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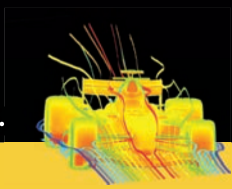
A Winning Formula

Infiniti Red Bull Racing and ANSYS

Victories by Infiniti Red Bull Racing. Simulation by ANSYS.



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Degrees of Freedom

by Jamie J. Gooch

Manufacturing a New Image

After serving in the Navy, my brother-in-law went to work in a factory, turning parts into vacuum cleaners. While I was growing up, he mostly worked the midnight shift. He said he liked the hours because the factory wasn't air conditioned and at least it was a bit cooler overnight than during the heat of the day. He often seemed tired. His complaints of aches and pains eventually evolved into multiple surgeries for carpal tunnel and fused vertebrae. He seemed to constantly worry about being laid off, or the company shutting down and moving its operations to Mexico. Instead, the plant where he worked was shut down by the Chinese company that eventually bought it.

As my high school graduation drew near, I never considered following my brother-in-law or my other family members into a blue-collar field. I joked that my brother-in-law was the reason I went to college, but that was, at least in part, true. I was interested in technology, and to a teenager at the time technology meant desktop computers, not screw machines, welders and presses.

Manufacturing in the U.S. still has an image problem.

That may be changing, and the change can't come soon enough. Manufacturing in the U.S. is showing positive signs of growth, but it faces many challenges, not the least of which is an image problem.

Don't Underestimate the Cool Factor

For an article in this month's focus on prototyping, I interviewed representatives from Roland DGA Corp. and Tormach, LLC, makers of milling machines and accessories. I wanted to see if they felt left out of the mainstream media circus that has surrounded 3D printing for the past few years. Their responses surprised me. Both agreed that the spotlight on additive manufacturing was also increasing interest in subtractive prototyping and manufacturing technologies. In short, 3D printing had made people realize that making things — manufacturing — is cool.

The leap from the hip Maker movement, which is fueled by online collaboration, affordable open source technologies and 3D printing, to the factory floor isn't that vast. You can see it in initiatives like Manufacturing Day (mfgday.com), which "addresses common misperceptions about manufacturing by giving manufacturers an opportunity to open their doors and show, in a coordinated effort, what manufacturing is — and what it isn't," according to the site.

One organization participating in this year's event on Oct. 4 is the National Additive Manufacturing Innovation Institute (NAMII, namii.org). Like other participants in Manufacturing Day, NAMII is hosting an open house. It is inviting the public into its Youngstown, OH, headquarters where they'll see additive manufacturing systems from Stratasys, 3D Systems, ExOne, and Renishaw quietly working away, making physical representations of the 3D models that visitors will see on computer screens.

No doubt visitors will hear about NAMII's second call for additive manufacturing applied research and development projects from NAMII members and their partners. NAMII will provide $9 million in funding for multiple awards to advance research in additive manufacturing design, materials, processes and equipment, certification, and knowledge development. They'll learn about the National Additive Manufacturing Roadmap, which guides the organization's investment strategy by identifying areas for growth.

Most importantly, visitors will see that manufacturing in the U.S. is growing, has a high-tech future and can be, in a word, "cool."

Design Engineering Support

As professionals on the front lines of the manufacturing process, design engineers shouldn't shy away from promoting Manufacturing Day and other initiatives intended to improve the image of manufacturing. Just like the recent interest in 3D printing has also boosted interest in subtractive rapid prototyping, renewed interest in manufacturing is good for the entire production chain, and for the country as a whole. Manufacturing is responsible for 90% of U.S. patents, 70% of our private sector research and development, and 50% of the country's exports, according to Gene Sperling, director of the National Economic Council.

I encourage you to talk to your company about getting involved in the promotion of manufacturing, organize a tour of your shop and offices, or simply take someone from the next generation along on a plant tour during Manufacturing Day. We can all help dispel the myths about manufacturing's present and ensure that it has a bright future. The rising tide of manufacturing can lift all ships. DE

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

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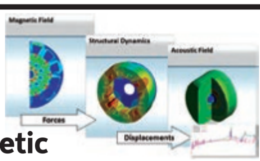

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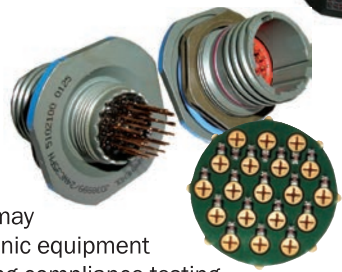

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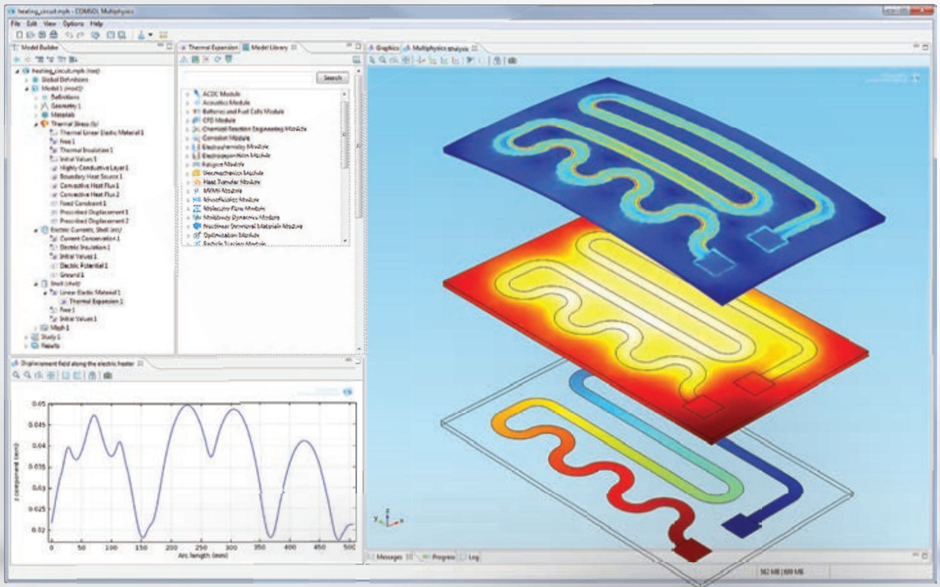

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Take the Guesswork out of Workstation Selection

Trying to settle on the proper workstation configuration can be a daunting, not to mention, risky endeavor.

The Workstation Configurator helps engineers determine their workstation needs based on their individual workflows.

While most engineers understand the core components of workstation technology, matching the technical specifications of processors, GPUs, and memory to specific engineering workflows isn't exactly a straightforward experience. Any misstep can have significant financial ramifications, leaving an engineer stuck with a pricey underpowered system that doesn't meet their needs or conversely, investing too much in a platform that is overkill for their day-to-day design tasks.

To help engineers sort through the confusion and make the best workstation match, Intel has launched its Workstation Configurator, an online tool designed to help engineers break out of the one-size-fits-all mold mentality and build a productive, custom workstation without overinvesting in technology. Working with engineering ISVs, Intel developed a set of benchmarks that help identify workstation configurations optimized to provide the best overall design experience for specific engineering tasks.

How it Works

Visitors are prompted to choose their typical engineering workflow broken down into three choices: 2D and 3D basic design for working with less featured parts in small assemblies that don't demand simulation; advanced design and basic simulation for addressing the needs of 3D design and modeling, and simulation of complex parts and larger assemblies; and advanced simulation and rendering, for work that requires flow simulation and photorealistic rendering of large projects.

For each workflow, the tool directs visitors to choose their most likely level of design complexity while serving up workflow requirements on screen to provide guidance through that choice. Once selected, the tool comes back with a recommended system configuration, with detailed descriptions to help the user navigate and fully understand the tradeoffs between core system components like processor cores, memory, video cards, and the right storage medium. There is also the ability to print out the spec sheet in addition to links to specific OEMs so users can vet out their optimal workstation configuration and get real-world pricing.

Two Examples

Let's say, for example, a user mostly engages in simple 2D and 3D design—a workflow the tool equates with designing parts of only 1 to 25 features and little requirement for assembly modeling. For that specific workflow, the recommended workstation configuration is an Intel Xeon processor E3-1200 v3 family with 4 cores, 8 GB of memory, an Intel HD Graphics P4600, and HDD memory.

Yet, someone looking to do advanced simulation and rendering work on parts with more than 200 features and assemblies with over 2,000 unique components is directed to a very different system. In that case, the recommended configuration is stocked with an Intel Xeon processor ES-2600 family with 6 cores, 64 GB of memory, a mid-range discrete graphics card, and SSD storage.

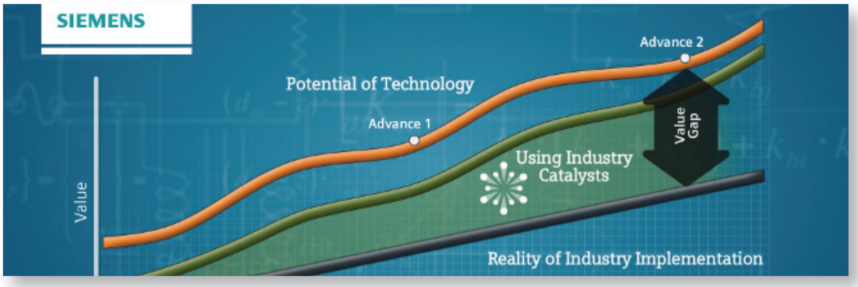
Of course, nothing is set in stone. Users can fine tune the recommended configuration and see how additional processor cores or the selection of a higher end graphics card will affect their system performance as well as the pricing.

To take the Intel Workstation Configurator for a test drive, visit: intel.com/content/www/us/en/workstations/workstation-configurator-tool.html. DE

by Kenneth Wong & Beth Stackpole

Siemens Steers Toward an Industry-specific Focus

Siemens PLM Software is now executing on a foundation it's been building toward for years — releasing a new series of industry-specific solutions, dubbed Catalysts, that aim to take some of the sting out of product lifecycle management (PLM) implementations. The Industry Catalyst Series will encompass a portfolio of solutions based on a specific industry's best practices and culled from Siemens' collective experience collaborating with customers. The idea behind the Catalysts is to help companies jump-start PLM deployments and accelerate time-to-value.



Siemens PLM Software introduces Catalysts Series, signaling a more industry-focused approach to its PLM business.

Components Speed Deployment

Each Industry Catalyst pulls together three basic components:

1. A set of industry best practices o digital templates that serve as a reference guide for how companies in a particular industry should operate throughout the various stages of the product lifecycle.
2. Deployment accelerators, which are a set of industry-specific recommendations for product selections, system design decisions, configuration procedures, and deployment best practices.
3. Open and configurable industry solution components, which are software modules that allow the PLM implementation to easily control the appearance and behavior of the overall platform without the need for custom programming.

By packaging Teamcenter and the rest of its PLM portfolio in this manner, Siemens execs say companies can expect to knock nearly 30% off their initial deployment time — while saving millions of dollars in upgrade-related costs over the years, according to Steve Bashada, senior vice president of industries for Siemens PLM Software.

"If it normally takes two to three months before most companies are up and running on PLM with a base of people, we now want them to be up and running pretty quickly — say like six weeks for a large installation and maybe a week or a few days for smaller organizations," he says.

Much of what Siemens is trying to do is to "productize" what is typically done as part of a PLM consulting engagement, reducing what can become the lion's share of the cost and what is frequently the primary obstacle for deployment. PLM vendors have offered vertical industry versions of their platforms for years, but they have typically been more marketing-oriented, packaging up a basic set of templates.

Siemens' competitors are moving in a similar direction, the most aggressive being Dassault Systèmes. Dassault is offering its EXPERIENCE platforms in a number of areas, from automotive and aerospace to its License to Cure EXPERIENCE aimed at medical device manufacturers.

Central to Siemens' Catalyst offering is the concept of Process Pillars — a common set of critical processes tuned to a specific industry. For example, the Marine Catalyst spans five business process pillars, including shipbuilding program and product management, fourth-generation ship design and engineering, digital ship construction, supply chain management, and ship service. The Catalyst for Electronics and Semiconductors comprises process pillars for parts lifecycle management, bill of materials lifecycle workflow, product maturity progression models, and change management, among others.

Bashada says he expects that the Catalysts will enable customers to implement 70% industry-neutral best practices, 20% industry-specific processes, and 10% customer-specific processes — a recipe Siemens believes is tailored for PLM implementation success. By avoiding a more custom-tailored PLM solution, companies will avoid the traps that inhibit adoption of future technology.

"This is a future-proof scenario so companies can move forward and avoid doing customizations that stop the entire operation from moving forward," he says.

The Catalysts for Automotive Functional Safety and Electronics and Semiconductors are available now; Catalysts for Shipbuilding and Footwear will follow in December. Bashada says there will be Catalysts in each of the eight industries Siemens supports — with the possibility of 30 to 40 available over time.

"That's the granularity we're looking at," he says. "It depends on the industry and what the problems are."

— B. Stackpole

by Kenneth Wong & Beth Stackpole

VMworld 2013: The Desktop Moves off the Desk

The latest trend in IT is to move the stack of hardware that used to sit in a climate-controlled server room to the cloud — according to organizers of the recent VMworld 2013. This led me to wonder whether I ought to log on to the conference from a browser rather than attend in person. Still, the venue is a mere 30 minutes away by train from where I live, so I headed out there with my camera and notepad for an old-fashioned exhibit walk. What I discovered is, you need a lot of sophisticated back-end hardware to hide the computer desktop from the user's physical desk.

As suggested by this display at VMworld, organized by makers of VMware, many IT vendors are looking at virtualization to boost productivity and efficiency.

My first stop was NVIDIA, the graphics processing unit (GPU) maker showcasing the NVIDIA GRID. The company offers two families of products under the NVIDIA GRID brand. The first, described by the company as a Visual Computing Appliance (VCA), is equipped with eight GPUs. This setup is designed to support up to eight virtual desktops as an appliance, which is easy for small and medium businesses with little to no IT staff to set up and use.

Design software makers — from Autodesk and SolidWorks to Adobe — are looking at virtual infrastructure, like those powered by NVIDIA GRID, as the future of workstations.

Justin Boitano, NVIDIA GRID's product marketing director, was demonstrating the second of the two GRID solutions at the show. To showcase the potential of the enterprise-class GRID K1 card, NVIDIA installed a wall of eight display monitors, all running on virtual machines powered by the Dell PowerEdge R720 server GRID solution. In this setup, each virtual machine gets its own virtual GPU, a performance-booster for rendering and simulation programs.

Turning the corner, I stumbled on the booth of Teradici, a PC-over-IP solution provider. Teradici launched a few years ago with a remote PC solution, facilitated via a host card (installed inside a workstation) and a client card (installed in a portable desktop box with connector ports). But the company's technology has gone through various incarnations. The latest addition to its product line is a PC-over-IP solution built right into an AMD GPU. The AMD FirePro R5000 contains a built-in Teradici host card, which allows you to remotely access the GPU's graphics-boosting power from a client device (for example, a low-powered consumer PC without GPU).

The Software Side

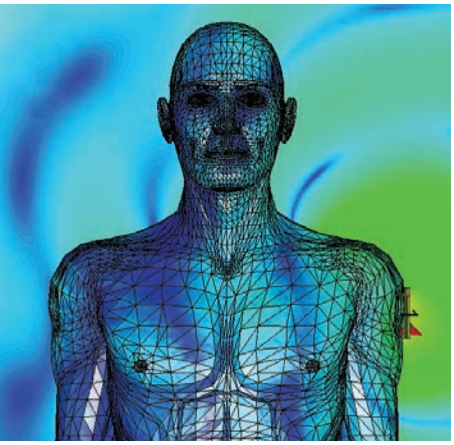
Virtualization also requires middleware that connects the back-end servers to remote users, so solutions from VMware (organizers of the conference) and Citrix will play a bigger role in such setups. Brett Newman, Supermicro's high-performance computing (HPC) specialist, observed, "If you were to put the CAD or design software into a virtualized environment without any special software sauce, you would find a much reduced performance. It has to do mostly with the data pass-through on the GPU, which the CAD software relies on a fair bit. Previously, you could not easily pass data through the GPU at all, or you could but to only one instance. And the [graphics performance] may not be as powerful as what you get on a normal workstation."

But that's no longer the case, Newman pointed out, "a little bit due to hardware changing, the driver models changing, and the virtualization software changing." Supermicro offers cluster solutions based on NVIDIA GRID in its SYS-1027GR-TRFT and SYS-2027GR-TRFT products, with one- or two-GRID setups. The virtualization is powered by Citrix software.

If you think workstation vendors — HP and Dell, for example — might shun a virtualization conference, you'd be wrong. They occupied some of the biggest booths at VMworld. Every virtual machine in the private or public cloud is powered by a piece of hardware with enough computing power to support it.

Cloud computing isn't the death knell for desktop workstations. It's the harbinger to a future where you don't necessarily need to be at your desk to get access to your computer desktop. Your desktop machine may be miles away, or virtualized in the cloud.

— K. Wong



by Kenneth Wong & Beth Stackpole

Zuken Eyes U.S. Expansion

Well-established in international circles, Zuken is striking out at the U.S. electronic design automation (EDA) software market with an expansion that includes a campaign to shift the conversation away from single printed circuit board (PCB) design to a systems-level approach that addresses current design challenges.

Zuken sees an opportunity to break out in the U.S. market because its EDA portfolio is architected on the premise of multi-board systems planning, according to Bob Potock, Zuken's vice president of marketing.

"Product development is no longer a single domain process — you really have to consider mechanical, electrical, software design, packaging and manufacturing as part of the whole thing," he explains. "You have to raise the design abstraction from what has been historically in our world, putting chips on a board, to the product level because boards are no longer designed in a vacuum."

Zuken is focused on what it calls product-level design abstraction, where the software addresses systems planning at a holistic product level, bringing the various engineering silos together early on in the development process with the idea of avoiding problems before the design is fully evolved.

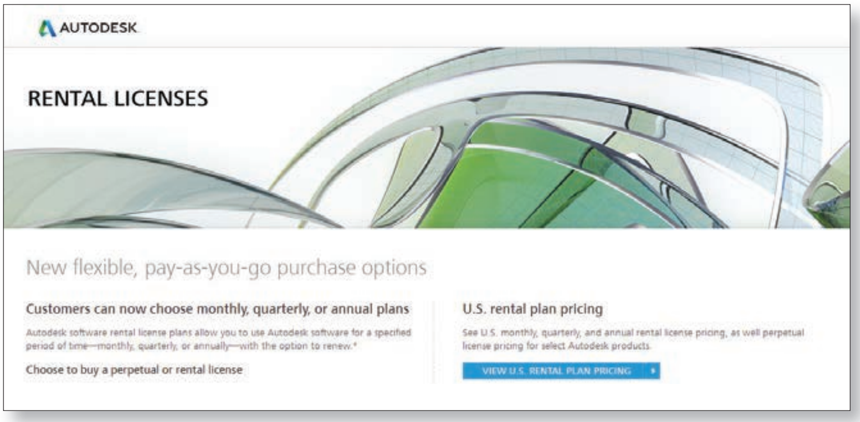
Zuken's flagship product is CR-8000, a multi-board, systems-level design solution that addresses planning from the concept-to-manufacturing stages across multiple domains.

Also central to Zuken and CR-8000's value proposition are capabilities around intellectual property (IP) management. It lets you strip out critical information as required, giving customers a higher comfort level when working with external outsourcing partners.

There is also the System Planner, which functions as the starting point for concept development. It brings together previously disconnected planning steps into a single view while maximizing design reuse, so there is no need to re-enter data between systems.

— B. Stackpole

For Rent: Design Software



Shortly after Siemens PLM Software launched a pay-as-you-go monthly licensing plan for Solid Edge, Autodesk rolled out monthly rental plans for a series of popular titles, including 3ds Max, Maya and the Design Suite.

Siemens PLM Software and Autodesk announced the launch of on-demand software rental — just a week apart from each other. For decades, perpetual licensing with annual maintenance contract was the standard way to purchase professional design software, but in the past three years or so, vendors began experimenting with other approaches, designed to appeal to smaller shops with limited budgets and those who need the software only for the lifespan of a project. Siemens and Autodesk's latest move to put Solid Edge, Autodesk Design and Creation Suites, Autodesk Max and Autodesk Maya are the latest examples.

Siemens first tested the waters with Solid Edge Design1, a CAD package targeted at a smaller pool of users working on Local Motors projects. It must have proven to be a viable business: It paved the way for Solid Edge subscription, priced between $130 and $350 per month.

The most basic of Autodesk monthly rental plans range from $50 to $195 a month for single titles, and from $285 to $395 for bundled suites. Premium and Ultimate plans cost more. In addition to monthly purchase plans, the company also offers quarterly and annual plans.

On-demand or subscription-based software has also become synonymous with browser-based or cloud-hosted software. However, that's not the case here. The versions of Siemens and Autodesk titles available for rental require local installation. The cloud-hosted subscription model (often called SaaS) is championed by Autodesk for its product lifecycle management (PLM) products under the PLM 360 brand. At press time, Siemens hasn't delved into the cloud with the same enthusiasm.

— K. Wong

Boost Performance by Matching Workstation Cores to Needs

Whether you should focus more on multiple cores or higher frequency processors depends on your workflow.

For most engineers, it's a matter of simple math: If a modeling or simulation application demands higher processing power, up the ante with a multicore workstation and presto, performance problem resolved.

As it turns out, however, the math isn't that simple. While multicore machines can supercharge the performance of some engineering applications, the majority of mainstream tools, including most popular CAD packages, don't benefit significantly (if at all) from the addition of multiple cores despite the added expense.

The reason is that most 2D and 3D CAD modeling tools are designed as single-threaded applications, which means they aren't architected to run in parallel in order to leverage the extra horsepower of additional cores. In addition, most modeling applications like CAD are frequency-bound, which means their performance is directly tied to the frequency of the main processor and not in any way impacted by the number of on-board cores.

The takeaway in all this is that making the right workstation choice is less about buying the most number of cores your budget affords, but rather evaluating your applications and workflows, and understanding their performance needs. "Understanding what your application is doing and what drives performance enables you to configure a new workstation most appropriately and ensure spending is targeted where it counts, not on blind assumptions," says Tim Lawrence, BOXX Technologies' vice president of engineering.

Making Your Workflow Match

For CAD and other modeling applications that are frequency-dependent, the best way to maximize performance is to invest in a workstation that runs at the highest frequency possible. Instead of allocating budget to configure the base platform with additional cores, the better approach is to channel those dollars toward other components that can boost performance. For example, while engineers working with large models and assemblies will profit from the highest frequency processor, they will also greatly benefit by channeling investment dollars toward SSD (solid state drive) storage or investing in a higher-end graphics processing unit (GPU).

Multicore comes into play for engineers tasked with highly complex simulation or rendering tasks. Specifically, applications like ray tracing and multidisciplinary simulation have been written with parallelism in mind, meaning they can direct multiple processing jobs to different cores. With this approach, a workstation can leverage multiple cores, scaling accordingly based on the complexity of the simulation or ray tracing problem and ensuring that the workstation—and the engineer's productivity—operates at the highest levels of performance.

So for the next workstation purchase, don't get caught up in the blind pursuit of extra cores as a matter of boosting performance. That's a surefire way to misspend budgets or to invest more than is actually necessary. Instead, stick to the simple equation of examining workflows and applications and matching the number of cores to their needs.

You can find out more about how BOXX Technologies can help you configure the optimal workstation at the website below.

INFO ➔ BOXX Technologies: www.boxxtech.com

For sales inquiries phone:
- 877-877-2699 (U.S.A.)
- 512-835-0400 (W.W.)

or email: SALES@BOXXTECH.COM

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Award Winning Composite Technologies

Kudos to Ticona and Innegra Technologies, which have both been honored for their work in the composites sector.

Engineers at Ticona outlined an analysis process to improve the accuracy of simulation results for glass fiber-reinforced thermoplastics, picking up the Best Paper Award at the SPE Automotive Composites Conference & Exhibition.

Innegra, meanwhile, picked up a JEC Americas 2013 Innovation Award for its new Innegra H line of hybrid yarns for composite applications. The Innegra H line includes olefin yarn co-mingled with carbon, glass, basalt and aramid fibers to increase durability and avoid shattering in lightweight, high-impact composites.

MORE ➜ deskeng.com/edge/?p=5443

Russian Aerospace Improves Compliance Using Simulation

Because Russia's aerospace industry has been plagued by corruption, poor design and a number of costly (and fatal) failures, the government has committed billions of dollars to revamping it in an effort to take a larger chunk of the global market for commercial aircraft.

GosNIIAS, the Russian state scientific research institute that supports aviation systems development, has partnered with ANSYS to help meet worldwide aerospace standards. The two organizations are

leveraging ANSYS' simulation expertise to create a new software called SCADE Solutions for IMA (integrated modular avionics) to streamline the code generation of avionics system architectures, and to create an automatic IMA configuration table.

The goal is to save time and cost during product design, and improve system reliability and safety compliance.

IMA represents a real-time network of airborne systems that works across hardware modules. GosNIIAS demonstrated at least one IMA-based application last year, and other systems are in development.

MORE ➜ deskeng.com/edge/?p=5431

Battery-free Wireless Sensor Technology

Engineers at the University of Washington have come up with a possible solution for powering wireless sensors: ambient backscatter technology that uses existing TV and cellular transmissions to allow devices to communicate with each other.

"We can repurpose wireless signals that are already around us into both a source of power and a communication medium," says lead researcher Dr. Shyam Gollakota.

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The Foldable Electric Car

The Korea Advanced Institute of Science and Technology (KAIST) has unveiled the Armadillo-T, a small, low-powered car that can fold itself in half to fit into even the smallest of parking spaces.

The vehicle is built specifically for urban environments. It seats two, has a top speed of 40 mph, and its 13.6 kWh battery will take you 62 miles on a charge.

Drivers can use a smartphone app to remotely fold the car (which shrinks from 110 to 65 in.) and park it.

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NVIDIA Opens Tech Center

NVIDIA has opened a new center in Ann Arbor, MI, dedicated to advancing automotive tech. In the remnants of the Rust Belt, silicon is slowly taking the place of steel and automotive manufacturing.

"NVIDIA's commitment to the state of Michigan is an encouraging sign for future growth and jobs in the technology and automotive industries," says Michael Finney, president and CEO of the Michigan Economic Development Corp.

Among the technologies likely to undergo development at the new center are NVIDIA's Tegra graphics processor and the Jetson Automotive Development Platform. Tegra has already been put to use by Audi in its multimedia system, but the processor is capable of far more than determining which MP3 to play. The Jetson Automotive Development Platform includes a Tegra processor — and may eventually offer an enhanced graphical overview of a car's surroundings, making for safer driving and better GPS.

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NAMII Calls for Projects

As the use and importance of additive manufacturing (AM) continues to grow, so does the value of the National Additive Manufacturing Innovation Institute (NAMII). In the year since NAMII opened its doors in Youngstown, OH, the institute has added 80 members to its roster, and continues to foster innovation in the 3D printing industry.

NAMII has announced a new call for projects, with $9 million in funding available for multiple awards. Selected projects should get underway early in 2014. The projects will focus on five different areas related to AM.

The call for projects is the "accumulation of months of focused work and in-depth analysis on two fronts that are intrinsically linked: the creation of a formal, member-driven project call process and the development of a National Additive Manufacturing Roadmap, our technology investment strategy," says NAMII Director and NCDMM Vice President Ed Morris.

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UPS to Offer 3D Printing

Following a small business poll in which respondents were generally favorable to the option of 3D printing services, UPS has decided to test the waters of additive manufacturing (AM). A select number of the more than 4,300 U.S. stores will offer the service, beginning in San Diego. UPS is looking to fill the needs of its customer base for rapid prototyping, artistic renderings and promotional materials.

For the test run, UPS has selected STRATASYS' uPrint SE Plus AM system.

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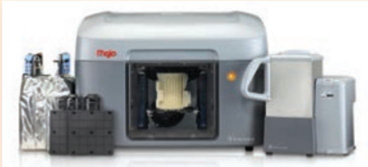
Win Your Own Mojo 3D Print Pack



If you're a successful designer or engineer, you probably have more than enough mojo, chutzpah, or gumption to pitch and propose bold ideas. We wouldn't presume to think we can supply you with that kind of mojo.

The Mojo we're giving away is Mojo with a capital M — a desktop 3D printing system from Stratasys.

Last year, in the inaugural Rapid Ready sweepstakes organized by *DE* and Stratasys, we gave away a uPrint 3D printer to Maegan Spencer, an R&D engineer from California-based medical equipment maker Avinger. A month after we delivered the prize, we revisited Meagan to find her churning out everything from custom tube-cutters and device holders to mountain-climbing accessories for her leisure time.

This year, in the Second Annual Rapid Ready sweepstakes, *DE* and Stratasys come together once again to give away a Mojo 3D Print Pack, usually sold retail for $9,900

You can enter to win via the link below. But hurry, the sweepstakes ends Oct. 29.

MORE ➜ deskeng.com/3Dprinter

NASA Invests in Bioprinting

NASA, already an early adopter of additive manufacturing (AM), is now ready to back bioprinting with a $100,000 grant. Unlike other forms of bioprinting, the project being backed would eventually be able to print nearly anything by pulling the ingredients from thin air.

The process is envisioned working by gathering sunlight and carbon dioxide by way of algae collectors to provide energy. Raw materials are gathered as well, in the most basic forms possible, forming the building blocks of printed objects. These materials are then built up in standard AM fashion into engineered cells that, in turn, build the object required.

Any benefits to the space program would more than likely trickle down to civilian industries, possibly bringing about new breakthroughs in medical bioprinting. The process could also be used to build miniaturized organs for testing — replacing the use of animals — for the creation of bioengineered implants, and biofilms for testing new medicines.

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ExOne Expands Options

Success in business is rarely achieved by sitting back and relying on a single product to succeed. In the additive manufacturing (AM) industry, systems are only half the equation; the other half is continuing development of new materials.

Alongside tried-and-true 316 and 420 stainless steel infiltrated with bronze, ExOne is now offering bonded tungsten, and iron infiltrated with bronze. On the sand casting side of the business, ExOne will be offering phenolic and sodium silicate to its suite of binders.

ExOne collaborated with rp+m to develop bonded tungsten for use in shielding products, designed to protect from ionizing radiation. Used in the company's M-Flex AM system, it can replace lead shielding — and is compliant with the European Union's Restriction of Hazardous Substances Directive (RoHS).

MORE ➜ rapidreadytech.com/?p=5054

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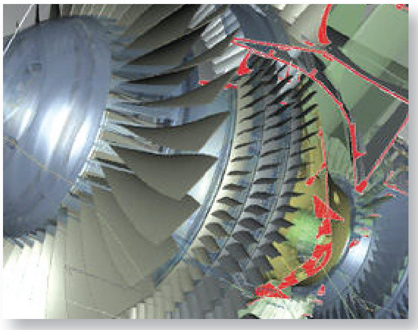
Editor's Picks

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.



Siemens Simplifies PLM Software Implementation

Teamcenter Rapid Start for growing into PLM also announced.

Siemens PLM recently announced a new release strategy for its Teamcenter applications. The applications are no longer dependent on a specific version of the main Teamcenter application. That means you do not have to wait for – nor do you have to upgrade to – the next version of Teamcenter to install a new application.

Teamcenter Rapid Start was also announced. This PDM (product data management) software leverages Teamcenter code and, by doing so, gives you a pathway to the full Teamcenter implementation by enabling you to add on Teamcenter capabilities as you need them.

MORE ➜ deskeng.com/articles/aabkhh.htm

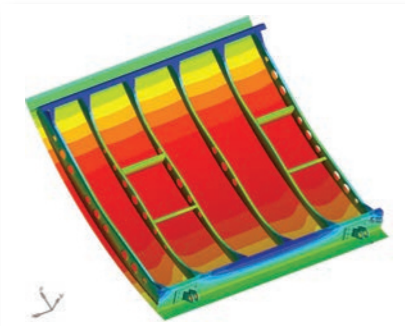
Design for Assembly Software Updated

Boothroyd Dewhurst DFA 10 said to deliver faster, easier-to-use analyses.

Boothroyd Dewhurst has announced Version 10 of its DFA (Design for Assembly) Product Simplification software. Now, generically what you may think you have here is a cost management system. But that notion alone is selling DFA short by a mile.

The basic idea here is that DFA helps you get to a design that uses the minimum number of parts to meet or even exceed your specifications. But even that savings is only a third of it. It also helps you achieve a design that is easier and faster to manufacture, assemble, and service. Finally, by doing all of that, it helps you design and deliver more robust products.

MORE ➜ deskeng.com/articles/aabkjp.htm



Fatigue Analysis Integrated into MSC Nastran 2013

Nastran also offers greater acoustics, nonlinear and explicit capabilities, and improved performance for HPC environments.

MSC announced the 2013 version of MSC Nastran, its pace-setting finite element analysis solver for decades now. It has all sorts of enhancements that would make this a really interesting release if it were not for one other enhancement that pushes 2013 into the immensely important release category.

The key advancement is embedded fatigue analyses. Integrated fatigue analysis, if you prefer. MSC calls this development NEF – Nastran Embedded Fatigue that couples the stress and fatigue calculation processes into a single, simultaneous procedure.

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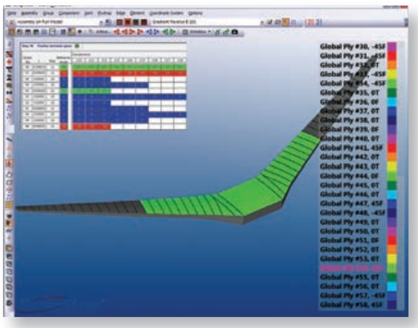

Composites Optimizer Self-Configures

HyperSizer's built-in intelligence is said to produce more accurate answers faster than earlier versions and with less user input.

HyperSizer software, 6.4.5's stress analyses and sizing optimization capabilities are intended to help you reduce the weight of structures. It works with major engineering systems to help you obtain optimized designs while eliminating manual calculations, offline spreadsheets, and model remeshing.

The key is, Collier Research says it reconfigured HyperSizer's core technology with built-in "intelligence" that produces more accurate answers with less user input and runs much faster than before.

MORE ➜ deskeng.com/articles/aabkpc.htm

Engineering for the Future

You can't engineer the future with yesterday's product lifecycle management system.

BY PETER SCHROER

Peter Schroer is the CEO & Founder of Aras.

If you're at a global company that is completely satisfied with your product lifecycle management system, you can stop reading right now. If you're still reading, it's probably because your PLM experience has been less than promised.

I've been in product development and manufacturing for more than 30 years, and during that time I've met thousands of engineers, managers and executives. If there's one thing they all have in common, it's that each one of their companies is different.

We're all different because we're constantly changing to grow and improve. Being different is how we compete. And it's why every company has different products and processes.

Today's PLM systems were never designed to handle this constant change. In my opinion that's a serious problem.

Managing Complexity

It's clear that the rate of change is only going to accelerate and that complexity will continue to increase with it.

My founding vision for Aras came from the fact that every company has unique and complex data and process models, and that PLM software should be adapted to fit those models, rather than the business compromised to fit the software. At Aras everything we do builds on this premise.

Our PLM platform is designed for global companies that have complicated products and systems where PLM is a necessity not an option. It's for businesses that must constantly change to compete in tomorrow's world markets.

We understand the complexity of designing the next generation of aircraft, vehicles and electronics. We know how to assure regulatory compliance and protect critical intellectual property. We know how important PLM performance is when thousands of suppliers are working in the system at the same time.

And we know you're going to need to change everything tomorrow.

That's why we built Aras Innovator. To provide global companies like yours with the advanced technology for PLM that will be necessary for the next 10 years of complexity and change. Because you can't engineer the future with yesterday's PLM.

A Different Direction

If your company develops products on more than three continents, if you design systems that integrate electronics and software, if your supply chain is taking on greater design authority, then you've got real PLM challenges.

Moving forward you'll need to control MCAD/EDA and ALM processes, manage more complex Bills of Material, bring together data from numerous enterprise systems, securely enable global supply chain access, provide systems engineering functionality, make mobile a reality and probably provide some form of cloud or hybrid cloud capabilities.

Find out what XEROX, Motorola, Honda, Boeing and thousands of other companies around the world already know. Aras is Different.

We encourage you to Be Different.

Discover your next generation PLM at aras.com

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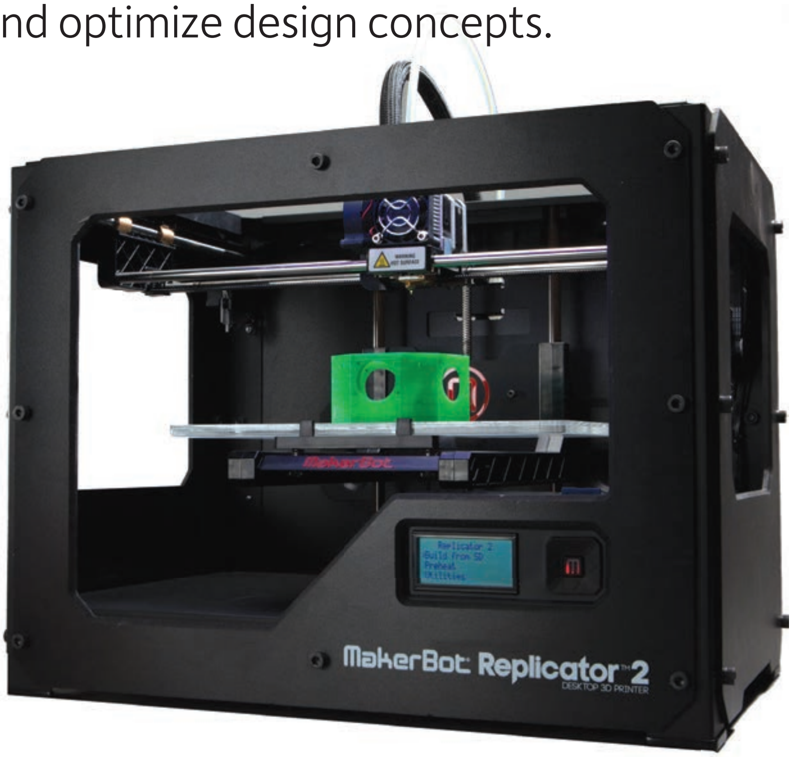
Getting *Personal*

Led by the fanfare over low-cost, consumer 3D printers, a new genre of professional-grade desktop models is helping engineers more quickly iterate, test and optimize design concepts.

BY BETH STACKPOLE

3D printers have long been a staple of the prototyping process for engineers in NASA's Jet Propulsion Laboratory (JPL). Historically, however, they've been high-end 3D printers accessible from a corporate service bureau, which meant departments would enlist the printers judiciously to avoid escalating project costs.

Things changed when a couple of engineers got a hold of MakerBot's Replicator 2, one of a handful of new lower-cost, desktop 3D printers with enough professional-grade strength to support real engineering workflows. JPL engineers began to tap into 3D printing earlier on in the development process, proving out design concepts and prototyping parts far faster and cheaper than they could with the service bureau model.



MakerBot's fourth-generation Replicator 2 Desktop 3D printer sports a resolution capability of 100 microns and a 410-cu.-in. build volume, making it a viable option for producing professional-quality models. *Image courtesy of MakerBot.*

As word spread through the engineering ranks, additional users began to lobby for desktop 3D printers — or alternatively, cajoled colleagues into making use of their printers during down time. Today, MakerBot touts JPL as its largest customer, and JPL says it's tapped desktop 3D printing on a much broader scale, using it for myriad prototyping tasks, including creating an early model of the heat shield used on the Curiosity Mars rover.

"It's starting to become well known in the lab," says Darrin Tidwell, a mechanical design engineer in JPL, who got his hands on one of the first Replicator 2 printers brought into the organization. "I have engineers coming to me wanting different things printed because people are beginning to understand the potential."

Beyond NASA, companies in industries from automotive to industrial equipment are quickly recognizing the possibilities for leveraging personal, professional-grade 3D printers to change the traditional engineering workflow. Ford, for example, is giving engineers access to desktop 3D printers in its Vehicle Design and Infotronics group, as well as in other parts of the company, as a means of facilitating early prototyping and doing more iterative design as part of R&D efforts.

So how did these lower-end 3D printer offerings hit the radar screens of professional engineers? Led by MakerBot and a host of other consumer-oriented, sub-$2,000 3D printers, 3D printing technology grabbed widespread attention over the last couple of years, generating excitement among mainstream users along with hobbyists and professional engineers. The recent hubbub over 3D printing fueled an influx of new prosumer and profes-

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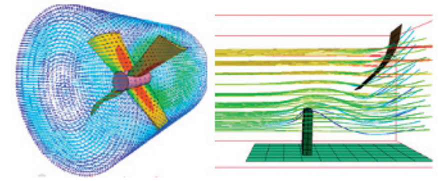

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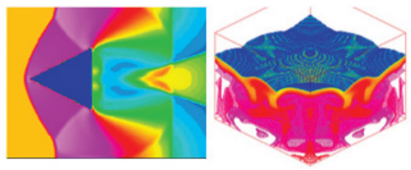
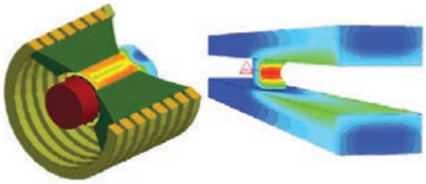


Welcome and Call for Papers

Livermore Software Technology Corporation (LSTC) and **DYNAmore Germany** are pleased to bring engineers, professors, students, consultants, industry leaders and interested parties together at the 13th International LS-DYNA® Users Conference to be held at the Adoba Hotel (formerly the Hyatt Regency) Dearborn, MI.



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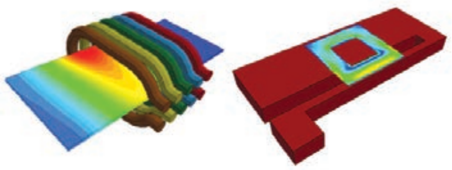

Abstract Deadline: Nov 11, 2013
Email Your Abstract to: papers@lstc.com
Notification: No later than Dec 15, 2013
Paper Deadline: Mar 5, 2014

The presenter of each accepted paper will receive free admission to the conference, provided that the presenter registers for a room at the Adoba Hotel under the LSTC Conference registration.

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3D Scanning for the Masses

As the need for 3D models increases, thanks in part to increased adoption of additive manufacturing (AM), more options for 3D scanners are appearing in the marketplace. Where once only the largest companies could easily afford a 3D scanner, now engineers have a number of reasonably priced options.

The Artec Spider handheld 3D scanner.

MakerBot recently entered the 3D scanner market with a desktop system called the Digitizer. The new scanner is targeted at the Maker crowd, small businesses, and any other customers who don't require high levels of detail from a scan. Prices start at $1,400.

The Digitizer offers a scan size of 8 x 8 in., with a resolution of .5 mm. A full scan takes around 12 minutes and generates 3D models with a dimensional accuracy of ± 2 mm. The system comes preloaded with software, and produces STL files that can be used with any 3D printer.

While that accuracy can't compete with handheld scanners like the Artec Spider, which has resolution up to 0.15mm and an upper accuracy of 0.03 – 0.05mm, the price tag is much less that the Spider's $20,000 one. That price doesn't include the Artec Studio software, which can be used to stitch together multiple scans in real-time without using markers or requiring manual alignment during post processing.

Another company, Fuel3D, is also trying to bridge the price gap with its $1,500, Kickstarter supported handheld 3D scanner. The company far exceeded its initial goal on the Kickstarter crowdsourced fundraising platform.

Likewise, the Matterform Photon 3D desktop 3D scanner also surpassed its goals on Indiegogo, another online crowdsourced fundraising platform. It promises to deliver the scanner, which it says is capable of scanning objects up to 7.5 diameter x 9.75 in. height, to backers for around $400.

It seems 3D scanning is riding the popularity wave of 3D printing, and may follow the same path of making affordable and capable equipment more available.

— DE editors

sional-grade offerings that deliver much more of the sophisticated capabilities of higher-end 3D printer models at significantly lower costs. Higher-end 3D printer manufacturers, taking note of this mainstream market demand, began introducing lower end offerings: For example, 3D Systems' ProJet 1000 and Stratasys' Mojo are each priced at less than $12,000. The icing on the cake was Stratasys' $403 million acquisition of Makerbot, which closed this summer.

"Stratasys does high-end industrial 3D printers well, and we come at it from a different way, making 3D printing as affordable as possible," says Bre Pettis, MakerBot's CEO. "We have the same mission to increase adoption of 3D printing and empower people to be more creative. It all adds up really nicely."

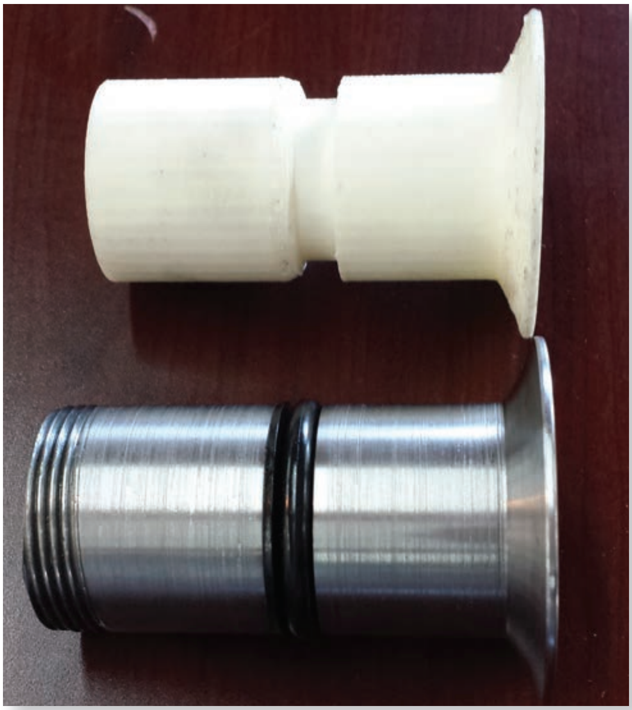
The Personal Touch

The concept of personal 3D printing is gaining ground because both high-end industrial printers, which can easily cost in the tens, if not hundreds of thousands of dollars, and the internal 3D printing service bureau model are out of reach for many companies, especially small- and mid-sized firms. Not only is the equipment cost-prohibitive, but companies often lack the specialized 3D printing expertise, which prevents them from effectively leveraging the technology throughout the entire design cycle.

Personal 3D printers change that equation because they are typically easier to use, thanks to packaging and user interface technology that makes them akin to a turnkey office printer and less like a specialized production tool. This category of 3D printers has also evolved to address ongoing complaints about limited materials choices, smaller build volumes and poor resolution — making them better suited for professional use.

"With a 3D printer at your desk or in an IT center if you're a small business, you could print a part, take a look at it, determine whether it fits in whatever large assembly, and if it's not perfect, you could try again and reprint it," explains Rod Strand, sales director at Aleph Objects Inc. In May, the company released its fourth-generation professional desktop printer, the $2,195 LulzBot TAZ 3D printer. "This kind of 3D printing really allows engineers to optimize their design, because there are no time or money constraints stopping them," Strand says.

That's not to say there aren't limitations or that this category of 3D printer is a direct replacement for the higher-end, industrial models, according to Todd Grimm, president of T.A. Grimm & Associates, a 3D printing consultancy. On the contrary, he says while the quality of 3D-printed parts from these machines is getting better, it's still not a match for what can be output with industrial-grade 3D printers. As a result, he agrees that desktop 3D printers can play a role in early-stage prototyping, helping



By leveraging the TAZ 3D printer to produce prototype parts in lieu of an outside machine shop, Lightning Hybrids has greatly reduced its development time. *Image courtesy of Lightning Hybrids.*

individual engineers and small teams get a handle on how a potential part design looks and feels. However, he says this category falls shy of being a suitable tool for testing form and fit, or for any kind of functional prototyping.

"Use the lower-cost, faster machines on the front end for early concept modeling, when you don't need to look at a pristine surface or when there isn't a requirement around ultra-tight tolerances or for specific materials," he advises. "When in the earlier design phases, 'good enough' is good enough. You just need a physical model replicated in the digital world for early reviews."

The lower-end 3D printers still fall significantly short in the area of material choices and part quality, Grimm says, the latter due to the fact that the extrusion process is typically not performed in a thermally controlled environment. Extruding hot thermal plastic and allowing it to cool too quickly causes problems, he explains, including rapid solidification and poor adhesion between layers. "Not managing the thermal characteristics of plastics can do funny things — think walls rising, layers delaminating, or crashing a build," he says.

Desktop 3D printer manufacturers like Makerbot and Aleph Objects claim their latest models address many of these concerns. The LulzBot TAZ is specifically designed with the technical user in mind, with its 12x11x10-in. build area and 75 micron-layer resolution, according to Strand. Makerbot's Replicator 2 offers 100 micron-layer resolution and a build volume of 410 cu. in., along with support for Polylactic Acid (PLA), a biodegradable plastic with a lot of features that the company says make it great for 3D printing and real engineering work.

"Our material is affordable so people don't have to stress out about making mistakes," notes Pettis. "They can iterate faster and work through more failures."

3D Printing-based Workflow

Lightning Hybrids, which builds hydraulic, hybrid retrofits for large delivery trucks and buses, has employed its TAZ desktop 3D printer as a replacement for the machine shop. Before, the 12-person startup would create a part design in CAD, then ship it out to a machine shop. It would then cost hundreds of dollars and take weeks before getting a finished prototype. Given its market and design processes, time is of the essence, so the traditional process was becoming problematic, according to Jonathan Reynolds, senior controls engineer.

"When we get a new design for a hybrid system, we have maybe a month from the time we see the vehicle to take measurements, make the design, build the parts, put it on the vehicle to test and then deliver it," Reynolds explains. "It's all kind of a stack-up: If one part takes too long to build, we're not able to put things together and push out testing."

With the TAZ, Reynolds and his team are able to crank out a print of a key adapter or part in a matter of hours. They're not as concerned with resolution because they are using the 3D printed model for fit and function testing, as opposed to making a production version.

"If you go the machine shop route, if you find something wrong or put the wrong threads on the adapter, then you have to do it again — and your timeframe just went from two weeks to four weeks," he says. "With TAZ, you spend about $1 on plastic, put it in place and see whether it works as it should."

Mike Kintner, CEO and founder of 360 Heros, which makes holders that allow video cameras to take full spherical video, is leveraging personal 3D printers (3D Systems' 3D Touch and CubeX systems) for conceptual prototyping — and at times, for producing more finished prototypes. Instead of using a computer numerically controlled (CNC) machine to mill the holder and assembling 2D parts, he now creates a 3D model in Alibre CAD (now Geomagic), and puts the CubeX and 3D Touch to work to create a finished working model. This can save hundreds of thousands of dollars creating rigging for an injection mold, he notes.

"In 3D printing, I can just print the mold and I'm not

Aleph Objects' LulzBot TAZ, a Libre Hardware-inspired 3D printer, touts its large 12x11x10-in. print volume as a key differentiator. *Image courtesy of Aleph Objects.*

worrying about how a model is held, so that expense is greatly saved," Kintner explains. With that in mind, 360 Heros' current engineering workflow is to use the personal 3D printers to print out a design, test it, prove out its strength and durability, and check tolerances. Once Kintner is satisfied, the design is then sent off to 3D Systems' QuickParts 3D printing services to produce the finished camera gear.

As this new class of 3D printers brings 3D print capabilities closer to the engineer, it's likely to have the same type of impact as when CAE software came out of the lab and became more accessible to the individual, says Strand.

"Now that engineers can do early prototyping themselves, they are likely to go through more [design] iterations," he concludes. "It's that old adage of a picture being worth a thousand words. A 3D object is worth more than that." DE

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

INFO → **360 Heros:** 360Heros.com

→ **3D Systems:** 3DSystems.com

→ **Aleph Objects Inc.:** LulzBot.com

→ **Jet Propulsion Laboratory:** JPL.NASA.gov

→ **Lightning Hybrids:** LightningHybrids.com

→ **Makerbot:** Makerbot.com

→ **Stratasys:** Stratasys.com

→ **T.A. Grimm & Associates:** TAGrimm.com

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Part 2

A New Look at Subtractive Prototyping

When deciding how to invest in subtractive rapid prototyping, take these five factors into consideration.

BY JAMIE J. GOOCH

It should come as no surprise that additive manufacturing (AM), aka 3D printing, has received an amazing amount of media coverage recently, literally doubling in the past year, according to industry consultant Terry Wohlers. Though 3D printing technology is almost 30 years old, more affordable options, ease of use and improved quality have recently combined to create the groundswell of interest.

But AM's rise to fame doesn't leave traditional subtractive rapid prototyping (SRP) out in the cold. In fact, the increased interest in turning digital designs into physical prototypes and end-use products has buoyed SRP manufacturers as well.

Roland DGA Corp.'s MDX-540 Benchtop Milling Machine.

A Rising Tide

"As designing for 3D manufacturing devices has become more popular, more people are learning the process," says Rachel Hammer, product manager for Rotary Devices at Roland DGA Corp. "With the additive processes out there, people are finding it to be something easy to grasp. In turn, that has helped all of additive and subtractive rapid prototyping. It's taking it out of machine shops and into offices and making it part of peoples' everyday lives."

Roland manufactures and markets computer numerical control (CNC) benchtop milling machines—from the iModela Mini Milling Machine and the MDX-15 and MDX-20 Portable Scanning & Milling Machines for the hobby market, to the MDX40-A Benchtop Milling Machine, targeted to engineers who need to create prototypes, up to the MDX-540 Benchtop Milling Machines, which are used for prototyping and short runs of end-use parts. It also has machines for specialized industries, such as the dental and jewelry industries.

"We position our products as a companion to additive manufacturing," Hammer says. "Where additive is lacking in some spaces, we can help out with that. Some customers use AM for basic prototypes and then move to milling when finalizing their project. When they actually go to manufacture it on large scale, it'll likely be a mill creating it. Creating a part for milling in the design stage saves so much time that SRP is widely used."

Andrew Grevstad, applications engineer for Tormach LLC, agrees that engineers don't have to choose between additive and subtractive prototyping technologies. Tormach offers a line of personal CNC machines — the PCNC 1100 Mill and the smaller PCNC 770 Mill — and tooling equipment that are aimed at prototyping, R&D, and product development applications.

"I think it really boils own to what are you trying to accomplish with your prototyping," he says. "Do you just want to see how it looks? If so, additive can be a good choice. If you're looking for functional prototypes — things you'd use to do additional mechanical testing or you need a specific material — SRP is often still the only choice for that. One of cool things about machine tool technology and using it as part of your prototyping process, is at end of the day your prototypes don't look that different than final product. You can transition to a final product quickly."

SRP Considerations

If easy access to milled prototypes would improve your workflow, take these five factors into consideration when considering entry-level SRP equipment.

1 Cost vs. needs. SRP excels at producing prototypes and short-run final parts with precise tolerances. If you need that type of precision in a prototype, or the ability to quickly create a small batch of parts, then subtractive equipment is an attractive option.

The prices of milling hardware are roughly equivalent to professional 3D printers. For example, Roland's MDX-40A retails for $7,995 and Tormach's PCNC 770 starts at $6,850. That maps well to entry-level professional 3D printers, even with options that increase those base prices. For example: The Roland MDX-40A can be ordered with a ZSC-1 contact scanning unit ($509.99) for digitizing physical parts and an ZCL-40A Rotary Axis Unit ($3,699) for automatically positioning parts for unattended 360-degree modeling. Likewise, the Tormach PCNC 770 can be ordered with a number of options, such as a digitizing touch probe ($1,259.50), automatic tool changer ($4,200.00), a plastic injection molding attachment ($884.00), prototyping mini-lathe attachment ($1,395.00) and a 4th axis kit ($1,287.83), just to name a few.

2 Software ease of use. In the past, CNC milling required machinists to learn G-code, a programming language that controlled the machine's toolpath and speed. While it isn't a complicated programming language, it is still no match for the "push to print" simplicity promised by 3D printers.

Today, basic software to prepare your CAD model for SRP and control the machine is included with most benchtop milling machines, which puts G-code in the background. More intensive (and expensive) computer-aided manufacturing software is available for those who need it. See Kenneth Wong's "A New Look at Subtractive Prototyping, Part 1" in the September issue of *DE* for more information on software choices.

3 Materials. The option to mill in many different materials is one of the strengths of SRP. Many 3D printers require materials to be purchased from the manufacturer, which can lead to higher prices. On the contrary, various metals (including aluminum), plastics, acrylic, engineered woods, plaster, styrene, and Nylon are all options for milling. However, be sure the equipment you invest in is suited to the materials you want the use. For example, the MDX-40A is not intended for metal cutting.

4 Tools. While optional features like rotary 4th-axis milling and scanning can save time and extend functionality, tools are not an option when it comes to SRP. Tools add an amazing amount of flexibility to SRP, but their cost must be weighed to make a purchasing decision. How many and what types do you need? That's not easy to answer, says Tormach's Grevstad.

"It really depends on what you're trying to accomplish," he says. "Cutting tool catalogs are a thousand pages long. There are many different ways to make the same part with a CNC approach. As far as SRP is concerned, it doesn't have to be complicated, but you do have to identify important design features like dimensional tolerance that will dictate your approach to tooling selection — whether you choose an end mill vs. a drill vs. a reamer vs. a boring head to finish a hole, for example. Tooling is one of the things that gives CNC machining a reputation for being more complicated than it is because there are so many options."

Tormach LLC's PCNC's 770 with optional accessories.

For SRP, as opposed to large-volume production CNC milling, the basics will suit most users. "We do offer a lot of different tools, but in the greater world of milling, that's just the basics," Roland's Hammer says. "The ones on our site are enough to get you started. Our SRP Player Pro beginner software lets you enter the tools you have and it will create a plan of action for your part. To make the process even easier, our higher-end MDX-540 mill is available with an automatic tool changer, which allows unattended milling when using multiple tools."

5 Maintenance and support. SRP equipment manufacturers are well aware they're fighting a reputation for complexity when it comes to CNC milling. Though huge milling machines run by machinists with specialized knowledge are not the same as their smaller benchtop cousins designed for prototyping, the misconception remains. To counter that, manufacturers have developed educational services, including in-person workshops, online blogs, user forums, webinars and more resources to ensure engineers have all the help they need to succeed with SRP. **DE**

Jamie Gooch *is managing editor of* Desktop Engineering. *Reach him via de-editors@deskeng.com.*

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Rapid Prototyping Tech Converges

Additive and subtractive technologies begin to merge in latest rapid prototyping processes and equipment.

BY JIM ROMEO

Recently, the Picatinny, NJ-based U.S. Army Armament Research, Development and Engineering Center (ARDEC) approached the National Nanotechnology Manufacturing Center (NNMC) in Swainsboro, GA, looking for a solution that would do two types of prototyping for one of their projects while maintaining accuracy between the processes of each. It's an example of the demands of prototyping for design, where flexibility and accuracy are key. The emergent capabilities of 3D printing are beginning to combine with traditional subtractive prototyping to meet such demands.

"They [ARDEC] wanted to do milling and then precisely lay down a paste on the machined part. Every time that the part was moved from the milling machine to the machine that laid down the paste, too much accuracy was lost," explains Calvin Close, NNMC's marketing manager. "ARDEC asked us to find a solution."

The result was the development of NNMC's patent-pending Multi Prototyping Lab (MPL).

"The concept of the MPL was that the prototype part is locked in position, then different prototyping processes are brought to the part, all within one machine." Close explains.

Large FDM machines (such as Stratasys' Fortus 900mc) allow companies to produce parts as large as 36x24x36 in. with real production-grade thermoplastics, making them durable enough for end-use.
Image courtesy of RedEye.

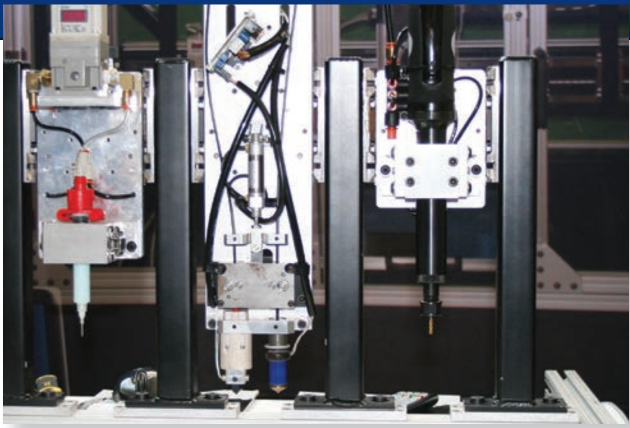
RedEye operates more than 150 AM systems globally, including nearly 100 from its Minneapolis headquarters.
Image courtesy of RedEye.

"The MPL is a multimodule machine. Each module, or attachment, performs a unique process such as 3D printing, drop-on-demand printing or laser curing. The MPL picks up a module such as the 3D Dual Additive Printing Module from its parked position, and performs that process on the prototype part. Once that process is completed, it returns the module to its parked position. The MPL then picks up another module, such as Drop-On- Demand Printing Module, and performs that process on the same prototype piece."

The Rapid Prototyping Evolution

The speed and flexibility of 3D printing enables part consolidation, experimentation with different materials, creation of limited-edition as well as jig production — and the ability to do this right in the convenience of an office setting.

"3D printing can be utilized to tackle the most unique design challenges in a host of industries," observes Bill Camuel, project



NNMC's Multi Prototyping Lab combines additive and subtractive technologies in one machine.

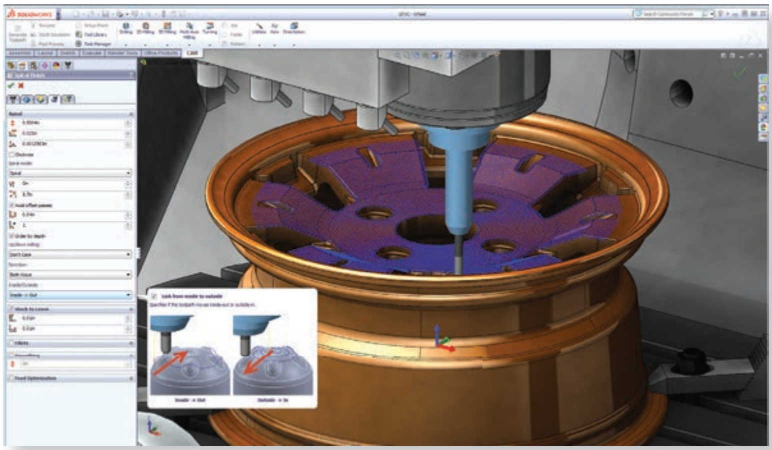
engineering manager at RedEye, by Stratasys, headquartered in Minneapolis. "Our engineers frequently help companies minimize assembly by consolidating dozens of parts into one, and making once-fragile parts more structurally stable.

Camuel notes that 3D printing can also be a bridge to traditional manufacturing, helping production parts get to customers faster and cheaper.

Computer-aided manufacturing is a mature technology, but it too continues to evolve to meet today's latest machining or subtractive technologies and strategies, explains Anthony Graves, product manager for the CAM, DLS Group at Autodesk.

"In the future, you will begin to see a whole new set of users begin to discover and leverage the benefits of subtractive manufacturing — starting in prototyping departments and small companies whose users you wouldn't normally associate with the title 'machinist,' or someone who typically runs a CNC machine," he says. "To support this reality, Autodesk has been working to deliver technologies that are truly open or classified as 'Open CAD.' For instance, we are developing CAM solutions for users of SolidWorks and Inventor. The objective is a completely integrated, seamless workflow."

As 3D printing and computer numerically controlled (CNC) machining technologies evolve, Grave notes, "there is a growing trend for designers and engineers to take a larger role in the creation of prototypes and production of their designs. From small businesses that normally outsource such work, to crowd-sourced start-ups, to even professional model shops and prototyping departments, CAM is the tool that allows designers and engineers to access the world of machining and subtractive manufacturing. The familiar user interface and workflow provides users with a comfortable environment where they can learn take advantage of what both additive and subtractive technologies have to offer."



A screenshot of Autodesk's Inventor HSM Express in action. *Image courtesy of Autodesk HSMWorks and GTVC, Inc.*

Additive and Subtractive All-in-One

While both additive and subtractive technologies are being used by more and more design engineers at different steps along the product design process, NNMC's Close says putting both processes together in one machine has added benefits.

"You can print an ABS plastic part, and machine the surface extremely precisely — and then print a copper track directly on the machined surface."

He says another great capability of the MPL is part production in remote locations. "You can have one machine in your office, and another machine in a war zone, the Antarctic or even on the moon," he says. "Design and produce the part in your office. When you are satisfied with the part, send the code to the remote machine and you can produce the part remotely. Now, instead of having to send parts to the moon, you can have some base materials there and produce whatever parts you need on demand. With our 3D Camera or Laser Inspection module, you can precisely check the remote part for correct dimensions, as well as visually inspect the part."

The MPL also has the capability to produce fully functional parts in one machine. "You can produce half of an ABS plastic part, print copper tracks directly on the part, add discrete components using the Pick and Place Module, solder the components to the copper track, then print the remaining ABS plastic to complete the part," Close explains. "You have just produced a complete part with embedded, encapsulated electronics. This cannot be done with any other existing technology in a single machine."

While that is true, there are a few newcomers looking to follow the path that NNMC has cleared over the five years and more than $1 million it has spent developing the MPL.

Mebotics, LLC, for instance, has launched a Kickstarter campaign to support its Microfactory, which it calls "the first widely-available machine to marry both additive and subtractive manufacturing, integrating machining and 3D printing into a safe, self-cleaning, networkable unit."

The company says that, along with 3D printing parts in plastic, the system can machine parts with wood or metals. It's even intended to be accurate enough to allow users to etch their own microchips.

At presstime, only $36,860 of the Microfactory's $1 million fundraising goal had been met, with 14 days left in the fundraising campaign.

That may have something to do with a competing Kickstarter campaign for AIO Robotics' Zeus, which claims to be "the first and only device that allows users to 3D scan, print, copy, and fax objects with a touch of a button from one device." It surpassed its $100,000 fundraising goal in 24 hours. While Zeus doesn't include subtractive technologies, it does integrate 3D scanning.

Another device that recently made the crowdfunding rounds promises 3D scanning, 3D printing and milling of different materials like foams, woods, aluminium or brass. At presstime, FABtotum's Personal Fabricator had more than tripled its $50,000 goal, and still had 25 days to go in the fundraising campaign on Indiegogo.

The additive side of the Personal Fabricator has an 8.2 x 9.4 x 9.4 in. build envelope, and an extruder head designed to be interchangeable with third-party heads. For subtractive prototyping, FABtotum claims PCB milling, engraving, and CNC pre-drilling.

As more rapid prototyping innovations continue to emerge and traditional technologies continue to advance, design engineers stand to gain the most from integrating rapid prototyping — whether from service providers, 3D printers, CNC machines or a combination — into their design cycles. **DE**

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

INFO ➜ AIO Robotics: aiorobotics.com

➜ **ARDEC:** ARDEC.army.mil

➜ **Autodesk HSMWorks:** HSMWorks.com

➜ **FABtotum:** FABtotum.com

➜ **Mebotics:** Mebotics.com

➜ **NNMC:** RapidPrototypingMachine.com

➜ **Stratasys:** Stratasys.com

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One Lucky Duck

3D printing with the ProJet HD 3000Plus helps Buttercup the duck get a new foot.

BY JACQUELINE TROUTMAN

If you had asked Mike Garey a year ago if he ever thought he would be getting calls from Australia asking for help with injured animals, he probably would have laughed politely and looked a bit confused. Yet that's exactly what has been happening. A Tennessee-based software engineer, Mike Garey recently and unwittingly stepped into the international animal-lovers' spotlight for fashioning a prosthetic duck foot using 3D printing technology, a big heart, and the curiosity to see what was possible. He has since received an influx of interest from media, pet-owners, and animal specialists worldwide, asking for his attention and help with animals from dingoes to ferrets, and everything in between.

Garey and his wife had not intended to own and operate a waterfowl sanctuary, but when the geese they bought for their pond never flew away, they realized not only that the birds were there to stay, but that there were many more birds in their community that needed a good home. Traditional animal shelters cared for dogs and cats, but domestic birds (birds that cannot fly) had no place to go. Feeling an ability and obligation to fill that gap, the Gareys decided to convert their four acres into a rescue reserve for domestic ducks and geese. The Gareys now have 27 birds at Feathered Angels Waterfowl Sanctuary that they tend to with proper veterinary care, food, and safety. And now, evidently, with custom-fit prosthetics.

Buttercup Comes Hone to Roost

In January 2013, a local high school student contacted Garey in search of a home for Buttercup, a domestic duck she had inherited from a high school science class. Buttercup was born with a malformed foot, and for two and a half months the student had hand-raised him, but was no longer able to. Garey agreed to take in the duck, but quickly realized two things. First, that Buttercup did not know he was a duck due to his lack of feathered socialization; and second, that Buttercup was unable to effectively socialize because his foot caused him extreme discomfort in the yard.

With Buttercup's first steps in front of Garey, Buttercup's malformed foot started to bleed. Garey wondered if preserving the foot made sense, so he consulted a veterinarian and confirmed that amputating would improve Buttercup's mobility.

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The Fast Track to Perfect Test and Control Projects

mF4LV: the new tool for optimizing design testing with NI LabVIEW.

Hardware-In-the-Loop (HIL) simulation techniques are gaining importance across a wide range of industrial sectors because they allow users to include the complexity of the plant under control in the testing and development steps by introducing numerical models for all the linked systems. In this way it is possible to determine failures in embedded hardware and software at an early stage and identify the errors before they are carried forward through the entire development cycle. Considering this scenario, optimization techniques are becoming a powerful tool to support the testing and development of plants by establishing best practices for saving time and reducing costs.

mF4LV, recently recognized as a Silver Product at NIWeek 2013, is an innovative software solution bringing together the functionalities of LabVIEW with the power of modeFRONTIER optimization algorithms, enabling time reduction and improvements in model and parallel software/hardware development. The result is a better representation of complex systems and exclusion of repeated configurations. Automated testing and calibration tasks can also be enhanced by reducing the test steps and automating the system calibration for testing at system level.

mF4LV takes the traditional trial-and-error procedures out of the equation by automating the process of finding the best solution in much less time through intelligent design space exploration. It modifies the values assigned to control parameters and identifies the optimal hardware behavior, significantly reducing calibration time.

The new integration between LabVIEW and modeFRONTIER can be used in a variety of applications. For example, by applying this approach to automatic calibration of electronic control units, Alma Automotive successfully addressed the challenge of reducing car manufacturing costs and development time. The high flexibility of National Instruments devices ensured complete control over the engine and test bed, while the advanced algorithms of mF4LV allowed the engineers to achieve their targets quickly and efficiently.

INFO ➜ ESTECO: esteco.com

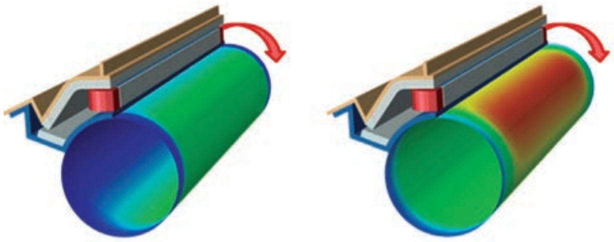
Adding EM Effects to a Multiphysics Analysis

Oh, the problems you'll solve with coupled physics simulations ...

BY PAMELA J. WATERMAN

Maybe you design solenoid valves, and need to understand the combined effects of electromagnetic (EM), fluid and structural forces. Perhaps the time-dependent behavior of your mechanical products can be influenced by electrical current flow, so you need to simulate Joule heating. How do you even approach such problems?

Whether div, grad and curl are your best friends, or Maxwell's equations are a distant memory, you'll appreciate the surprising ease with which today's multiphysics (MP) finite element (FE) analysis software packages incorporate EM effects. *DE* talked to a number of vendors about what's important for setting up useful simulations.



The co-simulation functionality of Abaqus 6.13 from SIMULIA, Dassault Systèmes enables the coupling of different disciplines — as shown in this example of the induction-heated fuser in a printer. Understanding temperature distribution and temperature rise time of fusing rollers is critical for energy-saving considerations. Shown in the figure are contour plots of roller temperature distribution, a little after one half and one full rotation(s). *Image courtesy of SIMULIA, Dassault Systèmes.*

Who's on First?

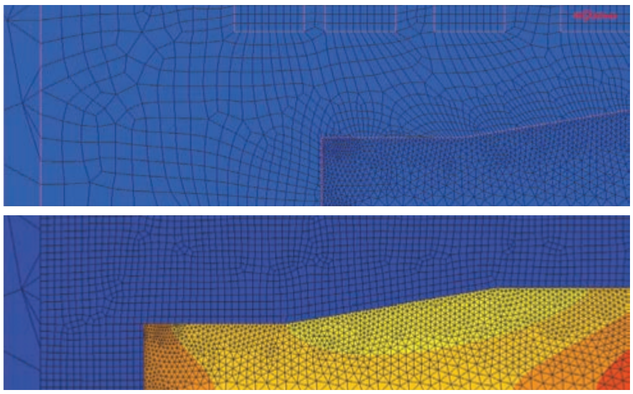
The ever-present drive to make products smaller, cheaper and faster has pushed design simulation software to broaden its MP capabilities. Historically, most such simulation software first combined structural, thermal and fluid behavior, then incorporated EM effects. One exception is Opera-3d software from Cobham Vector Fields Simulation Software, whose efforts started with the EM side.

Although EM simulations generally rely on FE for solutions, some also employ boundary element modeling (BEM); a useful characteristic is they can interface with both mesh-based physics and 1D physics such as multi-body dynamics and controls.

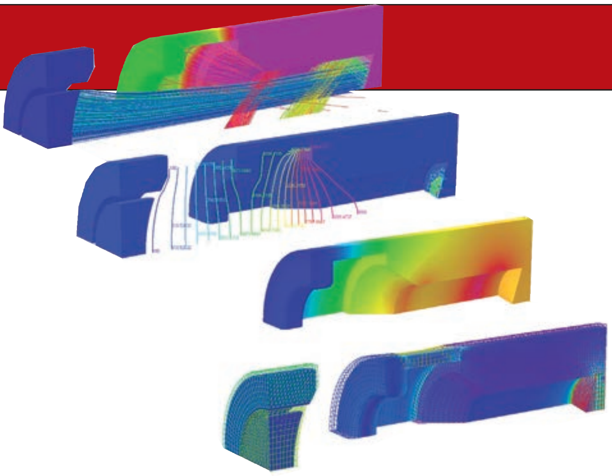
Performing an MP analysis that includes EM effects is, in many ways, no different than any other MP simulation task. Dr. Pierre L'Eplattenier, a senior scientist for LSTC, lays out the steps for LS-DYNA users interested in its EM capabilities: "Give the materials an electrical conductivity, give the time steps you want, and define a source electrical field (AC) or time-dependent DC field."

For best accuracy, LS-DYNA's computations are FE-based in the electrical conductor, and BEM-based for the mesh in the fluid or air surrounding the conductor.

Vendors are quite encouraging about designers taking on this task, even when new to MP. Dr. Valerio Marra, COMSOL's technical marketing manager, says, "Usually, setting



A tube is pushed through a heating coil, and a coupled magnetodynamic thermal structural analysis is performed in MSC Software's MARC. The harmonic magnetodynamic field generates induction currents in the axi-symmetric workpiece. From these induced currents, a heat flux is computed, which is used in the thermal analysis. The staggered sequence is repeated until the end of the analysis. Single or dual-mesh approaches can be used to handle the solid-to-air interface, and the process can also be conducted in reverse. *Image courtesy of MSC Software.*



MP analysis of an electron gun performed with Opera-3d from Cobham Vector Fields Simulation Software. Top to bottom: Surface potential and trajectories; potential map and volumetric power density; temperature distribution; and thermal expansion, demonstrating the inclusion of EM, thermal and structural analyses. *Image courtesy of Cobham Vector Fields Simulation Software.*

up the EM problem is easier and quite unambiguous. Adding thermal and mechanical effects can be difficult; that's when things can get arbitrarily more complicated."

Part of the process requires you to decide whether a sequential or a co-simulated approach is needed, by determining whether the different solutions both influence each other. An example of a sequential approach is running an EM simulation to calculate heat loss, then handing over such parameters as heat flux to a computational fluid dynamics (CFD) solver, which subsequently calculates convection behavior.

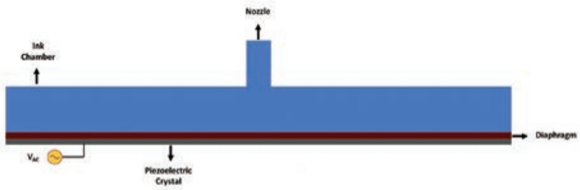
By contrast, Jon Quigley, Altair Engineering's director of multidisciplinary simulation, notes, "In the co-simulation case, both the EM solver and the other solver (which can be mechanical, thermal or fluid) trade data as time moves forward. This can be complicated to set up, due to additional information needed, but software packages continue to improve the ease of use."

One possible challenge: The time periods of interest may vary greatly between domains. For example, a thermal response may ramp up much more slowly (on a scale of minutes) than that of a mechanical (rotating) or electrical (AC) cycle operation. For such cases, designers can time-average losses, then convert them to temperatures as desired.

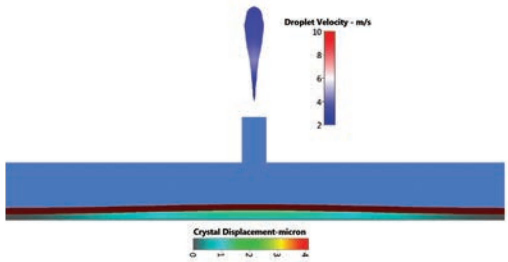
Choosing to use the same mesh or different meshes across the regions can also involve tradeoffs of computational time vs. accuracy. Today's packages generally have advanced algorithms that automatically map different meshes to each other as the simulation progresses.

Scott Stanton, ANSYS' technical director for advanced technology initiatives, explains how this can apply when designing a rotor/stator configuration: "You have a fine mesh

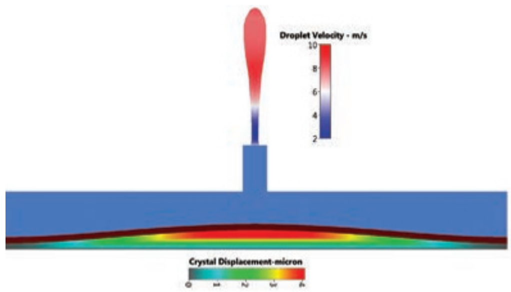
Inkjet printer-head operation simulated with the ACE+ Suite of simulation and optimization software from ESI Group. When voltage in alternating current (VAC) is applied to a piezoelectric crystal, the material physically changes shape and pushes out a droplet of ink. On this scale, the effect of gravity is negligible; therefore, this configuration shows the drop rising. ***Images courtesy of ESI Group.***



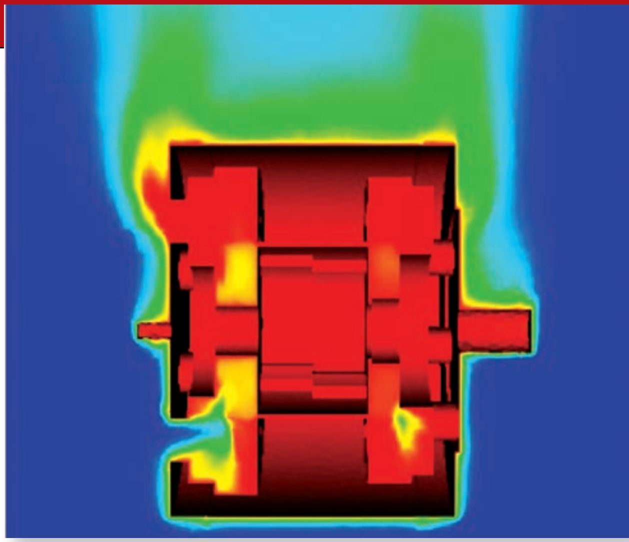
Schematic, piezoelectric inkjet printhead



Droplet ejection for VAC = 200V; slower, shorter drops



Droplet ejection for VAC = 300V; faster, longer drops



Joule heating in an electric motor. JMAG's JSOL solution was applied to the electromagnetic design to compute the Joule heat loss; heat flux values were then coupled sequentially to Altair Engineering's AcuSolve CFD code for designing a convective cooling solution.
Image courtesy of Altair Engineering.

at the edges of the stator, where the gradient is the largest, but for the thermal part, the heat is all the way across. What ANSYS Workbench does is recalculate the mesh from one to the other, handling the mesh interactions underneath." Automated check-sums that the user can see compare results across the mesh and allow manual changes, he adds.

Another checklist task for adding (or starting with) EM effects is defining the frequency domain of interest. Most MP activity is in the low-frequency arena, perhaps up to 100 MHz. Applications include actuators, motors, generators and circuits. High frequencies generally refer to microwave operation, such as for antenna and radar designs, or microwave ovens. Analysis of these latter designs is more complex because it cannot neglect EM field components and must solve the full wave equation.

Not all MP simulations handle the full-frequency cases, but this capability is a particular strength of AMPS Technologies Co., the developer of the Advanced Multi-physics Simulation (AMPs) non-linear analysis programs. The company was founded to address tough problems, beginning with fluid-structure interactions and adding EM effects in 2004.

Dr. Ted Lin, a product developer at AMPS Technologies, says that for crucial applications, it's important to include all the frequency terms when solving Maxwell's equations. AMPS always includes them, using a strain-rate (edge-type) continuum formulation and a consistent least-squares based method for all governing differential equations.

"We have all the physics on one equal interpolation function, tightly integrated," Lin says. "Everything converges to a better solution."

Convergence can be an issue, particularly if non-linear behavior kicks in. ADINA software employs a unified MP system to handle such effects as Joule heating and Lorentz forces along with mechanical and fluid variations, maintaining efficient solution convergence; it can also include Eddy current plus time-varying and high-frequency operation. See the company's website for interesting, detailed animations of microwave pasteurization and oven processes, for example.

MSC Software's MARC was developed specifically to incorporate non-linear behavior, and offers two ways to do so while including EM effects. According to Srinivas Reddy, MSC Software's senior product marketing manager, strongly coupled analyses are more accurate — but they can take more resources and be harder to get to converge. Users might find that a staggered approach works better if there are drastic material property changes. For example, current generation caused by piezoelectric behavior is strongly coupled, but use of the corresponding coupled solver takes lots of resources and may have difficulty converging. MARC can instead take a staggered approach with separate solutions for each time step, and results traded back and forth.

Material Concerns

As with any MP analysis, the biggest challenge can be obtaining the required input data. In the EM world, material properties can be both anisotropic and frequency-dependent, particularly related to skin depth. In addition, swept-frequency behavior can be quite unknown. An example where this becomes critical in the real world is with motor design: It can lose power as the temperature goes up because the material properties are changing. Simulation must take this into account.

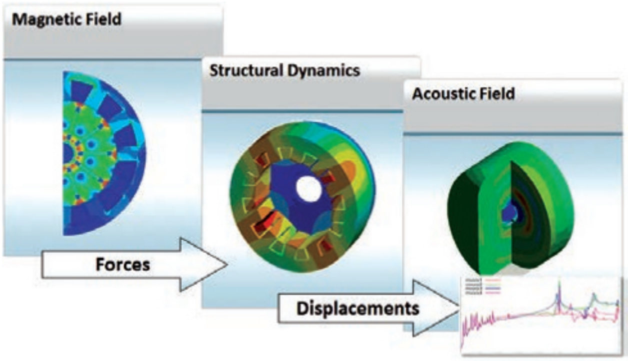
"You may have material properties at a single testing temperature whereas multiphysics allows for temperature-dependent material properties to be used," Dr. Nigel Atkinson, in sales and marketing for Cobham, explains. He adds that this is especially important for rare earth materials, which his company's Opera-3d software has been designed to handle; typical applications include magnetic resonance imaging (MRI) magnets, particle accelerators, loudspeakers and sputter-coating equipment.

COMSOL's Marra gives another example where material knowledge is critical: designing an optical fiber. "The EM side of the design problem just needs the dielectric properties, but what about when it bends? The stresses and strains change the optical properties, so the performance is quite sensitive on the structural side." He adds that many dielectric materials expand, given thermal stresses. Building the correct thermal model depends on understanding the influence of surface finish and contact pressure during operation at different frequencies and signal intensities, all of which determine performance.

Beyond Analysis, to Optimization

Atkinson notes that simulation is best employed when taken to the next step: optimization.

"Products need to be more robust, even though they are placed in more hostile environments," he says. "This is to be achieved with designs that are more innovative than their predecessors. For example, electrical generators might traditionally have been found mainly in turbine halls in power stations, where operating conditions were controlled and predictable. Nowadays, you see generators in many varied environments, from the top of wind turbine towers to hybrid cars. Designers cannot look at the electromagnetic performance in isolation;



ANSYS Workbench provides an environment that can access best-in-class single physics solvers and integrate their solutions. *Image courtesy of ANSYS.*

they need to consider temperature and mechanical effects to achieve an optimal, but robust design."

At ANSYS, the Design Explorer tool lets users try out various combinations of physical parameters for simulations throughout the possible design space. For example, the amount of torque produced by an induction motor is determined by how strongly the magnetic fields of the rotor and stator interact with each other. Give the thickness, outside diameter and material properties of the permanent magnets, the software performs a sensitivity analysis, showing which parameter changes the torque the most.

The sheer number of variables involved in an EM/MP analysis suggests that a hierarchy of prioritization is indeed important.

"Loads — for example, electrical current density on the EM side — are the easiest to optimize," notes Dr. Krishna Gundu, engineering specialist at SIMULIA for Dassault Systèmes. "Geometric parameters can also be optimized, but it involves a little bit more work."

At press time, SIMULIA is writing a tech brief that describes the tradeoffs made between temperature distribution and mechanical design for an induction-heated printer-roller mechanism, given an overall goal of energy savings.

An interesting optimization example comes from Kunal Jain, product manager for the ACE+ suite of analysis tools at ESI Group. "Most engineers want to improve the efficiency and minimize the size and weight of a device," he explains, offering drop-on-demand (DOD) inkjet printing technology as an example. "With DOD, individual drops are ejected only when needed. The underlying actuator mechanism can be piezoelectric or thermal, with piezoelectric becoming more popular since it works with a wide range of inks. In the piezoelectric DOD, the voltage pulse excites the piezoelectric element, which changes shape, forcing a droplet of ink from the nozzle."

Regarding optimization, Jain notes that "producing superior image quality requires small drop size and volume, precise drop shape and fast ejection speed. Amongst the various parameters that the design engineer can control include voltage signal, frequency, nozzle shape, material characteristics, and surface tension of the ink. However, an optimal design requires understanding the underlying phenomena such as surface tension, electrokinetics, fluid-structure interaction and multiphase flows, among others. CFD/multiphysics simulation tools can play a pivotal role in understanding the various complex phenomena, leading to faster, robust, cost-efficient design and optimization of these devices."

Altair's Quigley says that optimization goes right to the "DNA" of his company. "On the structural side, back even in the '90s, we saw that (simulation) goes beyond just getting the answers, but also putting automation on top of that, to be able to have the computers iterate the designs."

Multiphysics introduces a new dimension to that, Quigley adds, "because if you have some form of coupled simulation, the optimization can wrap around the entire coupled calculations." The company has just announced a new Altair Partner Alliance with JSOL to offer the low-frequency electromechanical analysis tool JMAG, as a complement to its partnership with EM Software & Systems and that company's high-frequency FEKO package.

With examples like these, it's clear that industry is moving beyond basic design and analysis toolkits. Whether you need an MP package that handles low or high frequencies, hysteresis, semiconductor materials or piezoelectric devices, now is a great time to add EM capabilities to your simulation and optimization projects. **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 ➜ **DINA:** ADINA.com

➜ **Altair Engineering:** AltairHyperWorks.com

➜ **AMPS Technologies:** AMPSTech.com

➜ **ANSYS:** ANSYS.com

➜ **Cobham Vector Fields Simulation Software:** Cobham.com

➜ **COMSOL:** COMSOL.com

➜ **EM Software & Systems:** FEKO.info

➜ **ESI Group:** ESI-Group.com

➜ **JSOL:** JMAG-international.com

➜ **LSTC:** LSTC.com

➜ **Magna Electronics:** Magna.com

➜ **MSC Software:** MSCSoftware.com

➜ **SIMULIA, Dassault Systèmes:** SIMULIA.com

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Filtering with Finesse

EMI and RFI noise may prevent new electronic equipment designs from passing compliance testing.

BY JOHN JAKE

As processing speeds in electronics continue to rise, and packaging continues to shrink, sensitive internal components are located closer and closer together. Higher clock speeds coupled with the increased density of components lead to increasing amounts of electromagnetic interference (EMI) and radio-frequency interference (RFI) noise.

Such noise can be detrimental to the performance of communication and computing systems. It can also cause false triggering and faulty readings in vital sensor circuits, resulting in system failures. Additionally, this noise can make systems incompatible with each other and cause them to be non-compliant with established military and commercial requirements.

It has become increasingly important for engineers to address the varying need for EMI/RFI/electromagnetic pulse (EMP) protection, along with that of transient voltages during the design and test phases of a project. Otherwise, they run the risk of failing compliance testing — and the accompanying possibility of incurring high costs in redesigning and retesting.

EMI suppression is often handled by filters that are designed to meet the increased performance demands levied during testing from MIL-STD-461, RTCA-DO-160, CISPRE, CE Mark, etc.

"Current trends in the industry that have caused increased EMI/RFI noise have led to the need for multiple approaches and higher performance filters to provide design and test engineers with new tools to help address this issue," says Brett Robinson, PhD, director of engineering for Irvine, CA-based EMI Solutions. "These filters have increased in both performance and sophistication, as well as in the choice of location."

Robinson says that while many of the electronic/mechanical component designers today have strong backgrounds in engineering, the problems that continue to occur from electromagnetic compatibility (EMC) layout may be somewhat new to them, or their training can be a bit outdated. They are often unfamiliar with the particulars of the design/test compliance requirement, or are unaware of the exorbitant costs associated with failing compliance testing and the resulting redesign costs for their devices.

"We could be talking about thousands to tens of thousands of dollars here," he says. "Even without failures, it can cost $50,000 to fully test and certify a device, including all environmental and EMI compliance testing. Sometimes failing the required test parameters, along with the device modifications, can easily cost twice that much."

Filtering Approaches

Essentially, there are four ways to address EMI/EMC filtering requirements. Filtering can be designed onto the printed circuit board (PCB) or in a device during the initial engineering phase. Otherwise, the filtering requirement can be handled by one of three devices after the device has already been designed:

- filter inserts, which are installed in front of device connectors;
- filtered connectors, where the filter is contained in the device connector; or
- filter/transient voltage suppressor (TVS) interface modules that are add-ons to an existing device.

Although filter inserts are generally considered to be at the lower end of the spectrum in terms of cost and filtering limitations, they are a very practical solution for many applications.

"The filter insert is a quick and simple solution. It allows to you to simply pop a filter into your existing system and see whether a simple chip cap level of filtering will solve your EMI issues. If they solve the problem, it won't cost you a lot," explains Bob Ydens, president of EMI Solutions Inc. "We have customers who have used filter inserts successfully for 10 to 12 years. We have other customers who have used these filter inserts to identify the solution to the EMI problems, but then have in turn bought our filtered connectors with the same filtering solution."

The next tier in EMI filtering is the filter connector, which is a higher-performance approach to eliminating EMI/RFI noise. This solution is more expensive than the basic filter insert, but includes a range of configurations and mounting arrangements.

Filter modules are add-on components that are attached to an existing device or "box." These modules can include any filter type, with or without TVS protection. Some of the advantages of using filter modules include more sophisticated filtration, avoidance of the need to insert additional PCB design integration into your already-functioning fielded unit, and avoidance of the time it takes to lay out and retest the circuitry.

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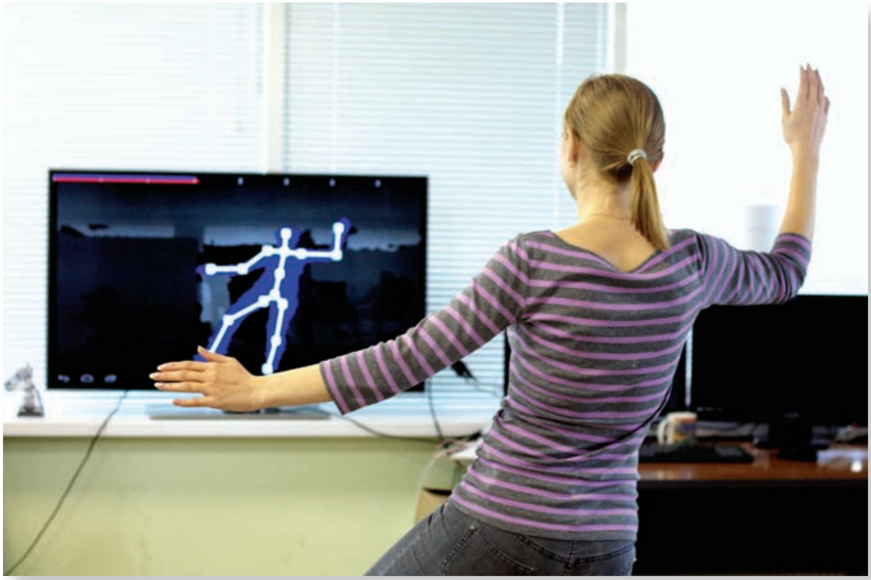
Your **Body** is the **Mouse**; Your **Hands** are the **Pointers**

It's time to rethink design and engineering software for the gesture-based future.

BY KENNETH WONG

A legendary piano instructor has a pricing scheme that confounds many clients. He charges $100 an hour if the student has never played the instrument, but $250 an hour if the student has taken lessons elsewhere. The two different rates seem counterintuitive, but the instructor has a perfect explanation: It takes less effort to teach an untrained student to play the piano the right way, and a lot more effort to untrain someone who's been playing it the wrong way.

This anecdote, most likely based on an apocryphal piano school, illustrates the importance of starting off on the right note when learning a new skill, and the price one must pay for the failure to do so. In the story of human-machine interaction, we may be the students who have been playing the piano the wrong way for nearly two decades, and must now pay a heavy toll to do it right.



3DiVi developed Nuidroid, a gesture-recognition middleware that works with Android OS.

How Computers See

Before the emergence of webcams, computers were essentially blind. Humans have eyes to perceive and discern figures and objects in their line of sight. Desktops and laptops had no such function. With the emergence of integrated cameras and detachable webcams, however, things started to look up, quite literally. For somewhere around $100 to $350, these devices allow our PCs to scan, record and process the outside world in pixels.

So far, computer vision is primarily 2D, a flat collage assembled from dots in an RGB color scheme. Depth cams are the next step in this evolution. The technology, as exemplified by the Microsoft Kinect-Xbox combo, uses infrared pulses to build a three-dimensional view of what it "sees." It's similar to how submarine sonar systems use sound waves to detect obstacles underwater. With this development, you could program game consoles to trigger certain actions based on the players' hand and body movements. For example, in Star Wars-inspired titles, players could use typical swashbuckling gestures to simulate light saber combats; and in a Michael Jackson-tribute title, a player's dance moves could be scored based on how closely it matches the late pop star's classic moonwalk.

The general consumer market's rapid adoption of gesture-based input is paving the way for the professional sector. The possibilities are tantalizing. For instance, you might use natural motions to test-drive a virtual car or inspect a complex CAD assembly. But CAD software development is too deeply invested in the mouse-and-keyboard computing paradigm. Switching from that to the new input mechanism is nothing short of turning around an oil tanker from its preset course. It would have to be an industry-wide effort, supported by vendors as well as users.

Showcasing Gestures

In his home office in Northern California, Brian Pene is teaching a string of C++ code to recognize human motion. As part of his job as a research strategist for design software maker Autodesk, Pene has to stay on top of cutting-edge technologies: stereoscope displays, virtual reality goggles and augmented reality installations, to name but a few. His research (which must seem like playing to many) could lead to commercial applications incorporated into the Autodesk portfolio.

"Gesture input won't be the be-all and end-all," Pene observes. "I don't think it'll totally replace the mouse. But as we move forward, it'll let us do more interesting things."

A program like Autodesk Mudbox, which generates geometry in response to simulated finger pokes and pinches, will be a better fit for gestures than, say, Autodesk Inventor. Currently, most Mudbox users employ a mouse or a multi-touch surface (like an iPad) to sculpt geometry. But gesture input will mimic sculpting gestures more closely. The only thing missing from the simulated interaction would be haptic feedback, the sensation one gets when sculpting with mud in the real world.

Pene managed to build a prototype version of gesture-driven Autodesk Showcase, powered by the Xbox Kinect. With the Xbox Kinect activated, Pene could rotate and tumble the ray-traced 3D automotive models in Autodesk Showcase with a wave of his hand in the air. Pene's work also led to the birth of the Leap Motion plug-in for Autodesk Maya 2014, a free plug-in for users to incorporate gesture-triggered sequences from the Leap Motion controller. The device is about the size of a pack of gum, available online or at Best Buy for $80. The plug-in lets you associate raw data received from the Leap Motion device with certain commands.

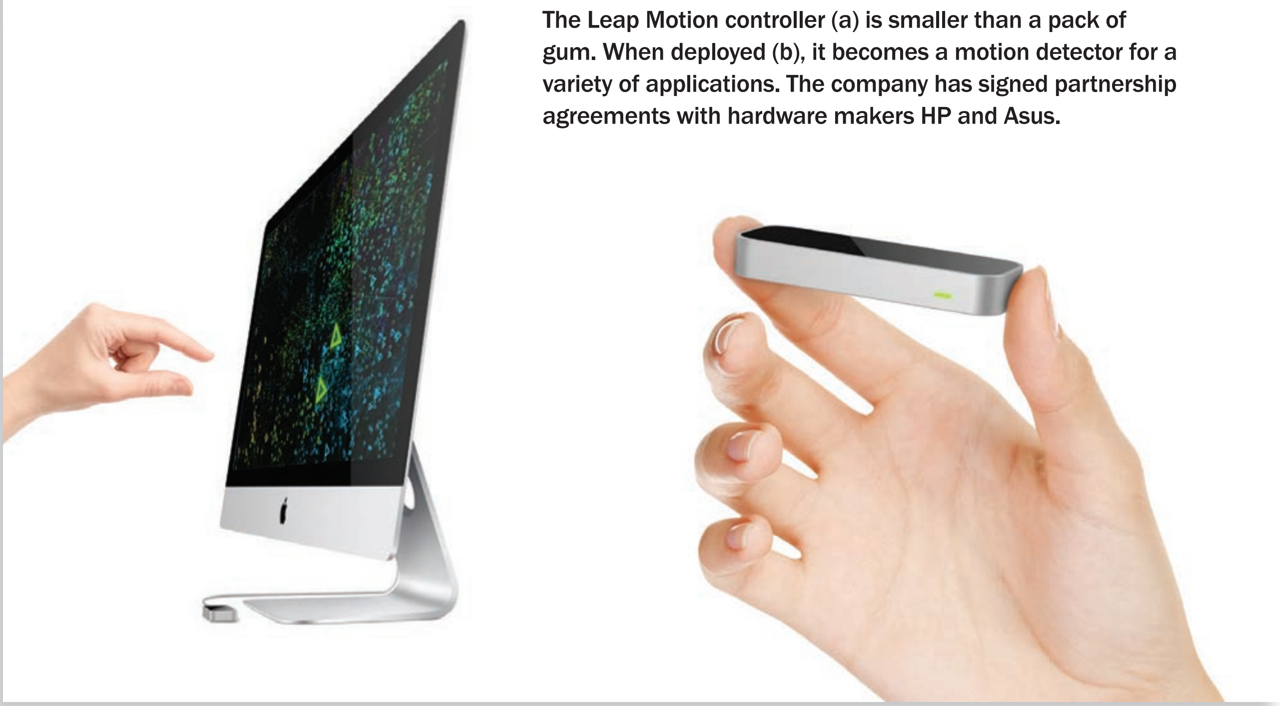
Do Androids Dream of Human Gestures?

The title of sci-fi writer Philip K. Dick's novel, which eventually became the basis for the film "Blade Runner," poses a thought-provoking question on artificial intelligence: *Do Androids Dream of Electric Sheep?* A team of developers in Russia, on the other hand, is convinced that there are enough Android users dreaming of the day their devices can understand human gestures, from hand movements and body motion to facial expressions. Accordingly, they came up with a middleware called Nuidroid, which promises "Kinect-style motion controlled applications to ARM/Android and other embedded platforms." The company, dubbed 3DiVi, states, "With a depth sensor, it adds real-time skeletal tracking to the next generation of smart TVs and game consoles."

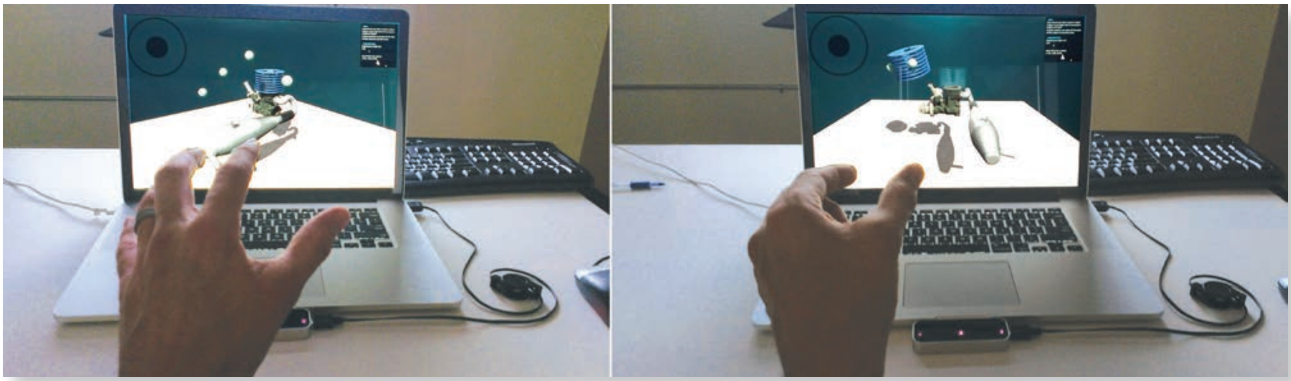
The Nuidroid middleware comes in several modules:

- Nuidroid Body, for segmentation and skeletal tracking from a depth map;
- Nuidroid Fusion, for integration of the depth sensor and a smartphone (the software can locate a smartphone and track its orientation when in use in front of the depth sensor);
- Nuidroid Face, for tracking of the face orientation and optional biometric identification; and
- Nuidroid Hand, for hand tracking to simulate point, click and scroll functions (still in development).

One of the reasons 3DiVi is devoting its energy to the An-



The Leap Motion controller (a) is smaller than a pack of gum. When deployed (b), it becomes a motion detector for a variety of applications. The company has signed partnership agreements with hardware makers HP and Asus.



In this experiment, Autodesk research strategist Brian Pene demonstrated how to use natural gestures to inspect and control a virtual assembly model. The prototype was powered by the Leap Motion controller, priced at about $80.

droid platform, according to Dmitry Morozov, the company's business development director, is low power consumption. To enable gesture recognition with a smaller power envelope would be a much greater challenge than to accomplish it with the more generous desktop hardware.

Nuidroid Face module is capable of both face recognition and face orientation. The latter could be a useful method for conducting virtual walkthroughs and assembly rotations without using a mouse. Imagine, for example, a ray-traced 3D scene that responds to a user's head tilts and shifting line of sight. Morozov admits, however, that there are some hurdles 3DiVi is trying to overcome: "The technology doesn't have enough resolution for biometric applications yet," he says.

If two players stand in front of a depth sensor, the current version of Nuidroid middleware can distinguish and track the two as different entities. That's quite sufficient for game and entertainment. However, if you'd like to use biometric data captured by a depth sensor for security (for instance, programming the design software to grant a user read-write-edit privileges based on facial recognition), the technology needs to be much more accurate and robust.

Current technology sophisticated enough for biometric security application is not cheap — certainly not within the price range 3DiVi wants to market its products, Morozov points out.

"Our software works with a majority of depth sensor devices, so it's not device-dependent," he explains. "We're currently focusing on Android OS, but our roadmap includes other operating systems."

Kinematic Input with SoftKinetic

The six-year-old company SoftKinetic offers depth-sensing hardware (both as portable cameras or as modules for embedding into devices) and gesture-recognition middleware. The desk-mountable DS-series cameras are priced between $249 and $299. Tim Droz, vice president and general manager of SoftKinetic North America, uses the terms depth sensing and 3D sensing interchangeably, but refers to his company's technology as "time of flight."

According to the company, its time-of-flight sensor "measures how long it takes for infrared light to make the trip from the camera and back — the time of flight — and gives the 3D DepthSense camera power to turn raw data into real-time 3D images, as well as grayscale confidence and depth-map images."

The resolution of the current gesture-sensing technology has often been cited as a roadblock in adopting it for professional design and engineering apps, but Droz says he doesn't believe that to be a major hurdle.

"SoftKinetic sells two sensors today," he points out. "One is designed for long range, used for gaming. The accuracy is about 1% of the distance. So at 3 meters, your margin of error in the relative positioning is about 3 cm. So at that distance, you can't get finger-level resolution. We also have a close-interaction camera designed to work at 15 cm to 1 meter away."

The close-range device, SoftKinetic DS325, is marketed under the Creative Labs brand, as part of the Intel Perceptual Computing SDK. "We are providing the sensor, camera, drivers and the gesture-recognition middleware," says Droz. "That technology allows you to do finger, eye and head tracking, along with gestures and poses."

SoftKinetic isn't ready to publicly discuss its initiatives and partnerships aimed at the professional design market, but "we are definitely interested in that space," Droz says. The company is also exploring 3D printing through data captured from depth sensors.

Space for Depth Sensors

zSpace, makers of an eponymous system, captured the imagination of 3D design software users with its clever integration of stereoscopic display, special eyewear, and movement tracking into a virtual reality workspace. The technology translates the position of the stylus (tracked by the system) and projects it into virtual space.

Its chief technology officer, Dave Chavez, says that while the current zSpace system doesn't use depth sensors, this could change as the company explores new ways to track movements or incorporate gesture recognitions.

"If it fits into the user experience and we feel that's where the customer wants to go, we'll add that," he adds. "Our system is architected in such a way so we can drop in new pieces."

Gesture-aware Hardware

Just about any laptop or monitor you buy today comes with an integrated webcam. But in the future, a depth cam or a motion detector may be a standard feature. In April, Leap Motion inked an agreement with HP to embed its technology in select HP products. This partnership was preceded by a bundling deal with Asus, another PC maker, in January. There alliances are all the more startling if you consider that, at the time they were announced, Leap Motion hadn't even launched yet. The company officially came online in July. By then, consumer electronic retailer Best Buy had already taken considerable advance orders of the device.

SoftKinetic has struck partnerships with both electronics component supplier Texas Instruments and automotive sensor and electronics supplier Melexis. SoftKinetic's sensor technology is expected to power Texas Instruments' time-of-flight chipsets and Melexis' in-car depth-sense cameras.

Mitch Markow, engineering technologist for end-user computing solutions at Dell, predicts that "gestures, along with voice and other input modalities, will play an important role in how users interact more naturally with their devices in the near future."

Markow notes that his company is actively investigating these technologies for upcoming products. "Our ultimate goal is not to simply integrate technology, but to create gesture-based experiences using the technology that customers will value," he says.

Rethinking How We Build Geometry

The way we currently create geometry in 3D mechanical design software is inseparably linked to the default input method: the use of a mouse and a keyboard. But a careful study of the steps used to generate shapes — from simple extrusion of 2D profiles to complex operations like revolving profiles along a spline — will show that the method is anything but optimal. Gesture input can significantly improve the modeling paradigm; it may also reduce injuries associated with repetitive motion required by the mouse and keyboard.

"It's a natural motion to reach out into the 3D space to touch and manipulate objects," says Droz, noting that one of SoftKinetic's demonstrations shows gesture-based navigation of the solar system.

The possibilities are nearly endless. What if, instead of dragging a 2D plane with a mouse pointer to extrude a surface, you can just raise your palm from the virtual ground to the desired height? What if you can indicate the lofting or revolving direction of a profile with the simple trace of a fingertip? The ability to define directions and perspectives in the air with complete freedom also offers the chance to do away with the use of drawing planes and construction planes inside virtual 3D space (a method currently used to draw on surfaces from various angles in today's 3D modeling programs).

zSpace's Chavez says he doesn't believe gestures will replace mouse interactions completely. "The use of tools for fine, comfortable, accurate actions is essential," he explains. "The mouse, for example, is very accurate, highly responsive, quick, comfortable, and has two or three buttons. While a finger on a touchscreen is ideal for a wide range of input and control tasks, there are many cases where tools are much more effective than hands alone."

In addition, Autodesk's Pene discovered something while experimenting with gesture input in front of a depth sensor. "Since you tend to make large gestures in front of the depth cam, you might not be able to do it for a long time," he observes. "You could get tired."

This revelation suggests the most straightforward adoption of gesture input may be for design inspection, such as rotating virtual objects and navigating virtual scenes. Adopting it for geometry construction may require more effort, both in creative programming and user re-education. After all, programmers and users have been using — and developing software for — a mouse and a keyboard for decades. It'll take much more than a couple of years to untrain us. **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 → **3DiVi:** 3DiVi.com

→ **ASUSTeK Computer Inc.:** Asus.com

→ **Autodesk:** Autodesk.com

→ **Dell:** Dell.com

→ **HP:** HP.com

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→ **SoftKinetic:** SoftKinetic.com

→ **Texas Instruments:** TI.com

→ **zSpace:** zSpace.com

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Straightened up and Flying Right

Bombardier's Test Flight Center uses Origin to troubleshoot flight errors.

BY ERIN HATFIELD

An estimated 2 million people take to the skies each day, making safety a top priority for aircraft manufacturers. Using both virtual and real-world analysis, companies must rigorously test each plane before it can be put into service. This involves instrumenting thousands of extra points on each test aircraft to gather critical data on the plane's performance. During real-world flight tests, this instrumentation generates tens of thousands of data points every second — and plotting that data to uncover possible dangers can send flight test engineers into a barrel roll.

Researchers at the Bombardier Flight Test Center (BFTC) have enlisted the help of OriginLab for data analysis and graphing software, to make plotting these points and discovering anomalies a little easier. BFTC uses Origin software to visualize its data and help isolate the cause of warning messages and other anomalies during test flights. Through a custom interface tailored to its workflow, BFTC imports multiple data points and plots them against time variables, while generating diagnostic graphs. Bombardier then makes system design changes as needed to its aircraft, during the development flight test phase.

Thousands of Data Points

Whenever Bombardier manufactures a new type of aircraft, BFTC normally gets the first few planes that come off the assembly line. The researchers perform ground and flight tests on these aircraft, often keeping one plane indefinitely so they can make product improvements, upgrades and other alterations that may commonly occur throughout the lifetime of an airplane. Using this data, BFTC can certify whether the new design is safe to fly, as well as identify any issues with the product.

Bombardier uses systems integration rigs and simulators to assist in the development of its products. This allows systems engineers to inject failures into their systems and safely evaluate each response under each of the failure conditions. The worst-case failures are then demonstrated during the certification testing on the aircraft.

Reliability and maintainability of the aircraft and equipment is an important part of the flight test certification process at Bombardier. On a new type of design program, one flight test vehicle (FTV) is dedicated to function and reliability (F&R) testing — which is simply to operate the aircraft as it would be operated in service, over a specific period of time, to evaluate the ease of use and the robustness of the Bombardier product. Pertinent instrumentation parameters are installed on these FTVs and rigs, to capture the appropriate data and demonstrate compliance with the certification authority regulations. The BFTC engineers specify the different elements for each parameter. These elements define the parameter type, the range, the accuracy and the sample rate, so that even the smallest inconsistency in flight data will be captured and analyzed.

Most production aircraft has standard instrumentation parameters, like those of the flight data recorder monitors and records. The pilot handwheel position is one of those parameters. Some parameters require a higher sample rate to extract minute details to determine acceptable and non-acceptable flight performance. The handwheel data helps engineers determine whether the pilot is correctly flying the aircraft, and this data often becomes an integral part of investigating aircraft incidents and accidents. On each FTV, BFTC also installs an instrumentation package, adding thousands of calibrated parameters to ensure that crucial data is collected.

"When certifying an aircraft system, every component of that system is instrumented to capture data for the purpose of demonstrating compliance, or for troubleshooting that system if it malfunctions in flight," notes Michael Konicki, section chief with BFTC. "For example, with the spoilers, we're concerned with the spoiler control lever, handwheel and the surface positions — in addition to all of the inputs and outputs to the electronic control unit that controls the spoiler surface positions. When analyzing flight controls, we produce cross-plots of the pilot's control angular position to the surface angular position. These plots produce a hysteresis curve, which provides the engineer with vital information, often identifying a system deadband."

Analysis and Customization

The instrumentation package on the flight test aircraft generates tens of thousands of data points a second. Each parameter can be programmed to record data at a rate ranging from a sample every second to 1,024 samples every second. For BFTC to observe, analyze and make sense of all this information, however, is a substantial undertaking. The department required a graphing and data analysis tool that could manage the large volumes of data generated by each instrument, while being flexible enough to facilitate importing different file formats.

About 10 years ago, BFTC began using Origin to graph and analyze its test flight data. Designed for ease-of-use for customers at varying technical levels, Origin's solution provided the flexibility and functionality to manage BFTC's complex data analysis and graphing.

With Origin, BFTC continues to be able to quickly and easily analyze its flight test data, and export it for reports and regulatory compliance. The team's flight test engineers highly value Origin's ability to handle large datasets in virtually any format.

"We had instances where we've collected 2 kHz of data, meaning there are 2,000 samples every second," Konicki reports. "The high volume of data required us to use Origin, because Excel wasn't an option due to row limits in earlier versions of the software. Origin doesn't have that limit, and we've even been able to process a dataset with more than 1.5 million rows."

Origin also contains a built-in dialog builder, which the flight test team uses to create and fine-tune a custom interface. By customizing the interface, BFTC is able to handle a collection of data from various formats, including the team's proprietary in-house file format.

"The custom Origin interface enables us to prebuild our datasets, move the data to and from specific locations, and call it up automatically," says Konicki. "We can import data using the tool, modify the plots, apply templates, and then export them to PDFs, which we use in our reports — all in a single solution. Any type of data that we need to report, we can adapt the custom interface to process that data, a practice that is much more complex in Excel and other software. The ease of plotting and integration into our data system are key components of the Origin system."

Over the years, BFTC has continued to work closely with the OriginLab team to ensure that this interface optimizes Origin's latest features and capabilities.

Troubleshooting Flight Errors

Using the custom Origin interface, BFTC creates graphs of the data gathered from each instrument on the test flight. Most often, the team plots the data against time, a practice that enables them to quickly and easily identify data outliers and pinpoint the timeframe when any instances occur.

When needed, Origin's robust functionality allows the flight test engineers to plot two positions on the same plot and see how they line up. The solution also enables BFTC to create cross-plots with completely different variables, or derive a third parameter from two measured parameters. Konicki says the team can manipulate how data is displayed to ensure it is in the most advantageous format.

But where Origin really excels, says Konicki, is troubleshooting any test flight errors. On occasion, flight test engineers might receive a warning message that posts and blinks for a few seconds, then goes away. This raises a red flag for the crew, who then works to narrow down the problem and identify the error. Using the data collected from the instrumentation after it's graphed in Origin, however, BFTC can pinpoint the error, which can range from a loose wire connection to the pilot overcorrecting the controls.

"Without the ease of plotting the data in Origin, it would take our team a lot more time and effort to troubleshoot the issues that arise during a test flight," adds Konicki. "Even though we're tracking multiple variables, we know what time an error occurred and can go back to that time to see what happened. Having data to review saves us from taking a shotgun approach to troubleshooting, such as unnecessarily replacing line-replaceable units (LRUs), to try to solve the problem." **DE**

Erin Hatfield *is a freelance writer specializing in software and technology topics. She wrote this article on behalf of OriginLab.*

INFO → **Bombardier:** US.Bombardier.com

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Simulation Drives Better-designed Products

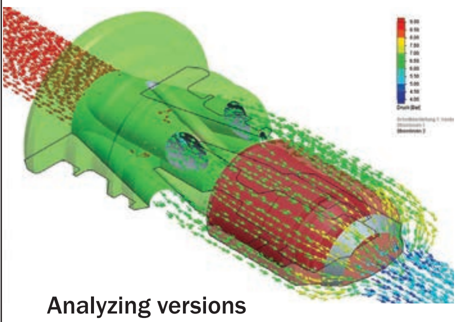
Forward-thinking companies such as Bucher Hydraulics have firmly placed CFD simulation tools in the hands of the product developers to eliminate roadblocks in their design process.

BY JÜRG GERBER AND JOHN MURRAY

Bucher Hydraulics Division produces valves that are mainly used in mobile applications in construction and agricultural machinery, as well as in wind turbines or industrial applications. Bucher Hydraulics AG Frutigen, located in the Bernese Oberland in the Swiss Alps, is one of the company's six competence centers; it specializes in cartridge and customized valves and valve manifolds. Each competence center is responsible for a separate area: design/layout/construction, prototyping and testing, serial production, sales, and aftersales.

In the past when Bucher Hydraulics engineers built small- and medium-sized valves, they were able to obtain test results and optimize the products in a short time at reasonable costs from the prototyping and testing competence center. They didn't need to use flow simulation because they were able to quickly use real results.

But today's projects are for valves that deliver high flow and pressure at very low pressure drop within small dimensions. For these housings or manifolds, all the computational fluid dynamics (CFD) calculations were being done at a specialized competence center. This was causing delays because of the turnaround time needed for handover from the designer to the operator (preparation of data files and explanation of the task), handover from the operator to the designer (visualization of the results and its explanation), and misunderstandings of task and interpretation that led to several repetition loops. To further complicate matters, the team was working with four different software programs for modeling, meshing, calculation and visualization, which needed dedicated people to use and maintain daily.



Analyzing versions and running through what-if scenarios is quick and easy in FloEFD for Creo. ***Images courtesy of Bucher Hydraulics.***

Bucher wanted simulation and testing software that would be easy to learn and use for the valve designer. The company also wanted quick and precise results with good and simple visualization, simple use of existing CAD-3D data, and a data repository that would include variants.

After reviewing the options, Bucher chose Mentor Graphics' FloEFD for Creo because it enables engineers to conduct fluid flow analysis inside the PTC Creo MCAD environment — and to simulate their designs quickly, efficiently and early in the process. Three design engineers were trained by Elinter Ltd., a reseller of Mentor Graphics solutions, on how to use FloEFD. They in turn trained two more engineers. Within a few months, Bucher organized a two-day training session (including a half-day of support from Elinter) for four more engineers from other competence centers.

Bucher found that the layout of valves has become automatically better, especially in regard to performance and costs, because its team can analyze more variations in the amount of time it used to take to analyze a conventional design without CFD. The first design is now much closer

Custom valves created at Bucher Hydraulics.

to the target, and optimization of the prototypes is much more efficient with FloEFD. Because of the good results and availability, Bucher uses FloEFD for the design of new products as well as the optimization of existing valves.

Time is of the essence in today's global marketplace, and by enabling design engineers at Bucher to conduct what-if analysis and progress their designs quickly, the company is able to provide products that offer a great combination of functionality and high reliability — with a great price:performance ratio. DE

Editor's note: *See the related commentary on page 52.*

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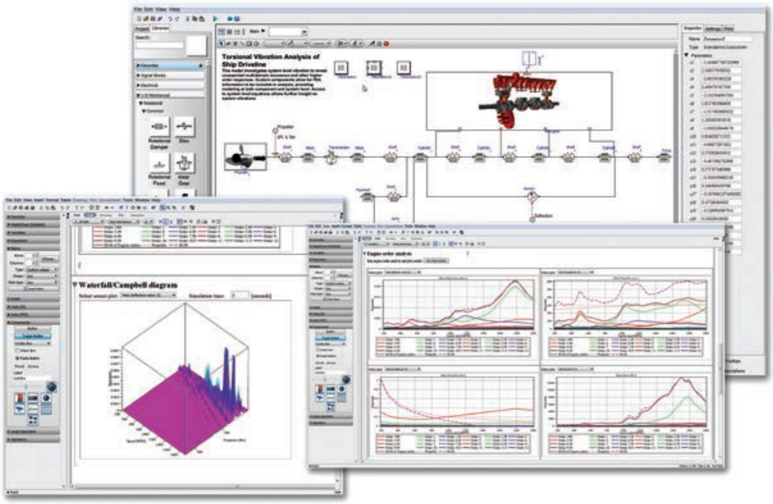
MapleSim 6 **Goes Social**

Building and executing mathematical models is a team sport today, and MapleSim brings detailed simulations to the entire team.

BY PETER VARHOL



MapleSim lets engineers experiment with various configurations and parameters, and visualize the resulting simulations.

As design engineering increasingly adopts simulation as a way of lowering costs and accelerating the development process, engineers seek the best balance of analytical design with simulation results. In many cases, they use Maplesoft's Maple and its accompanying simulation package, MapleSim. The two work together — Maple to produce formal analytical models based on mathematical representations of system behavior, and MapleSim to execute those models as a part of a simulation. The simulation can be entirely in Maple, or it could include actual system components or simulations from third-party software.

MapleSim 6 was released last year, and it is now up to version 6.1. I ran MapleSim on an HP Z600 workstation with dual 64-bit Intel Xeon 5600 processors, each with two cores, running at 2.8GHz, with 12GB of memory, a capable midrange engineering system. To get started with MapleSim, first I installed Maple 16, the analytical engine for symbolic mathematics behind MapleSim. Then I installed MapleSim, which works with Maple to turn analytical models into simulations. Both products can be downloaded from Maplesoft.com, with the purchase of a license key needed to activate them. Installation of both products and activation of the license took only a few minutes, with no problems.

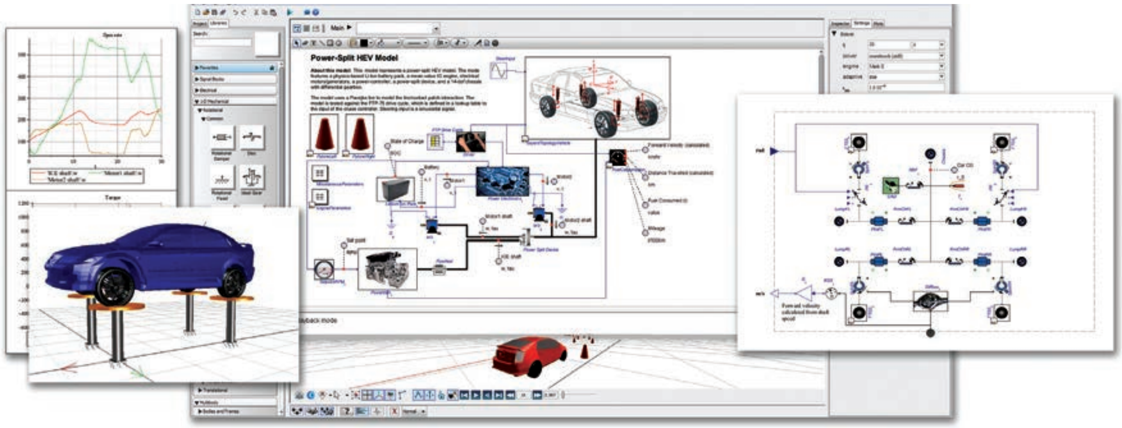
Maple provides the symbolic solutions to computational engineering problems. It enables engineers to build mathematical analyses to solidify design decisions, rather than make estimates that often result in over-engineering. MapleSim takes the results of those analyses and creates a functional and working model out of the equations. You can then go one step further and simulate the operation of these models — both examining the model visually and producing data that can be evaluated separately.

Performance remains a focus in both the major and point releases. While I didn't benchmark MapleSim, I did note that a few of the simpler simulations I tried executed in what appeared to be real time for the modeled system. Maplesoft continues to optimize both the symbolic math engine and the resulting code generation to produce efficient simulations. While engineers can hand-code routines to make them execute more quickly, it's likely that the generated code is at least as fast as most programmers can do on their own.

MapleSim also automatically simplifies equations with no loss of fidelity or accuracy. If a given simulation doesn't require certain parameters, MapleSim has the ability to reduce the equations to exclude them, improving simulation performance. Removing extraneous calculations from a model makes it possible to offer big advances in the performance of certain types of models.

One aspect of performance is the ability to make use of multiple cores on a single system, and to effectively employ clusters to run simulations. With the Maple Grid Computing Toolbox, engineers can distribute parallel computations across a wide variety of distributed systems, including multiple multicore processors, workstation clusters, traditional server clusters, and supercomputers.

As a result, many simulations can run in real time, especially when multiple cores and processors are available.



MapleSim is used heavily in the automotive industry, where its ability to work with electrical and mechanical systems together is highly valued.

In addition to enabling engineers to observe and record system behaviors as they occur, it lets engineers do more simulations than they might otherwise have the time to do. That can incrementally improve the quality of the design while still working within the project schedule.

Engineers Share Models across Teams, Industry

Both Maple 16 and MapleSim 6 reflect recent cultural trends toward collaboration and sharing in a social context. The ability to generate royalty-free source code enables the sharing of models across a distributed project. It also provides for the ability to maintain a library of useful models that can serve as a starting point for further development for specific projects.

In fact, Maplesoft itself maintains just such a repository. MaplePrimes.com is a learning center where Maple and MapleSim users contribute articles and models that enable the larger Maple community to learn what others are doing, how to solve a variety of different problems, and to provide a starting point for different design variations.

In addition to MaplePrimes, Maplesoft has an application center that lets both the company and users upload samples and actual models for learning and use by others. Maplesoft stores these samples and user-contributed models in a cloud environment, making them available around the world to any Maple and MapleSim user looking for answers to design problems.

Documentation is another aspect of design sharing, and Maple and MapleSim's smart document interface lets engineers include mathematical equations, plotting and animation, and even programming as a part of design and model documentation. With dynamic multimedia documentation, the entire project team (as well as customers) can understand and work with the products that result from MapleSim design simulations.

MapleNet brings Maple and MapleSim to websites and web applications, with the ability to develop and share comprehensive technical designs with others. MapleNet includes a web services programming interface to connect MapleSim models and simulations to other application components, and the ability to share documents and models within web browsers. It works with JavaServer Pages (JSP), applets and other types of applications, and enables simulations to be driven from inputs to web pages rather than from within the MapleSim development environment.

MapleNet sharing offers the opportunity for vast new design opportunities. In conjunction with on-demand manufacturing and 3D printing, it has the potential to enable customers to modify designs on the fly and have those designs custom-manufactured for them. This concept could also be extended to suppliers, who could get fast information of subassembly and component characteristics, and quickly adapt designs based on the needs of individual customers.

Integrating MapleSim Models into Complex Simulations

MapleSim features hardware-in-the-loop (HIL) simulations, which enable engineers to take the code generated from their computer simulations and test it as a part of a physical system. By loading code simulating a hardware or embedded device, engineers can observe and measure the performance of a critical part of a larger system without having to build a physical prototype.

In support of HIL simulations as well as other types of integrated simulations, MapleSim offers a large (and continually growing) array of connectors to other engineering software and hardware systems. Third-party software connectors are available for MathWorks' Simulink, LabVIEW and Veristand from National Instruments, dSPACE controller boards, Functional Mockup Interface (FMI)-compliant toolchains supporting Modelica, and VI-CarRealTime, to name a few. Maple is continually adding the ability to play well with significant hardware and software vendors in its targeted markets.

MapleSim includes extensive component libraries in areas such as magnetics, thermofluids, fluids, expanded electrical, and mechanical modeling — making it ideal for fluid dynamic, airfoil and electromechanical applications. It enables 3D multibody and 1D multi-domain in a single environment, so that systems can be simulated more completely.

In fact, MapleSim is based on the Modelica modeling language standard, so that engineers can become quickly up to speed on creating and executing sophisticated models. This approach lets engineers experienced with other modeling and simulation environments go through the learning curve more quickly than if they were learning an entirely new way of modeling.

Those who make use of mathematical models as part of their design process, along with HIL simulations, can use MapleSim to build models that fit right into their simulation harness. It makes it possible to understand the parameters of the design early in the process, and test out alternative designs later on.

Maple and MapleSim are popular in industries such as automotive, aerospace, robotics and other areas that with complex fluid dynamics or mechanical electromechanical components. But any design engineer whose products have moving parts, electrical operation or structural stresses can benefit from the integration of mathematical modeling with code generation and simulation.

Because Maple itself is a prerequisite, MapleSim is most appropriate for those who are already using Maple. Otherwise, there would be a corresponding learning curve for Maple itself. But if you're not doing formal analysis, modeling and simulation yet, you might want to consider starting down this path. The cost and time-to-market advantages of not building physical prototypes can be significant. And MapleSim is a good way to get started with that process. **DE**

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INFO → **dSPACE:** dSPACE.com

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→ **MathWorks:** MathWorks.com

→ **Modelica:** Modelica.org

→ **National Instruments:** NI.com

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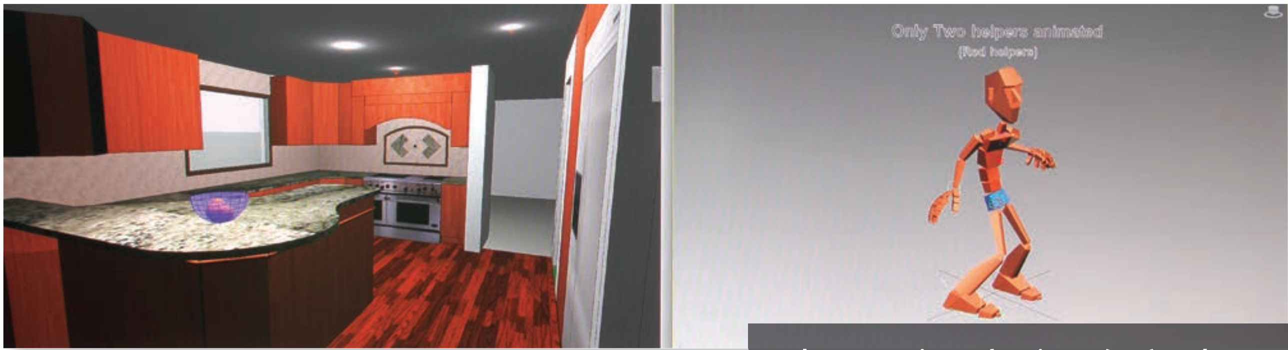
A Magnificent Monitor

The 30-in. Lenovo ThinkVision LT3053p IPS LED monitor delivers lots of features.

BY DAVID COHN



When set to picture-by-picture (PBP) mode, two separate video sources display side-by-side, but leave black bands of wasted space above and below the images. *Images courtesy of David Cohn.*

We spend countless hours in front of our monitors, yet it has been quite a while since we last reviewed a new display aimed at color-critical applications. So we were quite excited when Lenovo recently sent us its top-of-the-line ThinkVision LT3053p, a beautiful 30-in. widescreen backlit in-plane switching (ISP) LED display.

The monitor arrived neatly packed, with the display itself wrapped in a cloth bag. In addition to the power cord, Lenovo also includes a plastic shading hood and five cables — DVI, DisplayPort, VGA, USB 3.0 and USB 2.0. It took less than five minutes to assemble the two-piece stand, attach the display to the stand, connect the cables, and slide the shading hood into place. The entire display weighs just over 25 lbs., and measures approximately 23.5 x 27.5 x 14 in. (HxWxD) at its full height in landscape mode and with the shading hood in place. The panel without the hood is just 2.5 in. deep. Cables can be routed through a red plastic cable management ring located near the top of the stand shaft. A small button at the rear base of the shaft unlocks the vertical height adjustment mechanism. The hood has a small door on the top to accommodate a color calibrator.

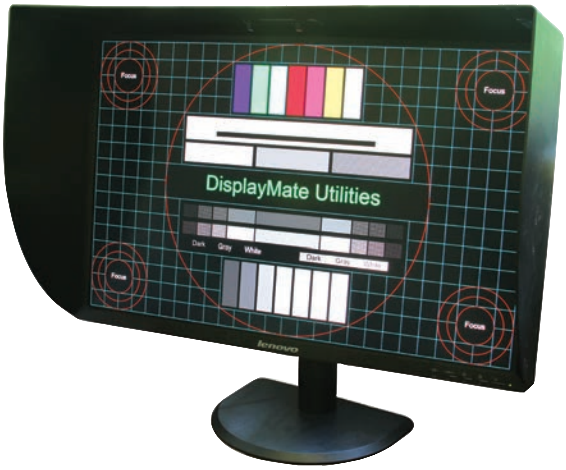
The included stand provides stable support, but a standard 100mm VESA mount allows the display to also be wall-mounted or attached to other supports. The stand enables a tilt range from -5° to +30°, with 90° of swivel and a height adjustment range of 4.33 in. When raised to its maximum height, the panel easily pivots from landscape to portrait mode.

The LT3053p has some pretty impressive specs. The widescreen aspect ratio (16:10) panel has a native resolution of 2560x2600, with a 0.251mm pixel pitch, a brightness of 350 cd/m2, and a contrast ratio of 1000:1. Lenovo claims a dynamic contrast ratio of 3 million-to-1. Because the monitor uses an IPS display, it has an impressive viewing angle of 178° in both the horizontal and vertical planes; the 6-millisecond response time reduces image smearing to a bare minimum. The monitor supports 99% of the Adobe RGB color gamut, and is capable of displaying up to 1.08 billion colors (vs. 16.7 million colors in more traditional panels).

When set to picture-in-picture (PIP) mode, you can view images from two video sources at the same time, but the smaller secondary image is too small in which to actually work.

Well-connected

The Lenovo ThinkVision LT3053p also provides plenty of connections. A downward-facing panel on the lower rear of the display provides a total of 10 connections, including five



Lenovo ThinkVision LT3053p

- **Price:** $1,499.99 MSRP
- **Size:** 30-in. (diagonal)
- **Display type:** IPS LED backlit
- **Screen dimensions:** 25.24 x 15.77 in.
- **Physical size (HxWxD):** 23.5x27.5x14.0 in. (with shading hood)
- **Weight:** 25.35 lbs.
- **Native resolution:** 2560x1600 pixels @ 60Hz
- **Horizontal frequency range:** 30kHz – 100kHz
- **Vertical refresh rate:** 30 Hz – 75 Hz
- **Aspect ratio:** 16:10
- **Pixel pitch:** 0.251 mm
- **Dot/Pixel per inch:** 101
- **Brightness:** 350 cd/m2
- **Contrast ratio:** 1,000:1
- **Response time:** 6ms (gray to gray)
- **Number of colors:** 1.07 billion
- **Power consumption:** 60 watts typical, 1.2 watts standby (130 watts max)
- **Video input ports:** VGA, Dual-link DVI, HDMI, DisplayPort, MHL
- **Video output ports:** DisplayPort (daisy chain)
- **I/O ports:** USB 3.0 in, USB 2.0 in, five USB 3.0 out, audio out
- **Other features:** tilt/swivel base, portrait/landscape pivot, shading hood included, cables included: power cord, VGA, DVI, DisplayPort, USB 3.0, USB 2.0
- **Warranty:** Three years

different video input ports: VGA, DisplayPort, dual-link DVI, Mobile High-definition Link (MHL), and HDMI. There is also a DisplayPort output port so that you can daisy chain the display to a second monitor.

There are also two separate USB input ports, one USB 3.0 and one USB 2.0 and USB output ports labeled specifically for keyboard and mouse. Another panel on the left side of the monitor provides three more USB output ports that connect to the USB 3.0 input port, with the topmost port able to charge USB devices up to a maximum 2 amps. The side panel also includes an audio jack for connecting headphones or external speakers. This audio port only works with the DisplayPort, HDMI or MHL video input sources, however, which support both video and audio signals; there is no separate audio-in jack for use with the VGA or DVI inputs.

This is the first monitor we've encountered that supports MHL, a relatively new standard that enables connection to mobile phones, tablets and other portable consumer electronics. The MHL standard supports up to 1080p high-definition video and 7.1 surround sound audio while simultaneously charging the connected device. We did not have any MHL-capable devices available to test this feature — but we certainly tested just about every other aspect of this ThinkVision display.

We were particularly anxious to try out some of the exclusive features the ThinkVision LT3053p has to offer, including the ability to view images from two different video sources at the same time. The monitor supports both picture-in-picture (PIP) and picture-by-picture (PBP) capabilities. With PIP, the image from one video source takes up the majority of the display, with the image from a second source displayed in a small window located in one of the four corners. With PBP, the two video sources are located side-by-side, with both images taking up half the screen or one filling one-third and the other two-thirds of the panel. After using the on-screen menu to select the mode and determine the primary and secondary video sources, you can then quickly switch between them using a dedicated front panel button or via software supplied on the driver disc.

While PIP and PBP could be handy in some circumstances, we doubt it will find much use in engineering applications. The smaller PIP image has three possible sizes, but even at its largest setting, users would be hard-pressed to actually do any work inside the small window. PIP could be nice, however, if you wanted to keep up with sports action or the news in the small secondary window while you were working in the primary window.

We found PBP to be even more limiting. Because the monitor maintained the aspect ratios of the two digital video sources, the resulting display filled a more limited area centered across the width of the display, with black bands above and below the two images — sort of like the letterbox display of movies on older 4:3 aspect ratio television screens. For serious use, we'd likely fill the entire display with the image from one computer and switch between systems when necessary.

The LT3053p also provides capabilities similar to a keyboard, video and mouse (KVM) switch, so that you can connect two separate computers to the monitor and use a single keyboard and mouse. To do this, we connected the USB 3.0 input cable to one computer, the USB 2.0 input cable to the other, and then attached a keyboard and mouse to the appropriately labeled USB ports on the rear panel. We could then press one of the buttons on the front panel of the monitor to quickly switch the keyboard and mouse between computers. You must press another button to switch video sources, however. This arrangement gets even more confusing when using PIP or PBP, because the mouse and keyboard only control one of the video windows.

Gorgeous Images

We used DisplayMate from DisplayMate Technologies to help evaluate the visual quality of the monitor. The Lenovo ThinkVision LT3053p displayed excellent color and grayscale, and showed no pixel defects. We were able to read text down to 6.8 points, even at different intensity levels. The ThinkVision display's fast response time resulted in no image smearing when viewing full-motion video.

Lenovo backs the ThinkVision LT3053p with a three-year warranty with customer carry-in or mail-in rapid replacement service. While the monitor carries a suggested retail price of $1,499.99, that's on par with other 30-in. IPS displays. You could purchase two smaller monitors (24- or 27-in.) for the same or less cost, which would give you even more display real estate. But that sort of arrangement would take up more desk space as well.

For CAD and graphics applications, I cannot stress enough how nice it is to work at high resolution on a 30-in. display. While I found some of the PIP/PBP and one-touch toggle features to be less useful than they initially seemed, the Lenovo ThinkVision LT3053p is one monitor I would love to stare at all day long. **DE**

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Commentary

by Jürg Gerber and John Murray

The Power of Simulation Driven by Design

Companies are striving to design innovative products while reducing the cost of product development and time to market. The pace of product innovation has increased dramatically, and it's a primary contributor to companies' overall profits and market share. They have to grapple with increasing product complexity, the time and cost to create physical prototypes, and a lack of resources to perform required analyses and simulations.

Product validation during the design phase of products has historically been the responsibility of engineering analysis specialists. However, as the need for faster product development grows, designers and product engineers have to be assured that their designs are progressing in a valid direction long before there is a complete product design.

Workflows have to be developed that will guide and automate the CFD setup and analysis.

Democratizing CFD

Today's complex mechanical and electro-mechanical products increasingly require an understanding of cooling, hydraulics and other fluid-flow issues. Performing comprehensive computational fluid dynamics (CFD) analyses is crucial to ensuring that products perform as required. And as product complexity and demands on innovation and time-to-market continue to increase, CFD will need to be used by a broader range of designers and engineers.

CFD analysis has historically been decidedly complex, and it required a great deal of expertise to set up and run valid analyses. In addition, most of the computer-based solutions that support CFD were created with CFD experts in mind — and have thus not been easy to use by non-experts, such as product designers and engineers. Workflows have to be developed that will guide and automate the CFD setup and analysis that in the past required a specialist's level of knowledge to expand the number of people who can perform CFD analyses.

A CFD solution from Mentor Graphics was developed for designers of mechanical systems, as well as electromechanical products, with the aim that it should be easily accessible to non-specialist engineers within their familiar MCAD environment, a method called "concurrent engineering." The FloEFD software is integrated within several MCAD programs, and provides guidance so that engineers who are not CFD specialists can perform fluid flow, cooling and other analyses as part of their design process and within their product design tool.

Concurrent CFD means that the most onerous CFD pre-processing steps — the same steps that once required the attention of a trained specialist — are now automatic. Some of these complex steps include preparing the geometry for analysis and defining the fluid volume or creating a mesh. Meshing takes minutes, rather than hours of iterating back and forth. This automation also means that product designers can try out a succession of ideas out on a design without risking the project deadline.

The CFD software also makes it relatively easy to conduct "what-if" tests. FloEFD helps create multiple variations of designs by modifying a solid model, which can then be analyzed without having to reapply loads, boundary conditions, material properties, etc. The engineer simply compares the results among the many design options to choose the best possible design.

This type of tool enables product designers as well as specialists to accelerate key decisions at their workstations, as they experiment with design scenarios and as they home in on the best, most efficient, reliable, and cost-effective design. This "virtual prototyping" process allows designers to optimize a product during the design stages. In fact, that first physical prototype often becomes the design that goes into final manufacturing — delivering the best design at lower cost (because of fewer physical prototypes), and getting it to market faster than ever before. DE

***Editor's note:** See the related applications story on page 44.*

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