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## Reviews:

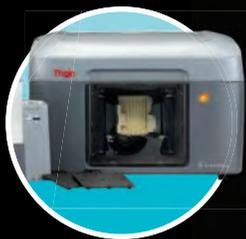
AutoCAD 2013 P. 34

Maple 16 P. 38

HP Z-series Workstations P. 41

DAQ via Tablet P. 44

CAD ROI P. 50



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technologies on a budget.

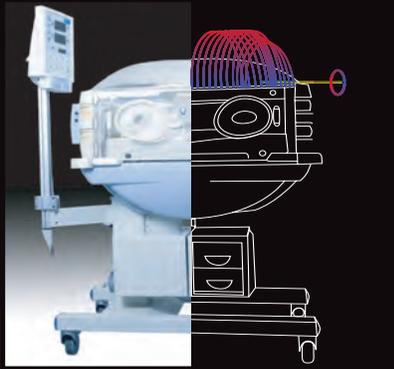
LOW-COST CAD OPTIONS P. 17

PERSONAL 3D PRINTERS P. 22

SAVE ON SUPERCOMPUTING P. 27

PLM PRICED FOR SMBs P. 31





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## Women in Engineering

In April I attended the Additive Manufacturing Users Group Conference ([additivemanufacturingusersgroup.com](http://additivemanufacturingusersgroup.com)) in Costa Mesa, CA. It was my first time at the event, and I was pleasantly struck by the enthusiasm of the attendees and vendors. This was definitely a “user” event. Everyone I talked with was responsible for the operation and/or maintenance of 3D printing, prototyping, or manufacturing equipment. I attended sessions on everything from building tools for sheet metal stamping to cleaning lasers. I even had the chance to talk at length with Zehavit Reisin of Objet about the simulation of materials.

I also had the opportunity to spend some time with Pam Waterman, a well-known *DE* contributing editor. She started with *DE* in 1997 covering engineering software. Pam has been writing on technical subjects most of her engineering career. At dinner, we talked about how she became a technical writer, her background as an engineer and, especially, of her 23-year-old daughter Hilary who recently graduated with a degree in chemical engineering. In Pam’s early years as an engineer, she worked

the uPrint was “How many women registered for the sweepstakes?” I hazarded a guess of about 10% to 15%. It reminded me of my conversation with Pam. Engineering has been dominated by men, yet here was Maegan, designing a catheter about 2mm wide that can detect the arterial wall using optical coherence tomography, and helping to save peoples’ legs and lives.

### Continuing the Conversation

After returning to the office here in Dublin, NH, I wrote Pam and asked her what she and her daughter Hilary thought were the greatest challenges to young women pursuing an education in science, technology, engineering and math (STEM).

“High schools have made great strides over the past few decades in getting young women to take advanced math and science classes that qualify them for STEM majors in college,” she replied. “However, ultimately, the problem is the lack of practical support systems.”

Hilary agreed, writing “One of the most discouraging things is that girls in high school and college have almost no support outside of the classroom ... especially when you get to the higher levels. That’s because people who actually understand STEM don’t become tutors, they go get jobs as scientists and engineers that will pay them much, much more money.”

One organization helping to change that is the Society of Women Engineers ([swe.org](http://swe.org)). Its mission is to “stimulate women to achieve full potential in careers as engineers and leaders, expand the image of the engineering profession as a positive force in improving the quality of life and demonstrate the value of diversity.”

While SWE has been making great strides via scholarships, mentoring and outreach since it was founded in 1950, there is still a long way to go. When I asked how we could make STEM more appealing to young women, Pam suggested expanding some of the after-school technical competitions to build designs other than cars and robots. “Also, TV shows featuring female engineers with outside lives and non-geek clothing would help,” she wrote.

Hilary was on the same track: “I think the most important things are to provide the necessary support and also convince women that they can go into a STEM field and *still have a life*.”

There are many issues facing young adults interested in pursuing STEM. I think we should help them. This publication reaches more than 60,000 individuals who could help increase the rates of women becoming scientists and engineers. Are you willing to help? I would like to hear your ideas. **DE**

**Steve Robbins** is the CEO of Level 5 Communications and executive editor of *DE*. Send comments about this subject to [DE-Editors@deskeng.com](mailto:DE-Editors@deskeng.com).

**Many issues face young adults interested in pursuing STEM. I think we should help them.**

as a part-time coordinator for Women in Engineering Programs at Oklahoma State University. We discussed the challenges that she and her daughter face in pursuing an engineering career path.

### A Winning Woman in Engineering

Our conversation was still on my mind the next morning. I was off for my 6:35 flight to San Francisco to be on hand for the delivery and setup of a Stratasys uPrint SE 3D Print Pack to Maegan Spencer, the winner in *Desktop Engineering*’s Rapid Ready Sweepstakes. When I arrived at Avinger ([avinger.com](http://avinger.com)), the company where Maegan works, I could tell they were in the startup phase. The energy level was through the roof. Meeting Maegan, its senior R&D engineer, only cemented my belief that the company was on course for accomplishing great things. Avinger is developing the next generation of catheter-based treatment for peripheral artery disease (PAD).

As we walked through the building, I noticed a Stratasys Dimension 3D printer in use. Maegan said it ran 24 hours a day. The engineers were using it for everything from printing custom Dremel tools to designing prototype catheter handles.

One of the first questions Maegan asked me as we unpacked

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## COVER STORY

# High Tech, Low Cost

**17** This month *DE* explores low-cost options to everything from design software and hardware to 3D printing. There are two primary forces at work that are driving down costs: 1) As technologies evolve, what was yesterday's cutting edge becomes tomorrow's bargain, and 2) new technologies are often discounted to speed up adoption rates. We explore how you can make both forces work for you in this month's focus on affordable tech.

**ON THE COVER:** Low-cost technologies can save money. Images courtesy of iStockphoto, HP, Stratasy and BOXX Technologies.

**CORRECTION:** An incorrect image accompanied the HBM nCode article on page 46 of the May 2012 issue. The correct image can be seen at [deskeng.com/articles/aabeec.htm](http://deskeng.com/articles/aabeec.htm).

## DESIGN

### 34 Review: AutoCAD Gets a Facelift

Model documentation and interface improvements lead the list of AutoCAD 2013's new features.

By David Cohn

### 50 Optimize ROI via CAD Tools

A new Aberdeen study identifies the design efficiencies that organizations can gain by using the right CAD technologies.

By Michelle Boucher

## SIMULATE



### 38 Maple 16 Makes Engineering Math Easier

Maple continues to evolve for learning and applying symbolic mathematics.

By Peter Varhol

### 48 Opting for Optimization, Part 2

Find out how this powerful concept can rev up your analysis tools.

By Pamela J. Waterman

## ENGINEERING COMPUTING

### 41 Wowing them in Vegas

Comparing HP's new Z-Series workstations, including the Z1 all-in-one.

By David Cohn

## TEST

### 44 Tablets in DAQ

In the quest for ever-smaller data acquisition systems, tablet computers bring a great appeal.

By Peter Anderson

## FOCUS: AFFORDABLE TECH

### 17 Affordable 3D Modeling Options

Software makers' search for new markets leads to low- and no-cost editions.

By Kenneth Wong

### 22 3D Printing on the Cheap

Is now the time to make or buy your very own personal 3D printer?

By Pamela J. Waterman

### 26 Go Pro for Less Dough

Invest in a professional 3D printer to save money over time.

By Jamie J. Gooch

### 27 Clusters for Small Teams

Can a small engineering house build (and maintain) an effective computer cluster?

By Peter Varhol

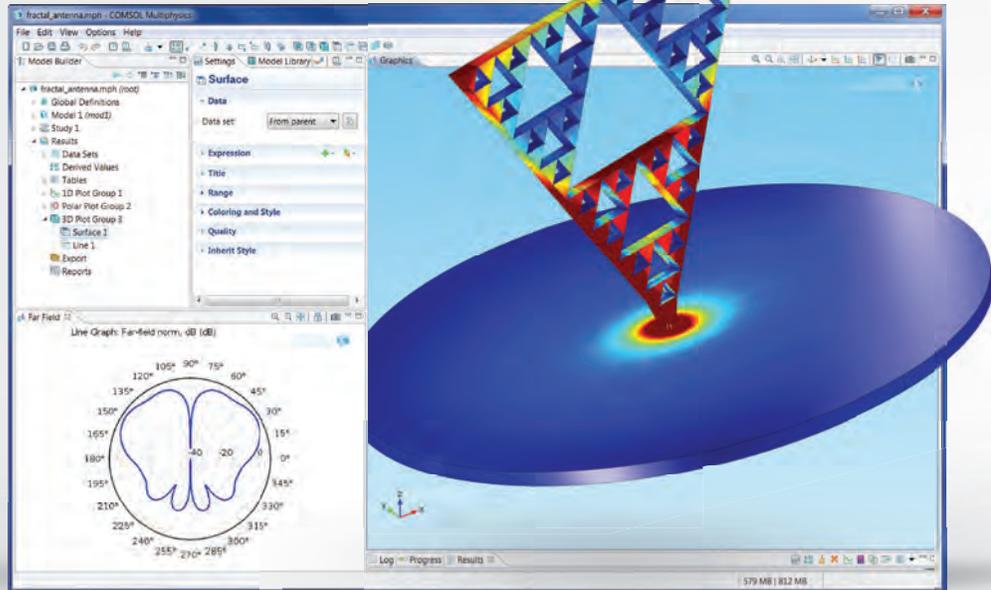
### 31 PLM for the Rest of Us

SaaS and a mobile workforce are leading the transformation.

By Kenneth Wong



**ANTENNAS:** The Sierpinski fractal monopole antenna shows multiband responses inherited from the nature of a fractal structure. Results show the magnitude of the electric field on the surface of the structure as well the far field radiation pattern.



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LiveLink™ for Inventor®  
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LiveLink™ for MATLAB®



## DEPARTMENTS

### 2 Degrees of Freedom

A spotlight on women in engineering.  
By Steve Robbins

### 8 Kenneth Wong's Virtual Desktop

SketchUp acquired, COFES talks get cloudy, Project Stimulus previewed and Arena gets revamped.

### 12 Engineering on the Edge

Vacuum vehicles, jumping robots, self-healing plastic and flying cars.



### 14 Fast Apps

Engineering case studies.

### 16 Rapid Ready Tech

EOS is profiled, 3D-printed robots, continuous 3D printing and the President suggests additive manufacturing funding.



### 51 Spotlight

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

### 53 Advertising Index

### 54 Editor's Picks

Products that have grabbed the editors' attention.

By Anthony J. Lockwood

### 55 Commentary

Implementing cost management.

By Jessica Milan

### 56 Cool Tools

New 3D printers from Stratasys and Objet.



#### EDITORIAL

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# MODEL PHYSICAL SYSTEMS

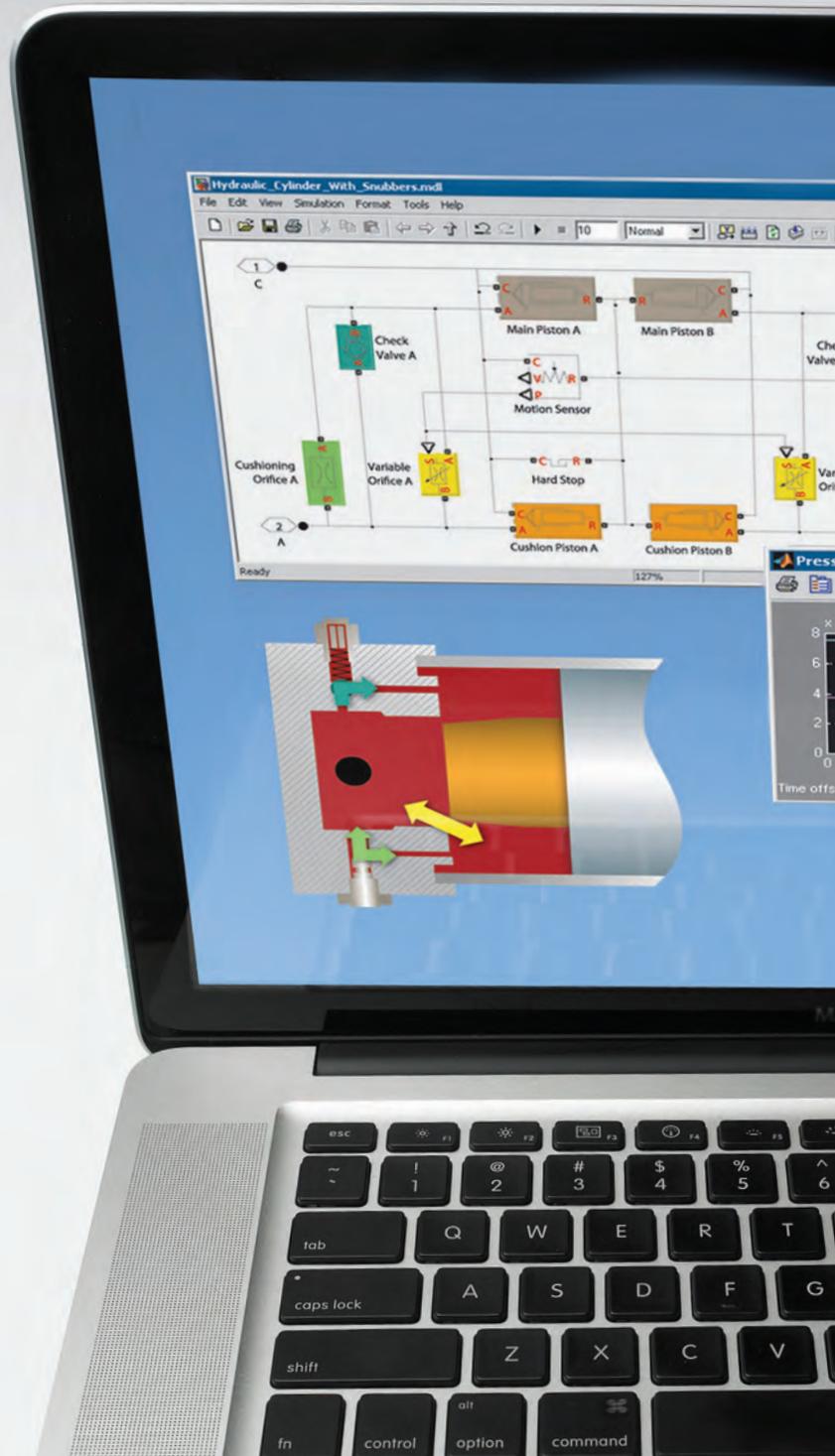
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# Google SketchUp Set to Become Trimble SketchUp

In 2006, @Last Software's SketchUp found a new home at Google when it was acquired by the search engine giant. In April, history repeated—with a different player. Trimble, known among civil engineers and construction crews for its GPS, laser and optical devices, has signed on to buy SketchUp from Google for an undisclosed sum.

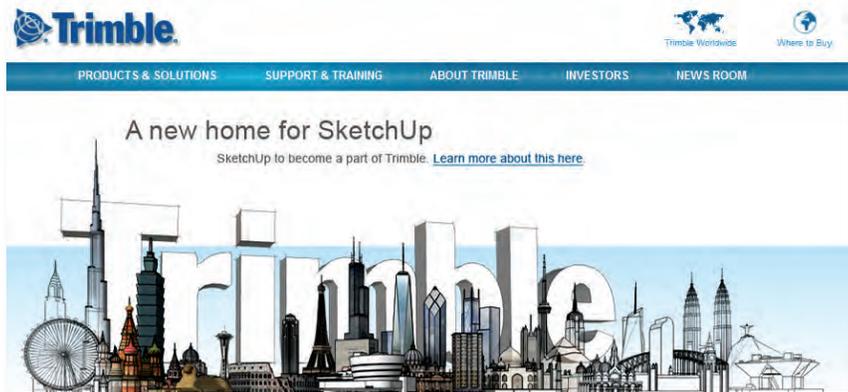
In a blog post that echoed the one posted after Google's acquisition, John Bacus, product manager for SketchUp, announced "A new home for SketchUp" ([sketchupdate.blogspot.com](http://sketchupdate.blogspot.com)).

"Thanks to Google, more people than we ever imagined possible have been introduced to SketchUp," he wrote. "Thanks to Trimble, we'll be able to continue to make SketchUp into the tool that we—and you—have always hoped it would become. With a strong wind at our backs and plenty of sunshine ahead, this voyage just keeps getting more exciting."

## Acquisition Anxiety

The SketchUp team may have a sunny outlook, but user comments to the blog post suggest there's a certain amount of anxiety about the acquisition in the SketchUp community. One asked, "Should I be excited or worried now?" Another wondered, "Is the same developer team going to continue? Is SketchUp going to fragment to the different user groups?" Another chimed in, "I hope they talk to the community about what's going on and what their plans are. I'm sure a lot of people are worried, me among them."

In its FAQ document for the acquisition, Trimble addressed the fate of the SketchUp development team: "The core team for SketchUp remains intact ... Trimble values the creativity and customer focus of the



With a pending acquisition, Trimble is set to become the new owner of Google's popular free 3D modeler SketchUp.

SketchUp team. Trimble intends to grow the team by adding resources and collaborating with other Trimble divisions."

In anticipation of what could arguably be the biggest concern for users, SketchUp's Bacus wrote, "The free version of SketchUp is an important part of our world as well, and that isn't changing in the least." It was reinforced by Trimble's press announcement, which stated, "We are committed to continuing to provide SketchUp as a free version to millions of users."

Explaining the reason for acquiring SketchUp, Bryn Fosburgh, Trimble's vice president, said, "Trimble has already created the de facto standard for field data models and project management tools for our key markets. SketchUp, together with these existing capabilities, will provide a standalone and enterprise solution that will enable an integrated and seamless workflow to reduce rework and improve productivity for the customer ... In addition, the SketchUp platform will enable Trimble, third-party developers and our distribution partners to efficiently develop new applications."

## A Shared Warehouse for Now

One of the most attractive aspects of SketchUp is its community and user-supported 3D content portal, Google 3D Warehouse. The site is home to an estimated 2 million user-generated models. At least for the foreseeable future, Google and Trimble said they will "host and operate the 3D Warehouse for Trimble, and together the companies will continue to offer the same capabilities, functions and services that are offered today."

Concern over the acquisition is understandable. Since Google's acquisition, SketchUp has become a 3D modeler for beginners as well as professionals. The user community encompasses beginners, enthusiasts, do-it-yourself tinkerers, makers, hobbyists and professional designers and engineers. Among architects, it has become the go-to software for quickly creating and exploring building concepts in 3D—the digital equivalent to a cocktail napkin. With so much data and workflow invested in SketchUp, these users expect Trimble, the new owner taking the helm, to chart a prudent course.

# Autodesk Project Simulus: Prepare Locally, Solve Remotely

In Project Simulus, a technology preview now available at Autodesk Labs, Autodesk bundles together three components of analysis—an easy model-editing environment, a guided finite element analysis (FEA) workflow, and remote access to cloud-hosted CPUs—into a single interface. The software stands alone; it installs and runs on your desktop machine. But it also has a single-click button that lets you tap into scalable computing power hosted elsewhere. Straddling the local machine and the network, Project Simulus is another example of the type of hybrid applications Autodesk envisions for the future.

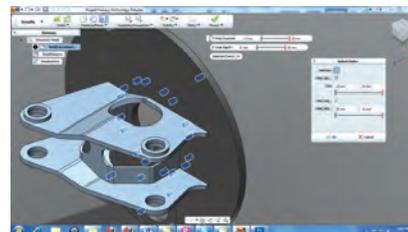
In its present incarnation, Simulus gives you the option to run linear stress, model frequency, thermal or thermal-stress analysis. Once you've picked the type of analysis you'd like to run, you'll be prompted to load the model in a sup-

ported CAD format or a neutral format.

The Simplify environment in Simulus offers one of the easiest ways to remove details that you deem too insignificant in your analysis. The slider bar lets you specify all the minor features you'd like to isolate and remove (for example, every hole with a radius below 5mm). Geometry edits—if you choose to make them—are fairly easy. Simulus gives you a set of direct-editing tools (push-pull operations to relocate faces and features).

The software also allows you manually select a feature and suppress it. By suppressing a feature (like a hole with filleted edges), you're telling the software to disregard it in the meshing and solving phase, but you're not changing the geometry in your CAD model.

Once your model is ready for analysis, you can add constraints (fixed points, for example), loads (pressure, force or



**Project Simulus gives you a way to isolate and suppress non-essential details in your model before analysis.**

gravity) and contacts, then solve your scenario. Here, you're sending your analysis scenario to a remote server equipped with multiple processors, so you get your results back in a few minutes. The results can be displayed in traditional color-coded models, but you may also choose to show two scenarios, side by side, for comparison.

Simulus is a preview, so when and if it appears as a commercial product, something like it may conceivably be sold for a certain fee, with optional pay-as-you-go fees for accessing the computing power from a remote server.

To watch a video demonstration of Project Simulus, visit [deskeng.com/virtual\\_desktop/?p=5596](http://deskeng.com/virtual_desktop/?p=5596).

## COFES 2012: Risk and Opportunity in the Cloud

In early April, there was a cloud hanging over Scottsdale, AZ, the site of the Congress on the Future of Engineering Software (COFES, [cofes.com](http://cofes.com)).

A network of interconnected computers, collectively forming "the cloud," is posing serious threats to the old ways. Will traditional client-server setups still be around five years from now? Will everyone soon toss aside shrink-wrapped software titles in favor of browser-based software? Will the cloud inevitably become an extension of individual workstations?

Organizers observed, "Our understanding of the cloud today, and the way it will change business, is similar to our understanding of the Internet back in 1996: It's already affected us, we know it will change everything, but we are in for an interesting ride as the world is about to

change in ways we just don't get yet."

Mike Payne, cofounder of SpaceClaim and CEO of Kenesto, noted that "cloud is a platform, just like 32-bit Windows is." Success stories varied. One project manager in a large automotive manufacturing firm said, "We're moving back to servers, bringing our stuff back in-house, because the cloud hasn't worked for us." A small business owner, who cited his ability to eliminate IT cost by moving to cloud-hosted IT, said, "It's working for us." Randall Newton, managing editor of GraphicSpeak, added fuel to the inflamed conversation by pointing out, "Some businesses [that relied on the old ways of computing] will be forced to retire."

For CAD vendors who have thrived on selling professional software installation at about \$5,000 a seat, the cloud could

be a reason to be nervous. What will happen when users get a taste of mobile CAD delivered via the cloud?

Through Twitter, I sent my hypothetical question: What is the risk of not taking risk? Steve Bodnar, Autodesk's vice president of product lifecycle management (PLM) and product data management (PDM), responded, "No risk = no reward." Oleg Shilovitsky, cofounder of Inforbix, responded, "[That is the] same as to decide NOT to decide." Several Twitter users in the room also cited Dick Morley, member of the COFES board of directors, in their responses. Apparently, Morley had said earlier that "not taking a risk is to 100% guarantee failure."

To listen to podcasts with COFES interns and attendees, visit [deskeng.com/virtual\\_desktop/?p=5554](http://deskeng.com/virtual_desktop/?p=5554).



## Arena Revamped with New Look, New Pricing

**A**rena Solutions, the cloud product lifecycle management (PLM) company that has been offering Software-as-a-Service (SaaS) subscriptions for \$99 per user per month, is getting a facelift, so to speak. In mid-April, the company rebooted its site with a new look.

But the change is not just cosmetic; Arena Solutions is also introducing new prices:

- \$49 a month for a basic account, which covers three seats and 10 suppliers; or
- \$79 per seat per month (up to 125 seats), which covers up to 75 suppliers.

Both options come with guided implementation and standard support. There is another option with unlimited seats, unlimited suppliers, custom implementation and dedicated support, but the company doesn't publish the price for that plan.

### New Modules Introduced

The revamped site also marked the debut of two new modules:

- Arena PartList serves as a way to publish lists of parts into bills of materials (BOMs), ready to use for purchasing. The module lets you import your electronic components (ECAD) BOMs as CSV files, mapped to targeted fields. PartList comes with an Autofill feature, powered by Octopart. Taking advantage of the wealth of data available at Octopart, which lists 24 million offers from 105 distributors for 18 million unique electronic components from 3,317 manufacturers, Arena Solutions' PartList can automatically populate appropriate fields with input available from Octopart datasheets.
- Arena PDXViewer, integrated right into the browser, allows you to

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15	ECO42A154MG	Panasonic	CAP 15UF 275VAC INTER SUPP X2	10	C124,C125,C127,C128,C129,C130,C131,C132,C133,C134	\$0.83			Visit	BUY
16	0805A100JA2TA	AVX	CAP CERM 10PF 5% 50V NP0 0805	4	C143,C144,C145,C146	\$0.09			Visit	BUY

**PartList**, a new module in Arena Solutions' cloud PLM suite, can automatically populate appropriate fields with input available from Octopart's extensive datasheets.

read and edit common BOMs published in PDX format. The feature lets you build and share quote packages in a way that your suppliers can access and read. Arena Solutions' core product comes with a series of BOM control tools, including tabs for BOM management, change management, supplier collaboration, compliance tracking and project collaboration.

Unlike traditional, on-premise PLM solutions deployed at a client's site, Arena Solutions' products are delivered through a browser, so no installation is required. The company has managed to maintain 99.98% system uptime in the past 10 years, proving a long history of reliability.

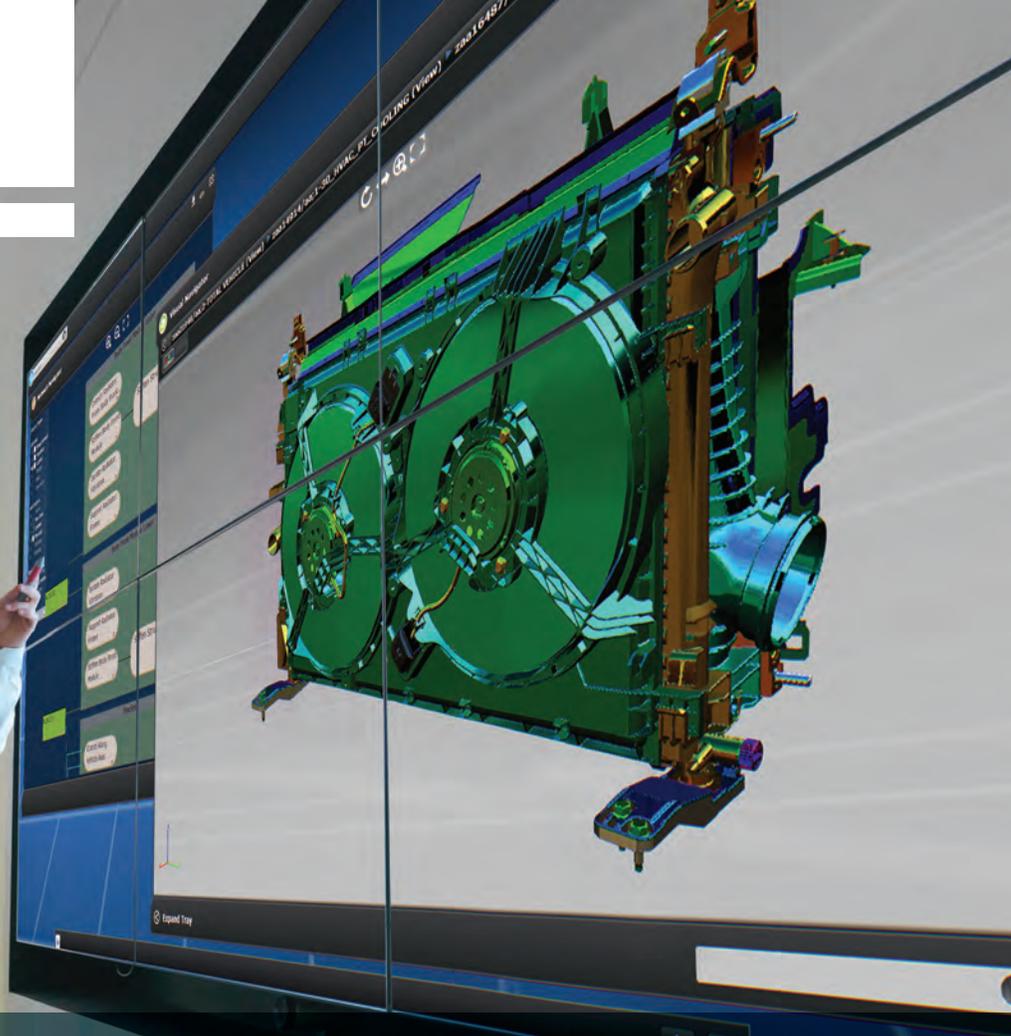
### The Forecast for the Cloud

Cloud-hosted PLM is generally attractive to small and midsize

businesses (SMBs) because of its affordable price and its low (or no) IT overhead. The market has long been ignored by traditional PLM vendors, which concentrate on selling to enterprises that require heavily customized, onsite implementations. But the tide may be turning. With Autodesk venturing into SMB territory via its newly launched Autodesk PLM 360, SaaS PLM is once again capturing the imagination of many. And with subscription pricing starting at less than \$100 per user per month, SaaS PLM is bound to capture many wallets as well. **DE**

**Kenneth Wong** is Desktop Engineering's resident blogger and senior editor. Read his Virtual Desktop blog at [deskeng.com/virtual\\_desktop](http://deskeng.com/virtual_desktop), drop him a line at [kennethwong@deskeng.com](mailto:kennethwong@deskeng.com) or share your thoughts at [deskeng.com/facebook](http://deskeng.com/facebook).

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### Engineers Clean up in Dyson Challenge

Dyson recently let its UK-based in-house engineers cut loose by having a competition to see who could build the fastest model car using Dyson's vacuum motors and spare parts. The fantastic video the company posted online (you can see it in our blog post) features one brave engineer who incorporated an office chair into his design so he could ride along.

Company founder James Dyson's foundation, coincidentally, offers an annual student design award that accepts entries through August.

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### Jumping Robots

Boston Dynamics' SandFlea is a pint-sized robot that can leap tall buildings in a single bound (with the help of some compressed carbon dioxide).

The 11-pound robot operates like a remote-controlled car on the ground, but can jump up to 30 ft. using a piston actuator and disposable fuel cartridge. An onboard gyroscopic stability system helps control the landing altitude, and specially designed wheels cushion the shock of



multiple jumps. There's also a laser-based system to guide the launch, live video feed for remote operation, and it can be controlled so precisely that users can send it through windows or up staircases.

It was designed for surveillance work in rugged terrain, such as in Afghanistan, where the U.S. military plans to test nine of the robots.

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### Thermoplastic 'Bleeds' to Indicate Damage

When plastics are damaged, they generally have to be replaced. So what could you do with self-healing plastics that can also visibly indicate when they've been compromised?

A team of researchers has come up with a new category of plastics that mimic human skin in their ability to self-heal scratches and cuts—and

even "bleed." The plastics change color to indicate wounds, and can heal themselves when exposed to light.

The University of Southern Mississippi in Hattiesburg team, with some funding from the U.S. Department of Defense, developed water-based thermoplastics that include small molecular links that span chains of chemicals in the plastic. If the plastic is scratched or cracked, the links break and change shape. The team further refined the links so that they produce a visible color change: a red mark near the damage.

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### Finally, Flying Cars

Terrafugia successfully completed a test flight of its Transition Street-Legal Airplane, a two-seat vehicle with folding wings that can be driven on a highway and flown using standard unleaded gasoline. The car was fueled at a gas station, driven to an airport and reached an altitude of 1,400 ft. for around 8 minutes. The Woburn, MA-based company is accepting \$10,000 deposits for the vehicle, which will sell for \$279,000 once the company completes six more phases of flight testing.

Netherlands-based PAL-V, meanwhile, expects to make its Personal Air and Land Vehicle (PAL-V) available to drivers/pilots in 2014. The gyrocopter can fly up to 315 miles at an altitude of 4,000 ft. On land, the blades can be tucked away, turning it into a street-legal three-wheeled car. Expect to pay around \$330,000 to \$400,000 to take one home. **DE**

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### Big Data Receives Big Investment

**B**ig data is about to get a boost from the Federal government. The White House announced its "Big Data Research and Development Initiative" at the end of March, pledging a \$200 million commitment that will span six Federal agencies.

The initiative was launched in response to recommendations from the President's Council of Advisers on Science and Technology, which previously concluded that the government was under-investing in big data technologies. The initiative aims to:

- advance core technologies needed to collect, store, preserve, analyze and share huge quantities of data;
- harness those technologies to "accelerate the pace of discovery in science and engineering, strengthen our national security, and transform teaching and learning"; and
- expand the workforce needed to develop big data technologies.

Among the investments outlined in the White House announcement were a joint solicitation from the National Science Foundation and National Institutes of Health that included encouraging research universities to develop interdisciplinary graduate programs in science and engineering, and a \$2 million award for a research training group focused on using graphical and visualization techniques for complex data.

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# What is in your workstation?

How to get more value from your engineering workstation.

BY PET ER V ARH OI

**A** workstation consists of processors, graphics and I/O technologies that range from memory, to solid state drives or hard disk drives, to network interconnects or PCI-Express buses. If you configure your software and hardware correctly for the type of work you do, you can realize a great deal more performance and value from your workstation investments.

In a recent study presented at SolidWorks World by CATi, a SolidWorks reseller in the Chicago area, there were some performance observations worth sharing across the engineering community. These tricks will impact the performance of your CAD applications on your next workstation purchase.

- An ideal workstation will have between four and six cores, providing as much as a 20 percent improvement in productivity. While it is true many CAD applications are single threaded, users are not. They often multitask between several application and projects.

If you are doing any rendering, ray tracing or simulation, then you should consider a workstation with two Intel Xeon E5-2600 processors, so that you can take advantage of one of the processors for those types of activities.

- Increasing your processor clock speed can help to deliver more performance, but only by about 15 percent. Over-clocking of consumer-based solutions is possible, but engineers can count on Intel Turbo Boost Technology to turn off unused compute cores and boost clock frequency. Using Intel Xeon processors provide testing and certification with professional design applications, so you're not simply taking a shot in the dark.

- Avoid disk swap by buying more memory, and you could potentially realize a twofold increase in your system's performance. Your system loads only a portion of an application into memory, and keeps the rest on disk, which is significantly slower than memory. The more of the application you can get into memory, the fewer disk swaps you have. This will speed up your computer more than almost anything else.

The ideal memory configuration is twice the size of your largest engineering model. If you elect smaller sizes, your model may seek swap space on the system's hard disk, and your performance can decrease by more than 50 percent. Ouch! When compared to an engineer's time, the cost of memory represents an inexpensive investment in your engineering resources.

- Manage your image quality. It is probably set too high for day-to-day work. You'll gain almost 30 percent more performance with a lower — but still high — resolution. Check the image quality setting of your CAD application. If it's at the highest level, you can safely knock it down one step and visual quality will remain unchanged to your eye.

- Solid state drives (SSDs) accelerate more than start up times — over a three-fold increase in productivity. The Intel Series 520 SSD may seem pricey, but it's a real game changer in terms of raw performance and productivity. SSDs are fast and expensive, but the productivity advantage can easily make up for the cost. (See [youtube.com/watch?v=WKKf9hxSNRY](http://youtube.com/watch?v=WKKf9hxSNRY) for a side-by-side comparison of SSD vs. HDD.) And if you're worried about the number of times you will read and write disk, Intel's limited warranty extends for 5 years.

- Use professional graphics — it really does accelerate professional application performance. If you are using consumer-based graphics solutions, please reconsider. Intel, NVIDIA, and AMD all invest in optimizing professional graphics to exploit their graphics solutions. They almost always either deliver more performance or unlock features that are not available on consumer-based alternatives.

- Check your operating system and computer user settings and potentially realize 9 percent more performance. Adjust your system options, drawings, display style, image quality, memory settings, and assembly setting and potentially gain back 10 percent or more performance.

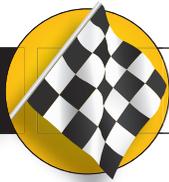
## Summary

With a little bit of reconfiguration, you can get better performance out of your next engineering workstation, and see corresponding improvements in the quality and delivery times of your designs. Check your system and operating system settings to take your type of engineering work into account, adjust your configurations and be ready to realize the real value of workstation. **DE**



INFO → Intel Corp: [intel.com/go/workstation](http://intel.com/go/workstation)





## Ply-Cycle is Ready to Roll

*ANSYS Composite PrepPost assists in an efficient, cost-effective design of a carbon fiber-based bicycle frame.*

**BY DR. LOTHAR KROLL, JOERG KAUFMANN AND NORBERT SCHRAMM**

*Editor's note: This article was originally published in German in Infoplaner magazine from ANSYS channel partner CADFEM.*

When designing frames for premium bicycles, engineers must take into account a large number of characteristics, including strength, stiffness, weight, durability, ease of manufacture, type of bike and rider preference. Frames can be constructed from metals such as steel, aluminum or titanium, or they can be made of composite materials that are based on carbon fiber.

Traditionally, the use of conventional simulation in the bike industry has been limited to the metallic materials. However, scientists at the Institute for Lightweight Structures (IST) at Germany's Chemnitz University of Technology used engineering simulation to successfully identify the stresses for a carbon-fiber reinforced mountain bike frame for Ghost Bikes GmbH—builders of premium bikes in all classes and categories. The research team used ANSYS Composite



PrepPost software to analyze potential failure within the complex lightweight structure.

Carbon-fiber reinforced polymer (CFRP) is an increasingly popular material for mountain bikes because of its lightweight characteristics and ease of manufacture. In addition, fibers can be oriented to better withstand loads, and provide weight-efficient parts with high stiffness that will increase the overall stiffness of the frame—a desirable characteristic. To optimize the use of materials and determine fiber orientation, complex calculations are necessary, and numerical simulation methods are required. Conventional composite simulation programs can require additional work to define fiber orientations and plies.

ANSYS Composite PrepPost software, integrated within the ANSYS Workbench environment, simplifies analysis of CFRP structures by using innovative modeling and analysis capabilities.

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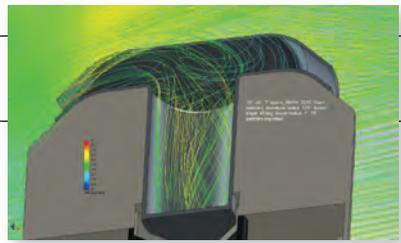
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## The Best Defense Is a Good Offense

*Solid modeling and flow simulation help get Innovaprep's design of an innovative air sampler right the first time.*

Innovaprep LLC, Drexel, MO, is a company with 16 employees that competes successfully against the giants of the defense industry by getting innovative products to market in less time. The company recently developed a portable air sampler designed to detect contaminants in environments ranging from the battlefield to food-processing plants. But the compact size of the product makes it difficult to produce a consistent flow regime in the outlet duct where flow measurements are taken.

That's where simulation software comes in.

"We used SolidWorks Flow Simulation to diagnose flow inconsistencies in the original concept design, evaluate a series of proposed solutions, and ensure that our design met both uniformity and pressure-drop requirements," recalls Zachary Packingham, an Innovaprep design engineer. "The result was that we saved prototyping and tooling cost, and got the product to market faster by getting the design right the first time. FISHER/UNITECH, our SolidWorks reseller, played a key role by helping us select the right toolset and helping us quickly overcome bumps we experienced along the way."

### Product Evolution

The idea for the new air sampler took shape when the U.S. Department of Defense issued a request for information for a battery-powered portable aerosol sampler. The project appeared to be a good fit with an Innovaprep-developed technology that quickly and efficiently removes particles from a membrane filter.

The company's design uses a dry, 52mm electret filter as the collection media. Electret filters are produced from di-electric polymer fibers that develop an electrical charge when air flows past them. This substantially increases the collection efficiency of the filter, and allows for the use of lower-pressure drop filters, which in turn allows for higher sampling rates for extended periods using battery power.

Innovaprep engineers started the project by assembling a prototype using parts from other products that were available. They showed the prototype to the program office, and got the go-ahead to proceed.

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### 3D Printing Company Profile: EOS



With global headquarters in Krailing, Germany, EOS (Electro Optical Systems) was founded by Dr. Hans Langer in 1989. Langer was originally contracted by BMW to develop stereolithography (SLA) for industrial use. When his research into SLA was finished, he wasn't satisfied by the limitations of the process for use in manufacturing. With the idea of what would eventually come to be called additive manufacturing (AM) in mind, Langer began work on a different process that could produce more durable parts and prototypes. The result of his work was laser sintering.

Andy Snow, North America regional director for EOS, predicts that the 3D printing industry shift from prototyping to manufacturing will continue—driven by an increased range of materials, greater precision in part production, and adoption of the kinds of process controls and quality assurance that are common with traditional manufacturing processes.

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### NSF's Printed Robots

Robots are still expensive to design, build and code. The National Science Foundation (NSF) hopes to alleviate that expense with its \$10 million project: "An Expedition in Computing for Compiling Printable Programmable Machines."



### U.S. to Fund AM Research

As part of a continued push by his administration toward increasing manufacturing based in the U.S., President Obama has proposed creating a National Network for Manufacturing Innovation.



Part of the proposal is the creation of up to 15 hubs of commerce, scattered throughout the states to help U.S. manufacturers become more competitive and bring investor cash flow to the process. The president has suggested a \$1 billion investment for the network. Even if the proposal is accepted, it'll take some time to begin construction on the network hubs. In the meantime, President Obama said he would like to create a pilot institute for the manufacturing initiative using \$45 million in existing funds drawn from the Departments of Defense, Energy and Commerce, as well as the National Science Foundation.

A focus of the pilot institute is additive manufacturing (AM). This includes 3D printers, materials, digital design, supply chain and environmental impact.

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The research team for the project pulls together experts from MIT, the University of Pennsylvania and Harvard University. Their goal is to create a system that allows the rapid construction of simple, inexpensive robots.

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### 3D Printing Springs Into Manufacturing

LayerWise and TNO have teamed up to produce an end-use part through additive manufacturing (AM). In the course of developing an actuator for high accuracy positioning, TNO found it required a specific type of spring.

Working with STL files provided by TNO, LayerWise was able to create titanium springs using laser sintering. Titanium is lighter than steel, and the alloy selected was able to withstand 300 MPa, but that wasn't quite good enough. TNO was able to rework the design.

The new design used springs half the thickness of the first AM prototype. TNO then moved to a hollow coil with triangular cross sections to distribute stresses more evenly. These efforts combined to create a spring with stress levels four times lower than the original steel prototype.

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### Continuous 3D Printing

Voxeljet has developed an inkjet 3D printer intended for continuous printing. It uses a conveyor belt to move objects as they are being printed. Objects that start in the build area eventually emerge from the other side of the machine, ready for post-production work or packaging.

Voxeljet says the 3D printer will have a build envelope of 19.69 sq. in., but the process allows for nearly any length of object to be built. The slightly tilted build area allows the print head to move quickly, speeding build times. The resolution of the new printer is set at 600 dpi, with a layer thickness of 150  $\mu$ m to 400  $\mu$ m.

According to Voxeljet, other advantages of the system include an increase in the amount of reusable printing materials and the all-in-one nature of the machine that eliminates the need for an unpacking area. The new printer is set to become available early 2013.

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# Affordable 3D Modeling Options

Software makers' search for new markets leads to low- and no-cost editions.

BY KENNETH WONG

**A**ffordability is a relative term. A \$75 steak that a CEO routinely orders at his or her favorite lunch spot is a luxury reserved for special occasions for a receptionist or a parking attendant. It may even be completely beyond the reach of the latter.

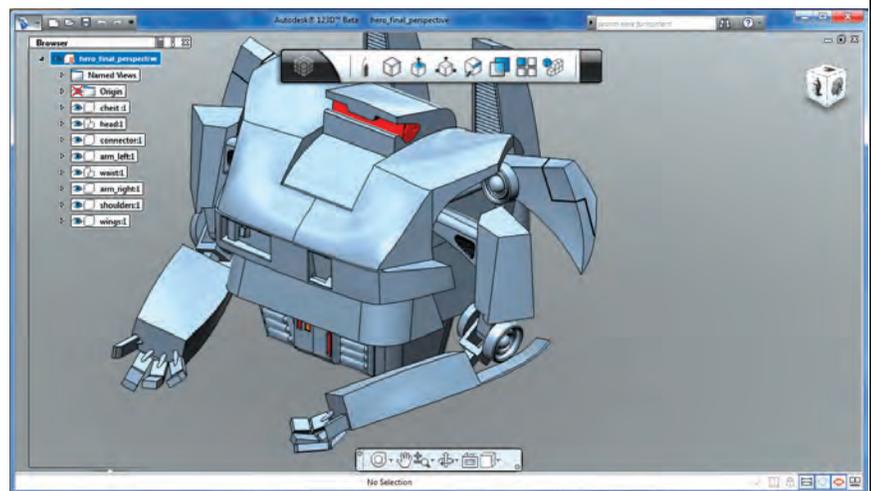
A robust 3D mechanical modeling software program costs somewhere between \$3,000 to \$6,000—and more if it includes complex operations like surfacing, simulation, analysis and data management modules. This amount is a perfectly reasonable investment for a professional engineer or designer with a steady stream of assignments. But for enthusiasts, amateurs or art students, that's a big price tag—a significant dip in the budget that may not be justifiable.

Many software vendors seem to have decided to concentrate on their core markets while doing a better job reaching out to potential new customers outside of that core. Their strategies include, among other things, releasing less-costly or free versions of their products, repackaged with cleaner interfaces to appeal to the uninitiated.

In the last five years or so, a field of low- or no-cost CAD programs has come to market. Some are equipped with enough features for users to produce detailed designs fit for manufacturing. The vendors' strategy may be to attract new users and build brand loyalty at the point of first contact, but nothing prevents proficient users from taking advantage of the wallet-friendly 3D modelers.

## Google SketchUp: A 3D Napkin for Your Concepts

Long before it became Google SketchUp, the general-purpose 3D modeler belonged to @Last Software, headquartered in Boulder, CO. Most 3D modelers in existence at the time were not easy to use; they were difficult by design. The prevalent attitude was that 3D modeling was a sophisticated technology,



Cloned from Inventor Fusion's DNA, Autodesk's 123D is a free 3D modeler that targets enthusiasts, hobbyists and novices. Its direct links to the 123D online community and 3D printing service providers make the software a good fit for the maker market.

and average Joes and Janes had no business meddling with it. But SketchUp's interface, which let users push and pull on faces to create and reshape geometry, proved to be a hit—not just with the professional crowd, but with those who had never used a 3D modeler before. In 2007, SketchUp found a new home at Google after the search giant acquired it. (As press time, Trimble Navigation Ltd. signed an agreement to acquire SketchUp from Google—so the software may soon become Trimble SketchUp instead. See page 8 for details.)

With an installed program directory that takes up less than 70MB, SketchUp is arguably the 3D modeler with the smallest footprint. The compactness makes a difference in how fast it loads, runs and responds to your commands. The software was developed for 3D modeling tasks of all kinds, but it saw swift adoption in architecture before it did elsewhere. Today, SketchUp seems to be the de facto 3D "napkin," the go-to pro-

gram for architects looking for a way to quickly model an idea.

That, of course, shouldn't prevent you from exploring SketchUp for mechanical design.

The software has a series of sketching tools, though not as extensive as the collection you'd find in a professional 3D MCAD program. If you have used 3D MCAD programs, you'll find that you can use the same approach—sketch a profile, then add volume by extruding the profile—to create your basic shape. If this is your first exposure to 3D modeling (a highly unlikely scenario, since you're reading a professional engineering magazine), you may find that SketchUp is a good training ground for direct editing—the push-pull modeling paradigm that has made its way into many MCAD packages. The software comes with a collection of basic materials, but they cater primarily to the building industry (roofing materials, carpeting, textile, etc.).

If you're using the free version of SketchUp, the finished design may be saved as a native SketchUp file or exported as Collada. The Pro version (\$495) offers a lot more export options (including 3DS, OBJ, DWG, DXF and VRML formats). Many architecture modelers now have the ability to import SketchUp models.

Support for SketchUp among professional MCAD programs is growing, but not extensive. You may find plug-ins (Sycode's SKP Import for Inventor, Solid Edge and Solid-

Works, for instance) to bring native SketchUp files into other MCAD programs.

### 123D: Fusion for the Masses

Autodesk's answer to direct editing was Autodesk Inventor Fusion, a program launched in 2009. With a clean, sparse interface, Inventor Fusion allows you to create geometry from scratch, or edit imported geometry from other MCAD programs using pushing, pulling and rotating faces. Many of Inventor Fusion's features are migrating to Inventor classic, currently still a parametric CAD package.

123D is derived from Inventor Fusion, intended for novices and beginners. "Autodesk has added features for makers [the do-it-yourself community and craft makers], allowing for easy fabrication of designs to a 3D printer or laser cutter with the click of a few buttons. So essentially, 123D is not really a truncated version of Fusion, since it has features not available in Fusion," says Thomas Heermann, Autodesk's director of product management for Consumer Products.

Still, with more than half a gig of program code to run, it's a full-sized modeler. Most of you are running professional workstations, so the horsepower in your machine should be enough to launch 123D in, well, 1, 2, 3. But the program might test the power of some consumer PCs—the kind beginners will likely pick up from Best Buy.

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123D's modeling window is fully integrated with the 123D community, offering you a way to download and import 3D models others have created and chosen to share. Like a typical CAD program, it gives you tools for 2D sketching, 3D volume creation (including more sophisticated methods like Loft and Sweep), and edge treatments. It also allows you to insert construction planes in 3D space, or create patterned features. The language and the prompts will present no challenge to those familiar with CAD modelers, but it may not be the best for novices still learning the basics of 3D modeling. Robust support for general 3D formats (IGES, STEP, OBJ and even SketchUp files) makes this a great program for opening and editing imported 3D designs.

"Users can save to a wide variety of formats after signing in. Upon doing so, the user can save their files to My Corner—cloud storage that lets the user access their file directly from within other 123D apps," Heermann notes. "Once users sign in, they can save to VRML, STEP, IGES, DXF, SAT, STL, DWG and SVG [as well as 123D]."

123D modeling software is part of Autodesk's 123D initiative, a move to introduce Autodesk products (some repackaged from the professional portfolio, others developed from scratch) to the consumer market. In the last five years, as the do-it-yourself market has grown, propelled by events like the annual Maker Faire, major CAD vendors begin to turn their attention

to the same demographics. The thinking is that they can serve the market with a combination of easy-to-use 3D software and 3D printing technology.

Autodesk's strategy is to release a series of apps, housed under the 123D brand, to enable people with little or no training in 3D modeling to create digital designs—and produce them at rapid prototyping service bureaus or print them in consumer-friendly 3D printers.

### Shaping Up with 3DVIA

Dassault Systèmes, better known for CATIA and SolidWorks, offers a free downloadable modeling software program dubbed 3DVIA Shape. With all-basic modeling tools (profile sketching, solid volume building, Boolean operations, freeform deformation and more), the software allows you to create basic 3D design concepts with ease.

The drawback, however, is that the software offers no option to save the design to your local hard drive. It's set up to nudge you toward the online 3DVIA.com community and upload it there.

Exchanging data with other users who don't use 3DVIA also proves somewhat cumbersome. You'll have to instruct your collaborator to sign on to 3DVIA.com, the portal where your 3D model is hosted, then download it as 3DXML or Collada format (.DAE extension).



modo<sup>601</sup>



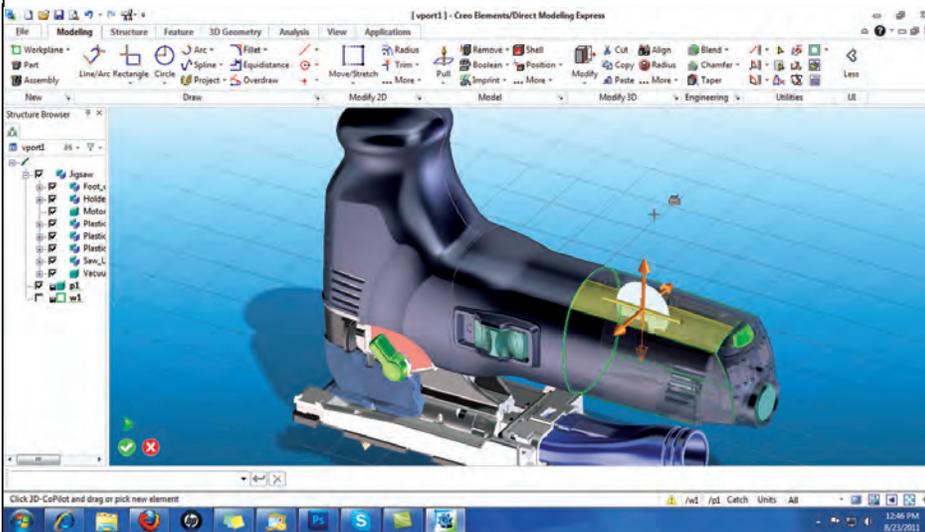
*"modo is the modern tool for industrial design. It's the world's best conceptual modeler. The rendering is built-in, super fast and realistic.*

*And, since I can take my data on round trips between modo and my NURBS-based CAD tools, I can make sure my design gets built the way I want it to look."*

— Paul McCrorey  
McCrorey Digital

conceptual model and visualization in modo® by Evgenii Kudinov

Luxology.com/whymodo



PTC's direct modeling technology is the foundation of PTC Creo Elements/Direct Modeling Express, a lighter, leaner direct modeler that serves as a good introduction to the technology.

### Creo Goes Direct to Enthusiasts

PTC, once known for the all-inclusive CAD-CAM-CAE program Pro/ENGINEER, has started to break up its offerings into smaller chunks of code. Rebranded as Creo apps, the company's products reappear as Creo Sketch, Creo Parametric, Creo Direct, Creo View, Creo Simulate and the rest. The company has also released a series of free Creo products, including Creo Elements/Direct Modeling Express.

The 180MB download for Creo Elements/Direct Modeling Express gives you access to a simpler, easier version of PTC's direct modeling technology, repackaged for 3D enthusiasts and beginners. The free version limits you to 60 unique parts in your assemblies; the commercial version, Creo Elements/Direct Modeling, has no limit. In both the free and paid versions, you may import 3D designs as STEP and IGES files, then export them as VRML and STL files. The paid version offers export addition export options, include STEP, IGES, SAT and IDF.

### Alibre Design: CAD under \$200

Alibre Design, once sold for just slightly less than its competitors (primarily SolidWorks, Solid Edge and Inventor), stunned the CAD market with its dramatic price drop in late 2009—to \$99. The special version the company introduced then, dubbed Alibre Personal Edition, is still available today for just a little more than its introductory offer. It now sells for \$199.

Alibre was recently acquired by 3D Systems, a leading 3D printer manufacturer, but the new owner seems content, at least for now, to continue to develop and distribute Alibre Design as before.

Whereas many other low-cost CAD packages use direct mod-

eling as their core technology, Alibre Design remains a classic history-based modeler. History has proven that history-based modelers tend to take longer to learn than direct modelers, so if you're a beginner, you'll have to invest some time to learn the software. On the other hand, if you're well versed in history- or feature-based modeling and you simply need a CAD package that costs less, Alibre Design is an attractive option.

To get access to surfacing tools, you'll need to purchase Alibre Design Professional. Moment of Inspiration (MoI) is a separate installable package for surfacing, and it is bundled with Alibre Design Pro.

### Solid Edge by Subscription

Beginning in November 2011, Siemens PLM Software began distributing special editions of Solid Edge with Synchronous Technology, dubbed Design1, through a partnership with Local Motors. For as low as \$19.95 per month, Local Motors members may purchase a subscription to Design1, which entitles them to install and use the software on Local Motors projects.

With a strong emphasis on crowd-sourced design, Local Motors lets members post design ideas (mostly automotive design) to the community, solicit design proposals, and fabricate the design at member-accessible manufacturing facilities in several locations. Solid Edge subscriptions for members are available in several tiers, ranging from \$19.95 to \$299.

The \$19.95 subscription gives you export options for Parasolid, IGES, STEP, STL, PDF, u3D, JT and more. It also comes with import options for SolidWorks, Inventor, Pro/E, NX, Parasolid, IGES, STEP, STL, PDF, u3D, JT and more. More complex functions—such as surfacing, finite element analysis (FEA), motion simulation and rendering—are available only in higher-level subscriptions.

### More options in 2D

For 2D drawing and drafting, many more options now exist besides AutoCAD and AutoCAD LT. Some of the options—such as Dassault Systèmes' DraftSight, IMSI/Design's DoubleCAD XT, Siemens PLM Software's Solid Edge 2D, and PTC's Creo Sketch—are free. Other options requires a fee, like \$795 for Graebert's ARES Commander. Almost all support the gold standard in 2D drawing: DWG. (For more on this topic, read "Designs Live On and On," *DE* May 2012, page 37.)

### Pay Attention to the Handshake

Free and low-cost 3D modelers offer beginners, enthusiasts and prosumers (those who are generally more tech-savvy than



Siemens PLM Software launched Design1, a special edition of Solid Edge with Synchronous Technology intended for Local Motors members who can use it to help crowd source designs.

average consumers, but lack the justification to buy a full-featured professional product at full price) a chance to create their own digital assets in 3D without the cost of professional CAD software. Many of the programs mentioned here use direct-modeling technologies—and for good reason. Direct modelers are generally easier to learn and master than their counterparts in feature- or history-based modeling.

But the real value lies in the programs' ability to read and write formats commonly supported by professional 3D modelers. Without the ability to exchange data with its higher-end cousins—without the handshake with professional packages—a 3D modeler remains no more than a learning tool. **DE**

**Kenneth Wong** is Desktop Engineering's *resident blogger and senior editor*. The list in this article is not an exhaustive study of the low-cost modelers available; it simply represents a collection known to work well (some more than others) with professional-class engineering and design software programs. If you know of other workable software titles not mentioned here, please feel free to drop the author a line at [kenneth-wong@deskeng.com](mailto:kenneth-wong@deskeng.com) or share your thoughts at [deskeng.com/facebook](http://deskeng.com/facebook).

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→ Autodesk 123D: [123Dapp.com](http://123Dapp.com)

→ Dassault Systèmes: [3DVIA.com](http://3DVIA.com)

→ Maker Faire: [MakerFaire.com](http://MakerFaire.com)

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→ Siemens PLM Software: [Local-Motors.com/solidedge](http://Local-Motors.com/solidedge)

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# 3D Printing on the Cheap

Is now the time to make or buy your very own personal 3D printer?

BY PAMELA J. WATERMAN

**M**akerbot, PrintrBot, Fab@Home and more—where does one begin in the universe of personal 3D printer (P3DP) choices? Given the exponentially growing number of additive manufacturing (AM) systems targeted directly to consumers, you definitely have a few decisions to make.

Established systems and crowd-funded start-ups now number in the dozens, and are getting more exciting by the week. From total-do-it-yourself to assembled-but-needing-attention to almost-completely-out-of-the-box, the variety of choices dictates you do your homework. *DE* gives you questions to consider and resources to read or view for sorting out the best fit for your interests, skills and budget.

## Getting Started

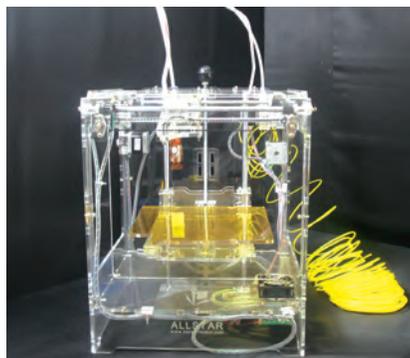
P3DPs are the man-in-the-street response to commercial AM systems (See “Additive Manufacturing 101,” *DE*, November 2010) whose prices have, until recently, started above \$20,000

and often run to \$100,000 and more. Emerging from both university-based and individual efforts, the P3DP movement began in 2004 with the open-source RepRap Project at the University of Bath, England.

Invented by engineer and mathematician Adrian Bowyer, RepRap stands for Replicating Rapid-prototyper, a Tinker Toy-looking structure that builds parts layer by layer by extruding melted plastic filament such as acrylonitrile butadiene styrene (ABS) and biodegradable polylactic acid (PLA). (This approach is often compared to Fused Deposition Modeling, or FDM, the approach Stratasys invented in 1989.) In addition to its simplicity, the radical aspect of a RepRap system is that its software, documentation and designs are distributed at no cost under the open-source GNU General Public License. Further, a driving philosophy and primary feature is that the system can build 50% of the parts needed to build another identical system—thus, the term replicating.

Dozens of companies have since sprung up that sell RepRap part kits and fully assembled models. In addition, in 2006, a new evolutionary branch of the P3DP concept began with the introduction of the Fab@Home system. Developed by Hod Lipson and Evan Malone of the Cornell University Computational Synthesis Laboratory, the Fab@Home project replaces the filament and nozzle of RepRap with a syringe feeder for material placement. This latter design allows the use of any semi-solid material of a consistency that will feed through the syringe—supporting 3D printing in silicone, cement, frosting, chocolate and more.

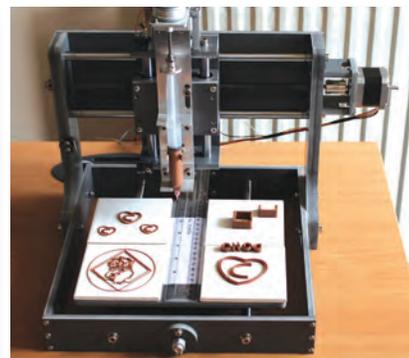
This fast-paced subculture has already created multiple printer generations, and inspired dozens of straight-talking blogs, forums and user groups. Some online communities focus on a single brand, while others discuss and compare systems, software, materials and the personal-printing universe in general. To ensure a good fit, minimize



The Cannonball Allstar from iPrint Technologies is a RepRap-based 3D printer, available assembled or in a kit. *Image courtesy iPrint Technologies.*



Glacier Steel, a sturdy, steel-frame RepRap printer from The Future is 3D. *Image courtesy The Future is 3D.*



Choc Edge 3D edible chocolate printer (Fab@Home style) system, showing extruder syringe dispensing melted chocolate. *Image courtesy Choc Edge.*

frustration and get totally psyched, you could, and should, spend hours learning from these experienced users.

### What's Your Type?

Where do your interests lie?

- Does opening a box filled with nuts, bolts, rods, plates, motors and gears just make your day? Do you push the operational limits of every piece of hardware that comes your way? Is there anything in your shop that you haven't modified in some way to improve its performance? Then you're the classic kit customer, well suited to the assembly, calibration, repair and tweaking often required to get the most from your system. Kits start at \$549 (PrintrBot).

- Are you a hands-on person with a streak of geekiness who doesn't mind fine-tuning a device to make it work its best? Do you want to spend more time designing and printing objects than dealing with the printer itself? Then you'll probably be happiest buying a fully assembled model from a company that provides strong online support. Just announced, the assembled RepRap-style Solidoodle starts at \$499.

- Have you been waiting for a P3DP that eliminates the whole wires-and-struts look and might have more in common with your coffeemaker? Even you can join the P3DP revolution, though currently you'll pay more for the op-

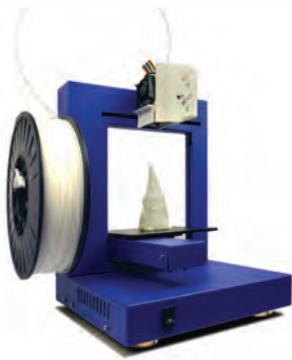
portunity. Bridging the office-desktop and kitchen-counter, these more productized systems range from \$1,299 to \$19,900, but can create pieces with quality rivaling those from production AM equipment. (3D Systems has made quite a splash entering this market with its new Cubify Cube.)

You'll find many details to keep in mind as you compare systems, so don't choose by price alone. Basic differentiators are build envelope (the cubic dimensions of the largest part you can build), part smoothness (mostly affected by layer thickness and build speed, which can vary greatly), and available materials. Most systems are driven by computer (PC vs. Mac), but some read files directly from an SD card. Verify whether all electronics—and possibly a heated build-platform—are included.

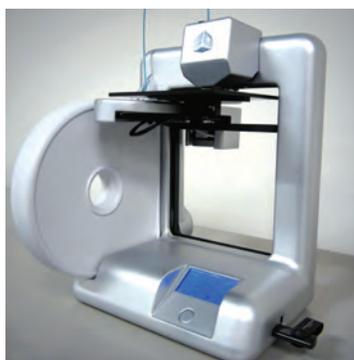
Think, too, about multiple-color (dual/triple head) printing, delivery cost, lead time and whether you care if your system can use any supplier's materials (you could be locked into those sold only by the system manufacturer).

### Dozens of RepRap Choices

RepRap.org offers instructions for building its Prusa Mendel, MendelMax, Wallace, Original Mendel and RepRap-Pro Huxley models. A number of companies sell kits and/or assembled units based on these designs; representative



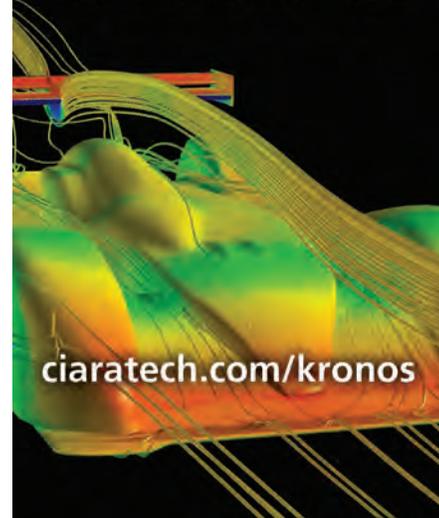
The ABS filament Up! V1.1s printer; the extruder moves in the x-axis only, while the build platform moves in the y and z directions. *Image courtesy Delta Micro Factory.*



The 3D Systems Cube 3D printer creates parts from a filament of ABS plastic, available in many colors. *Image courtesy 3D Systems/Cubify.*

# FEA Engineers

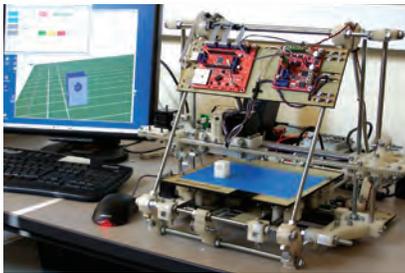
# Cut 50% from your projects' computing time



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An example of a classic, open-source RepRap Mendel 3D printer. Image courtesy RepRap.

models with build volumes and pricing are as follows (see company websites for additional models and specifications):

- BitsfromBytes (a 3D Systems company): RapMan 3.2 (270x205x210mm, kit \$1,390); 3DTouch (275x275x210mm, assembled, single-head version \$3,490).
- BotMill (a 3D Systems company): Axis (200x200x140mm, kit \$1,065), Glider (same, assembled \$1,395).
- Buildatron: Buildatron 2 (200x200x140mm, kit \$1,599; assembled \$2,500). You can send Buildatron pictures of problem builds, and the

company will help diagnose what went wrong and how to fix it.

- Delta Micro Factory: UP! v1.1s (140x140x135mm, assembled \$1,499); UP! Mini (enclosed structure, just going into production, 120x120x120mm, assembled \$899). Extruder moves in x-axis only, while platform moves in y and z directions.
- The Future is 3-D Inc.: The company builds RepRaps for you, no money down. Mendel Basic comes in three sizes: smallest build 300x300x240mm, assembled \$2,100; largest build 406x406x292mm, assembled, \$2,300. Glacier Steel, with one-piece-metal construction, has a largest build of 406x406x445mm, assembled, \$2,800.
- iPrint Technologies: Prusa Explorer (200x200x100mm, DIY kit, \$595; semi-assembled, \$795, assembled, \$995); Cannonball Allstar (200x200x120mm, DIY kit, \$1,195; assembled, \$1,595).
- Leapfrog: Creatr (hobbyist, 300x250x260mm, assembled \$1,635); Xeed (business, 370x340x290mm, assembled \$6,438); robust laser-cut aluminum housing.

- Makerbot Industries: Thing-O-Matic (listed here for completeness, but no longer available); Replicator (225x145x150mm, assembled single head \$1,749); Dualstrusion (\$1,999).
- MakerGear: Mosaic, for people primarily interested in printing (127x127x127mm, kit \$899; assembled \$1,299); Prusa Mendel, for the true build/mod/maintain user (203x203x203mm, kit \$825).
- Mauk Custom Creations: Cartesio M(edium) VO.5, a desktop computer numerical control (CNC) machine with a 3D print extruder (200x200x200mm, kit \$2,256).
- PrintrBot: funded through Kickstarter.com, just started shipping kits in March (152x152x152mm, kit \$549).
- Robot Factory: 3D ONE (245x245x245mm, assembled \$3,926).
- Solidoodle: Solidoodle 3D printer (152x152x152mm; assembled \$499 Base Model; Pro Model with heated platform, \$549).
- SUMPOD: SUMPOD BIG (300x250x150mm, kit \$718); SD card-reader included.
- Ultimaking: Ultimaker, described as having very simple electronics (210x210x220mm, kit \$1,562).

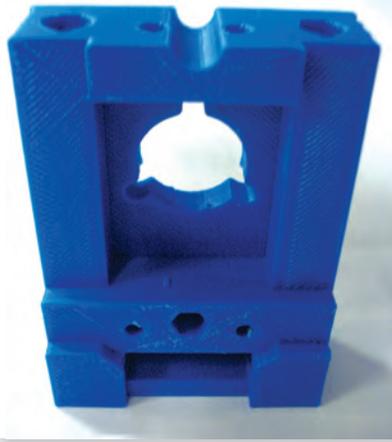
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  - Delta Micro Factory: [Up3dUSA.com](http://Up3dUSA.com)
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  - MakerGear: [MakerGear.com](http://MakerGear.com)
  - Makibox: [Makible.com](http://Makible.com)

- Maxifab 3D Printing Framework: [Maxifab.blogspot.com](http://Maxifab.blogspot.com)
  - Mauk Custom Creations: [Mauk.cc](http://Mauk.cc)
  - Miicraft: [Miicraft.com](http://Miicraft.com)
  - The NextFab Store: [NextFabStore.com](http://NextFabStore.com)
  - PrintrBot: [PrintrBot.com](http://PrintrBot.com)
  - RepRap: [RepRap.org](http://RepRap.org)
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- For more information on this topic, visit [deskeng.com](http://deskeng.com) and DE's new blog at [rapidreadytech.com](http://rapidreadytech.com).

## The World of Fab@Home

The Fab@Home project includes hundreds of engineers, inventors, artists, students and hobbyists across six continents—all with broad production goals ranging from food to toys to replacement parts to buildings. Its roots were in the design of a robot that could “evolve” by reprogramming itself and producing its own hardware; the project quickly became much broader. One of its key elements is the openness to use multiple materials, such as edible ingredients or a two-part epoxy.

Compared to RepRap designs, Fab@Home systems are still much more DIY projects, with numerous parts suppliers listed on the project's website. The original Fab@Home Model 1 has a build volume of 203x203x203mm; Model 2 has the same build volume, but has been



ABS plastic part created on a BotMill (RepRap style) system. Image courtesy BotMill.

redesigned to perform better and be easier to assemble, particularly with respect to the electronics.

- Essential Dynamics: Imagine 3D Printer (203x203x203mm, assembled \$2,995).
- The Next Fab Store: Fab@Home v1 (203x203x203mm, kit \$1,950; assembled, single syringe \$3,300); v2 (203x203x203mm, kit, single syringe \$2,125; double syringe \$2,500)

### More Recent P3DP Activity

There seems to have been an explosion this past year in the P3DP development field. 3D Systems' new Cubify Cube certainly elevates the legitimacy of this market. The sleek, fully assembled ABS-filament-fed unit features a build volume of 140x140x140mm and was specifically designed for home use. It employs USB and Wi-Fi connectivity and costs \$1,299.

Many more systems are in the works, including those launching via the new wave of crowd-funding online communities such as Kickstarter, Indiegogo and Makible. An extremely hot topic is the development of a personal, high-resolution ultraviolet (UV)-cure-resin printer; several are for sale, while some are just at the prototype stage:

- Veloso: high-resolution 3D printer based on TI's digital light processing (DLP) projector and liquid photopolymers; Indiegogo crowd-funded

(150x112x200mm, Basic Kit I without projector, motors or linear guides, \$599; Basic Kit II without projector, \$1,999; Full Kit \$3,999).

- MiiCraft: DLP pico-projector-based system with open-source software (43x27x180mm, kit with projector approximately \$2,000).
- LemonCurry: UV photopolymer DLP 3D printer; Google open-source project.
- ScribbleJ on Thingiverse: DLP-based resin printer (prototype, used parts purchased for less than \$200).
- Vienna University of Technology: LED-cured resin ("milk-carton sized," possibly \$1,570).

### Building on the RepRap design:

- Makibox: Makible crowd-funded (kit listed at \$350).
- Maxifab: 3D Printing Framework (203x203x203mm, looking for funding on Kickstarter).
- SUMPOD: Aluminum Small (120x120x100mm, assembled \$653, Indiegogo pricing).

New in the Fab@Home world is the Choc Creator chocolate extrusion-printing machine from Choc Edge (175x175x70mm, assembled \$3,256). In addition, a P3DP based on sintering powders is under development: Check out BluePrinter ApS' selective heat sintering (SHS) thermal print-head printer for plastics (160x200x140mm, assembled \$13,079).

Space constraints limit this discussion to the basics. Depending on your needs, you may want to put in the required web research hours to learn more about the many P3DP and hobbyist offerings online.

However, if you're looking for more professional 3D printing options that still won't break the bank for a small- or medium-sized company, just turn the page. **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 [editors@deskeng.com](mailto:editors@deskeng.com).*

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# Go Pro for Less Dough

Invest in a professional 3D printer to save money over time.

BY JAMIE J. GOOCH

Just as the market for consumer and hobbyist 3D printers is heating up, prices of professional-level 3D printers are coming down. Granted, there is a big difference between \$500 and \$10,000, but pros need to consider more than just the sticker price before purchasing a 3D printer.

To produce 3D printers more affordably, hobbyist 3D printers have to make sacrifices. That might mean you have to assemble the 3D printer, fine tune it before getting acceptable output, use difficult software, wait longer for parts to be printed, and cut, sand and file away support structures to get the final output you want. Those trade-offs may be perfectly acceptable if you are 3D printing as a hobby, but they don't cut it for most professionals.

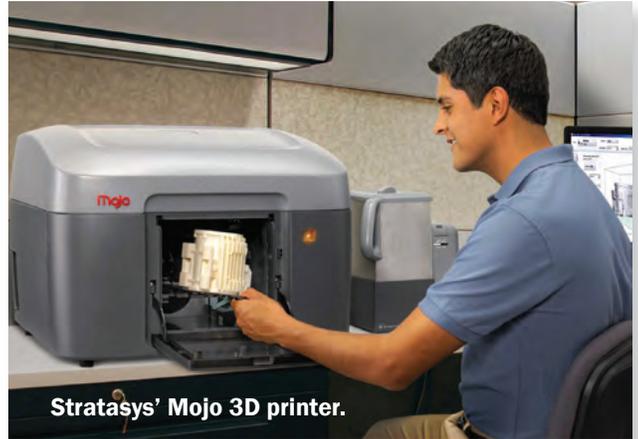
"A business-class system is meant to be run hour in and hour out, and is expected to have a long lifecycle," says Todd Grimm, president of T. A. Grimm & Associates, a rapid prototyping consultation firm. "If you get into business-class technology, whatever you throw at it you should expect to get good output from it. The capabilities in consumer class systems are not quite there."

## Breaking Price Barriers

Grimm was speaking at the unveiling of Mojo, Stratasys' new professional grade 3D-printing system. When purchased as part of a print pack that includes everything you need to get up and running — the printer, material, support material, and support-removal system — Mojo sells for \$9,900. That's about \$1,000 less than 3D Systems' ProJet 1000. Stratasys calls Mojo the lowest-priced professional-grade 3D-printing system on the market, but their definition might be different than Asiga's, a relative newcomer that offers its Freeform Pico 3D printer starting at \$6,990. The diminutive Pico has an 8.6-in. footprint and a small envelope (1.57x1.18x2.95 in.) suited to jewelry or small medical parts. By contrast, Mojo has a build size of 5x5x5 in. and the ProJet 1000 has a build size of 6.75x8x7 in.

Beyond the \$10,000 mark, users can find more options, such as color 3D printing in the Stratasys uPrint SE Plus, and 3D Systems' ProJet 1500 and ZPrinter 150. Prices for each are around \$15,000. Blueprinter, a Denmark-based manufacturer, plans to begin competing at this price point as well with its Selective Heat Sintering system that should be available later this year.

Moving up from there is Objet's Objet24 at \$19,900, and Objet30, which can build with five different materials, for \$30,000. The company also just announced its Objet30 Pro, which can print with seven materials, including high-temper-



Stratasys' Mojo 3D printer.

ature and clear options, for \$43,000.

"There are lots of designers and others dying to jump into 3D printing, but products like the Makerbot are not going to meet their needs, and they don't want to spend \$150,000, so they've been sitting on the sidelines," says Objet's Bruce Bradshaw.

## Choices, Choices

Beyond what many would consider "low-cost" are larger build sizes, faster speeds, additional material options and different additive manufacturing technologies. However, even engineers on a budget can get a taste of higher-end systems by using a service provider, such as 3D Systems' QuickParts or 3Dproparts, Stratasys' RedEye On Demand, or Solid Concepts' ZoomRP.com.

There is no shortage of options when it comes to 3D printing and additive manufacturing. When deciding where to invest, begin with outlining your needs. What's most important to you? Cost, speed, accuracy, build size, color, ease of use, materials? The answer may lead you to a combination of technologies and service providers that can best fit your needs. **DE**

Jamie Gooch is Managing Editor of Desktop Engineering. Send e-mail about this article to [de-editors@deskeng.com](mailto:de-editors@deskeng.com).

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For more information on this topic, visit [deskeng.com](http://deskeng.com) and [rapidreadytech.com](http://rapidreadytech.com).



# Clusters for Small Teams

Can a small engineering house build (and maintain) an effective computer cluster?

By PeTer V Arhol

**M**ost engineers are well aware of the growing performance advantages of computing clusters for many types of engineering work. Any computing problem that can be broken down into large numbers of small, but independent computations has the potential to be significantly accelerated by the many processor cores available on most clusters. This includes just about any type of simulation, as well as standard analyses such as computational fluid dynamics (CFD) and finite element analysis (FEA).

In contrast, most design practices are sequential in nature, and can only make use of one core at a time. It's important to note that any software used for these applications has to be written specifically to make such computations independent. Several leading engineering analysis vendors, such as ANSYS,

have made their software friendly for multicore systems.

Despite those limitations, clusters have become the state of the art for much of engineering computing. Virtually all of the Top 500 supercomputers employ some form of cluster technology. But the cost and complexity could still put the technology out of reach of small engineering groups.

## More Complex Than It Sounds

Actually making use of a cluster's significant benefits is more difficult than it seems at first glance. Built from scratch, clusters can be technically difficult to purchase, configure and administer. The combination of processors and processor cores, cache, system memory and interconnect are highly dependent upon one another—and on the actual type of work being done.

Computing clusters, such as this one from IBM, have revolutionized design engineering by speeding analysis and simulation.



Clusters from vendors such as BOXX can be relatively easy to set up while performing specialized tasks such as rendering.

Further, administering a cluster involves loading and managing jobs, watching computational trends to properly allocate resources for specific types of jobs, and making sure that jobs are queued up appropriately to take their turn on the cluster. If you get it wrong, at best you're not optimizing your use of the cluster. At worst, it means wasting much of the time and expense of obtaining the cluster in the first place.

Engineering groups that approach the process as simply "buying multiple PCs" are likely to have underestimated the amount of planning and computing skill needed to get a high level of performance from a cluster. Probably the biggest misconception surrounds the interconnect. Simply performing computations on processor cores is only part of the equation. Because data has to be moved rapidly among systems in the cluster, transfer speed can make or break the process.

## The Roads to Cluster Computing

There are several distinctly different ways of getting to cluster computing without the time, money and skills needed to start from scratch. Possibly the simplest is that afforded by a combination of technologies from the likes of Intel, HP and virtualization vendor Parallels. Using Parallels' Extreme Workstation, engineers can create a virtual machine that spans multiple workstations, opening up a potentially large number of cores and amounts of memory to devote to the cluster.

The key to clustering here is Parallels, which segregates processor cores, memory and disk space for use by the cluster job. For high performance computing (HPC), Extreme Workstation implements Intel's Direct Virtual I/O (VT-d) technology, which provides a means

of accessing workstation I/O very quickly through software. Because the biggest bottleneck of cluster computing is typically moving code and data from one location to another within the cluster, improvements in I/O are an important key to a successful clustering operation.

Such a cluster is built with high-end, single-user workstations that divide computing resources between the interactive engineering user and the cluster jobs. It can be useful to analyze individual parts of a larger project, or running Monte Carlo simulations for sensitivity analysis. Its principal benefit is the rapid turnaround of these types of jobs. Engineers can run analyses while continu-

ing design work, and immediately obtain the results to look at certain design characteristics. This feedback can be integrated back into the design without waiting for a traditional cluster or mainframe job to be scheduled.

For those who would like to custom-configure a cluster, Intel has devised a program called Intel Cluster Ready, where hardware and software vendors have already done much of the testing and engineering work. In effect, Intel has published a set of specifications on how system architectures, memory, data busses, interconnects and even software interact with one another.

A part of Intel Cluster Ready is Intel Cluster Checker, a cluster diagnostics tool that helps make HPC clusters practical for smaller shops that don't have a lot of experience with managing clusters. The Cluster Check has two main components. First, software vendors have defined representative workloads and used Intel Cluster Checker to confirm that their applications ran successfully on an Intel Cluster Ready system.

Second, once the cluster is installed and configured, it can be run regularly by administrators to enhance system reliability and ensure optimal performance. It assesses firmware, kernel, storage and network settings, and conducts high-level tests of node and network performance on an ongoing basis. While the actual relationship between the benchmarks used and individual job performance can vary widely, they do provide the best indication of the level of efficiency available.

If you don't want to take the do-it-yourself approach, several hardware vendors are offering prepackaged cluster solutions, including hardware and management software, to ease the transition to cluster computing. These systems tend to be straightforward to set up, configure

and begin using. In many cases, the vendor or systems integrator will walk the buyer through the initial setup, configuration and management processes.

The Appro Xtreme-X Supercomputer is one example of a cluster designed and tested by a single vendor, integrating the necessary components into a packaged solution. A high-end version of the Xtreme is high on the list of the Top 500 supercomputers. One significant value of the Appro Xtreme-X cluster is that it offers several different configurations, designed for different types of workload, including capacity computing, hybrid computing and data-intensive computing.

The Appro Cluster Engine Management Software suite can reduce the complexity of managing HPC clusters, while providing tools to run complex applications and workloads. It offers server, cluster, storage and network management features, combined with job scheduling, failover, load-balancing and revision control. Management software is an important way to understand how to use your cluster in HPC jobs.

BOXX Technologies has a specialized system designed for optimizing rendering performance for 3D graphics and animation workflows. It offers a rack-mounted cluster that consists of multiple systems, each configured with up to 12 cores and 192MB of memory, connected with Gigabit Ethernet.

Ciara Technologies manufactures what it calls Personal Clusters, including its NEXXUS C series. According to the company, the NEXXUS C is designed and optimized for advanced modeling and simulation. It promises to combine the capabilities of a data center cluster with the usability of a workstation. It can be outfitted with up to 20 Intel Xeon processors for a total of 120 cores, 16-GP-GPU and almost 2TB of memory.

#### **Your First Steps**

If your engineering group doesn't have any experience with clusters, and you don't have dedicated and experienced IT support, it's im-

portant to start small and get expert help if possible. Preconfigured cluster configurations from the likes of Appro, BOXX and Ciara can provide an out-of-the-box solution to get quickly up and running.

However, clusters should be configured and tuned carefully to make sure they are executing their workloads efficiently. You get this level of understanding primarily through experience.



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# Focus on: Affordable Tech /// HPC for SMBs

A great way to learn about cluster computing from the ground up is the workstation cluster. You still have to use high-end workstations with at least Gigabit Ethernet connectivity, but those workstations can be used interactively—and at the same time, their resource can be applied to a cluster. In addition to being cost-effective, they provide an easy way of starting to understand how clusters need to be managed.

Once the group gains experience in both cluster configuration and management with a small workstation cluster, it may be time to look at one of the higher-end approaches. A solution from a single vendor can make sense, although you're paying for that vendor's expertise in integrating and configuring it for your needs.

Building your own cluster is a more difficult challenge, and ideally you would like to have dedicated IT expertise to do so. Whether or not you do, Intel Cluster Ready represents a smart way to configure a cluster to meet specific needs. While there will possibly be some configuration issues, much of the integration work has already been done.

Even if you're a team of only a few engineers, chances are you'll benefit from some level of clustering. You can do a more detailed level of analysis, or

deliver end products more quickly than you can today. But clusters aren't like PC workstations. You need to understand the relationship between cluster configuration and your workloads, and you need software to queue up and monitor jobs. Still, if your team can make this leap, the cluster will ultimately reward you with better designs more quickly. **DE**

*Contributing Editor Peter Varhol covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at DE-Editors@deskeng.com.*

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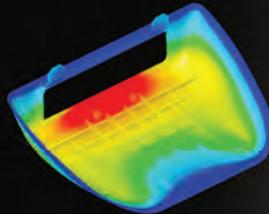
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# PLM for the Rest of Us

SaaS and a mobile workforce are leading the transformation.

BY KENNETH WONG

At first glance, a product lifecycle management (PLM) system for a small business sounds silly, like a chauffeured Mercedes for someone needing a cab, or a private jet for someone who needing a cheap flight home. In fact, about 10 years ago, PLM vendors catered almost exclusively to those who made, or could afford, Mercedes and jets. The rest made do with Excel or a homegrown system.

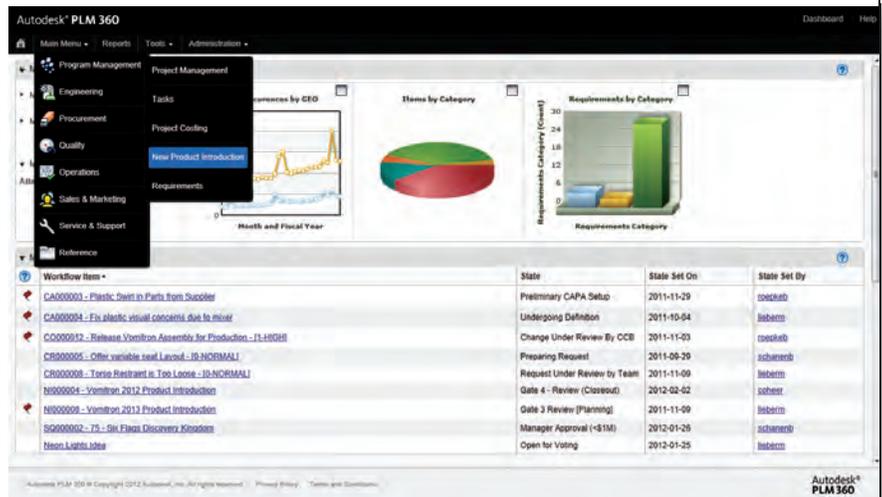
But the economic landscape and technology have changed quite a bit since then. Several PLM providers have figured out ways to repackaging their large-enterprise products so they can be applied to smaller enterprises, at a more reasonable cost. There are also new providers who are small and midsize themselves. They continue to develop and provide the kind of no-frills data management and project management solutions their peers could use. These products are often characterized by low IT overhead, fast implementation, and modular structure (you can adopt them incrementally as your needs grow).

The real game changer is the cloud, the internet's ubiquitous reach and accessibility. By unshackling PLM from the previous client-server architecture to web-hosted structure, some providers managed to deliver solutions with unprecedented affordability. They now offer Software-as-a-Service (SaaS) PLM subscriptions priced below \$100 per user, per month—something unimaginable 10 years ago.

The mobile army—the growing population of professionals who insist on using smartphones and tablets—are also a reckoning force. With the emphasis shifting from desktop clients to tablets and phones, all you need to access your PLM system may be a mobile app. With this revolution (mobilution?), a greater number of people are now poised to participate in new product introduction, change order requests, design revisions, supply chain management, and more—possibly without ever signing on to a formal PLM system or launching a CAD program.

## Crowd in the Cloud

When Autodesk decided to enter the PLM market it once mocked, the company knew it couldn't offer the same type of software and services its competitors had been selling for



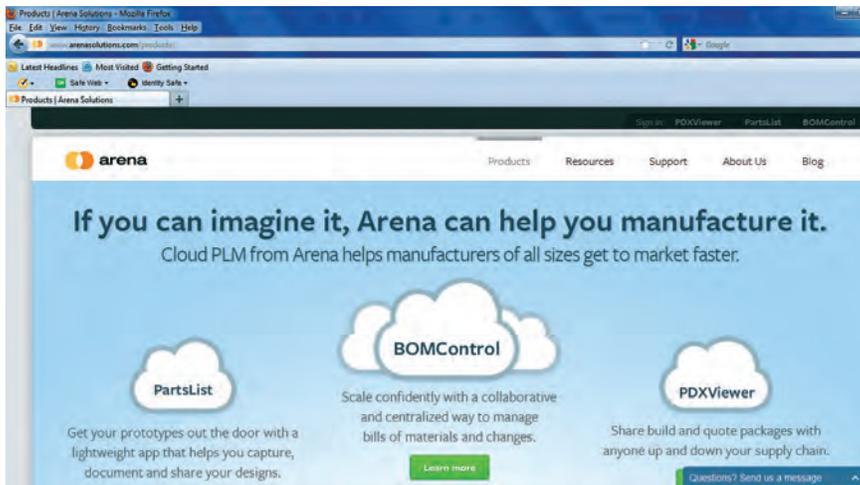
Autodesk's reversal of its position on PLM led to the launch of Autodesk PLM 360, a series of web-hosted modules available by subscription.

years. Bypassing the traditional client-server approach, Autodesk chose instead to house its PLM system in the cloud, as a series of web-hosted modules.

The cloud was already getting a bit crowded, with a number of smaller PLM providers offering a variety of specialized SaaS applications. Arena Solutions, for instance, has been offering SaaS PLM since the mid-1990s. Newcomers like Inforbix and Kenesto also rely heavily on the cloud. What distinguishes Autodesk's solution is the comprehensiveness and price. Many other SaaS PLM providers offer a web-hosted software interface that performs a specific set of functions. For Inforbix, the focus is search and retrieval of product data. For Kenesto, the focus is business process automation. Arena Solutions' specialty is bill of material (BOM) management.

By contrast, Autodesk PLM 360, the company's SaaS PLM brand, comes with a buffet-style spread, covering business process, BOM, supply chain, change management, incident report and much more. The price of admission to the buffet, too, is almost irresistible: The first three users in your account get in for free. You may add additional users at \$25 to \$75 per user per month, through yearly subscriptions.

If you own an Autodesk product, you may already own Autodesk Vault, an Autodesk product data management (PDM) solution. The company makes a distinction between PDM, which



**Arena Solutions, a longtime SaaS PLM provider, revamped its site and solutions by adding two new modules: Arena PartsList and Arena PDXViewer.**

encompasses data housing and collaboration (where to keep CAD files, how to control access, how to track revisions and versions, and so on), and PLM, which covers a wider area of the product development. Autodesk PLM 360 can be used in conjunction with Autodesk Vault, but you do not need one to use the other.

### Arena Solutions Revamped

Originally, Arena Solutions was known as BOM.com, a clear indication of where its focus was. In 2002, the company decided its expertise—collaboration, compliance and supplier management, in addition to BOM—had expanded beyond its initial focus. Accordingly, it rebranded itself as a SaaS PLM provider.

In its latest incarnation, which came online in April, Arena Solutions incorporated PartsList, a way to publish lists of parts into BOMs, and PDXViewer, a way to read and edit common BOMs published in PDX (Product Data eXchange) format. The new modules have new introductory pricing: \$49 a month for basic account, which covers three seats and 10 suppliers; or \$79 per seat per month (up to 125 seats), which covers up to 75 suppliers.

With SaaS products, you pass the responsibility to purchase, maintain and operate an IT infrastructure on to the provider. This reliance on the provider is both an advantage and an exposure. You save significant expense by signing on to a multi-tenant IT setup in the cloud; however, it is offset by the trust you place in your provider's ability to keep the system up and running 24/7. As a pioneer in cloud-hosted software, Arena Solutions can rightfully brag about its extensive history, which shows a 99.98% system uptime in the past 10 years.

### n!Fuze and n!Volve for Collaboration

Though not a comprehensive PLM suite, Dassault Systèmes' n!Fuze for SolidWorks users and n!Volve for CATIA users are expected to serve small and midsize businesses looking for a way to collaborate and share design files. Delivered as SaaS and dis-

tributed via Dassault Systèmes' 3D Store, both give SolidWorks and CATIA V6 users a secure online workspace (inside the CAD modeling environment) to work with others.

If you are a SolidWorks user, n!Fuze can be installed as an add-on to the software. If your collaborators do not use SolidWorks, they may interact with you from a web client or a mobile app to view CAD models and trade comments. Anticipating CATIA users' PLM workflows, n!Volve gives users a way to integrate the n!Volve toolset into CATIA's CAD modeling environment, DELMIA's process simulation environment, and SIMULIA's analysis environment.

n!Fuze and n!Volve are available by subscriptions, priced \$77 and \$300 per user per month, respectively. There is currently a mobile app for n!Fuze available for free at the Apple App Store.

### Insight XT to Extend Solid Edge PDM

Solid Edge, part of Siemens PLM Software's Velocity Series, includes a data management component called Insight. This month, the company extended the functionality of Insight with a new product, called Insight XT. Based on Microsoft SharePoint, Insight is meant for vaulting and managing Solid Edge design files, revisions, releases, check-in/checkout, and access control. The solution is meant for customers with "lower end-user support requirements," as stated on the product's home page.

Solid Edge Insight XT will support common Office documents in addition to Solid Edge files. It will also include a relationship navigator, an environment for displaying file relationships as a dynamic diagram. Departing from the conventional Windows Explorer look, Insight XT will be housed within a browser-inspired interface. It is, however, not a browser-based SaaS product. It's intended for on-premise deployment.

At press time, no pricing was available, but according to Bill McClure, director of Velocity Series, Insight XT is meant for small businesses and will be priced accordingly.

### PLM for Free?

PLM is often associated with sticker shock (one of the reasons small businesses tend to stay away from it), but with Aras PLM, you might get a different kind of sticker shock. It's open source: free. The company offers three flavors of PLM:

- Aras Managed Solutions: Available for free download under an enterprise open source format (no license required).
- Aras Community Solutions: Developed and contributed by Aras Community members, freely available on the Aras Community Project Site.
- Aras Commercial Solutions: Developed and distributed by Aras and Aras Partners; some licensing fees may apply.

So how does Aras stay in business? It thrives on offering support and services to customers who want to tailor Aras and Aras



Inforbix, a relative newcomer, offers cloud-hosted PLM modules, complemented by a mobile app. Shown here is the Dashboard module.

partner products to fit their specific IT setup and workflows. Aras products cover a range of PLM functions, including BOM, CAD file management, configuration management, project tracking, regulatory compliance, and new product introduction. Aras PLM runs on Aras Enterprise Application Framework, a platform developed in service-oriented architecture.

### Bite-Size Pieces

Often, a small or midsize business may not be in a position to commit to a full PLM suite all at once. In that case, products that focus on specific areas of PLM may be more attractive.

Taking his cues from social media, Vuuch founder Chris Williams came up with what he calls “enterprise social software.” When you decide to start a collaboration session in Vuuch, your CAD file gets a Facebook treatment, sort of like launching a Facebook page for your file or project. Everyone associated with the file or the project (your file’s “friends,” so to speak) get regular updates when something is done to the file.

You don’t have to be using a CAD program to participate in a Vuuch-enabled discussion thread. You could join in from your email client. CAD files and snapshots will appear as JPG thumbnails. Vuuch works as a plug-in for Inventor, SolidWorks, SpaceClaim, Pro/ENGINEER and AutoCAD. It also works with Office applications unrelated to engineering and design.

Another solution, CADFaster, offers a way to share and collaborate on design files using both desktop clients and mobile devices. With background syncing and online file storage, you can use CADFaster to discuss design issues, and even modify 3D files in a co-viewing mode (you and your collaborators are online at the same time, interacting with the same design file).

On the other hand, if your priority is data reuse, you may consider a cloud-hosted search and retrieval product like Inforbix. Currently, Inforbix offers a series of modules for browsing saved search results, project lists and reports; finding and locating prod-



With CADFaster, a desktop client and mobile device may share a model in a collaborative co-viewing session. Shown here is the screen of CADFaster’s mobile app.

uct data, design files, reference files and BOMs; visualizing data in graphs and charts; organizing search results and aggregating your updates, searches and files. These apps are supported by a mobile app, primarily for search and retrieval.

### The New PLM Proposition

The PLM proposition used to be all or nothing: Either you sign up for the whole suite, along with consultation fees and a multi-year commitment, or you choose to sit by the sidelines. But the new breed of PLM, often powered by the cloud and accessible from mobile devices, gives you options. With prices that go as low as \$0 (Aras PLM is free) to \$25 (Autodesk PLM 360 begins at \$25 per user, per month), you could still have objections to PLM, but price and IT overhead aren’t the obstacles they used to be. **DE**

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# AutoCAD Gets a Face Lift

Model documentation and interface improvements lead the list of AutoCAD 2013's new features.

BY DAVID COHN

As surely as spring heralds the arrival of warmer weather, it also marks the release of a new version of AutoCAD. On March 27, Autodesk unveiled AutoCAD 2013, the 27<sup>th</sup> major release of the world's most popular CAD program. And as expected, based on Autodesk's three-year development cycle, the new version brings with it a host of new and enhanced features and functions.

Upon launching AutoCAD 2013, users are greeted by a new Welcome Screen that includes tools for creating new drawings, as well as opening existing drawings and sample files. There's also a list of recently accessed drawings, and links to videos explaining many of the new features. A panel containing tools for accessing a redesigned Autodesk Exchange app store, a new cloud service called Autodesk 360 where you can store and share data, and links to social media sites including Facebook and Twitter are also included. With all of its online links, the Welcome Screen can take a while to load, but you can easily disable the automatic display and access it only when needed.

## Power-charging the Command Line

In a move to reduce clutter, AutoCAD's command line has been dramatically modernized. By default, it now appears as a single-line panel at the bottom of the screen, rather than as a four-line docked palette. But because users still need to be able to see multiple lines of prompts, as you work, the previous three lines scroll up into a semi-transparent history area. When you end a command, these slowly fade away, and instead of just a blank space after the command cursor, the command line says "Type a command."

When a command is active, an icon helps identify the command and indicates that the program is awaiting input. You can



Users are greeted by a new Welcome Screen that lets them easily open files, learn about new features, access the Autodesk Exchange Apps store, and use cloud-based services via Autodesk 360.

also click on this icon to quickly view and launch recently used commands. And when a command offers several options, in addition to typing, right-clicking or using dynamic input, you can now click on the desired option right in the command line.

Pressing the F2 key or clicking a special flyout expands the command line to display additional lines of command history. The command line can be floated, docked to the top or bottom of the AutoCAD window, or snapped to the left or right edge. And like most other tools in AutoCAD, the new command line is completely customizable.

While the changes to the command line are obvious, a new feature called in-canvas property preview is much more subtle. In the past, when you made changes to the properties of objects—changing their color or linetype, for example—you didn't actually see the results until you committed to the change. Now, if you select objects and then use the Property palette to change the color, the selected objects dynamically

change color as you move the cursor over each color in the list. It's amazing how helpful this small change can be.

### Improved Arrays

By far, the biggest improvement in AutoCAD 2012 was the introduction of associative arrays, which introduced three new commands for creating rectangular arrays, polar arrays or evenly distributing objects along a path. Once positioned, you could select an object in the array and make adjustments, such as changing the spacing, the number of objects or even the objects themselves. But creating a rectangular or polar array in AutoCAD 2012 could be a bit confusing.

The array functionality in AutoCAD 2013 has been enhanced, making it faster and easier to create objects in a pattern. For example, after selecting objects for a rectangular array, they are immediately displayed in a three-row-by-four-column grid. When creating a polar array, the selected objects are displayed in a full circular pattern of six copies as soon as you specify a center point. And when creating a path array, the objects you select are immediately displayed evenly along the entire path, as soon as you select the path.

Multi-function grips display for all three types of arrays, so you can dynamically modify relevant properties. In addition, new tools in the ribbon make it much easier to control the creating and editing of associative arrays.

### Model Documentation Gets Real

The other big change in the last release was the introduction of a completely new set of tools for documenting 3D models. Here again, Autodesk has learned a lot from that initial set of tools. As a result, the Model Documentation functionality has been greatly enhanced in AutoCAD 2013. The model documentation tools are now located in a new Layout tab alongside common tools for creating and managing drawing layouts and views.

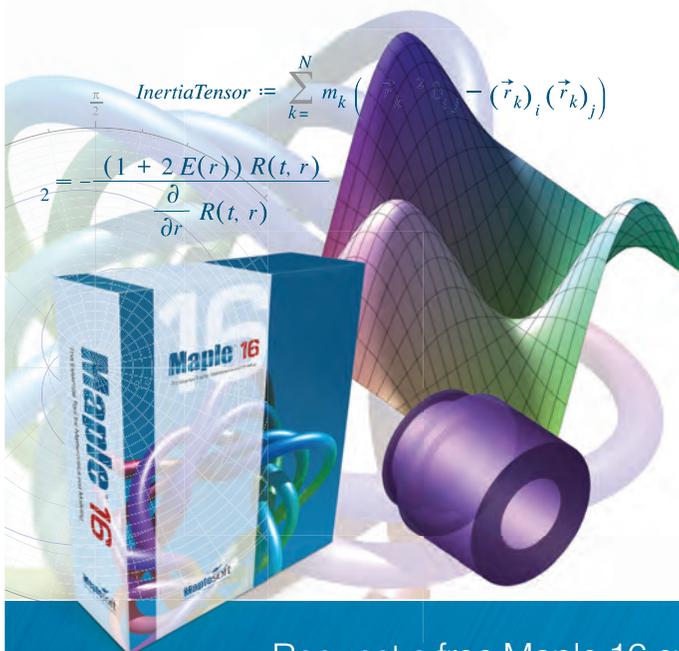
The process of creating model views still begins by placing a base view into a layout, but now, when you start the process, you can choose to generate the base view from a model in model space or from a model created in Autodesk Inventor. If you choose Inventor, AutoCAD prompts you to select the Inventor file you want to import. If you choose a model space model, the program asks whether you want to use the entire model or individual model space objects.

In AutoCAD 2013, if you're currently working in model space, the program prompts you to specify the name of layout in which you want to place the base view, and it can even create a new paper space layout on the fly. You can even go back and select additional 3D objects to add to the base view.

Once you've placed a base drawing view and created projected views, you can use a new Viewsection tool to create full, half, offset or aligned section views from any existing drawing view. A section identifier is automatically applied and incremented as you

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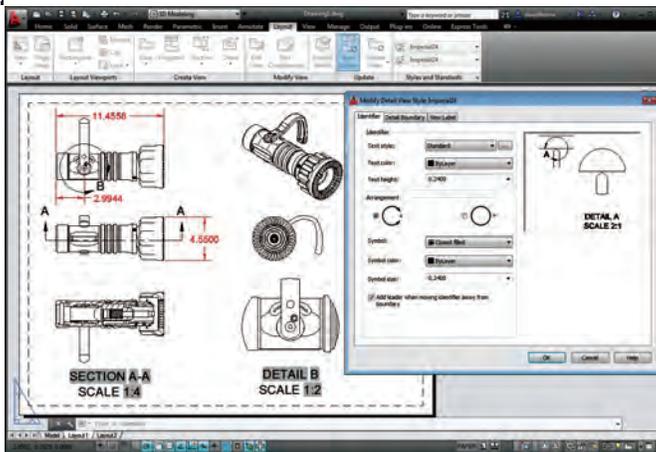
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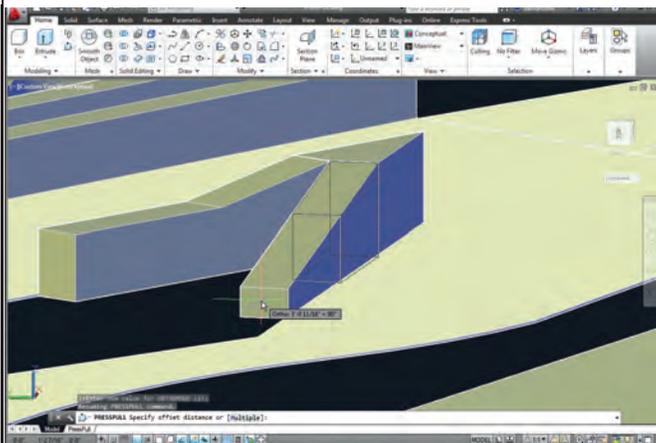
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Users can now document models created in AutoCAD, Inventor or other CAD programs, create section and detail views, and control those views using styles.



The PressPull tool can now offset a planar face as it extrudes to follow the taper angle of adjacent sides, and has been enhanced to include a multiple option.

## AutoCAD LT 2013 Borrows Some Improvements

With each new release of its flagship, Autodesk also adds new features to AutoCAD LT, the lower-cost 2D alternative to AutoCAD. Once again, AutoCAD LT 2013 benefits from some of the new features in AutoCAD 2013. For example, AutoCAD LT 2013 sports the same command line improvements as its full-featured sibling. LT users will also have access to the Autodesk 360 cloud storage, AutoCAD WS and mobile devices. And they'll be able to synchronize customized settings with their Autodesk 360 account.

The improvements to associative arrays are also fully incorporated into AutoCAD LT 2013, as are the new property edit preview functionality. AutoCAD LT 2013 also gains the same multiple hatch-editing capabilities, strike-through text, and external reference path editing. And this time around, AutoCAD LT 2013 for the Mac will also be released along with the Windows version, and for the first time will be available through other retail channels in addition to the Apple Macintosh App Store.

With its two-dimensional functionality nearly equal to AutoCAD itself, AutoCAD LT 2013 should meet the needs of anyone looking for a lower-cost 2D-only alternative to AutoCAD. All of this should guarantee that AutoCAD LT remains the top-selling 2D drafting application.

AutoCAD LT 2013 has a \$1,200 MSRP.

create subsequent section views. You can even control whether individual model components are included in the section view, and specify whether it should include the full depth or just a slice.

After a section view has been created, you can use the new section view style settings to control the appearance of section identifiers, the cutting plane, the view label, and the hatch pattern applied to the cross-section. You can also create detail views from existing drawing views, and control their appearance using the new detail view style controls. Like other styles in AutoCAD, you can create and save as many different section styles and detail styles as you need.

AutoCAD's parametric controls have been extended to drawing views, so you can constrain section lines and detail boundaries to key points in the drawing views, ensuring accuracy even as the model or layout changes. And now, when you add annotations to detail views, those annotations are associated to the drawing view based on the vertices selected or inferred by the selected edge. As a result, if you update the drawing view, the annotations adjust appropriately.

While it's still possible for changes to the underlying 3D model to cause annotations to become disassociated, AutoCAD 2013 includes a new Annotation Monitor button on the status bar. Whereas last year, almost any change caused annotations to become disassociated, this time around, AutoCAD handles most changes without causing annotations to lose associativity.

## A Host of Smaller Enhancements

In addition to the big changes, AutoCAD 2013 includes several smaller, welcome changes and additions. For example, the Help system has been restructured to provide faster search results. And the Quick View Drawing thumbnails now display a bold border to emphasize the current active view.

AutoCAD 2013 lets you select multiple hatch objects and modify them all at once using the Hatch Editor ribbon, and when working with external references, you can now edit the Saved Path directly in the External References palette.

Point cloud functionality has also been enhanced. You can attach and manage point clouds similar to working with images and external references (XREFs) files.

When working in 3D, the PressPull tool has been enhanced to include a multiple option—and is no longer limited to clicking inside a bounded area. You can now select 2D and 3D curves as well. In addition to extruding faces straight out, you can offset a planar face as it extrudes to follow the taper angles of adjacent sides. Plus, a new Extract Isolines tool enables you to extract isoline curves from an existing surface or face of a solid.

Improvements to 2D drawings include new annotation capabilities and an addition to the Draw Order tool to bring all leaders to the front. The Offset command has been improved to show a preview of the offset results as you use the command. And the Content Explorer, the file indexing and search component added in AutoCAD 2012, has been enhanced to support more file types.

### Autodesk in the Cloud

A new feature that will undoubtedly appear in other Autodesk software is the introduction of Autodesk 360, a cloud-based service you can use for online file sharing, syncing customized files, and more. After signing in and specifying default settings, you can choose to automatically sync them so that you can restore them on any computer.

There's also a new Online ribbon with tools for accessing your Autodesk 360 cloud storage area, controlling your online options, sending a notification to your mobile device so you can find and open the current drawing on your tablet or phone, uploading drawings to your Autodesk 360 account, syncing your settings, sharing a document from your Autodesk 360 account with someone else, and opening an online session with AutoCAD WS in your default browser so you can collaborate with another WS user.

Everyone gets 3GB of free cloud storage. Those with subscription accounts get 25GB of storage, plus 100 cloud credits for things like cloud-based rendering.

### Simultaneous Macintosh Release and Suites

This time around, Autodesk isn't delaying things for Apple customers. AutoCAD 2012 for the Mac lagged six months behind the Windows version. This year, AutoCAD 2013 for the Mac was announced simultaneously with the Windows release and will share many of the same features, including the array and press-pull enhancements and surface curve extraction.

AutoCAD 2013 for the Mac will also include model documentation capabilities, but users won't be able to create model views using the native Mac release. The new Mac version also gains PDF underlay capabilities, and shares the same DWG file format as AutoCAD 2013.

Autodesk is also putting more emphasis on suites, and those suites provide some pretty good deals. For example, in addition to AutoCAD itself, the AutoCAD Design Suite

Standard includes Sketchbook Designer, Showcase, Mudbox and AutoCAD Raster Design (a bundle worth \$8,225 if purchased separately) for just \$500 more than the cost of AutoCAD alone. The Professional suite adds 3ds Max Design to the mix (\$4,995, for the equivalent of \$11,720 worth of software), and the AutoCAD Design Suite Ultimate adds Alias Design as well (\$5,995 for a bundle that would cost \$15,715 if purchased separately). **DE**

**David Cohn** is the technical publishing manager at 4D Technologies. He also does consulting and technical writing from his home in Bellingham, WA. He's a contributing editor to Desktop Engineering and the author of more than a dozen books. You can contact him via email at [david@dscobn.com](mailto:david@dscobn.com) or visit his website at [DSCobn.com](http://DSCobn.com).

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### AutoCAD 2013

#### Price:

- Full system: \$3,995
- Annual subscription: \$450
- Upgrade from AutoCAD 2012: \$595
- Upgrade from AutoCAD 2011: \$1,195
- Upgrade from AutoCAD 2010: \$1,795

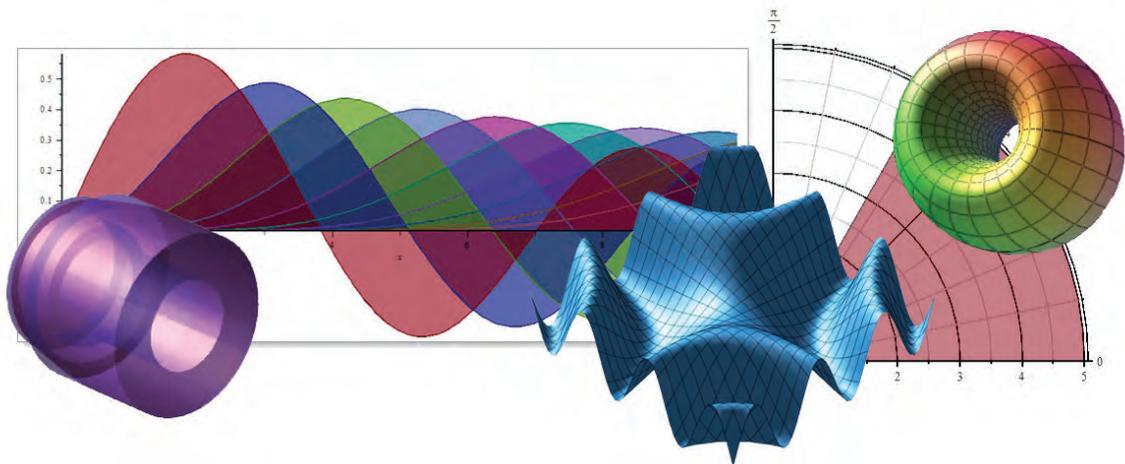
#### System Requirements

##### AutoCAD and AutoCAD LT for Windows

- **OS:** Windows 7 or Windows XP (SP3 or later); 64-bit or 32-bit
- **CPU:** Intel Pentium 4 or AMD Athlon dual-core 1.6GHz or greater (3.0GHz or greater recommended for Windows 7 or 3D modeling; AMD64 or Intel EM64T processor for 64-bit version)
- **Memory:** 2GB RAM, 4GB recommended (1GB for AutoCAD LT 32-bit; 2GB for LT 64-bit)
- **Disk space:** 6GB free disk space for installation (1.4GB for AutoCAD LT 32-bit, 4GB for AutoCAD LT 64-bit)
- **Video:** 1024x768 VGA with true color minimum (for 3D modeling: 1280x1024 with 128MB video RAM or greater, Pixel Shader 3.0 or greater, Microsoft Direct3D-capable workstation-class graphics card)
- **Other:** Microsoft Internet Explorer 7.0 or later

##### AutoCAD and AutoCAD LT for Mac:

- **OS:** Apple OS X v10.6.4 or later with 64-bit Intel processor
- **Hardware:** Apple Mac Pro 4.1 or later; MacBook Pro 5.1 or later (MacBook Pro 6.1 or later recommended); iMac 8.1 or later (iMac 11.1 or later recommended); Mac mini 3.1 or later (Mac mini 4.1 or later recommended); MacBook Air 2.1 or later; MacBook 5.1 or later (MacBook 7.1 or later recommended)
- **Memory:** 3GB of RAM (4 GB recommended)
- **Disk space:** 2.5GB free disk space for installation (3GB recommended)
- **Video:** All graphics cards on supported hardware; 1280x800 display with true color (1600x1200 with true color recommended)



# Maple 16 Makes Engineering Math Easier

Maple continues to evolve for learning and applying symbolic mathematics.

By **PET ER VARHOL**

**E**ngineering design can be supported either by formal mathematical analysis or by simulation in some way, such as Monte Carlo. If the forces involved aren't well understood, or if the math is complex, many turn to simulations—and often to over-engineering—to compensate.

For those whose engineering design efforts involve a fair amount of formal analysis, one of the leading symbolic mathematics engines available is Maple, a mature and capable solution now in its 16th major release (I have a copy of Maple 5 on my bookshelf from circa 1994). Maple helps engineering design efforts through its ability to define designs and forces through symbolic equations, and solve those equations. Maple also provides the ability to easily create graphs from equations that can help in visualizing different aspects of a design.

In this release, Maplesoft continues to work to broaden the base of potential Maple users, with features that shorten the learning curve and make it more accessible to a larger community, as well. These features make Maple more usable in general, and help engineers do more analysis prior to building simulations and prototypes.

The product includes several of these features under the umbrella of “Clickable Math,” a term that brings to mind using the mouse to click your way to a solution. Clickable Math includes

the ability to solve equations by dragging individual terms around on the screen, and the ability to use Smart Popups to look at results of individual parts of equations before solving the entire equation. Both approaches open up the realm of symbolic solutions to the simple click of a mouse button, rather than a complex analytical process.

## Working Together across the Cloud

MapleSoft 16 continues to encourage collaboration among distributed individuals and teams through the Maple cloud, an online repository and set of communities that exchanges Maple programs, lessons and assistance on analyses, irrespective of industry, geographical location or application. Users can also create ebooks from their Maple documents using the eBook Tools package—making it possible to package applications, graphs, plots, analyses and supporting documentation together into a PDF booklet.

Collaboration, especially across distributed teams using cloud services, is becoming the new normal of a lot of engineering projects. Maple is taking advantage of collaboration approaches to share information, applications and tools across distributed groups, and to facilitate learning by asking in the cloud.

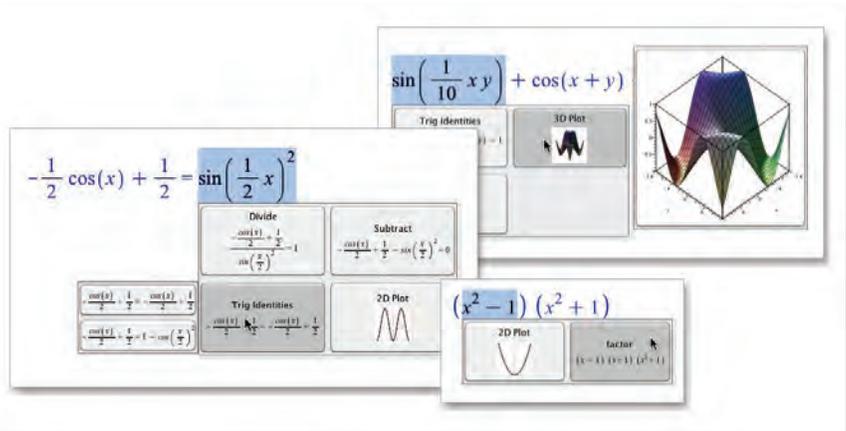
In addition to being a symbolic mathematics engine, Maple is also a programming language. Engineers can use a combina-

tion of symbolic equations and a simple instruction-based language to create mathematics programs that solve equations and inject them into larger-system designs and simulations. Engineers can write programs to analyze data, create plots, and do other solutions or computations if needed on a regular basis.

Many engineers don't have a large need for the programming aspect of Maple. Analyses primarily consist of single-use equations, although engineers may copy apps and other equations from analysis to analysis if they are required. But some will appreciate the ability to write and reuse programs with the ability to input data from external sources, and apply more complex sequences of solutions to engineering problems.

### All about the Math

Of course, Maple continues to excel at symbolic mathematics and computations in general. Even though much of Maple is built using the Maple programming language, it performs very well for most exploratory computations.



**In Maple 16, Smart Popups and Drag-to-Solve join other Clickable Math tools for the next phase in mathematics software usability.**

The ability to visualize data with plots has been improved with tools that enable engineers to easily zoom and focus on points of interest. The default graphs are also more lifelike and relevant to most projects, saving the time needed to customize a graph view. Also, Maple 16 offers live data plots, which display data distributions with a single button click. You can simply select the graph and manipulate the data and kind of graph you produce.



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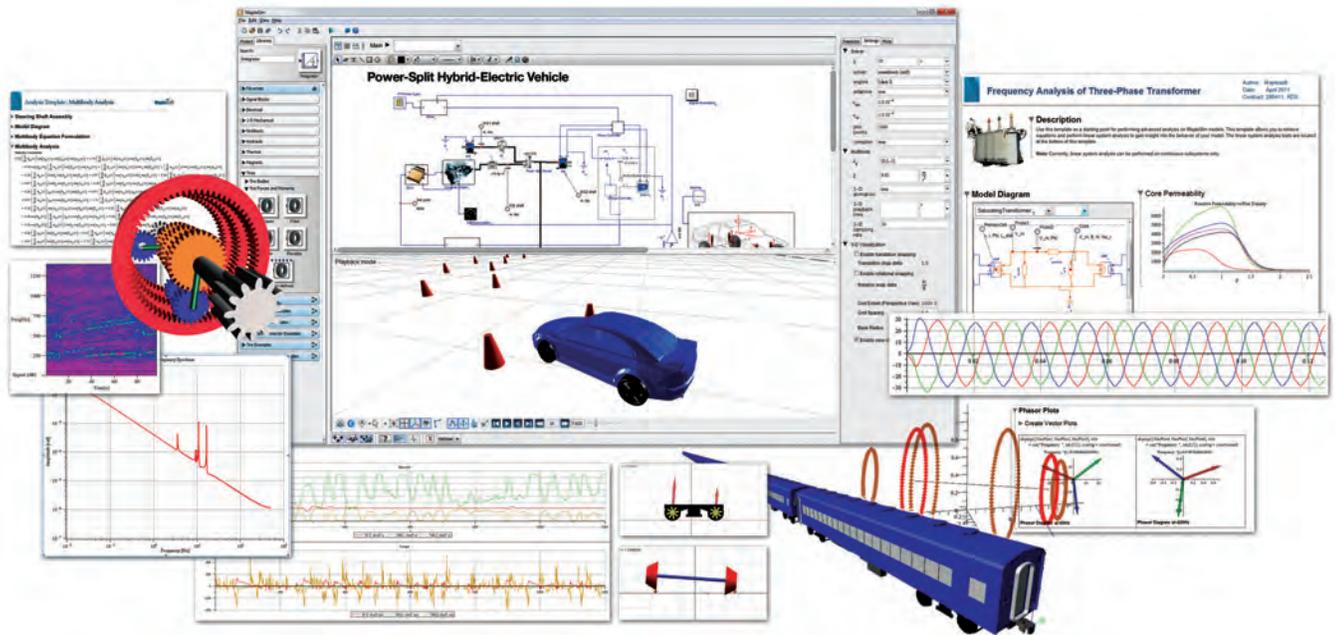
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Product information and online ordering at  
[www.tormach.com](http://www.tormach.com)



Combining Maple with MapleSim creates a solution to enable system modeling and simulation.

It includes about 100 new Math Apps, small applications written in the Maple programming language that can be used to illustrate specific approaches to different types of problems, or even reused almost in their entirety in user applications.

Analytical tools of this type no longer cut the mustard if they work in an entirely serial way, without the ability to take advantage of multiple cores. Maple 16 can make use of up to eight cores in addressing problems that can be solved in a parallel fashion. Granted, this doesn't apply to many symbolic solutions. But in computations that can be parallelized, Maple will take advantage of most or all of the cores on a typical workstation.

### Details, Details

I installed and ran Maple 16 on an HP Z600 workstation with dual Xeon processors and 12GB of memory. While this system is more than a year old, and was only a midrange system when new, the execution of equations using the product was smooth and fast. For most computations, less than a second passed between my requesting a solution and the solution appearing on the display.

Maple itself is a computation engine and symbolic solver. Combined with its companion product MapleSim, it is also a powerful way of enabling system modeling and simulation, including hardware-in-the-loop (HIL). There is also connectivity built in between Maple and engineering tools such as MATLAB, Simulink and CAD software. You can use Maple to drive CAD designs and provide input for MATLAB programs, making results more analytically accurate than they might otherwise be.

I've been using Maple on and off for a number of years. Maple 16 continues to refine efforts to make symbolic mathematics engines easier to use—and enjoyable to use to solve all types of symbolic equations. It does substantially more compu-

tations than it did a decade ago, and whenever I pick up a new version, it always seems easier to get back up to speed.

The question is whether substantially greater numbers of engineers can make effective use of a symbolic mathematics engine, no matter how easy it is. For a professional community like engineers, it's not so much a matter of ease of use as it is value of the tool. Many will see a significant value, however many of these types of features are more valuable in engineering and scientific education endeavors than in engineering practice.

What may grow its use among engineers is the ability to quickly solve more types of equations. Maple remains a great tool for engineers whose design work encompasses a moderate or large degree of symbolic or even numerical computations. It can also be creatively used in conjunction with other design tools such as CAD packages, MATLAB and modeling software to build a more complete design and simulation environment.

For engineers and other professionals who are regularly solving symbolic equations in producing designs, or for those who need to perform large numeric computations, Maple remains the standard for exploratory analysis. It has the ability to reach beyond initial design efforts, into modeling and simulation through interaction with other products. Maple 16 would be a great addition to the toolkits of design professionals who spend a lot of time in exploratory design. **DE**

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*Contributing Editor Peter Varhol covers the HPC and IT beat for DE. His expertise is software development, math systems, and systems management. You can reach him at [de-editors@deskeng.com](mailto:de-editors@deskeng.com).*

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# Wowing Them in Vegas

HP unveils its new Z-Series workstations.

BY DAVID COHN

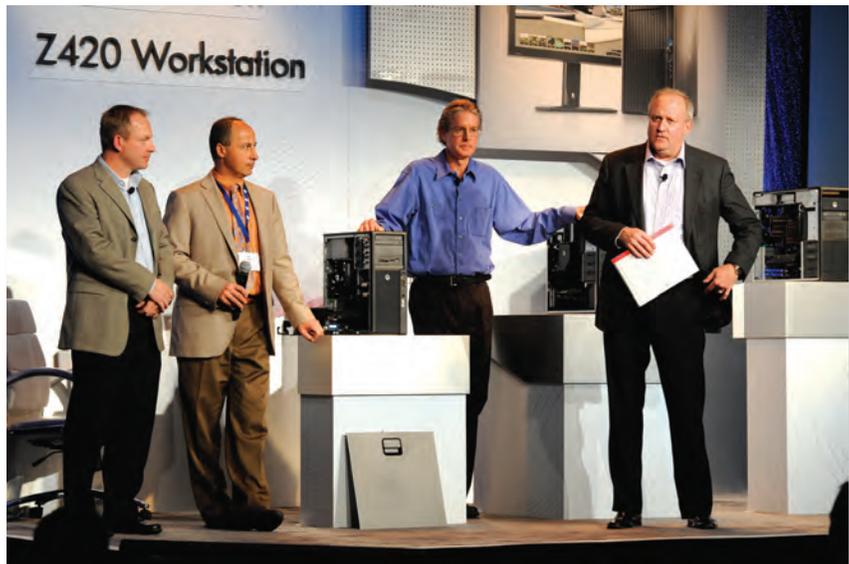
**H**P recently unveiled the latest updates to its Z-series workstations. *Desktop Engineering* was on hand for the company's launch event in Las Vegas, and was impressed by the newest members of the HP family. The new workstations feature the latest eight-core Intel Xeon processor E5-2600 product family, offer up to 512GB of DDR3 memory and are independent software vendor (ISV)-certified for the design, engineering and analysis applications upon which our readers depend.

The latest additions to the line of HP Z Workstation also feature third-generation PCI Express technology to provide increased performance with the newest generation of graphics cards. HP also unveiled what it calls the world's first all-in-one workstation with a 27-in. display. These new workstations join the HP Z210 entry-level workstation we recently reviewed (see *DE*, April 2011, page 38).

Like their predecessors, which remain available, all of the new HP Z-series workstations feature tool-less access. We got to spend some hands-on time with all four of the new workstations, and spoke at length with members of HP's senior product management team.

## HP Z420: Performance and Value

The new HP Z420 is aimed straight at the heart of mainstream CAD users. Housed in a convertible minitower that bears a strong resemblance to the rest of the Z-series, with distinctive vertical fins concealing its front-panel air intake, the Z420 provides a single CPU socket. Built around the new Intel C602 chipset, HP offers a choice of Intel Xeon E5-1600 and E5-2600 series processors with four, six or eight cores and base clock frequencies up to 3.6GHz.



*Desktop Engineering* was on hand in Las Vegas when HP unveiled the latest additions to its Z-series workstation lineup.

The motherboard provides three PCIe Gen3 slots (two x16 and one x8), and users have a choice of 11 different graphics cards (five from AMD and six from NVIDIA), including the high-end NVIDIA Quadro 5000. There are also two additional PCIe Gen2 slots (one x4 and one x2), as well as a single PCI slot. Depending on the configuration, the system can support up to six 3D or eight 2D displays.

Eight memory sockets enable the system to support up to 64GB of four-channel, 1600MHz ECC memory. The chassis provides three external 5.25-in. drive bays and three internal 3.5-in. drive bays. There are two integrated 6Gb/s SATA ports.

HP offers a range of storage options—including SAS, SATA and solid-state drives—for up to 11TB of internal storage. There are also lots of USB ports, including two front USB 3.0 ports and two more in the rear. The HP Z420 comes with a 600 watt, 90% efficient power supply. Prices start at \$1,169.

## HP Z620: Compact Power

With the new Z620, HP takes a system that had formerly been marketed primarily into the financial market and broadens its focus to also include midrange CAD. The system has been updated to support both single- and dual-socket processors. Like the Z420, HP offers the same choice of Intel Xeon E5-1600 and E5-2600 series processors, but customers can configure systems with up to 16 CPU cores.

The Z620 motherboard provides 12 memory sockets, enabling the system to support up to 96GB of four-channel, 1600MHz ECC memory. It also matches the expansion port capabilities of the Z420—and again, HP offers a choice of 11 different graphics cards. But here, the top choice is the NVIDIA Quadro 6000 with 6GB of discrete graphics memory. An optional NVIDIA Tesla C2075 is also available for high-performance computing. The HP Z620 can support up to eight 3D or 2D displays.



The HP Z420 is targeted to deliver workstation performance at an affordable price point.



The HP Z620 provides an affordable dual-socket solution in a compact package.



The HP Z820 is HP's ultimate workstation, providing a wealth of expansion capabilities.

## HP Z-series 2012 Workstation Family

	HP Z210	HP Z420	HP Z620	HP Z820	HP Z1
Starting Price	\$645	\$1,169	\$1,649	\$2,299	\$1,899
Form Factor	Convertible minitower	Convertible minitower	Narrow minitower	Standard minitower	All-in-one
Processor	Intel Core i3/i5/i7 and Intel Xeon Processor E3-1200 Series	Intel Xeon Processor E5-1600 and E5-2600 Series	Intel Xeon Processor E5-1600 and E5-2600 Series	Intel Xeon Processor E5-2600 Series	Intel Core i3 and Intel Xeon Processor E3-1200 Series
ECC memory (max)	32GB	64GB	96GB	512GB	32GB
Internal Storage	4.5TB	11TB	11TB	14TB	2TB
Displays	3 3D or 4 2D	6 3D or 8 2D	8 3D or 8 2D	8 3D or 8 2D, NVIDIA SLI	2 3D
Graphics	Up to NVIDIA Quadro 2000	Up to NVIDIA Quadro 5000	Up to NVIDIA Quadro 6000	Up to Dual NVIDIA Quadro 6000	Up to NVIDIA Quadro 4000M
Bays	3 external 5.25" 3 internal 3.5" HDD	3 external 5.25" 3 internal 3.5" HDD	2 external 5.25" 3 internal 3.5" HDD	3 external 5.25" 4 internal 3.5" Up to 8 external SAS	2 internal 2.5" or 1 internal 3.5" 1 external 5.25"
Slots	1 PCIe Gen2 x16, 2 PCIe Gen2 x4, 2 PCIe Gen2 x1, 2 PCI	2 PCIe Gen3 x16, 1 PCIe Gen3 x8, 1 PCIe Gen2 x4, 1 PCIe Gen2 x1, 1 PCI	2 PCIe Gen3 x16, 1 PCIe Gen3 x8, 1 PCIe Gen2 x4, 1 PCIe Gen2 x1, 1 PCI	2 PCIe Gen3 x16, 1 PCIe Gen3 x8, 1 PCIe Gen3 x4, 1 PCIe Gen2 x4, 1 PCI	3 mini PCIe Gen2 x1, 1 PCIe Gen2 x16 MXM
Power Supply	89% efficient	600W, 90% efficient	800W, 90% efficient	850W 88% 1125W 90% efficient	90% efficient
ENERGY STAR	Yes	Yes	Yes	Yes	Yes

Designed to fit into tight spaces, the narrow minitower with integrated handles provides two external 5.25-in. drive bays, while still offering space for three, modular, direct-connect 3.5-in. internal drives. The Z620 includes two integrated 6Gb/s SATA ports, and the same broad selection of drives to accommodate up to 11TB of internal storage.

The system also provides four USB 3.0 ports (two front, two rear) and includes dual Intel LAN on motherboard (LOM) ports with Intel vPro Technology. An 800-watt, 90% efficient power

supply supports all of the system's energy needs. Prices start at \$1,649.

### HP Z820: High-End Performance

HP expands upon its successful Z800 with the launch of its new Z820. Aimed at MCAD and demanding engineering applications, the system is available with one or two Intel Xeon E5-2600 series processors for up to 16 CPU cores.

The Z820 comes housed in a minitower case equipped with numerous modular components, including the same cutting-edge modular power sup-

ply design first introduced in the Z800 (see *DE*, January 2010). To accommodate increased energy needs, the Z820 is available with a choice of 850-watt/88%- or 1125-watt/90%-efficient power supplies.

A total of 16 memory sockets enables the Z820 to be equipped with up to 512GB of RAM and it supports 1600MHz DDR3 ECC memory. Here again, HP offers a choice of 11 different graphics cards—but this time, with support for up to 300 watts of graphics, the system can accommodate dual NVIDIA Quadro 6000 cards. The Z820 also sup-



The new HP Z1 all-in-one workstation design doesn't compromise performance or configurability.

ports NVIDIA SLI. HP offers up to two optional NVIDIA Tesla C2075 HPC cards. Depending on the configuration, the HP Z820 can support up to eight 3D or 2D displays.

The motherboard includes seven expansion slots, but here they consist of three PCIe Gen3 x16 slots as well as a PCIe Gen 3 x8, PCIe Gen3 x4, PCIe Gen2 x4 and PCI. Like the Z620, the Z820 comes with dual Intel LOM ports with Intel vPro Technology.

Like its predecessor, the Z820 case includes integrated handles and lots of space for drives, including three external 5.25-in. bays and four internal 3.5-in. bays. It includes six integrated SATA ports (two at 6Gb/s and four at half that speed), as well as eight integrated 6Gb/s SAS ports. Customers have a choice of drives for up to 14TB of total internal storage, as well as up to eight external SAS drives. Prices start at \$2,299.

### HP Z1: Power Without the Tower

While the flagship Z820 commanded a lot of attention at its Las Vegas premiere, the HP Z1 stole the show. The all-in-one Z1 combines a sleek industrial design with workstation performance in a package that consists of little more than a display and keyboard. But the display snaps open to let you swap out parts and make upgrades—no tools required. And packed inside the display, users have a choice of dual- or quad-core Intel Core i3 or Intel Xeon E3-1200 series proces-

sors, and either Intel HD graphics or one of four NVIDIA Quadro graphics cards, including the Quadro 4000M.

The 27-in.-diagonal 2560x1400-pixel display supports more than 1 billion colors and has a 178° viewing angle; the Z1 can also power a second monitor. The stand lets you adjust the display height and tilt the panel forward and back. There are also either two internal 2.5-in. drive bays or a single internal 3.5-in. bay, as well as an external 5.25-in. bay that comes with a slot-load 8X DVD+/-RW drive or an optional slot-load Blu-ray disc writer. HP offers a variety of storage types, including SATA, solid-state drive (SSD) and redundant array of independent disks (RAID) configurations. Four memory sockets support up to 32GB of extended error correction (ECC) memory.

The Z1 is also equipped with front-facing, dual-cone speakers, plus an HD webcam. Expansion slots include three mini PCIe Gen2 x1 slots, and one PCIe Gen2 x16 MXM slot. A wireless keyboard and mouse come standard.

“With its game-changing design and an experience that optimizes visual and computing performance, the HP Z1 will help attract new customers and expand our market leadership,” says Jim Zafarana, vice president and general manager of HP’s Commercial Solutions Business Unit.

We were certainly impressed. With prices starting at \$1,899, the Z1 will likely find a home on many a designer’s desk. **DE**

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

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# Tablets in DAQ

In the quest for ever-smaller data acquisition systems, tablet computers bring a great appeal.

**BY PETER ANDERSON**

**D**esktop personal computers gave engineers the power to create custom test-and-measurement applications. Laptop computers gave engineers the ability to create smaller and more portable data acquisition (DAQ) systems. Are tablet computers the natural evolution of this trend?

While the penetration of tablets still lags that of traditional PCs, their growth rate has been phenomenal. According to Pew Research, 57% of adults own a desktop computer and 56% of adults own a laptop computer. However, tablet ownership climbed from 8% in May 2011 to 19% in January 2012.

The growth in tablets, however, has not yet substantially penetrated the engineering lab. Because both desktop and laptop platforms shared much of the same infrastructure the move from desktop computer to laptop was relatively seamless. Tablets, on the other hand, support different programming languages, run under different operating systems and have less processing power and connectivity options than their PC counterparts.

There are two other drawbacks to consider:

- The top two programming languages for custom DAQ applications, C# and LabVIEW, are not supported in either Android or iOS.
- USB, a common DAQ bus, is found on only a small subset of tablets on the market today.

Because of these technical discontinuities, moving to a tablet requires special attention to how systems and applications are put together. With limited battery capacity and lack of

processing power, the tablet offers a less-forgiving environment for DAQ application developers, and requires a deeper understanding of how the program and the OS interact.

## Tablet Apps

There are a few test-and-measurement apps on the market, though, including Oscium's iMSO-104, a 5MHz bandwidth, mixed-signal oscilloscope. The iMSO-104 oscilloscope supports one analog and four digital signals, and offers 12MSPS sampling. Its circuitry connects to the dock connector port, and uses the iPad, iPod Touch or iPhone as the display and user interface.

Another app is National Instruments' Data Dashboard Mobile. The Data Dashboard, which runs on both iOS and Android, allows users to create custom and portable views of National Instruments' LabVIEW applications by displaying the values of network-published shared variables and/or web services on charts, gauges, text indicators and LEDs. While not taking data directly, the Data Dashboard does provide access to real-time test data on a tablet.

The Oscium and National Instruments apps provide a useful start to bringing tablets into the lab, but neither of them let users build custom DAQ apps like they have for years on desktops and laptops.

The ability to create custom applications that fit a particular industry need catapulted the PC into the test-and-measurement arena. If the tablet is going to significantly break into this market, users will need to be able to create custom applications for this platform as well.

There are three main differences in creating a DAQ application on a tablet vs. creating one on a PC:

1. **Hardware connectivity.** PCs were designed to easily add peripherals, either with internal or external buses. The controlled environment of a tablet has far fewer options for connecting peripherals. Wi-Fi and Bluetooth are two communication methods that most tablets support, and the Apple iPad includes a proprietary dock connector port. However, connectivity to existing DAQ devices is a challenge for tablet applications.

A survey of the DAQ market shows few options that offer Wi-Fi, Bluetooth or the Apple dock connector port. The communication method that offers the most options—both in tablets and DAQ devices—is USB. A limited number of Android tablets support USB host mode and offer a respectable DAQ platform.

## Getting Started

If you are interested in creating your own DAQ application on a tablet, you will need to download the required tools and the software development kits (SDKs). Android development can be done on a Mac, Windows or Linux machine, while iOS development requires a Mac.

- To download the Android tools, visit [developer.android.com/sdk/index.html](http://developer.android.com/sdk/index.html).
- To download the iOS tools, visit [developer.apple.com/ipad/sdk](http://developer.apple.com/ipad/sdk).
- To download the Measurement Computing example program for Android, visit [mccdaq.com/android](http://mccdaq.com/android).



As the application space for tablets in test and measurement grows, though, more devices supporting Bluetooth, Wi-Fi and Wi-Fi Direct will become available.

2. Program language/structure support. Most PC-based DAQ programs are written in LabVIEW or C#; however, tablets support neither of these programming languages. Programming in Android is done in Java, while programming in iOS is done in Objective C. Both are object-oriented languages that are similar to C++ and C#.

Unlike PCs, where languages like LabVIEW or DASyLab allow novice users to create custom applications, tablets require expertise in object-oriented programming. This means that tablet app development is really the domain of those with a strong background in programming.

Beside the language difference, programming a DAQ application on a tablet is significantly different than programming a DAQ application on a PC. Tablets have limited memory and processor speeds, so they cannot handle having many programs running at once. Instead of letting programmers manage when an application closes (as a desktop OS would do), the tablet OS—either Android or iOS—decides when to close them. This is why you do not typically see a “close” button on a tablet application.

3. Device driver availability. Device drivers offer a high-level way to easily

and reliably execute DAQ board functionality. Device drivers are components of DAQ systems that many take for granted, because these drivers are usually supplied free with the DAQ hardware. While most DAQ companies provide drivers for Windows, no major company at this time offers DAQ drivers for tablet OSs. Without the device driver or intricate knowledge of the device, interfacing with a DAQ device from a tablet is futile.

Measurement Computing has a solution for this, though, with its DAQFlex-supported collection of USB DAQ devices. Unlike most DAQ devices, which interface to the computer via low-level commands, DAQFlex devices interface with simple text messages.

For instance, to read a channel from a DAQFlex device, a programmer would send (“?AI{“ channel”};VALUE”) over a USB Control Transfer and read the response from the device with another control transfer.

DAQFlex-supported devices contain an internal device engine (see Figure 1), which consists of the “Message Engine” and “DAQ Engine.” Once received, these messages are parsed and converted to instructions and sent to the DAQ Engine. The DAQ Engine then configures the device, performs the operations, and returns the data to the Message Engine, which in turn sends the data to the host when requested.

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## Application Lifecycle: Android OS

**T**he application lifecycle is an important concept to understand when programming tablet devices. To understand application lifecycle, let's look at the Android OS.

Android defines four program components, and we will focus on two: "activities" and "services." An activity represents a single screen with a user interface, which may be closed at any time. A service is a component that, when set to foreground mode, can run without interruption to perform long-running operations.

Activities are managed in a stack. When a new activity is started, it is placed on the top of the stack and becomes the running activity—while the previous activity always remains below it in the stack. This activity will not come to the foreground again until the new activity exits.

### An activity has essentially three states:

1. If an activity in the foreground of the screen (at the top of the stack), it is active or running.
2. If an activity has lost focus, but is still visible (that is, a new non-full-sized or transparent activity has focus on top of your activity), it is paused. A paused activity is completely alive (it maintains all state and member information, and remains attached to the window manager), but can be killed by the system in extreme low-memory situations.
3. If an activity is completely obscured by another activity, it is stopped. It still retains all state and member information; however, it is no longer visible to the user, so its window is hidden. It will often be killed by the system when memory is needed elsewhere.

If an activity is paused or stopped, the system can drop the activity from memory by either asking it to finish, or simply killing its process. In essence, if an application is not in the foreground, it has the potential of being killed by the OS. Imagine this happening during a critical data collection operation!

One way around this uncertainty is to use services—an application component that can perform long-running operations in the background. An activity has no control over when it is considered in the foreground or in the background. By contrast, a service can be manually set to run in the foreground, minimizing the chance that it will be closed. An activity can start a service and have it continue running, even if the user switches to another application.

For example, a service might handle network transactions, play music, perform file I/O or collect data from a DAQ device, all running without interruption of another activity coming into the foreground. While services can also be killed by the OS, it is far less likely, and only in states of low memory or low power.

Sources: *The author and Developer.Android.com*

A growing number of measurement computing devices support DAQFlex:

Device/Series	Description	Available
USB-1608G Series	16-bit multifunction DAQ	Now
USB-2408 Series	24-bit multifunction temperature and voltage	Now
USB-7000 Series	12- and 16-bit multifunction DAQ in OEM packaging	Now
USB-2001-TC	20-bit single-channel thermocouple	Now
USB-1608FS	16-bit simultaneous sampling multifunction DAQ	Q2 2012
USB-1208FS	12-bit multifunction DAQ	Q3 2012

Users can create their own simple drivers for any OS using the DAQFlex message-based protocol. Open-source drivers are available for Linux, Mac and Windows.

### Sample Program Available

One way to learn how to program for tablets is to look at an example. Dave Fraska, an application engineer at Measurement Computing, has put together an example program for Android tablets that reads temperature data from the Measurement Computing USB-2001-TC thermocouple measurement device, which supports DAQFlex, displays the data on a chart, and saves it to local memory. It has three main parts:

1. A simple device driver for communicating with the USB-2001-TC. This driver has two main, low-level methods that send and receive messages through USB control transfers. Because multiple devices share this DAQFlex protocol, the programming will be similar for all DAQFlex devices.
2. An acquisition service for collecting and saving data. The background service interfaces to the driver, controlling when the data is captured and saving the data to memory. This service is not tied to the activity lifecycle, and runs until the application/activity stops it or the tablet powers down.
3. A charting activity for requesting data from the acquisition service and charting it to the user interface. The application requests data from the acquisition service and plots it on a strip chart. It uses an open source chart ([www.AchartEngine.org](http://www.AchartEngine.org)).

This application program shows that data acquisition on a tablet device with a standard off-the-shelf DAQ device is possible—with the right driver support, an understanding of the platform limitations, and a good knowledge of object-oriented programming. **DE**

**Peter Anderson** is general manager of Measurement Computing.



**INFO** → Measurement Computing: [MCCdaq.com](http://MCCdaq.com)

→ National Instruments: [NI.com](http://NI.com)

→ Oscium: [Oscium.com](http://Oscium.com)



1

### 1 Nikon Announces MCT225 Metrology CT System

Nikon Metrology's ([nikonmetrology.com](http://nikonmetrology.com)) new Metrology CT system, MCT225, provides Metrology CT for a range of sample sizes and material densities with 9+ L/50 µm accuracy in accordance with the VDI/VDE 2630 guideline. All internal and external geometry is measured in a single non-destructive process. A full 3D visualization of the sample volume additionally provides insights into part deformations and internal structural integrity. According to the company, a key component of the MCT225 system is the in-house developed Nikon Metrology 225 kV micro-focus X-ray source. It produces sharp images with low noise levels, enabling magnification levels up to 150x with 2 µm feature detection

### FieldLogger Software Updated

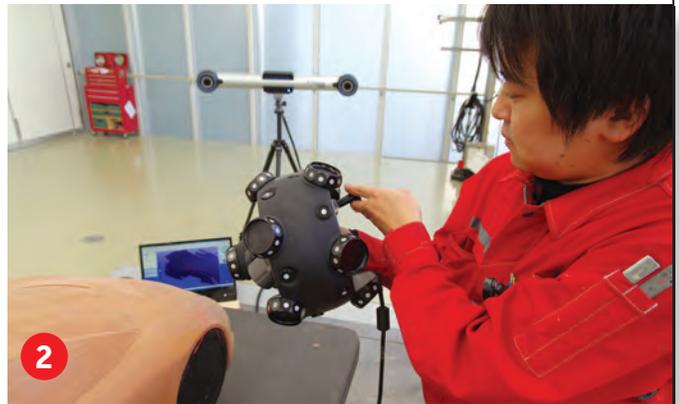
CAS DataLoggers ([dataloggerinc.com](http://dataloggerinc.com)) and Novus Automation have announced the latest software upgrade to Novus FieldLoggers. Version 1.2.2 improves the export speed of all downloaded data and also chart viewing. Modbus-TCP communication has also been enhanced, lowering instances of communication errors. Resolved issues include fixing of certain string translations, corrections made on the Diagnostics screen, and other user-suggested changes.

### Tektronix Enhances OM4000 Optical Analyzer

Tektronix ([tektronix.com](http://tektronix.com)) announced that its OM4000 Series Optical Modulation Analyzer can now drive the DSA8300 Digital Sampling Oscilloscope to perform analysis on PM-QPSK, QAM, and other complex-modulation signals with higher vertical resolution than real-time based solutions at a lower total system cost. According to the company, the OM4000 paired with the DSA8300 is ideal for network equipment manufacturers and designers who require higher vertical resolution than what can be accomplished with real-time oscilloscopes.

### 2 Enhanced MetraSCAN 3D Optical CMM Scanners

Creafom ([creafom3d.com](http://creafom3d.com)) has unveiled its new line-up of MetraSCAN 3D optical CMM scanners for quality control



2

and reverse engineering applications. The combination of a MetraSCAN 3D CMM scanner and a HandyPROBE arm-free CMM creates a complete measurement system for points and surfaces, and enables geometrical and freeform inspection on the same part, with the same system. The new MetraSCAN 3D handheld scanners are now offered in two versions. The MetraSCAN 70 offers optimal resolution. The MetraSCAN 210 offers increased measurement speed. Its increased stand-off and depth of field make for enhanced scanning flexibility for large surface metrology and large-scale reverse engineering. **DE**

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# Opting for Optimizing

Find out how this powerful concept can rev up your analysis tools.

BY PAMELA J. WATERMAN

In part 1 of this article (see page 42 of the May 2012 issue), we discussed how optimization helps engineers take their designs to the next level by systematically finding design alternatives. We looked at optimization tools from VR&D, SIMULIA, Red Cedar Technology, and Collier Research. This month, we continue the discussion by examining solutions from Altair, Sigma Technology, ESTECO, Phoenix Integration, Optimal Solutions Software and Openeering.

## From Weight Reduction to High-Level Optimization

Altair Engineering's Hyperworks division has been developing optimization tools since 1994, to such an extent that it now has one of the world's largest organizations addressing various aspects of the subject. The company offers two software choices that help make optimization tasks an integral part of a complete design process — Altair OptiStruct and Altair HyperStudy — as well as several engineering services.

Altair OptiStruct is a finite-element-based package with an internal solver that uses a gradient-based topology approach to developing lightweight, structurally efficient designs. Given input for size requirements, targeted design parameters and manufacturing process parameters, OptiStruct helps users generate feasible,

manufacturable products. Advanced capabilities include optimizing laminate composite ply-up sequences, incorporating multidisciplinary responses (e.g., buckling or heat transfer), and dealing with multi-body dynamic systems. The latter task is handled via the company's own Equivalent Static Load Method (ESLM).

Altair HyperStudy applies the concepts of design optimization to a range of tasks — from product weight reduction and design of experiments to multidisciplinary studies and stochastic investigations of reliability/robustness factors. HyperStudy is a solver-neutral optimization package with direct interfaces to dozens of popular solvers such as Abaqus, ANSYS, Fluent, LS-DYNA, MARC, Matlab/Simulink, NASTRAN and StarCD. Users can tap an API tool to bring in external related algorithms, while post-processing and data-mining tools help users sort and analyze results.

Another Altair division, the global ProductDesign group, is dedicated to offering client and online resources that include “useful, informative and inspirational content concerned with minimizing the weight of products across industry.” As part of highlighting advances in lightweight design techniques, materials technology and manufacturing processes, the group offers the latest in relevant news at its Enlighten Knowledge Center blog.

## Optimization Options Worldwide

Optimization, as with all aspects of engineering design, is clearly a global subject. Two other significant contributors to this field are Sigma Technology of Moscow and ESTECO of Trieste, Italy. Both have US distributors and years of US applications; they share dozens of case-study experiences on their websites.

For more than 25 years, Sigma Technology has worked to integrate mathematical models, engineering prototypes and exploration methods inside an environment of unified optimization. The result has been an innovative new generation of multidimensional, nonlinear optimization technology termed “indirect optimization based on self-organization (IOSO).” This statistical approach solves practical engineering tasks with non-convex, non-differentiable and stochastic objective functions.

The critical aspect to this approach is the search of optimums in each iteration as two steps:

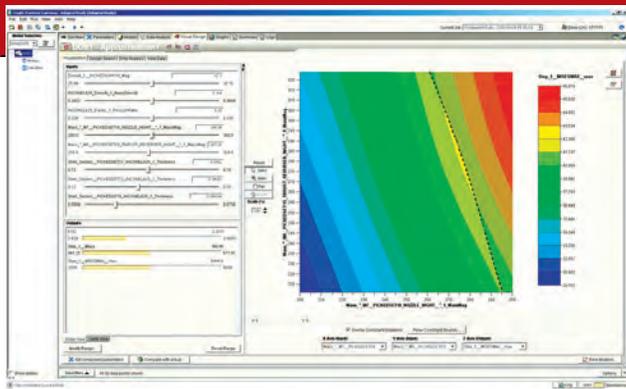
1. constructing the functions that approximate the objective functions in some region; and then
2. searching for extremum of these functions.

Key to IOSO's success is its ability to handle tasks involving 100 independent design variables and up to 100 constraints. Its multidisciplinary, multi-objective approach can determine the

## Principles of Design Optimization

Red Cedar Technology, developer of HEEDS MDO optimization software, offers the following principles as driving the development and application of MDO.

1. Start with a good concept, not necessarily a good design. Let the optimizer do the work of searching for good designs.
2. Optimize early and often—not just at the end of the design cycle or after all other means have been exhausted.
3. Define the design problem you need to solve, not the one that can be solved by a certain optimization strategy.
4. Optimize system interactions, not just components.
5. Let the optimization algorithm figure out how to search the design space. There's often no way to guess which search method and tuning parameters will work out best.
6. Don't perform optimization using models of models. Response surface or surrogates can increase effort and error.
7. Be an engaged participant in the optimization search. Leverage your knowledge and intuition during a collaborative search process.
8. Care about the sensitivities of your final design, not those of your initial guess.



With Isight optimization software, users can employ graphic “sliders” to see, in real time, the combined effects of changing up to eight individual design variables at once. Here the (Factor of Safety > 2) constraint is overlaid (shaded area) on the predicted value of maximum von Mises stress. *Image courtesy of SIMULIA.*

optimal practical solution that could be implemented with high probability for the given production technology level. The software achieves major processing speed-ups through the use of parallel optimization algorithms, and offers direct integration to FLOW-3D, ANSYS Workbench, FlowVision, Concepts NREC, SolidWorks and Excel.

ESTECO is the developer of modeFRONTIER optimization software. The package offers multi-objective optimization techniques that overcome traditional simplification problems by keeping objectives separate during the optimization process. The company points out that in cases with opposing objectives (minimize a beam’s weight and its deformation under load, for example), frequently there will be no single optimum because any solution will be a compromise. The role of the optimization algorithm, then, is to identify the solutions that lie on the trade-off curve known as the Pareto Frontier, named after the Italian-French economist Vilfredo Pareto.

Through its multi-objective robust design optimization (MORDO) module, modeFRONTIER also helps users perform a design analysis to check on a system’s sensitivity to manufacturing tolerances or small changes in operating conditions. ESTECO has a number of strategic business partnerships with such companies as CD-Adapco, ANSYS, Siemens and SolidWorks.

### Take the Next Step Toward Improvement

Once you’ve investigated the general benefits of optimization software, you’ll find even more software options to consider. Check out PHXModelCenter MDO software from Phoenix Integration; Optimizer and Sculptor Core from Optimal Solutions Software; and the open-source SciLab, used by Openeering to create a multi-objective optimizer. Different approaches, application focal areas and price points across the marketplace mean that there’s bound to be a solution that works for your needs.

Structural (FEA) optimization is a mature, robust technology, useful with many applications. Multidisciplinary optimization has shown itself to be a powerful tool for saving time and

## Optimization Web Resources

- Altair ProductDesign: Enlighten resource for product weight reduction: [enlighten.altairproductdesign.com](http://enlighten.altairproductdesign.com)
- SIMULIA Isight: Design Exploration and Quality Engineering Methods: [3DS.com/products/simulia/resource-center/webinars-on-demand](http://3DS.com/products/simulia/resource-center/webinars-on-demand) (click on Isight)
- Red Cedar Technology: HEEDS MDO Optimization and the Sherpa Method: [Youtube.com/watch?v=qIT-Cgvksg&feature=channel](http://Youtube.com/watch?v=qIT-Cgvksg&feature=channel)
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- Vanderplaats Research & Development: Fifty Years of Structural Synthesis: [VRand.com/sites/default/files/pub/Webinar2011.pps](http://VRand.com/sites/default/files/pub/Webinar2011.pps)

money. As an example of time saved with Red Cedar Technology software, Ryan notes that previously one customer spent 12 man-weeks manually investigating a military product design using DOEs and response surfaces, but could not find even one feasible solution. The customer then requested 250 evaluations using HEEDS MDO software; after just three days and 200 simulations, HEEDS already had found 63 possible designs that met all design requirements—and identified one with a very high performance/cost ratio.

Today’s computing power and memory capabilities are making this progress possible, so that highly detailed designs don’t have to be simplified to be evaluated. As Collier says, “This is the decade of optimization.” **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](mailto:de-editors@deskeng.com).*

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→ SIMULIA: [SIMULIA.com](http://SIMULIA.com)

→ Vanderplaats Research & Development: [VRand.com](http://VRand.com)

# Improve ROI of CAD Tools

A new Aberdeen study identifies the design efficiencies that organizations can gain by using the right CAD technologies.

BY MICHELLE BOUCHER

**G**rowing complexity, combined with pressures to get competitive products to market more quickly, is prompting organizations to take a closer look at how work is done in CAD. Advanced CAD capabilities frequently help reduce mundane tasks and increase agility in the design process.

To this end, “Top CAD Tips for Designing Today’s Complex Products: What Are the Right Tools for the Job,” a new study from the Aberdeen Group, reveals that the need to improve engineering productivity is a top factor driving organizations to evaluate their CAD solutions. In some cases, this means making a change to their primary CAD tool.

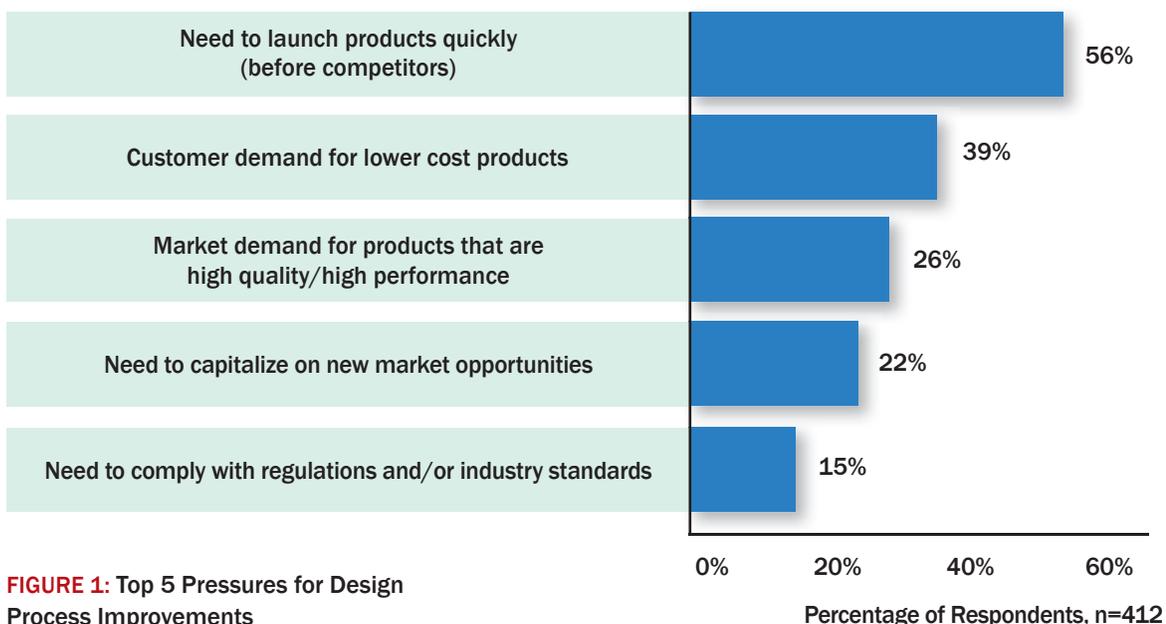
Aberdeen’s research indicates that taking advantage of the right CAD technology results in improved design efficiency—including, on average, a 14% reduction in development time since implementing their current CAD environment. The most successful achieve about twice that improvement. However, organizations that do decide to switch CAD vendors and blindly pursue change for change’s sake without taking the time to adequately support their CAD tool, risk seeing marginal, if any, improvement.

## Pressures and Obstacles Drive Change

As the economy continues its slow recovery, the new products companies develop are critical to growing profitably. Releasing products that successfully capitalize on available market opportunities requires a nimble and responsive design process. In this vein, Aberdeen’s research identifies a need to launch products ahead of competitors while meeting demand for low-cost, high-performance products as the top factors currently driving organizations to improve their design processes. (See figure 1.)

A requirement of the design process is the delicate dance of balancing conflicting customer demands with the constraints of a competitive release schedule. Attaining this balance requires a streamlined workflow—and the flexibility to quickly evaluate different design alternatives to make cost and quality trade-off decisions. While difficult enough on its own, a host of design challenges affect organizations’ ability to achieve this balance.

The organizations participating in Aberdeen’s study reported their top design challenges. The central theme emerging from their answers indicates the critical obstacles created by changing design requirements and a lack of engineering resources.



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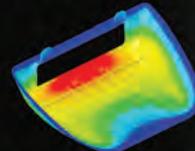
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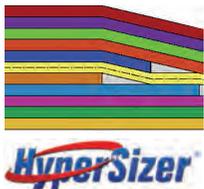


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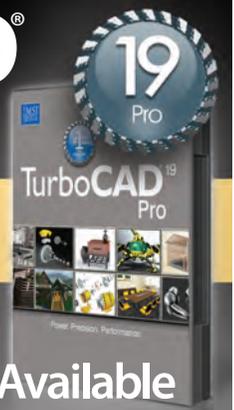
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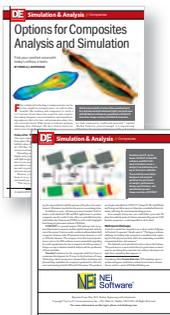
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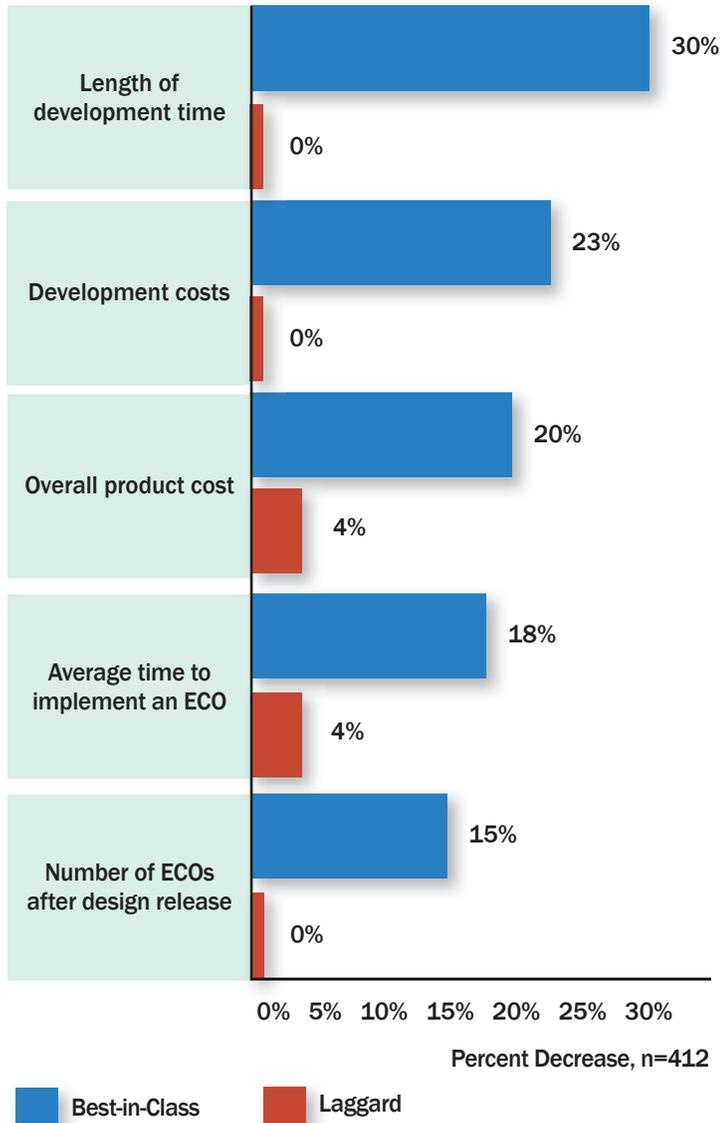
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**FIGURE 2: Design Process Improvements of the Best-in-Class and Laggards**

The top challenge, reported by 39% of study participants, is frequent design changes. Invariably, designs will be changed as a result of shifts in product requirements (reported by 34% of respondents). However, engineering change orders (ECOs) can also result from poor insight into how parts or assemblies interact, or problems with the manufacturability of the product. Frequent changes to design requirements and ECOs impede the design process as engineers abandon new work and search for ways to fix existing designs or accommodate new needs. The later these changes occur in the design process, the more difficult and taxing it can be to address these needs (reported by 19% of respondents).

The next two challenges further limit the ability to execute on product objectives:

**1. Insufficient engineering resources:** Workforce reductions, staff departure, and a short crop of new engineering talent have resulted in thin engineering staff resources (cited by 29% of respondents).

**2. Increased complexity:** Product complexity has expanded in all sectors (25% of respondents). Assemblies have become larger and include a greater number of components. Similarly, many companies have expanded the number of configurations involved in any product line.

The combination of these two challenges puts considerable pressure on engineers to maintain high levels of productivity—while simultaneously tackling more difficult design work.

This is where CAD, particularly the advanced features that have been released by vendors in recent years, can provide much needed support.

### CAD to the Rescue

Companies should look at the latest advancements in CAD to help manage design complexity, as well as modeling technologies that offer the flexibility to efficiently make changes to the CAD model. Technologies that also make it easier to reuse CAD models will save time and put less strain on limited engineering resources. Even improved functionality, such as embedded configuration rules that automate the creation of standard features, can make a significant impact on the speed and efficacy of product development by removing redundant work and unnecessary rework from the design process.

In addition, synchronization of model data across distributed locations improves collaboration and makes it easier to take advantage of distributed resources to further improve efficiency. As a result, organizations that successfully employ this functionality are better prepared to take advantage of market opportunities.

For some organizations, taking advantage of the latest CAD developments focused on improving productivity may require a change in an organization's primary CAD solution. The most frequent reason companies make a switch in their CAD tools is access to new functionality. Following shortly behind, participants indicated that they changed tools to improve design productivity (44%). Other top concerns include the migration to a 3D application, ease of use of the solution, and software quality.

### Improvements Reap Rewards

Investments in CAD consistently return significant benefits to the design efficiency. Study participants reported an average reduction in development time of 14% since their most recent CAD implementation. They further reported 11% reductions in

development cost and overall development costs. Since their most recent CAD implementations, these organizations have reduced ECOs by 8%—and the time required to execute an ECO by 9%.

Of course, this does not mean that organizations can simply swap in new CAD and expect dramatic changes to their design process. The poorest-performing organizations (“Laggards”) isolated by Aberdeen saw no change in development time or development cost after their last CAD implementation. (See figure 2.) These organizations did see some improvement in product costs and the time required to execute ECOs (4% reduction in both), but this is less than half the average improvement experienced by all organizations. While this is marginal improvement, the loss suffered on the implementation makes it difficult to justify further expansions in an organization’s toolset.

By contrast, organizations that see the most benefit from their CAD tools take advantage of the right support processes and capabilities. Top performers (“Best-in-Class”) report exceptional improvements that reach well beyond the average. These organizations have reduced development time by 30%, product costs by 20%, development costs by 23%, ECOs by 15%, and the time required to execute ECOs by 18%. This is roughly twice the improvement experienced by all participants.

### Key Takeaways

For many organizations, a change in CAD tools will permit access to new functionality that has a significant impact on engineering productivity. Organizations that implement and support the CAD capabilities that best support their design processes can expect to see performance improvements on par with the Best-in-Class. Organizations that fail to take advantage of these tools

effectively are less likely to see real change in their processes.

It is imperative to assess your own needs and identify the CAD functionality that best supports them. Organizations that implement the functionality that best provides for the needs of their design processes will see more substantial improvements. Aberdeen Group’s “Top CAD Tips for Designing Today’s Complex Products: What Are the Right Tools for the Job” report provides further information about how organizations are using CAD to improve their design processes, including the CAD capabilities the Best-in-Class use that their competitors overlook.

By implementing the CAD functionality and process changes deployed by the Best-in-Class, organizations will be able to recover the time and cost they lose to redundant and avoidable tasks. Organizations that effectively incorporate these CAD capabilities into their design processes gain tangible competitive advantages resulting from improved design process flexibility and designer productivity. Those that don’t needlessly expend resources on software investments that leave design performance functionally unchanged.

The full Aberdeen study is available at no cost until June 30, 2012 at [aberdeen.com/Aberdeen-Library/7792/RB-product-design-development.aspx](http://aberdeen.com/Aberdeen-Library/7792/RB-product-design-development.aspx). DE

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3D Systems Corp.....	39	Kubotek USA, Inc.....	30
Altair .....	CV3	Luxology.....	19
ANSYS.....	CV2	Maplesoft.....	35
Arena Solutions .....	43	MathWorks .....	7
Cadre Analytic.....	51	National Instruments.....	3
CD-adapco.....	15	Okino Computer Graphics, Inc.....	47
Ciara Technologies, Inc.....	21	Omega Engineering .....	1
Ciara Technologies, Inc.....	23	Omega Engineering .....	51
Ciara Technologies, Inc.....	25	Professional Systems Associates.....	29
Collier Research Corp. ....	51	Quickparts.com, Inc.....	14
COMSOL .....	5	Sabalcore Computing, Inc. ....	51
DE Reprints .....	51	Saelig Company, Inc. ....	51
HSMWorks ApS, USA.....	18	Siemens-Americas Marketing.....	11
IMSI Design.....	51	Solid Concepts, Inc.....	45
Intel Corp. ....	13	Stratasys-Mojo .....	CV4
Kubotek USA, Inc.....	39	Tormach LLC.....	39



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.

## Find, Reuse Data Hidden in Enterprise Systems

*NovaQuest VisiQuity data discovery and reuse solution has knowledge management.*



Overcoming a drag on productivity by enabling you to find, retrieve, reuse, and re-purpose your data is the raison d'être underlying VisiQuity. It's search-based application from NovaQuest, a provider of product and lifecycle management solutions. Joel Lemke, BTW, is the president and CEO of NovaQuest. He once headed up ENOVIA

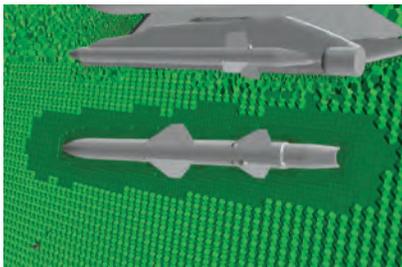
and Dassault's PLM operations in the US.

Just enhanced with knowledge management capabilities, VisiQuity combines Dassault's Exalead CloudView platform for search-based applications with NovaQuest-developed information management functionalities.

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## Overset Meshing Enhances CFD Analyses

*New STAR-CCM+ enhances conjugate heat transfer and multiple result exploration.*



All CAE disciplines have been hot lately, but perhaps none has been hotter than CFD (computational fluid dynamics). CD-adapco deserves a lot of the credit or, depending upon your point of view, a lot of the heat for the torrid pace of technological advancement recently. They've been busy, and their most recent step ahead is the version 7.02

release of their STAR-CCM+ multidisciplinary engineering simulation package.

You might think that .02 means this is just a bug-fixing point release, but CD-adapco does not seem to operate that way. STAR-CCM+ v7.02 has three especially cool new features.

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## New Single-Board RIO Embedded Devices from NI

*Provide embedded control and monitoring developers multifunction I/O and FPGA.*



National Instruments has introduced four new single-board RIO devices that are intended to make it easier for you to design and develop the customized parts of your embedded system applications. How? By providing all the foundation stuff like real-time processor, memory, analog and digital I/O lines, and networking, then combining all

that with an FPGA (field-programmable gate array) that you can program with LabVIEW.

The boards eliminate whole steps you'd have to take if you were starting an embedded system design process from scratch. And that means a lot of scratch saved for companies.

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## Large-Format Technical Print and Copy System

*Océ ColorWave 650 prints in color and black and white.*



Océ recently announced the launch of its Océ ColorWave 650 print and copy system. The short of it is that this is a 42-in. large-format print system for technical users who need to print and copy a fair amount of documents — “mid-volume” is how Océ describes that angle of the unit. It can handle applications ranging from CAD and GIS to posters. It can reside in a

centralized or decentralized print environment, and you can manage, print, and share documents from your desk using a web browser.

The ColorWave 650 uses solid Océ TonerPearls toner and Océ CrystalPoint technology to deliver black-and-white or color prints on plain paper.

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# Implement Cost Management

**T**he benefits of a systematic product cost management program are significant, yet many manufacturers struggle to implement them effectively. Let's discuss the guiding principles to initiating an effective product cost management program.

## Who Owns Product Cost Management?

Many people and departments within an organization have an impact on product cost. An engineering team decides on a specific design, but design alternatives dictate different costs. A sourcing team pays to produce a specific design, but there are multiple potential costs for manufacturing the design. A manufacturing team selects one way to produce a design and estimates a ballpark cost, but there may be more cost-effective ways to manufacture it.

Traditionally, product cost management has been performed by cost engineering experts. Their domain knowledge builds over time, but it's difficult to duplicate and scale across all products developed by a large organization. Effective product cost management requires a set of systematic activities, processes, and tools for use throughout the enterprise to guide decisions to the lowest costs available. For design engineers, this approach enables you to attack cost at the point of origin and yield the greatest impact.

## Core Cost Management Activities

There are a number of core activities involved in effective product cost management that involve design engineering—as well as other departments. Some of the most recommended include:

- studying cost tradeoffs of different concepts at the R&D stage;
- evaluating multiple design alternatives for lowest cost during new product introduction (NPI);
- evaluating the cost of proposed solutions to an engineering change order;
- evaluating multiple manufacturing and tooling alternatives for lowest cost, including make vs. buy analysis;
- generating a detailed “should cost” to validate supplier quotes and ensure lowest pricing;
- batch analyzing current prices of commodity groups to find over-cost outliers; and
- evaluating multiple cost-down ideas on current products in real time to identify the highest potential reduction.

## Cost Management Processes

The core activities above fit into various processes over a product's lifecycle, and include key cost control points during the product development process. These are measurable, managed checkpoints that dictate where and when people should perform the core cost management activities above. The output and re-

sults of these activities continue to build on one another throughout the product development lifecycle.

For example, during NPI, there are typically design review meetings at regular intervals to ensure that it's meeting requirements. But rarely is there a conversation about the financial implications of different design alternatives. Mandatory cost evaluation should be part of key design review milestones.

Another example is when a design reaches the release to manufacturing milestone. At this point, there is often a decision to make or buy that product, or key components within it. The company that has implemented a cost control point at this milestone could be quickly calculate the financial impact of both options to make an economically wise decision in a fraction of the time it would take to create and manage a request for proposal.

## Cost Management Tools

Effective product cost management is also enabled by putting the proper tools in the hands of everyone who has an impact on product cost, especially design engineering. These tools help identify and assess true product costs at a detailed level at any stage, and enable people to act on the appropriate opportunities to reduce costs. Some of these tools might include:

- product cost estimation systems that can quickly and consistently generate and manage accurate cost estimates without requiring specialized manufacturing or cost knowledge;
- reporting systems for documenting and tracking cost management results and key product indicators over time;
- analytics systems to search large volumes of data and identify cost outliers and trends; and
- bill of materials cost-tracking systems to roll up costs at any point in a product's lifecycle.

Without these core activities, processes and tools, product cost management remains a manual and decentralized function—of value only to manufacturing or cost engineering experts. It also leads to inconsistent estimation methods with static information that is difficult to update, manage and share.

To truly affect product costs and drive down the costs of goods sold by entire percentage points, manufacturers must deploy product cost management further upstream in the development process and across all departments and levels. Design engineers must identify key cost control points, and define the activities and processes needed to reduce costs. Organizations must also have the right tools to analyze the cost of trade-off decisions quickly and easily each time they make a decision. **DE**

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### Mojo Built for Simplicity

**1** Stratasys' new Mojo 3D Print Pack includes the printer and everything you need to get started, including a pack of ABSplus thermoplastic build material, SR-30 soluble support material, Print Wizard pre-processing software, WaveWash 55 support removal system and build platforms for \$9,900.

### Innovative Printhead System

**2** To minimize maintenance, Stratasys has integrated the printhead into the material packs. When material is replaced, so is the printhead. It snaps into place like an inkjet printer printhead. The company says there is no premium on the integrated printhead. Cost per cubic inch with Mojo is about \$5, which is similar to Stratasys' other 3D printers.

### More Materials

**3** Objet has released a new 3D printer that adds functionality that goes beyond its Objet30 printer. The Objet30 Pro 3D printer can use seven different types of materials, including VeroClear, a transparent material, and RGD525, a high-temperature material. The materials, which are in 1-kg cartridges, can be hot-swapped during printing. Objet says such features in a 3D printer cost more than \$100,000 before the Objet30 Pro, which costs \$43,000. Depending on the materials and application, Objet says print costs are \$5 to \$6 per cu. in.

### Functional Performance

**4** The Objet30 Pro is capable of 0.1 mm accuracy and 28 micron (0.02 mm) layers. It can create up to 11.81 x 7.87 x 5.9 in. functional parts with spinning wheels, working hinges or meshing gears, for example, that have a high-quality finish. It has a print speed of 112 cm<sup>3</sup>/hr (for opaque materials) and 60 cm<sup>3</sup>/hr (for transparent materials).



#### TECH SPECS

##### Stratasys' Mojo 3D Print Pack

- Printer size: 25x18x21 in.
- Build size: 5x5x5 in.
- Layer thickness: 0.1778 mm, (0.007 in.)
- Model materials: 1, ABSplus ivory
- Technology: Fused Deposition Modeling
- Cost: \$9,900

For more information, visit [stratasys.com](http://stratasys.com)

##### Objet's Objet30 Pro 3D Printer

- Printer size: 32.25x33.85x40.94 in.
- Build size: 11.81x7.87x5.9 in.
- Layer thickness: 0.02 mm, (0.001102 in.)
- Model materials: 7, VeroWhitePlus, VeroGray, VeroBlack, VeroBlue, DurusWhite, VeroClear, High Temperature RGD525
- Technology: Polyjet
- Cost: \$43,000

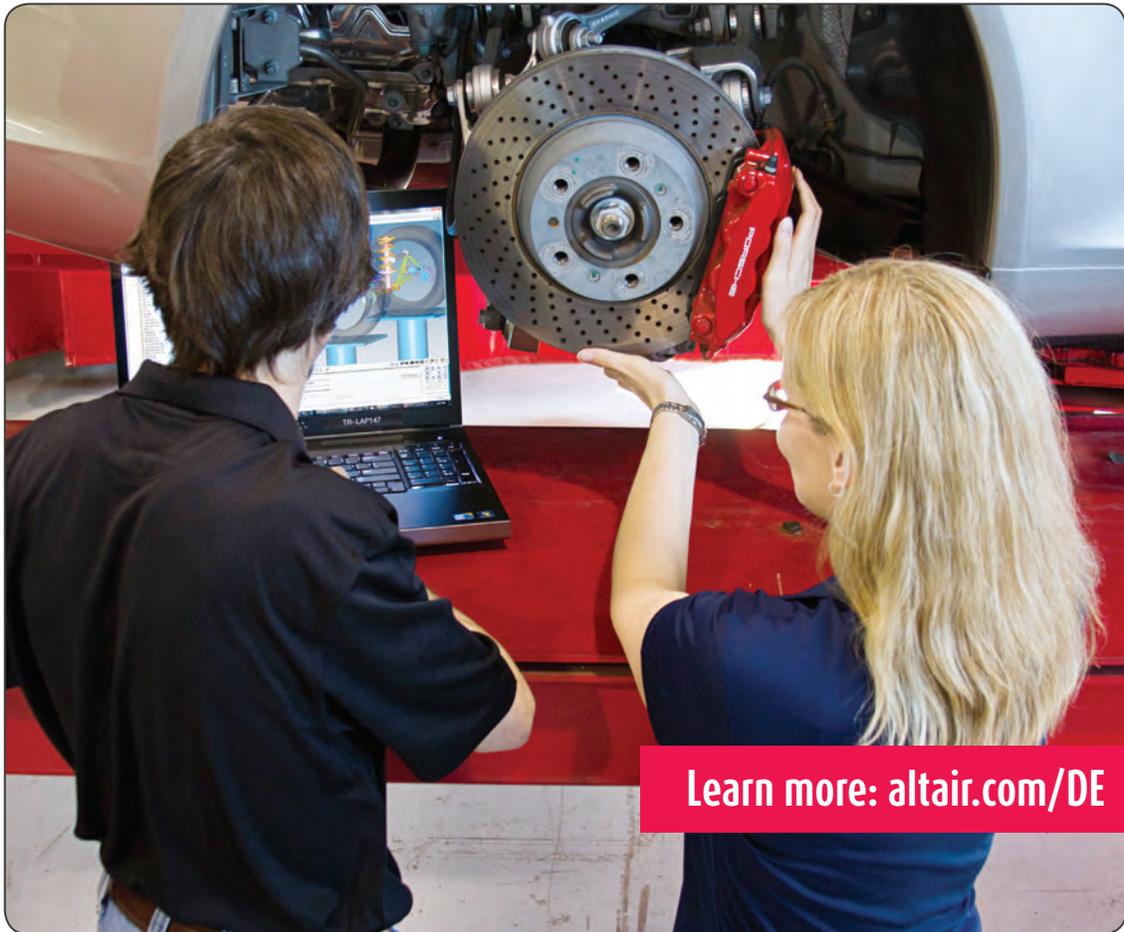
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**Mojo**  
3D PRINTER



The Siemens logo is displayed in a white rectangular box in the top left corner of the advertisement. The logo itself is the word "SIEMENS" in a bold, teal, sans-serif font.

SIEMENS

The background of the advertisement features two men in business attire (white shirts and ties) standing in a modern office or control room. They are looking at a large, multi-panel digital display. The display shows a complex 3D CAD model of a vehicle chassis, rendered in green and blue. The interface includes various toolbars, a navigation pane on the left, and a central workspace with the 3D model. The men appear to be in a collaborative discussion, with one pointing at the screen and the other holding a tablet.

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