company relied on RedEye's on-demand rapid prototyping services to create functional prototypes, shown here as 3D renderings (right).

printer to create patient-specific surgical guides and occlusal splints. This enables transfer of the pre-operative plan to the operating room, potentially reducing OR time and assisting in the placement of implants."

Kamara observes that the ability to print out the target region for surgery, with all the nerves and blood vessels in color, and to see where the veins are connected is absolutely huge. "But how can that be quantified?" he asks. "That's the challenge." To put it bluntly, who would pay for the print job? At least for now, the question produces more debates than answers.

Bridging Engineering and Life Sciences

Jean Colombel, vice president of life sciences industry for Dassault Systèmes, says he believes the medical device industry can benefit from greater collaboration between engineers and physicians, who often speak different languages and use different lingos. (For more on this, read "From Classical Mechanics to Biomechanics," July 2013.)

"The knowledge about human beings and human bodies is still a partial knowledge," he says. "How can we get the expertise of the physicians and the case histories of their patients added to the ideas of the engineers? It's really about getting them to collaborate more, so they can create digital models for simulation."

According to Colombel, Dassault's SolidWorks 3D mechanical software is "a leading 3D design tool for the medical device industry." He predicts that "leveraging 3D as part of medical community will improve communication between doctors and engineers."

Even though Dassault is primarily a software powerhouse, the company keeps a mini-manufacturing center called FabLabs on its Paris campus. Among the hardware choices at the facility is a pair of Cubify 3D printers from 3D Systems. Priced at $1,299, they target home users and hobbyists with limited CAD software expertise.

The Missing Software

In aerospace, automotive and consumer goods manufacturing, the current crop of mechanical 3D modeling packages serve as concept modelers. But the range of geometry you can produce in them may prove inadequate to address the non-uniform, asymmetrical anatomical shapes medical professionals need to analyze.

"In my opinion, the software is lagging — not just in medical application, but even in consumer goods," says the Consortium's Kamara. "In 3D printing, I can print anything. Shape complexity is an advantage. But not so in most of CAD software."

Detailed humanoid shapes are the domains of high-end character modeling and animation programs like Autodesk Maya, the standard tool for filmmakers and game developers. But the learning curve for such a program may prove too steep even for regular 3D software users. It would certainly be an unfair burden on medical professionals, whose primary job function is not 3D modeling.

At the Consortium, students use Mimics from Materialise and Freeform Plus from Geomagic (a subsidiary of the rapid prototyping machine maker 3D Systems). Both packages offer one crucial function for medical application: You can sculpt 3D models out of CT, MRI and ultrasound data.

From Prototype to Production

Most people consider AM to be a prototyping technology, suitable for creating test models and mockups, not for full production run. But RedEye, a division of Stratasys, defies this generally accepted belief. Medical device projects account for about 15% of RedEye's business, according to Jeff Hanson, RedEye's manager for business development.

"Typically, medical companies come to our portal [website] at the prototyping phase," Hanson says. "Our job is to understand the story of the part: What's the end use, the intended manufacturing material, the market? If we know those, we might be able to migrate the customer from prototyping to manufacturing."

In medical device manufacturing, early digital concepts are likely to go through many iterations. Some are minor geometry adjustments; others are more drastic to improve the instrument's performance. They're often prompted by findings from lab tests, cadaver tests and clinical trials.

"If [the customer] comes to us during an early concept phase, everything is at risk for change," notes Hanson. "Maybe the strain release doesn't work right, a boss interferes with the device's operation, or the skin doesn't fit — these are typical design changes."

For large-volume production of devices that measure bigger than the built chamber of a 3D printer, traditional manufacturing methods are still the better choice. But RedEye has found a niche in low-volume, quick-turnaround production runs, described by Hanson as "in the low thousands." Often, on-demand 3D printing like RedEye's services can be the best way to introduce a new product to the market without committing to costly machine and mold setups.

Work in Progress

The U.S. Food & Drug Administration (FDA) and other regulatory bodies insist on compliance, not just with the medical devices manufactured, but also with the manufacturing processes themselves. To be certified for medical use, the way the machine cures print materials itself is subject to close examination.

3D printer makers have done an admirable job developing print materials that are acceptable for medical use. The Consortium's Kamara points to the development of polyetherketoneketone (PEKK) polymer, a medical-grade material that can be used with 3D printing and is acceptable for implants, as an example.

Although complying with stringent regulatory requirements like ensuring a sterilized manufacturing environment for implants created in 3D printers is a work in progress, late-breaking news shows encouraging signs. In November, polymer-based cranial implants made with the AM process from EOS became the first of its kind to receive FDA's 510K clearance.

Tom Weisel, president of medical device developer Arch Day Design, states that he and his team "print instruments and occasionally anatomical parts such as bone sections. It will be nice when the [3D-printing] materials represent bone more accurately." That would allow them to print, for instance, "a bone with cancellous and cortical sections."

How soon will Weisel's wish become a reality? That may depend on how big a chunk of the AM market's revenues the medical sector is hauling in. "We can't put in the R&D effort on such materials until we know a return on the investment," explains RedEye's Hanson. "We usually wait until the market demand reaches a certain point."

For the medical industry that has already discovered 3D printing, it's difficult to ignore the advantages the technology offers. As the Consortium's Kamara concludes, "If a picture is worth a thousand words, a prototype is worth a thousand pictures." **DE**

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

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➜ **Dassault Systèmes:** 3DS.com

➜ **DePuy Synthes CMF:** Synthes.com

➜ **EOS:** EOS.info/en

➜ **Geomagic:** Geomagic.com

➜ **Materialise:** Materialise.com

➜ **Rapid Prototyping Consortium:** RPC.MSOE.edu

➜ **RedEye:** RedEyeOnDemand.com

➜ **Stratasys:** Stratasys.com

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Engineering Data Growth: The March is On

Today's companies need document management systems that enable access, security and protection, as well as a means of archiving valuable layers of intellectual property that have grown through the years.

BY JIM ROMEO

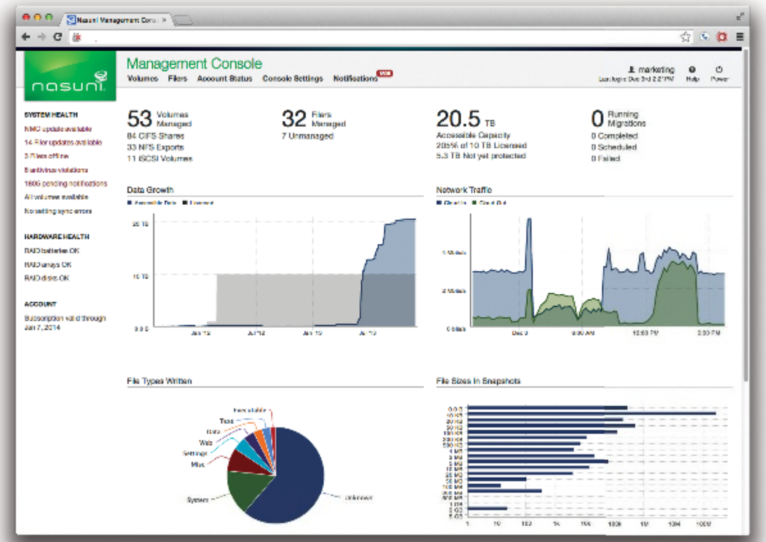
From office furniture to conveyor belts, forgings, castings and a host of other products, durable goods manufacturer JSJ Corp. ran into the same problem many industrial firms face daily: so many people using so much data in so many places. Headquartered in Grand Haven, MI, JSJ's design teams are dispersed in about 28 locations around the world, and its 95 years in business means the company has an arsenal of intellectual capital to not just draw from, but to protect.

The march of engineering data is on, and solutions that accommodate it are emerging. For the engineering design community, such data is big business, with big choices.

"The growth of engineering files is a huge problem — not to mention the burgeoning size of the files themselves," says Andres Rodriguez, founder and CEO of Nasuni, a company specializing in enterprise data storage technologies based in Natick, MA. Nasuni helped JSJ improve upon their data strategies.

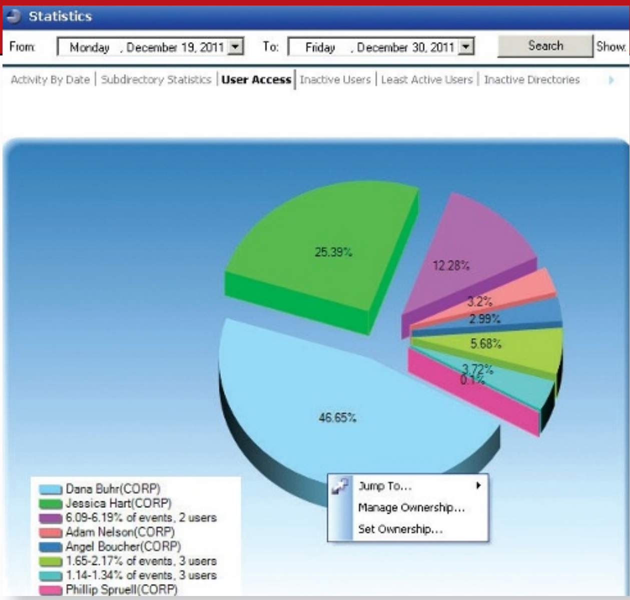
"Capacity, of course, is a problem, but so is access, especially given that most large industrial and engineering companies have international teams that need to work on the same files," Rodriguez points out. "Putting the cost of bandwidth aside, the files are so large that conventional WAN acceleration and replication systems can't provide the performance that a globally distributed team needs."

According to Robert Sobers, director of inbound marketing for Varonis — a company specializing in data storage, access and protection — document management can be a confusing term because there are technologies known as "Document Management Systems." However, managing documents well does not require that they be placed in specialized repositories.



Nasuni's cloud-integrated storage solution looks and feels just like the network attached storage it's been using for decades, but makes possible features such as fast access to a global fileshare from any location, unlimited capacity, automatic backup and data protection, and centralized management of the global storage infrastructure. This screenshot shows how IT can manage global storage through the Nasuni Management Console.

"Most enterprise documents are stored in unstructured repositories like file shares, intranets and email, and documents in these repositories can be better managed through the use of metadata," explains Sobers. "Metadata, when combined with big data analytics, provides needed insight and control while retaining, and even enhancing the accessibility of traditional file stores. Good document management for these systems can lead to more productivity, with



Varonis' products allow users to visualize document management. ***Image courtesy of Varonis.***

less risk and less cost."

According to Rodriguez, cloud storage offers a bright future. "Raw cloud storage, however, isn't enough," he says. "The services offered by the large public cloud storage providers are the 21st century equivalent of commodity hard drives. No one would buy a pallet of hard drives and start putting enterprise data on them.

"It works the same way with commodity cloud storage," he continues. "The next generation of storage vendors are using public cloud as the back-end for 21st century storage arrays that combine the look, feel and local speed of the [network attached storage, or NAS] controllers that IT storage experts already know, with new capabilities now made possible by the cloud: unlimited capacity, access from anywhere, unparalleled redundancy and resiliency. By combining on-premise gear with the cloud, enterprise IT can provide the best of both the cloud and traditional enterprise storage."

Engineering document management affects a company's knowledge management. The way engineering documentation is stored and archived ultimately aids in that firm's competitive advantage. By enabling a document storage system to be accessed by many, it aids innovation and also drives management decisions.

"We have worked with organizations where engineers had to wait anywhere from 20 minutes to several hours to access a CAD file their colleagues overseas had been working on," explains Rodriguez. "This kind of delay makes it difficult, if not impossible, for engineers to truly work in concert with other globally dispersed teams."

Cloud computing is the new paradigm for data storage, and offers new innovative technology that is far removed from dusty flat-drawer file cabinets in a technical library. In addition, the emergence of cloud technologies also makes it an attractive cost alternative to physical or tape-drive storage.

"The cloud gives organizations the ability to keep all the enormous CAD files currently in use cached locally, with the deltas synced up every five minutes or so with every other team across the globe — and the 'gold copy' stored in the cloud," says Rodriguez. "In addition, thanks to advancements in deduplication and compression technologies and the ever-plummeting price of cloud storage, it can be more affordable to store old files in the cloud instead of on tape. In this way, these files are readily accessible and not on a tape that's buried in a warehouse somewhere off-site."

Readily accessible data enables data reuse, and this is a key advantage that knowledge management affords. "With modern CAD environments, it is easy to create and reuse data in new projects, or quickly modify the data that currently exists," explains Chris Grossman, senior vice president of the Enterprise Applications Division of Rand Worlwide. "The challenge users have is knowing that the data actually exists. How does a project engineer, who is working on a new program, know about components, contracts, documents and even processes that were used in other projects in which they were not involved? What if they were done in another part of the company? Or even in a different language? Data and

An example of an Linear Tape Open (LTO) tape storage station. As opposed to disk, this tape-based data storage solution stores all documentation offline. One LTO-6 tape can store 6.25 terabytes of information and store up to 400MB per second. With the introduction of Linear Tape File System (LTFS) technology, storage managers can share tapes easily and not have to worry about having the right system to read the information. The LTO tape with LTFS also has two partitions, which means you can know exactly where the documentation is when you need it. *Image courtesy of LTO.org.*

process reuse is critical for success, and is only available with a single source of search that is intelligent enough to understand the engineering data and processes."

Other Options

Data reuse is not only available with a traditional cloud storage model, of course. Variants of cloud storage may also be used in the architecture of such storage for document repository for data and documentation storage.

"There are a number of vendors, however, who can provide cloud gateways," says Rodriguez. "These appliances typically have a large cache that keeps the most frequently used files stored locally while keeping the 'gold copy' of the full fileshare in the cloud. Alone, however, these gateways don't fulfill the full promise of the cloud. When integrated into a larger service, enterprise IT can gain the ability to sync files across the entire enterprise, manage all of enterprise storage from a single console, or even replicate the entire fileshare to a secondary cloud completely behind the scenes for extra peace of mind."

Not everyone believes that cloud storage is the only way, or even the most reliable way to store data. Craig Butler, senior program manager of IBM Data Protection and Retention Systems, cites a Forrester research study that states that 76% of companies have experienced a disaster or disruption in the past five years. He interprets the study as highlighting the risk of allowing all data to reside in one medium. Different types of media mitigate risk of loss from disaster. Disk and tape, specifically, is one viable storage option worth considering as a supplement to existing media and storage configurations.

In addition to tape and disk, attention should be paid to equipment associated with documentation and data. Nasuni's Rodriguez also emphasizes that for on-premise equipment, given the immense size and value of the files with which engineering firms work, IT organizations should think about taking advantage of flash storage. Reliable equipment to accommodate such storage is also needed, to ensure that engineers can keep working even if the storage controller goes down.

Protecting Integrity

Yet another consideration for today's engineering enterprises to consider is the risk that document storage potentially poses to the integrity of intellectual property. Precautions are necessary to prevent hackers and other threatening agents from raiding a company's intellectual property.

"The volume and velocity in which data is being created, copied and shared is unprecedented," says Varonis' Sobers. "The biggest challenges for industrial and technology companies will be in the management and protection of their intellectual property — knowing where their engineering documents exist, who can access them and who's been accessing them."

"The most important precaution is actually pretty simple: Encrypt everything before sending it to the cloud, and make sure that only you control the keys," advises Rodriguez. "There are a lot of cloud storage services out there that encrypt files at rest and in transit, but because they do not have an on-premise component, they have to own the keys so they can decrypt the files when they need to work with them."

As for JSJ Corp., which sought a better way to manage its document storage solutions, the company wound up saving about $300,000 over a five-year period through effective use of bandwidth, backup and hardware. JSJ's story is becoming a familiar one as the market for data storage technology advances, and solutions allow such companies to perform better and compete smartly. DE

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Dealing with Data Storage

Simulation data can consume massive amounts of storage — stressing networks, infrastructures and engineers.

BY FRANK J. OHLHORST

Storing engineering simulation data has become a significant challenge for businesses today. After all, most simulations are run numerous times, and the results — as well as the source information — can take up gigabytes, if not terabytes of valuable storage space.

What's more, as processing power increases, multiple simulation runs are becoming commonplace. While this trend allows engineers to investigate many more what-if scenarios, it also creates even more data that must be easy to access, able to move quickly across the infrastructure and grow exponentially.

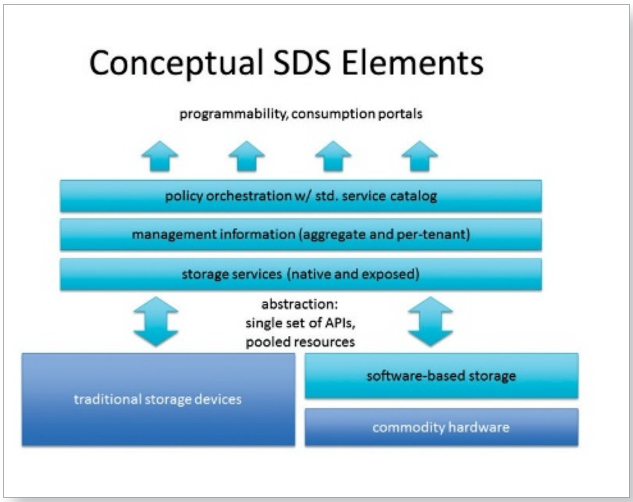
Complexities Abound

If you ask Graham Chapman, director of engineering for Morgan Motor Co., why simulation data is so important for the development of automobiles, he will come back with a long laundry list of the benefits of simulation, which can range from proving aerodynamics to crash engineering to the noise, vibration and harshness (NVH) simulations that can have an impact on design.

While Chapman would never discount the value of simulation, he can be heard decrying the technological challenges that simulation presents. "The amount of data stored and the number of sensor inputs are on the rise, as well as the number of simulation runs," he adds. "The flexibility offered by today's simulation applications means that more simulations can be performed and more scenarios investigated."

Chapman points out that simulations can save countless hours of physical testing by eliminating many of the "what-if" scenarios found today with product design and development. But running complex simulations also uses resources at an exponential rate, meaning that more data has to be managed, tests orchestrated and more comparisons of results must be performed.

Chapman is far from alone in his observations. Keith Meintjes, Ph.D., practice manager, simulation and analysis for CIMdata, notes that "engineering simulation data is unique when it comes to product development, simply because context proves to be the key element for determining value of simulation data."



Software defined storage can be used to turn storage hardware into an easily accessible central repository. ***Courtesy of EMC.***

According to Chapman, context should be defined as knowing what inputs produced the simulation result — such as design maturity of the part or vehicle as well as other critical pieces of data. He observes that context goes beyond inputs, and should include knowing what simulation tools, simplifying assumptions, and versions of software were used.

Simulation results are usually temporary, but they still produce gigabytes of data. Engineers often want to continually analyze those large data sets and develop reports and recommendations, which in turn are offered as long-lived results, requiring archiving and management. This is unlike the raw results, which users are forced to delete because of the amount of space consumed. That often proves to be regrettable, simply because that raw data may have additional value and could be used for other projects — or even reduce the need for additional simulations.

Adding to the storage conundrum is the fact that much of that raw data, and even completed reports, tend to be scattered throughout an organization. They reside in such disparate places as corporate databases, shared drives or even an engineer's personal hard drive. That translates to data storage needs multiplying, especially in the case of duplicate information, where the same data may exist in many places, consuming valuable storage real estate.

What's more, scattered storage makes it much harder to organize and share simulation data across multiple users or organizations. Even worse is the fact that the data may differ from one source to another, thanks to file revisions and updates that are not replicated everywhere. Add to that situation the complicated requirements of data backup and data protection, and a situation emerges were data can be easily lost to equipment failures, theft or malicious acts.

Scattered and unmanaged data proves to be a less-than-ideal way for organizations to protect their intellectual property, especially costly simulation run results.

Is More Technology the Answer?

Too often, enterprises simply throw technology at the storage problem. However, buying more storage hardware and the related subsystems is not always the correct answer to meet growing demand, especially when IT management cannot predict growth. The reality is that few enterprises have a solid handle on how storage resources are even being used throughout a large enterprise. Most ignore the efficiencies of centralized storage, instead focusing on the short-term benefits of siloed storage elements, which can be controlled independently of one another.

That said, technology still may prove to be the salve for growing storage needs for high-speed analytical data and raw data files that permeate engineering departments worldwide. But rather than taking the form of bigger and faster physical disks, the technology is comprised of better management of the storage systems that are already in place.

Virtualization technology has given birth to a new storage paradigm, where large storage arrays can be managed in a highly flexible fashion: software-defined storage (SDS). Simply put, SDS allows abstraction of storage services from the physical storage hardware, turning storage hardware into a virtual depot of data, which can be centrally managed and re-provisioned with ease.

Dozens, if not hundreds of vendors are playing in the SDS space, offering a wide variety of solutions that range from open standards-based solutions to proprietary products that only run on a particular vendor's platform. Nevertheless, IT managers looking to transform storage from a static environment to a virtualized data warehouse need only look to the current market for readily available solutions from the likes of Dell, EMC, HP, IBM, NetApp and VMware.

Of course, the latest and greatest SDS solution means little if the data itself is not managed properly. SDS provides the closet space; engineers still have to figure out how to hang their coats. They can use the hangers provided by simulation data management (SDM).

Data Governance

According to GE Aviation's Oscar Morataya, SDM offers one of the best paths to gain control over simulation data and promote its reuse. The concept also makes it easier to share simulation data for collaborative purposes, and brings a new methodology to dealing with the massive amounts of data generated by engineering simulations. In short, SDM allows engineers to govern and track the raw data, and keep it organized and available as needed.

Morataya explained the benefits of SDM during a presentation at Siemens PLM Software's NX CAE Symposium, which took place last fall in Cincinnati. Morataya pointed out that capturing the context of simulation data brings long-term value to SDM by allowing that data to be reused, shared or otherwise manipulated for future use.

Although not a new idea, SDM is garnering interest among multiple businesses, especially those firms that are heavily vested in engineering and design services. Many vendors and project managers consider SDM as a functional subset of product lifecycle management (PLM), and that SDM should always be integrated into PLM.

Morataya summarized the value opportunities of SDM as security, quality, productivity, innovation, lowered costs and knowledge management — backing those assumptions up with observational experience. For example, he explained that security is enhanced by the inclusion of export control policies, as well as the protection of intellectual property. Simply put, if the simulation data can be managed, then access and movement can be controlled.

Morataya also pointed out how SDM offers improved quality control, enabled by the abilities of SDM to orchestrate simulations while tracking the results. SDM gives users better control over configuration management, embraces design accuracy rules and offers a "first-time-right" paradigm.

SDM also helps to reduce operational costs two ways:

1. simplifying the control and orchestration of simulation data; and
2. reducing overall storage needs by eliminating duplication and discarding easily recreatable data elements.

Of course, SDM delivers on the promise of productivity enhancements. Morataya points out that SDM makes it simpler for global collaboration, while enforcing data management. This saves time and labor. Ultimately, it can be integrated into PLM, delivering a holistic approach to product management — from prototype to delivery.

However, SDM may introduce additional challenges to organizations looking to maximize the value of simulation data. Morataya told attendees that adopting SDM requires revamping business processes and training users on the nuances of process management, all while calculating costs, implementing storage management and orchestrating the movement of legacy data into the system.

Another challenge can be related directly to the in-place file systems, such as NAS, SAN and storage arrays: the ability to move large amounts of data or files quickly and reliably. After all, if it takes longer to move the data than create it, cost reductions and productivity gains are negatively impacted.

The Choice is Yours

For those venturing into the realm of SDM, choices abound. Traditional vendors, such as Altair, ANSYS, Dassault Systèmes, PTC, MSC Software and Siemens PLM Software offer a variety of solutions, ranging from cloud-based options to applications that integrate with design suites. It all comes down to choosing what works best for a given environment.

With SDM, the context of a past simulation can be used as the starting point in a new, similar prototype design. What's more, SDM automation speeds processes up by automating data inputs. This allows additional simulation runs — with more variations accomplished by automatically varying the inputs — which allows engineers to quickly understand how a design will react to slight variations.

For most engineering operations, implementing SDM has become not a matter of if, but when. DE

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

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Truly Portable Power

The Eurocom Racer 3W mobile workstation from Eurocom is a winner.

BY DAVID COHN

Eurocom has sent us a number of impressive mobile workstations, such as the Panther 4.0 that we reviewed in June 2013. While that Panther system proved to be one of the fasted mobile workstations we have reviewed, it was also expensive, very heavy, and in spite of doubling the battery life of an earlier Panther model, still ran for just 74 minutes.

Happily, the new Eurocom Racer 3W mobile workstation that recently arrived at our test lab overcomes all of those issues. It was half of the Panther 4.0's weight, had three times the battery life, and had a price tag one-third of the Panther — yet delivered excellent performance.

Unlike previous Eurocom mobile workstations, which were built using some decidedly non-mobile components (such as server-class Intel processors), the Racer 3W is a pure mobile system. The base configuration includes an Intel Core i7 mobile CPU and an NVIDIA mobile GPU, and its base price of $1,559 (without an operating system) reflects that.

The Eurocom Racer 3W measures 14.75x10x1.75 in. and weighs 6.7 lb., although the large (6.5x3.25x1.5-in.) 180-watt power supply adds an additional 2 lb. to the total package.

Raising the lid reveals a beautiful 15.6-in. backlit LED display with a native 1920x1080 resolution and a full-size keyboard with a separate numeric keypad. For the Racer 3W, Eurocom eliminated the backlit keyboard we saw in previous reviews. There is also a touchpad centered below the keyboard with a pair of buttons and a fingerprint reader. A 2-megapixel webcam, centered above the LED, is standard and flanked by a microphone.

A pair of speakers for the Sound Blaster X-Fi sound system are located below a perforated band that extends across the top of the keyboard. It actually took us a few seconds to find the rectangular power button located at the far left end of this band. LEDs to its left indicate number lock, caps lock and scroll lock, while a similar bank of LEDs at the far right show hard drive activity, airplane mode and whether the system is using its discrete graphics processing unit (GPU) or the graphics integrated into the Intel CPU. LEDs along the right-front edge of the system indicate AC/power and battery status.

Interestingly, there are no dedicated buttons for speaker volume, Wi-Fi, Bluetooth or the webcam. The system relies instead on keyboard combinations. You need to press the Fn+ESC keyboard combination to access the system's Control Center app to toggle Wi-Fi, for example.

Configuration Options

The right side of the case houses the optical drive bay, which in our evaluation unit was the tray-loading 8X dual-layer DVD +/-RW ROM drive that comes standard in the base configuration (along with a copy of Cyberlink Media Suite 8 software). As is typical of most Eurocom systems, the company also offers other options, including a Blu-ray Disc burner or an additional hard drive. Here you will also find audio jacks, including headphone, microphone, S/PDIF-out, and line-in as well as a single USB 2.0 port and a security lock slot. The left side of the case hosts a 9-in-1 multi-card reader, a combined eSATA/USB 3.0 port, two USB 3.0 ports (one of which is powered for charging devices), an RJ-45 LAN jack, and a mini-IEEE 1392a FireWire port.

While there are no jacks or ports along the front of the case, the rear provides a DisplayPort, HDMI-out port and a mini DisplayPort, as well as the power connector and a pair of air vents. There are two more air vents on the bottom of the case, plus access to the internal component bay, hard drive bay, a subwoofer and the battery compartment. Although a wireless LAN is standard, Eurocom included an Intel AC-7260 wireless LAN module with Bluetooth 4.0 and 802.11ac.

That was just one of the options we received. Customers have lots of choices. For example, while all systems come with a 15.6-in. backlit 1920x1080 display, the panel in our evaluation unit was enhanced with a non-glare matte finish — capable of displaying 95% of the National Television System Committee (NTSC) standard color gamut, a $110 add-on. Our display was also professionally calibrated; it came with its color profile stored on a CD, for an additional $45.

The base Racer 3W configuration comes with an excellent NVIDIA Quadro K1000M GPU, a discrete graphics card with 2GB of GDDR5 RAM and 192 cores. But Eurocom offers a choice of seven different GPUs, including the Quadro K5100M, an ultra-high-end board featuring 8GB of memory and 1,536 cores. It's an option that would add $2,018 to the price — and we suspect its 100-watt power demands would significantly decrease battery life. Instead, Eurocom equipped our evaluation unit with an NVIDIA Quadro K1100M. While it matches the 2GB of memory in the K1000M, it has 384 compute unified device architecture (CUDA) cores without drawing additional power, an option well worth the $92 premium.

The Eurocom Racer 3W is based on the Intel Haswell HM87 Express chipset. You can configure the system with one of five different quad core processors, ranging from the 2.4GHz Intel Mobile Core i7-4700MQ in our evaluation unit up to a 3.0GHz Intel Mobile EXTREME Core i7-4930MX, which would have added $734 to the system cost. The i7-4700MQ has a 6MB cache, and provides a max turbo frequency of 3.4GHz, while maintaining a thermal design power rating of 47 watts.

All of the available CPUs support up to 32GB of system memory, and we were somewhat surprised to find that our evaluation unit came with 16GB of DDR3-1600 MHz memory. What proved even more surprising was that 16GB is standard for the

Mobile Workstations Compared		Eurocom Racer 3W mobile workstation (2.4GHz Intel Core i7-4700MQ quad-core CPU, NVIDIA Quadro K1100M, 16GB RAM)	BOXX GOBOXX G2720 mobile workstation (3.6GHz Intel Core i7-3820 quad-core CPU, NVIDIA Quadro K5000M, 16GB RAM)	Eurocom Panther 4.0 mobile workstation (3.1GHz Intel Xeon E5-2867W 8-core CPU, NVIDIA Quadro K5000M, 16GB RAM)	Lenovo ThinkPad W530 mobile workstation (2.90GHz Intel Core i7-3920XM quad-core CPU, NVIDIA Quadro K2000M, 16GB RAM)	Eurocom P150HM Racer mobile workstation (2.70GHz Intel Core i7-2960XM quad-core CPU, NVIDIA Quadro 5010M, 16GB RAM)	HP EliteBook 8560w mobile workstation (2.30GHz Intel Core i7-2820QM quad-core CPU, NVIDIA Quadro 2000M, 16GB RAM)
Price as tested		$2,172	$5,895	$6,800	$2,592	$4,933	$4,063
Date tested		11/10/13	5/28/13	4/20/13	12/29/12	5/1/12	5/1/12
Operating System		Windows 7	Windows 7	Windows 7	Windows 7		Windows 7
SPECview 11	higher						
catia-03		28.97	73.23	65.87	34.82	49.74	27.49
ensight-04		17.38	61.24	61.01	18.40	41.07	18.46
lightwave-01		31.53	78.03	65.85	62.75	60.13	48.21
maya-03		51.20	111.58	102.18	62.04	93.79	58.12
proe-5		9.43	16.06	13.82	15.58	10.97	9.77
sw-02		24.95	63.26	55.06	39.48	53.57	35.85
tcvis-02		27.70	60.91	59.28	30.63	45.65	23.12
snx-01		23.17	63.57	64.62	25.14	42.48	19.85
SPECapc SolidWorks 2013	Higher						
Graphics Composite		3.63	2.72	2.26	2.06	n/a	n/a
RealView Graphics Composite		3.97	2.93	2.42	2.18	n/a	n/a
Shadows Composite		3.95	2.93	2.42	2.18	n/a	n/a
Ambient Occlusion Composite		5.35	6.09	5.14	3.76	n/a	n/a
Shaded Mode Composite		3.83	2.66	2.41	2.13	n/a	n/a
Shaded With Edges Mode Composite		3.44	2.78	2.12	2.00	n/a	n/a
RealView Disabled Composite		2.55	2.02	1.72	1.65	n/a	n/a
CPU Composite		3.99	3.61	3.72	3.59	n/a	n/a
Autodesk Render Test	Lower						
Time	Seconds	55.83	79.20	57.33	62.00	76.66	89.83
Battery Test	Higher						
Time	Hours:min	3:47	1:15	1:14	6:09	1:50	2:37

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

Racer 3W, although that memory came configured as two 8GB dual in-line memory modules (DIMMs), allowing for additional expansion. That option adds just $37 to the system cost. Configurations of 24GB and 32GB of RAM are also available.

There are 16 different storage options from which to choose. The Racer 3W supports up to two solid-state drives (SSDs), plus a third hard drive that can be SSD, regular or a hybrid drive — as well as a fourth drive if you forego the optical drive. So you could equip the system with nearly 4 terabytes of storage.

Battery life has been an Achilles heel of previous Eurocom systems. Happily, after opening the Control Center and switching to Power Saving mode, the Racer 3W ran for 3 hours and 47 minutes. The Racer 3W also remained cool and relatively quiet during our tests, although the fan became quite audible at times.

Great Performance

While its use of mobile rather than desktop components enabled the Racer 3W to trim weight and extend its battery life, we wondered what impact this would have on performance. We're please to report that the tradeoffs appear to be justified.

On the SPECviewperf test, which focuses graphics performance, the Racer 3W lagged behind other systems we have tested recently. But that's to be expected, considering its GPU was just one cut above entry-level while every other mobile system we've tested in the past two years came with at least a mid-range card.

On the SPECapc SolidWorks benchmark, which is more of a real-world test, the Eurocom Racer 3W was quite impressive, beating every other mobile system we have tested to date.

And on the AutoCAD rendering test, in which the competitive edge clearly belongs to systems equipped with fast CPUs with multiple cores, the Racer 3W outperformed systems with faster CPUs. This is even more impressive when you consider that the system we tested was equipped with the base-level CPU.

The modest number of add-ons Eurocom included boosted the price of our evaluation unit to $2,172, making the Racer 3W one of the most affordable mobile workstations we have ever tested. That price includes Windows 7 Professional 64-bit edition. Eurocom also offers Windows 7 Ultimate and Windows 8, or you can order the system without an operating system and install your own. The price also includes a one-year warranty with return-to-depot service, but you can extend the warranty to two or three years for $151 or $271, respectively.

Eurocom says that the Racer 3W is designed for professionals who frequently travel and require capable hardware to fulfill their professional commitments. We think this is right on target, making the Racer 3W an excellent alternative to similar mobile workstations from more mainstream companies. DE

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INFO ➔ Eurocom Corp.: Eurocom.com

Eurocom Racer 3W

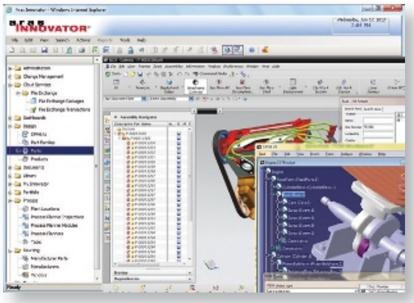
- **Price:** $2,172 as tested ($1,559 base price)
- **Size:** 14.75x10.0x1.75-in. (WxDxH) notebook
- **Weight:** 6.7 lb. as tested, plus 2.2-lb. power supply
- **CPU:** 2.4GHz Intel Core i7-4700MQ quad-core with 6MB cache
- **Memory:** 16GB 1600MHz DDR3 SDRAM (32GB max)
- **Graphics:** NVIDIA Quadro K1100M with 2GB memory and 384 CUDA cores
- **LCD:** 15.6-in. diagonal (1920x1080), non-glare, calibrated, 95% NTSC
- **Hard Disk:** 120GB mSATA SSD and 1TB 7,200-rpm Hitachi HD
- **Optical:** Panasonic 8X DVD+/-RW dual layer
- **Audio:** line-in, S/PDIF-out, microphone, headphone, built-in microphone and speakers
- **Network:** integrated Gigabit Ethernet (10/100/1000 NIC); Intel AC-7260 802.11 ac wireless LAN; optional integrated Bluetooth 4.0
- **Other:** two USB 3.0, one USB 2.0, one eSATA/Powered USB 3.0 combo, one mini IEEE-1394 (Firewire), 9-in-1 card reader, HDMI-out, DisplayPort, mini DisplayPort, 2MP webcam
- **Keyboard:** integrated 98-key keyboard with numeric keypad
- **Pointing device:** integrated two-button touchpad

Advertising Index

by Anthony J. Lockwood

Editor's Picks

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



Latest Aras PLM Innovator Platform Released

Update improves multi-CAD management performance.

Aras recently released the latest version of its Aras Innovator PLM (product lifecycle management) platform and solutions. Aras is an open system, and Aras the company also tries to take the hassle out of PLM from installation to the deployment of new applications that expand your PLM functionality.

Complementing its out-of-box PLM functionality is a suite of engineering, project, and product management solutions to control and manage processes like BOMs, configurations, product complaints, regulations, requirements, supply chains, variants, and more. That means you can build out Aras Innovator PLM to fit your needs.

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LabVIEW 2013 Released

Integrates access to the latest technologies, enhances developer efficiency, and provides access to an ecosystem of training and partner tools.

National Instruments' 2013 version of its LabVIEW system design software is filled with enhancements that sound like they'll make it easier to use new technologies and program everything from a basic measurement system to full test platforms.

One key enhancement is native support for the newest hardware from vendors like ARM and Xilinx. What this means is that you can develop high-performance systems that leverage a dual-core ARM Cortex-A9 processor, a Xilinx system on a chip, and FPGAs (field programmable gate arrays).

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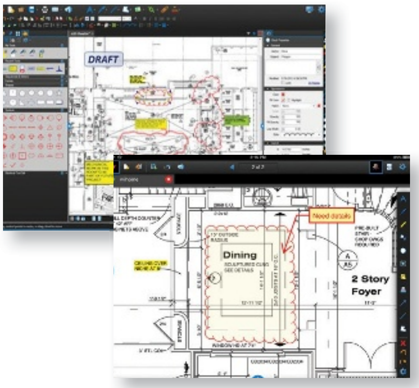

Paperless Workflow System in New Release

PDF creation, markup, editing, and collaboration solution Bluebeam Revu version 11.5 released.

Bluebeam Revu is a suite of applications for PDF file creation, markup, editing, and collaboration. It's all about making your workflows as paperless as you want to be. Revu provides you 2D and 3D PDF markup tools like callouts, highlighter, lines, notes, and stamps (dates, signatures, etc.). It offers one-click PDFs from MS Office applications as well as PDFs from other Windows applications or CAD programs.

You can also save or share frequently used markups, take measurements, compare versions of drawings and documents, and search for keywords within PDF files.

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3Z MAX 3D Printer Builds Casts and Molds

Solidscape says its new 3D printer is its fastest.

The 3Z MAX is a 3D printer for lost-wax casting/investment casting and mold-making applications. That is, the 3Z MAX creates high-precision wax patterns to be cast in metal or pressed into ceramics. Solidscape says the 3Z MAX supports a higher throughput for bulkier precision designs. Based on its nearly $50k price tag, this 3D printer seems targeted at small- and medium-size outfits, although I wouldn't rule out any organization getting serious value out of it

So what are some of the values you get out of 3Z MAX? Start with its being desktop-sized and that it uses non-toxic wax and wax-blend build and support materials ...

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Commentary

by Julie Driscoll

Keep NPI on Target

If you are working on a new product development initiative (NPI) for a discrete manufacturer, you're likely under pressure to work within specific cost, weight, market and quality targets under very tight timeframes. Developing and producing products that can meet all of these criteria, particularly cost, can be extremely challenging.

The cost implications of design decisions made during development are often more significant than most manufacturers realize. Profit margins are reduced because of product cost overruns; time-to-market is delayed because of the need to firefight cost "surprises." And there is often expensive post-production cost reduction rework required.

At the core of all of these challenges is the inability to accurately identify, assess and manage detailed product costs early enough in a product's lifecycle.

Most cost management activities fit naturally into existing engineering activities.

Incorporating Cost Management

Best-in-class companies are applying effective cost management strategies in the earliest stages of their product design process, and collaborating on cost analysis across functions. As a result, they are realizing huge repeatable benefits in both hard and soft cost savings, including:

- Setting and managing cost targets and getting them right the first time, before products or parts go into production.
- Quickly evaluating the cost of new product design alternatives so that they can focus more time on product innovation and less on cost analysis.
- Identifying the real cost drivers behind a product design, and minimizing engineering changes later in the release cycle where they cost more to address.
- Eliminating long waits for price quotes from internal cost experts, manufacturing experts or external suppliers.
- Creating should-cost estimates to be used to support vendor selection, quote validation and supplier negotiation.

Few would argue against any of these benefits, but it's not uncommon for engineers or sourcing and manufacturing team members to worry about product cost management activities slowing them down. In fact, the opposite is true.

Implemented properly, most cost management activities fit naturally into existing engineering and sourcing activities and processes. These teams often see time efficiency gains because they don't wait as long for cost estimates to come from suppliers — and they reduce expensive, late-stage rework.

Early Cost Visibility

Companies should evaluate tools that enable engineers to quickly and precisely determine cost by automatically pulling geometric and feature information from a CAD model. This enables team members who are not cost engineering or manufacturing experts to create an estimate and compare against established target costs. Strategic sourcing managers and manufacturing engineers should also have early visibility to product designs and the most current cost estimates, so they can provide input into alternative designs, sourcing options and manufacturability.

Costs should be regularly reassessed as features and design ideas are added or subtracted, so tradeoff decisions can be evaluated and cost impacts can be addressed. Cost evaluation milestones should be established.

Get a Cross-Functional View of Product Cost

Providing cross-functional teams with a common view of product cost at each stage of the product development process ensures all parties affecting product cost are collaborating early, accessing the same information and working to prevent late-stage cost surprises. The resulting benefits are significant:

- Strategic sourcing managers are able to consider make vs. buy decisions earlier. This can improve profitability, and leverage the design and manufacturing expertise of supply chain partners.
- Manufacturing engineers can regularly evaluate designs for manufacturability, and suggest changes that can have a profound impact on cost and time-to-market.
- Cost engineers get access to a broader range of cost information than ever before, and are able to increase their overall economic impact on the company.

Integrate with Enterprise Systems

Because most new product initiatives typically build on a current platform, being able to load a bill of material (BOM) and carryover part costs from product lifecycle management (PLM) or enterprise resource planning (ERP) systems is important to successful enterprise cost management initiatives. Furthermore, after an NPI team member calculates cost for a new product design, it is important that your product cost management solution is capable of storing that data back within the existing PLM or ERP system to create a closed-loop flow of information. DE

Driscoll *is vice president, strategic marketing and product management, for aPriori, Inc. Send e-mail about this article to DE-Editors@deskeng.com.*

A STRONG CASE FOR COMPLEX DESIGN.
The Mojo 3D Printer knocks out complex parts with ease.
There's only one desktop 3D printer on the market that arrives equipped with everything designers and engineers need to start 3D printing complex geometries. The Mojo is powered by genuine FDM® to build spot-on, functional concept models and rapid prototypes in ABS*plus* thermoplastic. Take it for a spin and we think you'll agree – the competition better get a move on.
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