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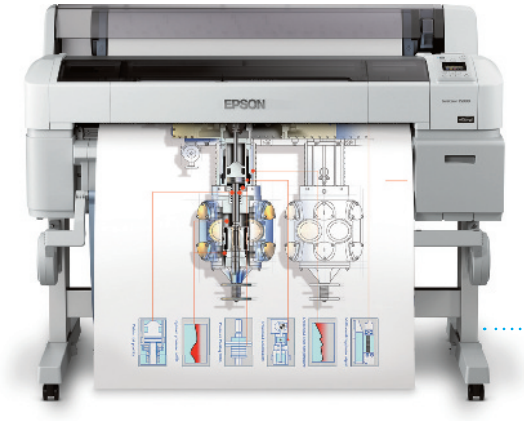

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by Jamie J. Gooch

The March of the Robots

With the slow, heavy steps reminiscent of their earliest sci-fi counterparts, humanoid robotic progress marches on. Sure, we already have giant arms that help build our cars, oversized hockey pucks that vacuum our floors or mow our lawns, and rovers that explore distant planets, but that's not enough. When we think of robots, what we really imagine are machines that look and act at least a bit like us.

Blame it on Lost in Space, The Jetsons, Star Trek, Star Wars, The Transformers or WALL-E, depending on your generation, but the idea of robots with some human characteristics — arms, legs, hands, feet, eyes, ears, mouths and even personalities — have become part of our culture. Turning that idea into reality has kept teams of engineers and scientists busy for decades, and much progress is being made.

Divide and Conquer

When designing any new, complex engineering system, it's often more realistic to begin with one piece of the whole. *DE's* Engineering on the Edge blog (engineeringontheedge.com) has chronicled many such robotic milestones.

An obvious next step is a robot that can interact with humans with some degree of autonomy.

For example, iRobot (the company that brought us the Roomba vacuum cleaner) has developed a three-fingered hand that has enough fine motion control to turn a key in a lock and open a door. It was developed with support from Harvard and Yale, and funding from the Defense Advanced Research Projects Agency. (See page 18 in this issue for how DARPA is supporting disaster response robotics.) Another company giving robotics a hand is Robot Rebuilt, which is researching the use of sensors to calibrate grip, find the edges of an object, and detect force.

The US Navy has begun investigating the use of pheromones to make trails for robots to "sniff" and follow, and is working with Virginia Tech on a firefighting robot that can see through smoke and navigate ship passageways. It's also developing a Battlefield Extraction-Assist Robot that it hopes will be able to carry wounded soldiers out of danger.

The University of Essex's CRONOS series of robots focus on the internals, including muscles, bones and joints with degrees of freedom that mimic our own.

MIT's Humanoid Robotics Group has developed many robotic technologies, including Kismet, which is designed to recognize human social cues and react appropriately with head movement, facial expressions and vocalizations. At the University of Pisa in Italy, the Hybrid Engine for Facial Expressions Synthesis can give expressions to the group's FACE robot via 32 motors and a polymer skin.

Researchers at the University of Arizona have developed robotic legs that mimic a natural human gait using load sensors in the feet. They're working on adding vision and tactile capabilities to allow the legs to correct themselves after a stumble.

These are just some of the many robotic research breakthroughs being made. Imagine combining them all, and a science fiction humanoid robot seems just around the corner. In reality, it's still quite a ways to that corner.

Greater than the Sum of its Parts

As advancements are made in individual technologies needed to move humanoid robotic development forward, an obvious next step is to incorporate that knowledge into a system that can interact with humans with some degree of autonomy.

One example of work toward this end can be seen in the ECCEROBOT, which stands for Embodied Cognition in a Compliantly Engineered Robot. It builds on the CRONOS research with the goal of investigating human-like cognitive abilities. The ECCEROBOT is intended to be anthropomimetic, which means it has the same inner structures as a human form so that it can interact with the world in a more humanlike manner. It has polymer bones, polyethylene tendons, visual, auditory and tactile sensors, as well as a behavioral subsystem. The project is funded by the European Union.

Back at MIT researchers are building on their own experience developing robots to build a platform called Cog (short for cognition). The Humanoid Robotics Group at MIT says Cog "seeks to bring together each of the many subfields of artificial intelligence into one unified, coherent, functional whole." Cog is a torso, and the researchers have given it a face, arms, basic social skills and a biochemical subsystem so it can react to its own energy consumption. The goal is to make it possible for the robot to interact with humans in a human-like way, which will allow the researchers to learn from those interactions and advance robotics accordingly.

While the engineering technology of humanoid robotics is amazing, society may not be ready for them quite yet. There's no rush. The robots are coming, but they're coming one step at a time. DE

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

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ON THE COVER: Robots vie for DARPA's Grand Challenge. *Images courtesy of (clockwise from bottom left) NASA-JPL, Boston Dynamics, Drexel University, Virginia Tech and SCHAFT.*

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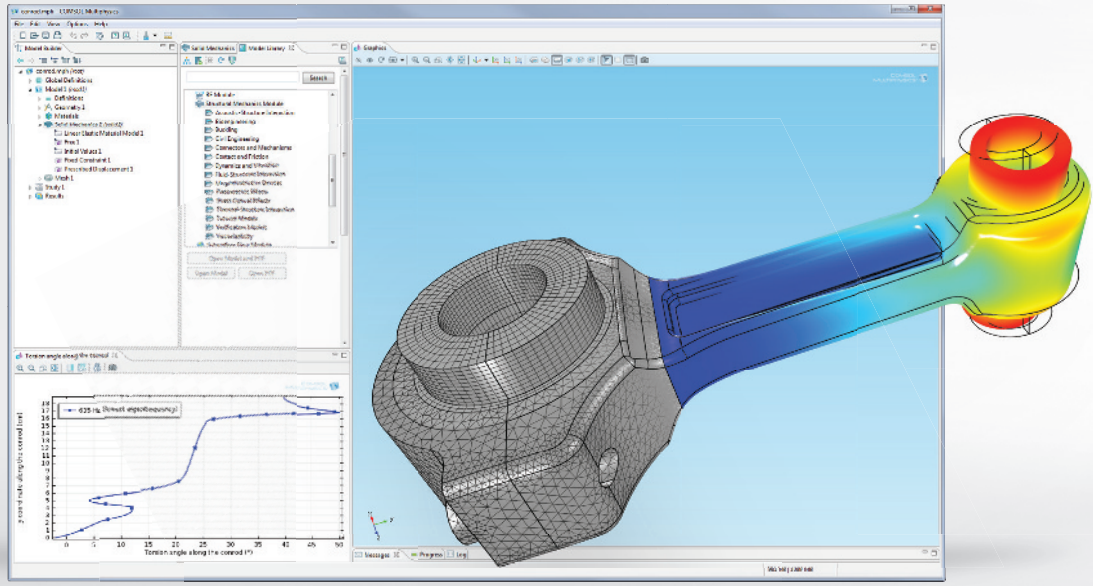

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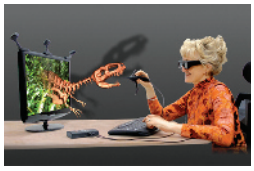

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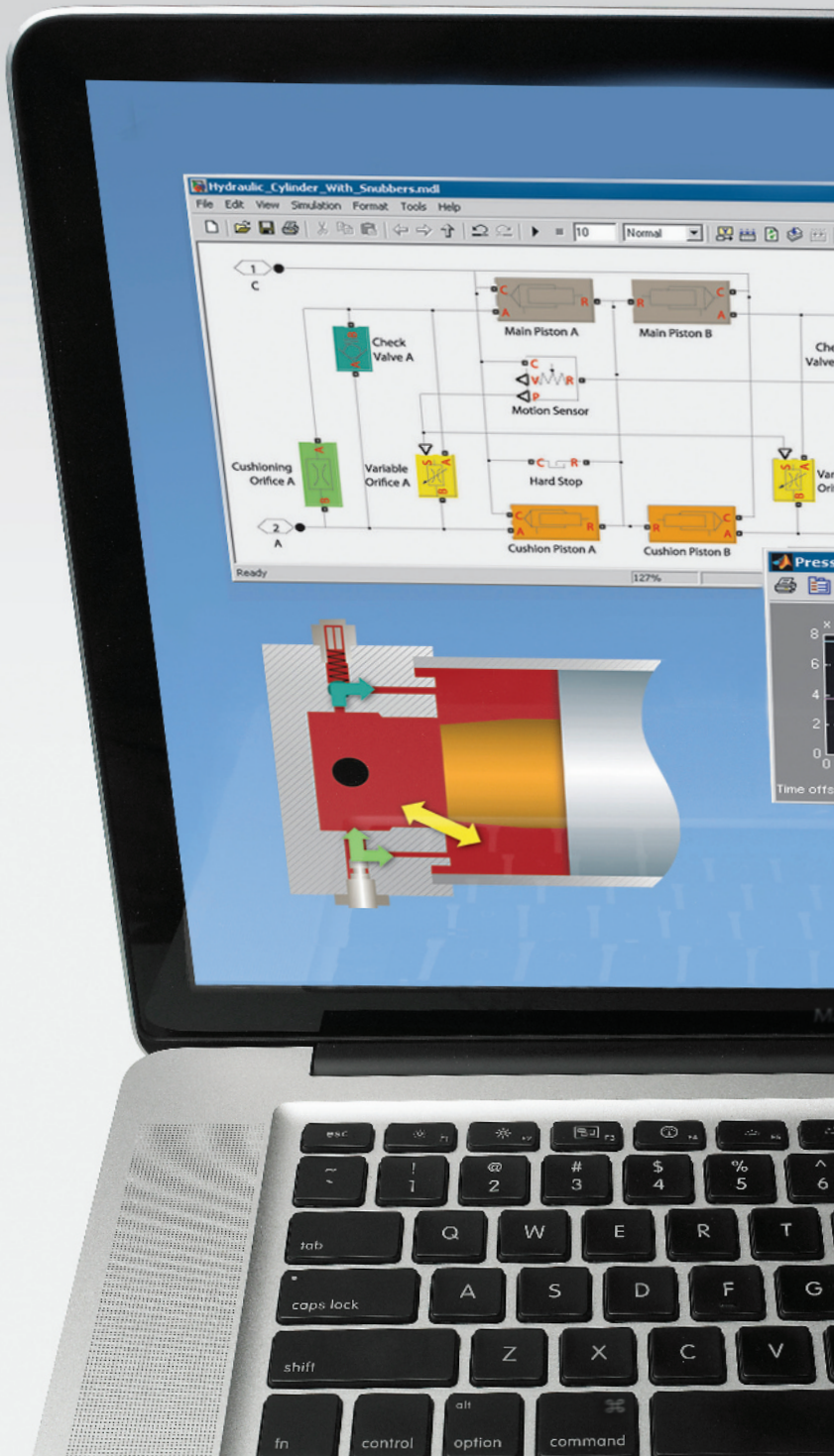

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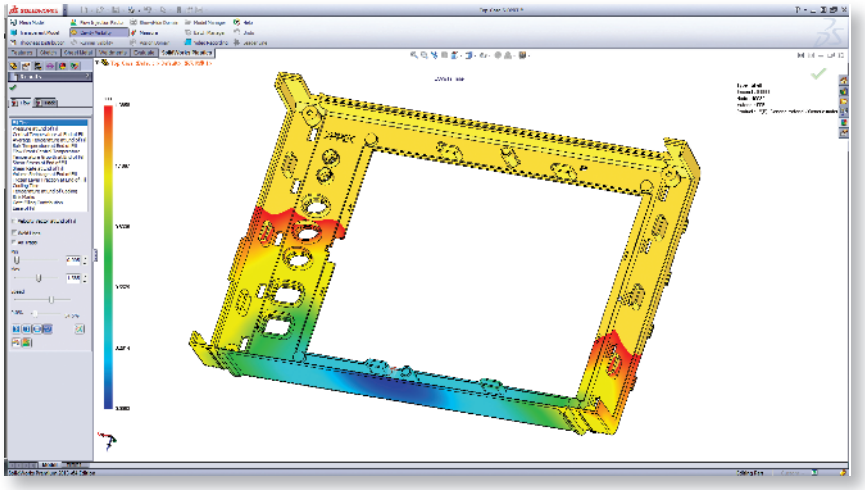
Going with the Flow: Dassault Joins the Mold Simulation Game with Acquisition

Injection molding is fluid flow simulation of a different kind. It's generally lumped with CAE, but it's too specialized to fit into computational fluid dynamics (CFD). Thus, tailor-made software like Moldflow, Moldex3D and Simpoe emerged to fill the gap.

Although plastic parts are an integral part of contemporary products (especially in consumer goods), CAD, product lifecycle management (PLM) and finite element analysis (FEA) software makers aren't particularly keen on developing their own mold-simulation packages. So they certify third-party packages or license such technologies for incorporation into their main offerings. In 2008, Autodesk decided the plastic market was important enough to warrant an in-house technology. The company paid $297 million to buy Moldflow, considered a leader of the pack.

In May, Autodesk's rival Dassault Systèmes snatched up Simpoe for an undisclosed sum. Peter Rucinski, a senior product manager for Dassault, observed, "At least 80% of all plastic parts manufactured are produced by the injection molding process … And, the use of plastics continues to increase over time as new advances in material technology allow them to be used in higher temperature and strength applications. Simpoe products are great for the mainstream or casual user because of the ease of use, but they also have the power of advanced functionality — such as predicting plastics part warpage — that serves the high-end users."

Simpoe currently offers Simpoe-Works for SolidWorks users, SimpoeEdge for Solid Edge users, and SimpoePro for PTC software users. In addition, Simpoe offers Simpoe-Mold, a standalone version that works with neutral 3D file formats, and SimpoeXpress, a free, lightweight version. Simpoe-Mold has an interface that allows SpaceClaim software users to automatically optimize plastic parts design and manufacturing in Simpoe-Mold. It also interacts with CATIA, Dassault's high-end modeler, through the SimpoeLINK module.



Dassault Systèmes, parent company of SolidWorks, snatched up injection-mold simulation software maker Simpoe. Simpoe's technology is already embedded in SolidWorks Plastics (shown here).

Simpoe's technology has already been incorporated into Dassault's SolidWorks, under the name SolidWorks Plastics. The module is described as "an easy-to-use injection molding simulation" software. Dassault's high-end CATIA software suite currently has CATIA Plastic Parts, but the product is strictly for designing plastic parts, not for simulating mold operation. This will likely change now that Dassault has full access to Simpoe. According to Rucinski, a Simpoe-based mold simulation product for Dassault's SIMULIA brand is also under consideration.

Simpoe has an original equipment manufacturer (OEM) agreement with PTC, a competitor to Dassault. According to PTC's February announcement, this agreement has "authorized Simpoe to develop a new extension for PTC Creo for the plastic industry [that] will replace PTC's Plastic Advisor extension."

Rucinski noted that "there will be no changes in the short term" to Simpoe's commitment to PTC.

Moldflow is now tightly integrated with Autodesk's flagship CAD package Inventor, but the software can also accommodate parts designed in other CAD packages. Moldex3D, another well-known mold simulation software from CoreTech, is tightly integrated into the NX 3D CAD program from Siemens PLM Software. The outcome is NX EasyFill Analysis, which appears inside NX 8.5. (*For more, read "NX 8.5 Plugs Mold Gap with EasyFill," December 2012.*)

Although the demand for mold simulation is undeniable, the number of products serving the niche market is relatively small. That number continues to shrink as bigger fish swallow up smaller ones.

—K. Wong

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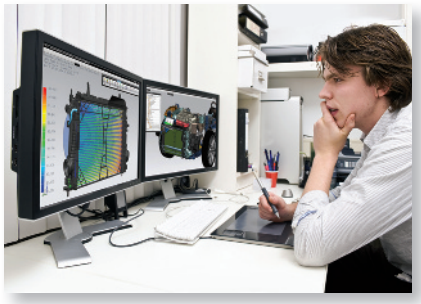

Siemens PLM Software launches a job-training initiative for returning veterans.

Siemens PLM Software is offering CAD, CAM and CAE training — courses that usually cost as much as $17,000 — to recently returning veterans for free. In May, the company outlined the program in an announcement:

"Ten, multi-day courses are offered, including comprehensive training on NX software, Siemens PLM Software's leading integrated solution for CAD/CAM/CAE, and Teamcenter software, the world's most widely used digital lifecycle management solution. The training will help enhance veterans' qualifications for skilled positions in a wide variety of manufacturing industries ..."

Chuck Grindstaff, CEO and president of Siemens PLM Software, can understand how difficult the military-to-civilian transition could be. His father is a veteran of the Korean War. "Just thinking about what he went through when he came back, [this program] just makes sense to me," he says. So when some employees suggested the idea, Grindstaff and the executive team signed off on it.

In April 2011, in participation with the White House's Joining Forces initiative to support and honor America's service members and their families, Siemens pledged to reserve 10% of its 3,000 open positions for veterans. The company revealed it has hired more than 1,000 veterans in the last two years.

"There's a constant requirement for well-trained, skilled workers among our customers," Grindstaff observes. "They all often complain that they can't get the right people in. So we thought it might be a perfect match."

Siemens is partnering with Still Serving Veterans as the designated contact for enrollment in the job training initiative. The free courses will be offered at 22 Siemens PLM Software training facilities throughout the U.S.

—K. Wong

Team Nabs $1 Million Prize in DARPA FANG Challenge

The winner of the $1 million prize in the U.S. Defense Advanced Research Projects Agency's (DARPA's) Fast Adaptable Next-generation Ground Vehicle (FANG) mobility/drivetrain challenge was a three-person team with members in Ohio, Texas and California. The challenge, the first of which kicked off in January, aims to spark innovation around the design of the vehicle — not only from inside traditional defense industry circles, but also from the outside world.

Equally important to the competition, however, was putting a new genre of development tools to the test in the hopes of significantly compressing the design-to-production cycle of complex defense systems, according to Army Lt. Col. Nathan Wiedenman, DARPA program manager.

Specifically, the FANG Challenge tasked teams to use the META design tools and model libraries, along with the VehicleFORGE collaboration platform developed by Vanderbilt University to design and simulate the performance of potential mobility and drivetrain subsystems. VehicleFORGE is the collaborative platform used by competitors to manage and submit their designs from geographically separate locations in the DARPA FANG challenges.

"DARPA obtained a great deal of valuable feedback from the FANG Challenge, including ideas for improving the usability of the tools, the robustness of the models, and capabilities required for the development of more complex designs," Wiedenman explains. "While the META tools are not yet fully mature, the FANG Challenge helped to prove that the underlying principles are sound, and that DARPA's goals for compressing design-to-production design are feasible."

FANG Challenge winner Ground Systems scored highest in the three main categories used to judge entries.

—B. Stackpole

by Kenneth Wong & Beth Stackpole

Dassault Systèmes Debuts HT Body for High-tech Electronics Design

Consumers are actively engaged in a love affair with their electronics gear, upping the ante for product development teams now tasked with creating seductive designs on top of the traditional engineering challenges.

Call that an opening for Dassault Systèmes, which is aggressively trying to promote its wide and varied 3D design, digital mockup and product lifecycle management (PLM) tools under its 3DEXPERIENCE umbrella into integrated solutions for specific industries. The latest in Dassault's string of such offerings is HT Body, a broad-reaching platform aimed at engineers and designers in the electronics-manufacturing sector.

This helmet-mounted digital camera was created with HT Body, which helped a supply and design chain streamline engineering-to-manufacturing. *Image courtesy of Dassault Systèmes.*

Much like its Licensed to Cure industry solution for the medical device sector announced last October, the new HT Body aims to deliver what Dassault calls a single, pre-integrated design and engineering experience. Via a combination of Dassault tools, built-in best practices, and proven workflows, HT Body aims to connect and foster relationships between stakeholders in the design chain — from consumer to company, between industrial product designers and product development teams, all the way through product development and manufacturing, explains Michel Monsellier, Dassault's solution experience leader for the high-tech industry.

"We're building a new generation of solutions that take the process from beginning to end, combining the best products in the Dassault portfolio and mapping them as close as possible to address customer concerns," he explains.

In the electronics design sector, the challenges or concerns typically fall into two buckets:

- helping the upfront design team nail the external appearance of a device so it has an emotional impact with consumers; or
- streamlining the collaborative process between engineering and manufacturing to ensure the product is of high quality and can meet the continually ambitious time-to-market demands of this particular market sector.

One of the more interesting aspects of HT Body is its focus on the social collaboration and visualization tools that let manufacturers engage the public to provide ongoing feedback on the look and feel of designs. At the heart of the capability is Dassault's See What You Mean (SWYM) social innovation platform, which lets device manufacturers create online communities of designers and consumers to share ideas, elicit feedback and virtually test drive potential designs. Dassault's Natural Sketch tool is also part of the platform, allowing designers to easily draw concepts in a digital form and transform 2D sketches into 3D models as the design evolves.

"Instead of spending weeks building physical prototypes and going around the world to propose them to consumer panels, manufacturers can share 3D models in a very realistic, rendered way to get initial feedback and share the product's look, feel and shape with consumers," Monsellier explains.

While a big focus of HT Body is on the front-end design shop, the platform also delivers functionality to ease the back-end design process. Through Dassault's traditional set of 3D CAD and PLM tools, the platform gives manufacturing, quality and design engineers real-time access to design data, and supports bidirectional feedback of critical requirements. It also enables real-time change directives and workarounds to be delivered to the shop to minimize delays and costly rework, incorporates functionality for mold and tooling design, and can help simulate machining processes.

—B. Stackpole

Beauty of a Balanced System

A workstation where all the elements are chosen for your needs is the best way to work.

BY DOUG BARNEY

Ever notice what makes a world class sports car? It has a magnificent engine of course, but surrounding that power plant is a refined suspension, great brakes, superb transmission, and ideal balance from front to rear.

The same is true for a great workstation. Of course the engine, in this case the processor, must be awesome. But the best processor in the world means little if it isn't accompanied by the right mix of storage, memory, I/O ports and graphics.

Determine You Needs

These components should be chosen to match your workloads. This balanced approach will offer the best user experience, the most productivity, and the far fastest return on investment (ROI). And the best way to achieve this balance is with a new workstation.

Like a top end car, it starts with the engine. A Porsche 911 wouldn't the same with a moped engine. Xeon processors are ideal for workstations, having been designed for high performance, reliability, and data protection through its Error Correcting Code (ECC) RAM, which prevents 99.995% of all memory errors. Plus Xeon supports multiple processors on the motherboard, so if you require a separate full Xeon processor, it is simple to add.

Get the Most Bang for Your Buck

How many cores do you need? For basic CAD only, a single Xeon processor can be sufficient, but try to have one with 4 to 6 cores. CAD users will benefit from two processors. Fast Xeon processors have been shown to easily pay for themselves in around 11 days.

If you are engaged in simulation or photo realistic imaging, then you will most certainly benefit from more cores, so add a second CPU.

RAM is perhaps the second most important element when configuring a new workstation. For some low-end uses and work on small assemblies, 8GB of RAM may be enough, but won't offer top performance.

Those who work on more than one important task at a time, or run compute-intensive jobs such as large assemblies, simulation, ray tracing, or finite element analysis, are much better served with 16 to 32GB of RAM. This extra memory speeds up demanding applications so much it often pays for itself in less than two days.

For optimal performance, a solid state drive (SSD) is critical. These superfast drives are much like extra RAM—they speed applications tremendously and vastly improve productivity and the user experience. Use of SSDs can boost the speed of work by as much as 3x. SSDs can pay for themselves in less than four days if your work involves large assemblies.

Depending on how much your applications exploit discrete graphics cards, you may want to invest in one. In most cases, the Intel graphic solutions that come with Xeon, such as the Intel HD Graphics P4000, are perfectly suitable for engineering and design needs.

Buy New or Upgrade?

If your machine is relatively new and includes a modern Xeon, adding more RAM, a new graphics card, or an SSD could add a nice snap, and let you work that much faster. These upgrades all offer a positive and fast ROI. Just make sure the upgrade costs aren't half or more that of a new workstation. If they are, a new balanced machine is the way to go.

Can you afford a new workstation with more RAM, SSDs and processors? I would suggest if you are either upgrading or purchasing the latest software, you cannot afford not to buy a new workstation. If your workstation or PC is three years old, you are potentially running at half speed and not realizing the real advantages of your software investment. DE

Doug Barney *is a computer journalist with nearly 30 years of experience.*

INFO → Intel Corp: intel.com/go/workstation

Link Motion Coming to HP

HP and Leap Motion are collaborating on gesture control technology, integrating the Leap technology with laptops and workstations.

The deal will see the Leap Motion Controller bundled with select HP computers sometime later this year. Airspace, Leap Motion's app store, will also come pre-loaded on these computers.

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Robots Catch Some Sun

Liquid Robotics announced the latest version of its floating sensor robots, Wave Glider SV3, which will use solar power for propulsion. Previously, the robots used solar cells to power onboard sensors and communications systems, while wave energy alone kept them moving.

Wave Gliders can collect weather data, monitor marine life and hurricanes, and even snap photos. Because they

don't require fuel, they can operate longer (and greener) than other types of probes or manned research vessels. The new version will be able to maintain position in strong currents, thanks to the additional solar power. It should also be able to travel faster.

More than 200 Wave Gliders have been deployed everywhere from the Arctic to Loch Ness, traveling more than 300,000 nautical miles and surviving 10 hurricanes. The company's customers include NASA, Stanford University (as part of a shark tracking program), BP, Cornell University, and the U.S. National Oceanic and Atmospheric Administration (NOAA).

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BionicOpter Draws Inspiration from Nature

Festo's new BionicOpter is an ultralight flying robot that bears an uncanny resemblance to the dragonflies upon which its design was based. The body of the craft is constructed from flexible polyamide and terpolymer, while the wings are a carbon-fiber frame with a thin foil covering. The entire unit weighs 6.2 oz., and contains a battery, nine servo motors, a high-performance ARM micro-controller, sensors and wireless modules. Operators control the new robot with a smartphone app — making it easier to operate, in theory, than many remote-controlled cars.

The flapping wing design of the BionicOpter enables it to fly in all directions in space and hover in mid-air, just like a helicopter. Unlike a helicopter, however, the dragonfly does not need to tilt forward to generate forward thrust.

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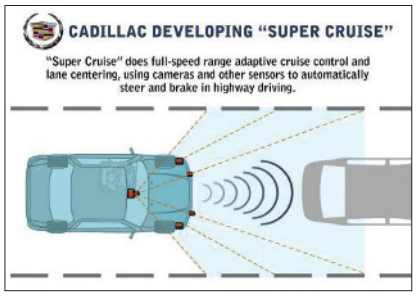
Cadillac Tests Super Cruise

Cadillac is moving forward with its semi-autonomous driving system, dubbed Super Cruise. It uses a mix of GPS, radar, cameras and ultrasonics to keep the car on the road.

According to Cadillac, every feature can be integrated seamlessly into its vehicles — meaning Super Cruise can hit the road as soon as testing is completed. Unlike other self-driving cars in development,



Super Cruise isn't intended to replace drivers, but to assist them.

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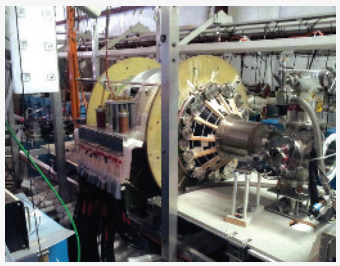
UW Readies Fusion Spaceship



The University of Washington (UW), in cooperation with MSNW LLC, is developing a functional fusion propulsion system. If the system works as planned, it could cut down the time required for a trip to Mars from nine months to about 30 days. The trick is getting it to work.

The UW/MSNW team is developing a system that forces tiny metal rings through a magnetic field with specific properties, designed to collapse the rings. When the rings collapse, they do so around a wee bit of deuterium, compressing it and producing a fusion reaction that lasts for a few millionths of a second. Even that short a burst should output a large amount of energy.

The fusion system will go into testing later this summer. If successful, it could usher in a new era of energy production here on Earth as well as among the stars.

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How to Configure the Ultimate Engineering Workstation

Why you need overclocking, SSD caching and dedicated rendering.

Most engineering applications, like SolidWorks, Autodesk Revit, or Autodesk Inventor, are frequency bound (meaning they predominantly use only one processing core), so their ideal hardware platform is a workstation with fewer cores but higher frequency. However, if your workflow also includes rendering and simulation (which use multiple cores simultaneously), you'll need the maximum number of cores to run at peak performance. For most workflows, a quad core Intel® Core™ i7 processor is optimal, especially if it's overclocked like those found in XTREME edition workstations from BOXX.

Overclocking Matters

While brand name computer manufacturers focus most of their attention on mass produced, general use PCs, BOXX offers professional grade workstations custom configured and overclocked for 3D visualization. And with the ability to achieve 4.5 GHz, overclocked 3DBOXX XTREME workstations hold a decided advantage over competitors' top-of-the-line models, which can only manage 3.7 GHz— the speed threshold since 2006.

"It's the frequency plateau," says Tim Lawrence, BOXX Technologies' VP of Engineering. "Improvements to architecture have helped somewhat, but not enough. With processor speeds remaining virtually stagnant for six years, overclocking is the only way to significantly increase core speed and thus, performance."

Faster processes result in an accelerated workflow, greater efficiency, higher productivity, and a better overall user experience.

And if you're concerned about the effects of overclocking on a processor, rest assured knowing BOXX has shipped overclocked systems since 2008 and with thousands of systems in the field, the company has not experienced a processor failure rate any different from that of standard processor systems. And like all BOXX systems, XTREME systems are backed by a three-year warranty.

Critical Components

3DBOXX 4050 XTREME and 4920 XTREME performance is enhanced by the option of Intel® Smart Response Technology, whereby the system automatically learns which files users access frequently and copies them from the hard drive to the solid state drives. The next time the files are requested, they're loaded from the SSDs, rather than the slower hard drive. The result is faster booting, faster application loading, and accelerated performance.

In regard to system memory, you'll need at least 8 to 10 GB. With this amount, if your workstation is responsive and executes tasks quickly, you've made the right choice. If not, you may need to increase your RAM (in many instances) to as much as 16GB.

Although an NVIDIA Quadro 600 card is serviceable, BOXX recommends the NVIDIA Quadro 2000 as an ideal mid-range graphics card for most engineering workflows.

Because rendering is a key aspect of engineering workflows, engineers should consider off-loading it to a dedicated rendering system like BOXX renderPRO. Available with Intel® Xeon® E5-2600 series processors, renderPRO features up to 16 processing cores. It enables users to deliver complex projects within budget and on schedule by drastically reducing rendering time.

Increasing Productivity and Profit

The key to increasing productivity and profit is to accomplish more in less time. Faster turnaround means fewer employee hours invested and more time for new projects and clients. So when you configure the ultimate engineering workstation, consider solutions you won't find anywhere else delivering performance you can't get anywhere else—overclocked 3DBOXX XTREME workstations. DE

Highly Recommended

For engineering workflows, BOXX recommends the following workstations:

3DBOXX 4050 XTREME is a liquid-cooled workstation, powered by an overclocked quad core, Intel® Core™ i7 processor running at 4.5 GHz. Available with up to two GPUs (NVIDIA Maximus™ technology) and support for solid state drive (SSD) caching for increased storage performance, 4050 XTREME is the industry's fastest single socket workstation for engineering and product design applications.

3DBOXX 4920 XTREME, another liquid-cooled BOXX workstation, includes an overclocked, six core, Intel® Core™ i7 processor also capable of speeds up to 4.5 GHz. 4920 XTREME is available with up to four GPUs (NVIDIA Maximus™ technology), and support for solid state drive caching for increased storage performance.

INFO → BOXX Technologies:
www.boxxtech.com/solutions/solutions.asp

3D Systems Launches New Full-color Printers

3D Systems has launched a new wave of additive manufacturing (AM) systems with the announcement of its ProJet x60 line. The line is fueled by new VisiJet PXL materials, which have been developed specifically for the ColorJet Printing (CJP) technology that drives the x60 series. 3D Systems is offering six different x60 systems as part of the launch.

"These exciting, next-generation color printers embody 3D Systems' commitment to democratize access to powerful and affordable 3D printing solutions for professionals, educators and consumers alike," says Michele Marchesan, vice president and general manager, personal and professional printers for 3D Systems. "The new ProJet x60 series builds on our innovation heritage, leverages our expanded line of 3D content-to-print solutions, and enables users to create more, faster."

MORE ➜ rapidreadytech.com/?p=4007

Leonar3Do Brings Virtual Reality to 3D Design

Leonar3Do, a Hungarian startup, is ready to offer a different approach to 3D design by allowing people to design fully in 3D. The company's proprietary technology uses imaging glasses and a stylus called the "Bird" as part of a virtual reality (VR) design space that creates objects in 3D.

The system uses infrared position detection in the form of three sensors mounted around the workspace. The glasses have built-in infra LEDs enabling head-tracking positioning, and the Bird is a spatial input device that allows users to create and interact with 3D VR images.

The basic Leonar3Do package, including glasses, sensors and Bird, costs $500. Software to run all that hardware runs another $500 (and will work on a laptop). The company also offers a software development kit to further integrate the Leonar3Do system into your workplace.

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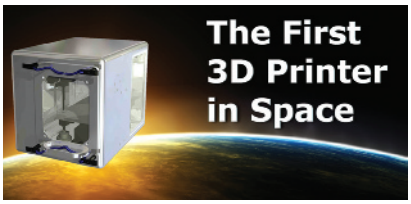
Made In Space Focuses on Otherworldly 3D Printing

Made In Space brings together NASA research veterans, astronauts and entrepreneurs to explore possibilities offered by off-planet 3D printing.

In addition to the core team, Made in Space has partnerships with NASA, 3D Systems, Stratasys, MakerBot, Autodesk and many other companies that have an interest in furthering development of additive manufacturing (AM). The company has conducted several microgravity tests of how well material extrusion works in zero gravity, and is under contract with NASA's Marshall Space Flight Center to build the first 3D printer specifically designed for use in orbit.

Once the company has succeeded in proving it has a 3D printer ready for space, Made In Space will be responsible



for designing an AM facility to be added to the International Space Station (ISS). The facility will be responsible for continuing research and production of all sorts of useful items, including replacement parts, tools, science equipment and anything else that can be built using AM rather than having a new item shipped from Earth.

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Artec to Release Spider 3D Scanner

3D scanners are a vital part of additive manufacturing (AM), providing a relatively quick method of generating 3D data for reverse engineering or continuing product development. As AM becomes more prevalent, the need for 3D scanners continues to grow — which increases the number of options on the market and decreases the price.

While professional 3D scanners aren't normally described as inexpensive, per se, what used to cost $30,000 and up can now be found for much less. Artec entered the 3D scanner arena with its Eva portable scanner, and is now set to release the Spider.

Like the Eva, the Spider is a portable, handheld 3D scanner. The name is taken from the scanner's "many eyes," which combine their imaging power to produce scans with a high resolution up to 0.15mm and an upper accuracy of 0.03 to 0.05mm. While the Eva has been put to use mainly scanning the human body, the Spider is intended for more industrial uses.

The Spider provides real-time scanning without using markers or requiring manual alignment during post-processing. Scans have texture and, according to the company, the new scanner is accurate enough to record sharp edges and thin walls. The Spider will be priced under $20,000.

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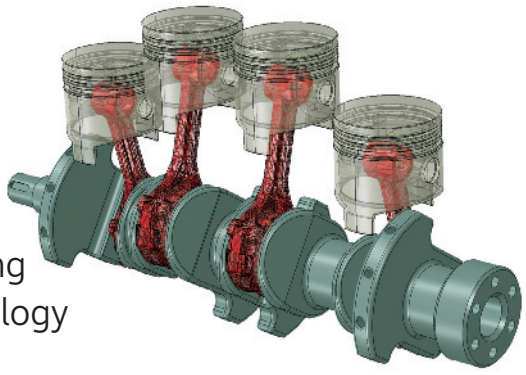
3D EXPERIENCE: Innovating without Fail



There is a dramatic payoff for companies leveraging Dassault Systémes' Realistic 3D Simulation Technology for fracture and failure.

Anyone assessing components for fracture, delamination or fatigue must have come across tantalizing glimpses of the rich range of technologies now available in Abaqus. Simulation capabilities even include arbitrary crack shapes without the nightmare of re-meshing. Where has this all sprung from and who is behind it? *DE* takes a closer look at the SIMULIA technology available as part of Dassault Systémes' 3DEXPERIENCE Platform.

The Team

Zhen-zhong Du is based in Dassault Systèmes office in Providence, RI, where he leads the SIMULIA Fracture and Failure R&D efforts. Fracture and failure are inherently complex phenomena requiring advanced simulations. Du explained the team's goal is to make the modeling of this advanced technology as straightforward as setting up a simple elastic-plastic analysis.

For the last 10 years, the overarching strategy behind SIMULIA's fracture and failure technology has been driven by a tightly knit Fracture Customer Review Team (FCRT).

The importance of this approach is underlined by Bruce Englemann, Chief Technology Officer, Dassault Systémes' SIMULIA. "Our global team of researchers and developers is at the forefront of the evolution to develop new mechanics simulation technology and methods … we have been on this journey of exploration and discovery with our customers and partners for more than three decades," he said in a recent statement.

Working with the FCRT, the SIMULIA R&D team has ensured that key functionality has evolved across a widening front. Equally exciting is the adoption over a range of industries. Initial drivers were major aerospace OEMs needing to understand composite damage and fatigue mechanisms. Now the technology is being used in many areas, including thermal cycle fatigue in automotive engines and solder connections in electronics.

Evolving Technologies

Abaqus technologies developed over the years include Virtual Crack Closure Technique (VCCT), cohesive elements, material damage models and many others. This provides Abaqus users with a rich set of well validated and documented methods to assess delamination, cracking and other failure forms, including low cycle plastic fatigue crack growth. The sheer volume of conference and academic papers using Abaqus in these fields is a testament to the simulation community's acceptance of Abaqus as the de facto solution. Boeing partnered with SIMULIA several years ago to develop VCCT as a fully integrated solution and led the way for the introduction of this technology. PSA Peugeot Citreon partnered to develop the Direct Cyclic Analysis technique to automatically calculate a stabilized steady state response to cyclic loading. This improves accuracy and solution time compared to existing methods. The methodology has since been adopted in aerospace, life science and other high technology areas.

XFEM enters the field

Extended Finite Element Method (XFEM) allows local enrichment functions to be incorporated into a standard finite element method. Additional degrees of freedom, together with these enrichment functions, mean discontinuities, such as an arbitrary crack front, can be handled. The mesh does not have to conform to the crack geometry, either in its initial configuration, or as it propagates through the structure. This is an extraordinary productivity boost to the user removing a huge burden of crack geometry definition and meshing. While the XFEM methodology has been around for some years, the SIMULIA team resolved many technical and architectural issues to deliver a robust, accurate and easy-to-use solution within Abaqus.

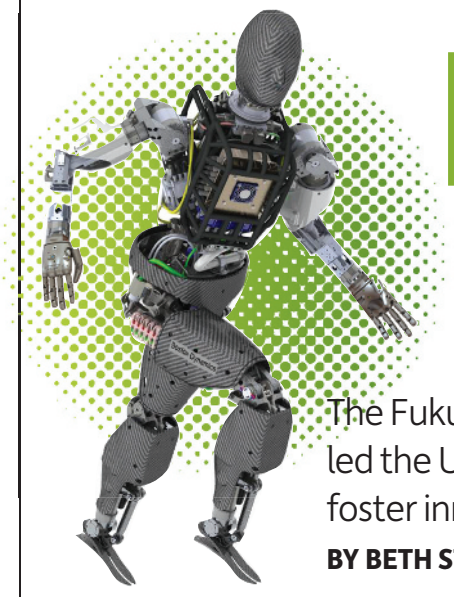
Conclusion

Engineering professionals are benefiting right now from the carefully planned development strategy for fracture and failure simulation. They can be assured that the very latest techniques are being assessed by SIMULIA R&D team in close collaboration with the FCRT and major Industry partners.

The introduction of XFEM opens up a particularly exciting time to be involved in this field. If you are investigating damage, cracking, delamination etc., you really need to be looking at what the Dassault Systémes SIMULIA realistic simulation application has to offer. DE

SIMULIA

INFO → SIMULIA, Dassault Systèmes: www.3ds.com/simulia



ROBOTS TO THE RESCUE

The Fukushima Daiichi nuclear disaster and other recent events have led the U.S. Department of Defense to issue a challenge intended to foster innovation around humanoid disaster-response robots.

BY BETH STACKPOLE

There's Thor, RoboSimian, CHIMP, Hubo and a pack of other contenders. Some are big, all are brawny, and each has keen powers of perception and dexterity.

They're not superheroes, per se, but they do have superhuman powers.

They *are* among the custom robots competing in Track 1 of the Defense Advanced Research Projects Agency (DARPA) Robotics Challenge, an event designed to spur the development of robotics technology to aid in disaster-response operations.

The devastation of recent natural and manmade disasters, including the Deepwater Horizon oil spill and the earthquake-decimated Fukushima Daiichi nuclear reactor plant, highlight mankind's inability to respond effectively to certain disaster situations. Recovery operators are often unable to get close enough to complete a mission because of safety or inaccessibility obstacles like nuclear contamination, structural instability or intense temperatures.

The Robot Brigade

While today's robots are certainly helping assuage these harsh situations — for example, robots were used to clean up and get the crippled Fukushima plant back online — there are few specifically designed for this kind of work. Most aren't equipped to navigate environments scaled to the human world, according to DARPA officials.

This glaring gap in robotics technology was the genesis for the DARPA Robotics Challenge. The goal of the program is to task the brightest minds in robotics to develop new technology that can execute complex tasks in dangerous and degraded human-engineered environments using vehicles and tools commonly available in populated areas. Improvements in the areas of supervised autonomy, mounted and dismounted mobility, dexterity, strength and platform endurance are among the chief requirements for building a robot that's actually capable of performing disaster response at the scale DARPA envisions, according to Gill Pratt, Ph.D., DARPA program manager. What they collectively enable, he explains, is a robot that is adaptable, capable of operating in an environment that's engineered for humans, even if it's degraded by a disaster, and generally robust enough to complete an actual mission from beginning to end.

"There have been great advances made in robotics, especially humanoid robots, both in the United States and internationally over the last decade. But most were developed and evaluated in labs and other controlled spaces," Pratt explains. "With the DARPA Challenge, we are looking to improve the capabilities of the robots by putting them into real-world situations, with their great variability and sometimes without skilled human operators to direct every movement the robot makes. If successful, we will be raising the bar for the field of robotics, moving the technology closer to working in unpredictable environments."

The Heart of the Challenge

Enabling supervised autonomy in robots will be a key to success. What this means, Pratt says, is shifting the process of directing robots from tele-operation, where human operators give a robot step-by-step commands, to task-level autonomy, where operators give commands like "Open the door" or "Climb the stairs," and the robot is able to figure out the basic steps necessary and complete those tasks by itself. This is necessary in a disaster-response robot, Pratt notes, because there is no guarantee of a clear communication channel between human and robot at the scene of any disaster.

Achieving supervised autonomy will demand improvements in sensors, hardware and software. It might also include machine learning, which will leverage new algorithms to control the robot's interaction with its environment and enable perception and tactile feedback, Pratt says. It also requires a relatively simple user interface so that humans who are not experts in robotics can issue commands and confidently anticipate the response.

To prove their mettle in the DARPA program, robot challengers will be faced with a disaster scenario that will require them to perform a series of operations, including:

- drive a utility vehicle at the site;
- travel across rubble;
- remove debris blocking an entryway;
- open doors to enter a building;
- climb a ladder and traverse an industrial walkway;
- use a power tool;
- locate and close a valve near a leaking pipe; and
- attach a connector like a wire harness or fire hose.

Teams hailing from the top engineering schools — and with sponsorship from leading companies — have signed up to participate in the DARPA Challenge. Most teams have been working on new designs or refining existing robot technology for months, gearing up for the first phase of the challenge held this month. This event is a virtual competition in which teams are tested on their ability to control a robot's perception, manipulation and locomotion.

The teams will be evaluated on their ability to complete the simulated tasks on Atlas (pictured, left), the robot designed by Boston Dynamics based on its Atlas humanoid robot platform and designed specifically for this competition. From there, teams will move on to the physical part of the challenge, with trials set for December 2013. The final leg of the contest will be held in December 2014, where teams have their robots tackle an end-to-end disaster scenario — with the winner nabbing a $2 million prize.

While a substantial heap of prize money can certainly be a draw, leaders of most Track A teams (the teams building their own custom robots) say the real impetus for participating in the DARPA challenge has more to do with advancing robotics technology for the good of solving humanitarian problems. A competition serves as a forum to foster innovation and creativity, particularly when the technology challenge is so extreme, notes Anthony Stentz, Ph.D. Stentz is a research professor at Carnegie Mellon University's Robotics Institute, the director of the National Robotics Engineering Center (NREC), and the lead of the CMU-NREC's Team Tartan, which is working on the CMU Highly Intelligent Mobile Platform (CHIMP) robot.

"Challenges do a number of things: They install an element of excitement, and the competition builds lots of energy around a task or project," says Stentz, adding that CHIMP is being designed specifically for the DARPA challenge, unlike some other challengers, which are building upon existing robot designs. "Challenges typically go after a very hard

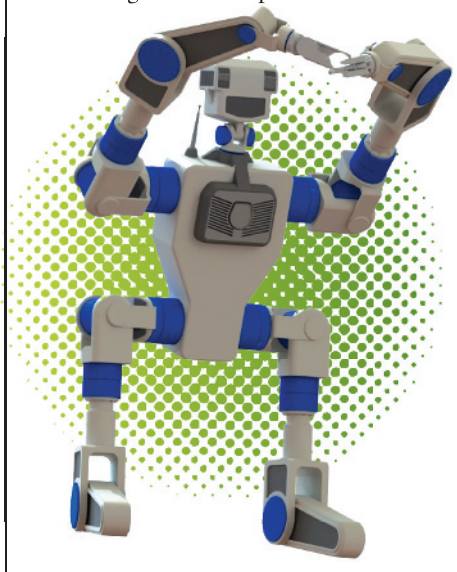
problem, but have a pretty fast-paced schedule. It forces one to take a big bite out of the problem — but not so big that it can't be done."

Meet the Contestants

CHIMP: CMU-NREC's CHIMP depends on four rubber tracks in each of its limbs for locomotion, which affords it much better stability and dexterity when crossing rough terrain or navigating obstacles, Stentz observes.

"Instead of walking over debris, it can drop down onto all fours and drive over it like a tank," he explains. "It's a human form, but without the complexity of control required for a human-like robot."

Specially designed drive joints on all four of CHIMP's limbs support human-like grasping motions, allowing the robot to complete the DRC tasks like operating tools or turning valves, Stentz says. There are also on-board sensors that create a texture-mapped, 3D model of the environment, helping CHIMP maintain stability and avoid collision — while also allowing a human operator to visualize the robot's orientation to aid in control.



Carnegie Mellon's National Robotics Engineering Center's CHIMP will have near-human form factor to work effectively in the environments, yet avoid the need for complex control by maintaining static rather than dynamic stability. *Copyright Carnegie Mellon University 2013.*

"We've figured out what the robot must do automatically without human involvement," Stentz says, explaining that CHIMP is designed with static stability in mind. "CHIMP can automatically detect if it's likely to tip, and it will stop before a collision occurs so it doesn't end up damaged."

THOR: The Tactical Hazardous Operations Robot (THOR) is the Virginia Tech Robotics and Mechanisms Laboratory's entry into the competition. It's designed to look more like a human. The robot, which is based upon prior work, including VT's SAFFiR robotics effort for the U.S. Navy, is battery-powered and employs high-end cameras for vision. It can operate without a control tether, according to Derek Lahr, a Ph.D. candidate in the university's mechanical engineering program and a member of the THOR team, which is headed by Dennis Hong, Ph.D., an associate professor of mechanical engineering at Virginia Tech's College of Engineering.

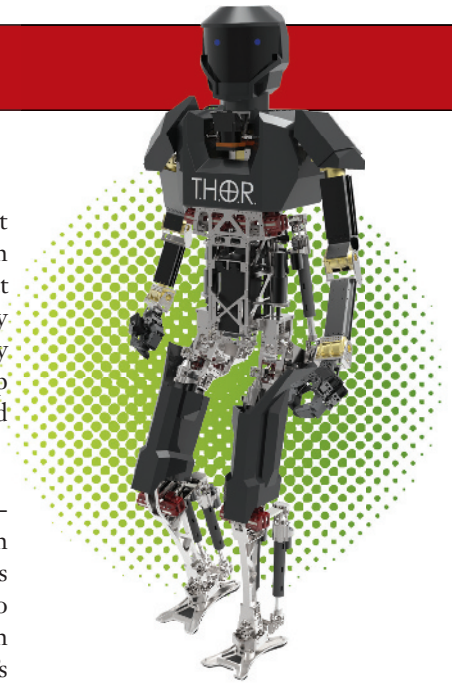
Not only does the Virginia Tech team see opportunity in creating a robot that can aid humanity, it views the DARPA program as a way to push robotics further into mainstream uses like in hospitals and manufacturing settings, Lahr says.

"What makes this unique is creating a robot to operate in environments that are designed for humans," he explains. "The key is making the robot strong enough so it can operate without human intervention in a very challenging environment."

The fact that DARPA is controlling the amount of bandwidth available for communication during the various events in the challenge presents a significant control problem, Lahr says, but there are also considerable obstacles in designing the mechanics and software.

"There is no easy task in this challenge," he admits. The VT team is using Siemens PLM Software's NX 8 and the Gazebo robotics simulation software as part of its development toolkit for creating THOR.

One key design point for THOR is its flexibility and high range of motion.



The Virginia Tech team is emphasizing three essential themes in developing THOR: hardware resilience, robust autonomy and intuitive operation. *Image courtesy of Virginia Tech.*

"A lot of robots these days have smaller ranges of motion than humans because of limits on the mechanical design and the actuators," Lahr explains. "We've been able to get a large range of motion while maintaining a lot of strength."

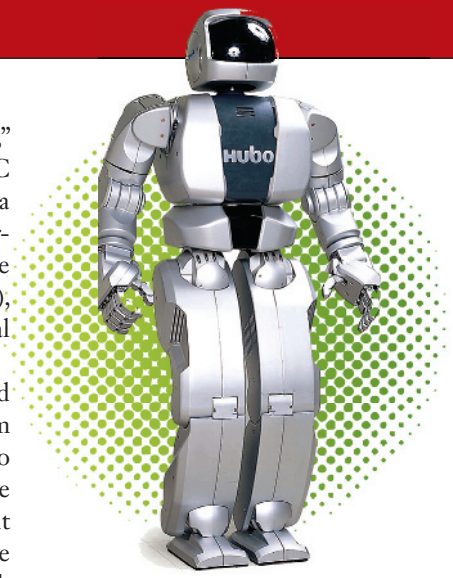
At press time, THOR's CAD model is about 90% complete. Lahr says the team has begun fabrication and aims to complete the physical prototype in August.

Hubo: Drexel University, which is part of a 10-school collaboration, claims to have a leg up on competitors because it is one of only two teams that is actually starting with a working robot, not a design concept. Hubo, which threw out the opening pitch at a Philadelphia Phillies baseball game last year, is a mature and tested design, according to Paul Oh, Ph.D., leader of the DRC Hubo team and a full professor in Drexel's mechanical engineering department. With its hardware design formalized, the Drexel team is turning its attention to coupling its software with the hardware, using its own open source simulator and models to program Hubo.

"We have seven robots ready to go, which enables us to immediately begin

programming, adapting and perfecting," Oh says. Drexel's partners in the DRC include Columbia University, Georgia Institute of Technology, Purdue University and the Korean Advanced Institute of Science and Technology (KAIST), which is a leader in electro-mechanical design.

Currently, Hubo has the form and function of a 10-year-old boy. The team is working to transform that design into something akin to a 19-year-old rescue worker. Says Oh: "We want to make it taller, give it stronger motors, and do the same thing with the hands so it can climb ladders and operate heavy tools."



Drexel University's design focuses on a mature, open-architecture, bipedal robot called Hubo, which is a full-sized humanoid. ***Image courtesy of Drexel University.***

R2: NASA Johnson Space Center is developing a next-generation humanoid robot and control paradigm capable of performing dynamic, dexterous, and perception-intensive tasks in a variety of scenarios. The DARPA contender is based on NASA JSC's prior work on Robonaut, which performed on the International Space Station in 2012.

Guardian: The inspiration for this self-powered, lightweight humanoid robot, to be developed by Raytheon, is based on the team's experience with human-scale exoskeletons. The Guardian robot will expand Raytheon's Exoskeleton (XOS) concept with new technologies in the areas of large range of motion, high specific torque/power actuators, and a rapidly modulated fluid supply for overall power efficiency.

• **Schaft:** SCHAFT's proposal is a bipedal robot based on mature hardware and software designed for its existing HRP-2 robot. SCHAFT will create an Intelligent Robot Kernel that will combine the necessary software modules for recognition, planning, motion generation, motion control, and a user interface.

• **RoboSimian:** Of all the competing robots, the NASA/Jet Propulsion Lab entry into the DARPA challenge takes a different approach, eschewing a traditional humanoid design for a simian-inspired limbed robot. Called RoboSimian, the robot has four general-purpose limbs and hands, all capable of mobility and manipulation.

"One of the things that seems true from an engineering standpoint is there is no inherent proof that a more humanoid shape is better at getting tasks done than a less-humanoid shape," notes Brett Kennedy, supervisor of the Robotic Vehicles and Manipulators Group at JPL.

While RoboSimian is apelike (like an orangutan, Kennedy clarifies), it has no head. Instead, it employs a camera system ringed around the robot to get visibility. It also has no preference for a bipedal form of mobility: The NASA/JPL design emphasizes stability over dynamics and deliberation over reaction.

"Our robot is patient; there is no penalty for it to stop and think about things before it reacts," Kennedy points out. The four limbs, none specified as arms or legs, are arranged in a symmetrical fashion, so there is no front and no back to RoboSimian. It's a design point that grew out of the lab's orbital mobility work, Kennedy says, and one that gives the robot efficiency and minimizes risk.

RoboSimian's design is also all about pushing robotics into the mainstream, so the team has opted to use no exotic materials. They're emphasizing low-cost manufacturability and maintenance.

"We're allowing ourselves to have lower performance componentry with the idea that this is something we can put in the field at the lowest cost as soon as possible," Kennedy concludes. DE

Inspired by an ape-like paradigm, RoboSimian brings human-level mobility and manipulation to disaster areas through the use of four identical limbs. ***Image courtesy of NASA-JPL.***

Beth Stackpole *is a contributing editor to*

INFO

➜ **Boston Dynamics:** BostonDynamics.com

➜ **Carnegie Mellon National Robotics Engineering Center:** www.rec.ri.cmu.edu/projects/tartanrescue/

➜ **The DARPA Robotics Challenge:** TheRoboticsChallenge.org

➜ **Drexel University:** dasl.mem.drexel.edu/DRC/#main

➜ **Gazebo:** GazeboSIM.com

➜ **NASA/JPL:** www-robotics.jpl.nasa.gov/tasks/showTask.cfm?TaskID=236&tdaID=700043

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

➜ **Virginia Tech:** Romela.org/main/Robotics_and_Mechanisms_Laboratory

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Conduct Fatigue Analysis using FEA

Calculating structure fatigue and stresses through finite element analysis can help predict weak spots and other potential problems — before manufacture.

BY TONY ABBEY

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

Fatigue is often cited as the most common form of failure in structures. It occurs at relatively low stresses, below the critical static value. But the stresses are cycling, typically between tension and compression. Early research work was motivated by railway axle failures some 170 years ago — and is still being undertaken to bring a fuller understanding of fatigue.

Cyclic loading applied on a structure will result in cyclic local stresses. A railway axle sees compressive loads in the top and tensile in the bottom of the shaft. Rotating 180° reverses the local stresses. A further 180° gives the original local stress state.

The cyclic stress history becomes important when it occurs at a potential crack initiation site. This can be any microscopic level defect or void inherent in the material or introduced by machining or other environmental effects. Damage is accumulated during the loading history of the component. If the damage grows beyond a critical point, the crack will initiate.

Fatigue analysis does not introduce a crack into the finite element model. Instead, it assesses the stress state together with loading and environmental factors for potential crack initiation. A fatigue "failure" is an indication that a crack will start. No calculation is made to explore subsequent crack growth.

A finite element analysis (FEA) is carried out to find local regions of high stress under operating conditions. The maximum and minimum stresses under cyclic loading are considered.

Fig. 1 shows a cyclic stress variation. The stress range spans the most positive and negative stresses. Stress amplitude oscillates about a mean stress level. A stress cycle, then, occurs between adjacent peaks.

The number of stress cycles, together with the stress amplitude, dictates the fatigue life of the structure.

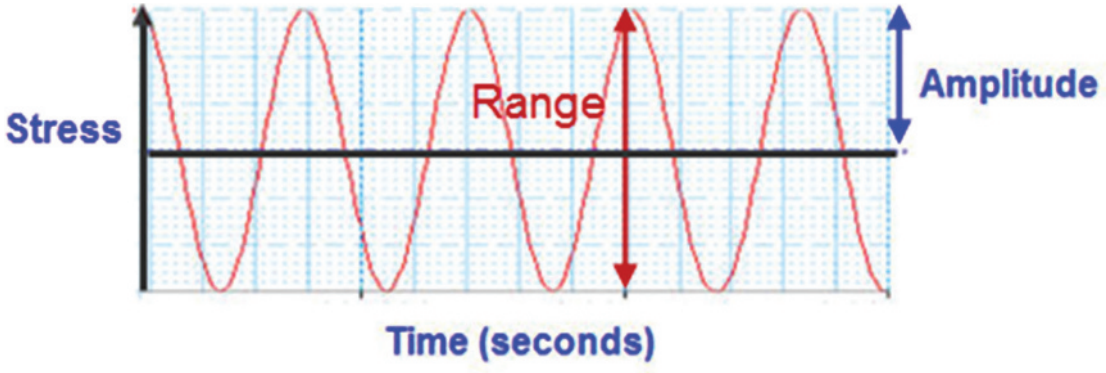

FIG. 1: Typical local stress history.

High-frequency loading is seen in a rotating machine tool. Wave loading on an offshore oil platform is low frequency. Fatigue life could be measured in terms of hours or years, respectively — with both having a similar cycle count at failure.

Early test data showed a distinct relationship among the stress amplitude (S), the cycle count (N) and the expected fatigue life. This led to the early adoption of the SN curve to predict fatigue (see Fig. 2).

For a stress amplitude (Si) , the number of cycles to failure (Ni) can be calculated. There is a cutoff in the slope at 106 or 107 cycles, described as the endurance limit. This indicates very low stress amplitudes could achieve an infinite fatigue life. Steels exhibit this behavior. In practice, loading, geometrical and environmental modifiers discussed later may prevent this.

Environmental and Loading Considerations

There are quite a few caveats with the SN curve, however. There is a wide scatter in test results, and the curve is drawn so that 50% of test results lie equally above and below. For more conservative life estimates, a lower percentage line is used.

The test results are for a specific material, condition, environment and loading type. A "raw" SN curve is a baseline on which to apply further factors to obtain a realistic life assessment.

Test specimens are often defined as smooth polished. This standard of finish is unlikely in any manufacturing process, so degradation factors are applied to the SN curve. Cast or forged components will have more degradation than high-quality machined parts.

Other factors have to be assessed and applied. This is probably one of the biggest uncertainties in fatigue calculation: It is easy to enter inappropriate data into a friendly graphical user interface (GUI) and overestimate the fatigue life. My recommendation is to seek training or advice, and obtain a good textbook such as "Fundamentals of Metal Fatigue Analysis" (Bannantine, et al. Prentice Hall 1990. ISBN 0-013-340191-X).

Many manufacturers and certification organizations go further than material specimen tests, which are difficult to match to actual conditions. Component tests allow more specific understanding of factors affecting fatigue life. A full-scale fatigue test may be used on the complete assembly. Finite element analysis plays an important role in helping to correlate stresses (and hence, fatigue) at each level.

High-cycle vs. Low-cycle Fatigue

If local stresses are low enough and within the elastic region, a component may have a long fatigue life measured in hundreds of thousands of cycles. This was the scenario in the early fatigue work with railway axles, pressure boilers and the like.

This is known as high cycle fatigue. The classic SN curve as described earlier is the main tool. One caution here: Although the SN curve shows a stress at 1,000 cycles, this is simply a lower datum point on the curve and should never be used. If a stress level is indicating a fatigue life below about 50,000 cycles, then the SN curve is not be appropriate and we should investigate using the following alternative method.

In some cases, the loading is more severe and local stresses, at a crack initiation site, do go plastic for at least part of the loading cycle. At this level of loading, the number of cycles to failure is much lower. It could be of the order 50,000 cycles, or even as low as 50 cycles.

This is referred to as low cycle fatigue. It is more recent technology only possible when plastic influences were better understood. Now stress in a load cycle is characterized by both its elastic and plastic response. This produces a nonlinear stress-strain hysteresis loop (see Fig. 3). The amount of plasticity is judged by the "fatness" of the hysteresis loop. A purely elastic cycle is simply a "skinny" linear stress strain curve.

A strain-based approach is used to characterize the load cycle response. Inside a component at the local high stress region, the local material sees a displacement or strain controlled loading from surrounding material. The elastic and plastic strain components can be calculated to give the total strain range across the loading cycle. A maximum and minimum strain replaces maximum and minimum stress.

The EN fatigue life curve is used, shown in Fig. 3. It is similar to the SN curve, but uses strain amplitude. The intercept of the strain amplitude with the EN curve establishes the number of fatigue cycles to failure. Confusingly, the theory and curves are developed in terms of load reversal, equating to half a load cycle, and strain range, which is twice the strain amplitude.

Low cycle fatigue (EN) calculations can predict fatigue lives as low as a few hundred cycles. Using this approach with low stress levels is fine, as only the elastic portion of the elastic/plastic analysis is used and is equivalent to an SN solution.

Mean Stress Effects

For the SN approach, the level of mean stress within a stress cycle is important. If both maximum and minimum stresses are tensile, every part of the loading cycle has a tendency to open and develop a crack. Conversely, if both are compressive, the crack can't open. In other words: Compressive stresses are beneficial, and a compressive mean stress will extend the fatigue life. A tensile mean stress will reduce the fatigue life.

Mean stress effects are incorporated via an equivalent amplitude stress with zero mean. The basic SN curve can then be used having corrected for mean stress.

Correction methods are also used for the low cycle fatigue calculation using the EN curve; however, these tend not to be so important, as the influence of mean stress is reduced in the presence of plasticity.

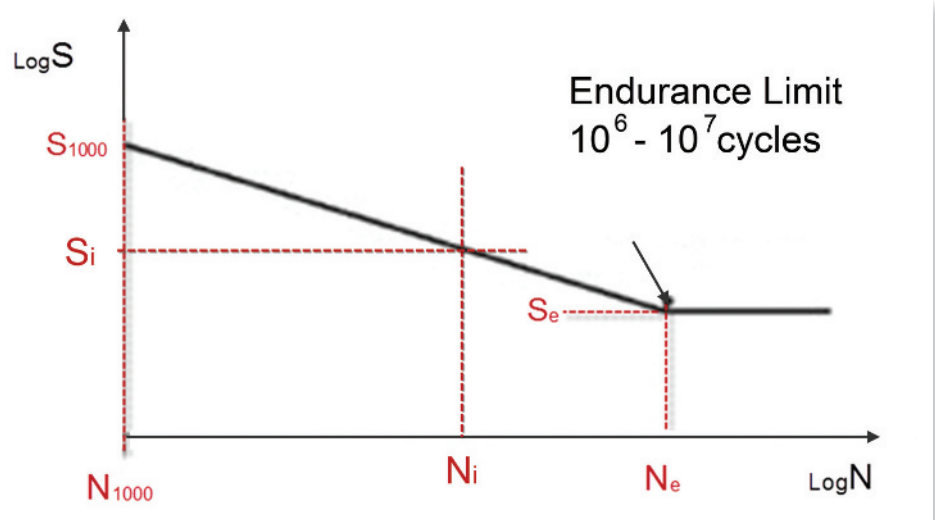

FIG. 2: Stress amplitude vs. fatigue life in cycles.

Notch Effects

Peak stress levels can be concentrated at very local features, such as a notch or hole. High cycle fatigue can be too conservative using these stresses. The local fatigue mechanism is influenced by factors ignored at the macro level, including notch size, stress level, stress gradient, etc. The stress concentration factor (Kt) is the ratio of elastic peak local stress to average or nominal stress.

Instead of using this, though, a term called the notch factor (Kf) is used. It tends to blunt the elastic stress result and give a longer life. Calculating Kf is complicated, and relies heavily on empirical methods with extra

data on notch size, stress gradient and other factors required for estimation.

Low cycle fatigue with more extensive local plasticity tends to blunt the effect of a notch even further. A typical correction methodology uses the Neuber relationship to establish an energy balance between the nonlinear stress strain curve of the material and the local plasticity in the notch.

Unscrambling Load History

Fig. 1 shows a constant amplitude loading. The amplitude and the mean stress level may in fact vary under loading. This may occur in natural blocks of loading, or it may be a random series of events.

For block loading, each block is dealt with separately. The mean stress correction is made and the number of cycles (N) that can be endured at the stress level (S) is found. The ratio of actual cycles seen in this block, n, compared to the total that can be endured, is n/N. This fraction is called the damage ratio. If n/N equals 0.5, then half the fatigue life is used up in that single block.

The damage ratio from each of the blocks is summed. If total damage is less than 1.0, there is adequate fatigue life. This accumulation process is called Miner's Law.

Miner's Law ignores sequencing effects, so a single large load cycle can occur at the beginning or the end of the loading history. In practice, early large levels of load often bring beneficial compressive residual stresses, increasing the fatigue life.

With a more random loading history, a process is required to synthesize equivalent pairs of peaks. One method is rainflow counting. We imagine the load history turned on its side and water dripping down the positive and negative faces. The peak that juts out more will capture a rain drop. That peak is tagged and removed from the load history. A second drip identifies the next highest peak, which is tagged and removed. This process continues until all peaks are removed and is done on both faces. Corresponding peaks from each face are paired to give equivalent cycles.

A similar process is used for low cycle fatigue, but is more complicated because equivalent stabilized hysteresis loops are synthesized.

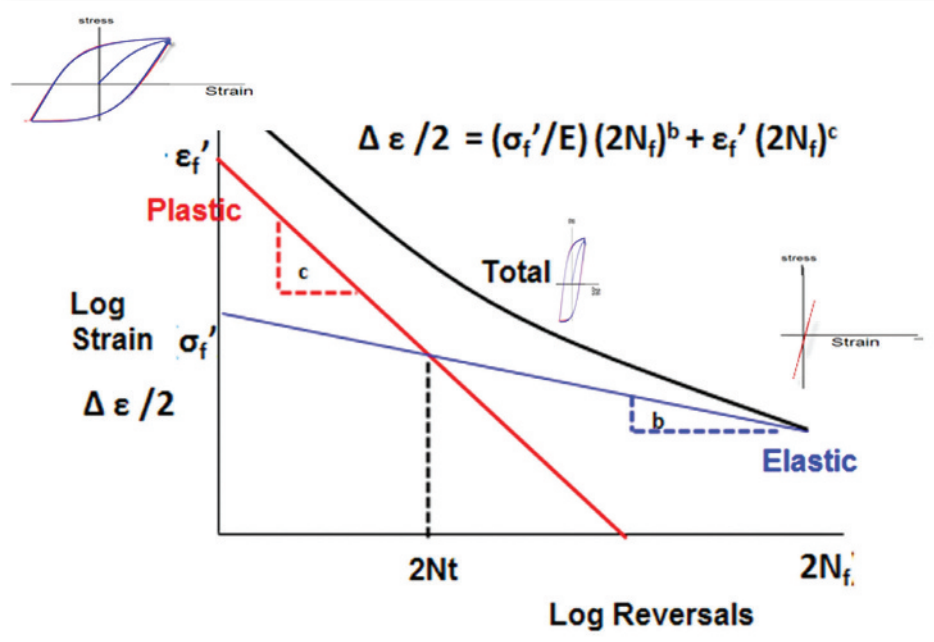

FIG. 3: Low cycle fatigue EN curve showing plastic and elastic contributions.

Going Further

This is a just a brief overview of some of the essential points of fatigue analysis using FEA. Fatigue analysis gets more complicated if the loading history is not a simple linear scaling of one applied load. This leads us onto multi-axial fatigue analysis, which is very much at the cutting edge of technology. Other specializations not described here include fatigue of seam welds, spot welds and bolted joints. Special-purpose, FEA-based tools have been developed to deal with these.

Finally, to investigate a specific crack and evaluate how it will propagate further or stabilize we turn to a complementary analysis methodology: fracture mechanics. DE

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Technology 'Drivers'

Test benches address advanced driver assistance systems with greater efficiency.

BY RANDY FRANK

Carmakers and their suppliers continuously confront greater complexity in their vehicles — as well as the need to reduce time to market, contain costs, satisfy customers and cope with increased regulatory pressures. One of the newest approaches for improving vehicle safety, advanced driver assistance systems (ADAS), involves all of these aspects. It has also attracted global interest: Market research firm ABI Research projects global ADAS revenues to reach $460 billion by 2020, up from $22.7 billion in 2012.

While addressing the increased complexity of ADAS, test benches save time and reduce the cost of developing these systems. New technologies rely on sensor systems to alert drivers to dangers, such as potential collisions, inadvertent lane changes and blind spots. Testing these systems to satisfy carmakers' quality requirements and meet regulatory safety requirements takes frequent rounds of physical testing. Virtual test benches have demonstrated the capability to reduce the amount of real-world evaluations.

Festooned with vision, RADAR, LIDAR and other sensors, Carnegie Mellon University's Boss vehicle was the winner of the 2007 DARPA Urban Challenge. *Image courtesy of Tartan Racing.*

Defining/Specifying ADAS

Perhaps the safest vehicles are those that take the driver out of the equation. In spite of the success of innovations such as the 2007 winner of the Defense Advanced Research Projects Agency (DARPA) Urban Challenge for a vehicle to complete a course without driver interaction, Carnegie Mellon University's Boss vehicle developed by Tartan Racing, and Google's self-driving car, these vehicles are a long ways away from consumer sales. The Association for Unmanned Vehicle Systems International (AUVSI) is working toward having autonomous vehicles as a viable means of transportation by 2022.

Autonomous vehicles are the ultimate implementation of ADAS technology. Today, many aspects of ADAS are already on high-end vehicles. Vehicle original equipment manufacturers (OEMs) and their suppliers use test benches from different software tool companies as well as their own custom solutions to bring systems to market sooner — and with lower and/or contained costs with each successive generation of technology.

For development and verification of system design, automotive OEMs and their Tier I suppliers use the V-model. This tool helps ensure that the system meets design specifications — and that it performs as anticipated.

ADA on the Way

Advanced driver assistance systems that have already been implemented in production vehicles or are in development for near-term vehicle introduction include:

- Adaptive Cruise Control
- Adaptive Headlights
- Autonomous-emergency Braking (AEB)
- Blind Spot Detection
- Collision Warning/Mitigation
- Driver Monitoring System
- Lane Departure Warning
- Night Vision
- Pedestrian Safety/Protection
- Rearview Camera

"When you look at the whole broad spectrum of modeling, there is the design side and then there is the verification side," says Jim Raffa, global engineering director for driver assistance systems at Magna International's Magna Electronics operating unit. "When you think about test benches, it really is more on the verification side and simulation side."

Mark Lynn, chief engineer of active safety at Delphi Automotive Systems, notes there are four different phases of verification "that we would do for an active safety product or feature that will use them. A few of them are pretty common with any controller that you would apply to a vehicle."

Hardware-in-the-loop (HIL) verification and vehicle performance testing are areas more specific to active safety systems. "Those are the things where there are unique methodologies that we do that are different in active safety than we would do in a body controller or crash-sensing controller," says Lynn.

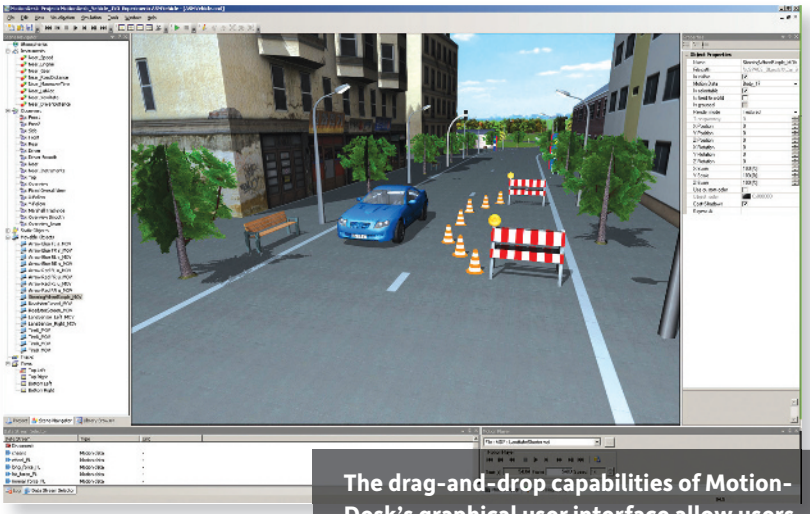
Visualizing the Environment

Unlike many other vehicle systems, ADAS depends on visual inputs to determine how the systems react. One of the ways to evaluate that visualization is through a tool such as dSPACE MotionDesk. MotionDesk reads the data from simulation tools and animates movable objects including the vehicle, wheels, steering wheel and more in real time in a virtual 3D environment.

A new rendering engine substantially improves the visualization capability of MotionDesk. According to Holger Krumm, product engineer test and experiment software product manager at dSPACE, MotionDesk's rendering capability has been increased from 20 to 60 Hz. "Now we are directly scaling with modern graphics hardware," says Krumm.

Customers perform the scene management and determine how the expanded capability is used. For example, complex trees take a lot of rendering time, so the customer may or may not choose to have them in the scene. "The customer can adapt his scenarios so they are running at his desired frame rates," says Krumm. "Our functionality to making it possible to fix it, for example to 20 or 30 or 60 Hz, comes directly from the demands that the camera system needs to steady."

In Europe, the Ford Focus is one of the cars with the largest portfolio of functionality for driver assistance systems. Its cameras need 30 Hz, in contrast to modern stereo cameras that need at least 60 Hz, Krumm offers



The drag-and-drop capabilities of MotionDesk's graphical user interface allow users to add elements to the scene.

as an example. The improved capabilities of MotionDesk allow the evaluation of multi-track maneuvers.

HIL Testing

With HIL, the visualization of a vehicle dynamic situation allows system engineers to easily determine whether the vehicle is behaving properly or drifting to one side or another.

MotionDesk's hardware access panel allows a simple connection to a HIL simulator to obtain information about a maneuver, as well as model and generated scene information to visualize the car's reaction. "If we are talking about vehicle dynamics, you can do this for every mechanical system," says Krumm.

Rather extensive collaboration and partnering occurs in software tools for the automotive space. For example, Mentor Graphics products can address some of the ADAS problems, including HIL simulations; it works in close cooperation with other tool suppliers. The company's System Vision allows users to model, simulate and analyze mechatronics systems.

"What we provide gives you the fidelity of the model you are trying to simulate in representing the physics of what you are trying to represent," says Subba Somanchi, principal engineer in the System-Level Engineering Division of Mentor Graphics.

Berner & Mattner's recently released MESSINA, a 3.7 test platform for HIL and software-in-the-loop (SIL) tests, also supports closed-loop evaluations. The tool allows vehicle OEMs and their suppliers to perform automated evasive maneuver testing in the laboratory. The simulation of real-time driving scenarios takes advantage of MATLAB/Simulink C-API (version 2011a) with a standardized interface.

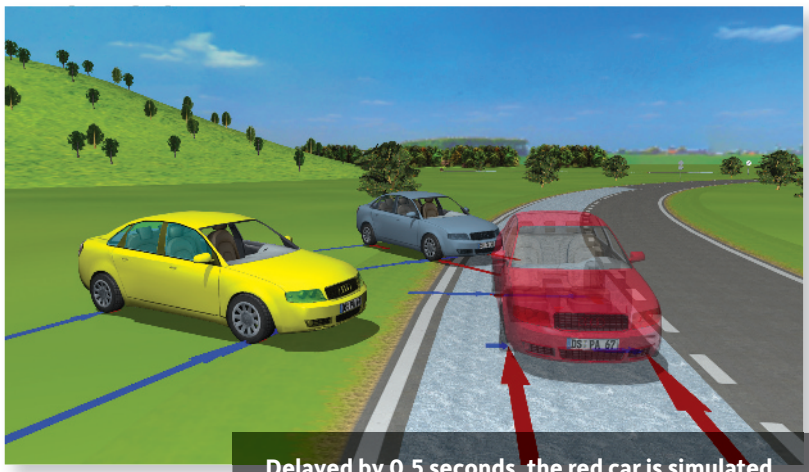
Delphi's Lynn acknowledges that HIL testing is typically done at the vehicle OEM. Delphi engineers use the OEM's setup because it requires all of the control units that go on a vehicle, and it is performed on a tabletop rather than in a vehicle. "It's there that you can really test things like closed-loop control algorithms," he says. "When we are talking about algorithms for auto braking or adaptive cruise control, then you need that level of interaction."

Rolling Their Own

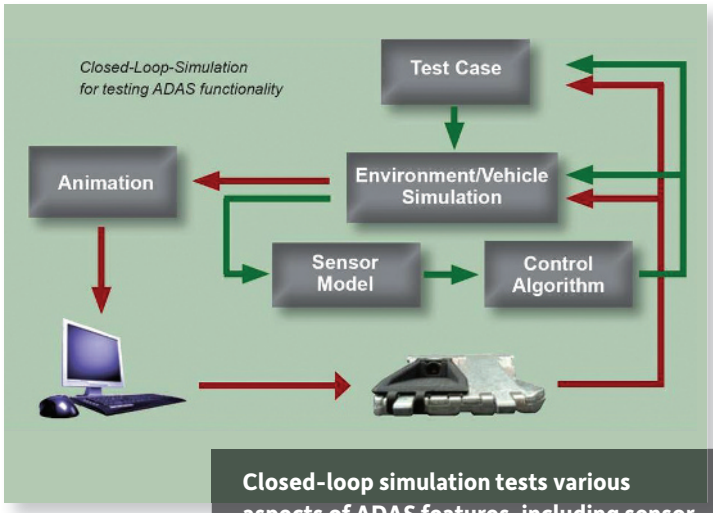
Even with all the tools and test benches that the software industry provides, some automakers and their Tier I suppliers still develop their own custom solutions. For example, Delphi's data visualization (DV) tool is a custom product developed over eight generations of active safety systems.

"We use it to collect data in a particular format, and visualize what the sensor sees around the vehicle," says Lynn. "The purpose of collecting all this data is, in the process of doing this, you are going to surface performance issues."

After performing real-world profile testing and collecting large quantities of data, Delphi engineers develop



Delayed by 0.5 seconds, the red car is simulated with Electronic Stability Program (ESP) support and stays on track. The yellow and grey car were simulated without ESP support.



Closed-loop simulation tests various aspects of ADAS features, including sensor models and the control algorithms.

test scenarios to evaluate ADAS features. For some functions, such as collision-imminent avoidance with full authority braking, this can involve as much as 1 million km of data collected in the real world to demonstrate the right level of confidence in the system for functional safety. The bench testing seeks to answer critical operational questions.

"Does the system actuate in the manner that you want when it is supposed to, and does it provide the right level of performance?" Lynn notes. "Then you have the reverse of that: You want to make sure that the system doesn't actuate when it shouldn't under all conditions. And that's almost the more important of the two criteria."

Magna International also develops its own custom test benches. "As we move forward, we've been putting together our own hardware-in-the-loop type systems that will record and play back video," says Raffa. "We're also working on systems that will record external driving information like location and weather conditions."

The extent of custom tools depends on how well software tool suppliers have addressed the individual requirements of automotive suppliers.

On the Horizon

So, what's the bottom line on software tools and testing when it comes to cost and time?

"The primary driver for extending ADAS for more volume, more broader applications across vehicles is generally going to be component cost or regulatory drivers — and those things are happening today," says Lynn. "But it does address our ability to reduce the development cost steps. That's an element of the final price to the OEMs. It's not a huge factor, but it is a factor."

Reduced vehicle testing through the increasing use of test benches contributes to reducing development time and costs. "We use modeling and simulation tools throughout the development process to reduce our development time, and ultimately our development costs," says Raffa.

Time is perhaps a more significant factor to Tier I suppliers and their automotive customers, he points out.

"Anytime you can reduce the amount of time I have to spend in a vehicle — and you do have to verify these algorithms in a vehicle — but if you are able to spend that time in a vehicle, create a video library of all these different drive scenarios, and then be able to play those back on the bench, it just saves a tremendous amount of time," says Raffa.

After developing eight generations of ADAS technology, Delphi's Lynn sums up the time-to-market situation. "It is difficult to measure what the time-to-market reduction is, but all the things we've learned over time and all of the tools that we've implemented, have been mechanisms, methods to allow us to meet the increased expectations from vehicle OEMs for faster and faster market introduction," he concludes. "It's been to keep pace with their growing expectations." DE

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

INFO ➜ ABI Research: ABIResearch.com

➜ **Association for Unmanned Vehicle Systems International:** AUVSI.org

➜ **Berner & Mattner Systemtechnik GmbH:** Berner-Mattner.com

➜ **Defense Advanced Research Projects Agency:** DARPA.mil

➜ **Delphi Automotive Systems:** Delphi.com

➜ **dSPACE:** dSPACE.com

➜ **Google test-driven car (video):** Youtube.com/watch?v=J3l5X3gYHPo

➜ **Magna Electronics, an operating unit of Magna International:** Magna.com

➜ **MathWorks:** MathWorks.com

➜ **Mentor Graphics:** Mentor.com

➜ **Tartan Racing:** TartanRacing.org

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Saving Fuel Saves Lives

The U.S. military consumes almost incalculable amounts of diesel and gasoline. The U.S. Army Tank Automotive Research, Development and Engineering Center is looking for ways to reduce that appetite.

BY MARK CLARKSON

The U.S. military has been operating a test fleet of hydrogen fuel cell vehicles on the Hawaiian island of Oahu for about two years now. The joint project is funded by the Office of Naval Research, the Air Force Research Laboratories and the U.S. Army Tank Automotive Research, Development and Engineering Center (TARDEC) in cooperation with General Motors.

"The vehicles are Chevy Equinoxes," says TARDEC project engineer Steven Eick, "with the engine and powertrain replaced with a fuel cell and electric drive, and the gas tank swapped out with high-pressure hydrogen storage tanks. Other than that, they're unchanged for the most part."

Well, there's also the contemporary camouflage and the words "FUEL CELL" written large across the doors and windshields. "That's part of our marketing," says Eick. "We want people to identify them as fuel cell vehicles.

"We're looking at durability and performance over time," Eick continues. "We wanted to get a large enough sample size so we felt comfortable with the results."

The program has 16 fuel cell vehicles deployed on Oahu — five in the Navy, five in the Air Force, and six in the Army. All are running the same GM-developed electric motors and 100 kW proton exchange membrane (PEM) fuel cells. The island provides a convenient location for all three services to work jointly, sharing information … and hydrogen.

The Challenge of Hydrogen Gas Stations

Each of the three services has built or is building a hydrogen refueling station on Oahu.

"One of the reasons we wanted to focus our efforts here," says Eick, "is we would be able to cover the entire island with just three stations."

And yet the biggest challenge has been the availability of hydrogen fuel. "We definitely haven't had as much success in getting full-fledged refueling systems in place as we had anticipated," he admits. "They are very complex systems, and take a lot of design and approval from the base. You're storing a large amount of flammable gas under high pressure. On top of that, you have to do a very controlled refueling, controlling the rate of flow of hydrogen, so you're not generating excess heat or pressure, and a lot of that is control system structure that has to tie in with all the safety factors. All that has to come together in one location."

Moreover, Eick says, the design and control is different from station to station, depending on available equipment, refueling protocol and the vehicles being refueled.

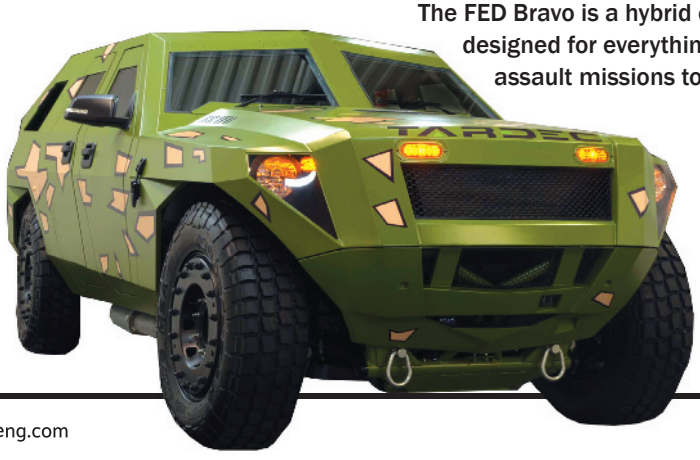
The vehicles' fuel tanks hold about 5 kg of gaseous hydrogen pressurized to 10,000 psi. That idea is bound to make some people nervous.

"People did have a bit of learning to do to get comfortable with hydrogen," Eick states. "That's part of what this program is about — introducing people to the technology, getting them familiar with hydrogen the same way people had to get familiar with gasoline.

"We provide training to first responders, to drivers, to any individuals that have an interest — to let them know what the safety factors involved in the vehicle are."

Performance Results

Despite seeing a lot of use on installations where the top speed is about 35 mph, the vehicles deliver between 25 and 40 mpg — nearly double that of standard vehicles in the same roles. (1 kg of hydrogen is roughly equivalent to 1 gal. of gasoline.) And they're holding up very well.



The FED Bravo is a hybrid electric vehicle designed for everything from urban assault missions to convoy escort.

"We've seen about 98% availability of these vehicles," says Eick, adding that's as reliable as any standard vehicle in the government fleet.

Unlike, say Humvees, these vehicles are intended strictly for administrative use. "We're trying to demonstrate the technology in real-world situations with the soldiers," says Eick, "without it being in our tactical vehicles. In the short term, we don't want to add a second fuel for our combat and tactical vehicles."

The FED Method

Because practical hydrogen power is still a ways off, TARDEC's Fuel Efficient ground vehicle Demonstrator program (FED) takes a very different approach to weaning the military off of diesel. Two very different approaches, in fact — using conventional fuel in less-conventional vehicles.

"The idea of the FED program," says FED Team Leader Carl Johnson, "was to create a concept vehicle that was as fuel-efficient as possible but could still do a military mission. I couldn't deliver the University of Michigan solar car; that really doesn't have any military function."

TARDEC took basic requirements from the military's Humvee and Joint Light Tactical Vehicle (JLTV) and boiled them down to a small set: acceleration, braking, passenger capacity, etc. Using those requirements, they developed two different fuel-efficient vehicles — the Alpha and Bravo — in two very different ways.

The Alpha's development was analytical, with tons of computer models running hundreds of thousands of simulated miles to determine the fuel efficiency sweet spot. "It was a very rigorous, textbook, system engineering approach," says Johnson.

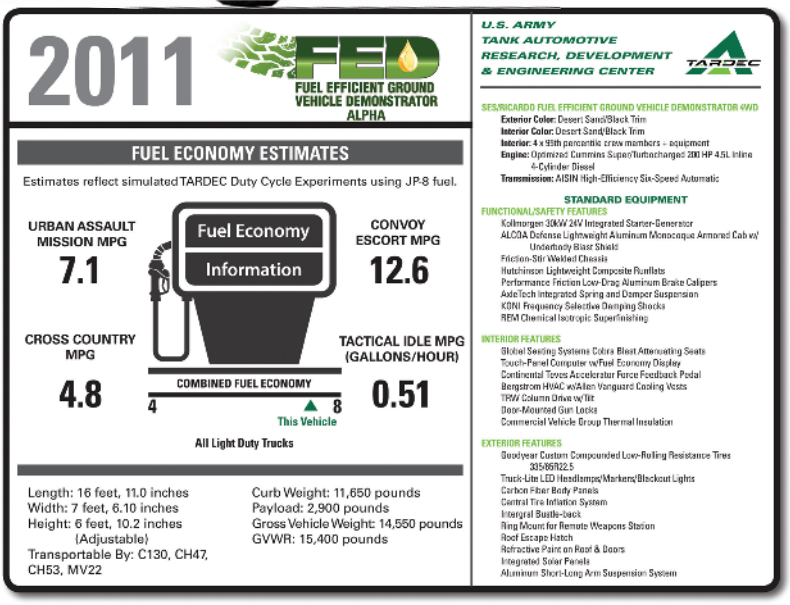
The Bravo's development was much more subjective. "I call it the 'Monster Garage process,'" says Johnson. "We took a lot of very smart people [who were] subject matter experts, threw them in a room and said, 'If you were going to make a vehicle fuel efficient, how would you do it?'"

The resulting Alpha is a conventional vehicle, with a modern diesel engine and six-speed transmission. Bravo is a parallel, road-coupled hybrid electric vehicle with an electrified front axle, and an electrified and mechanical rear axle.

Simulations showed the Alpha getting 70% better fuel efficiency than a Humvee, while the Bravo vehicle showed a 90% improvement. The Al-

Key features of the FED Bravo. Instead of city and highway miles, the fuel economy label on FED vehicles includes urban assault, cross country and tactical idle.

The FED Alpha uses a modern diesel engine and high-efficiency six-speed automatic transmission to achieve 70% better fuel efficiency than a Humvee.



Key features of the FED Alpha. That's right, kids — it's got an integral bustle-back and an escape hatch.

pha's trip through the Army's Aberdeen Proving Ground (APG) yielded real-world results that were actually slightly better than the simulated numbers.

Seventy percent improvement is pretty good, but if you want that extra 20% the Bravo gets you, it comes at a very high complexity cost. "Because it's a hybrid system," says Johnson, "you need a battery pack, and you need a cooling system for your electronics, battery pack and motors. It gets very, very complicated. But it gets you very, very high fuel efficiency."

Belts Begone

The team took a whole system approach to wringing fuel economy out of the more standard Alpha, without degrading performance.

"We got rid of all the belt-driven accessories on the front end," says Johnson. "The air conditioning compressor, the power steering, the water pump. All those things have been electrified so they can be controlled and turned on and off as needed."

Both vehicles sit on aluminum frames from Alcoa, and roll on custom Goodyear low rolling resistance tires — the only low rolling resistance tires Goodyear has ever made for the military. Aerodynamic touches were added where possible.

It all adds up, Johnson reports, but then there's the human factor: "You can [achieve] all these incremental 5% improvements, and a bad driver will wipe all that out."

He cites studies done by the over-the-road trucking industry that show the difference in fuel efficiency can vary as much as 30% among drivers.

"Most of our drivers are 19-, 20- and 21-year-old kids, and they're probably going to be driving the vehicle inefficiently," he says.

A vibrating gas pedal warns of low fuel economy, but driver training is a bigger part of the equation. "It's not a comfortable feeling to refuel out in the middle of someplace you can get shot at," says Johnson. "If you tell them, 'Drive more efficiently and you'll have to refuel less,' that gets through to them."

Life-saving Efficiency

"Look at what's delivered to the battlefield most," Johnson continues. "Everybody thinks it would be bullets; it's actually fuel and water. I can't tell the soldiers to drink less water, but if I can improve fuel economy so there are fewer convoys, fewer soldiers in harm's way." In fact, he says, a mere 1% increase in fuel economy translates into 6,000 fewer soldier trips in fuel convoys.

"It compounds as you roll out fuel economy savings across your fleet," says Johnson. "You need fewer mechanics. Fewer truck drivers. That's fewer soldiers I have to deliver water and food to. That logistical footprint gets smaller and smaller."

"It's good that we will be saving taxpayer dollars," says Army contractor John Wray. "And it's good that we're being solid stewards of our environment. But it's great that, through fuel efficiency, we'll be saving soldiers' lives." DE

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

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Change Brewing in the Power Game

Intel Haswell's promise of lower power and longer battery life prompts new views on HPC and professional workstations.

BY KENNETH WONG

At press time (mid-May), Intel Haswell was still a month away from its scheduled public release. Haswell is, in fact, just a codename, not an official brand. The product is the fourth-generation Intel Core architecture, a successor to the third generation Ivy Bridge. Processors built on Haswell are expected to first appear in Intel's consumer product line (branded Core i). Following Intel tradition, the same architecture is also expected to spawn processors for the professional workstation and server markets.

The details of Haswell reported in the media have come primarily from presentations at the Intel Developer Forum during the past two years. Keynotes from the International Consumer Electronics Show (CES) and other events have shed more light on Intel's plan.

Taking the stage at Intel Developer Forum 2011 in San Francisco, Intel CEO and president Paul Otellini shared the company's processor roadmap.

"Haswell was designed to enable a 30% (improvement) in connected standby power over the currently shipping notebooks using our second-generation Core microprocessors," he said. "We've targeted Haswell's design not just for lower power, but for architecting a system-level power management framework that … has the opportunity to reduce the platform power by a factor of more than 20 over our current design. We'll do and deliver all of this without compromising any of the performance you've come to expect from today's mainstream notebooks."

Haswell's design could lead to more than 10 days of connected standby battery life for lightweight, portable devices, according to Intel: "The advancements will aid in delivery of always-on-always-connected computing where Ultrabooks stay connected when in standby mode, keeping the e-mail, social media and digital content up-to-date" ("Intel CEO Outlines Company's Plans to Lead Future of Computing," Sept. 13, 2011, Newsroom.intel.com).

In a consumer market dominated by tablets, smartphones and lightweight notebooks, Haswell's promise of low power and longer battery life is music to buyers' ears. But the anticipation is also spilling into professional workstation and high-performance computing (HPC) markets, as original equipment manufacturers (OEMs) begin contemplating Haswell-integrated systems and servers.

At Intel Developer Forum 2012, Dadi Perlmutter, executive vice president and general manager of Intel architecture group, showcases a lightweight notebook as he discusses fourth-generation Intel Core architecture's low power consumption and longer battery life.

A Thin, Cloudy Future

Intel is betting heavily on the Ultrabook — a thinner, lighter type of subnotebook — as the future of day-to-day computing. The company has, in fact, trademarked "Ultrabook" as its brand. Haswell's architecture is expected to be the driving engine behind this slim-computing vision.

At Intel Developer Forum 2012, Dadi Perlmutter, executive vice president and general manager of the Intel architec-

The Dell Precision T1700 is available as a small-form factor (far right) or mini tower workstation, both of which can be ordered with the new Haswell 4th Generation Intel Core or Xeon processor E3-1200 v3 product family.

ture group, demonstrated a working prototype of Haswell by comparing the performances of two Ultrabooks: one running on present-day Ivy Bridge architecture, the other on Haswell.

"The great thing about this one [Haswell] — it was designed with mobility in mind," he said. "As the world moves to more and more mobility, I've been challenging the team to go figure out how to fit Haswell into something like this," he added, as he held up an ultra-slim notebook.

This January at CES, Kirk Skaugen, Intel's corporate vice president and general manager, PC Client Group, showcased a concept laptop called Northgate — a standalone tablet with a detachable dock — running on Haswell processors. "Haswell is the first product to develop with the Ultrabook in mind," noted Skaugen. "The other ones were things we had to retrofit."

The same Haswell technology is also destined to appear in the Intel Xeon E3 processors, according to reports emerging from Intel Developer Forum in Beijing. Xeon E3 targets the low-cost server market. Such clusters, especially when augmented with power efficiency, could be attractive solutions for vendors offering cloud-hosted solutions.

Because of their memory bandwidth and comparatively low CPU frequencies, current mobile tablets in the market are not considered ideal for running CPU-intensive design and engineering programs (for example, CAD, simulation and rendering software). However, Haswell's mobile-ready architecture could lead to the development of tablets with sufficient power to facilitate professional design operations now performed on desktop workstations.

OEMs Planning Ahead

Tim Lawrence, BOXX Technologies' vice president of engineering, observes that "Haswell is a good fit for some areas in the professional workstation market. There are many professional applications that cannot use more than a few CPU cores, and are therefore very dependent on CPU frequency and individual core performance. Regarding these applications, BOXX foresees Haswell as a significant platform for our entry-level through XTREME performance tiers."

BOXX is planning to offer Haswell-powered mobile workstations, desktops and overclocked workstations under its BOXX XTREME brand.

Dell recently announced its new Haswell-based workstation, the Precision T1700, which it calls the smallest and lightest workstation in its class.

Eliot Eshelman, Microway's senior technical account manager, notes that "Haswell will be the foundation for the majority of our products once the server chips are released. Haswell will be in our high-performance WhisperStations and traditional HPC compute clusters."

Even though Haswell's launch was still six weeks way when he spoke to *DE*, Tau Leng, vice president of corporate marketing and HPC at Supermicro, reveals that "We have over 50 solutions optimized for Haswell ready to ship." The advance preparation is partly to allow Supermicro's partners to develop and validate their solutions for maximum compatibility and performance.

"Haswell's lower power 3D transistor technology delivers more cores, better memory performance and higher efficiency," Leng says. "In some applications, we've seen more than a 30% gain in performance and power efficiency when combined with our overall system architecture."

David Okada, senior marketing manager for Supermicro, highlights the company's 3U (8, 12 or 24 node) MicroCloud as a unique platform optimized for Haswell.

"MicroCloud maximizes the advantages of low-power processor technologies with high-density integration in a cooling zone-optimized, easily serviceable modular design," he adds. "Haswell-based MicroCloud systems will offer enhanced performance, and even more cost-effective utilization of space and power with support for the full range of Intel Xeon E3-1200 v3 processors as they become available."

At CES, Intel's Skaugen revealed some Haswell processors could run on as low as 7 watts. BOXX's Lawrence says his firm foresees "a significant power advantage" with Haswell. BOXX is among the few suppliers offering overclocked systems. Overclocking allows the system to run the processor at a faster speed than manufacturer-specified speed, but it requires careful balancing of the thermal output and performance gain. Power-

efficient Haswell processors are expected to give BOXX more possibilities for overclocking.

Individual Haswell processors may use less power, but Microway's Eshelman cautions that might not be the case with all clusters built with Haswell processors.

"For those who are concerned with the overall heat generation and power consumption, I'm sure Intel has low-power variants [of Haswell server products]," Eshelman says. "But the highest-performing options, I'm guessing, will take a few more watts."

When calculated in performance gain per watt, the newer Haswell processors will prove to be a better bargain, he adds. Either way, power is a negligible factor for his customer base: "Our customers regularly use 115W, 135W and sometimes even 150W chips. Except in the largest clusters, they're not going to quibble about 10 more watts."

For Graphics-hungry Users

Intel's Ivy Bridge processors come with HD4000 graphics. Haswell-generation Xeon E3 products are also expected to contain integrated graphics and video functions.

"The progress that Intel has made with processor graphics is nothing short of phenomenal," says Wes Shimanek, Intel's workstation segment manager. "I'd say 50% of the people who work in basic CAD and 3D would be more than happy with the results from processors shipping now. Intel continues to dedicate additional silicon toward the graphics. In next-generation Haswell processors, integrated graphics will have more execution units. So you'll see a substantial increase in performance in rendering graphics." (*Author's Note: Execution units are part of the processor performing computing operations; they are not the same as computing cores.*)

The additional execution units, combined with new instruction sets, are expected to deliver better performance in engineering software programs like Autodesk Inventor, Dassault Systèmes' SolidWorks, Siemens PLM Software's NX and Solid Edge, PTC Creo, and others.

Integrated graphics is also Intel's countermeasure against NVIDIA's graphics accelerator hardware. The tight competition for consumer's pocketbooks put the CPU and GPU at loggerheads. Both want to convince the consumer that their hardware offers greater bang for the buyer's bucks.

If, after satisfying the basic performance needs, a consumer is still left with disposable income, NVIDIA would persuade the buyer to invest in a professional graphics card to boost visualization and parallel-processing capacity. Intel's Shimanek has a different suggestion.

"I work for Intel, so I'd love it if the consumer buys the top-end professor [with the highest frequency available in the market], but you can also buy about two frequencies down [for example, 2.8GHz instead of 3GHz], then invest the money you saved in buying twice the amount of memory equals to the highest model size you'll be working with," he says. "If you do that, you'll likely get twice the performance."

In Shimanek's reasoning, while users can always benefit from faster frequencies, he believes that a balanced computing solution can actually help users achieve a better overall experience.

"Save a little on frequency and increase your memory; save a little on graphics and invest in solid state drives," he says. "When you do that, you can actually impact a broader array of applications that users employ in the day in the life of an engineer."

Microway's Eshelman thinks there's something else in Haswell that's much more attractive than graphics to his customers. The new fused multiply-add (FMA) instruction set in Haswell, Eshelman notes, is particularly useful to those engaging in scientific applications.

"I've already had a scientist here and there asking for access to early Haswell silicon to test the speedups," he says.

Untouched by Multitouch

When demonstrating Haswell at CES, Intel's Skaugen explains that fourth-generation Ultrabooks will have a "mandatory touch requirement."

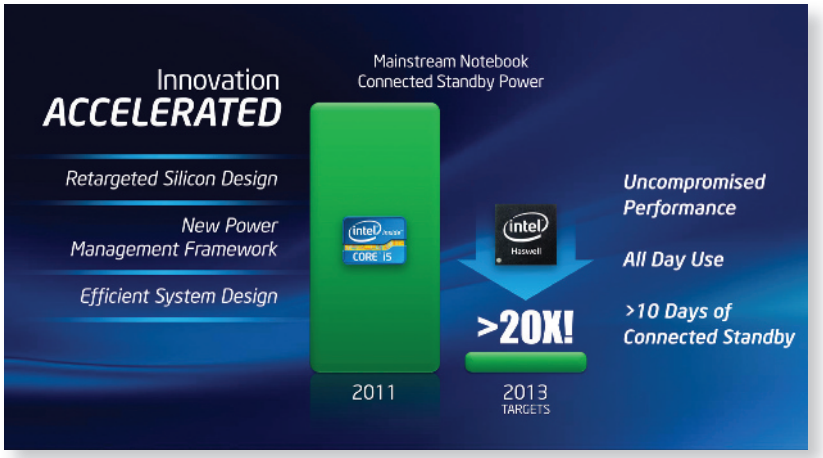
With such a requirement, Intel is not just laying the foundation but actively championing a new kind of computing experience — one that incorporates touch, voice, facial recognition and gesture-based interactions. So far, touch remains a touchy

subject in the professional market. Would you, for example, forsake your mouse and keyboard to draft in AutoCAD or model in CATIA using fingertips? Maybe there's a market for that among the iPad generation, but many OEMs aren't willing to gamble on it, yet.

BOXX's Lawrence reports that he hasn't seen a high demand for touch-enabled systems among his customers, although he adds that "touch is great for consuming the result after it has been created on a workstation."

Microway's Eshelman has had similar feedback. "We have not had one customer ask for a professional workstation with touchscreen," he says. "It may happen eventually, but none of the engineers I've spoken with are enthusiastic about such a change."

On the other hand, software makers like Autodesk, Dassault Systèmes, PTC and Siemens PLM Software have ventured into mobile devices by releasing robust mobile apps that offer viewing and markup functions, along with basic drafting tools. In the case of Autodesk's AutoCAD WS, the tablet-friendly, cloud-powered app is more than a viewer; it's meant as a drafting program to create and edit complex 2D plans from scratch.



From Intel CEO and President Paul Otellini's presentation at Intel Developer Forum 2011, comparing Intel Core i5 to Haswell's anticipated performance.

The Power Grab

Intel Haswell's tablet-friendly, low-power architecture is a good strategy to counter the recent advances made by GPU maker NVIDIA with its Tegra product line. At CES, while Intel hailed its new Haswell architecture, GPU maker NVIDIA was also introducing Tegra 4, its next-generation chip for smartphones and tablets. The latest quad-core Tegra integrates ARM processor cores, found in iPhone models.

As traditional desktops face unprecedented threats from mobile devices, hardware makers' competition for market share in the mobile market grows fierce. The next milestone for Intel, NVIDIA and their rivals is to offer supercomputing performance in the space and power envelope of mobile computers. Intel Haswell is a notable marker in that long-distance race. DE

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

INFO
- **AMD:** AMD.com
- **Autodesk:** Autodesk.com
- **BOXX Technologies:** BOXXTech.com
- **CES: CESWeb.org**
- **Dassault Systèmes:** 3DS.com
- **Intel:** Intel.com
- **Microway:** Microway.com
- **NVIDIA:** NVIDIA.com
- **PTC:** PTC.com
- **Siemens PLM Software:** PLM.Automation.Siemens.com
- **Supermicro:** Supermicro.com

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Fast Track Embedded Systems Development

Creating embedded systems takes skill, components, time and most importantly, the ideas that fuel innovation.

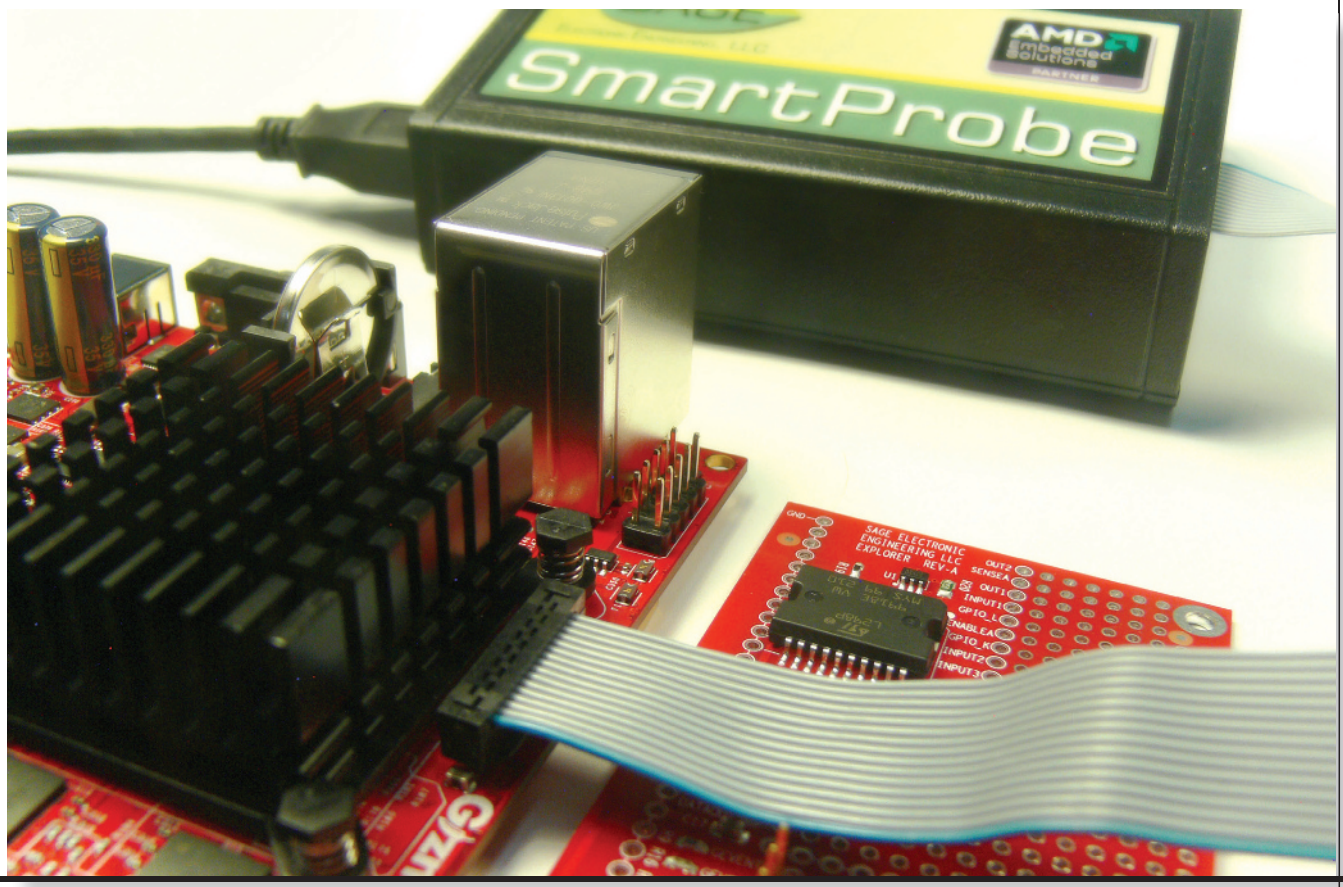
BY FRANK J. OHLHORST

Innovation usually comes at a price. Nowhere is this more true than with developing embedded systems, which usually requires a significant investment in components, tools, software and skills development. This reality has made many engineers hesitant to get involved with embedded systems design, forgoing what may be a lucrative and challenging practice.

However, manufacturers and vendors are increasingly partnering to lower the barriers to entry and fuel a boon for developers looking to leverage embedded technologies. The importance of this cannot be understated, as embedded systems become the key to distributing hardware (and software) intelligence away from centralized systems, and bring portability and power to the masses in all sorts of form factors.

Of course, embedded systems are not all that new; they've existed since the wholesale adaptation of transistor-based hardware and were used in such significant engineering achievements as the Apollo guidance system for the moon landing.

Embedded systems have grown exponentially in power and capability, and prices have fallen significantly. This has created an environment where almost anyone can tinker with embedded technologies and bring innovation to wherever software meets the physical world. Today, getting started with embedded systems design takes little more than a will to succeed and a few hundred dollars — thanks to vendors, groups and services that



Steps to Success

While getting started with embedded development takes little more than a credit card and free time, there are still best practices that can dictate the success or failure of that first project. Simply put, newbies can learn from the mistakes of others and can avoid repeating history — as long as they know that history. That's when an active development community can become one of an engineer's best allies.

Nevertheless, there are still some tenets that dictate how to proceed with a project and bring professional practices early into the process.

- **Have a plan:** Define your requirements and make sure you have a goal in mind. Only then can you select the proper elements to start a project.
- **Software choice is key:** Most engineers are wowed by hardware innovations and designs; however, what really matters the most is the software (or firmware) that the embedded device will run. It is critical to have an understanding of how code will integrate with hardware and how it will ultimately function.
- **Budget accordingly:** If history teaches us anything, it teaches that things tend to cost more than expected. Make sure budgets are capable of supporting your project, and expect the unforeseen to rear its ugly head and increase the time and monetary resources needed.
- **Choose hardware wisely:** Never forget the integral role that software plays in choosing hardware. In other words, make sure the hardware chosen will be supported by the software development environment.
- **Leverage the work of others:** For most developers, it is unnecessary to create operating systems or other software elements. A vast open-source community exists that may provide exactly what is needed when it comes to operating systems. What's more, determine whether an operating system is even necessary: Single-purpose designs (such as clocks, thermostats, sensors, and the like) do not have to juggle multiple tasks, and may not even require an operating system to function.
- **Keep It Simple, Stupid (the KISS Principle):** In other words, use simpler programing languages and design tools when getting started with embedded systems. For example, it is much easier to develop in Embedded C, as opposed to C++, which has a steep learning curve.
- **Invest wisely:** Don't be afraid to spend money on tools. Most tools speed development, reduce bugs and boost productivity — and pay for themselves very quickly with time saved.

— F. Ohlhorst.

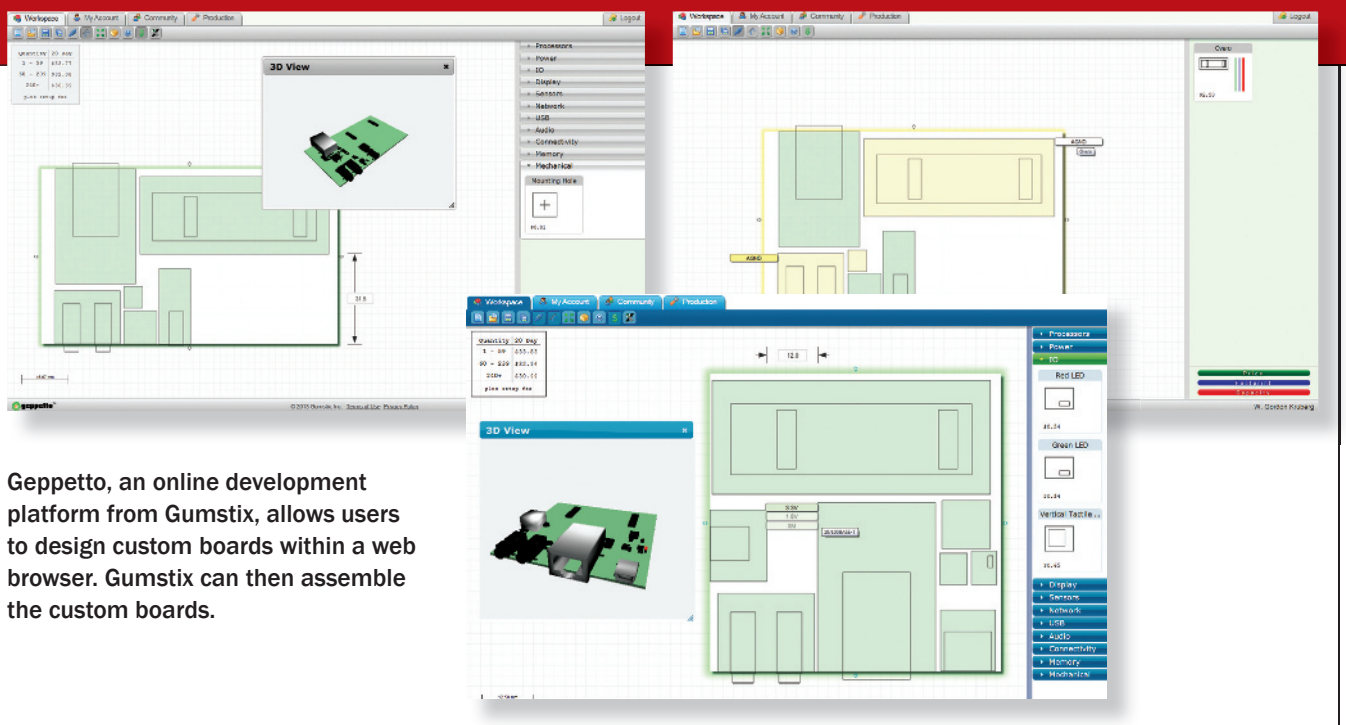
The Gizmo Explorer Kit includes the components and accessories needed to get started with embedded design.

are chock full of information and products to bootstrap almost any embedded design adventure. Let's take a look at just a few.

GizmoSphere A Place for Everything Embedded

GizmoSphere is a not-for-profit organization that functions as a resource center for embedded developers, as well as a community that supports a development environment built around the Gizmo Explorer Kit, a $199 concoction of elements that pretty much delivers everything an engineer needs to get started with embedded design. The kit includes:

- **The Gizmo Board:** This compact development board is powered by the AMD Embedded G-Series APU. It includes two custom card edge connectors, which can interface with SATA, USB, Display Port, PCIe, SPI, I2C, GPIO, PWM, ADC Input, DAC Output, Reset and Counter devices. The board also includes JTAG header, VGA video output, audio input/output, Ethernet, and USB ports.
- **The Explorer Board:** A companion board for Gizmo, the Explorer expansion I/O board offers additional experimentation and exploration opportunities. This two-layer board connects to Gizmo via the low-speed connector and provides an alpha-numeric keypad, a micro-display, and a sea of holes for prototyping and customization.
- **Sage SmartProbe JTAG Development Tool:** An automated, configurable plugin development tool for embedded designs. The SmartProbe offers full development and debug capabilities, including access to all registers and memory, USB and Ethernet support, remote access, virtual port, reset vector control and field-updatable firmware.
- **Sage EDK Graphical Interface:** A 30-day trial license for the Sage EDK, an intuitive graphical interface that streamlines development and debugging. The Sage EDK integrated development environment (IDE) provides the ability to build, inspect and debug software.
- **Pre-installed SageBIOS on Gizmo:** The Gizmo board comes pre-installed with SageBIOS, a distribution of open source coreboot, which supports several boot options, including a PC behavior option and an Explorer board option, among others.



Geppetto, an online development platform from Gumstix, allows users to design custom boards within a web browser. Gumstix can then assemble the custom boards.

- **Flash drive:** A bootable SLAX Linux distribution, which contains instructions for installing the Sage EDK and documentation such as the Gizmo Explorer Kit user guide.
- **Quick Start Guide:** A to-the-point guide to get you up and running quickly.
- **Accessories:** Power supply, Ethernet and USB cables round out the offerings.

Additional software licenses and development tools are available online for those looking to enhance the Gizmo Explorer Kit.

However, the Gizmo Explorer Kit is only one part of the GizmoSphere story, developers will find that the GizmoSphere site is loaded with reference materials, sample schematics, plans and most importantly, a very active developer community that offers interaction and help from numerous other developers. The community is further divided into groups and forums, making it simple for those working with Gizmo boards to get answers quickly, post comments and share ideas.

The most impressive feature of the Gizmo Explorer Kit is the Gizmo board itself, which features an AMD G-T40E dual core processor running at 1GHz, as well as a Radeon HD 6250 graphics controller and 1GB of DDR3 SDRAM, making the Gizmo board a powerful development platform for a variety of embedded functions, ranging from setup boxes, industrial control systems, and even casino gaming machines.

GizmoSphere claims that the Gizmo board offers 52 gigaflops of performance, and consumes just 10 watts of power. What's more, the Gizmo board can run Android, Linux, RTOSes and Windows operating systems.

Other Paths to Innovation

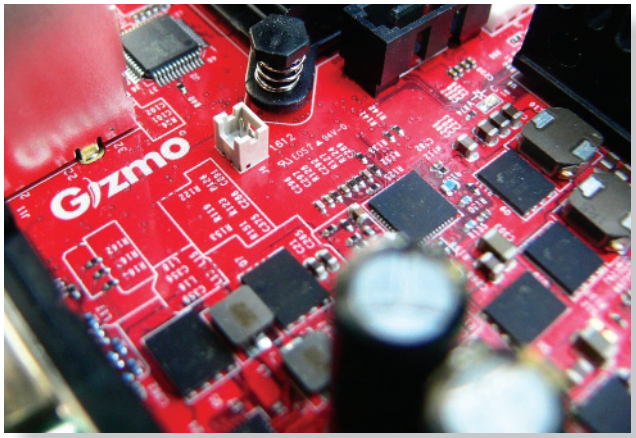
While the Gizmo Explorer Kit may prove to be a great starting point for those wanting to dip their toes into the waters of embedded design, there are other options as well — options that shift the development process to the virtual realm. Take, for example, Geppetto, an online development platform from Gumstix, a company known for designing custom boards for embedded applications.

Geppetto allows anyone with a proper web browser to design custom boards, which Gumstix then can assemble. Geppetto brings simplicity to printed circuit board (PCB) design. Users simply have to select the size of the board, add modules (USB, Ethernet, HDMI, etc.), and then allow the platform to render the board. Users are offered a 3D representation of the designed board, and then can share it with others (via the cloud) or request that Gumstix manufacture a physical board.

The entire design process only takes a few minutes, and the platform automates the rendering. Users need not know anything about PCB layouts, schematics or electrical engineering. The upside is that engineers can design embedded controllers that only contain the features they need — for example, if you don't need a video controller or Ethernet on the board, you can simply choose not to incorporate those modules into the design.

Initial board setup can cost as much as $1,999, and additional units vary in price, depending on the numbers ordered and the features requested. That said, Geppetto probably offers the quickest, easiest and most innovative way to design custom embedded devices.

No conversation on x86 embedded design would be complete without mentioning Sage Electronic Engineering, a company that provides everything from development tools to full design services. Sage is a partner of GizmoSphere, and offers tools that work hand in hand with GizmoSphere offerings to ease embedded system development. One of Sage's claims to fame comes in the form of its SageBIOS, which is a distribution of the open source coreboot project. SageBios replaces the proprietary boot firmware found on x86 systems with an open source implementation that is fully customizable.



The Gizmo is powered by the AMD Embedded G-Series APU and includes two custom card edge connectors.

Sage also offers SmartProbe, which is designed to give engineers full access to AMD processors to create a complete system view for debugging and design purposes. When paired with Sage EDK (an IDE-based development tool), developers have a complete environment for developing custom code for embedded systems. Sage EDK integrates every aspect of design into a streamlined, intuitive graphical interface that further simplifies the development process.

While embedded design is nothing new, never has it been as simple to get started with as it is today. Engineers can readily step up to the bat and get involved in the process, to create profitable solutions and devices that can drive the next generation of innovation. DE

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INFO ➜ **Advanced Micro Devices:** AMD.com

➜ **GizmoSphere:** GizmoSphere.org

➜ **Gumstix:** Geppetto.Gumstix.com

➜ **Sage Electronic Engineering:** SE-Eng.com

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Amazing Power in a Portable Package

The Eurocom Panther 4.0 "super-laptop" beats out top-of-the-line desktop systems.

BY DAVID COHN

We've come to expect a lot from Eurocom. In the past, this Canadian company has sent us several very impressive mobile workstations, many of which set new performance records — often with impressive price tags to match. Armed with that experience, we were quite excited when Eurocom sent us their latest mobile workstation, the Panther 4.0, which the company bills as the "world's first supercomputer-class, fully upgradeable and configurable super-laptop" designed for CAD, CAE, DCC, visualization and simulation applications.

While that's quite a claim, the Panther 4.0 lives up to the hype.

Like previous Panther mobile workstations, the Eurocom Panther 4.0 uses some decidedly non-mobile components — such as a server-class Intel Xeon E5 processor — to achieve all of that power. The last Panther mobile workstation we reviewed, the Panther 3.0, exhibited some significant cooling problems as a result of packing too many power-hungry components into a mobile chassis (see *DE*, November 2011). Happily, this time around, the Panther 4.0 showed no such issues.

The Eurocom Panther 4.0 measures 16.76 x 11.4 x 2.48 in., and weighs a hefty 12.5 lbs. — plus another 3.5 lbs. for its enormous (8.25 x 4.5 x 2 in.) 300-watt power supply. The system is configured like a traditional notebook computer, with a nicely finished black plastic and brushed aluminum case, but it's nearly twice as thick as more conventional notebooks.

Raising the lid reveals a beautiful 17.3-in. full-HD display with a native resolution of 1920x1080, and a full-size backlit keyboard with a separate numeric keypad. There's also a touchpad centered below the keyboard with a pair of buttons and a fingerprint reader.

Our evaluation unit came equipped with a 2 MP webcam centered above the LCD, flanked by a pair of microphones. Three speakers are located in the hinge below the LCD, with two more in the top corners above the keyboard. Between these are a series of touch sensors for adjusting speaker volume and toggling the Wi-Fi, Bluetooth and webcam on and off, as well

as hard drive and keyboard status indicators. These controls, as well as the large round power button to the right of the keyboard, glow bright blue when active.

Abundant Configuration Options

The right side of the case provides jacks for headphone, microphone, audio line-in, and S/PDIF-out as well as a pair of USB 2.0 ports, a subwoofer and a security lock slot.

The left side houses a pair of USB 3.0 ports, mini-IEEE 1394b (FireWire) port, combined eSATA/Powered USB 3.0 port, DisplayPort, HDMI-out port, RJ-45 LAN jack for the built-in Gigabit Ethernet, and DVI-I-out port. The optical drive bay is also located on the left side, and our evaluation unit came equipped with a Panasonic 6X Blue-Ray Writer, standard in the Panther 4.0.

The rear of the case contains just the external power connector centered between fan intake vents. The front includes more air vents, as well a 9-in-1 card reader and LED indicators for power and battery.

Like most Eurocom systems, configuring the Panther 4.0 is all about choices. The LCD display is available with or without non-glare coatings, and can be driven by a choice of 13 different GPUs ranging from an NVIDIA GTX 670MX to a pair of top-of-the-line NVIDIA Quadro K5000M (Kepler) graphics cards. Our evaluation unit came with a single Quadro K5000M with 4GB of GDDR5 ECC memory and 1,344 compute unified device architecture (CUDA) cores, adding $1,381 to the cost of the system. The system we received featured an AUO LED backlight and professional display calibration profile saved on a CD-ROM, options that added $86 to the price. A 3D display with a pair of shutter glasses is also available.

The Panther 4.0 is based on the Intel Sandy Bridge-E X79 Express chipset, and you can configure the Panther 4.0 with any one of 12 different Intel processors. In our case, Eurocom included an 8-core 3.1GHz Intel Xeon E5-2687W CPU with 20MB of L3 cache. That server-class CPU has a maximum turbo frequency of 3.8GHz and a maximum thermal design power (TDP) rating of 150 watts. The system can accommo-

Design Engineering Mobile Workstations Compared

		Eurocom Panther 4.0 mobile workstation (3.1GHz Intel Xeon E5-2867W 8-core CPU, NVIDIA Quadro K5000M, 16GB RAM)	**Lenovo W530** mobile workstation (2.90GHz Intel Core i7-3920XM quad-core CPU, NVIDIA Quadro K2000M, 16GB RAM)	**Eurocom P150HM Racer** mobile workstation (2.70GHz Intel Core i7-2960XM quad-core CPU, NVIDIA Quadro 5010M, 16GB RAM)	**HP EliteBook 8560w** mobile workstation (2.30GHz Intel Core i7-2820QM quad-core CPU, NVIDIA Quadro 2000M, 16GB RAM)
CPU	ratio	n/a	4.73	3.16	3.11
I/O	ratio	n/a	3.76	3.35	3.01
SPECapc SolidWorks 2013	higher				
Graphics Composite		2.26	n/a	n/a	n/a
RealView Graphics Composite		2.42	n/a	n/a	n/a
Shadows Composite		2.42	n/a	n/a	n/a
Ambient Occlusion Composite		5.14	n/a	n/a	n/a
Shaded Mode Composite		2.41	n/a	n/a	n/a
Shaded with Edges Mode Composite		2.12	n/a	n/a	n/a
RealView Disabled Composite		1.72	n/a	n/a	n/a
CPU Composite		3.72	n/a	n/a	n/a
Autodesk Render Test	lower				
Time	seconds	57.33	62.00	76.66	89.83
Battery Test	higher				
Time	hours:min	1:14	6:09	1:50	2:37

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

date up to 32GB of memory in four 204-pin small outline dual in-line memory module (SO-DIMM) sockets, and our system came equipped with 16GB of memory using four 4GB DDR3 1600MHz memory modules.

Like its predecessor, the Panther 4.0 supports up to three standard hard drives — or a fourth if you forego the optical drive. The Panther supports solid-state (SSD), hybrid or enterprise-level drives with redundant array of independent disk (RAID) 0, 1, 5, 10 capability, and again Eurocom offers 20 different drive options, including the ability to equip the system with 4TB of storage. In our case, Eurocom provided a 512GB Micron/Crucial SSD in lieu of the 1TB Seagate Momentum hybrid drive standard in the base configuration. Thanks to the SSD, the Panther booted to Windows 7 64-bit in just 41 seconds.

The 78.44Wh lithium-ion battery in the previous Panther was useful only as an uninterruptable power supply (UPS) rather than for actually powering the system. But here again, Eurocom has made improvements. After using the intuitive Control Center application to switch the system to its Power Saving mode, our Panther 4.0 ran for 74 minutes on battery power — double that of its predecessor.

Happily, the Panther 4.0 was also considerably quieter than its predecessor and ran much cooler. While air leaving the rear vents of the Panther 3.0 we tested in 2011 reached 107° F, the Panther 4.0 stayed below 100° F.

Incredible Performance

Based on Eurocom's lofty claims and our past experience, we expected to see stellar performance from the Panther 4.0. And we got it: On the SPECviewperf test, which focuses solely on graphics, the Panther 4.0 not only outperformed every mobile system we've ever reviewed, it beat all of the desktop workstations as well.

On the SPECapc SolidWorks benchmark, we can't make any comparisons. The SolidWorks 2005 benchmark that we had been using is quite old and was not really designed for Windows 7. For that reason, we've now switched to the new SolidWorks 2013 benchmark. The new benchmark performs a number of tests, yielding composite scores for graphics and CPU performance (the bigger the number, the better the score). But the Panther 4.0 mobile workstation marks the first system on which we've run this new test. Judging from the performance we experienced when actually running SolidWorks and other CAD software, however, we'd definitely expect the Eurocom Panther 4.0 to do an exceptional job on even the most demanding CAD, CAE and DCC tasks.

On the AutoCAD rendering test, in which the competitive edge clearly belongs to fast CPUs with multiple cores, the Panther 4.0 again beat every other mobile workstation we've ever tested, thanks to its equivalent of 16 CPU cores with hyper-threading enabled.

Of course, all of the Panther 4.0's power comes at the expense of a lot of weight and a very hefty price tag. The base Panther 4.0 configuration sells for $3,210. Once we added up all of the options included in our evaluation unit, the system we received would cost $6,800. Still, that's $1,440 less than its predecessor.

That price included Windows 7 Professional 64-bit edition. Eurocom also offers Windows 7 Premium or Ultimate, Windows 8 Home Premium or Professional, or Windows 2008 Server, or you can order the system without an operating system and install your own. The price also includes a one-year warranty and requires owners to ship the system back to a factory depot for repairs. Extending the warranty for a second year adds $151, or $271 to extend it out to three years. But Eurocom continues to offer lifetime upgradability, as well as credits of up to 20% if you trade in an older system when purchasing a new Panther.

The Eurocom Panther 4.0 is meant to replace a desktop workstation for power users on the go. While its price likely makes it a niche product, this time around Eurocom got it right. The Panther 4.0 really does perform like a super laptop, delivering amazing power in a portable package. DE

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INFO ➜ Eurocom Corp: Eurocom.com

Eurocom Panther 4.0

- **Price:** $6,800 as tested ($3,210 base price)
- **Size:** 16.76 x 11.44 x 2.48 in. (WxDxH) notebook
- **Weight:** 12.5 lbs. as tested, plus 3.5-lb. power supply
- **CPU:** 3.1GHz Intel Xeon E5-2867 W eight-core w/20MB cache
- **Memory:** 16GB 1600MHz DDR3 SDRAM (32GB max)
- **Graphics:** NVIDIA Quadro K5000M w/4GB memory
- **LCD:** 17.3-in. diagonal (1920x1080)
- **Hard Disk:** 512GB SSD
- **Optical:** Panasonic 6X Blu-Ray write and DVD+/-RW dual layer
- **Audio:** line-in, S/PDIF-out, microphone, headphone, built-in microphone and speakers
- **Network:** integrated Gigabit Ethernet (10/100/1000 NIC); Intel 802.11 a/g/n wireless LAN; optional integrated Bluetooth 4.0
- **Other:** two USB 2.0, two USB 3.0, one mini IEEE-1394 (Firewire), eSATA/Powered USB 3.0 combo, 9-in-1 card reader, DVI-out, HDMI-out, DisplayPort, 2MP webcam
- **Keyboard:** integrated 102-key keyboard with numeric keypad
- **Pointing Device:** integrated two-button touchpad

For more information on this topic, visit deskeng.com.

MotoCzysz *Rules the Racetrack*

BOXX Technologies helps this motorsport manufacturer take design to the next level in efficiency and aerodynamics.

BY JOHN VONDRAK

MotoCzysz has won three first-place IOM races with its electric motorcycles.

The Isle of Man (IOM) TT, located on the famed island in the Irish Sea, is home to the most difficult and dangerous motorcycle racetrack in the world. It is also where, for two weeks each year, motorsport manufacturers and riders alike come to prove that they belong among the motorcycling elite.

MotoCzysz has certainly earned its stripes in that arena. The Portland, OR-based design firm broke new ground in 2006 by moving away from gas-powered motorcycles to the new frontier of electric motorcycle racing. It has since grabbed three consecutive first-place victories in the IOM, among other titles.

The engineering team is at the core of the company's success, and in addition to its reputation for building meticulously engineered machines, MotoCzysz designs and fabricates most of the components used in its motorcycles. Over the years, MotoCzysz designs have garnered attention from major vehicle manufacturers like Segway, which hired the firm to modernize the look and performance of its renowned personal transporter.

MotoCzysz's latest endeavor is prepping the aerodynamic E1pc bike design for the IOM TT Zero 2013 ("zero" meaning "zero toxic/noxious emissions") race slated for June 6.

"We do a redesign every year, but it doesn't mean that every component changes," notes MotoCzysz Senior Engineer Nick Schoeps. "Some years we do groundbreaking changes; this year, it's all about optimization, seeing how we can further reduce weight, reduce inefficiencies, and optimize aerodynamics."

MotoCzysz has a number of optimization targets in sight, including creating power efficiencies throughout the drivetrain, making sure electrical paths are as conductive as possible via shorter wiring runs, and eliminating friction spots on mechanical components. There is also work underway to simplify the suspension design via a reduced fastener count, as well as cutting back on the number of parts on the E1pc to make it simpler and more lightweight, Schoeps says.

Simulation-driven Design

Key to MotoCzysz's design process is the ability to continually refine designs to create powerful and lightweight components. Yet as MotoCzysz began to take on more complex surfacing and simulation projects, it became clear that its existing workstations were taxed and additional GPU horsepower was in order.

The design firm's overclocked, liquid-cooled 3960 XTREME systems from BOXX Technologies were state-of-the art when purchased in early 2011, but as a single GPU system relying on an older-generation NVIDIA Quadro card, the workstations could no longer support the team's rendering requirements with optimal quality and performance.

With only six full-time employees and a limited budget, MotoCzysz had to carefully balance design decisions and cost concerns — all under the added burden of tight development and production schedules that began to dictate design decisions.

"With the older systems, we had to be pretty judicious about our resources," Schoeps says, explaining that the system's slow performance prevented engineers from

rendering full designs at full quality, which often led to unwelcome design surprises.

A case in point: MotoCzysz engineers developed a new fairing design (the shell placed over the E1pc frame to reduce air drag, as well as to protect the rider and engine) only to discover upon production that the part included surface imperfections that required additional body fillers. Had the team been able to complete a more detailed rendering during the design process, they could have detected the imperfections and optimized the design prior to production. It would have saved time, money and — most importantly on the racetrack — unnecessary weight, Schoeps says.

Better BOXX, Better Bike

To cross the finish line first, Schoeps says MotoCzysz needed a solution that would reduce the requirement for expensive physical prototypes and move its workflow toward simulation-driven design. At the same time, the solution needed to be budget-friendly.

Capitalizing on longtime relationships with NVIDIA and BOXX, MotoCzysz was able to pilot a new generation of 3DBOXX workstations featuring NVIDIA's Maximus technology, which combines the visualization and interactive design capability of its Quadro graphics cards with the computing power of NVIDIA Tesla GPUs into a single system. Tesla handles the photorealistic rendering or engineering simulation computation, freeing CPU resources to accomplish I/O, running the operating system, and other tasks, while the Quadro GPU is dedicated to powering interactive design.

The 3DBOXX 4920 XTREME, now the secret weapon in the E1pc bike's redesign effort, features a 6-core Intel Core i7 processor overclocked to 4.75 GHz, liquid cooling and Intel solid state drives (SSDs). Critical to the system is the Maximus technology — a Quadro K5000 and a Tesla K20 built on NVIDIA's Kepler GPU architecture.

"The 4920 XTREME with NVIDIA Maximus makes sense for us because we can create fully rendered images of a bike before we actually build it," says Schoeps.

While larger bike manufacturers might create physical clay models to prove out their designs, MotoCzysz is limited in its ability to do so because of its smaller staff and budget, Schoeps says.

"We shot from the hip a bit with the older systems, because we didn't always get the opportunity to do a rendering of the bike before making final parts, and sometimes we weren't pleased with the results when we saw them in real life," he says. "The new systems give us an edge in that space."

Not only does MotoCzysz have the confidence that a design is correct on the first pass, but the new workflows enabled by the 3DBOXX 4920 XTREME and related technologies has resulted into a 20% to 30% time savings, according to Schoeps.

For example, with earlier workstation models, Schoeps' team was forced to shut down a number of graphics features and simplify their models to make the rendering workflow more manageable. The Maximus-powered 4920 XTREME eliminates this obstacle, allowing the team to employ all graphics features and create physically accurate renders.

Multitasking with Design and Simulation

The 3DBOXX 4920 XTREME's performance also translates into optimal performance for MotoCzysz's array of core design tools, from SolidWorks CAD and Real View Graphics applications to Bunkspeed Pro, which the team is beginning to use for advanced rendering and analysis work. Now, Schoeps is able to multitask, creating a motion

The company optimized its motorcycle this year to reduce weight and improve aerodynamics.

MotoCzysz uses a 3DBOXX 4920 XTREME workstation equipped with a 6-core Intel Core i7 processor, overclocked to 4.75 GHz, and NVIDIA Maximus technology.

animation in SolidWorks while performing ray-traced renderings in the background with Bunkspeed Pro.

"Bunkspeed's performance on this system has been outstanding," says Schoeps. "I can rotate the model, and it updates the design in real time. I can see how the different design features are interacting and how light is reflecting from different angles — all in a high-frame rate."

Most importantly, the system allows Schoeps to concentrate on engineering, not on optimizing the workstation and worrying about properly configuring system resources.

"That's what I like most about the BOXX," he says. "It allows me to be a lazier engineer. I don't have to think about the number of files I have open. I've had as many as 20 or more parts files open along with a large assembly and there are no problems, no lag in performance. It's nice to have the freedom to think about the design and focus on the aspect of the project I'm working on, and not think about the machine."

In addition to the Maximus technology and overclocked Intel Core i7 processors, Schoeps credits the inclusion of SSDs as another factor in the 4920 XTREME's performance.

"SSDs really require a cost/benefit analysis," he says. "You pay a few hundred dollars more for SSDs , but how do you justify the cost of hiring another engineer? It makes economic sense to spend the money on the hardware that you rely on every day."

While MotoCzysz manages to take on three to five additional projects per year, the design firm's primary focus is still the E1pc — and winning races, especially the upcoming IOM TT Zero 2013. The improved performance throughout the design and rendering processes has enabled the engineering team to look at every aspect of the design from a fresh perspective.

"I've become the bottleneck in the system," Schoeps admits. "There are only a certain number of parts we can design in a certain amount of time, and we can only spend a certain amount of time optimizing each one. The new system lets us do more optimization in the same amount of time. It gives us the time to make our designs better." DE

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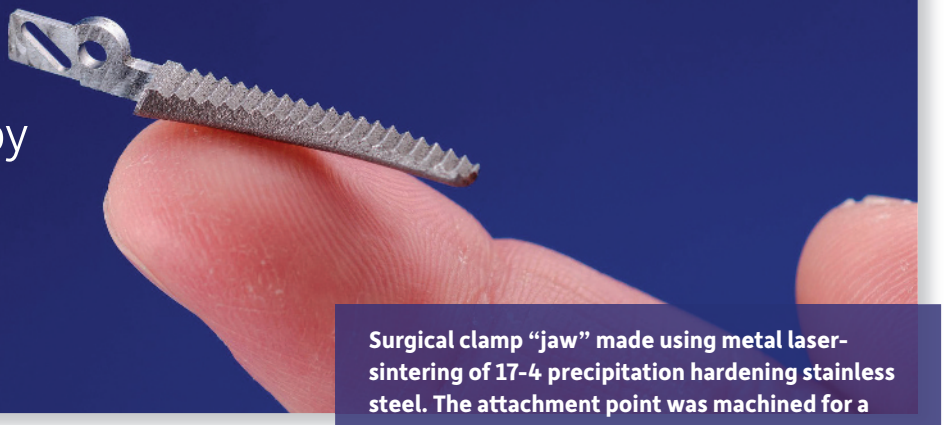
SPOTLIGHT

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

Choosing the Best AM Materials

Are you puzzled by the possibilities? Read on.

BY PAMELA J. WATERMAN



Surgical clamp "jaw" made using metal laser-sintering of 17-4 precipitation hardening stainless steel. The attachment point was machined for a precise fit. *Image courtesy of FineLine Prototyping.*

My home has a pool. After 30-plus years of sun exposure, it desperately needed resurfacing. I figured we could just redo it with fresh plaster or maybe a pebbly treatment, but Internet research turned up dozens of material choices. How to decide?

You may be facing a similar, though amplified dilemma if you're considering an additive manufacturing (AM) solution to part production. What factors are important to understand and consider when choosing the best material? *DE* asked a number of AM system manufacturers, material developers and service bureaus for their advice to prospective customers.

Material Properties, System Variables

Randy Stevens, operations manager at In'Tech Industries, says that because there are hundreds of AM materials from which to choose, asking three key questions can simplify the process:

1. What's the application?
2. What are the features?
3. How big is it?

A part that will be exposed to the environment (water, chemicals), for example, requires different material properties than a marketing model, which may differ from a part that will be hidden. Similarly, the need to see through a part will eliminate dozens of opaque possibilities.

With its experience operating multiple 3D Systems and Stratasys (Fused Deposition Modeling [FDM] and Polyjet) systems, Stevens' service bureau can guide you through creating that clear plastic part via three different approaches.

"3D Systems' Accura ClearVue is the ultimate in clarity for optically clear parts, while Accura 60 has a blue tint, but a higher Shore D hardness and builds fast," he offers. "And Objet VeroClear has a higher hardness and elongation at break."

The company's website features helpful charts, including a comparison of dozens of such material properties.

In the thermoplastic arena, Stratasys FDM systems offer 10 versions of functional materials, with varying properties of strength, biocompatibility, flame/smoke/toxicity (FST) certification and more. In addition, Stratasys Polyjet systems support material properties ranging from rubber to rigid and transparent to opaque. With Polyjet Connex technology, multiple materials can even be printed simultaneously in the same part.

Given the more than 100 possibilities, it's no wonder that Fred Fischer, Stratasys director of materials and applications product management, suggests users first take a higher-level viewpoint of their project.

"We sometimes ask users whether they are taking a top-down or bottom-up approach," says Fischer. "Users can prioritize the application requirements that are critical, 'would like to have' or irrelevant, and match them up to standard materials properties to find the combination that solves their needs. Or you can say, 'OK, I'm going to use this material in my final product — now tell me which material best mimics it.' That becomes more important on the Polyjet side of the business, where it's

either a plastic trying to mimic a metal or a resin trying to mimic a plastic."

Prior to the company's 2012 acquisition of Objet Geometries, Fischer authored a white paper on thermoplastics that points out key characteristics of FDM material types (see the Stratasys website).

More resources for evaluating multiple AM technologies and possible materials come from service bureau FineLine Prototyping on its technology-comparator and material webpages. Although the company does not offer part-production on all of the 11 listed plastics-based systems, the information is a good starting point for newcomers.

For customers with unusual applications, Rob Connelly, president of FineLine Prototyping, describes several ways his company's services stand out in the material world. He says, "Our SLArmor is kind of a bridging step between a plastic part and a metal part. You want to get close to the properties of metal, but you don't want to pay the full price of it. We make the part out of a ceramic-filled SL (stereolithography) material, very stiff and strong, then plate it with a structural thickness of nickel plating."

Connelly also describes an exclusive modified SL material/process called MicroFluidic Fabrication that his company developed to replace parts typically fabricated on glass with an expensive photolithography process. MicroFluidic Fabrication produces complex wafers with a clear shiny top and bottom for proof-of-concept parts, for such medical applications as lab-on-a-chip.

If you get the chance to speak with Solid Concepts marketing director Scott McGowan, you'll gain a wealth of information across the spectrum of six major AM technologies, all available at his company's service bureau facilities. He'll give you tips about the pros and cons of ultraviolet (UV)-curable plastics vs. thermoplastics, explain the nuances of thermal behavior between polyetheretherketone (PEEK) and polyetherketoneketone (PEKK) materials, and tell you which support materials are easier to remove than others. You'll also find the Solid Concepts material webpage brings together information that would take you hours to find from separate sources.

Moving into Metals

Say you know a given part needs to be metal. Greg Morris, founder of Morris Technologies (now part of GE Aviation), notes, "With metals, as a very broadbrush statement, the material properties will be close to wrought properties. That is relatively significant, because the properties are generally much better than cast properties, thus giving engineers and designers more freedom to use the process." The company runs both EOS and Arcam metal systems.

Morris adds, "Whereas in polymers it is easy to post-finish parts, in metals it isn't as easy — and there are a variety of technologies and methods to improve the surface finish of metal parts. Those techniques should be taken into consideration, even in the design. Also, one needs to take into consideration post-thermal processing steps, which usually involve stress relieving, HIP (hot isostatic pressing), solution heat treating, etc." He notes the last point differs from working with polymers.

FineLine Prototyping operates two Concept Laser Mlab systems that use a very small-spot laser to create MicroFine metal parts with fine features and high tolerances; the process works with two grades of stainless steel. Another multiple-technology service bureau, Forecast3D, gives a nice breakdown of material properties about the stainless steels and cobalt chrome it runs in its EOS direct metal laser sintering (DMLS) systems.

Just to mention some material providers, 3T RPD introduced AlSi10Mg, an aluminum alloy, in 2011, adding to its portfolio of Ti SS, Maraging Steel, CoCr and Nickel Alloy; LPW Technology sells metal powders for SLM and Arcam EBM systems.

Parameters, Post-processing & Payment

It's sometimes hard to separate the material from the system and its operational parameters. Generally speaking, the slower the "print speed" of a material, the longer the

Neil Lehman, vice president at Advanced Laser Materials, gives a basic list of material properties that, while specifically for sintered polymers, could be important to understand for building any additive manufacturing (AM) part:

- HDT: heat distortion temperature (higher temperature applications)
- Stiffness: flexural modulus or tensile modulus
- Part weight and cost per cubic inch: part density or specific gravity (weight is very important for aerospace applications)
- Toughness: elongation to break, impact resistance, ultimate tensile strength
- Flammability and smoke generation: (very important for commercial aerospace applications)
- Post processing: drilling, sanding, machining, etc.
- Surface finish and part detail: relates to particle size and particle size distribution
- Electrical properties: volume resistivity, surface resistivity and dielectric constant (insulating or static discharge)

—P. Waterman.

build time and the more expensive the part. In'Tech's Stevens notes that materials, build time and any desired post-processing all affect the cost of a part.

"All AM materials have different print speeds," he adds. "Working with a service bureau is a good way to find out how to best achieve your desired results."

EOS, maker of DMLS and polymer-sintering systems, started opening up some of its system operating parameters to allow users to define exposure and start values. More recently, the company expanded its Part Property Management function, offering both standard and custom parameter sets that help users balance such aspects as build speed and surface quality. System manufacturer SLM also offers application-optimized build processes.

Parts made with an AM process often need traditional post-processing steps. Mike Littrell, president at C.ideas service bureau, says, "All rigid thermoplastic AM materials can be sanded, tumbled, primed, metalized, etc., (plus) annealing can be used to increase the temperature capabilities of some. For projects that require parts that need to be under pressure, SLS versions are typically easier to seal then FDM'd pieces." The company has been educating clients on AM procedures since 1998, so you have much to learn from their experience.

Carl Dekker, president of Met-L-Flo and a longtime expert in the AM field, also emphasizes finishes as a critical part of choosing materials. He notes that people often don't include those steps in their budgets. Dekker's company offers five finish levels, from basic, mold-ready and premium to photometric (Class A, in automotive terms) and custom, and he can tell you which materials are a little easier to finish and which are more of a challenge.

Unconventional (and Conventional) Approaches

Plastics and metals from system vendors aren't the only games in town. Mcor Technologies wants you to consider using your own plain paper, with the company's Selective Deposition Lamination (SDL) process, as an AM material choice for low-cost, full-color concept modeling in the early stages of a design. Mcor President Conor MacCormack says, "SDL parts can be used effectively for sand casting, investment casting and living hinges." Service bureau BL3Dimension recently set up the

Clear AM Material Comparison

Material	Accura® ClearVue™ (3D Systems)	Accura 60 Plastic (3D Systems)	Objet VeroClear RGD810 (Stratasys)
Tensile Strength ASTM.D638	46-53 MPa	58-68 MPa	50-65 MPa
Tensile Modulus ASTM.D638	2,270-2,640 MPa	2,690-3,100 MPA	2,000-3,000 MPa
Elongation at Break (%) ASTM D638	3-15%	5-13%	10-25%
Flexural Strength ASTM D790	72-84 MPa	87-101 MPA	75-110 MPa
Flex Modulus ASTM D790	1,980-2,310 MPa	2,700-3,000 MPa	2,200-3,200 MPa
Impact Strength (Izod Notched) ASTM D256	40-58 J/m	15-25 J/m	20-30 J/m
Heat Deflection ASTM D648 @66 PSI	51'C	53-55'C	n/a
Heat Deflection ASTM D648 @264 PSI	50'C	48-50'C	n/a
Hardness Shore D	80	86	83-86
Glass Transition (Tg) DMA E	62'C	58'C	52-54'C
Water Absorption ASTM D570-98	0.3%	n/a	1.1-1.5%

Comparison chart of three clear plastic materials and their properties: two SLA resins for use on 3D Systems additive manufacturing systems and one photopolymer for use on a Stratasys Polyjet system. ***Chart courtesy of In'Tech Industries.***

Hairbrush built on the Stratasys Connex 3D printer, showing TangoBlack (flexible) material and VeroGrey (rigid) material, printed together at the same time. *Image courtesy of Stratasys.*

first U.S.-based Mcor IRIS system ready for customer projects.

If your application is a good match for parts that can be made on open-source filament extrusion systems such as the MakerBot 2, you are not governed by the restrictions of some AM systems to use only that manufacturer's materials. Many designers like the idea of working with polylactic acid (PLA), a biodegradable plastic filament; such parts are harder than acrylonitrile butadiene styrene (ABS), though more brittle.

An independent filament source is Taulman 3D, makers of white (RIT-dyeable) Taulman 618 and clear Taulman 645. People interested in making their own filament from pellets can do so by building the new open-source, award-winning Lyman Filament Extruder. (*Author's Note: See goo.gl/fZ9MK for a video about the extruder.*)

Back in the traditional manufacturing world, whether you're talking subtractive machining, injection molding or thermoforming, plastics have well-defined properties. Experts at service bureaus such as ProtoLabs point out simply that with its computer numerically controlled (CNC) equipment, "Your parts are machined from real blocks of plastic and aluminum." ProtoLabs' website notes the higher flexural and tensile property values displayed by machined and molded ABS test samples vs. those built in ABS material on an AM system (per independent lab testing, 2007).

System manufacturers such as Roland DGA also make valid points about situations where traditional materials can be more cost-efficient. For comparison data, see the company's online report, "Rapid Prototyping: Hype vs. Reality" at goo.gl/opwx3.

However, AM offers ever-closer values for these properties, and achieves both geometries and material compositions that are not possible with conventional processes. As consultant Todd Grimm points out, "These advantages, for the most part, won't be realized until there are fundamental changes in the way material properties are specified and in the predictive sciences."

The past year has seen a tenfold increase in market interest in AM processes, which means many more engineers not well-versed in 3D printing have come to service bureaus, needing to learn from the experts. One great venue for asking detailed questions of vendors and fellow AM users is SME RAPID 2013, June 10-13. Consider, too, joining LinkedIn's 3D Printing Materials Society group. DE

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- **3T RPD:** 3TRPD.co.uk
- **Advanced Laser Materials:** ALM-LLC.com
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- **BL3Dimension:** BL3Dimension.com
- **C.ideas:** BuildParts.com
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- **SLM:** SLM-Solutions.com
- **Society of Manufacturing Engineers RAPID 2013:** SME.org/RAPID
- **Solid Concepts:** SolidConcepts.com
- **Stratasys:** Stratasys.com
- **T.A. Grimm & Associates:** TAGrimm.com
- **Taulman 3D:** Taulman3D.com

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Large-format Printing for Small Businesses

Large-format printer manufacturers focus on ease of use and flexibility to appeal to small- and medium-sized businesses.

BY JAMIE J. GOOCH

The number of small businesses has been growing for decades, even as large corporations have downsized. In fact, since 1990 large businesses have eliminated 4 million jobs while small businesses added 8 million new jobs, according to the U.S. Small Business Administration, which also says the number of small businesses in the country has increased 49% since 1982.

That type of growth isn't being ignored by many suppliers looking to expand their markets as their traditional large customers' businesses contract. Large-format printing manufacturers are a good example. However, small- and medium-sized businesses (SMBs) have different priorities when it comes to large-format printing.

Large corporations may have an entire department dedicated to managing and maintaining the company's large-format printers. Many SMBs, on the other hand, have never owned a large-format printer, instead relying on local service providers for their printing needs.

Up until now, print service providers have had an easy time attracting SMB customers. After all, large-format printers were a sizable initial investment in both money and the time it took to train employees to use them. They also took up a lot of room. In the end, when SMBs compared how much they needed to use a large-format printer vs. the cost of ownership, service providers often won out.

To offer an alternative, printer manufacturers needed to focus on ease of use, mobility and costs.

Making It Easy

When Epson decided to expand into the engineering market, it conducted "a tremendous amount of focus studies," says Tim Check, product manager of Epson America's Professional Imaging Group. He says the company's SureColor T-Series, released last year, addresses the headaches their research uncovered.

"With T-Series, there are a lot of features that address ease of use," he says. "The MicroPiezo TFP (thin film piezo) print head is designed to give high-quality prints over time. It doesn't degrade over time, so there's no need to replace it. People don't have to think about it."

HP's Designjet T120 ePrinter uses the company's Print Anywhere technology.

Other areas that printer manufacturers are focusing on simplifying include paper loading and stacking, as well as drivers and touch panels that guide users through the printing process.

For example, HP's Designjet T120 (24-in.) and T520 (24- and 36-in.) ePrinters, which are targeted to engineering SMBs, have color touchscreens that the company says enable intuitive operation and simplify navigation and printing. The company's drivers have also been updated for ease of use.

"Our drivers now come with a true print preview," says Alex Monino, strategic marketing manager for HP's Designjet Business. "In the past, we had a layout preview, but that led to frustrations and wasted time and costs. Now anyone can print with the driver. It allows us to reach a much wider audience."

Canon has updated its drivers to provide new users with default suggestions, while allowing more experienced users to have more control over print jobs. The company also offers a driver designed to simplify printing from within AutoCAD.

Collaboration: Building Bridges

Faced with the explosion of screens — from laptops to tablets to smartphones — that threaten to obviate the need for

many small printing jobs, it's no wonder manufacturers see large-format printing as ripe for expansion. For design engineering work, a large piece of paper is still more efficient for collaboration than pinching, zooming and panning around a small screen.

"In many cases, the screens on tablets are not good enough," says Monino. "The collaboration and discussion is much more productive when using paper. The challenge is that all the design is happening on digital tools. We have that broken layer between digital and physical. We want to bridge that layer."

That bridge is being built with mobility in mind. HP's Print Anywhere technology enables remote printing via the web. Users can access a personal queue of prints online via a multitude of connected devices.

Check says Epson has been focusing on making sure its large-format printers are compatible with existing cloud printing services for plug-and-play interoperability.

Canon's Direct Print & Share software works with Google's cloud services to enable printing from any device that can connect to a user's Google account. Users who opt to add scanning functionality to Canon's large-format printers can also scan directly to the cloud and then print those files remotely.

Addressing Cost Concerns

With ease of use and mobility moving in the right direction, cost will always be part of the decision-making process. A clearer picture starts to emerge when tracking how much the average SMB spends on printing services, compared to the price of a new large-format printer, which start between about $1,000 and $5,000, depending on the entry-level model. Even at the higher end of that scale, it doesn't take many trips to a service provider for an in-house printer to pay for itself.

Epson's SureColor T3000 can be pushed up against a wall to save space. Paper and ink are loaded in the front, while ports are on the side.

Canon's imagePROGRAF iPF650 has four special CAD printing modes.

Canon recently released a short white paper titled "Printing Large Format Technical Documents — What's Best: Print In-house or Outsource?" that addresses the cost question.

"Based on current market survey information, outsourced printing costs can be as high as $40/page for 24" x 36" color printed maps and construction documents, and $4.50/page for 24" x 36" black & white printed construction documents," according to the white paper. "Printing these same documents in-house can usually be done for much less with an investment in a large format printer."

It goes on to cite savings of 46% or more on outsourced large-format printing costs when printing in-house. However, it also breaks down softer costs to large-format printer ownership, including supplies, labor and maintenance. SMBs should weigh those factors with the time and money saved sending files to the service provider and shipping documents back, or ordering more prints than needed to get a lower overall cost or "just in case."

Having a printer in-house enables more flexibility, which can help streamline workflows. Many entry-level large-format printers are designed to print on 8.5x11-in. sheets of paper, as well as 24 in., 36 in. or even poster board. That means they can be used for typical office documents, CAD files or even quick presentation posters.

"Users now have available devices at a price range and ease of use that makes it convenient to bring printing in-house," says HP's Monino. DE

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

INFO ➜ Canon: usa.canon.com/cusa/professional/products/printers

➜ **Epson America:** epson.com

➜ **HP:** hp.com

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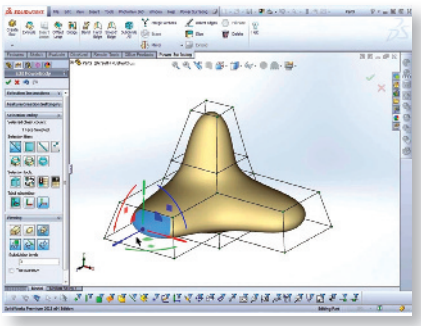
Editor's Picks

by Anthony J. Lockwood

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



Freeform Surfacing for SolidWorks

New nPower Power Surfacing plug-in enables Sub-D surfaces that seem created by SolidWorks.

nPower recently came out with a plug-in for SolidWorks called Power Surfacing that is, in effect, an industrial design toolset for SolidWorks. Here's what it's about.

The gist of Power Surfacing is that it gives you the tools to create complex, freeform organic shapes within the SolidWorks parametric design environment. The neat of it is that it connects Sub-D (subdivision) surface modeling with NURBS-based CAD modeling and your parts with Sub-D surfaces act as if you made them in SolidWorks.

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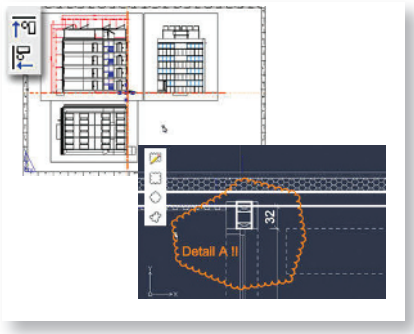

CorelCAD 2013 Released

Latest release supports AutoCAD .DWG 2013 files, improves performance.

CorelCAD is an inexpensive, full-featured 2D CAD system with 3D solid modeling tools. By inexpensive, I mean $699. It supports the AutoCAD DWG file format natively, which takes care of a lot sharing issues right away. It deploys with user interface elements, tools, and commands that complement the feel and conventions of your typical CAD application, meaning that CAD users, even occasional ones, should feel right at home with it.

The 2013 version of CorelCAD features alignment and revision tools, support for the AutoCAD 2013 file format, in-place text editing, an ExplodeX command and much more.

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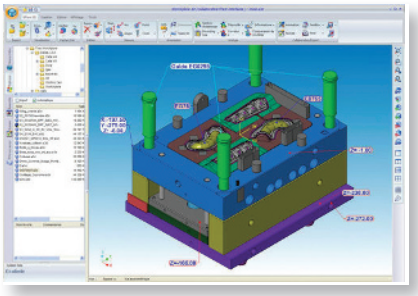

Sescoi Releases WorkXPlore 3D Version 3

CAD viewer said to provide a quick and efficient way to share design data.

WorkXPlore 3D is a viewing, markup, and analysis tool from Sescoi, a developer of software tools and systems for manufacturers. I downloaded the 30-day trial edition of WorkXPlore 3D Manufacturing Pro, the top-end version of the software. (There are three versions of WorkXPlore; each has functionalities tailored for different needs.)

Version 3 of WorkXPlore 3D has been enhanced with more CAD file import/export capabilities, new BREPs technology, new analyses functions, a new texture library, and a new 64-bit version. And, the company says that it is faster than previous versions.

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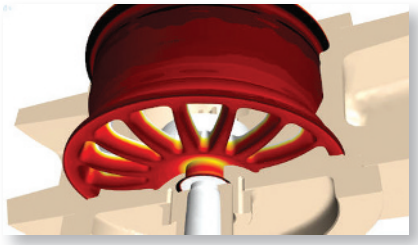

CD-adapco Releases STAR-CCM+ v8.02

Multidisciplinary solution improves usability and performance.

Three times a year CD-adapco releases a major update to its STAR-CCM+ integrated multidisciplinary engineering solution. Version 8.02, the first of this year, features key changes in usability, performance, and expanded coverage areas.

Productivity seems to be the big usability news in this version, including parts-based meshing, JT Open integration, and new surface preparation features. V8.02 is said to improve runtimes for jobs dealing with things like SCR (selective catalytic reduction) devices and chemical sprays by at least a factor of 2.5. When it comes to expanded coverage, version 8.02 sees a lot of interesting activity ...

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Quick as a Mouse

Duratec speeds its design cycle with 3Dconnexion 3D mice.

Duratec Ltd designs and builds custom bike frames. Each frame is tailor-made to enhance rider comfort and enjoyment. Founded in the Czech Republic in 1997, the company has grown to compete on the international market — and currently about 60% of the innovative frames it produces are exported.

"We work in a highly competitive and demanding industry," says Duratec owner Milan Duchek. "We're a small business, but an extremely effective one. All processes, from design and development through to manufacturing, marketing and sales, are managed in-house."

At the heart of the business is the Duratec Development Center, home to frame design, manufacturing and composites processing. It's here that Duratec design engineers use 3Dconnexion's

SpacePilot and SpacePilot Pro with SolidWorks, Catia V5 and 3DVia Composer to create the company's unique rides.

"We first learned about 3Dconnexion's 3D mice at a Dassault Systèmes [Product Lifecycle Management, or PLM] forum," explains Duchek. "They seemed like great products, and we were keen to learn more ..."

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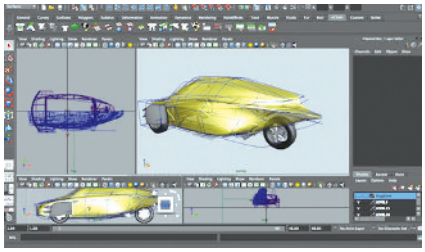
At the Speed of Thought

Imagination Technologies' Caustic Series2 ray-tracing cards power high-speed design for Switch Vehicles.



Clean, green and capable of running for up to 100 miles on a single charge, Switch Vehicles' electric cars are anything but your typical form of transportation. So it's fitting that the process by which they are created is also extraordinary.

To develop the bodywork and instrumentation for its latest models, Switch turned to design consultant Max Sims, who turned to Imagination Technologies' Series2 R2500 ray-tracing acceleration card and its Caustic Visualizer viewport plugin for Maya.

Thanks to their ability to display accurate real-time reflections in the viewport, Sims can now create innovative designs without having to wait for test renders.

Extraordinary Cars for Ordinary People

Based in Sebastopol, CA, Switch has been converting vehicles to electric power since 1991. The company now hopes to make that experience available to the mass market with a new range of electric vehicles at a price "that every American can afford."

Switch aims to step up to manufacturing 50 cars a month — and for that, it needs a roof. At present, the cars are supplied as exoskeletons, with an exposed roll cage. It's in keeping with the company's green design ethos, but off-putting to many buyers.

To help create the bodywork, the company called upon Sims.

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by Antoine Reymond

The Future of Computing

A grand title, but with the mass adoption of consumers using some sort of mobile computing device — either the phone or tablet — the area of high-end compute performance goes unnoticed while the focus is on the numbers of end users and not uses of computing that are pushing the boundaries. There are lots of intensive compute problems in the engineering and simulation world that need to be solved. They require the right hardware, software, and infrastructure to be in place to make that happen.

One area getting a lot of attention in the last few years is GPGPU (general purpose graphics processing unit), which is the use of the graphics card for more than just rendering real-time visuals on the screen.

Parallel Tasks

Modern GPUs are great when you have big data parallel computations that you need to execute. In fact, we have been able to see the performance improvements for parts of engineering software applications that use intensive computation like DGEMM, BLAS subroutines, or linear algebra system solvers. In these tests we learned that since GPUs can run asynchronously with other processors, it is a good introduction to heterogonous computing languages like OpenCL. OpenCL was designed to program heterogonous systems, which contain several specific processors running asynchronously from each other. Having CPUs and GPUs in a system and programming them to reach the best system and software efficiency is where OpenCL is aimed.

In the near future, large amounts of physical memory may be accessed by the GPU.

There are some limitations on algorithms that are still sequential or serial, for example reductions. When accessing system memory multiple times from the GPU during computation, if your data has a small granularity (i.e. a small block size of a few kilobytes) compared to computation, running multiple small compute tasks can add a high latency cost. The good news is that Heterogeneous System Architecture (HSA) and APUs solve this issue because the CPU and GPU are on the same die and will access the shared unified memory space. This eliminates the need to talk to via the PCI–Express bus, so latency is minimized.

HSA is an open-standard system architecture that provides a unified view of common computing elements. It allows programmers to write applications that seamlessly integrate CPUs, GPUs and other programmable compute elements while benefiting from the best attributes of each. AMD's APU combines the processor (CPU) and GPU together onto a single piece of silicon.

Optimizing Code

You can get major gains from using pure GPGPU today as long as the code is optimized for parallel computing. Most of the early gains have been in rendering technology, finite element analysis codes, or ray-tracing technology. With HSA and APUs there are potential gains by changing the code to take advantage of the shared memory, but the core architecture is there to run existing X86 programs today.

This is very important, as you can run your code now and modify only sections of the code when your resources allow you to take advantage of the enhanced memory access. Undertaking any major code changes in modern computer-aided design and engineering software is a complicated process. With HSA and GPUs, you can focus on just the areas of the code where there are the most benefits in the short term.

Looking Ahead

Dedicated discrete graphics cards come with a fixed amount of memory. Lots of analysis and simulation software programs use the larger memory footprints to compute masses of data at the same time. The current crop of professional AMD FirePro cards, for example, comes with 6GB of GDRR5 memory, which being very fast has a physical limit of 6GB. With HSA and APUs, the shared memory is user configurable. In the near future this would allow very large amounts of physical memory to be accessed by not only the CPU, but also by the compute engines of a GPU!

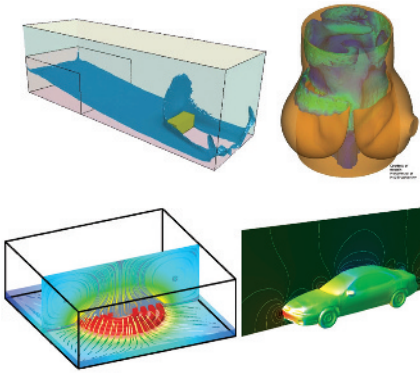
This could change the face of intensive computing forever. It would allow the GPU to become a complete and dedicated co-processor that can be used anytime, and in many cases, with better performance and energy efficiency. If you combine the easy access to using HSA and APUs by running current x86 architecture code and the massive physical memory potentially available with no loss of time swapping data, the future of computing is looking very interesting. DE

Antoine Reymond *is senior strategic alliances manager at AMD. Comment on this article via de-editors@deskeng.com.*

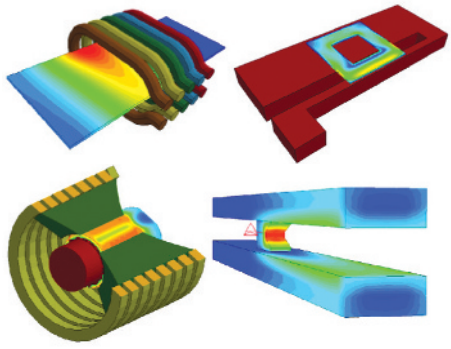
LS-DYNA R7

Three New Solvers for Multiphysic Purposes

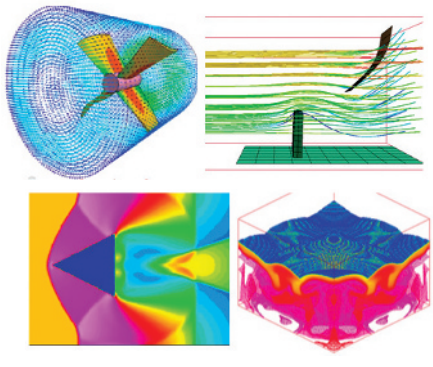
- **Incompressible CFD (ICFD)**
- **Electromagnetics (EM)**
- **CESE / Compressible CFD and Chemistry**



Incompressible CFD: The incompressible flow solver is based on state of the art Finite Element technology applied to fluid mechanics. It is fully coupled with the solid mechanics solver. This coupling permits robust FSI analysis via either an explicit technique when the FSI is weak, or using an implicit coupling when the FSI coupling is strong. In addition to being able to handle free surface flows, there is also a bi-phasic flow capability that involves modeling using a conservative level-set interface tracking technique. Basic turbulence models are also supported. This solver is the first in LS-DYNA to make use of a new volume mesher that takes nice surface meshes bounding the fluid domain as input.



The Electromagnetism Solver: solves the Maxwell equations in the Eddy current (induction-diffusion) approximation. This is suitable for cases where the propagation of electromagnetic waves in air (or vacuum) can be considered as instantaneous. Therefore, the wave propagation is not solved. The main applications are magnetic metal forming or welding, induced heating, and so forth. The EM module allows the introduction of a source of electrical current into solid conductors and the computation of the associated magnetic field, electric field, as well as induced currents.



CESE/ Compressible CFD: The CESE solver is a compressible flow solver based upon the Conservation Element/Solution Element (CE/SE) method, originally proposed by Dr. Chang in NASA Glenn Research Center. This method is a novel numerical framework for conservation laws. It has many non-traditional features, including a unified treatment of space and time, the introduction of conservation element (CE) and solution element (SE), and a novel shock capturing strategy without using a Riemann solver.

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- **Michigan Class - June 25th Contact**
- **California Class - July 01st Blast & Penetration**
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