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Degrees of Freedom

by Jamie J. Gooch

Solve the Data Dilemma

Big Data has been both hailed as the currency of the Information Age and derided as overhyped. Both statements are true because data immediately loses much of its value if it cannot be properly analyzed and acted upon to help make decisions.

Making use of data is getting more difficult as the amount of product information that needs to be shared explodes with increasingly complex products. At last month's NIWeek in Austin, TX, National Instruments' Executive Vice President of Global Sales and Marketing Eric Starkloff shared some sobering facts on our ability to generate data during a keynote address. He said by 2020 the Earth's 8 billion people will generate 50 trillion gigabytes of data yearly. If that data was saved on the floppy disks that were ubiquitous in the 1990s, you could stack them to the sun and back 300 times, by Starkloff's calculations.

That's a lot of information to collect, much less process and use as a basis for decision making. Those difficulties lead to inaccuracies. Nate Silver, the journalist who used data to correctly predicted the results of the 2012 presidential elections in all 50 states, has been quoted as saying "the gap between what we know and what we think we know is widening," partially because of a proliferation of inaccurate data forecasts.

Engineering is critical to fulfilling the promise of product lifecycle management.

Research firm Gartner recently analyzed its data to predict the death of Big Data as a term over the next two years.

Not to worry. A quick search of the Internet reveals that the term "Small Data" is gaining steam. Despite the birth of another soon-to-be overhyped term, this is actually a good sign. People are realizing that copious amounts of data aren't useful to most people. What is needed to make decisions is the right data at the right time.

Buzzwords Build Upon Each Other

"The Cloud," "Big Data" and "The Internet of Things" have been battling for attention. But they're more than just hype; they're actually working together to bring about what Joe Salvo, GE's Director of Global Research, hailed as the "Systems Age" during his NIWeek presentation. The Internet of Things (see the August issue of *Desktop Engineering*), will consist of ubiquitous sensing technologies in all types of products that will be generating environmental and usage data. A large portion of that data will be saved and communicated via the cloud.

In the vision of the coming Systems Age, the cloud is what ties together all of the information needed to create the systems. But engineers need not wait to begin building their own systems to tie software, mechanical and electrical engineering disciplines together and collaborate with department decision makers up and down the supply chain. Software vendors are already using the cloud to allow any company, large or small, to collect, share and collaborate on engineering data.

Technology vs. Human Nature

Technology is rarely the weak link that causes data management implementations to fail. 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 for design engineers 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 engineering's workflow, tempt people to defy data management best practices, or both. But a reluctance to change isn't the only roadblock to adopting a platform for systems engineering.

Data management, when implemented properly, is systemic. As such, it can be an expensive and grueling process to replace. Many companies feel locked into the data management systems they're using, even if they know there are better solutions. Scalability is critical when adopting a new system. If your solution won't scale to handle the influx of product information being shared, it's better to make the change now instead of letting it drag your organization down.

The need for data management isn't going away. With more simulation, larger models and the need for interdisciplinary and interdepartmental collaboration, it's only going to increase in the coming "Systems Age."

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


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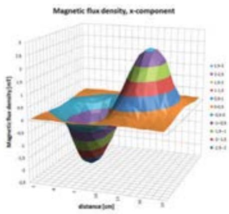
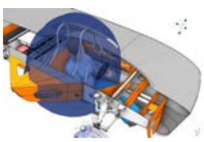
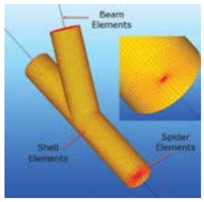
CAD Gets More Animated

SIMULATE





ON THE COVER: This Bunkspeed render visually represents the process of converting 3D engineering data into a visually appealing marketing image. *Image courtesy of Bunkspeed.*

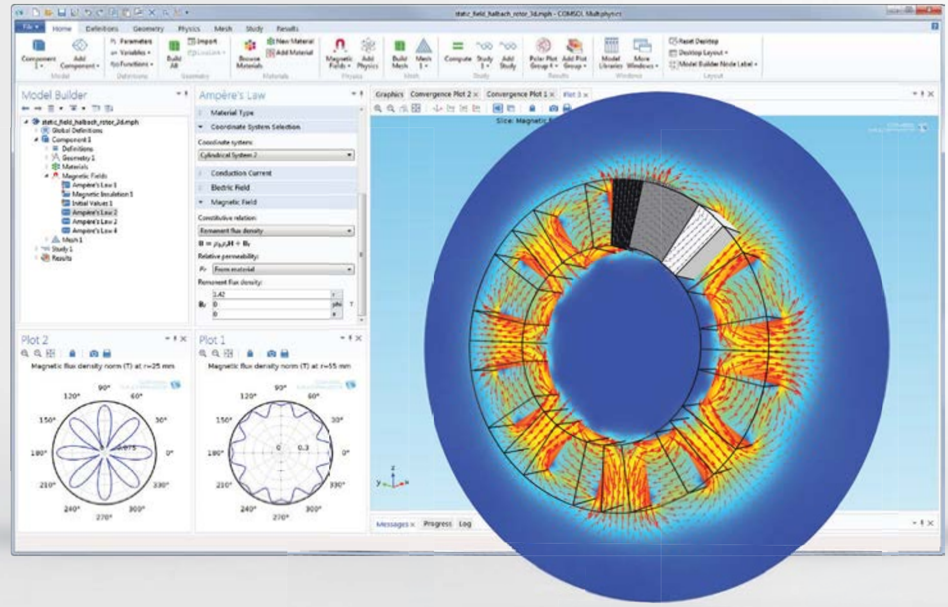


DESIGN

ENGINEERING COMPUTING

FOCUS ON DATA MANAGEMENT

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



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Professional Design Demands A Professional Workstation

A BMW may be a top-of-the-line ride for most, but its sleek design and superior handling are table stakes for the professional race car driver, who requires a whole other level of performance to get the job done.

It's the same story with engineering workstations. While processor improvements and inexpensive memory have given rise to a new category of low-cost workstations, not every model is created equal when it comes to serving professional engineers. Beyond the need for speed, professionals tasked with designing and building products require a workstation platform that is workload-optimized and specifically calibrated for high-level processing, robust graphics, and precision accuracy. While squeezing faster performance out of a CAD tool can improve an engineer's productivity, the real gains in innovation and accelerated time-to-market cycles come with new workflows that foster simulation-led design.

Just like a race car depends on components other than the engine to rev up performance, a professional workstation requires more than a state-of-the art processor to drive such advanced design workflows. Along with a processor that supports accelerated I/O performance for large data models, optimized cache utilization, and a data flow architecture for enhanced throughput, a properly balanced system should also draw from ample memory (nearly 2X the size of the largest model), solid state drives (SSDs), and robust-enough graphics capabilities to ensure the optimal productivity boosts from the new workflows.

Professional Workstation Building Blocks

To ensure the best possible workstation experience, aim for balance between four components:

- **Processors:** Choose the fastest processor possible.
- **Memory:** Configure system memory to be equal to or slightly more than two times the size of your largest CAD model.
- **Storage:** Whenever possible, Solid State Drives (SSD) should be part of the specification to ensure maximum impact.
- **Graphics:** Don't assume an advanced graphics card is a universal requirement—only invest in what is needed for your applications and workload.

Simulation-Based Design = Big Results

With this proper mix of components, a professional-grade workstation can be the springboard for an engineer to move past efficient 3D modeling work to simulation-led design and photorealistic imaging. By leveraging simulation studies throughout the development cycle, engineers are empowered to engage in the experimentation that promotes innovation as compared to late-stage simulation, which is keyed to final design validation and the need to reduce costs.

Those steering a course to simulation-led design are enjoying significant results. According to a study by Aberdeen Research, the top 20% best–in-class companies pursuing a robust design approach that includes widespread use of simulation are more likely to meet product launch dates, reduce development cycles, and hit product revenue, cost and quality targets.

Dyson, a respected innovator in consumer goods, is a case in point. By adopting a simulation-led design approach, Dyson engineers investigated 200 iterations of a fan design before settling on a final version, which is 10 times the number possible with physical prototyping. As a result of the new simulation workflows, Dyson engineers honed in on an optimal design, which ensured the fan performed 2.5 times as well as the original concept.

Litens Automotive Group, a tier one automotive supplier manufacturing power transmission systems and components, is another prime example. The company harnessed professional-grade workstations to facilitate simulation-based design—a move that helped it reduce prototyping iterations, save millions of dollars, and accelerate product development cycles.

Both examples underscore a clear ROI for a professional-grade workstation. With the average professional workstation priced around $3,000, the investment amortized over a three-year period translates into approximately $20 a week to realize as much as a 3X increase in engineering productivity.

Such numbers build a pretty compelling business case for a professional-grade workstation. With a minimal investment, engineering teams can shift simulation-based design into high gear, outpacing their competition and crossing the finish line to enhanced productivity and innovation.

To configure your ideal workstation, go to http://goo.gl/PsEpcN.

Making the Case

Need to convince management that a professional-grade workstation is worth the investment? These five questions can help build support.

1 What new projects could the company take on if engineers were 20%, 40%, 60%, or even 80% more productive?

2 Would you invest in technology that could pay for itself in six months?

3 Is it better to increase output by hiring more engineers or increasing the productivity of engineers already on staff?

4 What opportunities have we missed by not being able to react quickly to market changes?

5 What is the value of avoiding recalls and engineering change orders by having time to get the design right the first time?

How Intel Core and Intel Xeon E3-1200 Processors Stack Up

	Intel® Core™ i3 Processor Product Family	Intel® Core™ i5-3570 Processor Product Family	Intel® Core™ i7-3770 Processor Product Family	Intel® Xeon® Processor E3-1275 v2 Product Family	Intel® Xeon® Processor E3-1290 v2 Product Family
Processor Frequency	3.4 GHz	3.4 GHz	3.5 GHz	3.5 GHz	3.7 GHz
Max Intel® Turbo Boost Technology[5]	N/A	3.8 GHz	3.9 GHz	3.9 GHz	4.1 GHz
Cores/Threads	2/4	4/4	4/8	4/8	4/8
Intel® Turbo Boost Technology		✔	✔	✔	✔
Intel® Hyper-Threading Technology[6]	✔		✔	✔	✔
ECC Memory Support				✔	✔
Intel® HD Graphics P4000[4]				✔	
Graphics Frequency	650-1050 MHz	650-1150 MHz	650-1150 MHz	650-1250 MHz	650-1250 MHz
Professional CAD/Media/DCC certifications				✔	✔

By the Numbers

Computer Aided Technology Inc. (CATI), a SolidWorks reseller headquartered in Illinois, embarked on a research project to determine how to best maximize productivity for the popular CAD tool. The researchers ran a series of rigorous, controlled tests against a typical workstation environment to determine what factors, including upgraded workstation capabilities such as RAM, multicore processors, and SSDs, had on SolidWorks performance. Here's a snapshot of what they found:

35 minutes Time saved doing a specific task when upgrading from a workstation with two cores to one with four cores, which amounted to a 12% performance boost.

4-fold increase The performance gains using computationally-intensive engineering programs when moving from a system with four cores to one with 12 cores.

54% The improvement resulting from an increase in RAM from 8GB to 24GB, which saved two hours, 44 minutes, and 54 seconds on SolidWorks operations.

47% The increase in productivity by replacing the 7200 RPM hard drive with a solid state drive.

55 minutes The time it took to complete a set of engineering tasks with an optimal system compared to the five hours, one minute, and 35 seconds it took to complete the same tasks with a baseline workstation configuration.

Note: Test system was the 3DBOXX 8550 XTREME workstation, which was scaled up and down to meet the criteria for the baseline and optimal configurations.

Get Practical with PLM

Solve the top 4 product data management challenges.

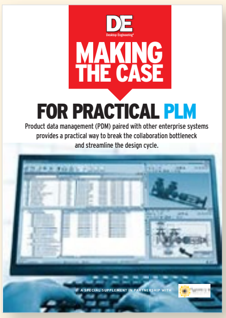
What company isn't under the gun to get products to market faster than the competition while simultaneously reducing waste and cost? With companies struggling under the weight of manual processes and of out-of-control product development-related data, it's time to get real about finding a solution. With a practical approach to PLM, you can connect everyone in the organization to the right data while facilitating better decision-making that results in great products.

Organizations have attacked the problem with a variety of technologies, from CAD-centric data management software to enterprise product lifecycle management (PLM) platforms, with varying degrees of success. The challenge is to manage an increasing amount of manufacturing data and to automate business processes without getting bogged down in complex PLM enterprise deployments that consume limited resources, break strapped budgets and take months, or even years to get going.

Rather than trying to "boil the ocean" and map a monolithic platform to a set of complex business processes, organizations need to zero in on the most common product data management (PDM) challenges. They should then go after them with a practical PLM approach that delivers efficiencies right out of the gate, while easily scaling to meet evolving needs.

Here are the most common product data management challenges and how to solve them with a practical approach to PLM that integrates PDM with existing enterprise business processes.

Making the Case for Practical PLM



Learn how product data management (PDM) paired with other enterprise systems provides a practical way to break the collaboration bottleneck in this eight-page paper produced by *Desktop Engineering* and sponsored by Synergis Software. In it, you'll discover:

- How to address the top PDM challenges quickly and easily.
- How three companies solved very different challenges using a practical approach to PLM that scales to meet their needs.
- Two approaches to practical PLM implementations: a QuickStart to help get companies up and running in five to seven days, and a more comprehensive implementation that generally takes eight to 15 days, depending on scope.

Download "Making the Case for Practical PLM" at deskeng.com/de/practicalplm.

1 Finding Files. By some accounts, engineers spend as much as 40% of their time searching for key files. Most companies are hamstrung by manual processes and far-flung development efforts that lock up critical product data and CAD files in siloed systems that aren't easily accessible by dispersed design teams, manufacturing or customer service.

Without a central repository and an advanced search capability to quickly find files, team members can't locate the data they need to make optimal decisions about product direction, and when and if they do, there's no guarantee they are working with a current version. The inability to quickly find information wastes valuable time that could be better spent doing real engineering work, while it also introduces errors into the design process.

Solution: A product data management platform provides a central repository for all multi-CAD design data, which can be accessed by team members based on their role and according to specified security permissions. There is no need for colleagues to dig up and email required files. Instead, there are structured metadata searches as well as full-text search capabilities that allow for a quick review of the contents of documents. Attribute or property data can provide another layer of detail for examining CAD or non-CAD documents such as Microsoft Office files, transcending what's possible with basic Windows file management. The ability to save commonly used search criteria can also ensure frequently used content is readily accessible.

2 Revision Control Errors. Conflicting document versions present many challenges, from duplication of effort to poor quality control. According to a 2012 Tech-Clarity survey, approximately 30% of organizations are hindered by inadequate revision control practices.

Manual revision control processes are error-prone and potentially costly, from both a financial and customer satisfaction perspective. Moreover, without an audit trail, companies have no record of who modified what documents, when, which opens the door to legal exposure from a compliance or litigation standpoint. It also makes it difficult to analyze workflow, identify bottlenecks, and improve overall design processes.

Solution: Along with secure and controlled access to a centralized repository of documents, a PDM system automates revision control and maintains an audit trail of changes to any one file, aiding in the traceability so critical for regulatory compliance and certification. Files with parent/child relationships are able to maintain links to current versions, and both major and minor versions and revisions are tracked to eliminate errors and ensure that all players in the design process are working from the same information, even if they are in globally dispersed locations.

3 Change Order Chaos. Engineering change orders (ECOs) are one of the biggest bottlenecks to design productivity and can cost companies plenty, especially if mistakes are made. In many organizations, ECOs are handled manually using spreadsheets, which makes them difficult to orchestrate into a consistent process. Manual handoffs provide no visibility into ECOs and no automated way to alert other stakeholders and departments involved in the workflow as to their status and final approval.

Solution: Leverage a product data management system's electronic workflow capabilities to automate ECOs and orchestrate a simple or complex routing and approval process. Workflow status updates can be sent via email, and time-based alerts can be set to identify bottlenecks and get projects completed faster. The ability to view the status of an ECO also ensures that any remaining steps are identified and duly completed, leaving no margin for error or overlooked missteps.

4 Collaboration Complications. It's the rare company today that doesn't have a need to collaborate beyond its four walls. Regular communication with globally dispersed departments, suppliers, partners and even customers is part and parcel of the modern-day development process, and remains a headache for most engineering organizations.

Without a "single version of the truth," organized and accurate collaboration is impossible. The rampant use of email only complicates matters, proliferating uncontrolled versions and resulting in product data management chaos. Moreover, sending large CAD files and assembly drawings across multiple sites through email or FTP is painfully slow because the files aren't replicated locally at each team's site.

Solution: With a centrally managed and controlled document repository, collaboration is transparent. Project data can be replicated across sites so everyone is working from the most current version without any degradation in performance. The ability to manage and view native, multi-CAD files can simplify design reviews, allowing non-engineering users to view, markup, and compare designs without having to purchase expensive CAD seats or deal with cumbersome and error-prone file conversions.

By integrating a core product data management platform, such as Synergis Adept, with existing enterprise systems, organizations can make collaborative product design the stuff of reality, not PLM fiction.

Download "Making the Case for Practical PLM" at deskeng.com/de/practicalplm.

By the Numbers

40% Can't find data they're trying to find.[1]

39% Cite frequent design changes as the biggest obstacle in the way of efficient design.[2]

73% Don't know the cost of engineering change orders.[3]

200 The number of people, on average, that use information associated with a design created by an individual engineer.[4]

33%-50% The total engineering capacity consumed by handling engineering change orders (ECOs).[5]

6 weeks The time it takes SchuF-Fetterolf to develop a new valve enabled by PDM, compared to competitors who typically spend from six to 12 months on valve development.[6]

42% The amount of duplicated data, according to company estimates.[7]

36% Organizations suffering severe consequences related to regulatory compliance as a result of failures in document-related business processes.[8]

3X The likely increase in being "very effective" at managing design projects with effective document management.[9]

$400,000 The average annual cost of a manual transmittal process for Taggart Global that was saved by automating data management and document management processes.[10]

[1] Tech-Clarity Perspective: "Best Practices for Managing Design Data," 2012, Jim Brown. Available online at http://www.plm.automation.siemens.com/en_us/Images/Tech-Clarity_Perspective_Design_Data_Best_Practice_tcm1023-184552.pdf

[2] Aberdeen Group; "Top CAD Tips For Designing Today's Products: What Are The Right Tools For The Job?", March 2012

[3] http://www.industryweek.com/companies-amp-executives/how-much-do-your-engineering-change-orders-cost-you

[4] http://www.plm.automation.siemens.com/en_us/about_us/newsroom/press/press_release.cfm?Component=25802&ComponentTemplate=822

[5] Terwiesch & Loch, 1999. http://cdn.intechopen.com/pdfs/432.pdf

[6] Tech-Clarity Insight: "Managing Engineering Data: The Role of Product Data Management in Improving Engineering Efficiency," 2010, Jim Brown

[7] Symantec State of Information: Global Results, 2012. Available online at http://www.symantec.com/content/en/us/about/media/pdfs/2012-state-of-information-global.en-us.pdf

[8] IDC white paper, "It's Worse Than You Think: Poor Document Processes Lead to Significant Business Risk," 2012. Available online at http://mds.ricoh.com/files/knowledge_center/IDC_Risk_WP_Ricoh_Eng.pdf

[9] Tech-Clarity Perspective: "Best Practices for Managing Design Data," 2012, Jim Brown. Available online at http://www.plm.automation.siemens.com/en_us/Images/Tech-Clarity_Perspective_Design_Data_Best_Practice_tcm1023-184552.pdf

[10] Synergis case study

by Kenneth Wong & Beth Stackpole

What Doesn't Kill a Blender, Makes It Stronger

In its "Torture Chamber," Blendtec runs physical tests to see what it takes to break its own products.

If you're a blender, you'd never want to see the inside of the testing lab in Blendtec's headquarters in Orem, UT. This small room is the equivalent of the Tower of London for blenders — the products that go in don't usually come out in one piece.

"We call [the test facility] 'the Torture Chamber' because we line up all of our blenders and brutally test them until they die," admits Reid Stout, a research and development engineer with Blendtec.

If you're an automaker, conducting a destructive test on your product means crashing a fully built car rigged with dummies into a wall — a costly experiment you can't undertake willy-nilly. If you're an aerospace manufacturer, crash-testing a plane for every new model is certainly out of the question. To bypass these costly tests involving massive products (not to mention the cleanup required afterward), manufacturers now rely mostly on digital simulation and software-driven analysis to perform tests. But if you make blenders like Blendtec does, you can afford to sacrifice a few blenders every month for the good of your customers.

"With digital simulation, you're looking at a very specific, narrowly defined scenario — like the deflection in a specific beam. You have to make assumptions, idealize the conditions, and there may be certain concerns you dismiss because you feel they're negligible," explains Blendtec testing engineer Joey Jacobsen. "But when you build and test a real product, you get everything, both intended and unintended effects."

Blendtec uses SolidWorks CAD modeling program's simulation functions, along with some basic computational fluid dynamics (CFD) tools for digital simulation, according to Jacobsen. But the nature of the products makes physical tests a lot easier to set up than computer-based simulation. "When a blender runs, the objects inside start off as solids, then transform into liquid. This is very difficult to model, a very complex CFD problem," Jacobsen says, noting that it's "perhaps too complex, when you can just build the product and test it."

The facility is set up to perform a series of rigorous tests on the blenders automatically — blending for a period of time, resting for short period, then blending again. During these blend-and-rest cycles, engineers monitor temperature, the number of cycles it takes to break a product, voltage and even sound. "The sound a blender makes could be an indicator of impending failure," Jacobsen points out.

When the Blendtec team came to the realization that the Torture Chamber was due for an upgrade, they began seeking fresh new ideas for improvement. But they didn't have to look far for people with creative, ingenious ideas on the art of destruction: The Capstone program run by the company involves working with students from local universities and schools. So the thrilling assignment to revamp the Torture Chamber went to a group of lucky undergraduates from nearby Brigham Young University (BYU).

One of the challenges in the previous incarnation of the test facility was to keep the lids fully secured while the automatic tests were in progress.

"We had even used fasteners to keep the lids closed," Jacobsen recalls. A BYU article about the students' contribution to the new Torture Chamber state that originally, test preparation was "a long, painful process that could take up to 30 minutes. The team would use silicone or even screws to secure the lids. Now, the lids can just snap on and off, reducing test preparation time to almost five minutes."

"The students also came up with easier ways to keep the test environment clean and sanitized," Jacobsen reports.

The Torture Chamber and the insights it yields serve as a reminder that, while digital simulation has become the norm in modern manufacturing, physical testing remains the gold standard for discovering design flaws and weaknesses.

— K. Wong

by Kenneth Wong & Beth Stackpole

PTC Kicks off IoT Focus with Axeda Acquisition

PTC's intent to steer a course toward the Internet of Things (IoT) is no secret, especially for those who attended the PTC Live 2014 event in Boston in June. With the proposed acquisition of Axeda Corp. made public in July, it appears PTC is about to go at the IoT full throttle.

Axeda, which PTC is acquiring for approximately $170 million in cash, bills itself as an IoT connectivity provider — it delivers a platform that gives companies building the "things" a secure way to connect them to the cloud. The Axeda Machine Cloud Service includes machine-to-machine (M2M) and IoT connectivity services, software agents and toolkits, all of which can be tapped to establish secure connectivity and to remotely monitor and manage a wide range of machines, sensors and devices.

Axeda got its start providing a "connected service" type of application, which PTC has been touting as the wave of the future for a new generation of smart, connected products. The Axeda technology came into existence to enable Diebold, a security provider, to deliver over-the-air software patches to its ATM machines as a way to reduce the cost of sending technicians on-site to remote locations to handle repairs. The product eventually evolved into an IoT connectivity platform, according to Jim Heppelmann, PTC's president and CEO.

The Axeda connectivity capabilities are a key piece of the PTC IoT development stack, Heppelmann explains, and they complement the ThingWorx rapid application development environment. PTC acquired ThingWorx last December for $112 million — yet another sizeable IoT investment.

"Another way to think of it is that, in order to capitalize on the Internet of Things, a company needs a product that generates data," Heppelmann tells *DE*. "It needs a way to connect to that product to collect the data, and it needs a way to develop the applications that make sense of the data. PTC is expanding from its historical roots in helping companies make products, with these new capabilities for connecting them and for leveraging their data."

PTC's push for the Internet of Things (IoT) can be seen in this ebook published and distributed by the company.

The data that the Axeda platform collects and securely delivers is the key source of input for ThingWorx-built IoT applications, Heppelmann adds. ThingWorx becomes the means through which companies build the IoT applications, as well as monitor, control, optimize and automate the new generation of smart, connected products participating in IoT. PTC's line of service lifecycle management (SLM) offerings, a result of its Servigistics acquisition, fill in another piece of the puzzle, providing a suite of tools that can help facilitate service and support of IoT-connected products in the field.

Are you confused and wondering how all of this IoT talk squares with PTC's decades-plus heritage in CAD and PLM? Heppelmann points out that it all makes sense when considering where products are heading, whether that product is an airliner or a washing machine.

"Products have evolved from purely physical components to complex systems, combining processors, sensors, software and digital user interfaces that are now connected to the Internet and each other," he explains. "The path to smart, connected products begins with CAD and PLM technology. After all, there is no Internet of Things without the 'things' — and those things require incredible sophistication in their design as they continue to evolve into complex systems."

The Axeda acquisition is expected to be finalized in PTC's fiscal fourth quarter 2014.

— B. Stackpole

Arena Looks Toward Quality Management

Customers' repeated requests to Arena Solutions have spawned Arena Quality, a full-blown quality management module, now part of the firm's cloud-based product lifecycle management (PLM) suite. As a closed-loop quality solution, Arena Quality directly connects quality processes to the product record in Arena PLM, providing the visibility that will allow engineering and manufacturing teams to rapidly identify, capture, collaborate and resolve product quality problems. While Arena provided some capabilities for tracking quality issues against items and engineering change orders (ECOs) in prior releases, this is the first complete set of functionality designed for an entire team to manage and lead a continuous improvement effort.

While there are standalone quality management solutions, they are typically isolated from the product record, which can create conflict and spark miscommunication between the quality and other product teams, explains Steve Chalgren, Arena Solutions' VP of product management and strategy.

That's where Arena Quality comes in. The capabilities are embedded in the product record, giving stakeholders from engineering, operations, and the supply chain complete visibility into quality issues. Arena Quality also captures all quality processes in an easily navigated history, which can serve as an audit trail for various regulatory compliance efforts, whether for the U.S. Food and Drug Administration (FDA), which is critical to medical devices companies, or the International Organization for Standardization (ISO) governing mainstream manufacturers.

Because quality processes vary across manufacturing sites, Arena Quality offers templates, which can be customized to reflect the various phases, attributes and terminology used by internal quality teams. In addition, the templates help companies get up and running on a quality process in short order, without having to start mapping processes from scratch.

Teams can assign responsibilities at multiple levels, manage schedules, and track progress to final resolution. Emailed notifications are displayed in the Arena PLM dashboard so everyone is kept up-to-date on outstanding issues. There is also a 21 CFR Part 11-compliant electronic signature capability, eliminating the need to print and manage hard copies.

— B. Stackpole

Sensing the World in 3D

The growing popularity of 3D printing among the hobbyists as well as professional designers suggests a comparable rise in the use of reality-capture devices — hardware that lets you scan and capture the shape and geometry of physical objects.

Priced at $399, the Cubify Sense captures not just geometry, but the attention of many early adopters and curious tech users. Measuring roughly 7x5x1 in., the 3D scanner is smaller and lighter than a typical hardcover book. The device has no independent power source. It operates through a USB connection to a tablet or computer. A computer is also required for downloading the Sense software to activate and drive the device. Because whatever you want to scan may not be located close to your desktop, a laptop or a mobile tablet you can carry around is the best option for operating the scanner.

The scanner works by emitting laser beams to detect and determine the object's surfaces and features. Because the scanner is handheld, to capture an object from all angles, you need to gently move around the target object and scan it from top to bottom, then from one side to another. The most compute-intensive part of the operation is when the software is using algorithms to assemble the point-cloud data acquired of the same target from different angles. Those with consumer-level machines may run into hiccups, resulting in the error message "Lost Track of Object."

Once you've lost track of the object, you may attempt to realign the scanner to the object. However, in my tests, I found it's not easy. It's much simpler to restart the scan altogether.

It's inevitable that the scan data would have a few missing slices and gaps — a consequence of imprecise hand movements. The software's Solidify function can effectively patch up those flaws to produce a complete polygon model, ready to be saved for editing or for 3D printing. The resulting 3D model may be saved as OBJ or STL, both easily readable in standard CAD programs.

The Sense scanner is lightweight and easy to use. The device could be improved if it's designed to operate independently, but doing so would require redesigning the scanner with a battery, memory card and built-in display — factors that might increase the cost beyond what enthusiasts would willingly pay.

— K. Wong

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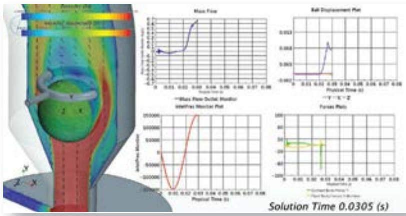
Editor's Picks

by Anthony J. Lockwood

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



CD-adapco Releases STAR-CCM+ Version 9.04

The simulation software has added concurrent per-part meshing.

This edition of this widely deployed integrated engineering simulation solution offers a number of enhancements that sound pretty nifty, including concurrent per-part meshing (CPPM) functionality and the ability to perform CAD robustness studies.

An assortment of enhancements in v9.04 simply speed things up for you, while others make working easier. For example, the Field Editor tool now provides immediate feedback on whether you built an expression correctly. And a new interactive color map editor lets you create, modify and import/export color maps.

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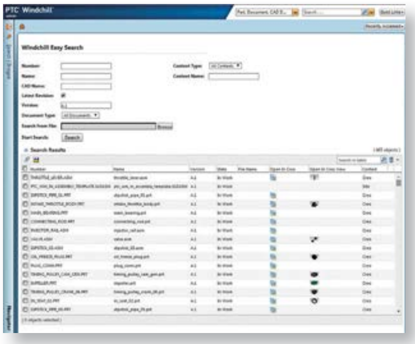

ETRAGE Unveils Design Solutions for PTC Creo, Windchill

The company specializes in automation, data migration and integration applications.

ETRAGE has a particular expertise working with PTC-related products. These people were busy before and during the PTC Live Global conference: They announced and demonstrated five new products for the PTC user community: the PTC Windchill – SharePoint platform, Windchill EasySearch, ETRAGE SmartPDF, Drawing Notes Search for PTC Parametric in Windchill, and WXML Universal Integrator for Windchill.

Perhaps the biggest of the lot is the PTC Windchill – SharePoint integration application. It enables bidirectional exchange of design data between Microsoft SharePoint and Windchill PLM.

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PTC Creo 3.0 Incorporates Unite Technology

Users can open CATIA, NX and SolidWorks files directly into Creo.

PTC Creo 3.0 introduces the company's new Unite technology. Unite is now part of the PTC Creo app family, including PTC Creo Parametric, the PTC Creo Direct 3D direct modeler, the PTC Creo Options Modeler app and the PTC Creo Simulate extension for PTC Creo Parametric.

Unite technology lets you open or import CATIA, NX and SolidWorks files directly in your PTC Creo app where you can work on them and protect design intent.

PTC's Unite technology enables you to convert a legacy file to PTC Creo on demand. You can also simply convert just the data you need.

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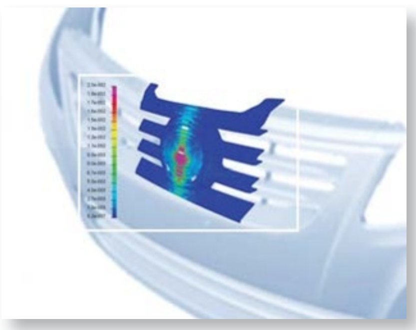

ESI Group Launches CEM Solutions 2014

The platform now includes a multi-scale modeling process.

CEM Solutions' abilities include enhanced virtual testing with a dedicated radio noise process. This helps you evaluate spurious electromagnetic noise from internal cabling and emitting components.

Version 2014 introduces a multi-scale modeling process. This process combines computational techniques with analytical formations and the ability to investigate the performance of radar sensors stashed behind plastic bumpers.

You can also take into consideration precise design parameters like 3D shapes and surface coating, which means you can assess the effects of thin coats of metallic paint.

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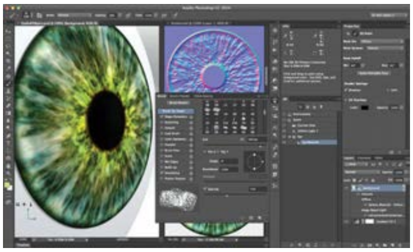
Photoshop CC Expands 3D Printing Options

In January, Adobe began supporting 3D design in Photoshop CC. Now, the company is expanding its additive manufacturing (AM) toolset, and is



increasing the number of service bureaus and AM manufacturers it supports.

The expanded options for 3D printers adds fifth-generation MakerBot Replicators to the list of supported systems, which already included Solidoodle, 3D Systems Cube and Mcor Iris. Available service bureaus have increased from just Shapeways at release to include Sculpteo and Japanese company DMM.com.

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Lockheed Martin Uses AM for Satellite Construction

Lockheed Martin recently redesigned the A2100 satellite, which has been used for telecommunications since the 1990s. Part of the redesign involved updating the electronics and power systems, along with a reduction in the overall number of parts required to build the satellite. Reducing parts makes the satellite less expensive to produce and reduces its weight. Part of the new design incorporates 3D printed parts, and the overall savings in parts is near 60%.

The current design of the A2100 features just 10% 3D printed parts, but the company is certain that number could rise to 50% in the next three years. As an example of the time that can be saved by building parts using AM rather than more traditional methods, Lockheed Martin reports that some brackets can take as long as 30 hours to produce a single finished part when machined. An AM system, on the other hand, can produce 300 of the same bracket in a single day.

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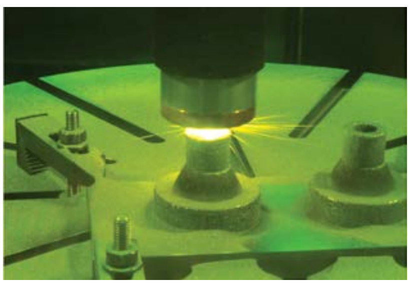
Research Paves the Way for Gradient Metal AM

A research team comprised of individuals from NASA's Jet Propulsion Lab; the California Institute of Technology, Pasadena; and Pennsylvania State University have come together to develop a method of building gradient metal objects. This will allow the design and production of parts in which the metal within a single part changes based on specific requirements.



The new process works by building the desired object on a rotating surface. A laser is used to deposit material on the surface as it rotates, drawing materials from four powder blowers. The process not only allows for the manufacturing of gradient materials, but can also include specific alloys on the fly.

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GE Aviation to Build High-volume AM Factory

Research performed at GE Aviation's Additive Technology Center (ATC) in Cincinnati has led to design breakthroughs and a willingness to invest further in additive manufacturing technologies. As a result of GE Aviation's successful research into building fuel nozzles using AM techniques, the company has announced it will be building a $50 million high-volume AM factory in Auburn, AL.

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Could 3D Printing Save the US Postal Service?

It's no secret that the US postal service (USPS) has been struggling. In 2013 alone, it lost about $5 billion, even after attempts to stem fiscal bleeding.

The reasons for the USPS' struggles are varied, but the end result is the same. The service that has existed in some form or another since 1775 has begun to look for new sources of revenue.

Among other efforts, the USPS' attention has landed on 3D printing: It offers fresh opportunities for the delivery of lightweight packages. As more consumers become interested in buying 3D printed objects from service bureaus, the USPS could see a substantial increase in business — an internal report forecasts up to $485 million annually.

The report also suggested that on-site 3D printers could be used to produce replacement parts for the postal service, potentially offering savings. Other suggestions include the possibility of renting out space on USPS grounds (or nearby) to further improve delivery times for service bureaus.

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PLM on the Go with Autodesk PLM 360

Mobile app augments the browser.

At Autodesk, we believe product lifecycle management (PLM) should reflect your own lifestyle. You're always on the go, always on the move. You manage a significant portion of your appointments and communications with mobile devices. You snap photos to record and share remarkable experiences, from delicious meals to outdoor adventures. No matter where you are, you can remain connected to your friends and family. So why shouldn't you expect the same mobility and convenience from your PLM software?

We think you should. That's why we came up with the Autodesk PLM 360 Mobile App, designed for iOS and Android devices. The lightweight app augments the way you manage your projects and product development teams in the Autodesk PLM 360 browser-based software. The mobile app features:

- The Dashboard, to stay on top of projects and to monitor outstanding items, recent changes, reports, and alerts;
- Workspace Data, to make sure the whole team is always connected wherever they are with access to an instantly updated single source of "the truth";
- Workflow, to avoid bottlenecks by letting task owners perform approvals and recommendations from wherever they are;
- Change Management, to immediately initiate or respond to change orders in real-time, with a clear understanding of the circumstances and history of changes;
- Attachments, to communicate ideas for products, assemblies, and components by quickly and easily capturing and attaching photos with your camera; and
- Reports, to improve decision-making with reports, charts, and graphs that reveal the big picture.

What Customers Say

Avi Robbins, Director of Global Product Development, Porex, is among those who have been using the Autodesk PLM 360 Mobile App to manage his teams. His observes, "The mobile app is making it easier for us to do our jobs. For example, working with test reports is faster. Since PLM is on our phones, we have the ability to snap a photo and attach it directly to the report right in the lab. We don't have to transfer the photo to a laptop, go back to the office, and then upload it to a PLM server."

Porex supplies porous industrial materials to a variety of manufacturers, including those in healthcare, consumer, and industrial markets. By its own estimate, Porex employs over 700 people around the world and serves over 1,300 customers in 65 countries. But you don't have to be a company of the same size to benefit from our PLM software.

Fit for a Business of Any Size

Priced $75 and $150 per user per month respectively for Professional and Enterprise seats, Autodesk PLM 360 is within the reach of practically any business owner, from the smallest design shops to international car makers. If you have

a core group of PLM users surrounded by a large pool of PLM data consumers, Autodesk PLM 360 lets you affordably add participants at $25 per user per month.

Built for the cloud from the ground up, Autodesk PLM 360 takes a radically different approach to PLM. We take on the responsibility of maintaining the backend IT infrastructure, leaving you to what you do best—make great products. Your subscription gives you access to an entire menu of PLM functionalities, but you can pick and choose only the components applicable to you to keep your data management burden to a minimum. The software's cloud architecture reflects the current workforce's lifestyle and behavior. Navigation is as simple as browsing a website. All these characteristics add up to a PLM product that new users will quickly embrace.

To see who have been using Autodesk PLM 360 and why they like it, read our customer stories at autodeskplm360.com/plm360-customers. For more on our mobile app, visit the Autodesk PLM 360 Chanel on YouTube at youtu.be/b5H6DxHTh8A.

The Cloud Opens Doors to Mainstream PLM

Businesses of all sizes are optimizing design collaboration, file management and engineering change orders with new cloud-based platforms — without the cost and complexity of traditional PLM.

BY BETH STACKPOLE

The cloud has leveled the playing field for companies to gain access to large enterprise-class business software. But it's just starting to become aggressively touted as a way to put product lifecycle management (PLM) functionality into the hands of small and medium businesses (SMBs), too.

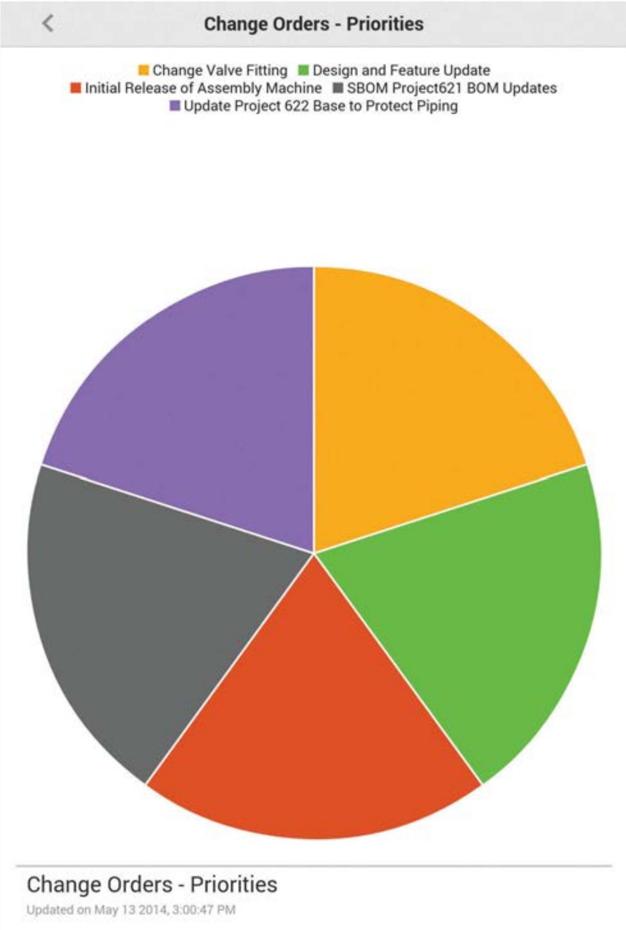
For the better part of two decades, PLM platforms have become widely entrenched in the engineering organizations of the leading aerospace giants, and by top-tier suppliers in the automotive supply chain, among other industries. The traditional, monolithic on-premise PLM system has been much slower to gain ground, however, in small- and mid-sized engineering businesses, which have had trouble digesting the technology because of its relative high cost and complexity.

PLM in the cloud helps Zep Solar gain tighter control over its change processes, while accommodating its rapid growth. *Image courtesy of Affinity Solar via Zep Solar.*

Like most traditional enterprise platforms, PLM requires a significant investment in software licenses, server and network infrastructure, consulting services, and IT resources to deploy, support and maintain the system. By contrast, cloud applications can be accessed with only a browser and basic Internet connection. Most are offered with a flexible utility-like licensing model, in which users pay a monthly, per-user fee that can easily grow or shrink depending on usage needs.

While the Software-as-a-Service (SaaS) or utility-based model was a near instant hit for enterprise systems like customer relationship management (CRM) and enterprise resource planning (ERP), PLM vendors have generally been slower to embrace the new delivery model. That's in no small part due to users' ongoing concerns about the security of design intellectual property (IP) in the cloud — and to a lesser extent, performance. But as comfort with the cloud increases and these worries dissipate, a new generation of SaaS solutions may finally be making PLM functionality accessible to other businesses, which have been handling design collaboration and engineering change orders (ECOs) armed primarily with spreadsheets and manual processes.

"Something like two-thirds of all engineering or CAD users don't have file management capabilities, because the solutions out there are too hard to use, too expensive and offer too much," notes Rob Stevens, VP of marketing and business development for GrabCAD, an online 3D content community, which recently introduced Work-



A new family of Autodesk PLM 360 mobile apps provides anytime, anywhere access to PLM data. ***Image courtesy of Autodesk.***

bench, a cloud-based product data management (PDM) capability. "The next big thing happening in PLM is cloud-based solutions because of the accessibility of the solutions."

Enabling Core Design Processes

Major vendors in the PLM space, including PTC, Siemens PLM Software, and Dassault Systèmes, are still experimenting with how to mash up their respective PLM platforms with the promise of the cloud. For the most part, they're offering their customers — typically larger enterprises — the ability to run traditional PLM in a hosted environment, or what some might call a "private cloud." It's the newcomers like GrabCAD, and PLM late bloomers like Autodesk, that are adopting a true SaaS multi-tenant model. They're offering functionality that addresses core PLM business processes like collaboration and ECOs without necessary dubbing it PLM.

That's exactly the strategy of Kenesto, which released its cloud platform for collaborative project execution aimed squarely at SMB customers in 2012. While Kenesto can be used to facilitate non-engineering tasks, one of its sweet spots is design collaboration and engineering changes. The cloud is the linchpin for making these capabilities attractive to the SMB audience, according to Steve Bodnar, Kenesto's senior VP of product and go-to-market strategy.

"There's no doubt that traditional PDM and PLM products offer functionality that companies need, but the one thing we've always challenged is whether those products deliver that functionality in a way that really makes sense," he says. "Engineers hate PDM products because they create a level of bureaucracy that engineers don't see as necessary, and are more about locking data down than facilitating business processes."

Bodnar points out that modern-day collaboration includes working with key partners, suppliers and customers that reside outside of a company's four walls — well beyond the jurisdiction of their networks and firewalls. That's where the cloud comes in.

"Products installed in the cloud are not limited, so you can engage more participants in the product lifecycle, whether that's in early concept through to design and engineering," Bodnar explains.

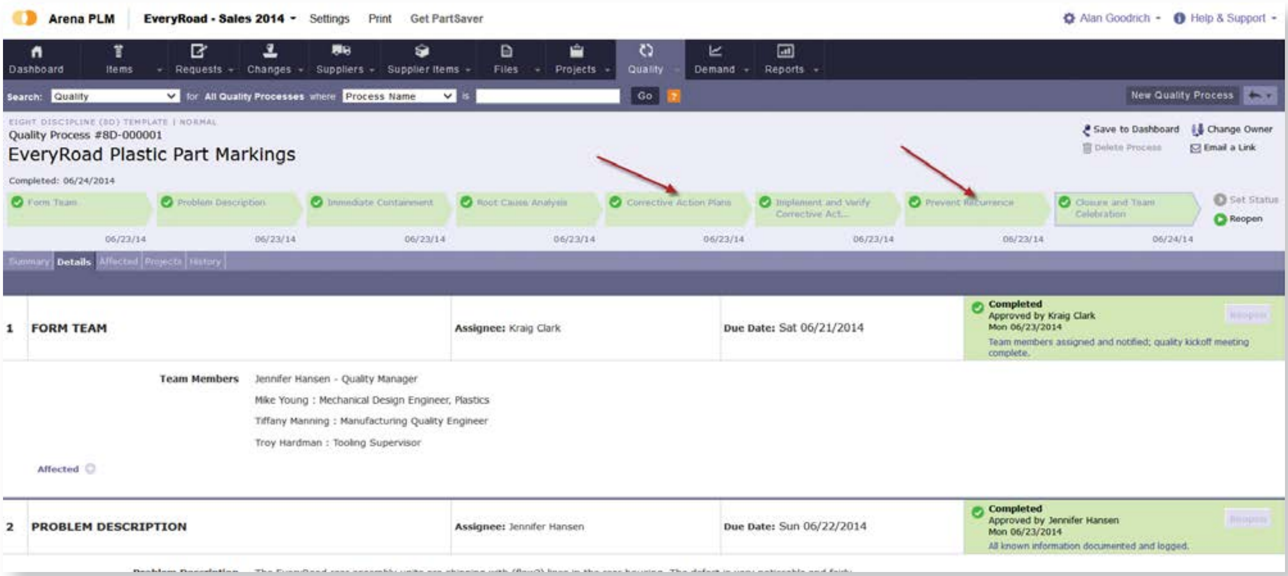
While Kenesto can be tapped to facilitate design collaboration, it handles things differently than traditional on-premise data management platforms like PDM or PLM, he adds. For example, Kenesto doesn't have explicit check-in and -out commands like PDM/PLM does, yet it still lets design teams access, modify and review key documents without errors or overrides, thanks to intelligent syncing capabilities.

"We think check-in/check-out are relics of the old way of doing things," Bodnar says. "By automating things, we can deduce what the user is trying to accomplish, and eliminate extra work and system-level bureaucracy that doesn't need to be there."

Autodesk, which came late to the PLM game with the February 2012 launch of PLM 360, contends the cloud delivery model is crucial for smaller companies that face the same challenges as larger firms, but are not equipped to handle PLM or have a negative perception of traditional PLM platforms. That's according to Ron Locklin, Autodesk's director of PLM 360.

"We're seeing a lot of smaller customers grapple with the same business challenges as larger enterprises, as far as distributed supply chains, offshore manufacturing and multiple design facilities," he continues. "Cloud-based PLM makes it that much easier for companies to solve those business challenges."

GrabCAD's Stevens also sees the cloud as a way to



Arena has extended its pioneering cloud PLM offering with Arena Quality, which directly connects quality processes to the product record. ***Image courtesy of Arena Solutions.***

remove the complexity from PDM and PLM systems and democratize core file management capabilities for more users. That's the idea behind Workbench, which manages project files in one secure location, provides file management capabilities from inside leading CAD systems, and can be accessed on-the-go from a mobile device, he says.

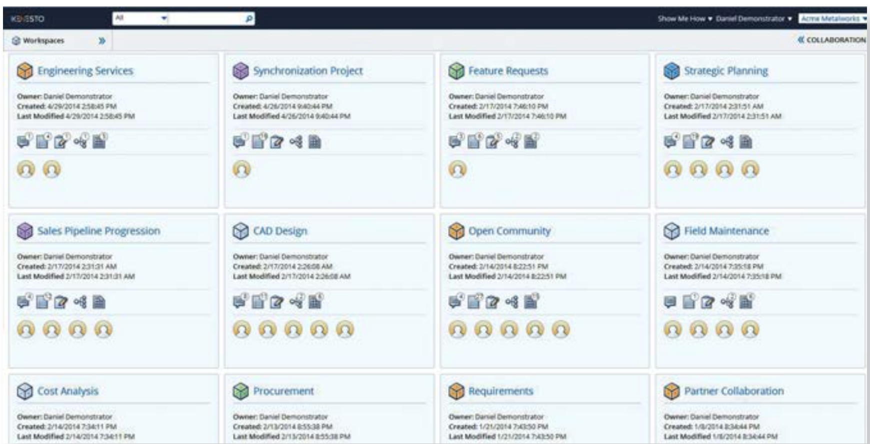
"The cloud is a great solution because it's all about collaboration, and the cloud makes it easy for everyone to get to data," Stevens adds. "Workbench makes it easy to share files with vendors without getting IT involved, and with a strong security model. Stakeholders can be integrated into the project on Day One, accessing the right version of a file and seeing comments from team members. That's almost impossible with a traditional PLM system."

Security Becoming a Non-issue

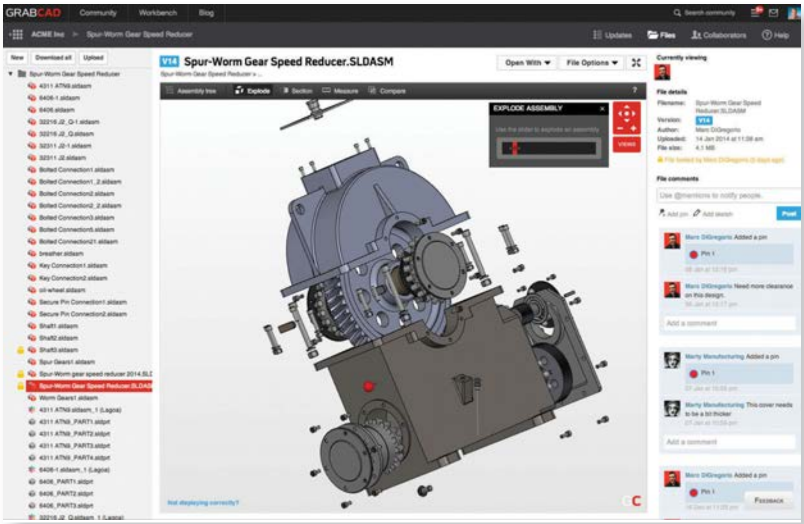
Historically the biggest hurdle to cloud PLM adoption, security no longer seems to be a pressing concern. SMBs and large organizations alike are becoming comfortable with the idea of storing critical data assets in the cloud. Arena, considered the pioneer of cloud-based PLM, is hearing less about security as an obstacle and seeing more interest among potential customers in identifying the core benefits of a cloud-based solution, according to Steve Chalgren, VP of the firm's product management and strategy.

"Now the barriers are use case and functionality as compared to competitors," he says. In fact, he says security has almost become an advantage for the cloud: "The money we spend on security, from firewalls to multiple backup and failovers spread across tens of thousands of users — SMB companies don't have the IT budgets to handle that."

What also resonates with users are the other advantages of a cloud-based PLM, from scalability — they can grow or reduce



Kenesto lets users organize, collaborate and work with others within Project Workspaces that can be created around a project, customer, process or group. ***Image courtesy of Kenesto.***



PDM Workbench leverages the cloud to make it easy for designers and engineers to manage and share files. ***Image courtesy of GrabCAD.***

the number of subscriptions as required and only pay for what's in use — to easy integration with other business systems, to substantial cost savings, Chalgren says.

Not only does cloud PLM spare companies from having to invest in costly on-premise PLM software licenses, maintenance fees, customizations and hardware infrastructure, they can channel those savings to fund new business opportunities, Chalgren points out.

"Cloud PLM frees up capital that can be invested into engineering new products in a company's domain expertise, rather than spending it on IT," he adds.

While it's easy to see SMBs as a likely target for cloud PLM, Aras Software also sees large global companies as good candidates — thanks to the significant cost involved in building out an infrastructure that could support tens of thousands of dispersed users.

"Think about global companies with 10,000 PLM users, 2,000 on each continent," says Aras President Peter Schroer. "That's a difficult IT data center to put together."

Unlike SMBs, which are gravitating to multi-tenant, SaaS cloud PLM solutions, these larger firms are looking at partners like Aras to host their PLM platform in a private cloud, he explains.

While cloud PLM's value proposition is strong, there are some caveats — particularly as they relate to cost savings. As companies add users to the cloud PLM system, costs grow. Experts say there can be a point where it's actually more cost-effective to bring the system on premises. Also, heavily customized PLM implementations are not well suited to the SaaS model, and experts caution potential customers to be diligent about their contracts, making sure there is an exit strategy for getting data out of the cloud if they choose to go with another cloud PLM provider or their own on-premise system.

According to Ty Hudson, VP of product development for Zep Solar — which is on its second deployment of PLM in the cloud — the cost, expandability, and data accessibility benefits of this approach far outweigh any of the drawbacks. The firm, which manufactures hardware for mounting solar panels to rooftops, is now using Autodesk PLM 360 to facilitate collaboration, provide a single source of information for its expanding team, and gain tighter control over its engineering change processes.

As a startup with limited resources, cloud-based services were essential for helping to control costs and allow rapid scaling, Hudson points out.

"The cloud deployment model allowed us to rapidly scale our user base as the company grew, benefit from system improvements from Autodesk, and easily roll out our own specific tenant enhancements in real time," he continues. "New employees can get up and running immediately, whether they are based locally or overseas in our manufacturing group."

Choosing between cloud and on-premise PLM comes down to how comfortable a business is operating online, Hudson concludes. For Zep Solar, the decision to go with cloud PLM was clear as day. Companies large and small may come to a similar conclusion when exploring the benefits of cloud-based PLM. DE

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

INFO → **Aras Software:** Aras.com

→ **Arena Solutions:** ArenaSolutions.com

→ **Autodesk:** Autodesk.com

→ **Dassault Systèmes:** 3DS.com

→ **GrabCAD:** GrabCAD.com

→ **Kenesto:** Kenesto.com

→ **PTC:** PTC.com

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

→ **Zep Solar:** ZepSolar.com

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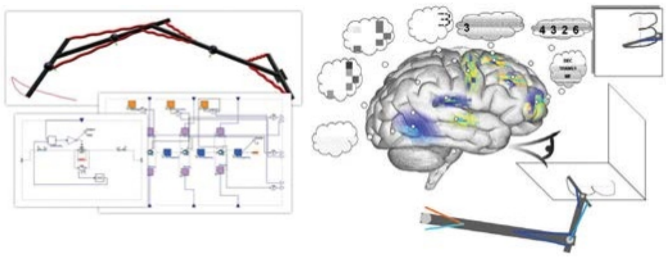
Arm Controlled by Simulated Brain

Robotic arm for world's largest functional brain model built using MapleSim.



A group of neuroscientists and software engineers at the University of Waterloo's Computational Neuroscience Research Group (CNRG) have built the world's largest functional model of the human brain. Named Spaun, the simulated brain has a digital eye which it uses for visual input, and a robotic arm that it uses to draw its responses.

The robotic arm, the output system, is the only motor control system of the model. Researchers used Maplesoft's simulation and modeling platform, MapleSim, to create the arm. Travis DeWolf, the University of Waterloo researcher who built the arm, attributes the success of the complex arm model to MapleSim's symbolic computation power and model simplification capabilities.

One of the problems Travis faced at the beginning of his research was that comprehensive models of the human arm were not readily available. However, empirical studies focused on brain research commonly involve having a subject perform various tasks with their arm. Consequently, it was important to have a simulated arm model to test the accuracy of a brain model.

Spaun (Semantic Pointer Architecture Unified Network) consists of 2.5 million simulated neurons, allowing it to perform eight different tasks. Spaun has a 28×28 (784-pixel) digital eye, and a robotic arm which can write on paper. The researchers show it a group of numbers and letters, which Spaun reads into memory, and then another letter or symbol acts as the command, telling Spaun what function to perform. The output of the task is then inscribed by the simulated arm. Using the arm, the brain demonstrates tasks such as copy drawing, counting, memorizing and reproducing sequences, and fluid reasoning.

In an article, *Popular Science* magazine describes it this way: "*The computer program recognizes items, learns and remembers--and even passes some basic components of an IQ test. It's a major leap in brain simulation, because it's the first model that can actually emulate behaviors while also modeling the physiology that underlies them.*"

A Helping Hand for Modeling an Arm

Using MapleSim, Travis and the team constructed a 9-muscle, 3-link (shoulder, elbow and wrist) arm model, based on the model presented in a paper by Dr. Kenji Tahara. The muscles in the arm were constructed in MapleSim based on the Hill muscle model. The controller was modeled in MATLAB®, and MapleSim's connectivity to MATLAB® via the Maple engine, provided seamless integration between the two systems. "We were able to gradually, and very smoothly, increase the complexity of the model using MapleSim," says Travis. "MapleSim allowed us to easily add in another muscle/link as we progressed, without losing any fidelity. This helped keep the overhead low, and allowed us to focus on developing the control system."

While Travis considered other similar modeling and simulation tools, it was MapleSim's symbolic computation capabilities that won him over. "In the other modeling software that we looked at, the underlying equations just weren't accessible for analysis," continues Travis. "With MapleSim, we had access to the symbolic equations driving the system, which meant we could get very accurate descriptions and do extensive analysis of the model. And the equations were automatically simplified in MapleSim, giving us a highly efficient simulation."

The research goal for Spaun was to evaluate how different scenarios affected the output of the brain system. Other research using this same MapleSim arm model have examined modeling the effects of damage to the brain, caused by blunt trauma, Huntington's disease, and cerebellar abnormalities. The results were compared to real-life patient data to evaluate the accuracy of the model. Having a realistic arm that behaves similarly to an actual arm, with appropriate muscle responses and arm segment lengths and mass, is important to getting accurate results.

Results from this research can be applied to modeling new patient treatments. For example, the effects of deep brain stimulation, i.e., the process of inserting a wire through the brain to send electricity for treating Parkinson's disease, can be modeled in this manner. Having a model such as Spaun will help in more in-depth and accurate investigation before treatment begins. Another application area is the development of neuroprosthetics – better understanding of the motor control systems and the outgoing signals will lead to better functioning prosthetics.

Having completed the Spaun model, Travis is now working on a learning based model of the motor control system of the brain system, rather than an analytical controller approach. MapleSim is playing an important role in this research because of its easy interface and the highly optimized simulations it provides. The arm simulations that Travis generated for the Spaun model are now being used for the development of other controllers. This will save Travis time and effort in creating new models, as he continues to pursue his world-class research.

For more information go to: maplesoft.com

6 Tips
for Smooth Data Management Platform Upgrades

What can possibly motivate a company to transition to a new and improved data management platform, and what can it do to make the transition an easy one?

BY RANDY FRANK

While "the only constant is change" may be true, when it comes to changing a product lifecycle management (PLM) or any data management system (DMS), the change may cause more than the usual of amount of concern to the enterprise. The kind of platform and when the user purchased it are two key considerations for upgrading.

For a company that installed and has been using a pioneering system from 10 years ago, the advantages of any new system could be quite compelling, with the justification being faster execution and greater efficiency. In contrast, a company that just installed its system two or three years ago could require a lot more convincing to spend more money now.

But both of these situations are not necessarily true.

Discussions with experts from three PLM suppliers have revealed six tips that PLM users should use to make the case for changing — and help make the transition go more smoothly.

1. Know When to Say When.

Aras uses the term "hitting the wall" to describe when a company recognizes that it needs to change its PLM approach. Peter Schroer, CEO of Aras says the situation is not unusual.

Speaking from the perspective of companies Aras has dealt with, Schroer explains, "We were going to do CAD management and then after that, we were going to go out to the shop floor. We were going to bring our suppliers on board. Then you realize two years later, the only thing you got done was CAD file management."

Different limitations include either technology or functionality walls. The technology wall is tied to hard-

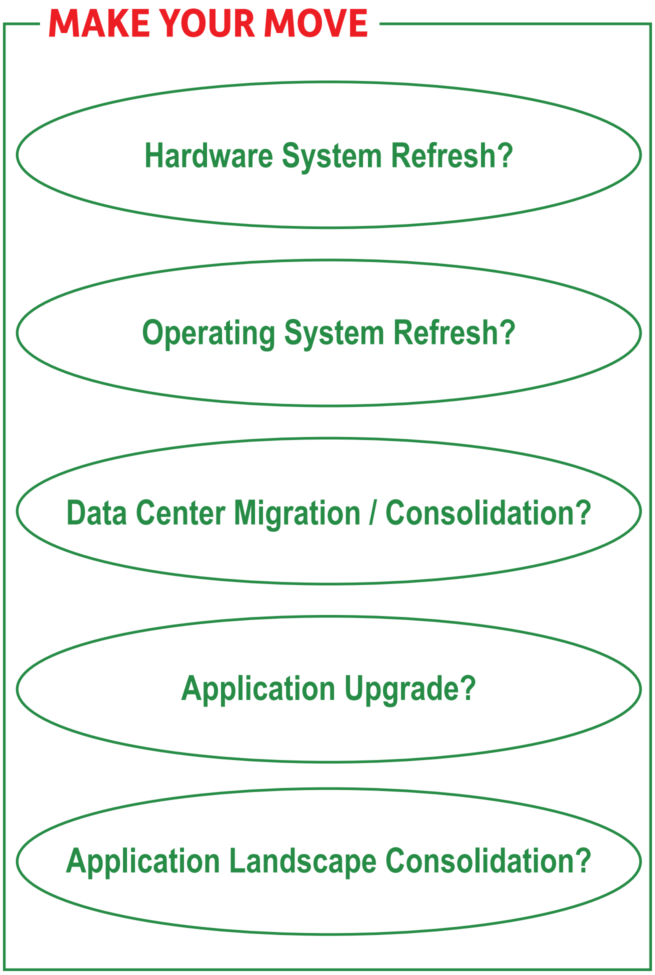


FIG. 1: Compelling events for database migration. *Image courtesy of SAP SE.*

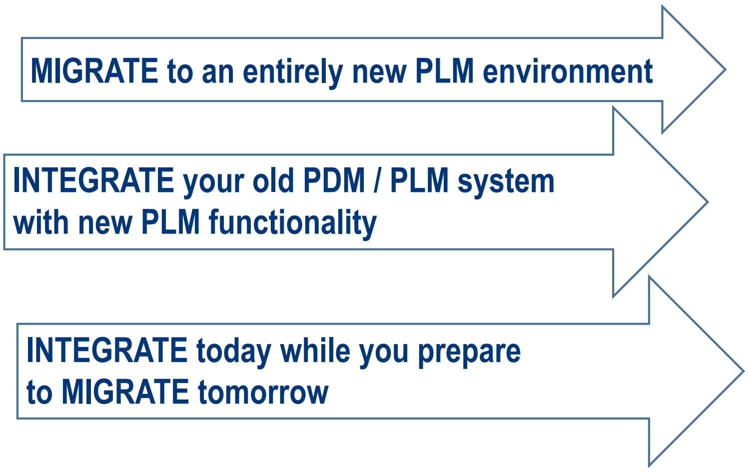


FIG. 2: Alternate paths to improved PLM can mitigate a complete overhaul. *Image courtesy of Aras.*

ware, operating system and database technologies. The functionality wall limits what needs to be done to support the business needs of the organization.

"So your PLM has kind of run out of gas, and it's not going to hit the scope that justifies the original ROI," says Schroer. "This could be because you picked the wrong PLM for the problem you are solving. Two years in, you realize it doesn't solve the business problem that you had."

2. Find a Window/Windows of Opportunity. An opportunity can also be seen as a compelling event or trigger point. Schroer shares the experience Aras has had regarding upgrades.

"At the point that you are being forced to do a major system upgrade, that's the time that we get the most phone calls," he says.

According to Dan Lahl, VP of database product marketing at SAP, "There's a number of different decision points that customers have to decide whether they want to pull out of their existing data management system and put in another data management system." (See Fig. 1.)

While a hardware refresh or upgrade every five years used to be common, today every three years is about the norm. "For the past five to seven years, it's been down to 36 months," Lahl reports.

A hardware refresh could occur because of a change from Intel's Westmere architecture to the Xeon E7 v2 Ivy bridge architecture, for example.

FIG. 3: An example of tying the user and its company, supplier and customer needs to cloud-based PLM pieces. *Image courtesy of Kenesto.*

"If they are going to make hardware switch, that's when we see customers saying, 'Do we want to make a data management switch as well?'" notes Lahl. "They know that they have to plan for a data center switch; they know they are going to have down time."

An operating system change provides another compelling event. For example, Microsoft recently announced that Windows Server 2003 is about to be obsolete.

In his 2014 Worldwide Partner Conference Keynote address in Washington in July, John Case, corporate VP, Microsoft Office Division, said, "This year alone, when Windows Server 2003 comes to the end of service, there's a $6 billion opportunity with 22 million instances still running on Server 2003."

"If you're sitting on a PLM system that requires this older technology, this is what we call a 'forced upgrade' — you're being forced to upgrade PLM because of an external event," says Aras' Schroer.

Another compelling event can occur because of a fiscal milestone. For example, many customers are concerned about annual expenses for license fees.

SAP's Lahl says he is increasingly seeing a number of customers saying creating a business plan to get off of some license fees, which can result in changing to an SAP database.

3. Look for Adaptable/Resilient Software.

In the last 10 years — and especially in the last five — significant changes have occurred in IT technology. There's also been a change in the methodologies of developing software beyond the actual software itself.

"People are thinking about what we call 'more resilient' systems," says Aras' Schroer. "The idea of building a system knowing that there is going to be a change."

With these new approaches, the right PLM decision could make the chosen system last longer before the next major change is required, he says.

4. Take Advantage of PLM's Increasing Importance to Engineering and Beyond.

"There are many compelling reasons why you need to get PLM right. This goes well beyond the need to manage CAD files faster," Schroer points out.

The increasing importance of data management can be witnessed by recent manufacturing incidents such as General Motors' ignition switch that an engineer changed without the proper controls in place — potentially costing the company more than $1 billion. Properly used PLM tools could have prevented such a change from being overlooked.

"Because of increased compliance, increased reliability and increased product life, getting PLM right is becoming almost mission-critical important," insists Schroer.

The importance of managing data goes far beyond the engineering department, reaching into every function of the enterprise.

5. Consider Alternatives to a Complete Overhaul.

Users may not have to abandon their existing software; newer compatible enhancements may provide the solution to system limitations. Fig. 2 shows one way to look at alternatives.

"Several years ago, there weren't good other alternatives," says Stephen Bodnar, senior VP, strategy and products for Kenesto. "Now, I think there are more good alternatives that not only do enough from a functionality standpoint to satisfy the needs, but the cost, the business models, are so drastically different today for some of these newer solutions, that it is very attainable for companies where it wasn't in the past."

In fact, many smaller companies have not pursued PLM software because of high product and implementation costs, Bodnar points out.

"They have implemented a collection of other tools to satisfy their need," he continues. "It is some combination of one or more of those tools that is not getting the job done, so they are starting to look at other options."

Fig. 3 provides an example of what companies may try to accomplish with disparate tools. Without interconnectivity, the tools' efficiency suffers — and users frequently change from one product to another to try to solve such shortcomings.

"Not only do you lose efficiency, it is more difficult to find information that might be interrelated," says Bodnar. "You have virtually no ability to capture an audit trail."

Products like Kenesto v7, he says, can enable firms with engineering projects to collaborate on plans — as well as manage, discuss, share and track engineering project information at various engineering and management levels. It also allows appropriate access by suppliers and customers to the company's information.

A situation can occur where the IT department or a business unit wants the latest software, and a manufacturing or engineering department is satisfied with its current system. Aras' Schroer says there is an alternate solution to forcing a change on the whole organization. The manufacturing or engineering staff can stay with its older version and continue to use it almost as a subnetwork, while the other parts of the organization move to a new tool like Aras which supports the latest Microsoft technologies.

"We use Aras Federation technology to get the data back and forth between the two systems," Schroer explains. "What you have done is minimized your cost, but more importantly, you just encapsulated the risk."

6. Look for Products and Services Supported by Transition Tools.

Many PLM software providers offer tools or support to simplify the transition from one system to another.

"We have this built-in web service for doing federation, and we are completely a web client," says Schroer, noting that Aras Federation uses web services based on open industry standards with a transparent data model.

Lahl says SAP has several tools "so you can move from one database to another, relatively painlessly." He cites SAP's DBA Cockpit as an example. It is a platform-independent tool that you can use to monitor and administer your database, according to the company. SAP says it provides a graphical user interface and covers all aspects of handling a database system landscape.

"They put in tooling that allows you to easily move your applications from one database to another," Lahl says. **DE**

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

INFO ➜ Aras: Aras.com

➜ **Kenesto:** Kenesto.com

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Cross the PLM Culture vs. Technology Divide

Image courtesy of iStock.

Getting employees to adapt to a product lifecycle management deployment takes planning — and understanding.

BY BRIAN ALBRIGHT

Product lifecycle management (PLM) solutions do more than just streamline data management. When properly deployed, they fundamentally change the way in which multiple departments engage with product data, both in terms of creating new data and accessing existing data.

That's why many companies find themselves facing operational and employee acceptance challenges, rather than integration problems, when they tackle PLM projects.

"The major hurdle to adopting a PLM solution is not technological, it's on the business process side," says Bill Lewis, director of product marketing at Siemens PLM Software. "There's a lot of work that goes into determining what business process should be going forward, and what it will look like."

The key to overcoming those business process challenges lies with employees across multiple departments. Some will embrace PLM enthusiastically; some grudgingly adapt because they value their jobs. Others simply take an over-my-dead-body position.

"The big win comes when you get those people who are averse to change to finally see the light and have an epiphany about the value of the solution," notes Todd Cummings, VP of research and development at Synergis Software.

But supporting data management is different than supporting a CAD solution. PLM systems are interrelated, multi-user and multi-department solutions that require employees to think beyond the confines of their own department or work process.

For the Greater Good

Companies are often surprised at the interconnectedness of their data, and how changes in one department can have far-reaching effects in areas of the company they weren't even considering as part of a data management project. "The plan has to be agnostic, and has to be about the greater good," Cummings says. "We have to follow every thread to its logical conclusion. There's an awareness-raising component to this that's part of the fun of what we do."

For example, design and manufacturing documents are often used by the marketing department well in advance of an actual product launch. Changes in the specs can also affect things like packaging, product shipping rates, pricing, materials sourcing and other areas that are not necessarily on the radar of most design engineers.

"Engineering groups often don't understand the whole suite of activities that go on — which take almost as long as the development cycle — that need to happen before you can make money on a product," says John Kelley, VP, product value chain strategy at Oracle. "Other groups are thrilled once they see how this works. Operational folks, costing, quality, sourcing or supply chain readiness — they are thrilled to have access to this data earlier than they've ever had it."

Engineering groups can, in fact, present a major obstacle if they are reluctant to share design data early and often. "There are still engineering folks who want to work in isolation because they don't want to expose what they are working on until the very end," Kelley notes. "But we see those situations less and less."

Other departments may balk at new or unfamiliar processes. "It's relatively easy to explain the company-wide benefits of PLM," says Kevin Eustace, senior VP of product driven services at Siemens. "But when you get to the department level, one department may be asked to do more than another, and you have to make the shift in importance clear in order to incentivize that department to embrace the work. You have to communicate the value."

Cummings agrees. "When you turn the key on these systems, it's a different world," he adds. "People have to work differently after the system goes live."

A 360° View

According to Cummings, the key to preventing employee resistance from undermining a PLM deployment is to engage every department during the planning stage. Engage a project team that can provide a complete view of the company and the product data, including members from the IT and user communities.

"The team should be made up of people who don't just have a title, but actually have some operational interaction with employees, who are respected and listened to, and who are willing to listen to the user base," he continues. "That's different than a top-down mandate with no explanation."

Address employee concerns about the solution as early as possible in the process, and emphasize the benefits. "Everyone has to be on the same page," Eustace says. "You have to make it clear that the solution will make you more competitive. And understand that when you tell people this will make you more efficient and productive, they start to wonder about layoffs. You have to address all of that up front if you want support for the project."

Another wrinkle in some organizations is that some functions (marketing, manufacturing or even product development) may be outsourced to third-party companies. Now the challenge becomes not just getting the internal team onboard, but also convincing the partner and their employees to get behind the initiative. You can't integrate data from multiple sources without considering the environment in which you're doing it — with heterogeneous corporate cultures.

"Companies that outsource strategically develop partner agreements that include a set of terms around data access," Kelley points out. "You need a strong supplier management group to negotiate those contracts, and ensure there is visibility."

Strong, engaged executive sponsorship at the VP level or higher is also key. That high-level support can help motivate reluctant managers, and provide assistance in cutting through red tape during the project.

Explain the Value

Developing a comprehensive project plan is also important for user acceptance. Assess the full scope of the project before presenting the plan to the company. If the baseline keeps shifting, or project goals change frequently, it will be harder to keep stakeholders engaged. It will eventually erode trust in the project.

Clearly define who owns the project, what data will be managed and for whom. Which departments will be affected? What are the expected risks and benefits? Define what success will look like in terms of improvements, and how those improvements will be measured.

"We have an assessment process we go through before we talk to customers about technology," says Siemens' Lewis. "We ask what their goals are, what they are trying to achieve in the next five years. Do they want to reach a new market? And then we dig in and find out what's keeping them from getting there."

Find ways that the value of the solution will extend to each department, and explain how the departments affect each other. "For example, we had a client where design engineering would always print the most current version of the documents for the people on the shop floor," offers Synergis Software's Cummings. "If the shop floor can get that on screen, then they don't have to waste paper."

Cummings notes that the concept can be expanded to things like computer numerically controlled (CNC) machines, for example: "Put the CNC code in the solution so we know that every time there is a change, the correct version goes out."

Siemens' Eustace notes that PLM makes walls disappear that previously prevented departments from effectively using data. "You can combine information coming from all of these systems in a format that allows them to make good decisions," he says. "The data becomes company data, and is available for re-use in ways that can be leveraged to make other activities easier."

It's important to look for subjective feedback — not just improvement numbers, but input on how users actually feel about the solution during the deployment. Otherwise, once the implementation is completed, users may slip back into old work processes and undermine the solution.

Know Your Data

A key piece of the planning phase is finding out how much data the company has, and what condition it's in. Evaluate data to determine how accurate or clean it is, and how it can be scrubbed. Find out who owns the data, where it resides, and who uses that data further along in the work process.

"No customer really knows their data," Cummings points out. "Whether you are talking about a small or a large organization, it's amazing how multiple people across multiple departments can use the same data without understanding that they are each consuming that information from different

7 Steps to Cross PLM Cultural Divide

1. Explain the "greater good" benefits to the company that a shared data platform will provide.
2. Communicate the specific value of a PLM solution to the engineering department.
3. Develop a comprehensive project plan well in advance of presenting it.
4. Uncover disparate, sometimes hidden silos of data during the planning phase.
5. Enlist "champions" to serve as leaders in removing organizational barriers to implementation.
6. Get strong executive-level support and maintain it throughout the PLM implementation.
7. Place a priority on training and listening to employees.

perspectives. It's multi-dimensional, and that's why its critical to have a project team with a 360° view."

This process will often uncover data repositories that are critical to the business, but that are otherwise not part of the official workflow. "There's always an opportunity to find out more than what is actually documented by the company," Cummings says. "Data sources have an odd way of multiplying once you start digging."

Finding those "hidden" data sources will also help smooth the transition for employees connected to those repositories, Lewis says.

"There is a whole universe of people orbiting the product data, from sourcing to sustainability to the field technician servicing the product," he adds. "Companies are seeing the value in having all of these people on the same system, and in an environment that is not an engineering tool. It's not geared to the technical power user, but it's for people who don't live their lives in the CAD system."

Breaking Down Barriers

With the project team in place and a thorough understanding of the company product data, project leaders can then enlist "champions" in functional areas that can serve as leaders and help remove organizational barriers to the project's success. These champions can come from any level of the company, as long as they are trusted and respected by other end users.

Communicate both the scope of the project and its progress frequently. Stakeholders should have some ownership in the process so that they are invested in the success of the deployment.

"This is where the local champions come in," Cummings says. "Those folks can have a tremendous positive influence in helping people understand the why and how of the solution."

These projects still encounter unexpected pockets of resistance, of course, particularly as the go-live date draws nearer. Users may cling to existing work processes, even if the new PLM can potentially make their jobs easier.

"Even if the old way is convoluted, complex and takes longer, it's remarkable how we see people hanging on to that old way," Cummings says. "That's because the old way is comfortable for them. You really have to map out how this will help them, and show them that it is more streamlined and saves time."

Employees may have an almost emotional connection to their workflows. While management can force those changes from the top down, a more nuanced approach can result in full employee buy-in, rather than grudging acceptance.

"At the center of those issues are people taking pride in what they do," Cummings says. "Often we'll find that at some point in the past, something didn't go right with a solution and they weren't able to do their job in the way they wanted to do it, or that they were expected to do it. The process then becomes a bit like arbitration."

In many cases, where there may be a larger need for education and change management, a third-party consultant or integrator can provide valuable assistance. "Having a systems integration partner that can come in and manage that process is really helpful," Kelley says. "We have a consulting group that can install the software and train the users, but you need someone there who can execute executive-level change management, and then take that process through the ranks."

The training approach can also ease employee acceptance. Train administrators and project champions early so that they can help lead group training. And allow time for "over the shoulder," hands-on training so users can experience how the solution will work in a live environment while they are completing their work.

"You have to keep everyone confident that when they sit down at their desks, they are not in a free fall," Cummings says. "They know that they can effectively get their work done."

Dashboard-level controls for management, meanwhile, will help keep executive sponsors involved in the process by providing tangible benefits through direct visibility into the product pipeline, along with analytics and reports. "The executive sponsors also have to stay engaged," Kelley points out. "You can't just bless the thing, hold a pep rally and then go away."

Finally, make sure everyone affected by the project is aware of the important role they play in maintaining product data, and what the value of the solution will be for their department and for their specific role in the process.

"Part of the job is helping people realize that they are connected," Cummings says. "There is an interdependency and reliance on the data, and a lot of times people may not understand that, even when the processes are well documented. You have to connect the people, not just boxes on the flow chart. When people connect, then the process challenges are a lot easier.

"This is a knowledge-expanding experience," he concludes. "You have to go in with an adventurous eye. The end result is a deeper understanding about how you work and how you can work better." **DE**

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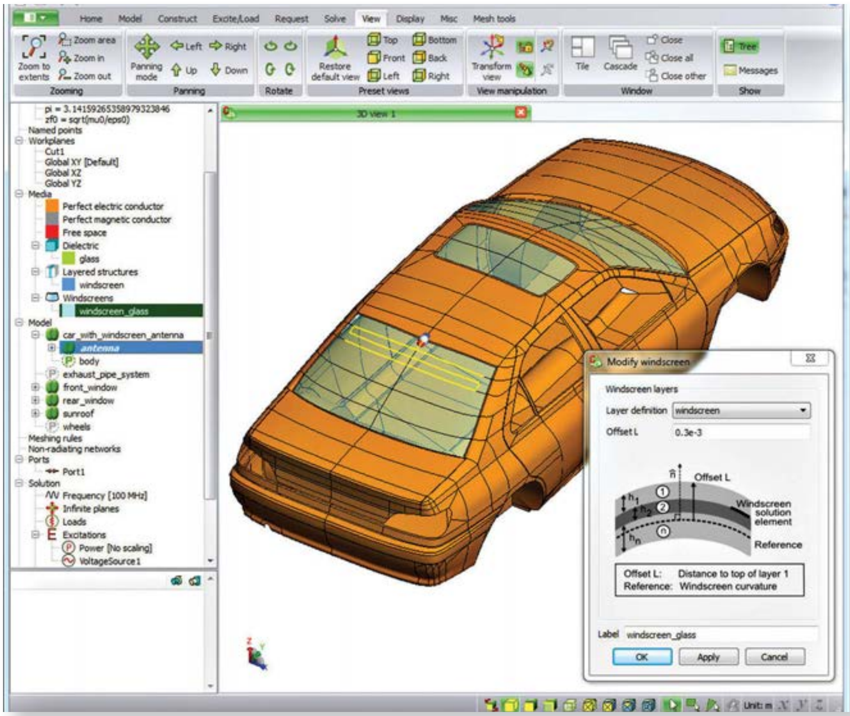
EM Collaborations

Today's tools ease electromagnetic simulations in a multiphysics workflow.

BY PAMELA J. WATERMAN

Collision-avoidance systems, deep-tissue heating devices and induction-heating stovetops all owe their existence to designs that used to be mostly mechanical, yet now include complex electromagnetic (EM) components. When working with low frequencies (as in motors, loudspeakers and transformers) or high (for antennas, microwave ovens and particle accelerators), mechanical engineers must move beyond electronic circuits and control systems into the realm of EM field theory. This step means adding new considerations to design and analysis tasks.

Knowing which aspects of an EM model are critical or minor for input to a mechanical analysis can be tricky. The finite element analysis (FEA) meshes for each physics simulation are most likely not the same — for example, you must model the air as a propagation path. Time-scales for electric, thermal and mechanical simulations can differ by a factor of 100. And combining EM and mechanical analyses requires twice the decisions about importing geometry, setting boundary conditions and defining material properties.



Windscreen antenna definition as part of CAD model creation, for analysis with Altair/EMSS FEKO software. ***Image courtesy of Altair/EMSS.***

New Design Strategies Needed

Considering the challenges of EM simulations, Walter Frei, a COMSOL Multiphysics electrical engineer says, "A good structural or thermal analyst can usually have an intuitive feel for what the solution will look like, even before they do much analysis. However, electromagnetics problems can be a lot harder to predict prior to analysis, especially if you consider induced currents, magnetic fields and resonant phenomena." His advice to mechanical engineers tackling their first EM projects: "Be familiar with all aspects of the design — the material properties, the operating conditions and most importantly, the outputs."

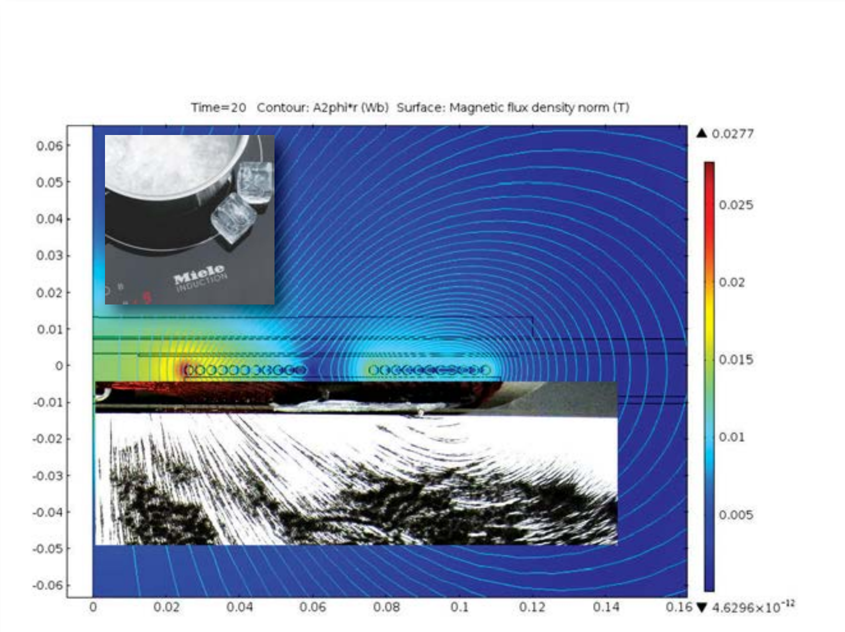
Standard steps apply, whether evaluating mechanical or EM part behavior. As with any simulation setup, says Pierre Thieffry, ANSYS product line manager for structural mechanics, engineers must define the loads, boundary conditions and forces at work.

"You must understand which data will have an influence on the model," he continues. "A potential source is heat transfer: If you look at EM systems, they usually induce losses. This means temperature changes in the body, which creates stresses due to thermal deformations (temperature differences in the structure). This effect could also be time- and frequency-dependent."

Designers need tools to readily transfer this data from one simulation to the other — sometimes in both directions.

"ANSYS Workbench is ideal to do that," says Thieffry. "Users just have to take the results of the electromagnetic simulation and drag-and-drop them on the project page to link them to the setup of the other simulation."

The Workbench I/O function takes care of data mapping and formatting, he adds, even if the mesh doesn't match up between the EM and structural simulations, which is usually the case. With ANSYS Workbench, users can couple ANSYS Maxwell models



A Miele induction-heating stovetop (inset) delivers energy directly to the pot as well as the food within — eliminating the need to heat the stove surface as an intermediary step. Comparison of measured and simulated magnetic flux density, with excellent agreement, as analyzed with COMSOL Multiphysics software. *Image courtesy of COMSOL.*

to ANSYS Mechanical, ANSYS Fluent or ANSYS Icepak to perform a stress, computational fluid dynamics (CFD) or thermal analysis.

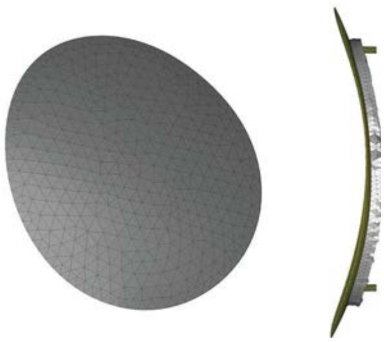
The operational frequency of EM components and systems may encompass the kilohertz, radio frequency (RF), microwave or even optical ranges, with each band requiring different mathematical approaches to simulation for the most accurate results. At Computer Simulation Technology AG (CST), this requirement is managed by the company's "Complete Technology" approach across CST STUDIO SUITE software.

"This means all our different solvers, optimizers and post-processing options are available within the same user interface, and can use the same models," says CST Technical Writer Stephen Murray. "For example, for an EM simulation, a particle simulation and a thermal simulation, you can use the same model — and the results from one can be imported directly into another."

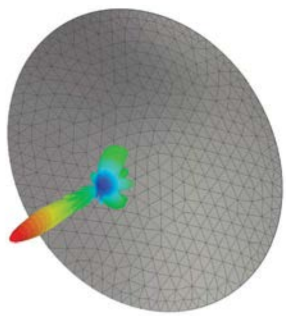
Since 2012, CST STUDIO SUITE has supported linking multiple simulation and post-processing tasks with its System Assembly and Modeling (SAM) framework. This tool breaks down and automates workflows as a series of tasks. It chains together multiple multiphysics (MP) simulations, even with different solver types — a parabolic dish and a feedhorn, for example. It uses the same model and parameters, then optimizes the results. The 2014 release offers a wizard that helps users create full-wave EM simulations combined with thermal simulations. Mechanical simulations can be added to calculate part expansion and detuning effects.

EM is just one of the many realms addressed by COMSOL Multiphysics software, which allows users to work in an integrated environment. Users define the geometry, set up the physics, create the mesh, find solutions and optimize results — all in one graphic user interface. Different modules target RF/Microwave, AC/DC, plasma or particle tracing; applications include bundled transmission cables, RF filters for a cell-phone base station, or the latest in home appliances.

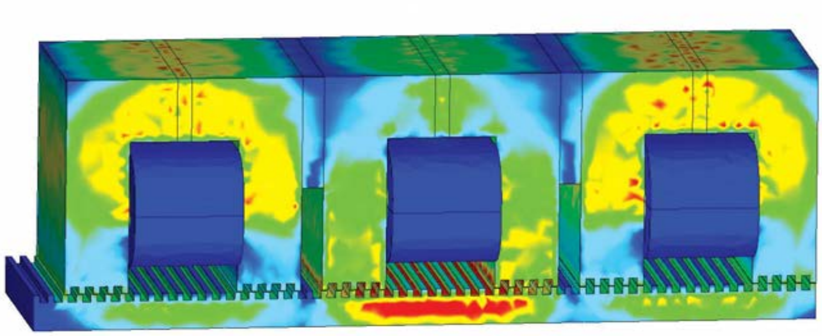
This satellite reflector dish shows a solar heating pattern when the dish is partially shadowed. The calculation was performed with the thermal stationary solver in CST MPHYSICS STUDIO. *Images courtesy of CST.*



Calculated deformation of a satellite antenna reflector caused by uneven thermal expansion (exaggerated plot), performed with the structural mechanics solver in CST MPHYSICS STUDIO.



Radiation pattern for a thermally deformed satellite antenna dish, showing solver mesh, calculated with CST MICROWAVE STUDIO. The change may be small compared to the pattern for the unstressed version, but it may be enough to cause signal problems at the edge of the satellite's footprint.



Magnetic flux density in a linear motor, calculated with ElectroMagneticWorks EMS analysis software (available as an add-on to SolidWorks and Autodesk Inventor). *Image courtesy of ElectroMagneticWorks.*

Breaking Down the Problem

Making it simpler to import CAD data, create meshes and select solvers can ease the transition between EM and mechanical analyses. FEKO software from EM Software & Systems (EMSS, recently purchased by Altair) pays close attention to exactly these tasks and more, with applications including the design and placement of antennas, RF components, radomes and bioelectromagnetics. Three particularly relevant modules and their functions are CADFEKO (CAD import), POSTFEKO (post-processing) and EDITFEKO (scripting).

Explains Ulrich Jakobus, the original author of FEKO software, as well as the EMSS director and FEKO product manager, "We try to make the CAD import process as streamlined as possible by carefully selecting a number of default settings of certain parameters that should work reasonably fine in most cases. For specific requirements, advanced users can have more control over these parameters."

Default and advanced settings are available in CADFEKO for fixing and healing CAD files. For really challenging cases, CADFEKO interfaces with more powerful pre-processing tools like Altair HyperMesh. To take advantage of parallel processing, FEKO's solvers have been rigorously parallelized for both distributed and shared memory architectures.

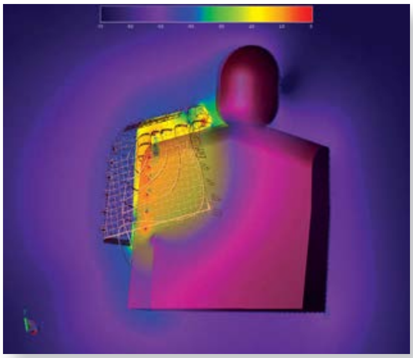
"We observe excellent scaling of both memory and run-time," says Jakobus. "GPU computing is also supported for specific solvers, and will be extended in the future to other algorithms as well."

Another business move that tightened the connection between a specialized EM design tool and a general analysis package came in 2011: CD-adapco, a CFD/FEA analysis company, bought SPEED, a well-known electric-machine design package. The combination offers an end-to-end simulation solution, starting with 2D CAD geometry and FEA models and extruding them into 3D models suitable for thermal analysis in CD-adapco's STAR-CCM+. The result is detailed thermal data vs. geometry, with easy-to-rerun solver templates that can be reused to evaluate design changes.

Stefan Holst, a CD-adapco electromagnetics (EMAG) application specialist, says one of the benefits of working on the front end with SPEED is that users can import CAD geometry with the properties already defined by the electrical engineers; this includes files generated in such design packages as CATIA and losses calculated in other EM packages. Holst explains that for a detailed thermal analysis, mechanical engineers should address the facts that material properties can be anisotropic, heat losses are not homogeneous (copper losses are non-linear and temperature-dependent, for example), and skin

Open to Open-Source?

If you like a challenge — and can live without customer support — you'll find several dozen free computational electromagnetic (EM) modeling codes listed by the Clemson University Vehicular Electronics Laboratory at cvel.clemson.edu/modeling/EMAG/free-codes.html.



Electromagnetic radiation analysis of a deep-heating therapeutic shoulder garment from ReGear Life Sciences, calculated with Remcom XFdtd electromagnetic analysis software. *Image courtesy of Remcom.*

effects require problem-specific setups for meshes and solvers. At the same time, many CAD model details can be simplified without loss of accuracy in the thermal results — for example, wires wound in a coil represented as a solid copper strip.

Simplifying CAD Integration

For more than 20 years, Remcom EM simulation and wireless propagation tools have supported MP analyses across a broad frequency spectrum. The company's flagship XFdtd package applies a time-domain/frequency-domain approach (explained at Remcom.com/xf7-fdtd-method) that scales with problem size; it's particularly effective at simulating non-linear materials. Fast processing speed is supported on NVIDIA compute unified device architecture (CUDA)-enabled graphics processing units (GPUs) and message-passing interface (MPI) clustering.

Acknowledging the need for smooth CAD integration and efficient design processes, Remcom developed its CAD Merge feature about 10 years ago. Scott Langdon, Remcom co-founder and president, describes how this feature was originally developed for mobile device manufacturers working with rapidly changing mechanical design files.

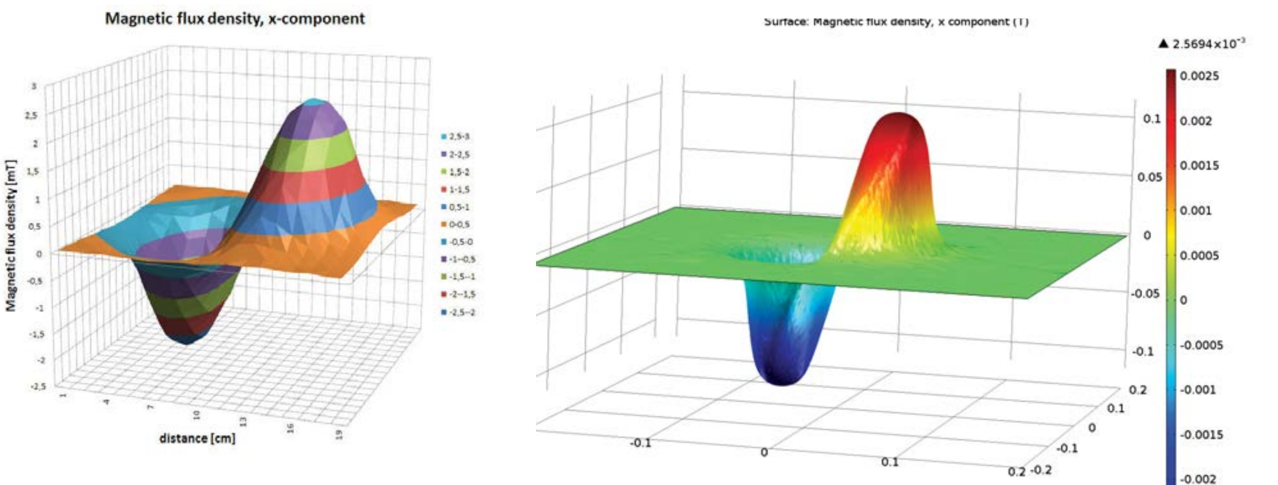
"Mobile device CAD files may have thousands of parts, and the antenna design engineers would sometimes spend an hour or more assigning electrical properties — which are typically not part of a CAD file — to perform accurate EM simulations," he explains. "Also, they would sometimes make other changes, such as regrouping parts related to the various antennas. The problem was, slightly updated versions of the CAD files would frequently become available, requiring the design engineers to again perform these material assignments and grouping operations on the new CAD file."

With CAD Merge, design engineers can perform an initial round of setting up material properties and parts hierarchy, and XFdtd will save it. When a new file is available, CAD Merge compares the two files to see what's the same. It then identifies new and deleted parts, and, for all unchanged parts, arranges them precisely as before with the same properties, quickly and automatically.

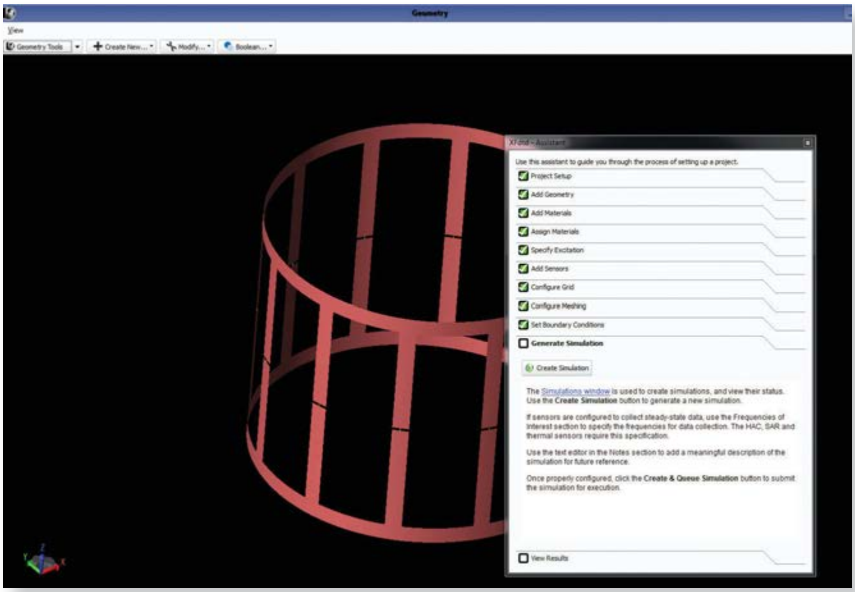
The XF7 Assistant in XFdtd is another productivity Remcom tool that eliminates redundant tasks. With XF7, users can turn a project into a template, store parts in a shared library, and save simulation for comparison. It also guides users through each step of a project setup, toggled on or off as desired, without the fixed sequence of a traditional wizard.

Few software companies with EM design and analysis products can say they've been in this arena almost 40 years, but that situation holds at Infolytica, founded in 1978. The company's first product, MagNet, has evolved from a basic 2D analysis system to a full 3D EM modeling program that is available standalone or totally embedded in SolidWorks. MagNet, along with ElecNet, Infolytica's electric field simulation software, now supports multicore mesh generation, solvers and post-processing.

Links to third-party software such as Matlab and Excel simplify automating MagNet and ElecNet model creation and post-processing, while both packages couple directly with Infolytica's



Measured (left) and simulated (right) images of x-component of magnetic flux density for coil design of a Miele inductive-heating stovetop, performed with COMSOL Multiphysics software. ***Image courtesy of COMSOL.***



Step-by-step optional XFdtd Assistant tool from Remcom, in support of its XFdtd multiphysics electromagnetic analysis software. ***Image courtesy of Remcom.***

ThermNet for steady-state and transient thermal simulations and OptiNet for automated design optimization. The Infolytica website lists a wide variety of applications, from loudspeaker and maglev system design to optimization of magnetrons and die-press equipment; many examples include helpful videos and even downloadable model files.

If you prefer working exclusively with CAD-integrated packages, look into ElectroMagnetic Works software. Its seamless integration with either SolidWorks or Autodesk Inventor eliminates the need for geometry import. Based on FE methods, the company's EM and magnetic software products — EMS, HFWorks and ATLASS — cover analyses ranging from DC to millimeter-wave frequencies. Sample applications include motors, micro-electro-mechanical systems (MEMS) devices, microstrip conductors, antenna feedhorns, multiplexers and cardiovascular catheters.

To run an EM simulation, EMWorks users select a study type for running multiple what-if scenarios on a CAD model, then assign materials and boundary conditions. The software performs automatic mesh generation, starts the solver and generates automatic reports as desired. A familiar feature tree displays all tasks; users can drag-and-drop simulations for cloned studies and easily share EMS study results across mechanical, thermal and fluid simulations within the CAD software. **DE**

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

INFO → Altair/EM Software & Systems: FEKO.info

→ **ANSYS:** ANSYS.com

→ **CD-adapco:** CD-adapco.com

→ **Computer Simulation Technology AG:** CST.com

→ **COMSOL:** COMSOL.com

→ **ElectroMagneticWorks:** EMWorks.com

→ **Infolytica:** Infolytica.com

→ **Remcom:** Remcom.com

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Quantum of Solar

University of Michigan's Quantum wins American Solar Challenge.

BY KENNETH WONG

Quantum is the 11th car built by the University of Michigan Solar Car Team (UMSCT). It weighs 320 lbs., with an anticipated top speed of 105 mph. The vehicle is 200 lbs. lighter and 30% more aerodynamic than its predecessor Infinium, according to the UMSCT's online records. That dramatic design improvement gave the team an edge in the American Solar Challenge. Plowing through roughly 1,720 miles across seven states, Quantum clocked in at 41:27 min and took first place — beating runner-ups from the University of Minnesota (45:19 min) and Iowa State University (50:18 min).

Because they were given access to a rich portfolio of advanced manufacturing software products from their sponsor, Siemens PLM Software, the UMSCT came to understand the importance of system-level thinking.

The Vehicle as a Whole

In a video interview with Siemens, Arnold Kadiu, the team's engineering manager, sums up the wisdom that drove them toward system-level design: "It's easy to design just a steering wheel that works really well, an isolated suspension system that works really well, or a braking system that works really well by itself. Bringing it all together is really the hard part."

This strategy led to switching all design works into a single modeling environment, NX 9. Pavan Naik, the team's senior business development manager, says, "As we began to prepare to compete with the best teams in the world in 2013, we knew we needed more comprehensive PLM software technology. The breadth of functionality for design, simulation, and aerodynamic surface modeling in NX are far beyond anything we have used in the past."

Connor O'Brien, the team's race manager, agrees: "Without the software, I do not see how we could have built the car."

In addition to NX software for mechanical modeling and simulation, the team also had the chance to explore Siemens' Teamcenter (for data and project management), Fibersim (for material behavior simulation), and LMS (for test and simulation data). Naik says the team might have saved about two months from the design cycle if they had begun using Teamcenter earlier.

UMSCT also used NX's Tecnomatix software to create Bobble Jack, a digital avatar that helped them analyze the driver's comfort and ergonomics. When the team wanted to study the driver's head clearance, tight deadlines prompted an ingenious shortcut. Instead of modeling a helmet, they resized Jack's head to match the volume of a driver wearing a helmet, resulting in an oversized head. And that's how Bobble Jack got his name.

The Carbon Fiber Advantage

The vehicle is powered solely by a lithium ion battery, a limited power source. So the best possible strategy to win the race is to improve the vehicle's aerodynamics.

"By using high-modulus carbon fiber, we were able to design thinner structures and maintain the car's low aerodynamic design," Naik says. In future incarnations, he adds, the team plans to use Siemens' Fibersim software.

The team's victory in the American Solar Challenge may be the prelude to something else. In a press release by Siemens, Naik reveals he and his colleagues are setting their sights on the World Solar Challenge 2015, set to take place in the Australian outback.

When *The New York Times* asked the team to explain the vehicle's name, project manager Rachel Kramer notes that "Quantum is appropriate because it makes you think of something very small and precise, and that's what we had to do to be the best in the world" (Source: "Taking Off the Pounds to Chase a Sun-Powered Victory," *NYT*, April 12, 2014). One might also recognize that the last two letters in its name happen to stand for the University of Michigan — and for that matter, its color scheme helps it to "Go Blue."

For more, read about two other solar car teams in "Racing Against the Sun," which starts on the next page. **DE**

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

INFO → The American Solar Challenge: AmericanSolarChallenge.org

→ Siemens PLM Software: Siemens.com/plm

→ The University of Michigan Solar Car Team: SolarCar.engin.umich.edu

Racing Against the Sun

Digital drivers, virtual tests and visualization boost two solar car projects.

BY KENNETH WONG

One is called Daedalus, named after the master craftsman in classical mythology. Another is called B-7, a descendent of Faust and Faust II. Both are chasing the sun.

In the Greek myth saga, Daedalus constructed a set of wings for his son Icarus, who attempted to fly to the sun with it. A group of undergraduate engineering students from the University of Minnesota decided to name their solar car after the mythical engineer. The vehicle doesn't have wings; it relies instead on Sunpower C60 solar cells and a 16kW-per-hour Lithium-ion battery for its speed.

About 1,000 miles east in Canada, the University of Toronto students came up with their own solar car called B-7, preceded by older models Faust and Faust II. The B-7 isn't selling its soul to the devil like Goethe's Faust did to ensure success, however. Instead, it shed some of its weight by using solar cells made of 22% silicon.

In the 2013 World Solar Challenge, both vehicles shared a 3,000-km stretch of the Australian outback. They also shared something else: The engineering teams behind Daedalus and the B-7 relied on digital human models, simulation software, and visualization to perfect the aerodynamics of their sun-chasing chariots.

Daedalus, the 11th-generation solar vehicle from University of Minnesota students.

B-7: Built Around the Driver

In 1997, the University of Toronto's Blue Sky Project produced its first solar car, simply called Blue Sky. It was, according to the team's online history page, "an experimental effort … to learn more about the production of solar vehicles." The original model evolved into Blue II (1999), Faust (2001), Faust II (2003), Cerulean (2007), and Azure (2011) before becoming the B-7, which finished in eighth place in the World Solar Challenge 2013. Each incarnation served as a lesson for the next.

"The parts were made by different teams, but the main assembly — the body and the chassis — was in CATIA V6," said Kshitij Gupta, mechanical team lead for the B-7. While using CATIA from Dassault Systèmes, Gupta and his teammates stumbled on human models, or digital manikins — part of Dassault's DELMIA virtual prototyping software suite.

When manufacturers began relying on digital models instead of physical mockups to simulate and test their products, CAD software vendors anticipated the designers' need to incorporate digital human models to check proportion, reach and ergonomics. The DELMIA human model, complete with joints that can be manipulated, is part of that small but growing market — digital stunt doubles that you can deploy to perform stressful, strenuous and dangerous tasks in a virtual environment so you won't need a real human volunteer to do it later.

Gupta notes that Dassault's Ergonomic Workbench in CATIA "has an inbuilt database of sizes of humans" according to nationality (Japanese, Canadian, etc.), sizes (according to percentiles), and sex (male/female). The B-7 design team selected a 50 percentile Canadian female, a mani-

With workstations accelerated by NVIDIA Quadro K5000 GPUs, the University of Minnesota student engineers were able to visualize the inner mechanism of their vehicle Daedalus.

kin that best represented the intended driver's stature and build.

The manikin has movable joints to allow the engineers to place her in the driver seat and try out various positions. If a certain position is ergonomically ill-advised, a warning symbol cautions the engineers to shun the position. Using this method, the B-7's team could conduct what's known in CATIA as rapid upper limb assessment (RULA) analysis, and obtain scores that reveal the relative comfort (or discomfort, as the case may be) of the driver.

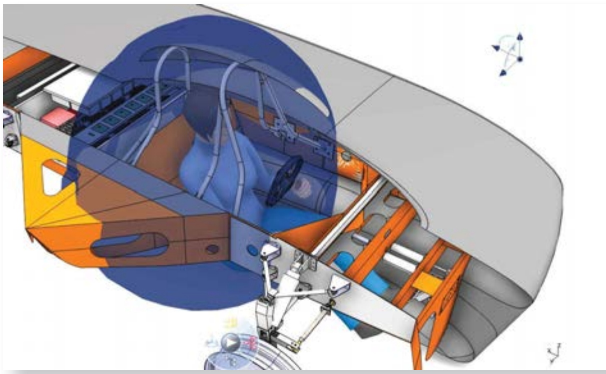
"Rather than design a chassis first, then go through iteration to fit the manikin, we designed the car around the manikin," Gupta explains. "That tells us whether the driver would be comfortable in that position driving eight hours a day." With the digital manikin, the design team could determine the driver's ability to reach essential instrumentation panels, seatbelts, radio, water bags, and fans as the vehicle's shape was developed. In previous design cycles, these measurements were approximated.

The driver position is highly constrained in accordance with the National Code of Practice for Light Vehicle Construction and Modification (NCOP) in Australia, Gupta says. Therefore, the use of the digital manikin also helped the engineers ensure their design complies with the NCOP standards before they started manufacturing the car parts.

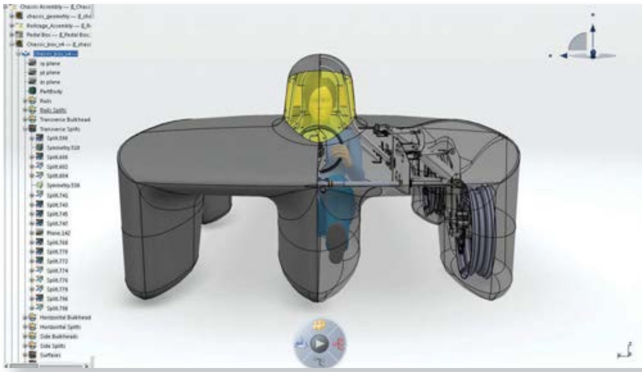
The B-7 was expected to run efficiently with 1 kW of power — roughly what it takes to power a hairdryer. For that to be accomplished, the designer needed the car's aerodynamics to give peak performance. The team uses ANSYS CFX software to run flow simulation to study and improve the vehicle's aerodynamics.

The width of the driver seat's bucket fairings was optimized to fit the potential driver, explains Gupta: "Furthermore, the main horizontal foil (on which we place the solar array) was made such that it just encompasses the shoulders of the manikin, thus the broadest part of the body was seamlessly integrated into the aero body without unnecessarily widening either the canopy or the butt fairing. The canopy width was also optimized, such that it just fit the driver's head and roll cage. The manikin ensured that we did not overdesign the driver space, which might lead to a higher frontal area and thus higher aerodynamic drag."

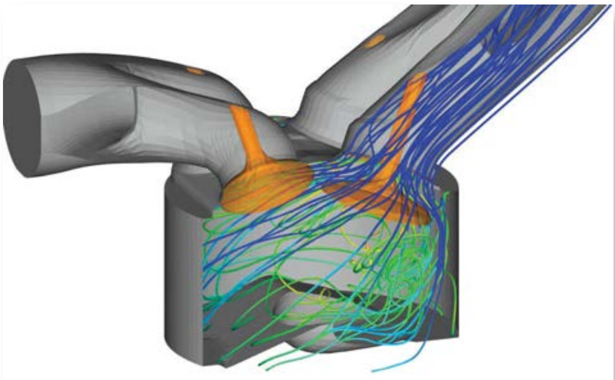
Becoming all too familiar with the digital manikin, they decided to refer to it by name. Initially, the avatar was nicknamed Beverly and Picard, no doubt after the Star Trek characters. But it was recently renamed Legolas, after the elven archer from Lord of the Rings. "Our driver doesn't look like Legolas [played by actor Orlando Bloom with long flowing hair and prosthetic ears]. It's just a joke," clarifies Gupta.



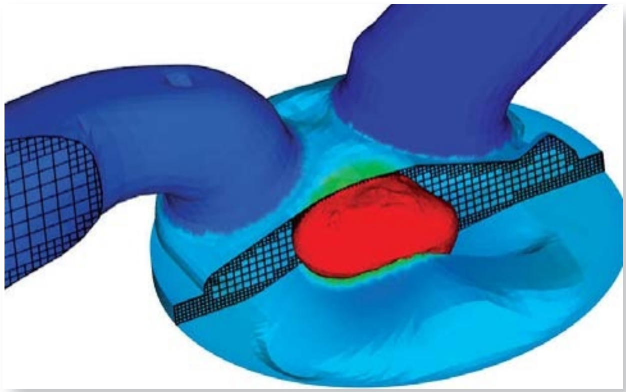
The Blue Sky solar car project from the University of Toronto employed a digital manikin from Dassault Systèmes' CATIA software to study and analyze the driver's reach and ergonomics inside the B-7.



Instead of building the vehicle and then revising it to accommodate the driver, the B-7's engineers designed the chassis and frame around the driver.



Streamlines show the intake process for a spark-ignition engine in a FORTE simulation.



DISI-combustion: Flame propagation for spark-ignition engine simulation, cut plane showing automatically generated mesh.

Daedalus: Boosted by Quadro

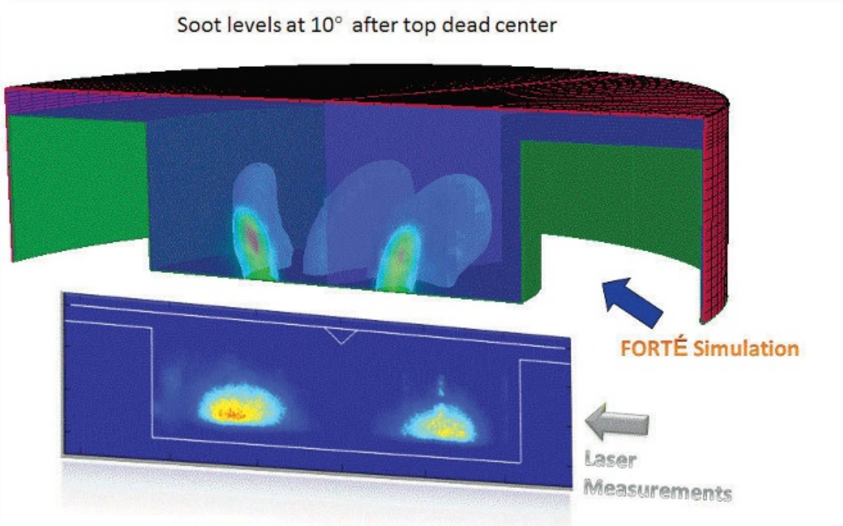
The dawn of the University of Minnesota Solar Vehicle Project (UMSVP) was a vehicle completed in 1993, dubbed Aurora. Since then, the project has produced 11 vehicles and raced in 24 events in five countries. By the time of the latest car, Daedalus, it has grown to involve as many as 50 undergraduate students.

Throughout its long history, the project has also amassed a large repertoire of reusable design data, archived in PTC Creo Parametric format (previously Pro/ENGINEER format). "The school as a whole uses PTC Creo software primarily. We really like [PTC Creo Parametric's] surface modeling tools," reports Neil Dencklau, project lead for Daedalus. "That helps us design a chassis made out of flat panels and complex organic curvatures."

Daedalus' engineers had to strike a balance between the power required to drive the vehicle and the aerodynamic gain and loss. "In previous races, we found out the biggest power consumption came from aerodynamic drag," Dencklau says. To offset the drag, the vehicle must increase its power, thus placing a burden on the vehicle's performance. "So we have to look at the best shape [for aerodynamics], and how to position the driver. For example, if we shift the driver's height, how does it affect the drag? Where should he or she sit in the car?"

The design team employed a mix of digital manikin placement (part of PTC Creo software), flow simulation with ANSYS CFX, and mechanical simulation with ANSYS Mechanical to refine the vehicle's shape and driver positioning. "Daedalus is a two-seater, so we had two digital manikins with helmets on inside the car [in the digital tests]. That's how we decided on where the seats should be placed, how much space was needed around them, and how much clearance was needed in our roll cage," Dencklau explains.

Software makers PTC and ANSYS were both sponsors of the project; therefore, the students had easy ac-



Simulation (above) and experimental measurement (below) showing regions of soot formation in the engine cylinder during combustion. Measurement is reproduced from A.P. D. Cruz, J.-P. Dumas and G. Bruneaux, SAE Technical Paper Series, 2011-01-1390, 2011.

cess to the professional CAD and simulation software titles from the companies. The trouble, however, was the underpowered computers with which they had to work.

"Our computer budget is relatively small," acknowledges Dencklau. "We built our own desktops with [Intel Core] i7 processors with 16GBs of RAM." For graphics boosts, the machine relied on consumer-level GPUs — suitable for videogame and multimedia playback, but not ideal for the precision required in CAD visualization. Project sponsor NVIDIA offered the team Quadro K5000 GPUs, certified for professional CAD and simulation programs.

"Having a powerful GPU made all of the difference in the world," says Mitchell Rogalsky, part of the design team. "With our prior systems, performance was about three frames per second. It was simply impossible to work interactively with our vehicle models."

Dencklau agrees. "Once we installed the Quadro K5000 GPUs, we found that we were able to load the top-level assembly of the vehicle and manipulate it efficiently," he adds. "And we noticed we were able to increase the quality of our rendering. Previously, when we had gaming GPUs, [the machines] just couldn't keep up with the work."

The high-pixel photorealistic display was not just eye candy. "With smoother edges and better rendering, we were able to see how things interact better," says Dencklau. "With a higher frame rate, we were able to rotate the model quicker. It made modeling a lot easier."

The ability to visualize the mechanical interaction was critical to the design of the front suspension region — "the most complicated area," Dencklau says. "There are lots of movements there. For instance, we needed to see how far the doors on the fairings are opening when making a turn [a feature to reduce drag]. All those mechanisms are driven by the steering wheel. We needed to be able to visualize how all those interacted with one another."

The project usually takes up to two years to build a car, partly thanks to the demands of the students' class schedules and homework. With Daedalus, the team had an extremely short design cycle: They had to design and manufacture a car in about nine months to compete in an upcoming World Solar Challenge. To speed up the manufacturing, the team manufactured the custom-designed battery cages in 3D printing, with help from project sponsor Stratasys, a 3D printer maker. "It was just cheaper than manufacturing them, and a lot faster," Dencklau says.

In the UMSVP project report published for 2013-14, the design team boasts, "Daedalus incorporated the best of the previous Aurora, Borealis and Centaurus vehicles, while continuing to push the technological boundary. Daedalus competed in the cruiser class of the 2013 Bridgestone World Solar Challenge, where she placed fourth."

UMSVP's Daedalus finished second place in the American Solar Challenge in July 2014. For more, read about the University of Michigan team that claimed the first prize in that race this month's article "Quantum of Solar" on page 45. DE

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

INFO ➜ ANSYS: ANSYS.com

➜ **Blue Sky Solar Racing, University of Toronto:** BlueSkySolar.UToronto.ca

➜ **Dassault Systèmes:** 3DS.com

➜ **NVIDIA:** NVIDIA.com

➜ **PTC:** PTC.com

➜ **Stratasys:** Stratasys.com

➜ **University of Minnesota Solar Vehicle Project:** UMNSVP.org

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Global to Local in FEA

Use a simple global model to establish the boundary conditions to apply to a high-fidelity local model.

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.

One of our major concerns in finite element analysis (FEA) is the required computing resource, including the time taken to run the analysis and the amount of memory it will use. We want answers in hours, not days and we want to solve within core RAM and not spill to virtual memory or physical disk, either of which will slow down the solution.

Techniques have evolved within FEA to reduce computing resources. These techniques still remain valid in modern analyses, as there is a natural tendency to use larger and more complex FEA simulations, as more resource becomes available.

In Situ Local Modeling

This approach positions the high-fidelity local model directly within the overall global model — that is, in situ. The analysis uses a single run with full connectivity between the model zones. The advantage lies in avoiding user interpolation of boundary displacements or forces from the global to local models. The disadvantage is that we introduce connection elements between the two models.

Fig. 1 shows an oil rig jacket modeled globally using beam elements. The joint is investigated for local stress concentrations. Beam elements cannot simulate the load path, and thus there are stresses locally across the joint between two members. All the load transfer in the beam element model takes place at the single nodal connection. The real load transfer is via the welded intersections of the cylinders, with resulting local stress concentrations.

To model the joint in detail, improved representation is made with a local shell model, shown in Fig. 2. This could be a local solid model if required. The shell or solids develop the correct load transfer path in the walls between the intersecting cylinders and stress concentrations at the intersections. The computing resource for a local/global model is much less than a full high-fidelity model.

Here, "spider" elements are used to connect the shell mesh and the beam mesh. This is a term used for this type of connectivity element. There are two variations of the spider:

- An infinitely stiff spider will make the connection between the beam end and shell cylinder free end fully rigid, so the cross-section cannot ovalize or move out of its original plane.
- A perfectly flexible spider will allow the shell cylinder to ovalize and distort out of plane.

The choice depends on the flexibility of the connection or load transfer structure being modeled. In this case, the pipe is

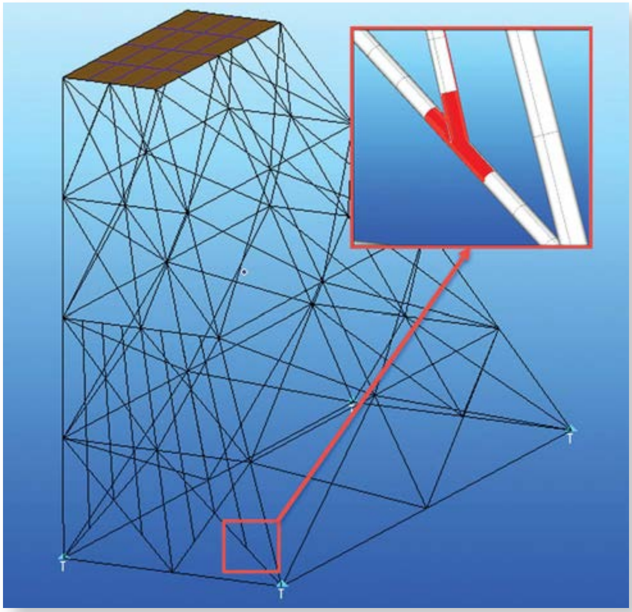

FIG. 1: Global model of an oil rig, showing joint of interest.

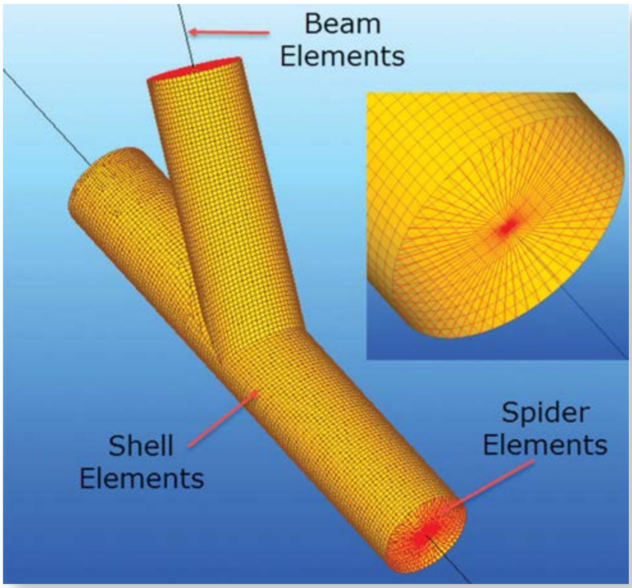

FIG. 2: Detail of local shell model connection into global beam model.

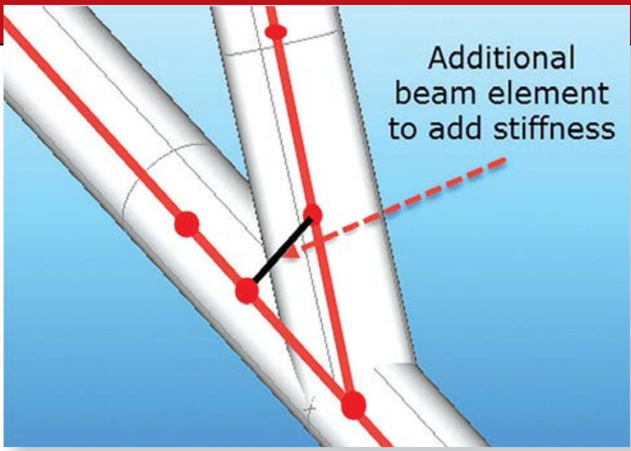

FIG. 3: Compensating for beam joint stiffness by adding a linking beam.

locally stiff, so a rigid spider is a reasonable approximation.

As an aside, it is interesting to compare the stiffness of the beam model and the shell model. The beam model is not stiffened by the presence of the intersecting beam walls, as would happen in reality. All stiffness is developed at the common single node "joint." Many analysts introduce a short connecting beam across the two main beams, as shown in Fig. 3. There is no exact way to define the properties and location of this adjusting element, but a rule of thumb would be to use the smallest pipe section and run the element through the intersection location.

An alternative for joining dissimilar element types or mesh sizes is to use a linear, or "glued" contact method. Contact methods have been developed over many years in nonlinear analysis to simulate components striking one another, bearing surfaces in lugs and pins and many other applications. The contact stiffness that is developed when surfaces mate can be used in a linear analysis — if it is assumed the contact is always present and forms a constant load path. The advantage is that we can connect dissimilar meshes together with a reasonably compliant contact stiffness.

Fig. 4 shows a dissimilar mesh used to put a high-fidelity local model into the region around a hole in a plate. This is an alternative to the usual approach of refining the mesh continuously from the coarse mesh region. The arbitrary zone we are considering as the local model is shown within the square. The stress contour pattern results in a comparative coarse continuous mesh.

To set up the global/local model, the inset square around the whole is cut out and meshed with much higher fidelity. This is the local model. It is placed within the remaining global model, and the two are connected together using linear contact. The resulting stress distribution in the fine mesh is shown in Fig. 5(b), and can be compared to the stress distribution of the original mesh shown in Fig. 5(a).

The glued contact method is extremely effective in enabling an in situ global/local modeling technique. There are many other applications. Fig. 5(c) shows an alternative hole configuration — in this case an ellipse, substituted via a new local model into the original global model.

The accuracy of the in situ global/local model using either of these techniques depends on how well the transition region (either connector elements or linear contacts) represents stiffness and load transfer path. The stresses in the transition zone are always suspect, so we ensure that this region is away from the stress concentration region of interest.

One rule of thumb is to consider a critical dimension, such as the hole radius or the pipe diameter, and set the transition region at least twice this distance. I have about three diameters on the pipe model, but only half the diameter in the hole model, for example. The justification is that stress concentrations in this configuration are known to be very local.

Independent Local Modeling

An alternative to in situ local modeling is to run the analysis in two stages. The local zone to be investigated is identified within a global model. This is important, as it allows nodes and elements to be aligned on the subsequent boundary between the global and local models. The global model is run, and either the nodal forces or nodal displacements are extracted from the boundary. The local model is then run, using the boundary conditions extracted from the global model. The objectives are typically as before — a high-fidelity mesh in a local region or a change in structural configuration in a local region.

An example is shown in Fig. 6, where a ship model is used as the global model. The objective was to investigate stresses at a de-

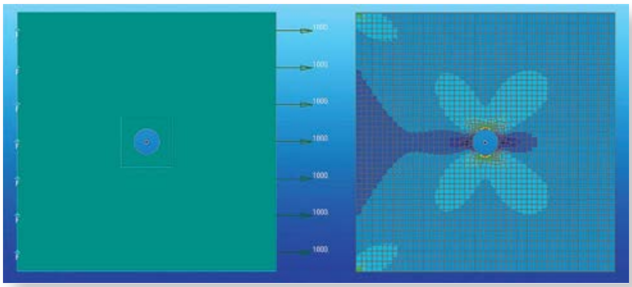

FIG. 4: Comparative model with a coarse mesh and no local model.

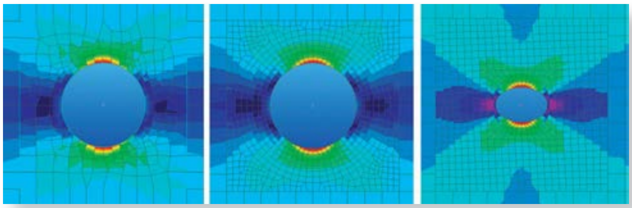

FIG. 5: From left: (a) peak stresses in the coarse mesh, (b) peak stresses in the fine mesh local model, (c) an ellipse replacing the circle.

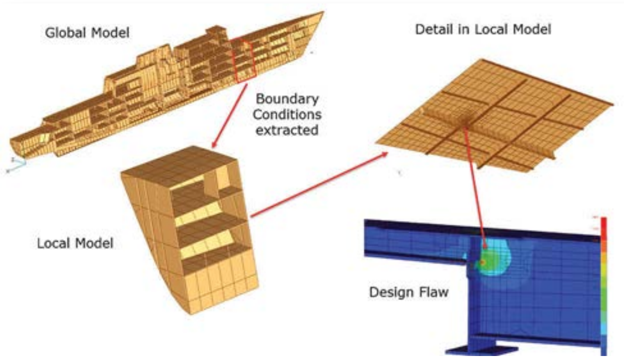

FIG. 6: A global/local analysis of a ship.

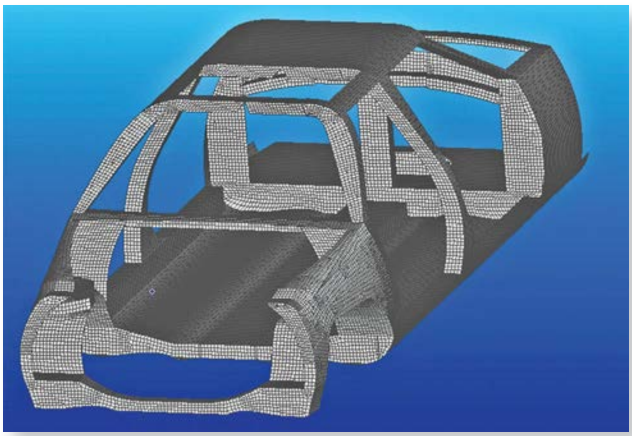

FIG. 7: A full mesh model of a vehicle body in white (BIW).

sign flaw. The load cases analyzed in the global model were used to map the displacement boundary conditions at the global/local interface into the detailed local model. The results of the global model can be considered as a database — from which local region results can be extracted to carry out local checking or redesign.

Both of the previous analyses could also be done using independent local models. Beam forces at each end of the oilrig joint, for example, could be extracted from a global model and applied subsequently to an independent local model. This boundary force approach is useful, as it verifies the loading in the structure. It does mean, however, that we need to use a minimum constraint method to make sure the model is constrained properly to ground. A model in balance must still be properly constrained.

We also have to be careful when interpolating forces from the global-to-local model across the boundary. With beams, we are dealing with point forces; however, with continuous shell or solid elements, we are dealing with a distribution of forces. We must maintain equilibrium between the models, but must also be careful of inaccurate stiffness representation on the boundary:

- If we model part of the local detailed model with a lower boundary stiffness, the resultant deflections will be higher, and the load path will move away from this region.
- If we allow low stiffness "widgets" (structures that will carry no load in practice) into the boundary region, we may have very large localized displacements.
- Part of the boundary may have a reduced stiffness thanks to the onset of buckling, which is not ideal in the global model. There is then a mismatch in effective stiffness.

If we use displacement boundary conditions, we are more likely to have a properly constrained model. However, it can be tedious to extract all degrees of freedom (DOF). Instead, we can look for simplifying constraint boundary conditions, such as a structure boundary sliding along a cut plane, or the edge of a stiff structure remaining straight as it displaces.

If we use the local modeling to investigate design configuration changes, varying damage states, etc., we must avoid changing the overall stiffness assumptions made between the global and the local models. For example, we cannot take a local section out and introduce an elevator shaft through the decks with significantly different stiffness. The boundary conditions mapped from the global model, without the elevator shaft, are now invalid.

Super Element Analysis

The overriding consideration in global/local modeling is that the strain energy on the global and local boundaries should balance. Strictly speaking, we should use both displacement and force at the same time to achieve this. We cannot do this in normal analysis, and have to pick one or the other. However, in static super element analysis, strain energy compatibility is enforced.

The super element method is complex, and its use has tended to be restricted to either experienced analysts or to companies that have invested in incorporating the technique into "black box" procedures. Despite this, it is useful to be aware of

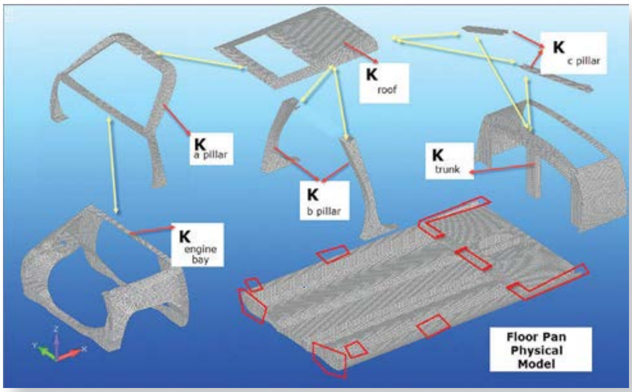

FIG. 8: **Components reduced to component stiffnesses, and assembled into the floor pan physical model.**

the method, as several software vendors have recently started to make the process more usable to the general community.

Super element technology allows an engineer to make a FE model of every component of a large system, such as an automotive body in white (BIW). Each component model is translated from its usual, "physical" format of nodes, elements, properties, loads, etc., to a set of structural matrices that represent the same information. Common boundary nodes exist between the components, so that all component matrices can be combined. The complete system can then be solved, and the results passed back to each component.

For example, Fig. 7 shows a full mesh for a vehicle, with no super element reduction. Fig. 8 shows the same vehicle, where the floor pan is used as the base or residual structural model, and super elements are added in as system matrices.

There is coupling defined between the interface boundary nodes on the floor pan and each of the engine bay, A-pillar, B-pillar and trunk components. On each interface, the nodes from each side must occupy the same position in space.

There is further coupling between components — the engine bay and A-pillar, for example. There is also a set of components that are indirectly linked via the first-level components, such as the roof being connected to the floor pan via the A-pillar, B-pillar and C-pillar (the last via the trunk). A wiring diagram is essential to keep track of the overall scheme.

The advantages of the super element approach include the fact that the creator of a component does not need to pass any detailed physical information to the person assembling and running the overall system model. The assembler could easily be restricted to seeing the component stiffness matrix and position of boundary nodes. The component designer, however, can see the full response of his or her model when attached to the system. Confidentiality is maintained both ways if required.

It can be an advantage to reduce model size for advanced analyses like nonlinear and dynamics for both performance and housekeeping. For a large system with many components, it can be convenient to split up a model between parallel project teams. For example, different components may have reached different design maturity — but as long as the interfaces are defined, a full system model can still evolve with the latest component designs.

Cost-Effective and Convenient

The use of global-to-local modeling can keep the cost of analysis down, and convenient in allowing logical breakout of local components. Placing the local model in situ, with only a single run needed, is the most intuitive and straightforward method, as long as care is taken over the global-to-local interface.

Analysis with an independent local model requires accurate and meaningful interpolation of either boundary forces or displacements. Some practice and comparison with high-fidelity benchmark examples will help to give confidence in the method.

The super element approach is the most technically exact method, and should give higher accuracy. However, the choice here largely depends on the ease of use in super element setup and analysis of the FEA software implementation available. **DE**

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CAD Gets More Animated

This Bunkspeed render visually represents the process of converting 3D engineering data into a visually appealing marketing image.

CAD animation is becoming more common, affordable and available — both within the CAD programs themselves, and through closely linked third-party applications.

BY MARK CLARKSON

In the grand scheme of things, animation of any kind is a relatively new capability for engineers. Many of you will still remember a time, not all that long ago, when most designs were drafted by hand on paper and rendered with ink and paint.

Today, engineers use CAD more often than not, and you will find some form of animation capability in virtually every CAD product, be it AutoCAD, Inventor, SolidWorks, Solid Edge, Rhino or something else. The extent of the programs' animation capabilities differ, but you can at least create simple turntable animations, and probably do lighting or sun studies. The animation capabilities of the heavyweights extend to the ability to animate fully articulated assemblies, such as internal combustion engines, or caterpillar treads powered by virtual gears, springs, motors and physical forces.

Why Third Party?

Given that you can almost certainly do animation within your CAD program itself, why bother to involve outside programs? There are a few reasons, but chief among them would be ease of use, render quality and speed.

There's a constant state of war between power and ease of use. Sometimes, a package capable of accurately animating an entire powertrain isn't the best choice for doing simple turntable animations. And while all professional CAD packages will produce *some* kind of animation, it might not be the best looking or the fastest to render.

Bunkspeed and KeyShot

Consider a pair of applications: Dassault Systèmes' Bunkspeed and Luxion's KeyShot. Without getting into the details of which program has the better feature implementation or the faster rendering engine, I'll just say that the two programs are clearly going after similar markets: people in search of fast, easy, photorealistic renders of their geometry. It's just flat-out easy to get a gorgeous render out of either application.

Both take advantage of high dynamic range (HDR) lighting where you use a photo of your intended environment and the application derives realistic lighting from that photo. The programs give you photorealistic radiosity, reflection, refraction and caustics. The final results are fit for a magazine beauty shot or a boardroom presentation. And they are very, very fast.

Both programs also support animation, which is kept as simple and intuitive as possible. The simplest animations — such as turntables — are accomplished in just a few steps, via wizards.

For more control, there's a timeline where you can drag key frames around. You can animate an entire model, or selected parts of a model. You can animate materials and lights. You can, for example, open up a car's door to show the interior, or simply fade the door away to transparency. You can change a car's paint job from red to green to shiny metallic blue. You can turn the headlights on and off. Both programs let you link parts together hierarchically to achieve more sophisticated animation.

Still, there's a limit to the complexity you can achieve in programs such as Bunkspeed and KeyShot. If you need beautiful renders as well as complex articulation, relationships or inverse kinematics, and your CAD environment doesn't provide it, you'll have to import your model into another application, such as Maya, Max or modo, that's designed for that kind of work.

Import Necessities

Because you can't create anything but the most basic shapes in KeyShot or Bunkspeed—planes, cubes, spheres and so on—it's clear that your geometry will be coming from somewhere else, most likely a CAD application. To that end, both KeyShot and Bunkspeed can import from all the major CAD file formats (CATIA, AutoCAD, Rhino, SketchUp, SolidWorks, Solid Edge, Parasolid, OBJ, etc.).

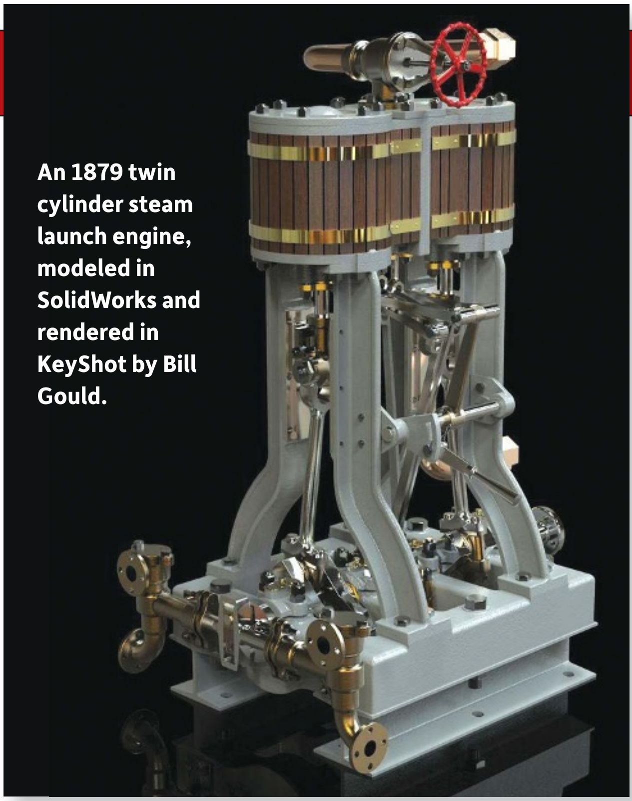
For even tighter integration, KeyShot's LiveLinking technology allows the program to run alongside SolidWorks, Creo and Pro/E, where it can be updated in response to geometry or material changes with a single click. Bunkspeed uses a similar technology to integrate with SolidWorks.

Real-time Visualization

Real-time rendering is something of a misnomer. Exactly how close you come to real real-time depends both on your workstation and on the amount of geometry jammed into the program. But what about an insanely complex model such as a modern automobile, comprising tens of thousands of parts and tens of millions of polygons? That brings you to the special domain of Deltagen.

The Deltagen application specializes in near real-time visualization of big, complex data sets. I wrote in a previous issue (deskeng.com/de/?p=1550) about then-RTT demoing Deltagen at SIGGRAPH 2013, where they pulled in an entire Nissan Pathfinder — more than 40 million polygons worth of data — with the help of a 12GB NVIDIA K6000 graphics card. With minimal cleanup and preparation, Deltagen was able to create a scene with high visual fidelity, running on a workstation in real time, with full global illumination. They could move the camera inside, outside or under the hood; the whole model was there.

RTT was recently acquired by Dassault Systèmes, and has been re-branded 3DXCITE. Dassault already owns heavyweight CAD applications CATIA and SOLIDWORKS and, with the RTT acquisition, also adds the above-mentioned Bunkspeed to its stable. Expect all these products to become ever more tightly integrated.



An 1879 twin cylinder steam launch engine, modeled in SolidWorks and rendered in KeyShot by Bill Gould.

Looking Ahead

CAD animation is getting faster, better looking and cheaper. As a consequence, animation is becoming available further forward in the design process. We've seen the same thing happen with 3D, finite element analysis, still rendering and more. Near real-time rendering is becoming common, which means more people are doing more renders, earlier in the design process. Expectations of graphic quality, consequently, keep going up.

Real-time rendering technology will have an even greater effect on animation, which requires orders of magnitude more rendering. It doesn't make sense to do animation tests early in the design process if they're going to take a few hours to render, for example. On the other hand, it might make a lot of sense if they only take a few minutes — or better yet, a few seconds.

How about big model rendering, as exemplified by Deltagen? While few of us will ever have occasion to fit an entire car into our CAD application of choice, we always seem to find a way to use whatever capability is available. The ability to work with ever-larger models can mean significant times savings that would otherwise be spent cleaning up and optimizing models before animating and rendering them. **DE**

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

INFO ➔ Dassault Systèmes: 3DS.com

➔ **Luxion:** Keyshot.com

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Old School Design Meets **New Technology**

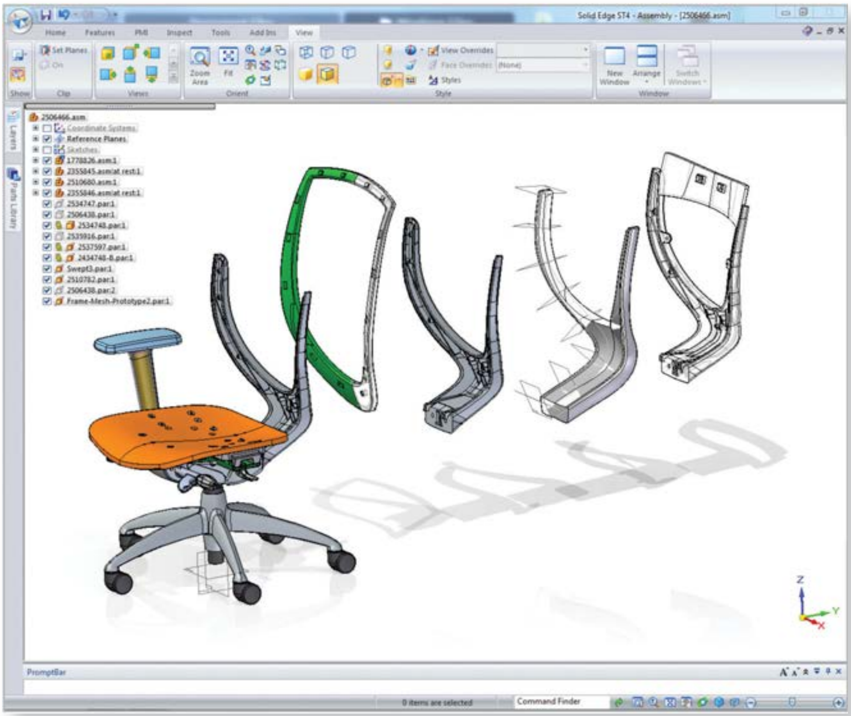
Furniture manufacturer Kimball International relies on 3D scanning to generate CAD data from products made decades ago.

BY JESSICA LULKA

Take a step back in time, about 25 years. Product design and manufacturing was drastically different, and didn't rely on CAD or computer design technologies in general. To create a new product or line, you'd start with drawings, then move to sculpted models created by artists. This turned into a months-long process with several expensive prototypes.

Today, furniture company Kimball International is still using designs that it created manually in the '80s and '90s to manufacture its products. While the inventory is slightly different, base elements of older chairs and tables are still found in new designs — including seat cushions, ergonomic factors and seat backs. At Siemens' Solid Edge University 2014, Research & Design Engineering Manager Ricardo Espinosa spoke about how his department generated CAD data from a design that was created manually years ago. How was his department able to make data? The easiest solution, according to Espinosa, is 3D scanning.

It is important, he says, to have computer-based data so that the global company can use information from its suppliers and collaborate with different offices. Plus, it's easier to scan a product than to take multiple manual measurements and enter them into the software program by hand.

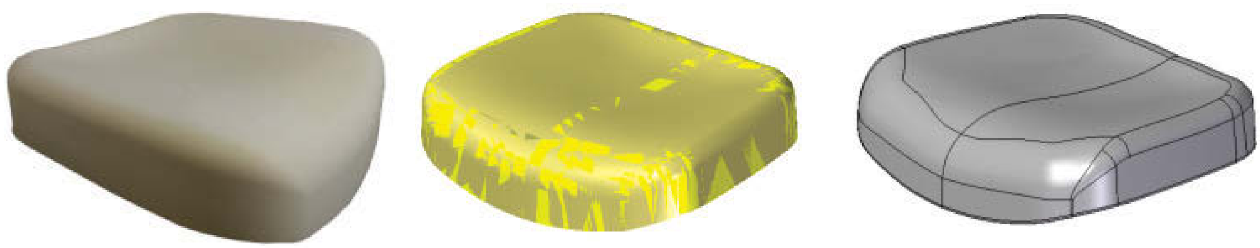


New parts can be created from existing surface scans.

"The traditional office space continues to evolve," Espinosa says. "A considerable number of office environments have migrated to an open plan concept for better interaction, collaboration and networking. New communication technology translates into people using office space in different ways. We're designing furniture to accommodate technology that has increased the integration of power and communications, which places new demands on engineering."

Capturing Data

To ensure accuracy in scanning and creating a proper model, Espinosa



The original part, scanned copy and cleaned up CAD file.

recommends having the following resources: a high-tech scanner, the right scanning resolution and good software to create CAD files, like STEP or Parasolid. He also says that if the part is symmetrical, it's more beneficial to scan half and mirror it with software to ensure complete symmetry. Before you begin, he notes, be sure to decide exactly what you need to scan, and avoid capturing extraneous parts.

After the part has been scanned properly, the design work begins for Kimball's design engineers in Solid Edge. There are a few techniques to create new parts, Espinosa says. The designer can make no changes; small changes such as adding or removing features; complex changes, which include modifying surfaces and enlargements; or create a new part from existing surfaces.

Successful Scanning

When creating a model from scanned data, keep these tips in mind:

- Eliminate overlapping surfaces.
- Consolidate your surfaces.
- Delete non-important or out-of-place features.
- Simplify curves.
- For a symmetrical model, scan half and then mirror the data for complete accuracy.

— JL

To create an editable model for more complex changes, Espinosa starts by using the basic model with anything he wishes to change. He then eliminates overlapping surfaces using the Geometry Inspector and Optimize features, and deletes non-important features. The surface joints are then healed, and the model is consolidated. He uses Multi-body to work on different parts of the model, and simplifies curves to finish making the design editable. At this stage, the data is ready to use how the engineer chooses. This can range from small changes or copying a part completely.

In his Solid Edge University presentation, Espinosa demonstrated how to incorporate the seat back and cushion design of a current chair into a new design. By being able to use scanned legacy data that was made editable, he pointed out that this creation process was reduced down to hours and days, as opposed to months. To create a new line almost 20 years ago, Espinosa says it would take six or seven months, plus five or six expensive prototypes. But part of using legacy CAD data isn't all about the modeling process — it's important to have the right software and technology, too.

Syncing with Software

In addition to 3D scanning, Espinosa also uses Synchronous Technology to help create new designs. This technology was introduced at Kimball in 2008, which was previously using history-based Solid Edge. With the introduction of such a system, he says the design time of each part has improved.

"Before Synchronous Technology, we had to start from scratch. Now with Synchronous Technology, we can reuse the legacy data that came in during the '90s and '80s. It's really easy to use the existing information and create new components," he says. The software allows his team to anticipate time savings in producing documentation and making even the smallest changes to designs.

At Kimball International, it's clear that being innovative has allowed for its engineers and research team to create a balance between old and new. By using 3D scanning to generate data paired with Synchronous Technology, Espinosa and his team have found a way to incorporate the positive aspects of Kimball's furniture through the years — while making even better designs. **DE**

Jessica Lulka *is assistant editor of DE. Send e-mail about this article to DE-Editors@deskeng.com.*

INFO → **Kimball International:** Kimball.com

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

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You Get What You Pay for

The ultra-high-end Microway WhisperStation workstation delivers unparalleled performance.

BY DAVID COHN

We recently received a new Microway WhisperStation. Never heard of Microway? This small, woman-owned company is widely credited with popularizing numeric coprocessors. Still doesn't ring a bell? Back in the early days of the IBM PC, Intel's 8086 CPUs could not perform floating point math calculations. That capability, crucial for most CAD applications, required the addition of an Intel 8087 numeric coprocessor. In 1982, Microway began to develop software for the Intel 8087 — and a year later introduced its own, faster version of the coprocessor.

Over the years, Microway continued to develop parallel processing boards, compilers, and other types of accelerators. By the 1990s, it was also selling its own line of custom workstations. Today, the company specializes in high-performance computing (HPC), offering a range of clusters, servers and storage systems.

It also sells high-end workstations aimed at simulation and 3D design, which brings us to the system the company sent us to review. The Microway WhisperStation is a workstation custom configured to exact user specifications, including large amounts of memory, large storage capacity, and add-ons such as NVIDIA Tesla graphics processing unit (GPU) accelerators for additional computation capabilities.

The WhisperStation comes housed in a black steel mid-tower case made by Chenbro, which measures 7.8x23.3x17.3 in. (WxDxH). Plastic feet swing out to help stabilize the 47.75-lb. system.

The front of the tower was a bit of a puzzle: A plastic silver-colored door conceals three accessible 5.25-in. drive bays, one of which contained a Lite-On dual-layer 24X DVD+/-RW drive as well as a panel containing a large round power button and five power and activity lights. That panel also contained knockouts for headphone and microphone jacks, but the panel in our evaluation unit had no actual audio connections. The activity lights are visible through the door, which also has a cutout for accessing two front panel USB 3.0 ports. But you would have to disconnect anything plugged into these ports to open the door to reach the power button or access the optical drive.

The interior of our WhisperStation unit is cramped, with the massive CPU heat sinks and cooling fans blocking access to the drive bays and memory sockets. An NVIDIA Quadro K6000 GPU and Tesla K40 GPU accelerator fill most of the available expansion ports — and consume lots of power. ***Images courtesy of David Cohn.***

Below the USB ports, an air intake fan was quite audible, even when the door was closed. Even more confusing, the door can be locked — effectively blocking access to the power switch and optical drive. With a second exhaust fan on the rear panel and an additional fan cooling the internal hard drive bays, the WhisperStation was somewhat louder than a whisper, but certainly not loud.

Crowded Interior

Access to the case interior requires unscrewing two captive thumbscrews to remove the left side panel, which is also protected by a key lock. Inside, we found four 3.5-in. drive bays, one of which held a 240GB Intel SATA solid-state drive (SSD). Accessing those bays is no simple task, however, because they were blocked by the massive heat sink and fan rising from one of the two CPUs.

Directly behind the drive bays, the Microway NumberSmasher dual Intel Xeon motherboard (manufactured by ASUS) is tucked into the interior and literally crammed with components. A pair of dual in-line memory module (DIMM) sockets is positioned to either side of each CPU. These, too, are difficult to access because they are partially covered by the CPU fans and heat sinks.

Our evaluation unit came with a whopping 64GB of memory, installed using eight 8GB DDR3 1866MHz ECC DIMMs, filling all available sockets. The system can support up to 128GB of memory using 16GB DIMMs. If you need more than that, Microway offers an alternate motherboard with 16 memory sockets, which supports up to 256GB of RAM.

Our evaluation unit also came with two 3.5GHz Intel Xeon E-2643v2 six-core CPUs, each with its own 25MB cache. This processor has a 130-watt thermal design power (TDP) rating and a maximum turbo boost frequency of 3.8GHz.

The motherboard also provides five PCIe slots that can support either four x16 double-wide boards or five x8 single-wide boards. Our system came equipped with an NVIDIA Quadro K6000 graphics card, a double-wide board with 12GB of GDDR5 ECC memory, and 2,880 compute unified device architecture (CUDA) cores. This GPU provides two DVI ports and two DisplayPorts.

In our unit, Microway also included an NVIDIA Tesla K40 GPU accelerator, a second double-wide board providing an additional 12GB of GDDR5 memory, and another 2,880 CUDA cores. This board added $5,499 to what was already an expensive system, and really didn't contribute much to our benchmark results.

Why buy a Tesla at all? Well, there are hundreds of applications across a wide range of fields that are optimized for GPU computing. In the world of CAD/CAM/CAE, some aspects of many popular CAD programs — such as surface and mesh modeling and rendering functions in AutoCAD, Inventor, CATIA and NX — take advantage

Dual-Socket Workstations Compared

		Microway WhisperStation workstation two 3.5GHz Intel E5-2643v2 six-core CPUs, NVIDIA Quadro K6000, 64GB RAM, NVIDIA Tesla K40	BOXX 8980XTREME workstation two 3.1GHz Intel E5-2687W eight-core CPUs over-clocked to 3.82GHz, NVIDIA Quadro K5000, 64GB RAM	HP Z820 workstation two 3.1GHz Intel Xeon E5-2687W eight-core CPU, NVIDIA Quadro 5000, 32GB RAM
Price as tested		$18,889	$13,454	$9.984
Date tested		5/10/14	5/9/13	7/16/12
Operating System		Windows 7	Windows 8.1	Windows 7
SPECviewperf 12	Higher			
catia-04		94.60	n/a	n/a
creo-01		79.40	n/a	n/a
energy-01		6.22	n/a	n/a
maya-04		68.75	n/a	n/a
medical-01		33.44	n/a	n/a
showcase-01		62.54	n/a	n/a
snx-02		90.03	n/a	n/a
sw-03		99.53	n/a	n/a
SPECviewperf 11	Higher			
catia-03		104.27	78.01	51.69
ensight-04		167.13	80.25	44.13
lightwave-01		81.01	77.07	59.02
maya-03		150.18	125.16	101.67
proe-5		15.45	16.14	11.72
sw-02		70.70	67.16	57.48
tcvis-02		87.47	71.58	44.52
snx-01		147.95	81.35	44.86
SPECapc SolidWorks 2013	Higher			
Graphics Composite		6.89	2.69	2.15
RealView Graphics Composite		8.05	2.86	2.37
Shadows Composite		7.96	2.86	2.36
Ambient Occlusion Composite		17.83	6.16	5.19
Shaded Mode Composite		7.04	2.62	2.27
Shaded With Edges Mode Composite		6.74	2.77	2.03
RealView Disabled Composite		3.69	2.11	1.45
CPU Composite		4.20	4.84	4.50
Autodesk Render Test	Lower			
Time	Seconds	30.33	38.00	41.00

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

The incredibly powerful Microway WhisperStation comes housed in a mid-tower case with a puzzling front panel. A lockable hinged door conceals the drive bays and power button, while providing a cutout to access two USB ports.

of GPU acceleration. When you move into the realm of computational fluid dynamics (CFD), structural analysis and simulation, most directly support the Tesla GPU.

All of the power-hungry components in the Microway WhisperStation are powered by a Thermaltake 1,350-watt 80PLUS certified power supply. When we closed the case and powered back up, the system displayed a "chassis intrusion" error and halted the startup. This is a feature, noted in the Microway literature. We had to restart the system for it to go back to work.

The rear panel provides two additional USB 3.0 ports, six USB 2.0 ports, a PS/2 keyboard/mouse socket, two RJ-45 network connections, an optical S/PDIF output port, and six audio jacks (separate microphone and line-in jacks, as well as front, side, rear and bass output speaker channels).

Amazing Performance

With two very fast six-core CPUs, an abundance of RAM, an ultra-high-end GPU, and the Tesla GPU accelerator, we knew the Microway WhisperStation was going to be fast — but we had no idea how fast. On the SPECviewperf version 11 benchmark, the WhisperStation wasn't just the fastest system we've ever tested, it literally blew away the competition.

We also ran SPECviewperf 12. Because the WhisperStation is only the fourth system on which we've run this benchmark (and the first dual-socket system), we cannot yet make meaningful comparisons. But suffice it to say that the WhisperStation was anywhere from two to 10 times faster than other systems we've tested to date on the various view sets.

The results on the SPECapc SolidWorks 2013 were equally astounding, with the WhisperStation outperforming every system we have ever tested. And on the AutoCAD rendering test, a multi-threaded test on which faster systems with more CPU cores have a distinct advantage, the Microway WhisperStation slayed the competition, completing the rending in an average of 30.33 seconds.

We also ran the new SPECwpc workstation performance benchmark. Again, we do not yet have enough data to make meaningful comparisons, but the WhisperStation turned in results far beyond those of any other systems we've evaluated thus far.

Microway pre-loaded Windows 7 Ultimate 64-bit and rounded things out with a 104-key Logitech Deluxe KB-120 USB keyboard and B120 optical USB mouse. The company backs its computers with lifetime technical support and a two-year warranty, with replacement components typically cross-shipped within 24 hours.

Unlike many other companies, you cannot just go to the Microway website and use an online configuration page to compare various options. Instead, you must enter your name and contact information and complete an online form; spell out your preferences for CPU, memory, graphics card, storage, operating system and so on; and then wait to be contacted by a Microway representative. While the personal touch is nice, it does make it difficult to comparison shop.

Our Microway WhisperStation unit — with dual CPUs, 64GB of memory, SSD, optical drive and NVIDIA K6000 graphics board — cost $13,359. With the addition of the Tesla GPU plus $31 for the keyboard and mouse, the grand total came to $18,889, making the Microway WhisperStation the most expensive workstation we have ever reviewed. Of course, it was also the fastest.

Were the bells and whistles overkill? For most users, sure. But if you are running high-end engineering analysis applications, we think you would be hard-pressed to find a more powerful workstation. DE

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

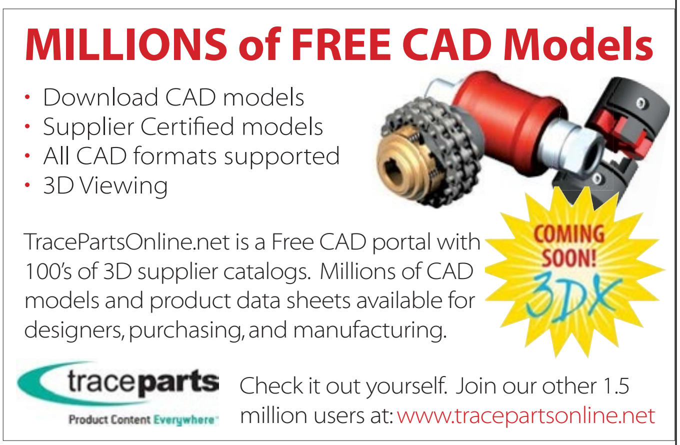
INFO ➜ Microway: Microway.com

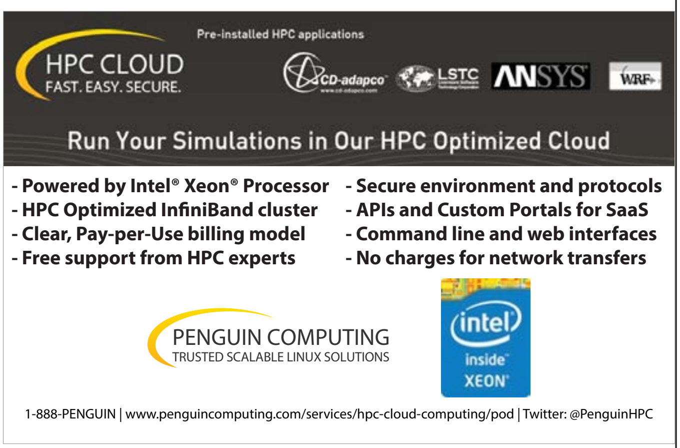
Microway WhisperStation

- **Price:** $18,889 as tested
- **Size:** 7.8x23.3x17.3-in. tower (WxDxH)
- **Weight:** 47.75 lbs.
- **CPU:** two Intel Xeon E5-2643 v2 (six-core) 3.5GHz
- **Memory:** 64GB DDR3 SDRAM at 1866MHz (up to 256GB supported)
- **Graphics:** NVIDIA Quadro K6000 and NVIDIA Tesla K40 GPU accelerator
- **Storage:** 240GB Intel 530 2.5-in. SATA III SSD
- **Optical:** Lite-On dual-layer DVD+/-RW
- **Audio:** Realtek ALC898 8-channel integrated high-definition audio (rear-panel only microphone, line-in, front, side, rear and bass)
- **Network:** dual integrated Intel 8257L gigabit Ethernet ports
- **Other:** six USB 2.0, four USB 3.0, optical S/PDIF, PS/2 mouse/keyboard
- **Keyboard/Mouse:** Logitech Deluxe KB-128 USB keyboard, Logitech B120 Optical USB mouse

SPOTLIGHT

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





HPC Options, Part 4

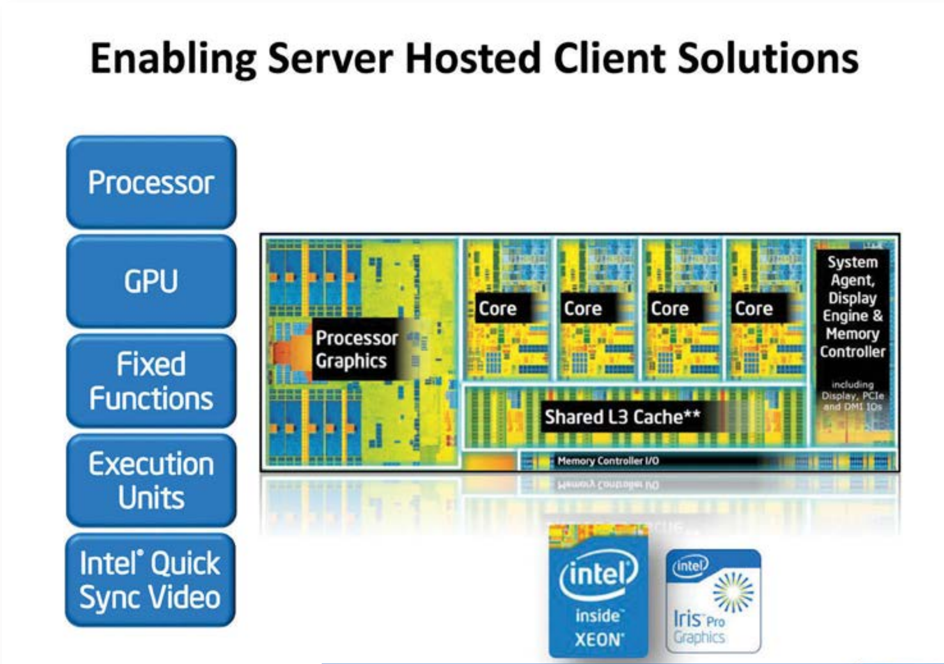
Solving the Mystery of the Invisible Desktops

Mobility and intellectual property security and increased bandwidth nudge users toward virtual machines.

BY KENNETH WONG

At Florida Atlantic University (FAU), if you pull the cord attached to the mouse used by a faculty member or a researcher, you won't find a computer at its end. Instead, you'll find it plugged into a box marked "Teradici," slightly larger than a paperback novel. The device has no CPU, no installed application, no operating system. It has a PC-over-Internet-Protocol (PCoIP) card that facilitates communication with a virtual workstation housed elsewhere.

The absence of real computers on premise, however, doesn't prevent FAU students, instructors, and researchers from running AutoCAD, SolidWorks, ANSYS and other professional design software.



Intel envisions supporting server-hosted workstations with its processor-integrated graphics technology. ***Image courtesy of Intel.***

At Roger Williams University in Rhode Island, students enjoy the bring your own device (BYOD) policy, even though the kind of software they're using for the coursework typically requires the horsepower of a workstation. So what if one student brings a mobile tablet, and another a MacBook Pro to do exercises in AutoCAD and Autodesk Revit? It really doesn't matter. iOS, Windows, Android — all are welcome. By downloading and installing the client software from Citrix, Students can remotely connect to their designated virtual machines, hosted on Dell PowerEdge servers equipped with NVIDIA Grid K1 and K2 boards.

At the engineering procurement and construction management firm SSOE Group, globalization ran up against data security. The huge data sets comprising detailed 3D models of commercial construction projects were nearly impossible to transmit through the web to teams located in China, Malaysia, Brazil, India and Singapore. Short of physically shipping a workstation preloaded with the proprietary building data, SSOE seemed to have no easy way to collaborate with overseas employees and contractors. But then the firm discovered VMware's Horizon View software, a desktop virtualization solution.

Today, SSOE talents located in Toledo, OH; Mumbai, India; Shanghai and other disparate locations work on the same model from their own locations, using the devices they prefer. They meet virtually, in an IT environment built on Cisco Systems servers equipped with NVIDIA Grid GPUs.

These setups are part of the virtualization trend challenging the long-held notion that you need to be sitting at your desk with a high-caliber workstation to do proper design and engineering work.

The Downscaling of Expert Workload

Jon Peddie from the tech consultancy JPR recently conducted a survey on remote graphics and virtualization, underwritten by a number of clients interested in the market.

"The hardcore superstar engineers segment is expanding very slowly, so the market opportunities aren't growing rapidly there," he says. "A lot of work is being pushed away from the superstars because they're an expensive group of talent. It's going to entry-level and mid-level engineers. Companies can justify spending, say, $10,000 on a superstar's workstation, but perhaps less on an entry-level engineer's. That downscaling of work — along with globalization, offshoring and the increased computing power that gives us more than enough to share — is the engine driving virtualization."

John Janevic, MSC Software's VP of Strategic Operations, agrees.

"We all once had this grand vision of putting simulation in the hands of designers," he says. "In my opinion, that really hasn't taken off the way the industry has hoped."

The expectation has since been revised to be more in line with what's possible, Janevic points out. Today, the push is to enable product engineers to take on the simulation experts' workload by "templatizing" what the latter would do in their specialized applications.

This new approach can be seen in the way MSC Software's client GKN Driveline, an automotive supplier, captured its simulation experts' operations in a browser-based interface so the same tasks can be performed by non-experts from wherever they happen to be. The workflow template was built using MSC Software's SimManager software for simulation process and data management. The so-called non-experts, Janevic clarifies, "may not have a Ph.D. in mechanical engineering, but they're still engineers with degrees. To be accurate, they're non-simulation experts."

The GKN project alerted MSC Software that businesses are looking for ways to free expert-driven operations from the desktop machines where they typically take place. Mobility — in this case, access to the template from a variety of lightweight devices — is essential to this setup.

In addition to MSC Software's efforts to ensure its traditional desktop software products are compatible with virtualization solutions, MSC works with partners such as NICE Software, which specializes in cloud-based desktop virtualization; and Rescale, which specializes in cloud-based simulation execution, to ensure it can meet market demands.

Would this shifting preference for virtual machines jeopardize the traditional workstation commerce? To the contrary, Intel's workstation segment manager Wes Shimanek sees it as an expansion of opportunity, not a threat. "There's always going to be that class of dedicated workstation users. They aren't going away," he reasons. "But virtualization allows you to create anywhere, and collaborate everywhere. It also allows workstations to go where they haven't gone before, like the manufacturing floor."

The NVIDIA Grid K2 board, designed to enable multiple users to share a single GPU, is a critical component of the GPU maker's strategy to capture the virtualization market. *Image courtesy of NVIDIA*.

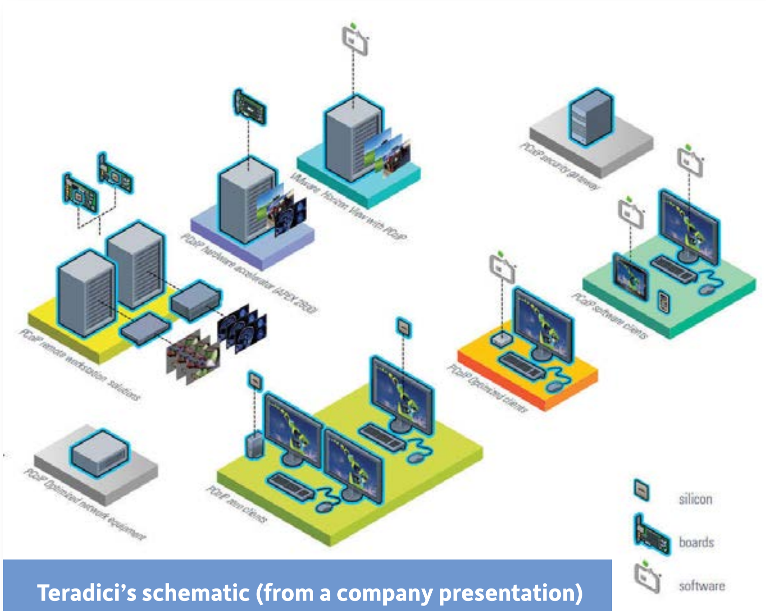
The Performance Question

Al Makley, Lenovo's director of development for the ThinkStation product line, says, "The return on investment (ROI) for virtualization is currently murky where the ratio is 1:1. But it's a little easier to justify with something like NVIDIA Grid, where you can have 2:1 or 3:1," referring to multiple users supported by one piece of physical hardware.

With this approach, overseers have the option to adjust the compute capacity in each virtual machine's configuration (CPU power, GPU acceleration, and memory) In some cases, it is identical to the physical workstation supporting it in the backend. IT managers refer to this as a 1:1 remote setup. But for enterprise bean counters, the real attraction of virtualization is in its ability to proportion the collective horsepower of the hardware into a number of theoretical machines, depending on the workload and the role of the user. The same approach also works as an on-demand delivery mechanism for second-tier engineers, whose intermittent involvement in the project doesn't justify giving them each a dedicated workstation.

Professional engineers' reliance on workstations is driven largely by the demands of the sophisticated software they operate. Siemens PLM Software's NX, Dassault Systèmes' CATIA, PTC CREO Parametric, Autodesk Inventor, SolidWorks, and other industry-recognized design software titles are known to deliver peak performance on workstation-class machines. Therefore, to make virtual machines a viable option for engineers, virtualization vendors must be able to offer assurance that the virtual experience is comparable (if not superior) to using actual workstations.

Mahesh Neelakanta, director of the FAU's Technical Services Group, shares his experience. "If you have lots of program windows open and you're dragging them across your



Teradici's schematic (from a company presentation) shows the variety of PCoIP solutions powered by its technology. *Image courtesy of Teradici.*

screen really fast, you'll notice some lag," he cautions. But that's a very deliberate move to test the limits of virtualization, not typical software user behavior. "Traditionally, engineers have their assembly open and they're rotating it slowly. For those scenarios, there's no problem," he adds.

Centralized Intellectual Property

David Hoff, Intel's GPU and visual computing strategist, singles out the need to secure sensitive IP as one of the driving forces for virtualization. "Customers are telling us IP protection is particularly important to them," he says. "Data sets are getting so large. People collaborate 24/7 around the world on projects. Keeping the IP safe, and avoiding the need to synchronize it around the globe, is becoming an issue."

Security and mobility — the ability to move around — seem to be the two driving forces for interest in workstation virtualization, agrees Hector Guevarez, Lenovo's worldwide product marketing manager: "They want to maintain the data in one location, but give access to it to project teams around the world."

When IP is passed from desktop to desktop during the project, a backend system is required to keep all different versions of the data (for example, a CAD file) synchronized. In virtualization, the data can reside on the same server or appliance supporting the virtual machines; therefore, project managers can better prevent accidental and intentional data leaks — at least, in theory.

FAU students, faculty and researchers use Teradici client devices to interact with virtual machines. The remote communication is made possible by a Teradici PCoIP client card embedded in the client device that sits at the user's desk, and the host card that resides in the actual hardware housed elsewhere.

"Users can see 'My Computer' and a C drive, but there's nothing they can do to it," says FAU's Neelakanta. "They can't save data to it." Instead, the data is saved by default to a shared common drive secured in the data center.

As this article goes to press, Dell and Teradici are getting ready to announce a new remote access software product at SIGGRAPH (Aug. 10-14, Vancouver). The advanced draft of the press release obtained by *DE* explains that the new "Teradici PCoIP Workstation Access Software for Dell Precision workstations gives mobile workers instant access to a rich remote computing experience — whether from a conference room, home office, or on-the-go." By installing the Teradici client software to a lightweight device (such as a Windows tablet) and the host software to a Dell Precision workstation, you can remotely commandeer your workstation from the tablet.

Whether you're using hardware- or software-based remoting from Teradici, PCoIP minimizes IP compromise, according to Teradici: "All user data and computing applications are transmitted as pixel-only images — not data." This approach is fairly typical in virtualization. It also explains why server-hosted workstations may offer better IP security.

GPU Acceleration in Virtual Machines

Both CPU maker Intel and GPU maker NVIDIA recognize they have much to gain (or lose) from how they respond to the budding virtualization movement. Accordingly, both are working with hardware partners to deliver appliances (think of them as mini-servers) that can support workgroup- and enterprise-level virtualization.

Andrew Cresci, general manager of NVIDIA Grid products, points out that engineering design projects generate massive data sets that, until now, "were impossible to move from the data center to the end user. Utilizing NVIDIA Grid technology for remote visualization allows companies to locate compute resource with the data in the server room, so load times become nearly instantaneous. This means that end users, ranging from automotive and aerospace designers to oil and gas exploration analysts, have real-time access to their designs, both on- and off-site, without comprise in performance."

In March, at the annual GPU Technology Conference (GTC), NVIDIA began pitching its Grid appliance as GPU-accelerated virtualization hardware. The advantage of the NVIDIA Grid, according to the company, is the ability to deliver virtual machines with the characteristics of GPU-accelerated professional workstations.

GPU acceleration in virtual machines has been a stumbling block in virtualization for years. In 2012, with the introduction of its Kepler architecture GPUs, NVIDIA declared it could begin facilitating GPU-accelerated virtualization. At GTC

2014, NVIDIA CEO Jen-Hsun Huang described virtualizing the GPU as "one of the greatest endeavors of [NVIDIA]." This May, NVIDIA launched a program to showcase virtual machines hosted on Grid, available to beta testers via Internet connection.

"Professional design applications from companies such as Dassault, Siemens and Adobe run on workstations, which almost exclusively rely on NVIDIA graphics to provide the performance and interactivity users demand," Cresci explains. "With our vGPU innovation, many more users can now access high-performance graphics with full NVIDIA applications compatibility."

Intel's Hoff says he believes processor-integrated graphics (different from a separate GPU installed as a co-processor to the CPU), like the Intel Iris Pro Graphics embedded in Intel Haswell processors, is ideally suited for virtualization. "[The architecture] has a shared memory for the CPU and other dedicated devices that don't have their own memory. In the remote usage scenarios, there's less data movement," he says.

Usually virtualization is made possible by a software component, like those offered by Citrix and VMware. "Intel's VT-x virtualization technology is pretty much industry standard," says Hoff. "That's true of our Intel Xeon E5 and E3 processors with integrated graphics."

Intel's answer to the NVIDIA Grid may be seen in HP's upcoming Moonshot system, described as the "New Style of IT" by HP. "This is the GPU pass-through model," explains Hoff. "The Intel VT-d (virtualization technology for direct I/O) makes the processor-integrated graphics available inside the virtual machine."

In early virtualization technologies, the GPU could not be shared. In other words, to support one virtual machine with GPU acceleration, you'd need to invest in one physical GPU in the backend hardware.

But in next-generation virtualization solutions, splitting the GPU is an option. For example, it's possible for two users to share the horsepower of a single physical GPU, virtualized and distributed across the network. Therefore, administrators may redistribute the power of the GPU depending on who's tackling graphics-intense workloads in a given period. For this purpose, Intel is developing the Intel GVT-d, a technology for graphics processor virtualization.

Motivation and Challenges

Lenovo's Guevarez acknowledges he's seen an increase in virtualization among his customers, but expresses reservations about the conversion to actual implementation. Nevertheless, he says Lenovo is striking up partnerships with NVIDIA, Teradici, VMware, Citrix and other major players in virtualization, in case the market rapidly begins to adopt it.

Guevarez's colleague Makley cautions that the emotional bond between engineers and their own hardware might become a hindrance to the switch to virtual machines. "That one-to-one bond between the users and the hardware that sit right by them is very strong," he warns.

JPR's Peddie outlines the challenges for virtualization vendors. "You have legacy systems, multiple OS developers, different hardware supplies with their own drivers, and roughly half a dozen brands of CAD software," he says. "The people developing virtualization solutions are confronted with a difficult choice. If they have to prioritize one approach for maximum economic opportunity, which OS-CAD-processor-and-graphics configuration should they tackle first? While they're contemplating that, the technologies are still moving ahead."

From the end user's perspective, Intel's Shimanek says, "the experience is most important. They want to know, 'Can I get my workstation experience with a virtual machine?' Our early tests prove, yes, they can. The next determining factor would be the efficiency of the solution."

Some of the considerations in the formula for efficiency may include the number of virtual machines a single hardware solution (like the NVIDIA Grid or the HP Moonshot) can support, the power consumption of the unit, and the ease with which administrators can manage the hardware. **DE**

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

INFO → **Autodesk:** Autodesk.com

→ **Cisco Systems:** Cisco.com

→ **Citrix:** Citrix.com

→ **Dassault Systèmes:** 3DS.com

→ **Dell:** Dell.com

→ **GKN Driveline:** GKN.com/driveline

→ **Intel Virtualization:** http://goo.gl/DHkKJxl

→ **Jon Peddie Research:** JonPeddie.com

→ **Lenovo:** Lenovo.com

→ **MSC Software:** MSCSoftware.com

→ **NICE Software:** NICE-Software.com

→ **NVIDIA Grid:** NVIDIA.com/object/grid-boards.html

→ **PTC:** PTC.com

→ **Rescale:** Rescale.com

→ **Roger Williams University:** RWU.edu

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

→ **SSOE:** SSOE.com

→ **Teradici:** Teradici.com

→ **VMware:** VMware.com

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Canon Océ PlotWave 500

The newest addition to the Océ PlotWave series offers a variety of features, including no-warm up delay, cloud integration and touch screen integration. It can print 10 D-size plots per minute at a resolution of 600 x 1200 dpi. It has web-based tools

for iOS, Android and BlackBerry devices. It is also cloud enabled, so print and scan jobs can be submitted via desktop, smartphone or tablet. Available formats for scanning include TIFF, PDF/A, PDF, JPEG and CALS. Scans can be saved to a USB drive, FTP site or elsewhere with a resolution of 600 x 600. The PlotWave 500 uses the Océ software suite, which allows users to define job settings and run tasks on the multi-touch panel, driver or submission tool.

Colortrac SmartLF SG

Available in 36 or 44 in. widths, the Smart LF SG offers an optical resolution of 1200 dpi, LED illumination and a high-speed Ethernet and USB3 interface. It can scan at 13 in. per second and is equipped with six CCD cameras across the scan with for minimal geometric distortion. The scans are completed using 48-bit (color) and 16-bit (monochrome) to capture image data. A new simplified thick media system is now available, allowing users to raise the scanner's lid and increase thickness to accommodate various media widths.

Users may also access additional capabilities with the SmartWorks Pro software, such as batch scanning, automatic paper size detection, file saving, name/date and time stamp and overwrite control options. The SmartLF SG is currently available in three models: monochrome, color and enhanced color.

Epson T Series

Available in both single- and dual-roll models the Epson T Series features the PrecisionCore TFP print head and UltraChrome XD pigment ink. The T-Series has accuracies up to 2880 x 1440 dpi and can print a D-size plot in as little as 25 seconds, the company says. Other features include the availability of three printer widths, the 24, 36 and 44 in. as well as a current and future-ready print language. Customizable options include a multifunction module, internal print server and the True Adobe Postscript Hardware Engine.

"The next-generation of SureColor T-Series printers were designed based on direct feedback from customers who demand cost-effective, versatile and scalable printing solutions," said Timothy Check, product manager, Professional Imaging, Epson America.

HP Designjet T3500 eMultifunction Printer

The HP Designjet T3500 eMultifunction 36-in. color and monochrome printer is equipped with copy capabilities and a high-productivity scanner with batch-scanning, multi-page PDF creation and scan-to-email functions. For secure printing, it is built with a self-encrypting hard drive, secure disk erase and controlled access printing. It supports a scan speed of up to 2.5 in./sec, a printing resolution of up to 2400x1200 dpi and a line accuracy of +/- 0.1%.

For media handling, the T3500 has

two automatic front-loading roll feeds of up to 650 ft. of media with smart roll switching and a total ink capacity of 1,800 ml. It is equipped with drivers for Windows and Mac OSX, and is ideal for line drawings, renderings, presentations, maps and orthophotos. The Designjet T3500 is currently available; HP intends to release several more large-format printers in early 2015.

Contex HD iFLEX

Key features of the Contex HD series include one-touch scanning, USB and Gigabit Ethernet connectivity, and the ability to scan an A1/D-size document on an A2/C-size flatbed scanner. It has an accuracy of +/- 0.1%, an optical resolution of 600 dpi, and a scan time of four seconds.

Users can access jobs on the cloud via PageDrop and scan in formats such as TIF, JPG, PDF, DWF, CALS, BMP. The HD iFLEX supports 32- and 64-bit Windows 8, 7, XP and Vista software drivers. It is also equipped with a full 48-bit data workflow and a 32-bit TWAIN application driver for use with EDM and other imaging software.

Additionally, Contex applications can create industry standard raster file formats that are suitable to use in any CAD or GIS application, according to the company.

Burning the Ships in the Harbor

Adept product data management helps Seahorse Bioscience position for aggressive growth.

Seahorse Bioscience has been serving the life sciences industry since 2001, providing labware products and metabolic analysis instruments and consumables for biological research and drug discovery.

To maintain company growth, Seahorse required a document management solution that would streamline collaboration between its two locations, be easy to implement without major disruption to internal systems and workflows, and provide the ability to scale up in the future.

From Slow to Almost-Real-Time Collaboration

When Bill Beard, engineering services manager, came on board in 2011, Seahorse's Billerica, MA, engineering division had no document control system; files were simply archived into uncontrolled Windows folders. The Chicopee, MA, manufacturing division did add a workgroup-based product data management (PDM) system, but soon realized that design collaboration would require an enterprise system.

"The ability for real-time design collaboration became a need, not a want," says Beard. "We took a hard look at what applications were available that would allow us to go from demo to go-live in a very short period of time."

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PLM Power Surge

Implementing PLM early on gives a Massachusetts wireless electricity company a boost.

Imagine a future in which wireless electricity makes everyday products more convenient, reliable, and environmentally friendly. WiTricity Corp. is developing wireless electricity technology that will operate safely and efficiently over distances.

The company was founded in 2007 to commercialize a new technology for wireless electricity invented by physicists from the Massachusetts Institute of Technology (MIT). With a growing list of global clients in industries including consumer electronics, automotive, medical devices and defense, WiTricity has emerged as a leader for Internet Protocol (IP) and expertise in highly resonant wireless power transfer.

Outgrowing the System

WiTricity was a typical start-up company, with a small team managing design information in Excel spreadsheets. Even with the minimal amount of data they were managing, they were experiencing the chaos of manual processes. Spreadsheet revisions had no formal change control process or centralized repository. It became obvious that they needed to replace their spreadsheets with a more controlled automated system.

While searching for products, WiTricity's local Mentor Graphics software sales and services partner, Trilogic, proposed Omnify Empower PLM as a viable solution. Omnify Empower was ideal for a start-up company like WiTricity, because it offers a price that was competitive with a part management system, yet provided the functionality and scalability WiTricity needed.

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Commentary  by Pranit Banthia

The Future of Simulation

The major industrial revolution is already here, as computers increasingly take charge of product development and manufacturing processes. Computer-aided simulation techniques have seen a remarkable growth over the past decade, and their global adoption has revamped the manufacturing industry. The recent acquisitions of SpaceClaim by ANSYS and Visual Solutions by Altair, for example, show how the simulation software giants are aggressively expanding their reach in newer markets — and simultaneously trying to establish themselves as a comprehensive solutions provider to the engineering community.

The ability to predict the product behavior in the early design phase makes simulation an intuitive tool for engineers during the development process. With the advantage of reducing manufacturing time considerably, software simulations remain a priority for many manufacturers. However, the quick adoption of simulation-driven product development brings along several challenges that restrain available technologies to some extent.

How far have we reached and what could be the future of simulation-driven design?

As product designs become more complex, the need for high-performance computing (HPC) becomes essential. Although present simulation technology fulfills the requirements of most engineering challenges, there's a lot more to be expected as digital designing tools are improved.

We have reached a stage where simulation tools have begun to use advanced technologies, both in terms of hardware and software. With the integration of cloud computing, the thirst for HPC in handling complex engineering problems has lessened, as the execution of the simulation process has become quicker. This transformation allows engineers to leverage the capabilities of software simulation, and perform dozens of simulations instead of two or three, as hardware no longer remains an obstacle.

Despite security concerns from early adopters, the cloud will remain a viable alternative for engineering organizations — to accommodate terabytes of data easily and effectively.

Simulation Data Management

Simulation is an integral part of today's product lifecycle management (PLM) systems, allowing collaboration among analysts, engineers and designers, and fostering productivity by providing the right information to the right user. With simulation data management, the reusability of simulation data has become easier, allowing manufacturers to leverage skills and knowledge across the enterprise. The concept of knowledge management is pointing toward simulation by crowdsourcing, which will allow engineers to collaborate, extract information and execute the simulation with shorter turnaround.

Knowledge-based Engineering

KBE systems have co-existed since the first application of computerized manufacturing in the early 1980s, yet its benefits have only been recently realized, thanks to the integration of artificial intelligence (AI) to automate product development. Today, KBEs play a role in monitoring organizational performance. KBEs and systems engineering are expected to become more simulation-focused in the coming years.

For example, the U.S. Army has forecast the future of systems engineering in 2025, stating how conceptualization, detailed engineering and manufacturing will be reinvented to remove the gap between the product development team and end users. Their proposed future process predicts that modeling and simulation will be more proactive than traditional computational fluid dynamics and finite element analysis. Today, engineers are required to manually fix the design and run the model for design optimization. An engineer of the future would only require describing the use-case of the part, and the computer will autonomously optimize the part using modeling and simulation.

As digital design solutions evolve with advancements in technology, simulation-driven product development is expected to grow exponentially. There could be a point where physical tests would become obsolete, as virtual prototyping becomes more intelligent and efficient. Adaptive mathematical models, genetic algorithms and agent-based models are becoming increasingly adopted to execute probabilistic simulation, and predict the random characteristics of nature more effectively.

There's also a significant contribution from supportive technologies, such as imaging, rapid prototyping and experimental laboratory integration, allowing the simulation tools to become more intelligent and serve as assistants to designers in a designer-controlled system. As more information continues to pile up within the KBEs and data management tools, the "smartness" of simulation software is likely to increase.

The future of product development, though, largely relies on computing capabilities, which necessitates the successful growth and acceptance of the cloud technology among engineering organizations. DE

Pranit Banthia *is the founder and CEO of the Hi Tech group of companies. Send e-mail about this article to DE-Editors@deskeng.com.*


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