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Digital Engineering

October 2016

SENSORS SPECIAL SECTION

Supersonic Simulation

Spike Aerospace tries to lower the sonic boom. P.10

by Jamie J. Gooch

Custom Customers and Complexity

THE CUSTOMER IS ALWAYS RIGHT. But which customer? The one who wants a shot of sugar-free vanilla in their tall soy latte, or the one who wants a triple venti, half-sweet, non-fat, caramel macchiato? Both, of course. On its website, Starbucks proclaims: "Our baristas can make you any drink you want from over 80,000 different drink combinations available!"

That's great for Starbucks' customers, but maybe not so great for the baristas. From coffee to computers to cars, companies of all types are trying to balance customers' expectations for personal service and customized products with the complexity it brings to product development, manufacturing and delivery. If coffee can have 80,000 different combinations, how many can a laptop, phone, plane or car have? How many options are too many? When it comes to offering customized products, design engineering teams are the baristas coming up with concoctions that customers supposedly want. But all the customers can't be right.

> The more difficult aspect of achieving efficiency in the face of complexity is a cultural one.

Mass Customization

Last year, customers were able to choose from among 341 front seat configurations when buying a new Volkswagen Golf. That's a far cry from the line attributed to Henry Ford: "Any customer can have a car painted any color that he wants so long as it is black." Volkswagen, which has since announced a plan to reduce that number, isn't alone in its efforts to deal with the choice vs. complexity conundrum. Many manufacturers are turning to technology to offer customers what they want while meeting government regulations and still developing a profitable, innovative product.

Ford was extolling the virtues of the assembly line and a common chassis for the Model T. Today's manufacturers have a number of different innovations to consider:

- Simulation-led design and optimization to find and verify the best design iterations early in the development cycle while reducing the time needed for physical testing.
- Engineering computing power that supports multiple, simultaneous optimization and simulation runs of complex designs and systems.
- 3D printing to create realistic prototypes to speed the development cycle while fostering new design thinking that can lead to the consolidation of multiple parts to simplify manufacturing and maintenance.
- Incorporating embedded software that in some cases can provide personalization and customization to customers via a common platform. (See page 24.)
- Product lifecycle management approaches to make supplier collaboration, change orders, model reuse and platform-based system design more efficient. (See pages 14 and 26.)
- Data collection and analytics to help discover anomalies and determine which customer requirements should be implemented vs. which would be loss leaders. (See page 30.)

Freedom to Fail

Henry Ford's first foray into commercial automobile production failed; so did his second. As Robert Green writes in his book "Mastery," Ford attributed the first to trying to meet too many customers' requirements and the second to his principal investors being too involved in the design process. More than 100 years later, the promise of digital manufacturing puts us on the cusp of another assembly line moment in industrial productivity.

Between now and when efficient, profitable mass customization is routine thanks to accurate market intelligence and flexible manufacturing lines all connected to engineering via a digital thread, many mistakes will be made. The technology already exists to take much of the guesswork out of marketing and the fear of failure out of design. The more difficult aspect of achieving efficiency in the face of complexity is a cultural one. Company leaders must be willing to invest in new technology to drive innovation, and everyone involved in product development and delivery must be willing to disrupt the status quo. **DE**

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TECHNOLOGY FOR OPTIMAL ENGINEERING DESIGN

INSIDE

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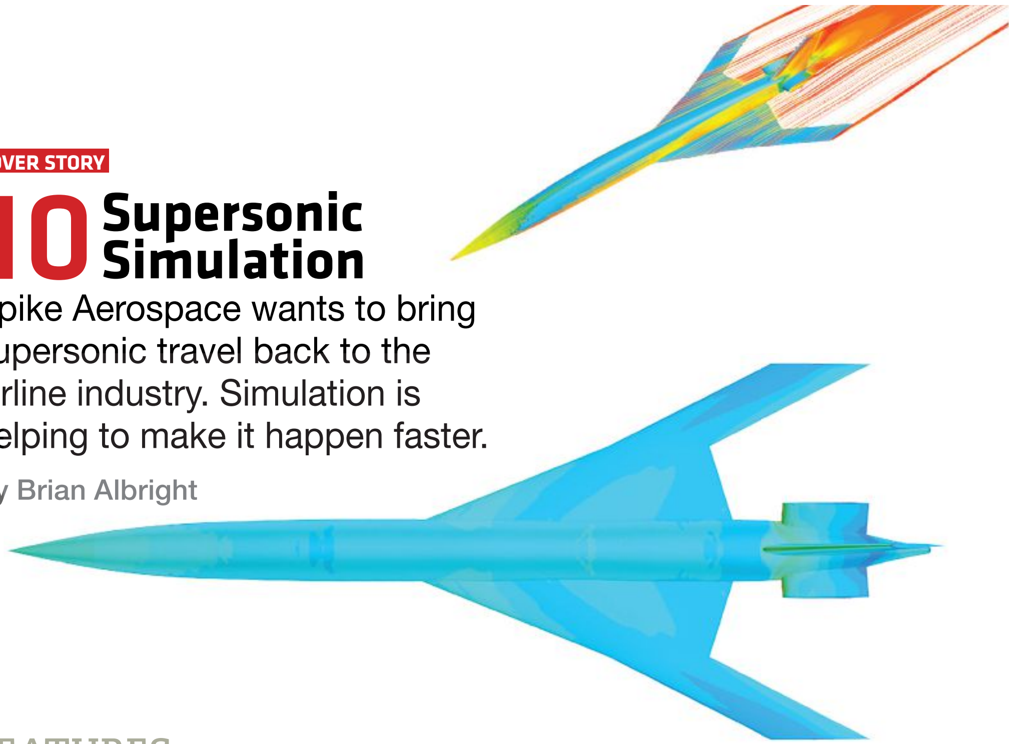

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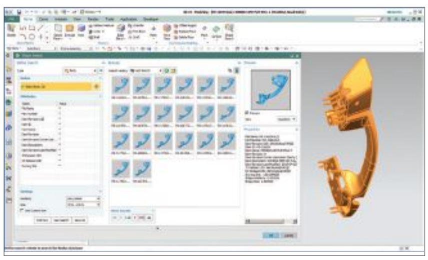
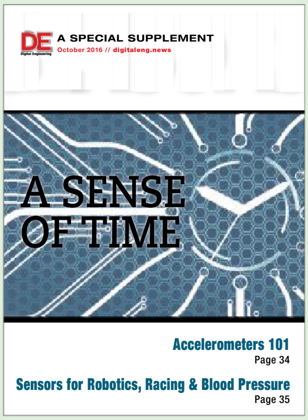
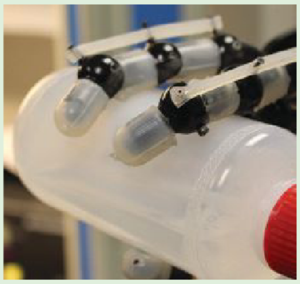


ON THE COVER: A CD-adapco simulation of Spike Aerospace's supersonic jet. Image courtesy of CD-adapco.

FOCUS ON SENSORS





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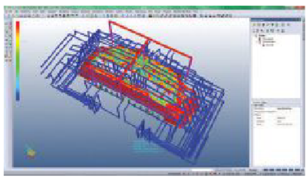

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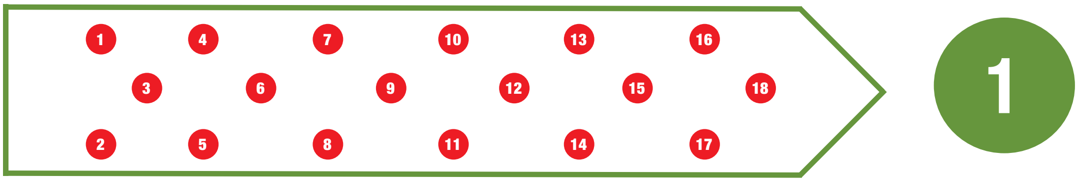
BY THE NUMBERS | PRODUCT COMPLEXITY

Boeing's Big Supply Chain

- The Boeing 787 has about 2.3 million parts.
- The 787 reduces mechanical systems complexity by more than 50%, compared to a 767.
- Boeing has a relationship with 5,400 supplier factories, including sub-tier suppliers.
- There are suppliers to the 787 program in 38 U.S. states and 19 countries.
- More than 750 million components and assemblies were procured by Boeing in 2012.
- 500,000 people are employed through the Boeing supply chain.

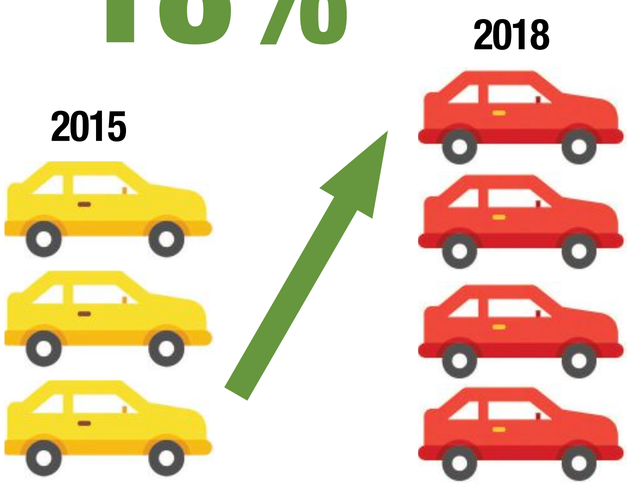
— Boeing



The fuel nozzle in GE's LEAP jet engine was manufactured with 18 components, but is now 3D printed as one component.

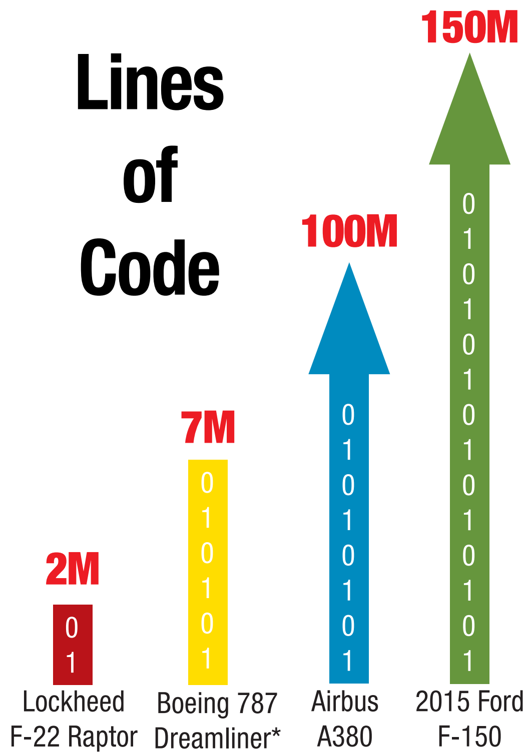
— GE

18%



The number of North American automobile models in production is expected to jump 18% from 2015 to 2018. This translates to more than 800 trim levels on the road by 2018.

— Harbour Results Inc. via Plastics Decorating



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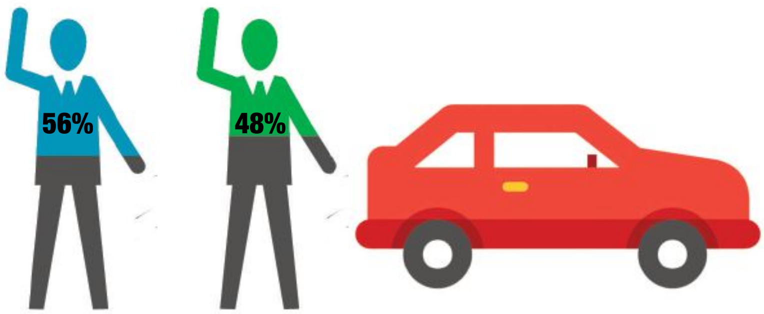
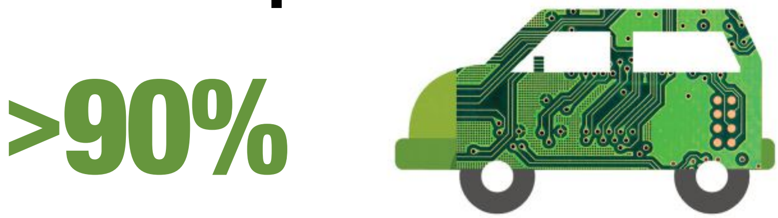
Technology vs. Loyalty

More than half (56%) of new car buyers said they would switch to a different brand if the one they were considering didn't offer the technology and features they wanted. Almost half (48%) said they would walk away from a vehicle they liked if the technology was difficult to use.

— PwC, 2016 Auto Industry Trends

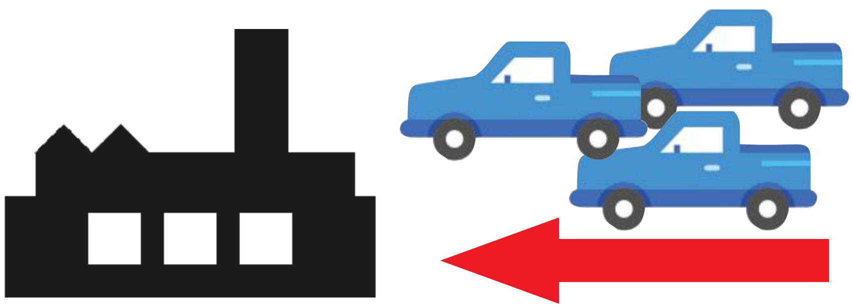


Car or Computer?



Electronics systems contribute to more than 90% of automobile innovations and new features.

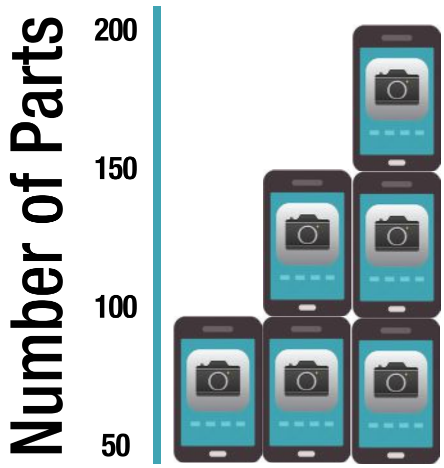
— PwC, 2015 Auto Industry Trends



Over the past 20 years, more than 437 million vehicles have been affected by safety recall decisions in the United States. In 2015, a record 51 million vehicles were the subject of safety recalls.

— J.D. Power and Associates/National Highway Traffic Safety Administration

The iPhone Camera



Last year, Apple's Graham Townsend told "60 Minutes" that there are over 200 separate parts in the iPhone camera module.

Townsend said 24 billion operations occur to capture one image.

Apple's Townsend also said a team of 800 people were focused on improving the camera. The improved camera was showcased during last month's iPhone 7 announcement event.

| CONSULTANT'S CORNER |

SIMULATION

by Monica Schnitger

Simulation-Led Design Changes Everything

OVER-ENGINEERING. Warranty problems. Unmet product performance targets. Missed windows of market opportunity. A depressing list of product design process flaws that is causing more and more companies to explore increasing their use of simulation tools, and doing so earlier in the design cycle. Companies starting from scratch with simulation (I'm looking at you, people who routinely add a "safety margin") as well as those who have long been using CAE to replace some of their physical prototypes are exploring simulation-led design.

A typical process has subject-matter expert designers and engineers working on their parts of the overall systems, simulating their components and periodically bringing everything together for a full system simulation and/or prototype. That process works, and can be very effective at speeding time to market and delivering a solid product.

But does it deliver the most innovative design possible? That's unclear, because it depends on how much time is allocated early on for creative thinking about the design problem.

Jumpstart Design

When simulation leads the design process, designers or analysts work with early stage concepts in a sandbox-like environment. They use knowns where they can and build assumptions while waiting for more details to emerge. Subject-matter experts may start with dozens of variations to see what concepts meet basic criteria; they refine these down to perhaps five to 10 options that meet more stringent requirements before settling on one or two to pursue in greater detail. Teams go from component to subsystem to system, exploring the variants that might meet or exceed the criteria. They can develop concepts quickly and relatively cheaply, and discuss them with marketing or sales, as the voice of the customer, to identify trade-offs. What emerges from this process is a CAE-based model (note, not a manufacturing-quality CAD model) that jumpstarts detailed design.

For many companies, this is a huge shift in who does what and has access to which tools. It may turn the traditional process and hierarchy on its head. After all, if analysts are usually called in at the end of a design cycle to verify fit-for-purpose, they may not be involved in the creative thinking around the design. Giving them the floor, as it were, to suggest alternatives means they need to know the design principles as well as the software technology they're already experts in—and not everyone is up to that task. Similarly, if you now expect designers to do simulation, you'll have experts in the product needing to become capable users of often sophisticated simulation technology—but it's worth it.

Optimization Options

One category of technologies that can help here are optimization tools. Depending on the vendor and type of solution, they can apply algorithms to create strong structures that use the minimum of material or optimize a design to meet a set of other targets. The criteria can be simple or complex, and they can be singular (as light as possible) or multiplicative (lightest, strongest, cheapest to source, etc.). The end result of this optimization is a frontier, a plot or table that shows the trade-offs that could be made: weighs X kilograms using material Y, and so on. Optimizations can also include cost to manufacture, cost to operate and many other factors—the criteria are up to the design team. But the more complex the optimization, the more compute power and time.

It's important to note that no optimization solution on the market removes the human from the design process. The computer suggests alternatives that may meet the criteria but be utterly impossible for some other reason, such as manufacturability. But the computer also has no preconceived notions about a design; it doesn't know what the last generation of the product to hit the marketplace looked like, so isn't bound to keep that aesthetic, for example. Optimizations can come up with alternatives that human minds won't have thought of—and that can be a very good thing.

Without giving away any secrets, I've seen many projects start with a mundane concept that grows into something interesting and unique because simulation helped explore how design variants would behave. The secret is doing that early enough in a design process to make a difference. Simulation-led design is an important process innovation that uses technology to boost that innate creativity. DE

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| ABBEY'S ANALYSIS |

FEA

by Tony Abbey

Define Your FEA Software Requirements

***Editor's Note:** Tony Abbey teaches live NAFEMS FEA classes in the U.S., Europe and Asia. He also teaches NAFEMS e-learning classes globally. Contact tony.abbey@nafems.org for details.*

A FINITE ELEMENT ANALYSIS SOFTWARE PURCHASE requires many considerations. I will assume you have taken the first step and selected your vendor. The next step is to consider a shopping list of solution technologies that are needed for your work.

Traditionally, linear statics, normal modes and buckling were considered quite sufficient for many analysts. However, hardware and software improvements have enabled more advanced analysis solutions at a reasonable cost. For example, the convenience of using contacts in assemblies has driven up non-linear analysis usage. Other advanced options have become a lot friendlier to use.

Building a Requirements List

What technology is needed to carry out your specific simulation tasks? Unfortunately, if you are moving into new technology, you may not know what is needed and should seek advice on selecting the right options.

Most FEA vendor sites present a list of features and options. Some cross-refer to industry sectors, but it is difficult to generalize which solutions will be critical. A site-based build-it-yourself application would be ideal, similar to those that hardware vendors provide (to customize your own list from a series of logical questions).

FEA vendors can be very helpful—but get technical help—don't rely on the salesperson. They probably have little knowledge of FEA and are motivated, quite rightly, to make a sale. A good software vendor should have high-quality pre-sales engineers. These teams know the software strengths and limitations, and have experience with industry applications. You can also contact others working in a similar field, use the engineering forums or appropriate LinkedIn groups. If you are a member of ASME, AIAA, NAFEMS or similar organizations, then solicit advice. Make your request clear—type of simulation, industry sector, general workflow—to focus guidance. You will get a lot of feedback and perhaps an even split between five- and one-star reviews. However, concentrate on the technology area to use.

Ideally, define benchmark simulations that exercise the range of technologies you need—this is a very useful learning curve. However, these are resource hungry exercises and you or the vendor may not have the time or staff to do this.

Matching the List to the Product

Assuming you've assembled a short list of requirements, next is the tricky part. How does this match the breakdown of features you can purchase? The definition of a product range is different across FEA vendors. Premium, Professional and Enterprise or similar labels are common to differentiate packages. It is not clear from this what the scope is; a full comparative feature table is rare.

You may anticipate a progression from basic to advanced functionality within packages. Traditionally, a basic package included linear static and thermal, normal modes and linear buckling. Non-linear (material, geometric, contact) and dynamic response (transient, frequency response, random, shock) was included in the advanced packages. Additional modules would cover super elements, acoustics, advanced composite failure and more.

A review of vendor sites today shows interesting variations. One "basic" package includes nonlinear contact (which is attractive) and segregates material and geometric nonlinearity to an advanced package. Another variation only promotes material non-linearity to an advanced package (which is even more attractive). Most vendors include normal modes analysis in a basic package, but confusingly some call this frequency analysis. This should not be confused with frequency response analysis—which is an advanced option. Basic composite analysis is promoted to an advanced option in one case.

Buying Confidence is Key

It can be expensive to over- or under-define requirements. I bought a CAD-embedded FEA solution from a well-known reseller earlier this year and the salesman assured me all features were included. Well, I got full the CAD features, but no FEA non-linear, dynamic response or composites. It now gathers dust. DE

Tony Abbey *works as training manager for NAFEMS, responsible for developing and implementing training classes, including a wide range of e-learning classes. Check out the ad on page 13 of this magazine for the Introduction to FEA class–with discount for* DE *readers.*

Supersonic Simulation

Spike Aerospace wants to bring supersonic travel back to the airline industry. Simulation is helping to make it happen faster.

BY BRIAN ALBRIGHT

COVER STORY SPIKE AEROSPACE, A BOSTON-BASED AEROSPACE FIRM, wants to make your business travel faster. The company is currently designing what could be the first commercial supersonic business jet, the Spike S-512. Once the plane is in operation, it could cut overseas travel times in half by reaching cruising speeds of Mach 1.4 to 1.6—and do so without the unsettling sonic boom that has kept supersonic aircraft from traveling over land in the U.S. for decades.

"It will be able to reach London from New York in three or four hours," says Vik Kachoria, Spike president and CEO, and a veteran of GE Aviation and NASA. "It's really designed for business travelers. I was traveling a lot when this project started and wondered why there hadn't been a replacement to the Concorde. You can't build another airline-size supersonic aircraft, but a business jet makes sense."

Using proprietary technology developed by Spike, the new jet design (in the works since 2013) will minimize the sonic boom of the plane by optimizing its aerodynamics. To help create the new supersonic jet, Spike has partnered with MAYA Simulation and Siemens PLM Software to leverage their experience in CAE and simulation.

"The power of software tools has really accelerated over the past few years, which has improved engineering efforts, analysis, design and verification," Kachoria says. "Smaller companies like ours can take advantage of those new technologies because we don't have the investment in those older legacy methods."

Simulation has been a key part of the design process. "We can design the entire thing on a screen, twist and turn, and get it right the first time," Kachoria says. "We don't have to spend a lot of time and money acquiring tooling and materials to build it. The simulation can do an amazing job."

"For such a small company, the cost of testing all the different scenarios would be prohibitive, if they had to go into a wind tunnel to validate the design iterations," says Marc Lafontaine, director at MAYA, a Montreal-based Siemens partner. "Smaller companies going into aerospace projects have to very quickly come up with the right design and have to make sure the design is viable at every step because they don't have infinite funds. They need upfront flexibility for looking at many scenarios and finding the best one, and they can do it at a fraction of the cost it would take to [physically] test every iteration."

Dormant Market for Supersonic Air Travel

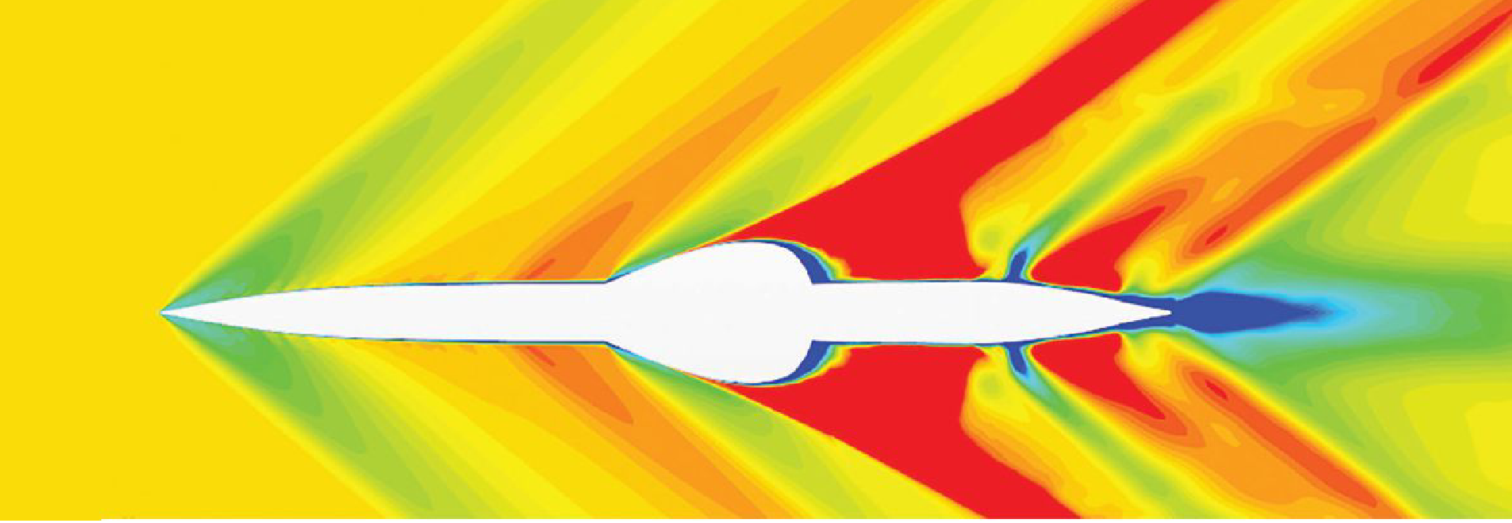
Supersonic aircraft have been around since the 1940s, but have been used primarily by the military or for experimental purposes.

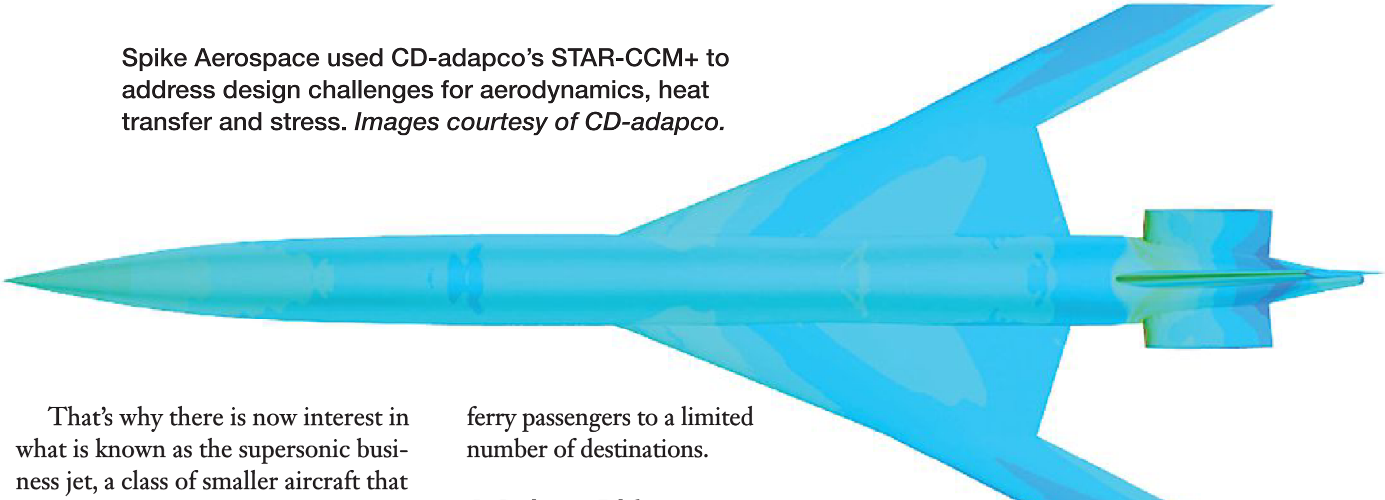
Only two types of supersonic planes have been used commercially: The Russian Tupolev Tu-144 (the first commercial supersonic transport aircraft) and the Anglo-French Concorde. The Tu-144 ceased production in the early 1980s. The Concorde was retired in 2003 because of financial viability issues and safety concerns raised after a crash in France that killed 100 passengers. Airbus also discontinued maintenance support for the Concorde after 2001. There were a number of problems with these aircraft, including cabin noise, mechanical failures in the Tu-144 and more.

From a design standpoint, supersonic flight poses a number of challenges, including intense heat generated at faster speeds, forces applied to the aircraft's structure during banks and turns, and noise generation.

"Supersonic adds a significant level of magnitude in difficulty," Kachoria says. "You have to be so much more aware of fuel burn, and if you can't manage that, it's a non-starter. You have to optimize the aircraft to minimize drag, and there are stability issues, airflow and other design challenges."

There were also economic challenges faced by supersonic airliners, including fluctuating aircraft fuel prices and the fact that subsonic flight appeared to be more profitable for the airlines that previously flew the Concorde.





Spike Aerospace used CD-adapco's STAR-CCM+ to address design challenges for aerodynamics, heat transfer and stress. *Images courtesy of CD-adapco.*

That's why there is now interest in what is known as the supersonic business jet, a class of smaller aircraft that would transport fewer than 20 passengers. In addition to Spike's S-512 (which will hold 18 passengers), there are a number of other projects underway including the Aerion AS2, HyperMach's SonicStar, Tupolev's proposed Tu-444, the SAI Quiet Supersonic Transport, as well as announced projects in Germany, Japan and elsewhere.

The market for these jets is potentially limited to transoceanic flights because of the loud sonic booms that supersonic planes produce. In the U.S., overland flight has been banned for decades because of noise concerns. However, research firm Technavio thinks the market for such aircraft could reach $3 billion by 2020, even though the first planes have yet to be manufactured.

Spike is hoping its Quiet Supersonic Flight (QSF) technology will propel its plane to the head of the pack, with the first jet to be available in the early 2020s. Spike's low-boom concept would allow for trans-continental travel at speeds up to Mach 1.6. That type of aircraft would have a much stronger business case than the old Concorde's, which could only ferry passengers to a limited number of destinations.

A Quieter Ride

QSF is a proprietary technology that works by optimizing the design of the wing, fuselage and tail to minimize noise created by the plane's sonic wake. It's based on the principle that, generally speaking, the longer and "pointier" the plane is, the less turbulence it will experience.

Aerodynamic studies used to have to be done in a wind tunnel, but that poses a number of physical challenges that can skew the results. Computational fluid dynamics (CFD) can replace the wind tunnel during the early design phases, substantially reducing the cost of designing the aircraft and making it easier for Spike to run through hundreds of potential iterations.

As part of its efforts to get to the right design faster, Spike partnered with MAYA Simulation Technologies, which offers training and consulting services in the advanced thermal and fluid flow analysis space, and offers the full suite of Siemens PLM Simulation software solutions.

"We are providing expertise in helping them run their CFD, do external calculations and making sure they can get to the next step, which is doing structural work and enabling the designers to work more efficiently," Lafontaine says. "CFD was an early requirement, because that's how they get to envelope analysis and get the performance they want with no noise or vibration."

Spike is using CD-adapco CAE and CFD tools along with Siemens NX CAD in the design of the jet. The company has tested other tools as well. "For the past year, we've experimented with different systems to see how they compare, and the integration between the simulation and CAD tools with Siemens is very tight," Kachoria says. "You can have a new solid created and go through analysis again very rapidly."

The company is using CD-adapco's STAR-CCM+ to simulate and analyze flow, heat transfer and stress issues in the design. "We chose STAR-CCM+ because of its meshing aspects," Kacho-

A rendering of the Spike S-512 supersonic business jet. *Image courtesy of Spike Aerospace.*

ria says. "We can rapidly create a mesh and then fit it tightly against the edges of the aircraft, and it was easier for our engineers to do. We are able to take the analysis and have the CAD guys update the design using that data. It's a fairly tight integration."

For example, the company is optimizing the wing configuration on the aircraft using aerodynamic analysis for various angles and increasing speeds, from subsonic to supersonic. "We can do rapid analysis, hundreds of times per day," Kachoria says. "We've worked with MAYA and Siemens to use technology to accelerate our optimization studies and to improve aerodynamic performance of the wing using NX CAD and STAR-CCM+ simulation."

Engineers have individual workstations, and the CFD and post-processing work is done on a high-performance cluster that was installed along with the Siemens deployment. MAYA and Siemens worked with cloud-based HPC (high-performance computing) provider Rescale to get Spike up and running quickly, supporting their simulation capabilities.

"Setting up a high-performance cluster would have required a dedicated team to understand how to connect the cores and do parallel processing and validation, and it takes a tremendous amount of time and capital to do that," Kachoria says. "MAYA, Siemens and Rescale got the HPC cluster up and running in two weeks, and we were ready in less than a month with almost no upfront cost. As we need to scale it up and do more complex work or access more memory, we can do that as needed. We didn't spend a million dollars, and we didn't hire any additional IT people. Within weeks were able to do some amazing calculations and analysis."

The company has completed its baseline study on the design and aerodynamics, and is now working on optimizing the aircraft structure. "We can reduce the sonic boom aspects and increase efficiencies, so this is tied into our sonic boom analysis capabilities," Kachoria says. "We have analysis in the CFD environment, and the sonic boom guys look at that. Eventually they will reach a convergence and agree on what the best solution is to all of this."

Kachoria says that the technology has made it possible to reach this stage much faster than would have been possible just a few years ago. "I'm amazed at how much can be done now sitting at a desktop without bending any metal," Kachoria says. "None of this is real until we build the model and see how the analysis comes out, but we've developed enough confidence that we know we are on the right track, and we'll get to the final design a lot faster than we would have in the past."

The company plans to begin detailed engineering in late 2017, and the first test flight of the aircraft is scheduled for 2020. "Once they have the shape they want to have, they will be iterating to determine the final structure and how to manufacture it," Lafontaine says.

The Siemens platform will also help Spike efficiently share their design work with other companies to help complete construction of the final aircraft.

"We are going to see rapid advances in aerospace because of these digital tools," Kachoria says. "We can do everything faster, and that's going to help Spike and other companies make some amazing changes happen." DE

Brian Albright *is a freelance journalist based in Columbus, OH. He is the former managing editor of* Frontline Solutions *magazine, and has been writing about technology topics since the mid-1990s. Send e-mail about this article to de-editors@digitaleng.news*

INFO ➜ MAYA Simulation: mayahtt.com

➜ **Rescale:** Rescale.com

➜ **Siemens PLM Software:** Siemens.com/PLM

➜ **Spike Aerospace:** SpikeAerospace.com

For more information on this topic, visit digitaleng.news

A Product Variation Flight Checklist

Make an engineering-based plan to deal with hardware, software and system design variations.

BY RANDALL S. NEWTON

The Airbus A380 has approximately 4 million parts and 100 million lines of code, plus avionic and interior variations, all of which add to its design complexity. *Image courtesy of Airbus.*

COMPLEX PRODUCTS SUCH AS ROBOTS, tractors, airplanes and battleships are now much more than mechanical products; they are sophisticated digital systems with a mechanical purpose. The Airbus A380 has approximately 4 million parts and 100 million lines of code embedded in processors scattered throughout the aircraft. Such a difference between part count and code line count is now normal in automotive, aerospace & defense, medical, high tech, shipbuilding and many other industries.

An individual part or assembly may stay the same on every A380 delivered, but there are wide variations from customer to customer for seats, interior design, avionics and the software systems driving virtually every aircraft operation. Managing the type of complexity that variation inevitably brings is emerging as a distinct engineering discipline in many industries.

Successful management of product variation must take into account hardware, software and systems. Mass manufacturing techniques must be changed to support customization; software and hardware engineers must collaborate; and systems engineers must be involved in all stages of engineering.

There are various approaches to managing product variation. Some companies create unique bills of material (BOMs) for each variation. But what is the role of the BOM when a company needs to build one item one thousand different ways? Such product variation requires an integrated approach to product lifecycle management (PLM) platforms, where multiple existing systems collaborate to add customer value, reduce transaction costs, trim lead times and control production.

Some manufacturers are rethinking the use of their existing PLM tools, such as configuration management, program management, engineering change management and engineering to order (ETO) or design to order (DTO). Change management tools in particular are being seen as more than a method to track how errors were found and eliminated.

The goal is to have an engineering-based plan for variability. Managing product variation means being proactive about reuse, whether it is parts, code or systems. Such variability management must account for both commonalities and differences, and model them both in a common and consistent way.

The internal cost in time and labor from poor management of change and variation can be enormous. The independent research team of Terwiesch & Loch conducted a survey on engineering change orders (ECOs) in 1999 and found engineering changes consume between one-third and one-half of total engineering capacity and represent between 20% and 50% of total tool costs in manufacturing. Given the ever-present need for speed to market and rapid innovation turns, such high statistics for handling ECOs should be unacceptable no matter the size of the company.

Reconfiguring Existing PLM Tools

Revising existing PLM products and methods is one approach. IT equipment manufacturer Inphi used a variety of software products to work with internal engineering data, but realized its processes for change management and variation control were not affected. The lack of communication among departments and systems forced employees throughout the company to spend time manually searching for needed data. With help from U.S.-based PLM implementation specialist Razorleaf, Inphi conducted an internal discovery process to determine the data points and business processes that would need to be integrated to achieve a proactive change management system that connected all of the affected processes and teams.

"Our customer response time, overall customer satisfaction and sales team efficiency have all improved," says Robb Johnson, director of Technology at Inphi. Inphi connected its change management to Autodesk Fusion Lifecycle and Autodesk Vault for engineering, and for operations and sales to the company's Oracle-based business systems and Salesforce.

Specific Tools for Product Line Engineering

The management of software inside manufactured products has become an important aspect of managing product variation. In some products, it is not the manufactured parts but the software "parts" that change the most from one product variation to another. The engineering discipline known as product line engineering (PLE) is gaining traction as a way to manage a portfolio of products and a shared set of software assets within an efficient means of production.

PLE was originally used only for managing product software, but in recent years has become a new way to manage the engineering process behind products with significant elements of variability and modularity. Using PLE requires a shift from building products to meet requirements—with occasional discreet modifications for variations—to planning around the notion of "systems of systems" where processes, code and parts are designed for reuse across families of products.

PTC is a proponent of the product line engineering approach. Derek Piette is the product management director for PLE at PTC. He says PTC customers using PLE take one of two approaches, the physical or the abstract. "An example of a customer implementing PLE in the physical domain is a truck manufacturer that uses our CAD software to design every possible configuration of specific vehicle features—like the height of the door or wheel, or size of the cab," says Piette. "No two trucks are alike."

By comparison, the more abstract use of PLE is to think about modularity and variability at the backend to identify standard components that can be shared across an entire product line. Piette says these standard components are then designed "in ways that make them easy to configure." He says Volkswagen designs one engine for all car models and then fine tunes it based on horsepower. PTC considers this to be "front-end PLE."

Another software vendor working specifically in the PLE space is BigLever Software. The company says managing product variation with PLE means moving from a product-centric point of view to a production system point of view. The production system is designed to automatically produce all of the products in a specific line or portfolio. The focus is on a singular means of production rather than on all the specific variant products.

BigLever CEO Dr. Charles Krueger says the product line engineering approach consolidates many activities that have been separate in the past, "to reduce the duplication of effort and activities. As a result we get very high levels of productivity, efficiency, scalability and time-to-market improvement." Krueger says the increases do not come as incremental improvements: "These are business transformation levels of improvement that can be factors of three to factors of 15 improvements."

Lockheed Martin is a BigLever customer. They adopted PLE when government contracts shifted toward encouraging commonality and use of shared assets in defense products. According to BigLever, when Lockheed Martin adopted its Gears PLE solution, it reported cost avoidance of over $139 million in a three-year period. Lockheed Martin also reported a 40-60% reduction in test cases. The company achieved these gains while producing variations of a weapons line for deployment by the U.S. Navy, the U.S. Coast Guard and the U.S. Department of Defense Missile Defense Agency, as well as for the navies of unnamed "key allies." BigLever says Lockheed also uses the feature-based configuration capability in Gears to provide full, automated traceability from features to delivered products, to demonstrate compliance with a variety of tough export control requirements.

A detailed case study titled "The Challenges of Applying Service Orientation to the U.S. Army's Live Training Software Product Line," from the U.S. Army and General Dynamics and published by the Association for Computing Machinery explains the evolution of their product management to a product line engineering approach. The product line in the study is a live weapons training system comprised of many elements and many variations. The transformation to product line engineering is called Live Training Transformation (LT2) in the study.

"LT2 has realized significant improvements in cost savings and cost avoidance totaling hundreds of millions of dollars in development and sustainment of live training systems," according to the case study. The study also cautions that "empowering product teams to drive to a more effective state of product line engineering can only be accomplished when product teams are motivated to change."

> **In 1999, engineering changes consumed between one-third and one-half of total engineering capacity and represented between 20% and 50% of total tool costs in manufacturing.**
>
> *– Terwiesch & Loch*

Paul Clements, VP of Customer Success at BigLever calls the cost benefits of product line engineering a "superlinear" phenomenon. "We call this effect superlinear cost avoidance because it exceeds the cost avoidance predicted by the linear cost models that, until now, have been posited in product line economics work," he says.

The Challenge of Increased Complexity

When a new process increases efficiency, the natural tendency is to test the boundaries of the process. A review of academic research shows there is a tendency among companies that are managing product variation with PLE to go big. One such researcher, Kyo Kang of Pohang University in Korea, sums it up: "When a family of products is derived from a common asset base and when these products and assets evolve over time, the complexity of managing products and assets increases an order of magnitude compared with managing versions of a single product."

The solution to complexity brought about by product variation is a high-level, top-down recognition of the issue. When senior management considers complexity management a discipline or job function in the organization—equal to any primary engineering task in the product development lifecycle—engineering teams will have the necessary resources to reap the potential benefits. DE

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INFO ➜ **Autodesk:** Autodesk.com

➜ **BigLever:** BigLeverSoftware.com

➜ **Inphi:** Inphi.com

➜ **Lockheed Martin:** LockheedMartin.com

➜ **Oracle:** Oracle.com

➜ **PTC:** PTC.com

➜ **Razorleaf:** Razorleaf.com

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Collaborative Design Made Easy

ESTECO VOLTA helps make interactions among people, data and workflows as efficient, safe and traceable as possible.

EVERYONE IS WELL AWARE of the many online options when deciding how to share pictures or an article with our friends: social networks, shared drives, collaborative bookmarks, etc. But what if we also need to make sure that all comments are captured? And track the history of those comments in a structured and easy to search way? How can we decide which is the best tool? Ask the same questions to design departments that deal with huge amounts of data: simulation models, results, statistic datasets, bill of materials, testing data, just to name few categories. The answer becomes more challenging.

As engineering processes evolve in response to the increased complexity in product and system design, technology advances to incorporate new routines and promote best practices. Today's design processes break the geographical and time zone barriers and ask for concurrent and synchronized contributions. Consequently, the focus of the technology dedicated to manage engineering workflows and Simulation Process and Data (SPDM) should be placed on interactions among people, data and workflows to become the most efficient, safe and traceable possible. And above all, always accessible from anywhere.

Centralized, virtualized environments enable the different players involved in the design process to access critical Intellectual Property (IP), work with models, analyze scenarios, their worries only being the internet connection.

Over the years, ESTECO has built fruitful relationships with its key customers to achieve an in-depth understanding of the governance of engineering workflows and procedures. Starting from modeFRONTIER, a well-established desktop solution for design optimization, integration and advanced data analysis, ESTECO technology has evolved in into a comprehensive environment for integrated management of simulation process and data – SOMO (Service Oriented Multidisciplinary Orchestration). This year ESTECO is moving a step further and renaming the next generation of its enterprise platform from SOMO to VOLTA. VOLTA incorporates the most modern web technologies with optimized UI and interactions, fostering simplicity and usability. This new release builds upon the company's expertise in optimization and integration to support leading companies in their organizational transition toward more complete simulation-based product development. All of that while maintaining crucial capabilities such as efficient management of job execution and computational resources (HPC/cloud).

VOLTA acts as the engineering hub, where teams benefit from customizable data structures and fine-grained permissions to ensure efficiency for each role involved. Simulation experts can avoid the burden of managing "work in progress" data with the advanced version control system that traces, organizes and makes all kinds of simulation-related data accessible: from models to library files, methodologies, key-results and reports. VOLTA facilitates another – sometimes unstructured – key process: conveying experts' skills and working experience into a codified and independent set of knowledge that is reusable. These simulation templates help access only the information that matters for the design task.

Often big OEMs approach the design of complex products by breaking them up in basic building blocks, creating physical predictive models and describing interactions and dependencies. With the new ESTECO environment, team leaders monitor the impact of changes on the system and gain a valid support for a faster decision-making, with secure data access. Ultimately VOLTA enables an effective simulation-driven product development, allowing non-technical, pivotal job functions to access and understand simulation and optimization data processes and to make better decisions.

For more information please go to: www.esteco.com

Math Tools for the IoT: At the Edge and Beyond

Cut smart-product development time with targeted math software.

BY PAMELA J. WATERMAN

IF YOUR BUSINESS IS NEW to the Internet of Things (IoT)—or if you want to improve the design process of your already-connected products—mathematics software can complement your current engineering tools. Packages from such companies as MathWorks, Maplesoft, PTC and Wolfram Research help users address the full spectrum of designing and operating smart devices. From planning the device (considered the leading "edge" of the IoT operational flow), through programming the operating sequence (i.e., "read temperature every five minutes"), to simulating in real time the expected behavior of an entire IoT control loop, you'll find there's a mathematics package that saves both time and money.

The Raspberry Pi 3 has a 1.2GHz 64-bit quad-core ARMv8 CPU, 802.11n Wireless LAN, Bluetooth 4.1, Bluetooth Low Energy (BLE), 1GB RAM, 4 USB ports, 40 GPIO pins, a full HDMI port Ethernet port, a combined 3.5mm audio jack and composite video, a camera interface, a Display interface, a micro SD card slot and a VideoCore IV 3D graphics core, all in 3.37x2.21x0.83 in. *Image courtesy of Raspberry Pi.*

The IoT Data Flow

Whether you're sensing temperature or tidal flows, programming Arduino, Raspberry Pi or custom microcontrollers, sending data to a cloud or fine-tuning a control algorithm, the general path followed is the same. (See the flow diagram on page 20.) A smart edge device (Stage 1) may feature a camera, optical reader, pressure sensor, moisture sensor or simple switch, and is mated with an on-board microprocessor that at a minimum can send or receive data (or both) via USB cable or Wi-Fi to a local server. The physical format can be a totally custom configuration or a system built around such popular embedded platforms as the Arduino microcontroller or Raspberry Pi fully functional computer board. (For some great basic examples see http://goo.gl/1QByQ8).

More sophisticated edge devices contain processing capabilities for data reduction and may perform according to embedded algorithms that can be remotely updated as needed (Stage 2). Depending on your goals for the task, and especially if real-time actions need to be triggered, these devices may also incorporate two-way interactions with powerful, near-user computational/storage resources. This relatively local configuration—designed to perform fast edge analytics, preserve communications bandwidth and reduce latency of critical commands—has come to be known as edge computing or fog computing (a term originated by Cisco and well explained at http://goo.gl/uwLGmS).

At the far end of the IoT chain resides Big Data, supported by the tools and algorithms needed for meaningful mathematical analysis, visualization and reporting (Stage 3). This activity primarily happens in the cloud, where massive computational and storage resources support many levels of decision making. Businesses can observe trends in data over multiple parts or systems across hours, days, months or years, making decisions about current operations or future designs based on aggregate behavior. Two-way communications are possible between any pair of stages in the IoT, and each stage involves design and analysis; however, we'll focus on the role of mathematical software in designing and simulating all aspects of edge devices for Stage 1.

Begin at the Beginning

Though it's easy to think that a smart device begins its life as a CAD drawing on a screen or paper, it really starts with the math behind the process—the mathematical concepts that need to be proven first then implemented in hardware and software designs. This is the broad viewpoint of CAD supported by PTC's MathCAD software.

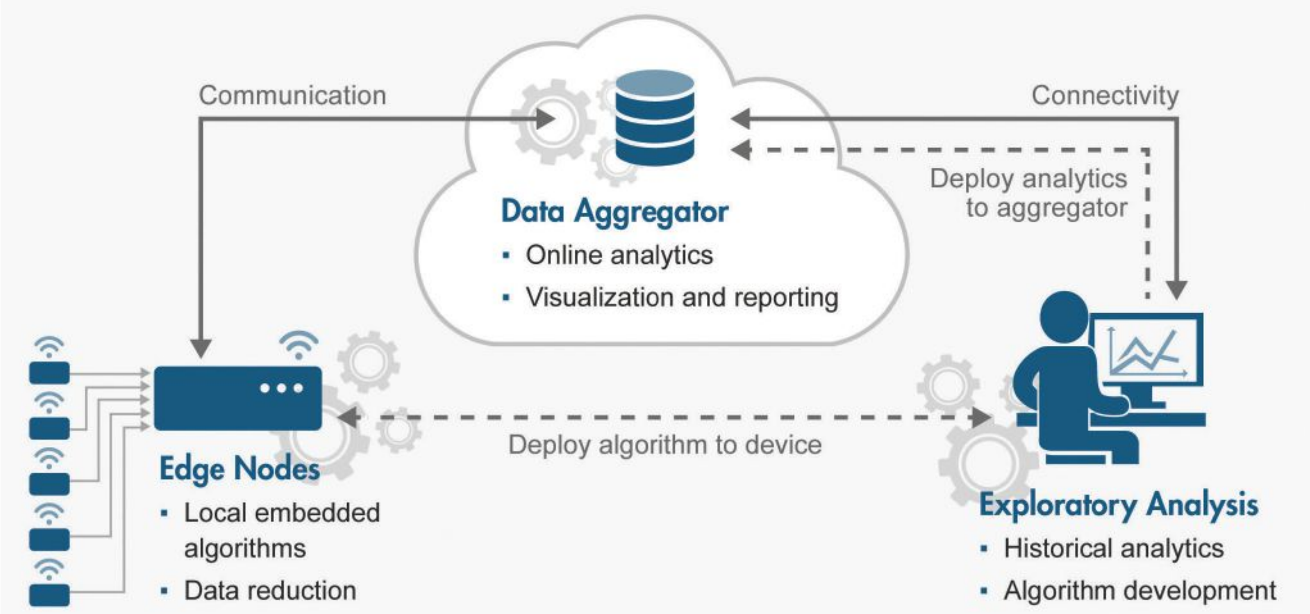
"We like to talk about showing your work: That all designs start from critical values and calculations that define a system," says Andrew McGough, product manager at PTC. "From an IoT perspective, we not only focus on defining sensors themselves—what you need and don't need—but also where they need to go and how you use that data." PTC is working on a number of initiatives to see how their products fit well in the smart-connected world.

One example McGough presents is that of a bike being outfitted with smart sensors. (See "Smart Mountain Bike Tells All" on page 20.) "You might want to get specific information to drive the constant design modifications or to drive simulations," he explains. "You want to know where to put the sensors on the bike to get the best result and what you need information for. It may be you can sense 10 different things, but you only need two; adding too many sensors to the bike can be intrusive to the system (changes the bike handling). You can use MathCAD design of experiments (DoE) to determine the best fit for what sensors you need and the absolute values." McGough adds that you may not even need gauges and readings for all of the parameters you'd like to have—pick two and use MathCAD to calculate the desired end values from the raw data.

Greg Brown, PTC senior director for CAD Business Development, expands on this concept with a different industrial use of MathCAD's capabilities. "Using accelerometers to detect and monitor vibration in rotating machinery, or any machinery, has been around for many years," comments Brown. Now, he says, connecting them for feedback in a digital way is interesting because you can monitor lots of different vibrations in different parts of the system. "This is another application of robust design and DoE where you've got huge amounts of data—real data—that tend to be very noisy compared to the theoretical data you get out of an FEA (finite element analysis) system. You can characterize a structure in FEA, and get nice smooth harmonics and look at where you would put sensors based on that, but in reality there's a lot more complexity to it." He says because sensors themselves give noisy data, "You might need a lot of filtering and number crunching after the fact to work out where is the most robust place to put them."

Programming with MathWorks

A little background about programming a microprocessor-controlled smart device: If you do it directly, you must create



Workflow of an Internet of Things connected device: Stage 1 – edge device (e.g., sensor, switch, optical reader); Stage 2 – local computational and/or data storage resource; Stage 3 – data aggregator resource, generally in a cloud, hosting massive computational and storage capabilities. Two-way communications are possible between any two stages. ***Image courtesy of MathWorks.***

state machines to control its actions, explicitly defining all inputs, outputs and timing, usually writing in C or C++. This produces the guaranteed fastest executions because there is no operating system involved. However it can be a very complex task, especially for newcomers.

MathWorks gets this, and is heavily into helping users simplify code generation. In fact, its website introduces Arduino programming support with this statement: "Arduino programming is supposed to be fun but can become frustrating and time consuming for tasks such as plotting sensor data or incorporating advanced math, signal processing or controls routines into your projects." By offering special support packages for MathWorks MATLAB and MathWorks Simulink software products, the company addresses challenges for both Arduino and Raspberry Pi programming, supporting two primary workflows: Read/write/analyze data from sensors and imaging devices, and develop algorithms that run standalone on these devices.

MATLAB is a high-level interpreted language, so no compiling is necessary. Eric Wetjen, MathWorks senior product marketing manager, says the MATLAB Support Packages for Arduino and Raspberry Pi (introduced in the MATLAB 2014a release) make programming edge devices much easier for any level of programmer or engineer. "With either MATLAB Support Package," he explains, "users write a script in MATLAB, using functions specific to the support package; that allows you to directly access [for example] the Arduino and anything attached to it, like an I2C or SPI bus temperature sensor." With this workflow, MATLAB is open and running on your PC or Mac, and the computations are done on the desktop in real time; you can also go back to analyze and visualize the data in MATLAB. The board and computer are always communicating, either via USB cable or by Wi-Fi—the latter if you add a Wi-Fi shield (daughter board) to the Arduino or Raspberry Pi.

When working instead in the MathWorks Simulink environment, you use its block-diagram approach to model a system and create complex control algorithms then deploy the algo-

Smart Mountain Bike Tells All

A demo of start-to-finish smart (and efficient) monitoring is that of a sensor-outfitted mountain bike controlled by a Raspberry Pi. At last year's NIWeek event, the bike and its PTC Creo CAD bike design were linked to an augmented reality display while a number of real-time sensor values were monitored through the PTC ThingWorx IoT platform. In one application, a light sensor on the rear wheel constantly registered an on/off condition to detect the number of rotations per minute. However, if all that data had been sent to the cloud to be translated into speed, there would have been massive amounts; instead, ThingWorx provided an executable right on the Raspberry Pi controller that performed an "edge calculation" (monitoring these values and then sending just a derived value or condition) at a slower rate, more efficiently providing the desired information. — *PJW* rithm you've written right onto the Raspberry Pi or Arduino. "The Simulink Support Package generates the code for you and downloads it to the board; the advantage is you can then do stand-alone operation, with the board disconnected from Simulink," Wetjen notes. The device sends data wherever you want, such as to a cloud server. From there, you could again use MATLAB, this time to access the data for analysis.

MATLAB also provides a great starting point if you have a brand-new sensor in development. "You can connect it up, see how the data looks, start applying some analysis and characterize the behavior. When you're satisfied, then you can write code for the device to operate autonomously," Wetjen points out.

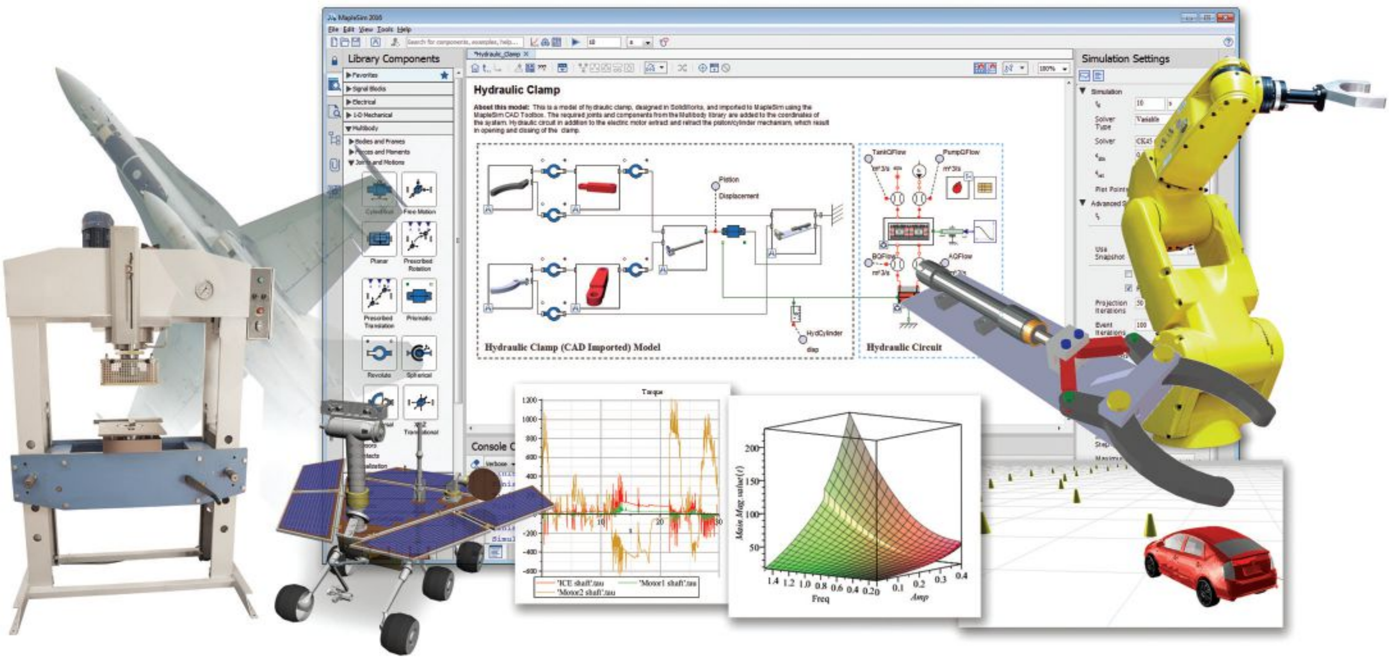
Maplesoft

MapleSim software from Maplesoft has always been about building models of devices and systems. Laurent Bernardin, chief scientist at Maplesoft, says that their customers use their products to simulate device behavior and get insight for optimization, seeing where perhaps a device would have problems and fixing it ahead of time. "In the context of the Internet of Things," he observes, "this is becoming important because you have all these devices that are connected and you get a constant stream of data on how those devices are behaving."

Arduino markets its MKR1000 (US only) and Genuino MKR1000 (outside US) as an ideal solution for IoT projects by those new to networking. *Image courtesy of Arduino.*

Bernardin adds: "We have, for example, a customer who is monitoring thousands of power plants around the world. The connected devices are generating data about how the individual parts are doing, and the goal is to detect failure before it becomes an issue. They are using mathematical simulation models in Maple and MapleSim to compare the data they gather in the field to the expected behavior that the simulation model is giving. That allows them to detect when things deviate from the normal and to predict in advance when a particular part is going to fail."

In another way of working with MapleSim, the user connects a physical device to a virtual device, and can compare the actual sensor readings to the expected readings from the model. Bernardin calls this the virtual Internet of Things, because the



MapleSim is an advanced system-level modeling and simulation tool that provides insight into system behavior, making it helpful with the Internet of Things design process. ***Image courtesy of Maplesoft.***

model has mixed virtual, simulated devices with hardware-in-the-loop. The approach lets you predict, compare and validate, incorporating an accurate mathematical model that stands in place for your devices.

An added benefit, notes Bernardin, is that as you develop a network involving IoT devices, you may want to deploy the complete system while you're still proving out a particular component. A virtual device, based on a simulation model, can be a placeholder for the missing device until it is ready.

One additional MapleSim feature that is relevant to working with edge devices is the ability to generate high fidelity models that still run in real time. This is crucial for comparing the sensor data to the model as it comes in; you can't fall behind because the devices send so much data on a continuous basis. Bernardin says MapleSim is rather unique in its ability to generate these real-time models for very complex systems where other tools might require you to compromise on fidelity. Although tempting to handle this task with one's standard FEA and CFD (computational fluid dynamics) simulation tools, those tools are not able to keep up with IoT data streams and do not allow a system-level view.

Wolfram Research

Wolfram Research sometimes seems to be in a world of its own, but its variety of tools offer convenient stepping stones to developing and using interconnected devices. The Wolfram Data Drop is an open service that helps users get data from hardware ports/sensors, accumulate that data in databins in the Wolfram Cloud, and access it from Wolfram Language and other systems. For example, you can use the Wolfram Language Device Connection for Arduino or the bundled Wolfram Language system on Raspberry Pi to read data and add it to a databin. The company's website also says the option to add embedded code to a databin is coming soon.

Beyond Edge

Each of these math-oriented companies also markets software that helps designers with Stages 2 and 3 along the IoT path. For example, MathWorks offers an option for storing data with the free ThingSpeak data aggregation service, where you can analyze it online using the integrated MATLAB engine or offline with a desktop installation. You can also access data with the MathWorks Signal Processing Toolbox and Statistics and Machine Learning Toolbox for filtering and sampling data, applying statistics and doing further big data analysis.

PTC's ThingWorx platform includes development, connectivity and data analysis tools that complement MathCAD, and the new statistical analysis and visualization tools in Maplesoft's Maple 2016 provide expanded insight into more Big Data from the edge. **DE**

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INFO ➜ **Maplesoft:** Maplesoft.com

➜ **MathWorks:** MathWorks.com

➜ **PTC:** PTC.com

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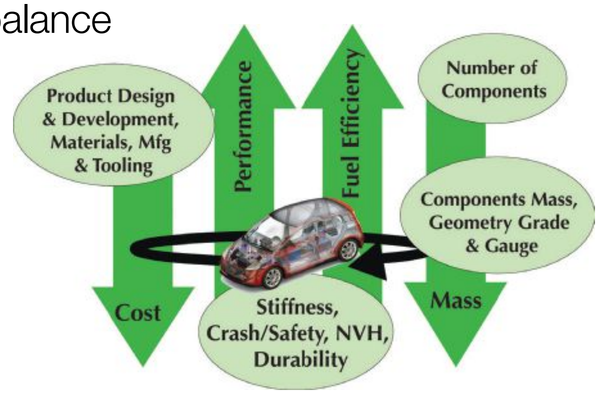
Technology Drives Innovation

ETA & BETA CAE Systems collaborate to balance competing design requirements.



AS STEVE JOBS ONCE SAID, "Innovation distinguishes between a leader and a follower." A profound perspective in this ever-changing world and likewise, technology continues to be the driver behind innovation.

This is certainly accurate in describing the product design and development space today. Processes have been changing rapidly since high performance cluster computers, model parameterization, multi-disciplinary optimization and new analysis tools have emerged.

Competing Design Criteria

Because the design of mechanical structures is driven by many competing criteria such as cost and weight reduction, contrasted by enhanced multi-disciplinary performance and manufacturability, new technology was required to solve these challenges.

Furthermore, the introduction of new manufacturing processes and materials, for example Advanced High Strength Steel (AHSS), significantly increases the available design space. A broader design space expands the set of all possible designs for mechanical systems, bringing the optimal design within reach.

Optimization Drives Design

To explore the entire design space more effectively, while trying to reduce design cycle times, engineers at Engineering Technology Associates, Inc. (ETA) developed an automated way to use optimization to drive the design process. They use a method that works as a virtual search engine resulting in hundreds of design possibilities that meet design criteria/constraints at varying degrees. Like plots on a diagram, the optimal design concept can be found when the most ideal balance is met.

Evolving over the last decade, the methodology used is the Accelerated Concept to Product (ACP) Process®, a performance-driven, holistic product development method based on design optimization. The methodology combines design, material and manufacturing expertise with CAD, CAE and CAO tools. As a result, product development time, cost and product mass is reduced, while overall product performance is improved.

Using the ACP Process, the engineer can easily reveal the optimal balance of structure and strength and can greatly decrease the time required to identify a set of feasible, or even optimal, designs prior to building and testing the first prototype. The methodology has proved that it could also compensate for the limitations of human intuition and provide design engineers with the freedom and power to seek creative solutions that are not obvious to even the most experienced design engineers.

Introducing ACP OpDesign

Last year, ETA joined forces with BETA CAE Systems, an innovation leader in engineering software specializing in state of the art CAE Pre/Post-Processing software systems. The partnership set forth to combine ETA's ACP Process with BETA CAE System's powerful software platform, ANSA, into ACP OpDesign. The tool will be released in this last quarter of 2016.

ACP OpDesign provides two major functions for product design and development. First, it acts as an Optimization Suite, which allows the engineer to perform any type of design optimization. It offers an easy and effective gateway to commercial optimization and solvers. Second, led by design optimization, it provides tools to design structural products, from concept to production.

CAE, design and manufacturing are all synchronized to find the optimal design solution. Using ACP OpDesign, various shape (geometry), gage, and material grade design variables are setup using ANSA's morphing and optimization setup functionality. Post-Processing is done in automated sessions, which track and report responses for the runs and optimization tools provide easy to use and simple to understand optimization results.

The solution can be applied to a range of structural products in a variety of industries. ACP OpDesign is a gateway to a variety of tools and promises to streamline the product design and development process, making a wide array of structural products lighter, cheaper, stronger and more efficient.

More information, as well as an opportunity to sign-up to be among the first to try ACP OpDesign, can be found by visiting www.ACPOpDesign.com.

Integrate Embedded Software

Increasing product complexity and limited resources are leading to an uptick in the use of embedded software development services.

BY BETH STACKPOLE

AS EMBEDDED SOFTWARE and control systems become a dominant part of a product's overall makeup, manufacturers are turning to embedded software engineering services and new types of design tools to ease the burden of embedded system design.

According to VDC Research, about half of companies across industries opt for some level of outsourcing of embedded software development tasks—a figure that has held pretty steady over the last few years. Manufacturers are bullish on outsourcing these functions for a variety of reasons—from taking advantage of low-cost labor pools in foreign markets to gaining access to talent and experience they simply can't replicate in house in any affordable manner, according to Chris Rommel, executive vice president at VDC Research.

Beyond lack of talent or inability to handle growing product complexity, many engineering teams are driven to outsource embedded software development simply because they are under pressure to get product to market quickly and a third-party partnership is the most expedient way to get work done. "As all products become much more complex, it's not that organizations don't have the talent internally to do things, it's that they are expected to create much more complex products in a shorter amount of time," Rommel says. "Sometimes having enough horses in the stable is the real challenge."

Being able to apply more man hours to get a product to market gives an organization far more agility to responding

> "It's not that organizations don't have the talent internally to do things, it's that they are expected to create much more complex products in a shorter amount of time."
>
> – Chris Rommel, VDC

to the ebbs and flows of project demands without as much liability or the need to carry significant overhead, he adds. It also allows for better utilization of design talent—for example, not overcommitting to hiring engineers with a specific skill set that might go out of vogue once a project is finished, he says.

"Planning for a certain percentage of work on an on-going basis to be conducted by contract engineers helps keep companies more agile," Rommel says.

Breadth of Domain Expertise

Nuvation Engineering, which delivers an array of product development services related to electronics design, is definitely seeing an uptick in demand for its embedded software expertise, according to Michael Hermann, the firm's COO. Customers typically contract the firm for two reasons: First, for bandwidth issues because they have too many projects on their plate and not enough resources, or second, because they need access to a capability that's outside the scope of their in-house talent. Even those companies with embedded software developers on staff often contract for outside services because they require expertise that transcends their internal knowledge of specific products and industries, Hermann explains.

"Companies with internal embedded software development functions see a lot less than a company like ours that lives and breathes product development," he says. "We provide services across so many industries and pieces of technology, we can take expertise gleaned from consumer electronics projects and apply them to a medical device effort, for example," he says. "The approach also allows companies to focus on their special sauce—the intellectual property at the core of their product. And when you're only dealing with an in-house team, you don't have access to that large group of engineers with different skill sets that will ultimately result in a product that's most effective."

Contracting for embedded software services can buy an engineering team a number of other benefits. For one thing, service providers like Nuvation follow a more rigorous design methodology than most small- and mid-sized companies, which will result in a lower cost of development and help eliminate problems early on before they become overly costly to address, Hermann says. Nuvation is also out in front in adapting newer agile software development practices, common in the software development world, to embedded software design that provides its customers with better results, he maintains.

Conquest Consulting, a software engineering company, has also seen increased demand for embedded software design services, but contracted in tandem with other kinds of services in areas like web development and communications. "In the old days, we'd be called in to design a closed-loop system used to perform a single task, but now embedded systems are being used to collect data and communicate it externally," explains Lance Liefert, CEO at Conquest. "Not very many companies have that diversity of expertise unless they use the outsource model."

Working the Relationship

Choosing the right embedded software services provider is half the battle, but it's key to put best practices in place—and adhere to them—to ensure the relationship delivers real value. On the hiring end, Liefert advises engineering organizations to make sure that they have a clear understanding of what technical capabilities they need, especially because embedded software is such a niche area of expertise. A high-level project manager with deep technical expertise, potentially in the area of systems engineering, can be an effective bridge between the engineering department and the outside services firm to keep everyone on the same page and to be sure all requirements are being met. "When it's just a business manager that determines what company to hire, that's where things can fall apart," Liefert says.

Ensuring that there are adequate internal resources to deploy on testing and quality assurance is also advised when there is externally developed embedded software code, says VDC Research's Rommel. Staffing up to handle review of external content and investing in automated testing tools are a good way to ensure the group is appropriately prepared.

The temptation for many companies will be to move forward to code quickly—a scenario that Nuvation's Hermann highly discourages. Having a defined set of requirements, working within a methodical, clear-step approach and leveraging proven change management and collaboration processes will ensure that things move forward at a reasonable pace—but more importantly, result in a top-quality product with a lower cost of development, he says.

Finally, Hermann says to bring the embedded software partner into the project in the early stages of development, not after work is well underway. "The earlier the better, because we can provide a lot of value with our multi-industry and technical expertise," he says. "We don't want clients to throw something over the wall early, we want the wall to be torn down with both partners working together." **DE**

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

INFO → Conquest Consulting: ConquestITConsulting.com

→ Gumstix: Gumstix.com

→ Nuvation Engineering: Nuvation.com

→ VDC Research: VDCResearch.com

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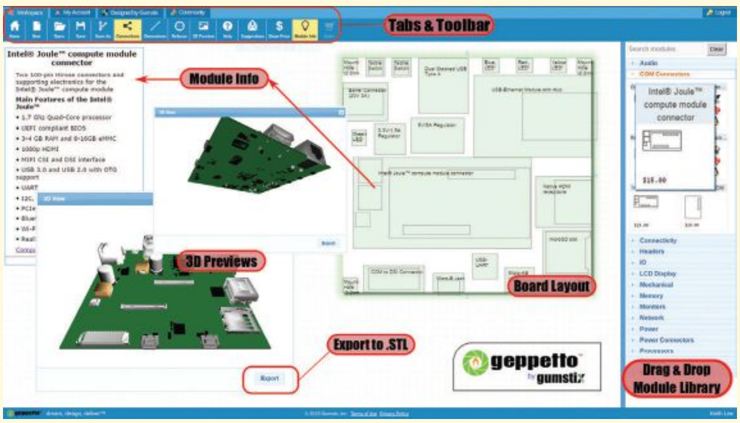
Geppetto Fast Tracks Embedded Designs

Service providers aren't the only ones lending a hand with embedded software design. Design-to-order systems like Gumstix are also doing their part to make embedded systems development a little more palatable for non-experts.

The company's Geppetto Design to Order (D2O) platform gives makers and engineers a jumpstart in customizing, designing and manufacturing custom boards through a graphical interface that lets engineers drag and drop modules like sensors, processors and connectors to create a design along with providing sourcing, component purchasing and fabrication services that will ensure a finished product.

Even large companies are opting for services like Geppetto to offload some of the routine electronics and operating system work involved in embedded system design so they can focus their efforts on the application layer, says Gordon Kruberg, Gumstix's CEO.

"The folks designing embedded systems understand what their value add is and that's in the system design and application layer," he says. "The application layer is the lifeblood and we don't see that being outsourced."



The Geppetto free online design tool now supports the Intel Joule module, supporting design in one day and production in three weeks. *Image courtesy of Gumstix.*

Search Shapes Up

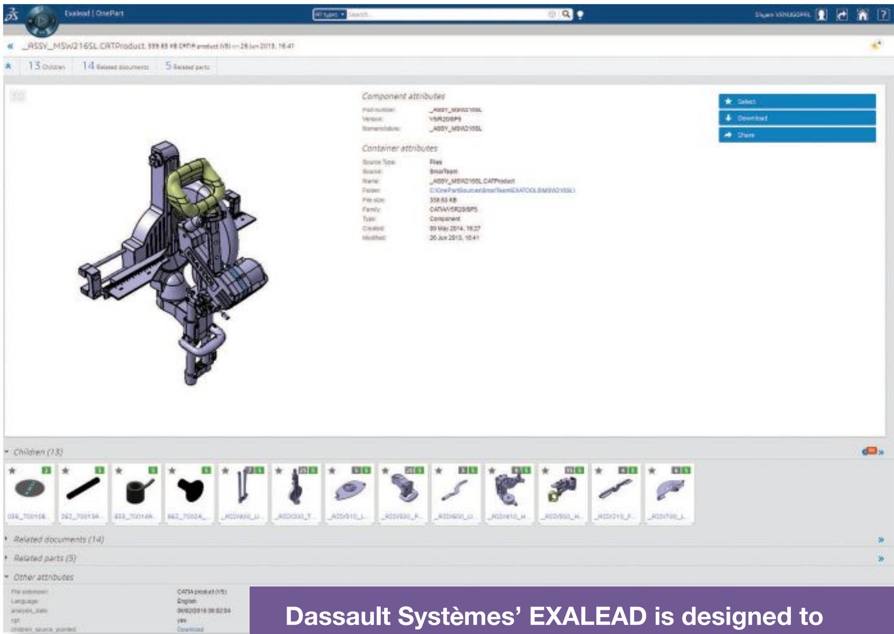
Geometry-based search functions may be the key to promote data reuse and discovery.

BY KENNETH WONG

THE SEARCH FUNCTIONS in most product data management (PDM) and product lifecycle management (PLM) systems rely heavily on your knowledge of the object you're trying to find. They use the fragmented information you provide—a partial file name, a classification, usage history or associated projects—as guiding criteria to search across the enterprise database, then present you with a list of items containing the stated attributes. The method works well with text or other data that fits nicely into a file folder structure, but it proves far less efficient with CAD data.

"This is a massive problem, inherently related to the geometric nature of the data and the fact that most organizing principles today rely on catalog schemes or part numbering systems that have to be manually maintained," says Mike Haley, Autodesk's senior director of Machine Intelligence.

Geometry-based search—identifying your target file based on geometric features—was previously deemed impractical, in part due to the heavy computation involved. Now that cloud computing can address the bulk of the work, many vendors are revamping their PDM and PLM architectures to include the use of shape as an input in their search tools. The goal: To significantly increase data discovery and reuse.



Dassault Systèmes' EXALEAD is designed to uncover the value of product-generated data combined with customer information. *Image courtesy of Dassault Systèmes.*

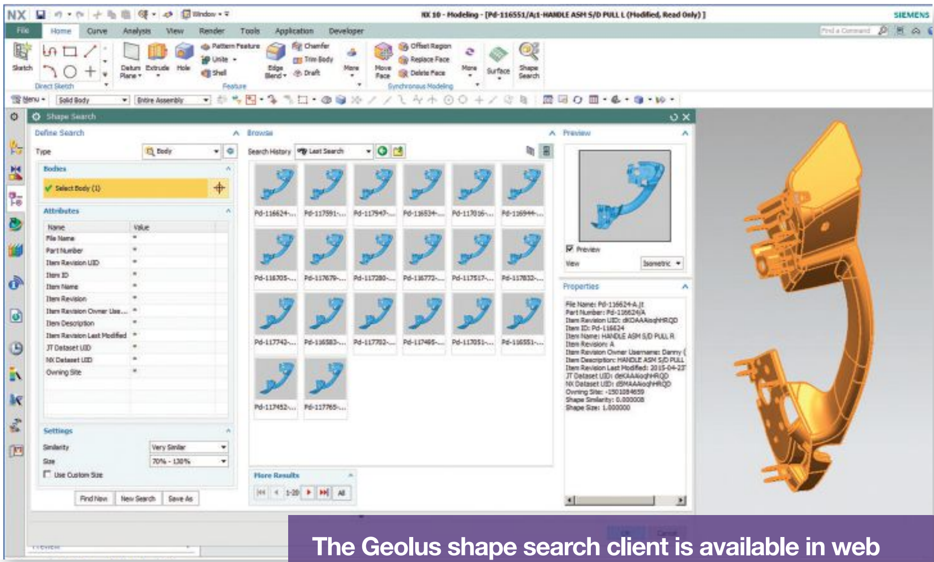
Why Reinvent the Wheel

How do you look for something whose existence you're not aware of? It sounds like the topic for a philosophical debate, but it's actually a data management conundrum. You wouldn't look for an object that you didn't know you could find in the archive.

"You'll find that problem in any company that has grown through mergers and acquisitions. Different teams are working independently, even if they belong to the same company," says Erwin Argyle, PLM senior product manager for Siemens PLM Software. "Each team may use a file naming scheme specific to a project, but alien to the other teams. So different groups may be solving the same engineering problems without realizing it."

And even if you do know the file exists in the database, if it's too cumbersome to locate, you might be tempted to recreate the model. "It's quite common for engineers to say: 'Oh, I remember making something like that, or seeing something like that.' They might poke around [the company database] a couple of minutes to look for it. Then, if they don't find it, they'll recreate it from scratch," says Kurt Lundstedt, PDM product manager for Dassault Systèmes.

The unnecessary re-engineering of existing parts and components has serious implications for time, labor and deadlines. "The problem is larger than CAD reuse," Argyle says. "Companies sometimes spend money vetting a new supplier or vendor unnecessarily, or miss an opportunity to negotiate a favorable volume discount [from the failure to realize the same part would meet the requirements of numerous projects]. Sometimes they reinvent an entire computer-aided engineering (CAE) process. These are all waste."



The Geolus shape search client is available in web browsers, Active Workspace, NX and partner applications. *Image courtesy of Siemens PLM Software.*

Search by Shape

Among PDM and PLM vendors, there's a growing recognition that shape is one of the important parameters in searches. Design engineers can often describe the rough shape of the object they need for a project. Searching for it by name, classification or previous projects, however, could be a tall order if they've never come across the file.

"Most engineers think about objects as geometry—a bracket, a part, something like that" says Lundstedt. "If they can find something similar based on the shape they're looking for, there's a higher chance they'd find something reusable."

Geometry-based search or shape-based search technologies usually permit you to use a readily available shape as input. Such systems employ robust shape-indexing algorithms to classify, group and organize files based on geometric feature similarities. Therefore, they can efficiently scan a database and identify existing models with the same geometric attributes as the reference item.

In the case of Dassault Systèmes, the underlying technology comes from EXALEAD, a search engine the company acquired in 2010. It's integrated into Dassault Systèmes' ENOVIA data management products. It also appears as EXALEAD OnePart, available through SOLIDWORKS sales channels.

Siemens PLM Software's shape search technology came from sd&m (software design & management AG Germany). Siemens acquired the technology, then took over its development in 2006 and incorporated it into its Teamcenter data management platform. The Geolus shape search client is available in all the popular web browsers, Active Workspace, NX and partner applications such as aClass from BCT.

"We re-architected this technology as a component so it can be integrated into different products, supporting multiple use cases," Argyle says. "It could be used to power, for example, a command to find alternative components and parts. In such cases, Geolus would be triggered to do shape search under the hood, then further filter the results based on business rules such as cost, usage in other engineering programs, or results of quality testing."

At Autodesk, shape search appears under Design Graph, part of the company's A360 (Autodesk 360) Drive. In its marketing collateral, the company writes: "Imagine having Google search-like functionality for the world of 3D models. Think of the simplicity and the speed at which you could work. This is what we have been working on at Autodesk and it is called Design Graph."

"With Design Graph, a designer may instantly find an appropriate part in any models previously produced or available to them," Autodesk's Haley says. "In the near future, we will be embedding this functionality directly into the CAD tool to facilitate this even further."

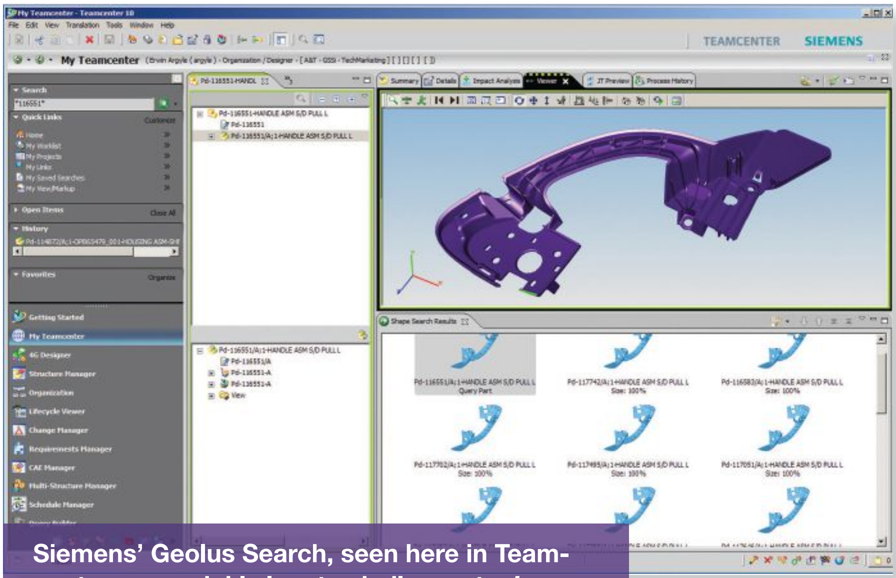
The Cloud and Machine Learning

With the rise of on-demand software-as-a service (SaaS), PDM and PLM offerings, a growing number of small and mid-size enterprises are turning to the cloud for data management. That can have implications in data retrieval and file searches.

"Searching on the cloud offers new business opportunities through broad access and optional, scalable hosting services," Argyle says. "Geolus' architecture complements this, so authenticated users can search from anywhere. A critical security benefit is that Geolus does not require parts to be moved from the owner's domain to perform the search. Parts are indexed in-situ and only the index data is added to the Geolus library. This index data is insufficient to reverse engineer the part's geometry."

According to Haley, in many companies data is not centralized, which makes it difficult to solve the data duplication problem. "By centralizing the data in the cloud, it's not only in one place but we can also apply large amounts of computing resources to sift through the data," he says.

Machine learning is part of Design Graph's indexing system, which allows the software to apply algorithms to group and classify the files based on shapes, attributes, and metadata. "We are able to use machine learning with taxonomies within a customer's data so it's dynamically cataloged, thereby promoting reuse," Haley says. "It's just not possible, due to lack of data and computing resources, to provide that sort of functionality in a locally hosted PDM or PLM system."



Siemens' Geolus Search, seen here in Teamcenter, can quickly locate similar parts. ***Image courtesy of Siemens PLM Software.***

In the case of Design Graph, the burden to acquire and maintain the high-performance computing infrastructure to perform machine learning is shouldered by the provider, Autodesk—not the customer. "There is no requirement on the users to have high-end hardware," clarifies Haley. "Once a customer's models are placed in A360 Drive, they will be automatically processed by the clusters. This is truly the promise of cloud where one large set of hardware resources can basically serve thousands of customers in a very cost effective way."

Built-In Data Management

Historically, CAD modeling and data management are treated as separate tasks: 3D mechanical modeling programs seldom come with data-management functions; and data-management programs typically don't offer modeling tools. Onshape, which offers a browser-based parametric CAD modeler, says the two should be tightly integrated. Its PDM tools are part of the modeling environment itself.

"Onshape doesn't have a separate PDM system; it's baked into the CAD program," says Noa Flaherty, Onshape's community development manager. In its approach to data management, Onshape takes inspiration from browser-based products like Google Docs. The cloud-hosted modeling software is constantly saving micro-versions of the document after every change. Therefore, retrieving a previous version of the design could be as simple as restoring the document to a previous state, marked by timestamps.

"Engineers habitually create a copy of an existing part file for a new project, so they end up with copies of the same part all over the company," Flaherty says. To discourage this practice, Onshape offers Linked Documents that allow engineers to reuse parts in new projects by referencing them, not embedding copies of the parts. "The good thing is, if the original part (the linked part) is revised and a new version is saved, everyone who referenced that part elsewhere gets a notice and can optionally update the model to the latest version," Flaherty adds.

Onshape also offers Branching and Merging, a workflow where members of a project could explore several derivatives or variants of the same design. When the team is ready to consolidate the best features from the variants, Onshape can merge them into a single version. In the merging process, the project lead can decide which features to adopt and which to reject from the different branches.

The Shape of Things to Come

At the annual SOLIDWORKS World user conference in February, the audience got a glimpse of how, in theory, shape search could be integrated into the CAD modeling environment itself.

"Ultimately, our vision is, as you start designing something, the software will crawl 3D Content Central [a publicly accessible database of 3D content] in the background for similar shapes," Dassault Systèmes' Lundstedt says. "When you're about halfway done, if the software finds something whose shape is a good match to your work in progress, it can urge you to take a look at what's already there."

It's a function Dassault Systèmes' hasn't officially placed on its roadmap. However, if it's implemented as demonstrated, the technology can prevent a lot of unnecessary CAD work right from the start. For one thing, you wouldn't have to wait until you have completed the modeling session to find out that the part already exists. Currently, the EXALEAD OnePart indexing process regularly checks for new parts added to the repository.

The key to promote model reuse—and, conversely, prevent unnecessary modeling efforts—rests with robust, intelligent search functions. Smart search tools allow engineers to identify and repurpose the models that already exist. **DE**

Kenneth Wong *is DE's resident blogger and senior editor. Email him at de-editors@digitaleng.news or share your thoughts on this article at digitaleng.news/facebook.*

INFO ➜ **Autodesk:** Autodesk.com

➜ **Dassault Systèmes:** 3DS.com

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

➜ **Onshape:** Onshape.com

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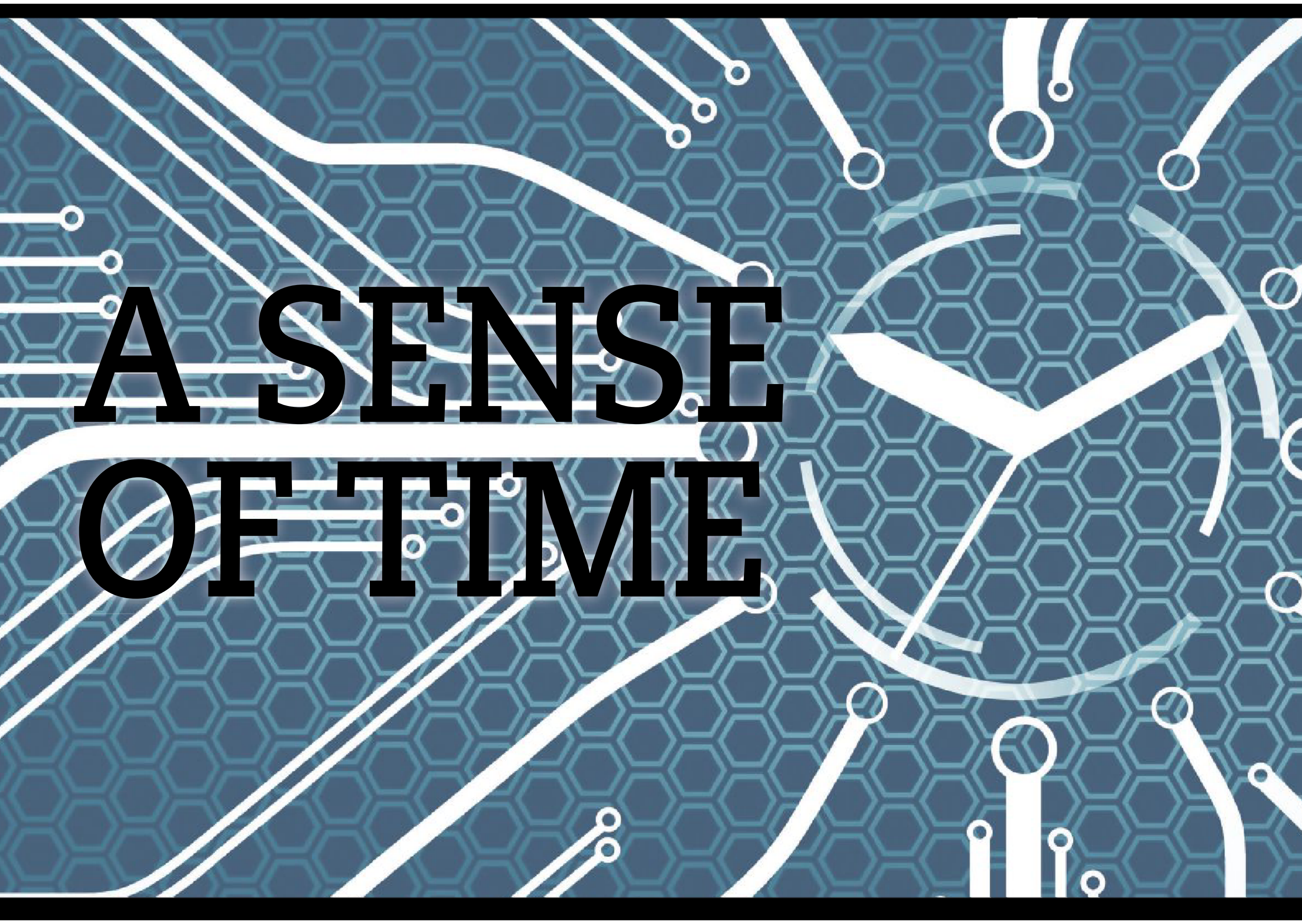

A SENSE OF TIME

Accelerometers 101

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Sensors for Robotics, Racing & Blood Pressure

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A Sense of Time

Time-stamped sensor data offers unanticipated insights.

By Kenneth Wong

Mike Stanley, a systems engineer at NXP, constructed a miniature water delivery system that included a pump and an accelerometer mounted on one of the pipes. That was the centerpiece of his presentation at this year's Sensor Expo and Conference (San Jose, CA, June 22-23).

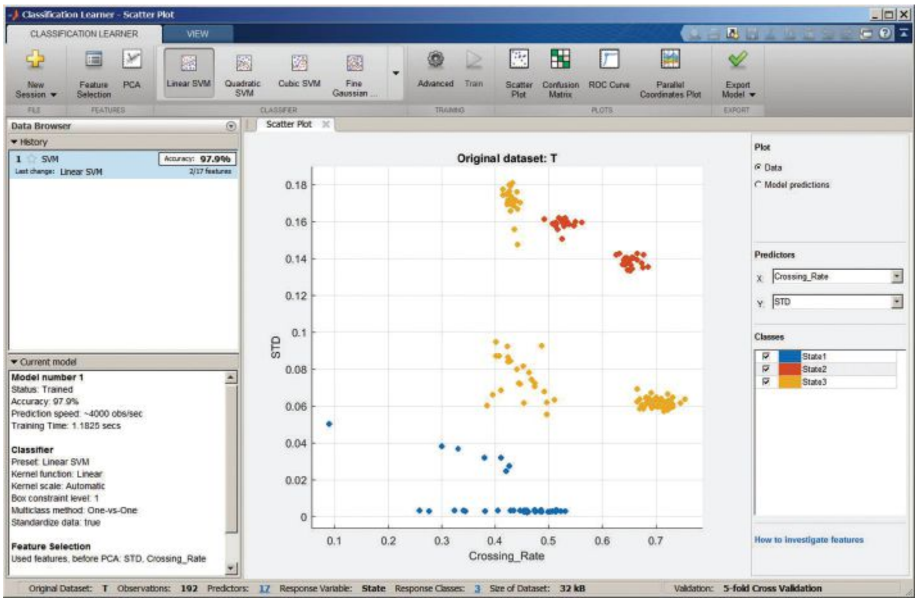
"There's often information in sensor signals you may not have anticipated," Stanley explains.

The purpose of the accelerometer was to measure the vibrations transmitted from the pump into the pipe. Vibration signatures accumulated over time reflected the health of Stanley's improvised system. By simulating blockages and recording the vibration signatures corresponding to those periods, Stanley learned to read signs of pending problems. That, he pointed out, was one way to "determine the health of a system from vibrations."

To be precise, Stanley didn't learn to read the vibrations. Distinguishing signs of anomalies from normalcy was an algorithm-driven process completed in software. It's machine learning, an artificial intelligence (AI) application that many see as a remedy to sensor data headaches.

AI Training

Employed by a well-known semiconductor maker, Stanley has a variety of sensors and PCB boards at his disposal for the experiment. He used an NXP RD-KL25-AGMP01 board as a data logger, with the sole purpose of sending the vibration data from the accelerometer to his workstation via a wired connection.



The Statistics and Machine Learning Toolbox built on top of MATLAB has interactive apps that guide you through the workflow for statistical analysis and machine learning. *Image courtesy of MathWorks.*

"The data analysis was done in MathWorks' MATLAB," says Stanley. "I ran machine learning algorithms on the sensor readings from different runs. MATLAB has a pretty good collection of machine learning routines and they're fairly easy to use."

Machine learning usually involves a computation-intensive training phase, where the software uses a large data set—in this case, sensor readings representing periods of water flow and pump closure—to understand and differentiate signs of normal operation and signs of trouble or failure.

"The techniques I used are no different from the machine learning techniques now used by Google or Amazon in some

Machine Learning

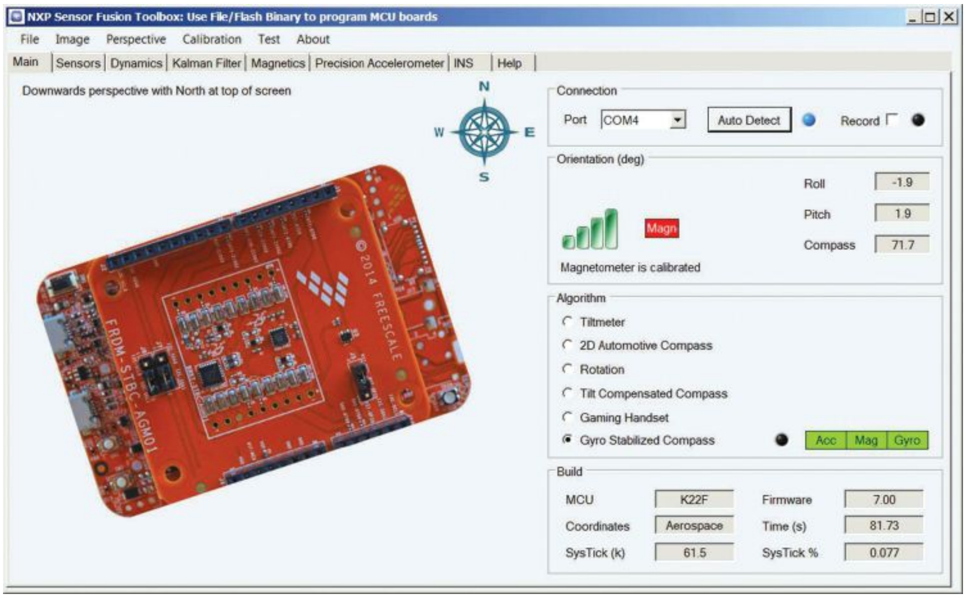
In the IoT-related lexicon, the term machine learning usually describes applying algorithms to analyze seemingly random data. Sensor data representing a momentary snapshot or a slice in time, such as the cabin pressure of an airplane at 30,000 ft., is reasonably easy to digest. On the other hand, the cabin pressure readings recorded at regular intervals throughout a 13-hour flight on the same route over a year's time might be impossible for ordinary humans to digest. Such time-stamped data or time series data is usually fed into a computation program, which can apply algorithms to study the bulk data and draw inferences. In that sense, the term machine learning is a misnomer, because the learning is rarely done by a conventional machine. Instead, it's usually done by a piece of software.

projects," says Stanley. At a larger scale, the same process can be used to train autonomous vehicles and self-navigating drones to recognize police cars, ambulances, road signs, power lines, trees and obstacles from camera-captured imagery.

Based on the amount of data involved and the computing capacity delegated, the training could take days, weeks or months. The more powerful the computing system, the faster the training. This is the reason rival processor makers like NVIDIA and Intel regard machine learning as an area of opportunity.

"The Statistics and Machine Learning Toolbox built on top of MATLAB has interactive apps that guide you through the workflow for statistical analysis and machine learning," says Paul Pilotte, technical marketing manager at MathWorks. "MATLAB and other toolboxes also make it easy to perform sensor analytics with image processing, signal processing, and more. Some image processing and image classification tasks are very compute-intensive. Deep learning is becoming a popular technique for automatic image classification. You can get results if you have a large corpus of images to train a model. For these challenging tasks, we offer a Neural Network toolbox, with a popular deep learning algorithm (CNN) that can be used with NVIDIA GPUs to speed up model training."

With sufficient training completed, the insights gained can be distilled into a much smaller program. Such a program or applet can run locally on a low-powered device



NXP's new software helps engineers with sensor fusion applications. *Image courtesy of Sensor Fusion.*

(like a smartphone or a drone) as the decision-making mechanism in self-guided operations. In Stanley's case, it can be used to issue alerts when it detects water flow disruptions. In autonomous cars and drones, it could form the basis for unsupervised navigation.

"Once the training is done, I then generated the C-code that runs on my other board, which performs system status validation in real time," Stanley says.

In the MathWorks white paper titled "Machine Learning Challenges: Choosing the Best Model and Avoiding Overfitting," the authors pointed out: "Machine learning proficiency requires a combination of diverse skills, but the apps, functions and training examples found in MATLAB can make mastering this technique an achievable goal."

Unlikely Insights

Some of the inferences you can draw from sensor data might surprise you. Shyamal Patel, senior technical product manager from MathWorks, recounted a project where MATLAB was used to determine a person's heart rate in real-time using the luminance data from video footage of the fingertip captured by a smartphone camera—a process many health apps on the market now employ.

"You can take a video of your fingertip with your smartphone," explains Patel. "From the video frames, we can extract luminance information, which changes as blood flows in and out of your fingertip with each heartbeat. If we analyze the luminance changes in the video frames over a period of time, we can estimate the periodicity and ultimately deduce the heart rate."

However, Patel cautioned, drawing inferences about someone's health using a single type of sensor data is a challenge due to individual differences. The process should be augmented by other data sources, such as an individual's activity level and text inputs about his or her own emotional state.

A Window into Time

The key to Stanley's experiment was time-stamped data. "If you're looking for anomalies in a large data set, you actually need the ability to tag the events with time codes," he says. "I have sensor data, but I also have additional data that identifies that specific data lines correspond to specific events [such as the pump's close and open states]."

Reflecting on his water pump demonstration, Stanley says: "What I did was hardware-in-the-loop simulation. In my setup, I could control the events, so it worked as a simulator." Conducting simulation with large-scale physical systems, however, would prove far more challenging. For instance, experiments possible with water flow in a citywide water delivery system would be severely limited due to its effects on the residents who rely on it for daily water use.

Many IoT (Internet of Things) applications involve more than one type of sensor. Often, system designers have to combine data from a variety of sources to draw inferences, in a process known as sensor fusion. (For more read "Harnessing the Power of Sensor Fusion" digitaleng.news/de/?p=31771.)

The Right Frequency

Because sensors are now becoming much more affordable, engineers might be tempted to deploy them wherever possible to collect data. However, Pilotte cautions that there are significant costs associated with uploading or sending the data over a network around the clock, so a good practice is to consider the entire system.

"The wireless uplink can be very expensive depending on the location and amount of data uploaded," he advises. "So, in some cases, you're better off embedding some of the processing or machine learning algorithms with the sensor, and just sending data about the anomalies. Some signals may need to be uploaded in real-time to identify pending warnings or catastrophic failures; other signals that help you identify trends, root causes, or help you with design changes could be bulk-uploaded during weekly maintenance visits. You want to consider the overall sensor analytics design to optimize where to place the analytics"

Best Sensor Placement

Sensor placement is an art form unto itself, defined in part by the designer's understanding and intuition of how the product will be used. This is where the work usually done in CAD programs could benefit from system modeling insights.

"With devices that are monitoring signals from the human body, you have to consider factors such as the shape of your device and how it interfaces with the body," says Shyamal Patel, senior technical product manager from MathWorks. "It could determine the quality of the measurement possible." (Think, for example, about something that must be inserted into the ear canal to obtain a diagnostic reading.) "With other IoT applications like devices installed on a bridge to monitor the health of the structure, the placement is important to get the best vibration data," he notes.

Optimal sensor placement goes beyond finding a space inside the tight assembly structure. Important considerations include the effects of heat on the sensor (a common problem for small devices like smartphones and cameras, where sensors and processors must sit close to one another), user behavior (how a consumer's typical use the device might interfere with sensor signals), and orientation (the best angle to get a good reading).

"Think about the type of sensors you need to accomplish your IoT objective," advises Paul Pilotte, technical marketing manager at MathWorks. "Use your design instincts. If you already have sensors, figure out what new ones you need, and where you'll put them; and give some thought about the analytics and where to place these too."

Recently, the drive to build and maintain digital twins—digital models that mimic their real-world counterparts based on real-time sensor data—has begun to pick up momentum, driven in part by the demonstrations of some major design software vendors. (For more, read "Driving Toward Digital Twins," digitaleng.news/de/?p=32214).

"If you want to do that, the latency could be a problem [the delay in receiving the sensor data from the field]. But in many systems, you're not interested in second-to-second updates. You might only be interested in updating your digital model at longer intervals. There's no reason you can't model that," Stanley points out.

Kenneth Wong *is DE's resident blogger and senior editor. Email him at de-editors@digitaleng.news or share your thoughts on this article at digitaleng.news /facebook.*

INFO:

NXP: NXP.com

MathWorks: MathWork.com

Accelerometer Basics

By Tom Kevan

If you use a smartphone, you benefit from motion sensors each time you pick up the device. These sensors monitor a variety of parameters, ranging from acceleration and rotation to orientation. But no one type of sensor can measure all of these factors. As a result, each smartphone contains a number of motion sensors. Combined, they enable the phone to determine location and context, elements essential to the services provided by apps.

The complexity of these sensors increases from one day to the next, as new technologies, materials and production processes are tapped to expand their functionality. Even so, the fundamentals don't change—so it's important to go back to the basics every now and then and review the principles that define these sensors.

Measuring Acceleration

One of the most commonly used motion sensors is the accelerometer. This electromechanical device measures non-gravitational acceleration forces in a given axis, quantifying changes in velocity. The forces can be static, like the constant force of gravity pulling on an object, or they can be dynamic, which is caused by movement or vibration. Design engineers often combine several of these devices to create multi-axis accelerometers.

Accelerometers typically provide measurements in terms of g force, which represents acceleration in increments of Earth's standard acceleration. For example, a stationary object experiences 1g of acceleration. The g forces involved in a car crash can measure as high as 100g.

Sensors for Different Applications

Accelerometers come in a number of forms. The most commonly deployed sensors use the piezoelectric effect. These devices contain microscopic crystals that become stressed when the accelerometer begins to move. The change in state generates a voltage. Piezoelectric accelerometers support a wide measurement frequency range and come in a variety of sensitivities, weights and sizes. This type of accelerometer is well suited for shock and vibration measurements.

Next, you have the piezoresistive accelerometer. This type of sensor generally has low sensitivity, making it suited for shock measurements, but it is less appropriate for vibration measurements. Piezoresistive accelerometers support a wide bandwidth and their frequency response can be as low as 0Hz, which means that they can measure long-duration transients.

Among the newest types of accelerometers, variable capacitance sensors, consist of two microstructures positioned next to each other. In a stationary state, a defined capacitance exists between the two structures. If an accelerative force moves one of the structures, the capacitance changes. The device converts the change to a voltage. This design offers a frequency response as low as 0 and has high sensitivities, narrow bandwidth, and exceptional temperature stability. Automakers often use variable capacitance accelerometers in crash tests.

Features to Consider

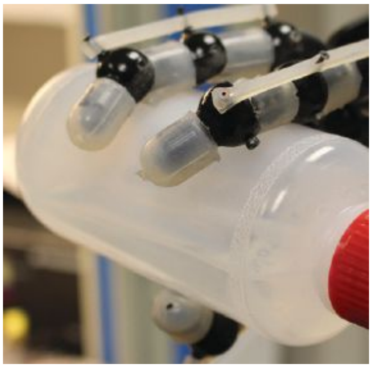
When selecting an accelerometer for an application, you have to consider several factors. The trick here is to match the sensor's operating parameters with the application's requirements. One of your decisions will be whether you need analog or digital outputs. To a large extent, the hardware that you are interfacing the accelerometer with will provide the answer to this question. For example, if your application involves a microcontroller with digital inputs, you will need to use a digital output accelerometer.

Analog accelerometers output a continuous voltage proportional to acceleration. Digital accelerometers use pulse width modulation (PWM) for output. With PWM, you get a square wave signal. The amount of time the voltage falls within the high range is proportional to the acceleration.

Next, decide whether you require single or multiple axes. Usually, two will meet your needs, but if your application involves 3D positioning, you'll need a 3-axis accelerometer.

Finally, be sure the accelerometer's bandwidth meets the needs of the application. In this case, bandwidth represents the number of times per second you can take a reliable acceleration reading. For slow moving applications, a bandwidth of 60 to 75Hz will be adequate. If you intend to measure faster motion, look for a bandwidth of several hundred Hz.

Tom Kevan *is a freelance writer/editor specializing in engineering and communications technology. Contact him via de-editors@digitaleng.news.*



A Light Touch, Thanks to Embedded Optical Sensors

Carnegie Mellon creates sensor-rich robotic hand and new stretchable sensor.

By Byron Spice

Optical sensors may be uniquely suited for use in robotic hands, according to Carnegie Mellon University (CMU) researchers who have developed a three-fingered soft robotic hand with multiple embedded fiber optic sensors. They also have created a new type of stretchable optical sensor.

By using fiber optics, the researchers were able to embed 14 strain sensors into each of the fingers in the robotic hand, giving it the ability to determine where its fingertips are in contact and to detect forces of less than a tenth of a newton. The new stretchable optical sensing material, not incorporated in this version of the hand, potentially could be used in a soft robotic skin to provide even more feedback.

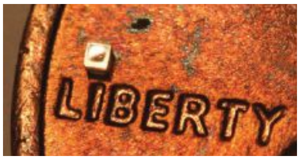
"If you want robots to work autonomously and to react safely to unexpected forces in everyday environments, you need robotic hands that have more sensors than is typical today," said Yong-Lae Park, assistant professor of robotics. "Human skin contains thousands of tactile sensory units in the fingertip and a spider has hundreds of mechanoreceptors on each leg, but even a state-of-the-art humanoid such as NASA's Robonaut has only 42 sensors in its hand and wrist."

Adding conventional pressure or force sensors is problematic because wiring can be complicated, prone to breaking and susceptible to electromagnetic interference. But a single optical fiber can contain several sensors; all of the sensors in each of the fingers of the CMU hand are connected with four fibers. And the optical sensors are impervious to electromagnetic interference.

Each of the fingers on the robotic hand mimic the skeletal structure of a human finger, with a fingertip, middle node and base node connected by joints. The skeletal "bones" are 3D-printed hard plastic and incorporate eight sensors for detecting force.

MORE: digitaleng.news/de/?p=32500

Intravenus Blood Pressure Sensor



Blood pressure is usually measured with a pressure meter and an inflatable cuff placed around the arm. In some clinical scenarios, however, physicians need to measure blood pressure inside a vein or artery. Until recently, such measurements were difficult or impossible to obtain.

Engineers at Microtech developed a sub-millimeter implantable pressure sensor. Clinicians communicate with the sensor via an ultrasound system.

Microtech developed a MATLAB algorithm to produce ultrasound waves and process waves reflected by the sensor.

By analyzing these reflected waves, the algorithm can calculate blood pressure to within 1mm of mercury (mmHg).

To calculate blood pressure, the ultrasound system processes waves modulated by the resonant frequency of the sensor's membrane. Microtech engineers needed to develop algorithms to process the reflected wave signals and use the results to calculate the blood pressure. They needed to incorporate these algorithms into an application that controls a function generator to produce the ultrasound waves via a transducer. The application receives the live reflected ultrasound waves using a data acquisition (DAQ) board sampling at 4MHz.

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Racing with Sensors

On March 5, one of the hardest and craziest amateur rallies in the world began: the Panda Raid. It was a seven-day race through the Moroccan desert. The only essential requirement was to drive an old Fiat Panda.

What makes this rally unique is its rules. GPS and internet are not allowed during the race. Participants only can use a compass and a roadbook to navigate and avoid getting lost.

This year, one member of Libelium Team took part with his 25-year-old Fiat Panda. This vehicle was different to any other, because it was equipped with a Plug & Sense! Sensor Platform from Libelium.

MORE: digitaleng.news/de/?p=32506

A Very Powerful Portable

Eurocom Sky DLX7's desktop CPU delivers performance at a price.

BY DAVID COHN

EUROCOM HAS PROVEN that it can deliver very powerful mobile systems. The Canadian company's Sky X9W mobile workstation we reviewed last spring (digitaleng.news/de/?p=28987) was one of the fastest portable systems we have ever tested, although its price and weight certainly made it a niche product. We recently received the Eurocom Sky DLX7, which the company claims is "the most powerful 'desktop laptop' ever made," based on the fact that it includes an LGA1151 socketed CPU typically found in desktop systems. With a claim like that, we couldn't wait to subject it to our tests.

The Eurocom Sky DLX7 is a 17.3-in. laptop based on the Intel Z170 Express Skylake chipset. The $2,666 base configuration includes an Intel Core i7-6700K CPU unlocked for overclocking, an NVIDIA Quadro K3100M mobile GPU (graphics processing unit), 16GB of memory, a 1920x1080 display, and a 1TB 7200rpm SATA hard drive, but no operating system.

The system we received came housed in a sculpted charcoal gray case measuring 16.72x11.81x1.6 and weighing a hefty 9.2 lbs. Its huge 330-watt power supply (7.75x3.75x1.75 in.) adds another 3.1 lbs. While most modern mobile systems have become thin and light, the Eurocom Sky DLX7 weighs more than 12 lbs.

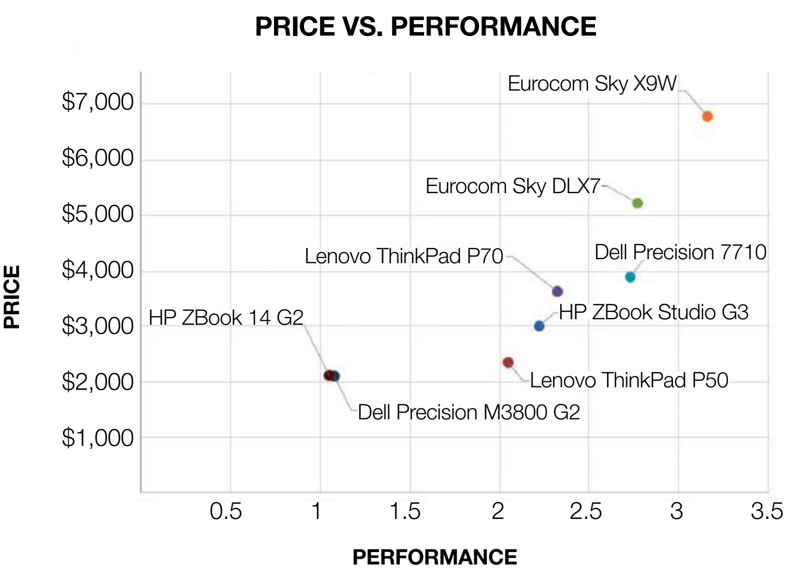
Raising the lid reveals the display and backlit 102-key keyboard and numeric keypad. Our evaluation unit came with a very nice 17.3-in FHD (1920x1080) IPS (in-plane switching) display with a non-glare surface, 300 nts brightness and 700:1 contrast ratio that covers 72% of the NTSC color gamut. A 4K UHD (3840x2160) IPS display with a 1000:1 contrast ratio and 100% Adobe RGB color gamut is a $353 option.

A gesture-enabled 4.25x2.5 in. touchpad with a pair of buttons and a built-in fingerprint reader is centered below the spacebar. Centered above the display is a 2-megapixel webcam and microphone array. There is also a pair of

INFO ➔ Eurocom: Eurocom.com

Eurocom Sky DLX7

- **Price:** $5,223 as tested ($2,666 base price)
- **Size:** 16.72x11.81x1.6 (WxDxH) notebook
- **Weight:** 9.2 lbs. as tested, plus 3.1 lb. power supply
- **CPU:** 4.0GHz Intel Core i7-6700K quad-core w/8MB cache
- **Memory:** 32GB 2400MHz DDR4
- **Graphics:** NVIDIA Quadro M5000M w/ 8GB memory and 1536 CUDA cores
- **LCD:** 17.3-in. diagonal (1920x1080), non-glare, IPS
- **Hard Disk:** 512GB M.2 PCIe SSD drive and 1TB 7200rpm SATA HD
- **Optical:** None
- **Audio:** Line-in, microphone, headphone, S/PDIF-out, plus built-in microphone and speakers
- **Network:** Integrated Gigabit Ethernet (10/100/1000 NIC) with one RJ-45 port, 802.11a/b/g/n/ac wireless LAN, and Bluetooth 4.2
- **Modem:** None
- **Other:** Four USB 3.0 (one powered), one USB 3.1 (Type C) Thunderbolt port, two DisplayPorts, HDMI-out, 2MP webcam, 6-in-1 card reader
- **Keyboard:** Integrated 102-key backlit keyboard with numeric keypad
- **Pointing device:** Integrated 2-button touchpad and fingerprint reader



Price of recently reviewed mobile workstations as tested vs. performance based on the SPECwpc Product Development benchmark dataset.

2-watt speakers for the built-in Sound Blaster X-Fi MB5 sound system located in raised panels above the top corners of the keyboard, with a subwoofer on the bottom of the case. A trapezoidal-shaped power button is centered above the keyboard with a V-shaped panel below this with LEDs to indicate airplane mode, hard drive activity, caps lock, scroll lock and number lock. Users can also control the intensity, color and effects of the keyboard backlighting and assign hotkey combinations to launch other programs.

Lots of Options

The right side of the case offers a single USB 3.0 port; an S/PDIF-out jack; audio ports for headphone, microphone and line-in; and a security lock slot. The left side provides an RJ-45 network port, two additional USB 3.0 ports, a USB 3.1 (Type C) Thunderbolt 3 port, a multi-card reader, and a combined eSATA/USB 3.0 port that remains powered for recharging devices even when the system is off (as long as the computer is connected to a working A/C outlet). The rear panel hosts a single HDMI port, two DisplayPorts, and the connection for the external power supply, flanked by a pair of air vents. There are many more air vents on the bottom of the case. As is becoming quite common, there is no optical drive bay; instead Eurocom sells optional external DVD and Blu-ray drives. As was true of the Sky X9W we reviewed previously, the Eurocom Sky DLX7 is also a closed system. Users can remove the battery to access a SIM card socket, but otherwise, users are not meant to access the interior (although access is possible after removing multiple screws).

Our evaluation unit came equipped with an Intel Core-7-6700K, a 4.0GHz quad-core CPU with 8MB cache, a maximum turbo frequency of 4.2GHz and a thermal design power (TDP) rating of 91 watts. This 14nm Skylake processor also includes Intel HD Graphics 530. Several other less expensive CPUs are also available. Eurocom also equipped our system with a high-end NVIDIA Quadro M5000M mobile GPU, with 1536 CUDA (compute unified device architecture) cores and 8GB of dedicated GDDR5 memory, increasing the system cost by an additional $1,417. The slightly less expensive Quadro K5100M is also available as well as a choice of three NVIDIA GTX graphics cards.

Although 16GB of system memory comes standard, with its four 260-pin SO-DIMM (small outline dual in-line memory module) sockets, you can equip the Sky DLX7 with up to 64GB of memory. Our evaluation unit included 32GB of RAM, installed as two 16GB 2400MHz DDR4 modules, adding $392 to the system price.

There are also many storage options. In addition to the 1TB 7200rpm Western Digital Travelstar SATA hard drive, our system also included a Samsung 512GB M.2 NVMe PCIe solid-state drive (SSD), adding $583. The Eurocom

Mobile Workstations Compared	Eurocom Sky DLX7 17.3-inch 4.0GHz Intel Core i7-6700K quad-core CPU, NVIDIA Quadro M5000M, 32GB RAM, 512GB PCIe SSD	HP ZBook Studio G3 15.6-inch 2.8GHz Intel Xeon E3-1505M v5 quad-core CPU, NVIDIA Quadro M1000M, 32GB RAM, 512GB PCIe SSD	Lenovo ThinkPad P50 15.6-inch 2.8GHz Intel Xeon E3-1505M v5 quad-core CPU, NVIDIA Quadro M2000M, 16GB RAM, 512GB PCIe SSD	Lenovo ThinkPad P70 17.3-inch 2.8GHz Intel Xeon E3-1505M v5 quad-core CPU, NVIDIA Quadro M4000M, 16GB RAM, 500GB PCIe SSD	Dell Precision 7710 17.3-inch 2.9GHz Intel Xeon E3-1535M quad-core CPU, NVIDIA Quadro M5000M, 32GB RAM, 512GB SATA HD	Eurocom Sky X9 17.3-inch 4.3GHz Intel Core i7-6700K quad-core CPU, NVIDIA Quadro M5000M, 64GB RAM, two 256GB PCIe SSDs and two 2TB SATA HDs
Price as tested	$5,223	$2,999	$2,353	$3,623	$3,890	$6,781
Date tested	7/26/16	3/9/16	3/21/16	2/12/16	1/23/16	1/23/16
Operating System	Windows 10	Windows 10	Windows 10	Windows 7	Windows 10	Windows 10
SPECviewperf 12 (higher is better)						
catia-04	99.74	35.30	42.44	80.54	75.57	102.23
creo-01	93.00	32.36	43.01	66.69	55.78	84.55
energy-01	7.60	3.08	4.12	6.39	9.00	10.52
maya-04	64.78	29.50	33.08	54.93	43.43	75.56
medical-01	33.66	14.46	18.53	27.23	31.21	40.75
showcase-01	52.93	21.04	22.02	46.70	48.07	45.87
snx-02	90.15	28.55	60.01	112.86	63.33	87.30
sw-03	116.72	55.23	64.70	88.04	82.02	121.63
SPECapc SOLIDWORKS 2015 (higher is better)						
Graphics Composite	8.59	2.92	3.56	4.62	3.88	6.07
Shaded Graphics Sub-Composite	4.90	2.27	2.89	2.41	2.40	4.36
Shaded w/Edges Graphics Sub-Composite	6.31	3.05	3.63	3.42	3.21	5.58
Shaded using RealView Sub-Composite	6.49	2.32	2.95	3.41	2.85	5.07
Shaded w/Edges using RealView Sub-Composite	10.45	4.03	4.92	5.89	4.93	8.36
Shaded using RealView and Shadows Sub-Composite	7.26	2.13	2.68	3.87	2.94	5.17
Shaded with Edges using RealView and Shadows Graphics Sub-Composite	10.92	3.49	4.30	6.19	4.85	8.11
Shaded using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	18.11	3.19	3.30	7.97	5.70	6.81
Shaded with Edges using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	25.53	4.62	5.01	12.01	8.74	10.28
Wireframe Graphics Sub-Composite	3.86	3.16	3.26	3.02	2.99	3.76
CPU Composite	4.95	2.82	2.51	3.47	2.56	3.03
SPECwpc v2.0 (higher is better)						
Media and Entertainment	2.93	2.29	2.43	2.60	2.57	3.38
Product Development	2.77	2.22	2.05	2.32	2.73	3.16
Life Sciences	2.98	2.46	2.49	2.56	3.18	3.91
Financial Services	1.39	1.15	1.15	1.14	1.19	1.40
Energy	2.69	2.22	1.86	2.27	2.66	3.13
General Operations	1.36	1.31	1.25	1.41	1.48	1.70
Time						
Autodesk Render Test (in seconds, lower is better)	65.7	76.80	82.80	50.00	85.60	64.90
Battery Test (in hours:minutes, higher is better)	2:28	5:18	4.37	5:15	5:30	2:17

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

There's room inside for up to 5TB of storage, but the interior is not easily accessible. ***Images courtesy of Eurocom.***

Sky DLX7 can actually accommodate two 2.5-in. hard drives and two M.2 SSDs, both with RAID 0, 1, 5 and 10 configurations, and the company offers 17 different SATA drives ranging from 128GB to 2TB and 16 SSD options ranging in size from 120GB to 1TB.

While a two-in-one 802.11a/b/g/n/ac WLAN+Bluetooth 4.2 plus Intel Wireless-AC 8260 card is included in the base configuration, Eurocom also offers both higher- and lower-end network cards. An eight-cell lithium-ion battery and 330-watt auto-switching worldwide power supply come standard.

You would think that the absence of an optical drive would leave room for a larger battery with longer battery life. But with all of those hard drives, a power-hungry desktop CPU and high-end mobile GPU, our evaluation unit managed just 2 hours 28 minutes before shutting down. Throughout our tests, the Eurocom DLX7 ran cool and quiet, averaging just 34dB at rest (compared to 29dB ambient background noise), climbing to just 44dB under compute loads (less than a typical office conversation).

Excellent Performance

Thanks to its fast CPU and high-end graphics card, the Eurocom Sky DLX7 turned in some of the fastest performance we have ever recorded for a mobile workstation. The only system to routinely surpass it on standard benchmarks was the Eurocom Sky X9W we had previously reviewed, which with double the memory bested it on several of the SPECviewperf tests.

On the SOLIDWORKS test, the Eurocom Sky DLX7 was the clear winner, surpassing every other mobile workstation we have ever tested.

We also ran the very demanding SPECwpc benchmark, and here again the Eurocom Sky DLX7 outperformed all but the Eurocom Sky X9W. But while its average rendering time of 65.7 seconds beat most other mobile systems, the Eurocom Sky DLX7 was nearly 16 seconds slower than the Lenovo ThinkPad P70, the current mobile rendering king.

Of course, as we have learned from past reviews, all of this power comes at a hefty price. As equipped, our Eurocom Sky DLX7 would cost $5,223 (including $166 for the Windows 10 Professional 64-bit operating system that came preinstalled). While that's $1,500 less than the Eurocom Sky X9W we reviewed earlier this year, it is still among the most expensive mobile systems we have ever tested. That price also includes only one-year of warranty coverage with return to depot service, but you can extend the warranty to two or three years for $146 or $313, respectively.

Like the Sky X9W, Eurocom Sky DLX7 is meant to replace a desktop workstation for power users on the go, and it delivers on this promise. But as was true for its sibling, the weight and price of the Eurocom DLX7 will likely appeal to a small but demanding set of users for whom performance matters more than portability and price.

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

EDITOR'S PICKS

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

Creaform Launches MetraSCAN 3D R-Series

Robot-mounted CMM 3D scanners enable optical measurement and automation.

The MetraSCAN 3D R-Series scanners enable you to bring quality control inspection tools to your shop floor and as close to the part as you possibly can.

The scanners have seven built-in laser crosses that can pick up to 480,000 measurements per second on complex surfaces with high reflectivity. They can automatically align parts, are equipped with dynamic referencing and have a technology called TRUaccuracy to ensure good measurements. The R-Series comprises two models for all your needs.

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National Instruments Debuts LabVIEW 2016

Release debuts a new channel wire and enhanced Python support.

LabVIEW 2016 sees enhanced interoperability with Python and third-party devices as well as new support for more than 500 instruments.

Of course, LabVIEW 2016 is fully compatible with the latest NI hardware technologies for design and test, embedded control and monitoring, including the company's new 1GHz vector signal transceiver. And LabVIEW 2016 adds new support for the new 64-bit versions of a slew of LabVIEW add-on modules.

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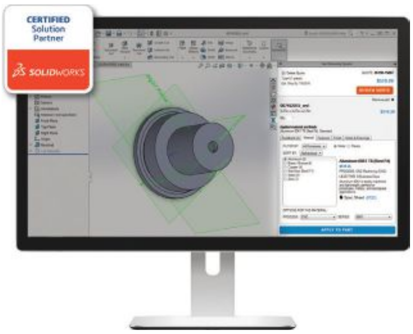

Xometry Creates Add-In for SOLIDWORKS

Module provides direct access to price quoting and manufacturing capabilities.

Xometry is a Maryland-based on-demand manufacturer. Its manufacturing capabilities include CNC (computer numerically controlled) machining, metal binder jetting, and a variety of 3D printing technologies.

With its new add-in, from a task plane in SOLIDWORKS you can access Xometry and its range of services directly. You tell Xometry what file you're interested in then select materials, surface finish, quantity and manufacturing process.

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Simulate Composites in the Cloud

CompoSIDE v2.8.2 brings material data, analysis capabilities together.

A quarterly or annual subscription to CompoSIDE gets you core functionality like a materials database, laminate calculation, beam section design, 3D FEA (finite element analysis) modeling, integrated reporting and BOM generation. The platform supports multiple simultaneous users, and has a whole set of administrator tools for setting roles, permissions and so on.

CompoSIDE v2.8.2 introduces the Materials Data Manager role with dedicated rights to approve and publish.

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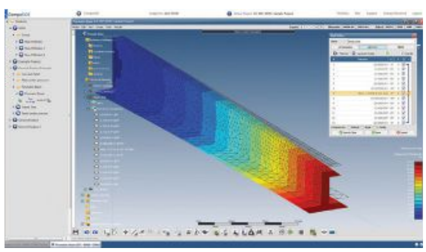

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solidThinking INSPIRE Heads to the Cloud

BY KENNETH WONG

In early September, under the warm southern California sun, the City of Angels played host to solidThinking Converge Americas, the premiere event for engineering software maker Altair's solidThinking brand.

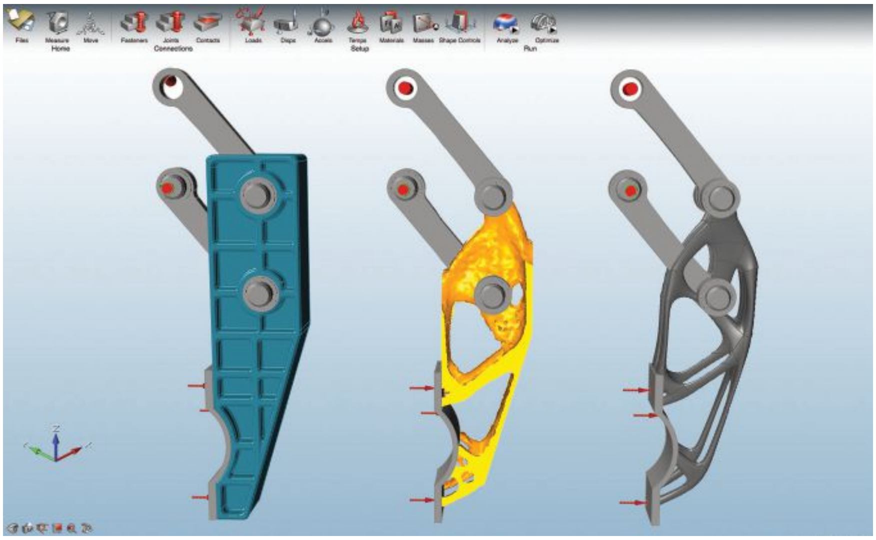
Altair is best known for its HyperWorks software suite and OptiStruct solver, both widely used by advanced simulation software users. The solidThinking brand, which targets design engineers and simulation novices, encompasses Evolve, Inspire, Clock2Cast and others. Altair products are often associated with aerospace and automotive manufacturing projects. But the solidThinking brand's reach, as suggested by the keynote talks at the debut conference in LA, is broader. The speaker lineup at the Converge Americas conference included Janine Benyus, co-founder of Biomimicry 3.8; Ralph Gilles, head of design for Fiat Chrysler Automobiles; and Jason Lopes, lead systems engineer for Legacy Effects.

Browser-Based Topology Optimization

At the event, Altair revealed its plan to launch a new product, Inspire Unlimited. The existing product, Inspire, is a topology optimization software program for desktop installation and usage. The new offering, Inspire Unlimited, will be cloud-hosted, delivered from the browser, powered by Microsoft Azure.

"When you're able to run Inspire in the cloud, it gives you the power to do much larger batches of simulation to drive design," said Altair's Chairman and CEO James Scapa.

James Daag, Altair's CTO of Modeling and Visualization, said the impetus to put Inspire in the cloud was computer power. He also said the company will be releasing more products and applications that run on the cloud.



Altair's solidThinking Inspire topology optimization software, shown here, is heading for the cloud as Inspire Unlimited. *Image courtesy of Altair.*

Altair has tested the cloud-hosted model with solidThinking Envision, a business intelligence and analytics program. The pending release of Inspire Unlimited is expected to benefit from the flexible computing power made possible by the cloud. In projects with large assemblies, manufacturers often use topology optimization as a strategy to keep the weight and costs down. Emerging environmental concerns and fuel economy also favor lighter products. Because topology optimization can be compute-intensive, the enabling software is a good candidate for the expandable cloud infrastructure.

Altair hasn't publicly announced if it would also permit partner products and third-party apps to run on the same infrastructure as Inspire Unlimited. Another design software powerhouse, Autodesk, now offers its Autodesk Forge platform to developers interested in harnessing its technology components and platform. The news was made public in June. (For more, read "Autodesk Hosts First-Ever Forge Developer Conference" at digitaleng.news/virtual_desktop/?p=11901.)

Larger design software makers with cloud platforms for their own products may find themselves at a crossroads. They could keep their platform strictly for their own offerings. Or, they could open up the infrastructure to partners and affiliated developers. The latter is a role that some like Autodesk have embraced. Others may be reluctant to take it on, due to revenue- and responsibility-sharing complexities.

With the LA Converge event out of the way, Altair now turns its attention to other Converge conferences, set to occur in major cities in Germany, China, Japan, India and Korea. **DE**

Kenneth Wong *is DE's resident blogger and senior editor. Email him at de-editors@digitaleng.news or share your thoughts on this article at digitaleng.news/facebook.*

New Tech from IMTS

BY JESS LULKA

Last month, Chicago became home to one of the nation's largest manufacturing shows—covering additive manufacturing, CAD/CAM software, robotics, automation and more. Attendees were able to see the latest and greatest in these different industry sectors in addition to a host of real-world applications in automotive, aerospace and manufacturing.

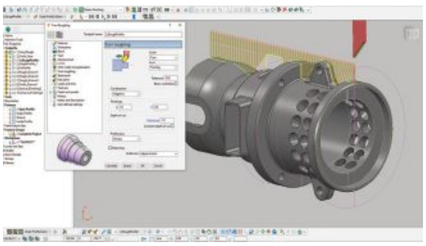
Here are a few of the new products showcased at the 2016 International Manufacturing Technology Show (IMTS).

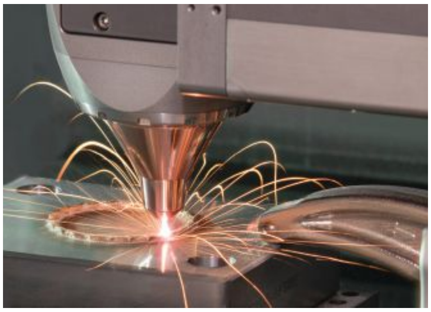
Autodesk Introduces 2017 CAM Products

Autodesk's 2017 CAM solutions include enhanced versions of FeatureCAM for automating CNC programming; PartMaker for precision part manufacturing with Swiss-type lathes; PowerMill for designing complex molds, dies and other components; PowerShape for the design of 3D complex parts; and PowerInspect hardware-independent inspection software.

- FeatureCAM 2017 has new automation tools, programming consistency, import capabilities for product and manufacturing information and pre-drilling for Vortex toolpaths.
- PowerMill 2017 adds turning routines for 5-axis mill-turn machines and more efficient 3D offset finishing toolpaths.
- Users of PowerShape now have a new rib capping tools for EDM technology and an electrode wizard.
- PowerInspect 2017 expands support for portable measuring equipment. Coordinate measuring machines and On Machine Verification are offered in a single package for PowerInspect Ultimate users.

MORE → Autodesk.com





Mitsui Seiki's Vertex 55X-H Hybrid System

Mitsui Seiki's new Vertex 55X-H combines a precision-built traditional CNC (computer numerically controlled) vertical machining center with a spindle-adapted laser DED (Direct Energy Deposition)/powder feed nozzle. Parts can be 3D printed or material can be added to existing parts. The nozzle loads into the tool changer like any conventional tool and is changed automatically via the CNC program prompts, a milling/drilling tool replaces it and aspects of the workpiece can be machined conventionally—including internal features. For example, perhaps surface work needs to be machined before the next layer of material is added. Or, the workpiece can be printed and then subsequent machining operations can be accomplished.

Customers can choose either a CAT or HSK spindle that offers 15,000 to 30,000 rpm. Mitsui Seiki has integrated a coolant system for either dry or wet machining best practices.

MORE → MitsuiSeiki.com

Method Machine Tools' 5-Axis Vertical CNC

Designed for high accuracy, hard milling applications of complex dies, molds and components, the YBM Vi40 features simultaneous 5-axis cone machining circularity of 2.32 µm, .89 µm positioning accuracy of the Y-axis, and indexing accuracies of ± 0.50 sec on the B-axis and ± 0.20 sec on the C-axis. A 24,000 rpm, 40-taper direct-drive spindle offers a high degree of precision, the company says.

The YBM Vi40 offers 5-sided machining in a single set-up. It also features a symmetric bridge-type structure for high precision when making heavy cuts. Single-piece high-grade cast iron construction, including the column and top beam, increases the rigidity. A rigid feed drive system features large diameter ball screws and high-speed interpolation control.

MORE → MethodsMachine.com

Stratasys Demonstrates Industrial 3D Printing

When you describe 3D printing to someone who isn't familiar with it, they may envision something like Stratasys demonstrated at IMTS—a robotic arm extruding materials that harden into a solid object, or a large part growing out of a machine too small to contain it. These are the products that the Robotic Composite 3D Demonstrator and Infinite-Build 3D Demonstrator may lead to.

Stratasys showed how it expects Fused Deposition Modeling (FDM)—one of the first additive manufacturing technologies—to fit into the digital factory. It also outlined a new go-to-market strategy.

CEO Ilan Levin said the company will adopt a more integrated approach to product development where Stratasys will work with customers to add value. That integration would include hardware, software and materials with a focus on repeatability, factory automation and training to help customers design products for 3D printing.

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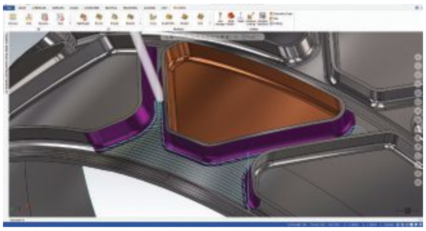
Mastercam 2017

Mastercam 2017 brings a new suite of programming tools focused on delivering speed, automation and efficiency for all machining jobs. Version 2017 also introduces a more efficient



workflow, improved usability and Dynamic Motion improvements, says CNC Software.

Mastercam 2017 features a new Microsoft Office-like ribbon user interface intended to make it easier for users to find the functions needed to complete tasks. The ribbon tabs group similar functions and displays them in order from simple to more complex. Each tab relates to a type of activity, from creating wireframe geometry to generating toolpaths. Editing functions are on the same tab as creation functions so that users have all the tools needed at the moment they are needed.

The software also introduces Maximum Stock Engagement for select 3D high-speed finishing toolpaths. This functionality allows users to limit how deeply the cutter engages uncut material as well as protects smaller tools from taking too heavy of a cut. Optimized Raster Motion improves toolpath efficiency by filling in steeper geometry with perpendicular raster motion to create a cleaner result. The Mastercam Mill-Turn package now supports multi-station tool locators for turrets as well as half index positions. Improvements to tool and job set-up, says CNC Software, improve overall workflow.

MORE ➔ Mastercam.com

ABB Brings the "Factory of the Future" to Life

At this year's IMTS, ABB's theme focused on collaboration, simplification and digitalization. Product news from ABB included:

- YuMI: a dual-arm industrial robot with no barriers, no cages and no zones. YuMi is designed to work closely with humans in small parts assembly and handling applications.
- IRB 1200 Foundry Plus 2: a compact robot that can increase flexibility and reduce cycle times for precision casting processes.
- RobotStudio: ABB's software tool for programming, configuration and virtual commissioning, designed to maximize the productivity and simplify the user interface of ABB robotic systems across all applications.

MORE ➔ ABB.com

3D Systems Shares its Production Strategy

AT IMTS, 3D Systems unveiled its strategy, solutions, partnerships and updated management team to help customers leverage its digital manufacturing solutions.

3D Systems' President and CEO Vyomesh Joshi (VJ) explained how 3D Systems' digital manufacturing ecosystem enables customers to digitize, design, simulate, manufacture, inspect and manage as they transition toward end-use part production. The company officially launched its 3DXpert software solution for streamlining and automating pre- and post-production processes for Direct Metal Printing. Additionally, Joshi announced a strategic partnership with PTC, a provider of CAD, PLM and IoT technology.

Jim Heppelmann, PTC's president and CEO, shared how the two companies are working together to integrate 3D Systems' 3D Sprint SDK into PTC's flagship Creo CAD platform. The collaboration is expected to provide Creo-users with seamless CAD-to-print functionality as well as a full set of print management tools.

Throughout IMTS, 3D Systems also demonstrated its Figure 4 technology, the company's fast, modular stereolithography (SLA) system designed for the production of plastic parts on the factory floor.

MORE ➔ 3DSystems.com and PTC.com

AIMS Launches Revolution Series HB

Designed and built around Renishaw 5-axis technology, the Revolution HB is the only mobile 5-axis CMM (coordinate measuring machine) on the market, the company states. AIMS' Revolution line of CMMs are supported by Renishaw through probe heads, touch probes, scanning probes, incremental encoder scale systems, change racks, styli, controls and Modus software.

Constructed with a polymer-cast base and a roll-around stand with casters that can be locked in place, the Revolution HB is easy to move. It runs on standard 110-volt power.

MORE ➔ AIMSMetrology.com

FANUC Wire EDM Series

The FANUC RoboCut a-CiB Series includes the C400iB, C600iB and the new, larger C800iBWire EDM. Accuracy is increased in the FANUC RoboCut a-CiB Series Wire EDMs via thermal displacement compensation, which compensates for thermal distortion of the casting when room temperature fluctuates greatly. It has a workpiece size of 49.2x38.4x11.8 in. and maximum workpiece weight of 5,000 lbs.

Also contributing to increased accuracy is the CiB Series moving tank design feature. The CiB Series Wire EDM column and lower arm are fixed, so the table and work piece move rather than the column, ensuring the highest level of accuracy.

Machine speeds have also increased to more than twice the speed of previous machines.

Similar to other FANUC EDMs, the new FANUC RoboCut C400iB, C600iB and C800iB Wire EDMs are capable of manufacturing complex components and offer seven-axis simultaneous cutting as an option.

MORE ➜ FANUCAmerica.com

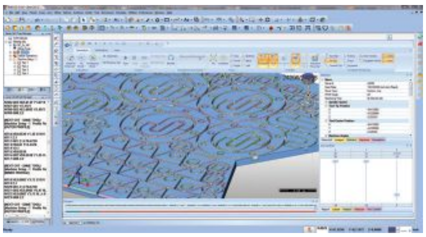
Third Wave Systems Enhances Advantedge

The development team at Third Wave Systems has been working to create a gear machining modeling capability for AdvantEdge, the company's finite element analysis (FEA) software. This will allow gear manufacturers to understand and improve machining processes through simulation of chip formation, in-process stresses and heat flow into the tool and workpiece. Understanding these effects enables users to reduce cycle time and increase tool life while reducing overall production costs.

To make the finite element analysis of metal cutting easier, Third Wave Systems added a results analysis wizard and automated report generation capability within AdvantEdge. The new results analysis wizard guides the user through their simulation data, providing suggestions of important variables for study and text to aid the experienced and novice finite element user in their decision-making.

MORE ➜ ThirdWaveSys.com

BobCAD-CAM Adds Software Nesting



BobCAD says its new software packages offer advanced nesting power with intelligent sheet optimizing technology that can increase material usage by 15% for sheet cutting on CNC mill, router, laser, plasma and waterjet machines. Nesting modules offer multiple ways for machinists to get more parts out of every sheet.

Nesting optimizers are now available, which can be used to create a fast or optimal nest. Nests can be completed within a matter of seconds.

The new modules work within BobCAD-CAM CNC programming software, which means you can do everything from designing and nesting your parts to creating toolpath programming, fully simulating the programming on a virtual version of your machine, and generating NC code for your CNC machine.

MORE ➜ BobCAD.com

EOS Launches the M 400-4 DMLS System

EOS' M 400-4 is designed for industrial applications. The quad-laser system expands the EOS DMLS offering by building on established EOS technology, yet takes it to the next level in terms of productivity, part quality and scalability to meet manufacturing requirements.

The M 400-4 has a build volume of 400x-400x400mm. It is equipped with four 400-watt lasers operating independently in 250x250mm squares each including a 50mm overlap.

"Following our strategy to establish the additive manufacturing technology for production in all industries we have developed this pioneering DMLS system," said Adrian Keppler, chief marketing officer at EOS. "The EOS M 400-4 is a perfect addition to our industrial systems portfolio. It shatters the boundaries of manufacturing as it meets the most demanding requirements of our industry partners in terms of efficiency, scalability, usability and process monitoring. As the system offers a modular platform designed for industrial 3D Printing, it can easily be integrated into existing production environments and the customer set of future innovations."

MORE ➜ EOS.info

Next-Generation Sanmac Increases Productivity

Each year, Sandvik Research & Development has applied and tested process improvements upgrading the melt of Sanmac material. The result is the introduction of a new generation Sanmac, a stainless steel material available in a range of grades the company says offer machinability at similar rates to carbon steel, and also exhibit excellent chip breaks and have consistent machinability from heat to heat and lot to lot.

The material is suited for mechanical seals, valve bodies, flow meters, pumps, and associated components for the oil and gas sector.

MORE ➜ Sandvik.com

Jess Lulka *is DE's associate editor. Email her at jess@digitaleng.news.*

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AD INDEX

BRIEFINGS
News and New Products

High-Performance Virtual Computers

Andy Bowker, executive founder of ebb3, believes proximity to data is the key to a good virtual machine experience. “The company was born out of the realization that the data the workstations are expected to handle is rapidly growing,” he says.

In the Internet of Things era, the increased use of sensors in connected devices is expected to generate large volumes of data. Furthermore, CAD and simulation software users are beginning to wrestle with significantly larger assembly files due to sheer complexity in products.

With an expandable computing infrastructure, virtual machines (VMs) are an attractive solution to firms with evolving or inconsistent project needs. But the large-volume data transfer to and from the VMs is the Achilles heel. It could become a bottleneck.

Adding a new twist and an extra letter to the widely used acronym HPC (high-performance computing), ebb3 came up with an offering dubbed HPVC (high-performance virtual computer). In ebb3’s HPVC setup, the data sits in close proximity to the computing resource.

MORE ➜ digitaleng.news/virtual_desktop/?p=12214

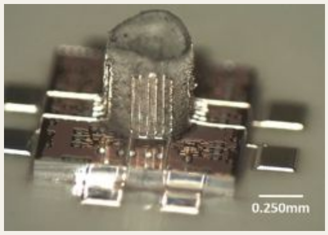
Daihatsu Launches Vehicle Customization

Japanese automaker Daihatsu Motor Co. has launched a new 3D printing pilot project that will allow customers to add unique elements to their new convertibles.

Customers buying Daihatsu’s Copen convertibles will now have the option of adding 3D-printed effects “skins” to customize their vehicles. The company is using Stratasys FDM 3D printing technology to build the three-dimensional patterns, which can be placed on the front and rear bumpers.

Daihatsu engineers worked with designer Kota Nezu and 3D modeling artist Sun Junjie to create the skins. The skins, which feature a variety of geometric and organic patterns,

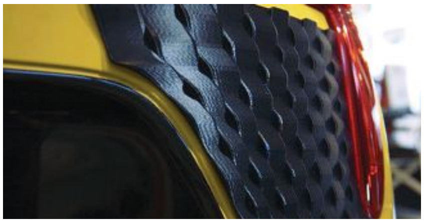
Optomec Announces Micron-Scale 3D Printing for Embedded Electronics



According to the company, Optomec has developed an improved method of printing at the micron scale using its aerosol jet technology, which allows for printing 3D polymer and composite structures with embedded electronics. Even better, the process works without the need for support structures.

The new process is enabled by a combination of Optomec’s aerosol jet printing, and a proprietary in-situ curing method that enables real-time solidification options. Structures built using the new process can be metalized with conductive traces and may include functional components, such as antennas or sensors. The end result is a fully functional, embedded electronic component.

MORE ➜ rapidreadytech.com/?p=10758



are printed on Fortus Production 3D Printers using Stratasys ASA thermoplastic 3D printing material. There are 15 patterns available in 10 different colors.

MORE ➜ rapidreadytech.com/?p=10857

Renishaw Joins Airbus-led UK Aerospace Project

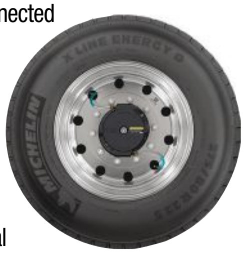
Led by Airbus, with expertise from Renishaw, the United Kingdom is launching a new project to develop improved airplane wings. The £17.7 million (over $23 million) Wing Design Methodology Validation (WINDY) project is being funded jointly by public and private interests.

WINDY will examine how to improve wing aerodynamics, using additive manufacturing (AM) to build both conceptual and functional prototypes. The project will also research the possibility of using 3D-printed parts for wing construction, and investigate the potential of leveraging AM for innovative loads control on aircraft for better efficiency in flight.

MORE ➜ rapidreadytech.com/?p=10801

Halo Tire Inflator Pumped Up by PLM

Aperia Technologies’ Halo bolts on to a wheel, employs a pendulum-like device similar to a self-winding watch to power a pump attached to a wheel as it turns. The device is set to a specific pressure, and once connected to the tire’s valve stem, a control system automatically ups or decreases airflow to maintain optimal pressure.



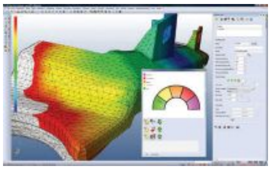
PLM played a critical role helping Aperia maintain an agile development process by keeping everyone on the same page, says Pete Dillon, the company’s business development & strategy associate. Arena PLM was instrumental in managing engineering changes, he says, as well as ensuring the design delivered was a minimally viable product.

MORE ➜ digitaleng.news/virtual_desktop/?p=12208

FAST APPS

Engineering Case Studies

The Artful Science of Mold Simulation



Upstate Simulations masters mold design with VISI Flow.

Laying the vital groundwork for a successful production launch before the tooling hits the shop floor is guaranteed to prevent financial loss, according to Rich Bryan, owner of Upstate Simulations in Canastota, NY.

"Many companies go into the tooling build and launch their product into production despite any problems that may arise, and that just ends up taking longer," says Bryan. "Mold simulation can take care of exposing not only part design issues, but many production issues down the line, as well."

Production challenges arise, Bryan explains, when designers and manufacturers fail to recognize the complicated array of variables that affect the performance of the tool and, ultimately, the quality of the customer's final product.

To help Upstate Simulations identify and improve the designs of new and existing products, it uses the VISI Flow mold simulation solution, by Vero Software. The analytical tools within VISI Flow assist Bryan in detecting potential manufacturing snafus and computes the maximum possible time frame for corrective measures.

MORE ➜ digitaleng.news/de/?p=32531

Fast-Forwarding Next-Gen Product Development

3D printing and simulation helped Globalstar deliver a new version of its telecommunication device.

BT MICHAEL LANDIS, PADT

Product development isn't simply about creating something new or building on the success of an existing product. It's also about improving the design process itself: Integrating the best of today's tools to build better products faster and cheaper. For Globalstar, makers of the SPOT personal global positioning system (GPS) communication device, that meant tapping the expertise in CAD design and 3D printing at Phoenix Analysis & Design Technologies (PADT) for its next-generation product. Putting the digital material capabilities of a Stratasys Connex3 printer to work made the difference.

MORE ➜ digitaleng.news/de/?p=32535

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16. Electronic Copy Circulation
a. Requested and Paid Electronic Copies: Average each issue: 9,498. Sept 2016 issue: 12,000.
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by Ed Israel

Additive Manufacturing vs. 3D Printing

I AM DISAPPOINTED IN OUR OWN INDUSTRY, which is missing out on a powerful message related to additive manufacturing (AM). When you look up the definition of AM, you see 3D printing and vice versa. When the terms "3D printing" and "additive manufacturing" are used interchangeably (including by vendors in this industry), there are large and important components of AM that are ignored—arguably some of the most important with regard to changing how we manufacture things. Here is what I think.

A simple definition of 3D printing from the web says it is the ability to use an additive process to print, layer by layer, a physical object as a three-dimensional part. Seems pretty straightforward. But, to define additive manufacturing, we need to dig much deeper.

Defining Additive Manufacturing

Generally, AM can be separated into two main definitions.

1. **Simple:** Producing 3D-printed parts in volume in both a dimensionally accurate and repeatable way. These parts are suitable for end-use applications.
2. **Not-so-simple, but very powerful:** It is a whole new way to start thinking about your business.

If you get a printer or multiple printers in your business to print parts and continue to do things the way you always have, but in a more cost effective way and perhaps with better part designs, you are off to a good start. If you think about what having this technology could really mean to your company, however, you will find a number of other bottom-line enhancing benefits, such as:

- **Lower costs** by creating a better way to manage your inventory and spare parts on demand. There are many examples of how major manufacturers have upset their customers when a product is discontinued and all the customer needed was a $2 part that it is not available either. With AM, they could say: "No problem, I will have one printed for you and on its way in two days or less."
- **Part complexity is free.** You can make your parts lighter, more functional and less expensive. You can reduce part count by combining multiple components into one, reducing assembly complexity and tolerance issues as well. Design for additive manufacturing, not design for manufacturing!
- **Re-thinking supply chain activities** such as capital to scale and capital to scope, and manufacturing closer to your customer.
- **Taking advantage** of a custom, short-run manufacturing model that may open the door for new customers and increasing time to market.

If you are a contract manufacturer or service bureau, you gain the ability to create a whole new proactive relationship with your customers. They will (and should always) be looking for a reason to do business with you. You can work directly with your customers to improve parts. Do not necessarily just print what they ask you to print; go ahead and print it but re-design it for additive manufacturing.

Embrace the Opportunity

So what is additive manufacturing really? It is not just producing parts in volume. Consider it to be an expansion of how you do things, similar to when CNC (computer numerically controlled) machine tools hit the manufacturing floor. You were able to envision a whole new world and way of doing things for your company and its customers—it was the future. AM brings you another opportunity at least as big.

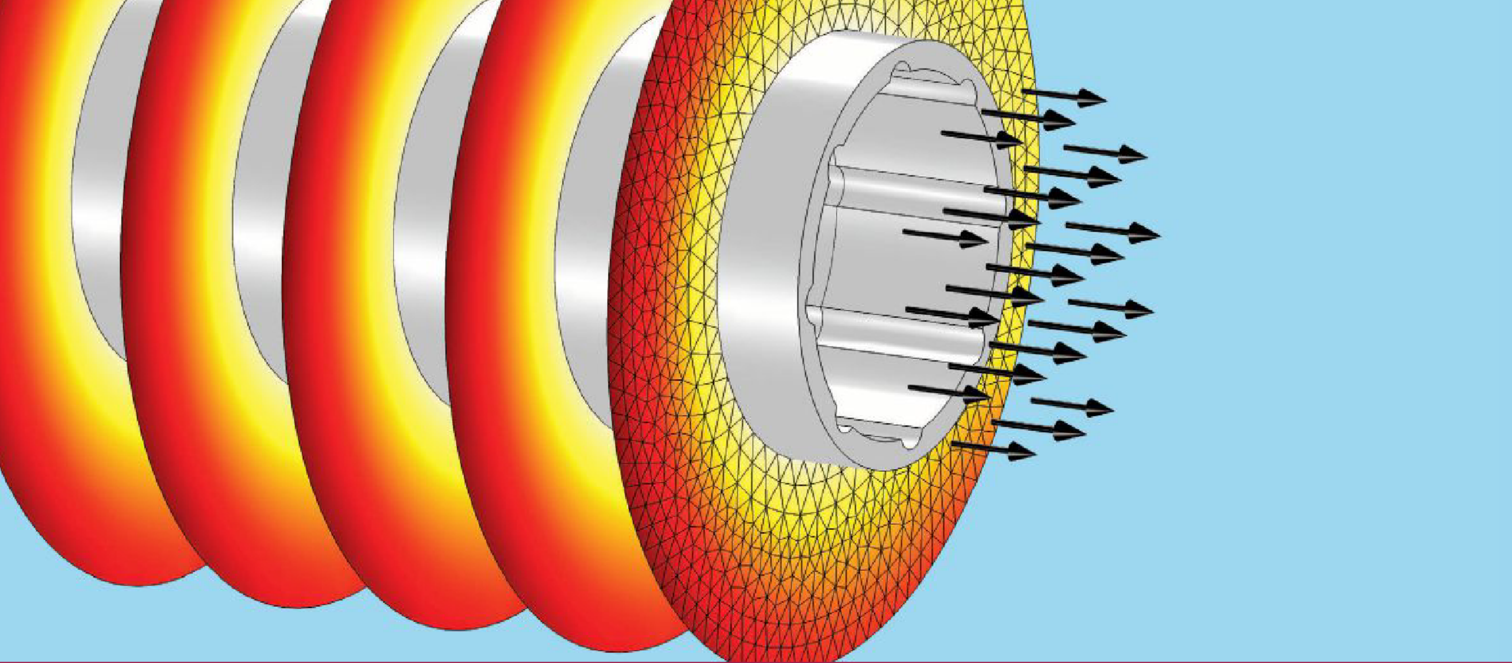
Before you invest, do your homework with vendors that understand and can support your goals. You do not want to earn a PhD in what 3D printer not to buy (one that ultimately won't meet your goals and requirements). Get help in selecting the materials that best match your printer's capabilities. Additionally, get some outside input on which of your parts would lend themselves to an AM process.

Be sure to do a cost-per-part case study to determine your actual return on investment and bottom line improvements, and weigh that with competitive benefits you will gain.

Select a vendor who is willing to earn your business, and can contribute as a partner to the new knowledge you'll need to take full advantage of the technology.

This is not just about buying a 3D printer. Treat it as an opportunity to find your next 10 years of competitive advantage, growth and profitability. Make additive manufacturing part of your strategy for success. DE

Ed Israel *is president and co-founder of Plural Additive Manufacturing (pluralam.com). Send email about this commentary to de-editors@digitaleng.news.*



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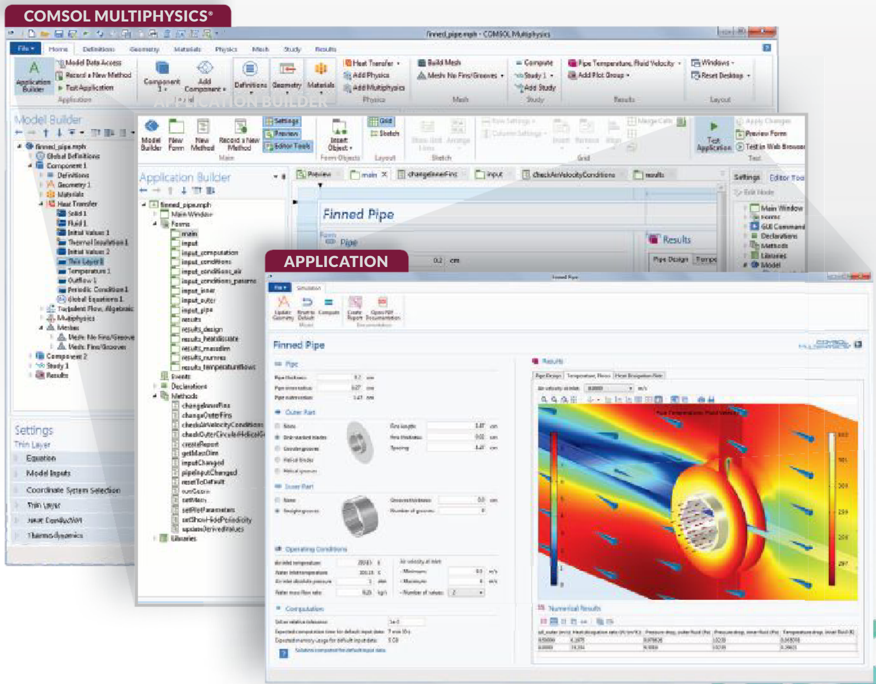

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