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DE Digital Engineering

May 2020

ENGINEERING A RESPONSE TO COVID-19

SPECIAL COVERAGE

- Designing From Home
- 3D Printing Medical Supplies
- Simulating New Treatments

Peerless MEDIA, LLC

By Brian Albright

Designing in Place

IF I HAD KNOWN A MONTH AGO that I would be spending the entire spring confined to my house, overseeing my daughter's test on "Charlotte's Web," rewiring the spare bedroom to connect my wife's IP phone system and teaching my son how to multiply and divide fractions, I might have prepared a bit better. I would have been more strategic during my last in-person visit to the grocery store. I may have invested in a better laptop. I definitely would have bought a bigger house.

Odds are, many of you are wishing you had made better use of your time outside the home before the coffee shops, bars, shopping malls, barber shops and gyms closed down.

Now, here we sit, sheltering in place and trying to navigate the logistics of working from home while packed together with our families or roommates or all by ourselves 24 hours a day. Many of us our struggling to guide our children through distance learning programs that were cobbled together at the last minute, while also trying to maintain some semblance of productivity. We are fretting about where to find toilet paper, and obsessively watching "Tiger King" on Netflix.

Over the course of the past month we have all been forced to re-evaluate what is truly essential, how we live, how we work, how we interact. We have learned revealing things about our health care systems, our school systems, our emergency response infrastructure, our leaders, our neighbors and our economy. Not all of those revelations have been pleasant.

During quarantine, my family has been catching up on our movie watching. One of the first things we watched was "A Beautiful Day in the Neighborhood," the Tom Hanks movie about Mr. Rogers.

"Look for the helpers," Hanks, who plays Rogers, says at one point, quoting a bit of advice that the real Fred Rogers said he got from his mother when world events seemed scary. It's a quote we've repeated often to our children and to ourselves during the last month.

And it's a line I'm reminded of daily as I read the news about our own industry which, I'm happy to report, is full to the brim with helpers.

Engineering to the Rescue

As the scope of the COVID-19 outbreak expanded and more and more states issued shelter-in-place orders, technology providers in our industry and many of our readers quickly rallied to support each other and healthcare providers. In fact, it became quickly apparent that the *Digital Engineering* community was almost uniquely prepared for this moment.

There's been positive action on a number of fronts. Design and simulation software providers have established new flexible or free licensing programs that are helping their customers work from home. Major vendors have been promoting cloud-based and hosted versions of their software for years, but many customers have balked at making the transition. Many of those firms are now taking part in an unplanned trial run of these solutions.

Meanwhile, engineers and additive manufacturing companies have come together to address a massive shortage of personal protective equipment (PPE) for health care workers, as well as to expand the number of available ventilators and respirators.

For years, analysts have fretted that decades of offshoring manufacturing operations in search of lower costs has come at the expense of supply chain responsiveness and flexibility. Some of those chickens have come home to roost.

In the health care supply chain right now, additive manufacturing has proven to be an effective solution. Universities and manufacturers have converted workspaces into impromptu face shield and ventilator valve factories, leveraging crowd-sourced designs and 3D printers. It has been amazing (and inspiring) to behold.

Having a front-row seat to this display of good-hearted ingenuity has helped keep my spirits high, even though there is still a great amount of uncertainty. We haven't seen anything like the current national lockdown since the influenza pandemic of 1918. That was a much different virus, and the world was a very different place. The next several months are going to be difficult, and I expect the economic fallout could be severe.

All of this is stressful, and it is easy to despair. So look to the helpers. If you've got the means, *be* a helper. There are plenty of opportunities for you to put your engineering know-how to good use. Check out the COVID-19 coverage on our website to learn more about these emerging initiatives. If you know about a program we haven't covered, drop us a line so we can share the information with the community.

Most importantly, stay safe. DE

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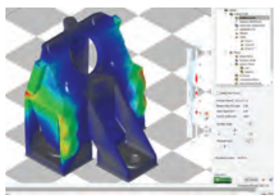
INSIDE



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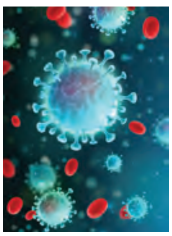

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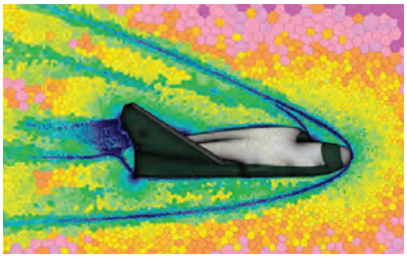

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BY THE NUMBERS | COVID-19

IT Infrastructure Takes a Hit

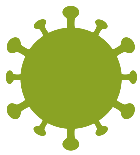
End user spending on IT infrastructure (server and enterprise storage systems) will decline in 2020 as a result of the widespread coronavirus pandemic, according to the International Data Corporation (IDC).

Worldwide End User Spend on Servers:
2019, 2020 and 2024 and 5-Year Compound Annual Growth Rate
(CAGR; Value in $ Billions)

IT Infrastructure Market	Market Segment	2019 Value	2020 Value	2020 Growth	2024 Value	2019-2024 CAGR
Servers	**x86**	**$83.8**	**$81.9**	**-2.2%**	**$109.8**	**5.6%**
	non-x86	**$8.0**	**$6.7**	**-16.0%**	**$6.8**	**-3.3%**
Total Servers		**$91.7**	**$88.6**	**-3.4%**	**$116.6**	**4.9%**

Source: IDC Worldwide Quarterly Server Tracker, March 26, 2020

COVID-19 Changes How We Work



The number of professionals that were **hesitant to go to work** rose from **67.8%** to **76.1%** in just 3 days.

47.3% of professionals stated that their **productivity** is negatively affected by the spread of COVID-19

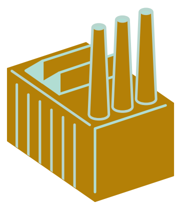
53.8% of professionals are concerned about their **job security**

62.2% of professionals think their **total income** is going to be negatively affected

Source: Blind, March 2020

COVID-19 Disrupts the Global Supply Chain

The National Association of Manufacturers released the findings of a survey of manufacturing leaders examining the economic and operational impacts of COVID-19. Findings included:



78.3% of manufacturers anticipate a **financial impact**

53.1% of manufacturers anticipate a **change in operations**

35.5% of manufacturers are facing **supply chain disruptions**

Source: National Association of Manufacturers, March 2020

CORONAVIRUS PANDEMIC NEWS

For more information visit: DigitalEngineering247.com/COVID19

CAASE20 PREVIEW

CAASE20 Conference Goes Virtual

The June 16-18 event will be held online; IndyCar's Bill Pappas to Keynote

BY BRIAN ALBRIGHT

NAFEMS Americas and *Digital Engineering* (*DE*) have announced that CAASE20 (the Conference on Advancing Analysis & Simulation in Engineering) will be presented as a virtual conference June 16-18, 2020. The conference was originally planned as a live event in Indianapolis this summer. Concerns around the ongoing COVID-19 pandemic led to the decision.

According to a statement issued by the event organizers:

"Over the past several weeks, NAFEMS and *Digital Engineering* magazine have explored numerous scenarios and options with the safety and best interests of our community in mind. We came to the decision to bring CAASE20 'online.' Many of us are dealing with a significant amount of uncertainty at the present time, and we wanted to take the decision to travel (or not travel) off the shoulders of our CAASE20 participants. Our hope is that transforming CAASE20 into a virtual conference will create a safe and robust alternative for bringing together the leading visionaries, developers and practitioners of CAE-related technologies to share relevant trends, discover common themes and explore future issues. Based on the preliminary discussions we've had, the community is extremely excited by this decision and support has been overwhelmingly positive. We will have more information to share in the coming weeks, which will be posted on nafems.org/caase20."

IndyCar Keynote

Despite the shift to a virtual conference, CAASE20 will still present its planned full lineup of keynotes and educational sessions.

Bill Pappas, vice president of Competition & Engineering at IndyCar, will be among the keynote speakers at the conference. Pappas has worked in auto racing for more than 33 years, including as a racing engineer with championship teams. He joined IndyCar in 2016 and oversees its technical department. His duties include looking at alternate technologies to integrate into the existing and future IndyCar, listening to concerns and issues of paddock and working with manufacturers to reduce costs for teams.

According to Pappas, IndyCar works closely with its network of partners to use simulation as a predictive tool to evaluate performance and safety limits of the vehicles. One of these partners is Dallara, the exclusive chassis supplier to the NTT IndyCar series.

"Dallara has a sophisticated CFD [computational fluid dynamics] vehicle dynamics program that we lean on quite heavily, because they are the designer of the car," Pappas says. "We can tell them we are going to a particular track and that the suspension load is going to be more than we might experience on an oval. [If we wonder] how much downforce should we take off to be within the limitations of the suspension, we can go to Firestone and they can use simulation capabilities to quantify loads that are acceptable to the tire designs."

The use of simulation has increased significantly over the past several years. "As these tools have become more and more available and have proven to be accurate, you start to rely on them more and more," Pappas says.

IndyCar has also leveraged simulation to help determine if a vehicle design can help drivers race near each other and overtake each other in a safe fashion.

"That's tough to do. In the real world you have to build prototype parts, go to the racetrack and do several enormously expensive tests," Pappas says. "If we can simulate beforehand to evaluate a wing design, we can go through these studies and look at what is the best solution."

IndyCar also worked closely with Dallara and Red Bull Advanced Technologies to create what Pappas says is one of the most important recent innovations: the Aeroscreen. The structure was designed to provide additional cockpit protection during crashes.

"Dallara and Red Bull did extensive structural testing and FEA [finite element analysis] studies," Pappas says. "I think it's going to be a huge game changer in driver protection for openwheel race cars."

Pappas says that Dallara has a driver-in-the-loop (DIL) simulator that also plays a key role in vehicle design. "The driver can sit in that, look at the big screen, feed in different track geometries and ... test a new concept on any track," Pappas says.

"Ultimately what we want to do is design a car using our tools to do the CFD study for the aerodynamic properties, and then before we build the car itself, put the driver in that driver-in-the-loop system and see if it drives better," Pappas says. "We're working on traffic studies where we can go from CFD to put that model into the DIL, and the driver can sit in the car and drive as if they are behind another vehicle.

"The idea is to cut down on manufacturing prototype parts and physically testing this stuff before we go into production," Pappas adds. "That's going to be a useful tool to build these cars of the future." DE

For more information, or to address questions or concerns, contact NAFEMS at americas@nafems.org or visit the CAASE20 website (NAFEMS.org/events/nafems/2020/caase20).

COLLABORATION

COVID-19 Spike Puts Remote Collaboration to the Test

Design tool vendors ease licensing restrictions and aim for scalability to meet surge in demand from work-at-home engineers.

BY BETH STACKPOLE

One of the many fallouts from the COVID-19 pandemic is a new work-from-home climate that while challenging for all, is particularly taxing for engineering organizations, which are dependent on high-octane computing horsepower and graphics-intensive design software to get their jobs done.

Engineering organizations, unlike other areas of the business, have been more resistant to switching their core design tools to a cloud-based model due to concerns about performance and, in many cases, the security of critical design intellectual property.

Now weeks into the global coronavirus outbreak, the reticence over a software-as-a-service (SaaS) deployment model and cloud-based design collaboration has been cast aside—at least for the foreseeable future. Millions of workers, including engineers, are scrambling to get their home workspaces in order and their mobile systems, including their favorite design tools, appropriately configured for remote work. Indeed, vendors offering cloud-based design tools and remote collaboration platforms are reporting an uptick in demand for those services and are responding with special offers and revamped license plans that make it easy for existing customers to expand usage of cloud-based tools while encouraging long-standing holdouts to finally take a test drive.

"We're definitely seeing increased interest and usage at a professional level," says David Katzman, vice president of customer experience and strategy at PTC, which recently acquired Onshape, a cloud-based CAD platform. "People are just starting to wrap their head around this so it takes some time."

Formulatrix relies on Onshape's real-time collaboration tools to streamline communication. Pictured above is a machine component that removes the lids from microtiter plates.
Image courtesy of Formulatrix.

Licensing for the New Normal

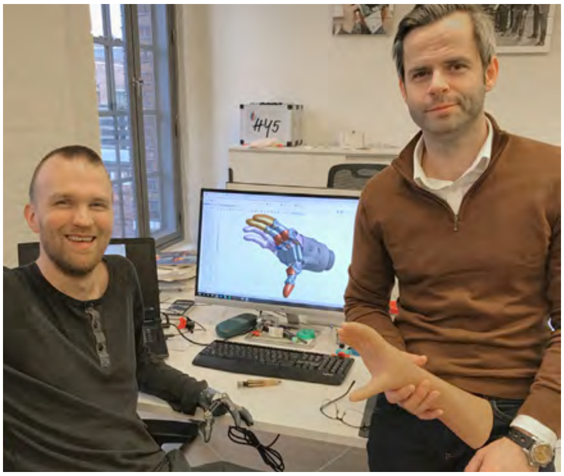
One of the biggest issues for engineering groups still fully reliant on on-premise systems is how to access their critical design tools when working from home. There are myriad roadblocks, from problems that make it difficult to tap into the software through the corporate virtual private networks (VPNs) to bandwidth concerns. In many cases, collaboration is stymied by technical issues—for example, internet compatibility issues with older servers or concerns that remote access identities might cause out-of-sync files.

"What we're hearing most from customers—and facing ourselves at Autodesk—involves adapting to the new work-at-home environment and making it the new normal," says a spokesperson at Autodesk. "With more people working remotely or from home, the ability to collaborate and stay connected is important to maintain productivity, ease stress and boost morale."

To minimize disruption to businesses and better support its customers, Autodesk is offering a temporary Extended Access Program for several of its flagship cloud collaboration products. Specifically, the Extended Access Program allows free commercial use of several of Autodesk cloud collaboration products, including BIM 360 Docs, BIM 360 Design, Fusion 360, Fusion Team, AutoCAD Web and Mobile, and Shotgun, until May 31. The program is available to new and existing customers.

"Our goal is to get a program up and running as quickly as possible to provide customers access to products they need to do their jobs and increase flexibility in a challenging work environment," the Autodesk spokesperson says.

For Onshape, the pandemic has prompted an uptick in usage from new customers, but for its internal employees and existing user base, the environment is pretty consistent with how they've always worked. Research from Onshape shows that even before the pandemic, over half of employees were working outside of their main office headquarters, at least two and a half days a week.



Based in Norway, Hy5 is devoted to providing affordable high-functioning prosthetic hands to people who previously could only access basic grippers. Hy5 says the iteration process is faster in Onshape, which allows multiple engineers to simultaneously work on the same design online. Pictured are mechanical design engineer Ola Kyrkjebø (left) and CMO Ole Olsen. *Image courtesy of Hy5.*

Because the Onshape platform was designed as a cloud platform and because it forgoes the file-based architecture of most CAD tools for a database-oriented approach, there have been little to no performance issues even with the spike in usage, Katzman says. He said PTC and Onshape are transparent with their performance numbers and directed those interested to check out status.onshape.com to review published benchmarks.

"With a modern SaaS offering, no one thinks about how many people are using the system at any given point in time," he says. "The system should work whether there are five, 500 or 5,000 users, and we've built in a lot of automation and tooling so that we can scale automatically. We don't have to do anything to enable scaling up as more users sign on to the system."

OnScale, a cloud-based multiphysics simulation platform, is also seeing a surge in interest, including from users of its on-premise and hybrid solutions, according to Ian Campbell, the company's CEO. Those customers, who decided to pass on the cloud option, are now interested in the deployment model due to their need to accommodate engineers working remotely.

"The trade-off is having highly-paid engineers not being able to do anything or relaxing some security protocols to access the OnScale cloud and they're doing the latter," notes Campbell. "They need to keep these guys productive—it could become a permanent fixture of the economy going forward."

Campbell says OnScale has seen some hiccups in performance due to the increased volumes, but it is working with partners like Amazon Web Services, Google Cloud Platform and Azure to address latency issues. "Our requirements call for top-of-the-line systems like 96-core bare metal machines, 100GB of RAM and tightly co-located infinity band backplane speeds with 100 gigabit per second interconnects," he says. "We are working like mad [with partners] to beef up the infrastructure accordingly."

Outside of bolstering capacity to meet increased performance demands,

Onshape's cloud-native product development platform is suited to remote teams, allowing engineers to work from anywhere on any computer, tablet or phone.

OnScale is also easing some of its license constraints. The company is offering free cloud core hours to its on-premise customers currently working from home.

Altair says that licensing constraints are some of the biggest issues for companies struggling to get their engineering teams access to mission-critical design software.

"The problem they have is drilling holes into their firewalls to access software based on on-premise licenses," says Sam Mahalingam, the company's chief technology officer. "Then they are loading up their VPNs and servers because people are working from home."

The company's patented units-based licensing model and the ability for Altair to host a company's HyperWorks server provide flexibility, allowing engineers to access the simulation portfolio from anywhere. "We've seen demand spike over the last few weeks for enterprises saying they don't want to host their own servers, but rather move units to a hosted server to give employees ease of access," Mahalingam says.

Another way organizations are tapping Altair technology is with Access, which provides an interface for submitting and monitoring HPC jobs on remote clusters and clouds. Companies can also take advantage of Altair HyperWorks Unlimited, a simulation appliance, as well as the Altair PBS Works web portal interface. DE

ADDITIVE MANUFACTURING

Hospitals and Innovators Turn to Additive Manufacturing to Fill the Supply Void in the COVID-19 Crisis

BY KENNETH WONG

During the peak of the coronavirus outbreak between mid-March and April, unprecedented spikes in demands for medical supplies led to previously unheard-of manufacturing activities. Fashion brands like Ralph Lauren started sewing hospital gowns and masks; some distilleries and perfume makers turned to brewing hand sanitizers; and several leading car makers launched initiatives to produce ventilators for the growing pool of patients battling COVID-19.

As global supply chains were strained by border closures and travel restrictions, manufacturing became much more localized, executed on the fly with the raw materials still in stock. Furthermore, the needs for face shields, personal protective equipment (PPE), and ventilators are highly localized and immediate. The crisis has forced innovators and engineers to look to additive manufacturing (AM) or 3D printing as a way to swiftly produce objects that are urgently needed.

Staff of 3D Systems' on-demand 3D service division poses with 3D-printed valves. *Image courtesy of 3D Systems.*

CoVent-19 Challenge

The news came out on April Fools' Day, but it wasn't a joke. A collective of Boston-area anesthesiology residents had just launched an eight-week hackathon hosted on the engineering collaboration portal GrabCAD.com to design a rapidly deployable ventilator for patients with COVID-19-related lung problems.

The CoVent-19 Challenge, as it's called, is open to teams and individuals anywhere. Finalists are expected to work directly with Stratasys 3D printing experts and the CoVent-19 Challenge team to produce prototypes for physical testing. Up to $10,000 in prizes are available for the challenge. Five days into the challenge, the site has already logged 20 entries, submitted as detailed CAD assemblies.

According to INNOVATE2VENTILATE, the dedicated portal for the event, "The deficit of ventilators in the U.S. alone is expected to be in the hundreds of thousands. Our goal is to rapidly expand the capacity of hospitals, by expanding our current ventilation abilities, in order to survive the peak of this pandemic."

The design challenge's judges include Evan Hochstein, medical applications engineer at Stratasys; Diana Barragan-Bradford, anesthesia resident, Massachusetts General Hospital; Richard Boyer, anesthesiology resident, Massachusetts General Hospital; and Jarone Lee, associate professor of Emergency Medicine, Harvard Medical School.

Separately, a team from MIT has developed an open-source low-cost ventilator that can be rapidly deployed. The inventors called it MIT E-Vent (emergency ventilator).

America Makes Organizes

In the early days of the crisis, America Makes, the national association for championing AM, launched a dedicated page in response to COVID-19. The site was created in collaboration with the U.S. Food and Drug Administration (FDA), the Department of Veterans Affairs and the National Institutes of Health (NIH). It houses a repository where additive manufacturers can upload 3D-printable designs to be reviewed and placed on the NIH 3D Print Exchange.

Designs submitted through the America Makes portal "will be placed in a fast-track workflow for faster review. Designs not submitted through the America Makes process may not be considered for the fast track workflow," according to America Makes. All approved designs are expected to become publicly available through the NIH 3D Print Exchange website.

"We have seen so much innovation throughout the AM industry related

CAASE20

The Conference on Advancing Analysis & Simulation in Engineering

Virtual Conference • June 16th - 18th

Co-Hosted by: DE Digital Engineering NAFEMS

NAFEMS Americas and Digital Engineering (DE) are teaming up (once again) to present CAASE, the (now Virtual) Conference on Advancing Analysis & Simulation in Engineering, on June 16-18!

CAASE20 will bring together the leading visionaries, developers, and practitioners of CAE-related technologies in an open forum, unlike any other, to share experiences, discuss relevant trends, discover common themes, and explore future issues.

Presentations at this event will center on four key themes:

1. Simulation-Driven Design
2. Implementing Simulation Governance & Democratization
3. Advancing Manufacturing Processes & Additive Manufacturing
4. Addressing Business Strategies, Challenges & Advanced Technologies

Visit nafems.org/CAASE20 for more information

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to the COVID-19 pandemic," says John Wilczynski, executive director of America Makes. "The question we've repeatedly been asked is 'are these products safe and reliable in a health care setting?' The design portion of the repository seeks to put clarity around that question for both manufacturers and providers. We believe it is a critical part to allowing the additive industry to effectively meet the needs of front-line health care workers."

System Makers and Service Providers Get Involved

Designed to protect medical staff from infectious droplets and toxins when treating patients, disposable face shields are quickly running out as the demands at the hospitals outpace the supply chain to catch up. Leading AM system makers are now getting involved to address the shortage. Stratasys set a goal "to deliver an initial 5,000 [face] shields to critical need locations over the next week."

"Stratasys is rapidly scaling its efforts to print both reusable and disposable face shields on dozens of FDM 3D printers located in Texas, California and Minnesota. These shields have FDM 3D-printed frames, with clear, full-face plastic shielding," the company writes in its dedicated page for COVID-19 response.

Once the face shields are in production, Stratasys plans to look into making face masks and medical components that can be 3D printed.

From its COVID-19 response page, 3D Systems also pledges to support medical device manufacturers and point-of-care hospitals. "The company is offering its expertise, services and production capacities as needed. Depending on the scope of the engagement, charges may be incurred, but the company is managing this on a case-by-case basis," according to 3D Systems' PR department.

The company has also added a downloadable ready-to-print face shield frame to the page. "Even though many individuals and groups are designing and manufacturing face shield frames for these responders, many of the designs are not optimized for high-density optimized additive manufacturing and cannot be accessed locally," the company notes. The design it offers is "optimized for high-density nesting" and intended to be printed in "medical-grade nylon that is autoclavable and compatible with disinfectant cleaners," it clarifies.

HP recently launched a page dedicated to using AM to contain the coronavirus outbreak. "HP has developed an investigational 3D printed nasopharyngeal test swab, designed for use in COVID-19 testing. HP has shared the swab designs with several premier research partners for clinical evaluation. We are working closely with leading researchers at Harvard University and Beth Israel Deaconess Medical Center to assist with gathering test data and to further refine the 3D printed swab designs, materials and printing capacity," the company writes.

The printer giant is also investigating 3D printed parts for a mechanical bag valve mask (BVM), designed for short-term emergency ventilation of COVID-19 patients. The company plans to make the validated design files for many of the parts that do not require complex assembly freely available from its dedicated COVID-19 site for download.

Massivit 3D has also mobilized its network of over 100 customers and distributors worldwide, to design and produce face shields. According to the company, its high-speed AM technology can churn out hundreds of face shields from each machine every day—a much higher rate than possible on hobbyist 3D printers. The company has also made available access to all 3D printable files of its newly developed face shields. The files were based on an original design by Art Nzo's Twan Kerckhofs.

Student workers at Stratasys using CNC cutters to cut face shield covers. *Image courtesy of Stratasys.*

Fictiv, an on-demand manufacturing service provider, recently announced hospitals can begin ordering the protective face shields in batches of up to 10,000 at cost for shipment as fast as one day. "Fictiv has invested in the upfront tooling costs to make the shields available as quickly and easily as possible to healthcare agencies, service providers, distributors and even non-health care OEMs that are pivoting to support the healthcare industry during this crisis," the company writes.

"The shield is based on open-source face shield designs, similar to the visor recommended by the NIH, but is modified with a closed top to be more consistent with the American National Standards Institute recommendations," the company clarifies.

Academia and Innovators Join the Fight

Carl Bass, former CEO of Autodesk, has lately been spending more time in his machine shop. He's been making hundreds of face shields, using polycarbonate sheets mounted on standard baseball caps, at a cost of $1 each. He has started delivering early batches to hospitals, he announced in his twitter feed @carlbass.

Syracuse University faculty, alumni and staff have also begun producing 3D-printed face shields, using the School of Architecture's digital design and production facility. The facility used the Lulz-Bot Taz 6 (an open-source 3D printer from MatterHackers), Gigabot 3+ (from re:3D) and Zortrax M300 printers to churn out shields. According to the university's blog post, the team can produce 60-90 face shields per day.

Impromptu Invention vs. Quality Control

On Saturday April 4, Jenny Chen, founder of the 3DHEALS, hosted a webinar called "Can 3D printing save us from the COVID19 crisis?" One of the panelists was Alan Dang, an orthopedic spine surgeon. He launched the Orthopedic Rapid Intelligent Fabrication (ORIF) program at University of California, San Francisco (UCSF) VA and is a founding member of the UCSF Center for Applied 3D+ Technologies.

When California was placed under the shelter-in-place order, he first trimmed his operations to a minimum. "Within a day, we were getting requests from our hospital partners facing COVID-19-related supply issues," he recalls. "This helped us go back into operation in full speed. The 3D-printed face shields have been one of the great success stories of this pandemic."

He also points out, "For the enthusiast community with desktop 3D printers, the instinct is to print as many units as possible to deliver to the hospitals, but with desktop printers, if you run it at a slower speed, it gives you better quality products."

In Dang's view, fused deposition modeling or fused filament fabrication printers are not suitable for printing face masks, as "they do not give you an airtight seal. You can use it for design prototyping, but not as a production device to make masks." (They may, however, be suitable for producing other items, such as ventilator parts or frames for face shields.) DE

→ RESOURCES

America Makes COVID-19 response: AmericaMakes.us/statement-on-covid-19

CoVent-19 Challenge: CoVentChallenge.com

Fictiv's response: Fictiv.com/covid-19-face-shields

HP's response: Enable.HP.com/us-en-3dprint-COVID-19-containment-applications

Massivit3D's COVID-19 response: Massivit3D.com

MIT E-Vent: E-Vent.MIT.edu

Stratasys COVID-19 response: Stratasys.com/covid-19

Syracuse University: Syracuse.edu/stories/3d-print-response-covid-19

3D Systems's response: 3DSystems.com/covid-19-response

3D Heals: http://3dheals.com

AUTOMOTIVE

Can Carmakers Make Ventilators?

BY KENNETH WONG

Two industry experts weigh in on automakers' ability to tackle the ventilator shortage during the COVID-19 crisis.

As the coronavirus outbreak accelerates, some carmakers voluntarily explored the option to reconfigure their supply chain and production facilities to address the serious shortage of ventilators at the hospitals. Others, like GM, had specifically been asked by the U.S. government to produce ventilators under the Defense Production Act, which allows the government to redirect manufacturing activities in wartime.

U.S. carmakers GM, Ford and Tesla had all pledged to contribute resources or help produce ventilators even before the Defense Production Act was invoked ("Automakers offer to build ventilators as U.S. faces critical shortage," ABC News, March 21, 2020).

General Motors and Ventec Life Systems partnered to convert the GM Kokomo, IN, ERC building for the production of Ventec ventilators in response to the COVID-19 pandemic. *Image courtesy of GM.*

Similarly, British carmaker McLaren had joined the efforts to tackle the same issue as the numbers of infections and deaths rose in the UK. All three arms of the McLaren Group—McLaren Automotive, McLaren Racing and McLaren

Applied—are part of a rapidly formed consortium (VentilatorChallengeuk.com) to design and deliver ventilators to UK hospitals.

In Italy, one of the hardest hit countries, local brands Ferrari and Fiat are in discussions with ventilator makers to see if they can boost production of the critically needed breathing apparatuses ("Ferrari and Fiat look at helping Italy make ventilators in coronavirus crisis," Reuters, March 19, 2020).

We spoke to Keith Meintjes, executive consultant from CIMdata, and Joe Barkai, an independent consultant and speaker, to understand the logistical challenges and opportunities for carmakers to pull off a rapid response. The following are excerpts from their conversation, with slight edits for clarity.

***Digital Engineering:* A lot of people are hoping the carmakers can address the ventilator shortage problem. I'd like to understand the challenges of reconfiguring the supply chain and assembly lines to produce a new product. Can this be done easily?**

Joe Barkai: Based on what New York Governor Cuomo has said, we do not have time to reconfigure the supply chain, no time to rebuild assembly lines. We need the ventilators today. Therefore, whatever action it is, it has to leverage the existing resources, whether it is physical materials, manufacturing facilities or human resources.

According to a CNBC report on March 24, Governor Cuomo said, "It does us no good if [carmakers] start to create a ventilator in three weeks, or four weeks or five weeks. We're looking at an apex of 14 days."

Keith Meintjes: A vehicle is a large, heavy device, so a vehicle assembly line may not be appropriate for manufacturing something like a ventilator. In terms of a facility through the automotive supply chain, those who produce air compressors and air conditioners might be a better fit.

***DE:* Can certain components in the automotive design be readily adapted for ventilators?**

Barkai: Medical devices have different QA [quality assurance] requirements; they also have certain characteristics that are not relevant to cars. Take the fan, for example. Cars have fans. Ventilators have fans. You can lubricate the fan in a car, but you cannot do that to a fan that blows air into a patient's lungs. But certainly, there are parts that can be good candidates [for ventilator production]. Automotive engineers can help identify these parts. I don't think the automotive industry should be doing QA on ventilators, because the QA standards in medical equipment are different.

But we may be talking about coming together as a team, to help provide machining or use 3D printing to create parts that do not exist.

Meintjes: We have capabilities we didn't even have a few years ago. For example, using 3D printing to make tooling to build components for ventilators. You can do that to get production up and running very quickly.

***DE:* How is this crisis different from past crises?**

Meintjes: The only thing comparable is the switchover of the American industries during World War II to make vehicles, weapons, ammunitions and aircraft. Back then, it was switching from building ordinary cars to building jeeps, for example. This, being a medical crisis, adds a different set of issues.

Barkai: The Defense Production Act allows the President to order businesses to produce things that are necessary for defense. The Act was created during the Korean War.

***DE:* Manufacturing has changed a lot since World War II or the Korean War. Right now, it is a globally dispersed activity. Are we better prepared to pull off a quick response?**

Meintjes: Things like internet communication play a prominent role in the response to the coronavirus, much more so than 20 years ago. Rapid response to competitive pressure in manufacturing is a reality, [and] has been so for some time. If a footwear manufacturer comes out with a new design, their lead time in sales is just a month or two before others respond with similar products. We see the manufacturers' willingness to get involved—for example, Ford and GM.

Barkai: Even 10 years ago, manufacturing was much more vertically integrated, so the field capabilities are relatively narrow. It used to be very local. The global phenomenon we're dealing with today, with global sourcing, gives us an opportunity. Automakers are particularly good at supply chain and logistics. They can find material sources, and they have the buying power most do not have.

To listen to the unedited audio of the interview, go to DigitalEngineering247.com.

The New York Times reported that, "On March 19, GM began collaborating with Ventec, which normally makes about 200 machines a month, to figure out how to make about 10 times as many in that time. Working through the weekend of March 21 and 22, they hurried to find new suppliers that could provide parts in high volumes … GM called in workers to clear out the Kokomo plant, which has been idled because of the outbreak, of machinery previously used to make electrical components for cars. Over the next few days, the automaker and Ventec plan to begin setting up an assembly line." ("Inside GM's Race to Build Ventilators …," March 30, 2020). DE

→ RESOURCES

CIMdata: CIMdata.com

Joe Barkai: JoeBarkai.com

HIGH-PERFORMANCE COMPUTING

Supercomputers Target COVID-19

Massive compute resources are being leveraged to identify treatments.

As governments around the world scramble to contain the coronavirus pandemic by shutting down schools, canceling public events, limiting travel and ramping up testing efforts, powerful technology resources are also being deployed.

At Oak Ridge National Laboratory (ORNL) in Tennessee, researchers used the Summit supercomputer to identify 77 small-molecule drug compounds that could potentially bind to the glycosylated spike (S) protein, through which the COVID-19 virus accesses host cells. One or more of those compounds could potentially disarm the virus and point the way to future treatments.

"We were able to design a thorough computational model based on information that has only recently been published in the literature on this virus," said team member and UT/ORNL CMB postdoctoral researcher Micholas Smith. Smith was referring to a previous study published in Science China Life Sciences that modeled the spike protein for risk of human transmission. When Chinese researchers sequenced the virus, they found that it infects the body via a mechanism similar to that of the SARS virus.

According to the South China Morning Post, researchers in China are also leveraging the Tianhe-1 supercomputer and artificial intelligence (AI) to diagnose COVID-19 patients using chest scans. The National Supercomputer Center in Tianjin claims the system was able to provide a diagnosis within 10 seconds based on computed tomography scan images. The system can direct doctors to other areas of concern in a patient's lungs, provides an estimate of the likelihood of the person having COVID-19, and even provides treatment suggestions.

The Joint Supercomputer Center of the Russian Academy of Sciences (JSCC RAS) is also providing priority access to computing resources for research teams studying methods to fight the COVID-19 coronavirus infection. Russian scientists, as a part of the multinational research team, recently upgraded the MVS-10P OP cluster system based on high-performance 2nd-generation Intel Xeon Scalable server processors. The international project aims to develop medicine for diagnostics and therapy against the coronavirus contagious disease.

Modeling Coronavirus

At ORNL, Smith built a model of the coronavirus spike protein based on the earlier studies of the structure. The Summit computer used NVIDIA V100 GPUs and GROMACS, a GPU-accelerated simulation package for biomolecular systems, to run the team's experiments on more than 8,000 compounds.

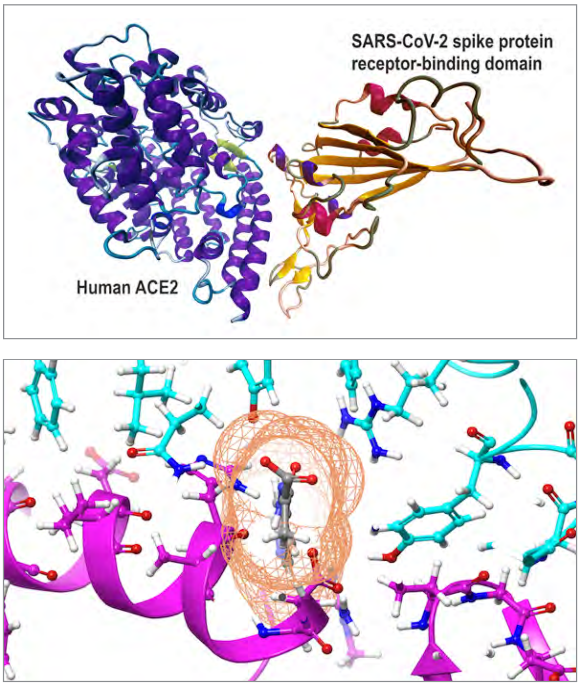
Smith was granted computational time on Summit through a Director's Discretionary Allocation, and he used a chemical simulations code to perform molecular dynamics simulations. The team simulated different compounds docking to the S-protein spike of the coronavirus to determine if they could potentially prevent the spike from sticking to human cells.

"Using Summit, we ranked these compounds based on a set of criteria related to how likely they were to bind to the S-protein spike," Smith said.

The team identified 77 small-molecule compounds, including medications and natural compounds, that could be candidates for further experimental testing. In the simulations, the compounds bind to regions of the spike that are important for entry into the human cell.

Researchers at the University of Texas at Austin have since released a more accurate model of the S protein, and the ORNL researchers plan to use that model to rerun the study.

IBM, which built the Summit, is also providing other resources to help researchers. According to IBM, the company's Watson Health unit is working directly with health organizations to better understand the nature of COVID-19. The IBM Clinical Development system has been made available without charge to national health agencies to accelerate clinical trials by providing data and analysis from web-enabled devices. In addition, IBM's Operational Risk Insight tool has been made available to nonprofit organizations to help analyze data on the spread of the virus. DE



Supercomputers are identifying potential COVID-19 treatments. *Images courtesy of the Russian Academy of Sciences and ORNL.*

At the Intersection of **CAD and CAE**

Mentoring is key to convergence success stories.

BY KENNETH WONG

Look at any standard CAD program and you'll find some form of simulation already integrated. Solid-Works Standard comes with first-pass analysis tools, targeting the early-concept design phase.

Autodesk Inventor comes with dynamic simulation and stress analysis. Solid Edge offers parts, assembly and computational fluid dynamics (CFD) simulations, with varying sophistication at different price points.

From the outset, CAD and simulation appear to be converging, leading engineers to identify and eliminate impractical concepts much earlier in the design process.

"We've gotten to a place where early adopters, innovators and pioneers [in the CAD community] are willing try out simulation-driven design," says Joe Walsh, founder of the membership-based Analysis, Simulation & Systems Engineering Software Strategies (ASSESS) Initiative.

For the trend to become widespread, Walsh believes a key barrier needs to be removed.

"First, the tools need to be easy enough for the designers to use without becoming a simulation expert," Walsh says.

This calls for a delicate balance. The designer-targeted simulation tools must employ terminologies familiar to the design, not a simulation expert. But it must also be extensive enough to tackle a range of linear, nonlinear, fluid flow and thermal flow to be useful.

Don't Water Down CAE

Many standard CAD packages offer some basic simulation tools at no extra cost. This is especially true of vendors that have both CAD and simulation products in their portfolio, such as Autodesk, Dassault Systèmes, Siemens and PTC. Vendors expect the familiarity with simulation inside CAD may increase adoption of higher-end simulation programs. It was a trend that began more than 10 years ago.

The mistake made by some vendors in the early days "was to water down the simulation tools given to the CAD users, because they were worried it might affect sales of their high-end simulation tools," recalls Keith Meintjes, fellow and executive consultant for simulation, CIMdata.

Although simplifying simulation tools to make them accessible for designers is the right approach, "reducing the physics in it" to create a watered-down version is not appropriate, Meintjes warns. Some early attempts to integrate simulation in CAD resulted in tools limited to linear physics, only good for single-component analysis. Such tools may be too limited to be effective enough.

Accessible CAE

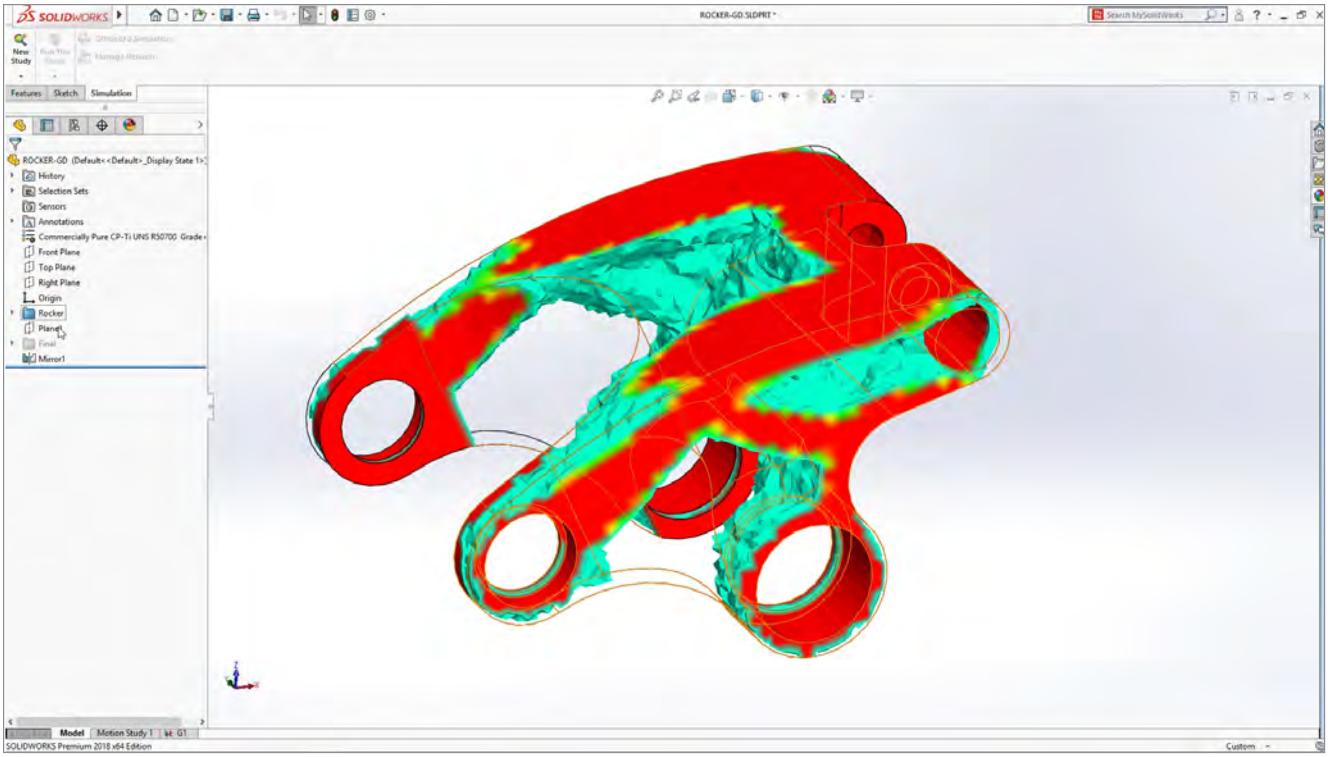
The barrier to entry to CAE can be lowered by programming and automating decisions that the designers are unequipped to make, such as mesh type or coarseness, Walsh points out. It could be further lowered by careful assessment of the terminology used in the simulation interface, he adds.

"Most of the designers design geometry; they do not design the function of a product," he points out. "For them, loading and boundary conditions are unfamiliar terms."

This issue, however, may not be solved just by revamping the user interface. It may involve training designers to describe products functions and physics in software-calculable values.

"We're making progress in that front, but we're not there yet," Walsh says.

"You might find that, in some companies, many CAD



SolidWorks' flagship mechanical CAD program includes simulation tools in its modeling environment.
Image courtesy of SolidWorks.

operators have a two-year associate degree, but they may not be engineers," warns Meintjes. "So they might not understand what load cases are, might not know what a von Mises stress is."

Standard simulation tools usually display analysis results, such as von Mises stress, in color-coded regions. To the untrained eye, they may be impossible to interpret, making them utterly meaningless.

Tailor-made Simulation

One effective method is purpose-built simulation (for example, a CFD simulator for valves or a fan blade stress analysis program), which reduces the choices down to a few geometry parameters.

These app-style simulations are a phenomenon of the cloud-powered on-demand commerce. Examples can be found in online simulation portals, such as Simulation Hub, which offers various simulation apps to subscribers.

Multiphysics simulation software maker COMSOL is among those betting on this trend. Accordingly, it provides the App Builder function, which allows experts to create purpose-built simulation apps and publish them for wider use.

Though easy to learn and master, these apps are also highly restricted in usage. Unlike general-purpose simulation software, the user cannot repurpose a CFD simulator for valves to run airflow analysis on a race car, for example. It can only be used to test and verify a single scenario with a broad range of variables.

Mentors Needed

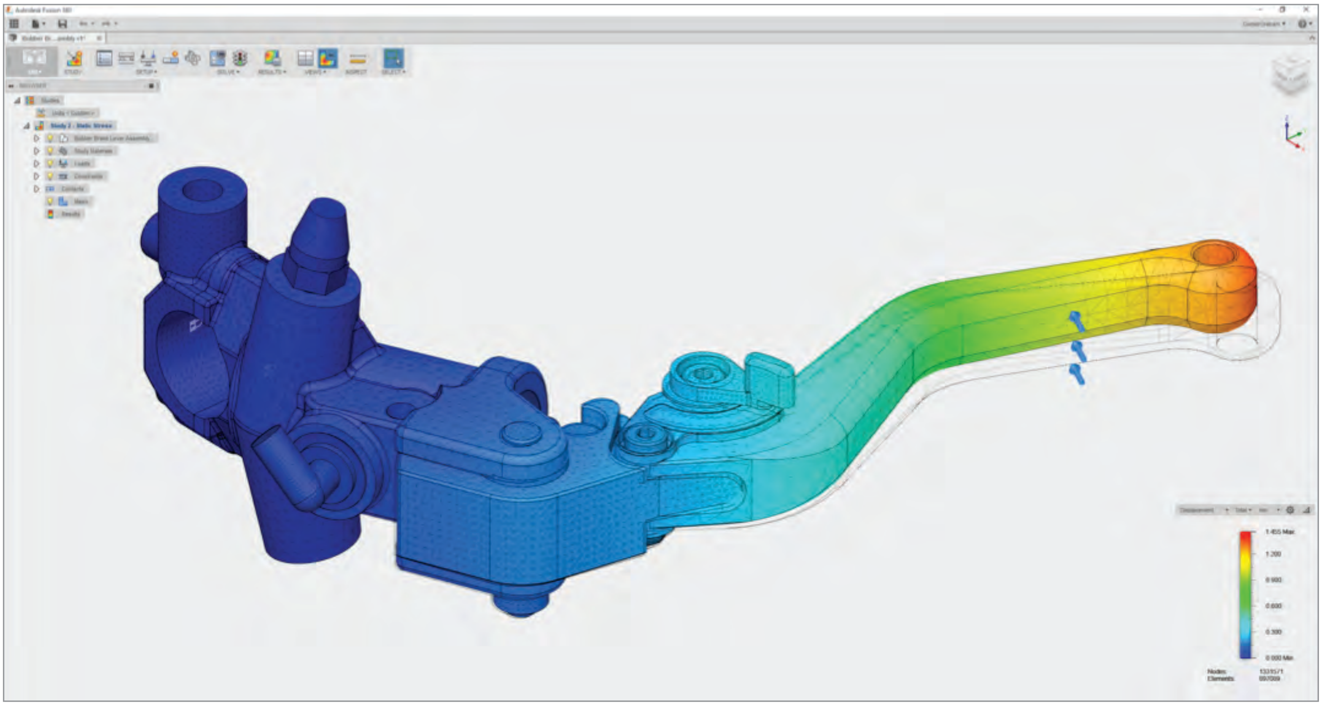
The success stories Meintjes have seen are where "the company made the CAE expert responsible for the success of the CAD designer," he recalls. "In these cases, the CAE experts are often the ones that provide the load case values, and they usually review what the designers did."

This formula, he notes, usually leads to first-time design concepts that are highly likely to succeed. There are encouraging signs that the CAD-CAE bond is getting stronger.

"The designers are getting mentoring from CAE experts more, and the tools are getting easier to use," Meintjes says.

Specialization in different types of simulation may also help CAD designers become better at simulation.

"Some people design wheels, some design axles and some design brakes, for example. Over time, they learn to apply different load cases to the same scenario and de-



Mainstream CAD program Autodesk Inventor, shown here, has integrated many simulation features into its modeling environment. *Image courtesy of Autodesk.*

"The question is not whether we should or shouldn't. The question is how to do it. Simulation tools are best used early in the process. That's when you have the freedom to explore various design options."

—Keith Meintjes, fellow and executive consultant for simulation, CIMdata

velop the knowledge to design ways to deflect stresses," Meintjes adds.

Benefits

Embedding simulation tools in CAD has two clear benefits, Walsh observes. First, it encourages the designer to use simulation early in the design process. Second, it's within the designer's familiar CAD environment, which makes simulation easier for the designer to embrace.

"The question is not whether we should or shouldn't. The question is how to do it," he says.

"Simulation tools are best used early in the process," Meintjes notes. "That's when you have the freedom to explore various design options."

The first-level simulation conducted by the design engineer doesn't eliminate the need for input from a simulation expert, Walsh warns. The first-stage simulation is only to ensure that the ones sent to the expert for verification are "more likely to succeed than fail." **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.*

MORE INFO

- **ASSESS:** ASSESSInitiative.com
- **Autodesk:** Autodesk.com
- **CIMdata:** CIMdata.com
- **COMSOL:** COMSOL.com
- **PTC:** PTC.com
- **Simulation Hub:** SimulationHub.com
- **Solid Edge:** SolidEdge.Siemens.com
- **SolidWorks:** SolidWorks.com

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Simulation Blazes New Innovation Frontier

To advance the tech, vendors are boosting simulation's accessibility to stakeholders and bringing in more functionalities for AI, automation and multidisciplinary modalities.

BY BETH STACKPOLE

On the heels of increasing product complexity, shorter time-to-delivery cycles and rising consumer demand for highly personalized products, simulation is in the spotlight as a critical innovation vector and fixture in the engineering toolbox.

To secure simulation's role in modern-day product design, innovation is happening on two fronts. First, there are myriad efforts to democratize simulation, making it easier for the average engineer to routinely tap sophisticated analysis capabilities as part of their core design environment without the need for cumbersome file translations, extensive meshing and a reliance on experts to refine and advance the models.

Second, plenty of efforts are underway to boost the rigor and breadth of advanced simulation. Multidisciplinary capabilities, real-time simulation, automation and infusions of artificial intelligence (AI) and machine learning are underpinning a new wave of simulation solutions designed to power up next-generation products in development hotspots like autonomous vehicles, electrification and 5G.

Although not all activity is new, the pace of innovation has stepped up, and engineers seem hungry to get on board and embrace more widespread use of analysis tools.

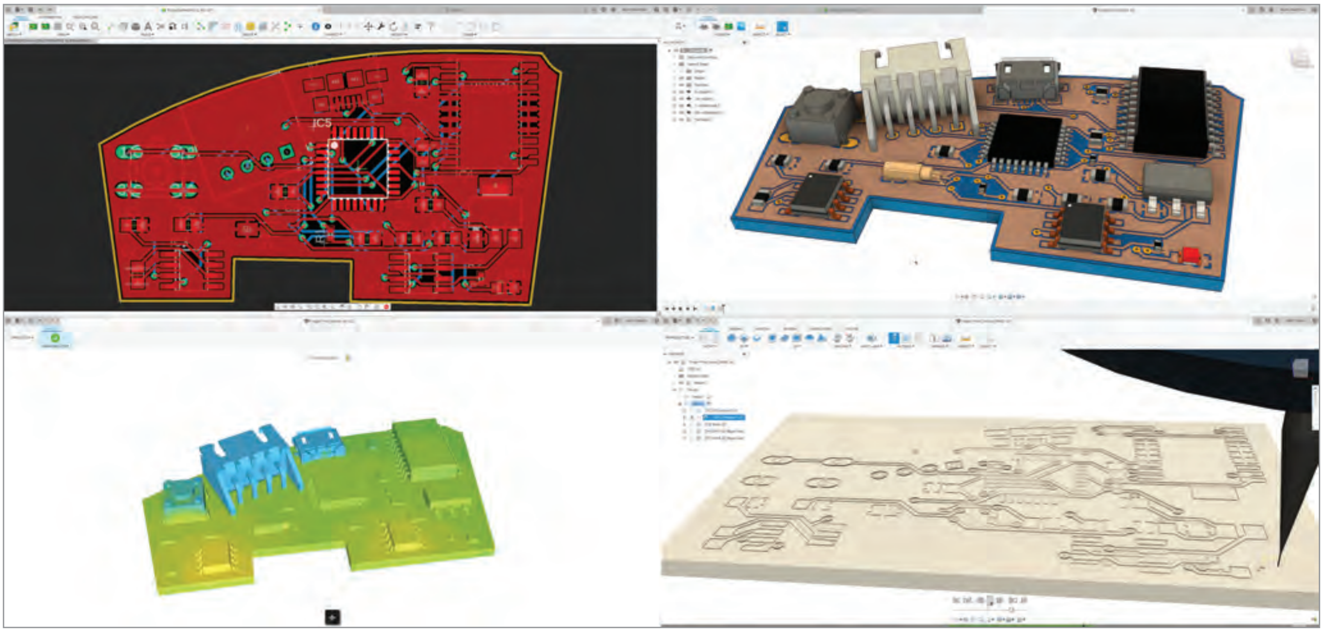
"Simulation, despite our best efforts, hasn't permeated the everyday design engineering ranks as well as we would have liked—that is finally going to change," says Brian Thompson, divisional vice president for PTC's Creo CAD business. "The biggest innovation we see relates to the ability to make simulation easier and simpler for the everyday engineer. It's less about pushing the boundaries of what you can simulate with new techniques or brute force computational technologies."

The GPU-based ANSYS Discovery Live delivers real-time insights into how design changes will impact simulations. *Image courtesy of ANSYS.*

Simulation Simplified

Much of the current simulation innovation is focused on transforming what has historically been complex technology for experts into a toolset that is usable and accessible for mainstream engineers. The so-called "democratization" of simulation has been underway for some time, but recent technology advances are finally making good on the promises.

Today, it's common to see basic analysis capabilities covering areas like finite element analysis (FEA) and computational fluid dynamics (CFD) folded into popular CAD and design tool environments. At the same time, a growing number of products put far more sophisticated and highly specialized simulation func-



Autodesk's electronics cooling workflow delivered as part of Fusion 360 aims to reduce the friction associated with simulation workflows. *Image courtesy of Autodesk.*

tionality well within reach of mainstream engineers typically as integrated extensions.

Autodesk is addressing the problem and removing much of the work associated with preparing CAD geometries for simulation and moving models between design platforms. The company now offers a CFD-based electronics cooling workflow directly inside Fusion 360, and officials say there will be additional, similar streamlined workflows to come.

PTC has continued to build in an array of simulation capabilities into its core Creo CAD platform, making FEA-type structural, thermal and vibration analysis solutions available within the familiar Creo user interface.

Through a partnership, PTC has gone further with Creo Simulation Live powered by ANSYS. The tool positions simulation as a real-time feedback mechanism for in-progress designs as part of the regular upfront design workflow, not just as a late-stage tool for validation. At any point in a Creo workflow, engineers can set specific temperature or thermal loads, for example, and the software delivers analysis-enabled feedback that steers design exploration and drives the iterative process.

"Half the problem associated with simulation is that engineers have to move data from the design environment to the analyst environment, which creates a loop of continuity that is difficult to maintain and manage," Thompson says. "Now simulation is getting easier to use and so fast, design engineers can use it as part of their everyday workflow."

The ANSYS view of spreading simulation use is not just about making it easier and more accessible to non-experts—it also involves making simulation use more pervasive across all engineering stakeholders and throughout each stage of the design process.

"Simulation used to be a capability only a handful of top analysts in a company would engage in to determine how a physical device might work or how fluid would flow through a structure," explains Larry Williams, ANSYS' director of technology. "Over the last few years, we've been driving the idea of more pervasive simulation. Instead of simulation being a scarce resource only available to [select users in] big enterprise industrial product manufacturers, it's now a more central part of the workflow."

ANSYS is focused on numerous areas to meet this goal. It is leveraging automation, streamlined user interfaces and tools like Discovery Live to eliminate complexities associated with simulation use and promote more widespread use of analysis tools in the upfront design process. It is also taking a multiphysics approach to extending its analysis portfolio.

"In order to be pervasive, you have to be comprehensive—to be true to life means you need to include more than one kind of simulation," Williams says.

Consider a biomedical application involving simulation of the human heart; Williams notes it would require a range of physics to perform a realistic simulation, including electrical signal, structural and material modalities.

COMSOL is also pushing hard on multiphysics innovations at an expert level in highly specialized areas such as autonomous vehicles, high-frequency electromagnetics and lithium-ion battery modeling. But the company also is making multiphysics capabilities accessible to non-experts. Key to that effort is Application Builder, a tool that lets simulation experts with years of experience create easy-to-use applications based on their simulations.

With Application Builder, multiphysics expertise and models that were historically the domain of Ph.D. experts can be made available to a much wider audience. This includes use by engineers as part of their upfront design exploration or for non-engineering experts like sales and marketing people who can leverage the apps to more effectively communicate product development choices and performance.

At Harman International, a library of COMSOL apps created with Application Builder is being leveraged by various engineering groups to predict loudspeaker performance with various configurations under different conditions. By democratizing simulation via the COMSOL apps, simulation experts are then freed up to focus on other, higher value projects, including work the company is doing in virtual reality.

Volkswagen Kassel is using COMSOL Application Builder capabilities to let non-experts in mechanical simulations predict stresses in rotors. The apps help increase product quality by automating the lengthy model creation process as well as standardizing models and results, says Marie Hermanns, one of the simulation experts at VW Kassel.

"With a few clicks of a mouse, they can make single physics or even multiphysics available to people who have never touched simulation because they don't have expertise or time to dig into that area," explains Bjorn Sjodin, COMSOL's vice president of product management.

It also prevents the simulation experts from becoming bottlenecks in the development process.

"It's inefficient for the engineer to go to the expert over and over again if they are changing a parameter," Sjodin explains. "[With COMSOL Apps] if they change the width or thickness of something, they can run a simulation and get results immediately without bothering a simulation expert. It makes for a completely new way of working with simulation."

Virtual Reality Meets Simulation

Melding virtual reality (VR) capabilities with simulation is another way to frontload the engineering process with insights gleaned from analysis-led design. Siemens Digital Industries Software is embedding collaborative VR capabilities in its STAR-CCM+ environment to help engineers to this.

Siemens has been offering VR functionality as part of its simulation portfolio, but more recently introduced Collaborative Virtual Reality, which allows dispersed teams to interact in the same immersive environment in real time. This allows for guided tours of products in progress as well as the ability to tap into expert knowledge for feedback on design decisions as well as on building, refining and reviewing mesh strategies and digital twins.

VR is also enhancing simulation workflows in COMSOL's lineup. COMSOL now supports GL Transmission Format (gITF) files, a new standard promoted by the Khronos Group for sharing 3D scenes and models between programs. This allows COMSOL Multiphysics users to export simulations as gITF files, enabling a more intuitive way to present results.

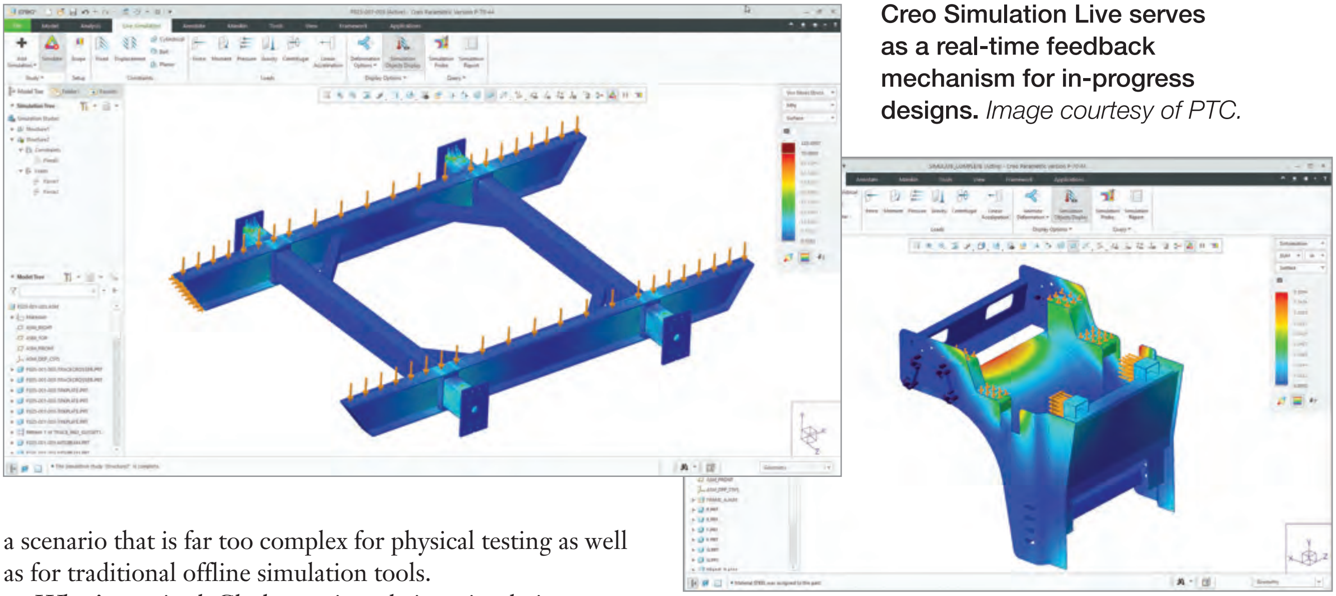
Simcenter STAR-CCM+ has collaborative VR capabilities that help teams across the globe effectively communicate simulation-driven design results. *Image courtesy of Siemens Digital Software Industries.*

"[gITF support] allows you [to] present simulation results to customers that are easier to grasp in a real-world context," Sjodin says. "If you can insert a colorful plot representing stress temperatures or fluid flow into a real-world environment like a factory in context, it's easier to explain the results of simulation to a wider audience."

Real-Time Simulation and AI

Beyond simulating individual components or subsystems, the trend toward model-based engineering is driving a need for operational-level simulation so product designs can be evaluated in the context of their operating location, according to Arnold Free, chief innovation officer at CM Labs, a provider of simulators and simulation software targeting automotive and industrial equipment use cases.

Consider the example of cars with lane-keeping or even autonomous capabilities, where you need to gather mountains of test data to train models—



Creo Simulation Live serves as a real-time feedback mechanism for in-progress designs. *Image courtesy of PTC.*

a scenario that is far too complex for physical testing as well as for traditional offline simulation tools.

What's required, Clark says, is real-time simulation capabilities coupled with AI and machine learning functionality.

"Real-time simulation is really important to training autonomous systems," Free says. "It's not enough to build a system model; you need to be able to take that model and test it in snow and icy conditions."

Generative design is another emerging area that applies simulation, AI and machine learning techniques to drive what-if scenarios that help engineers make design decisions more quickly.

As opposed to the traditional workflow of applying simulation to determine how to make a potential design lighter or pinpoint and address structural integrity issues, generative design leverages AI techniques to devise a range of possibilities based on specific design parameters, facilitating trade-off studies and greatly accelerating the process.

"Fully-integrated generative design is another beachhead in the front on the democratization of simulation," says PTC's Thompson. "It's simulation for building design alternatives faster and more efficiently than a design engineer could do on their own."

Creo 7.0 incorporates generative design functionality based on the Frustrum technology that PTC acquired in November 2018.

Process Integration and Automation

In addition to making simulation capabilities more accessible to mainstream engineers, companies like ANSYS and Aras contend it's necessary to make simulation knowledge available to the broader enterprise, not just keep it tucked away within engineering silos.

With platforms like ANSYS Minerva, powered by ANSYS, organizations can secure and manage simulation data across the greater enterprise. They can also tap into process automation capabilities designed to establish optimized simulation workflows and promote widespread sharing of simulation assets across departments proper through governance.

ANSYS' Williams contends these kinds of enterprise structures, which are common for mainstream business systems, can help establish simulation as an enterprise-wide business intelligence capability. This way, organizations can connect simulation and optimization to their larger product development lifecycle processes—a key tenet for making simulation use pervasive, he says.

"You advance simulation by making it a business-level decision support and knowledge management system," Williams contends. "It can be integrated and used across the organization much like PLM." **DE**

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

→ MORE INFO

- **ANSYS:** ANSYS.com
- **Aras:** Aras.com
- **CM Labs:** CM-Labs.com
- **COMSOL:** COMSOL.com
- **PTC:** PTC.com
- **Siemens Digital Industries Software:** SW.Siemens.com

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GPU-Driven Engineering

Mainstream engineering technology embraces shift to GPU-based real-time rendering.

BY RANDALL S. NEWTON

For many years rendering and visualization were a sideshow for CAD and simulation. Usually, a visualization specialist did these tasks primarily for client review and C-suite presentations. As technology advanced, however, realistic views became more incorporated into product development workflow. Most of the change was due to exponential growth in the power of graphics processing units (GPUs), which gained additional processing power at a much higher rate than CPUs.

The uneven rise in processing power keeps changing processes and workflows, from initial design to final manufacturing. Not only can mainstream CAD applications such as AutoCAD and SolidWorks take advantage of real-time rendering, but new uses for CAD and simulation data are popping up, including virtual reality (VR) review sessions.

These changes are fundamentally rewriting business plans as well as engineering workflows. For example, software vendor Luxion has specialized in rendering technology for product design since 2003. Its primary product is KeyShot, widely used by product designers and architects. Co-founder Henrik Wann Jensen was presented with a Scientific and Technical Academy Award for his pioneering work on rendering as used in cinema. For years, Jensen insisted the CPU was the best environment for rendering.

All that changed in July 2019 when Luxion announced it would support the NVIDIA RTX platform for real-time ray tracing, a key rendering technology.

"Our development team was able to quickly show KeyShot with GPU acceleration and [show] where performance could be gained, which further convinced us to move forward with support for NVIDIA RTX," said Jensen during the announcement.

Today the two largest vendors of GPU technology—NVIDIA and AMD—are both finding a fast-growing market for using real-time rendering in product development workflows. These changes are happening across all levels of engineering technology. Mainstream applications for engineering design and simulation are reaping benefits not possible only a year ago.

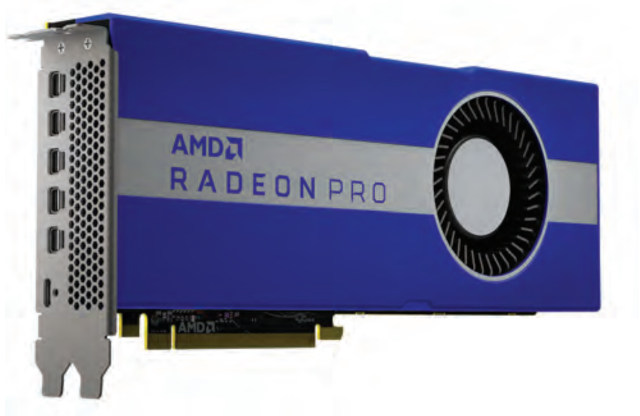
The One-Thread Bottleneck

Today's most popular CAD and simulation applications were written in an era when single-threaded performance was the norm because it was the only option.

This advice to customers from boutique workstation vendor Puget Systems' website has been typical for years: "Only 3D models require anything more than a basic GPU... In most situations, the faster the video card the better the performance you will get when working with a 3D model."

Now vendors are working to rewrite engineering tools to adapt to the rise of powerful GPUs.

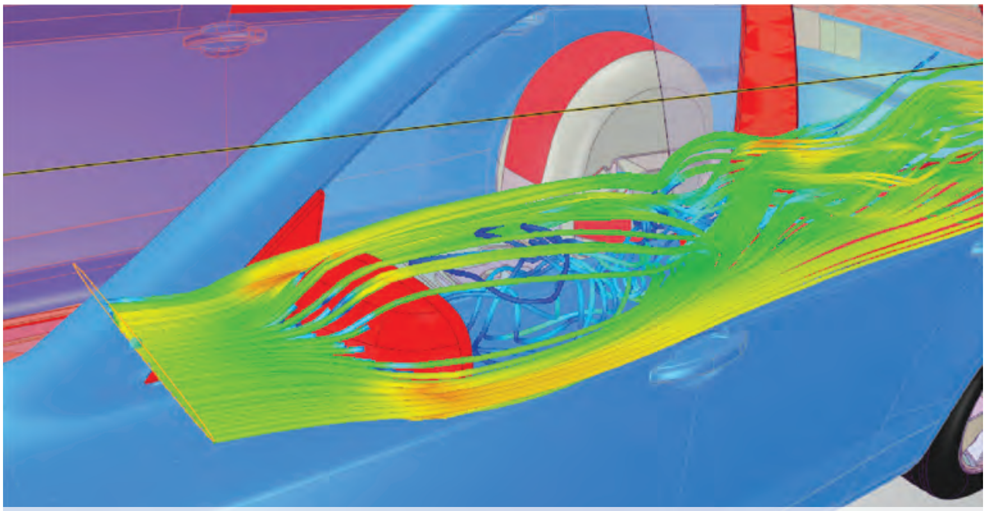
"Up until recently, mainstream engineering tools were all CPU-bound on single threads," notes Andrew Rink, a senior member of the marketing team at NVIDIA. "But now designers and engineers use multiple design tools, and there are new capabilities that require much more graph-



The new AMD Radeon Pro W5500 can render complex simulations and output to virtual reality at a suggested retail price of $399. *Image courtesy of AMD.*

ics acceleration. Someone might be using AutoCAD but want to drop the model into VR or use a physically based rendering tool. This completely changes the dynamic. If someone is thinking about real-time simulation or VR, they need a higher-level GPU."

"Throughout all design work, we are seeing two trends," says AMD's Glen Matthews, senior manager of product management for workstation graphics. "VR/AR is one. From a graphics standpoint, VR is a little more intense. The other is rendering within design; it shortens the prototype cycle. Both trends are about using visualization to design products faster."



In late 2018 ANSYS and NVIDIA shook the engineering community with the introduction of ANSYS Discovery Live running real-time simulation on NVIDIA GPUs. Today a wider variety of products at mainstream price points are also achieving these capabilities. *Image courtesy of NVIDA.*

Revolutionary Workflow

Dell is noticing two trends in how engineers are using their workstations, says Chris Ramirez, Dell's strategic alliances manager for manufacturing and construction. There is an evolutionary trend, where engineers are not changing how they work, but where they do the work. "We are now able to pack enough performance into our thin and light mobile workstations," Ramirez says. "The user is changing the where, not the type of work being done."

The second trend is revolutionary workflow, not evolutionary. "There are forms of engineering work that didn't exist 10 years ago," Ramirez says. "Visualization of design in VR and democratization of simulation are really interesting topics that can drive discussions around GPUs."

NVIDIA's Rink points to changes at SolidWorks as an example of revolutionary change. The add-on product SolidWorks Visualize Professional now does more than serve as a "camera" for product images. It can serve as a physics simulation engine on models, and it brings real-time realistic viewing to large models.

"Large assemblies are now a key consideration," notes Rink. "Fundamentally, the big boost is no reduction in level of detail when working with large models. These are exponential graphics gains, not linear. That's a big change."

This level of improved graphics in SolidWorks currently requires RTX technology found in newer NVIDIA GPUs. For many users, this change is an inflection point. "If you were using an entry-level GPU before, maybe now is the time to move up," says Rink.

Pervasive Simulation

Since the dawn of computer-aided engineering, the workflow required product design models be sent to a simulation expert. These experts were the ones with the more powerful workstations—or high-performance clusters. At most companies, the analysis review was a bottleneck in workflow.

Now both the traditional CAD vendors and the simulation-focused software companies are creating pervasive simulation technology that is fast enough and simple enough for non-experts to use.

"A designer can say to an artist, 'move the fan,'" notes Rink. "This doesn't skip full simulation at the end of design, but it does connect the silos between design and simulation." Experts are now getting much more refined models and can speed up final simulation processes.

Generative design is another tool making a difference in the design and simulation process, says Brian Frank, a senior product manager in Autodesk's Fusion 360 group. "The biggest use of GPUs and Fusion today is generative design." Because Fusion 360 is hosted in the cloud, the local user is not required to have a powerful GPU. Instead, they can get the GPU power they need from the cloud. "We leverage the right compute resources for the project," Frank says.

Dell's Ramirez sees similar trends. "There is a desire for engineers and designers to work untethered to the desk. There is a transition to more mobiles as they become more powerful." Both NVIDIA and AMD have mobile versions of most GPU products.

"A KeyShot engineer has historically been CPU only," Ramirez notes. "A Dell customer who makes motorcycles says rendering times have dropped 30 times using GPU-based rendering. We will see more work moving mobile, and those who did it on big mobiles are moving to thinner devices as the technology minaturizes."

Ramirez says Dell now has three areas of R&D focus for its engineering customers: intelligent performance, mission-critical reliability and immersive productivity. "Everything we do falls under one of these three areas or it doesn't get funded."

As the smaller company in the GPU duopoly, AMD sees the same trends in using GPU technology to enhance or rewrite design workflows. It is also using key product differences as it helps customers update their systems.

"Our new 7nm architecture consumes less power on the GPU," says AMD's Matthews. The software driving the GPU can adjust to changing requirements on the fly, which reduces the electricity load without affecting performance.

AMD sees "remoting" as a growing trend in engineering, as more companies of all sizes combine a high-powered workstation with a remote connection.

"The office workstation can be high powered and the user can pull up models on an iPad away from the office with nominal loss of performance," notes Antoine Reymond, AMD's senior industry executive for design and manufacturing.

"From our data, 70 percent of knowledge workers—which includes designers—are regularly working from home," adds Reymond. "Our job in this space is to remove unknowns. We don't expect them to be graphics experts, so we remove the bottlenecks as best we can. It is a stability and quality issue."

Upfront simulation in design and VR rendering for design review place differing demands on the GPU, says Reymond, but designers have one thing in common. "They all want better rendering, a better way to experience the product."

AMD has responded to the surging interest in VR for engineering by developing tetherless solutions. "VR is more widespread in enterprise than in mainstream engineering, but adoption is happening. VR in the professional space is a real thing, not a fad," says Reymond.

Workstation Trend Line

The new power GPUs bring to CAD and simulation is driving radical changes in workstation configuration, say the vendors we interviewed. The evolution of more cores in GPUs and CPUs means high-end performance is migrating to the mid-range and entry-level workstations.

"Workstations don't have major changes," notes AMD's Reymond. "The regular changes as models evolve are helping workstations be more accessible to great design experiences."

This is an example of normal product evolution meeting new needs. "Simulation now has a larger [market] as a result," he notes. Most of the more available simulation horsepower to mainstream users comes in the form of structural analysis, Reymond adds. "The key applications have been tested for both pre- and post-processing. The hardware is keeping up with mainstream simulation advancements."

The result is an "increase in where the average designer can get the understanding of the simulation," Reymond says. "Not necessarily the most accurate, but they can get the trend right, and know the stresses."

Reymond sees the long-term result of this new wave of pervasive simulation leading to "new design experiences and new methods to improve simulation workflow."

The Move to Virtual Reality

CAD and simulation vendors are making it easier to move engineering content into VR. For example, both SolidWorks Visualize and eDrawings now include rendering models for use in VR. Dell's Ramirez says an increasing number of their workstation customers "are at the point of understanding the sign-off process in VR." Collaboration in VR is also growing.

Dell now offers a bundle that combines the Dell Precision 7740 mobile workstation with an AMD Radeon Pro WX7130, a Wi-Fi router, and the HTC Vive professional VR headset. When used in conjunction with a CAD or simulation product and the use of Vive Focus and AMD Relive software, it becomes possible to take a VR experience off-site.

"With no tether, the user can roam the distance of the router signal, and experience the design in full clarity at full scale. No backpack, no tether, no desktop computer," says Ramirez.

"This is a revolutionary workflow, using VR in design and not just for review. Now add pervasive simulation driven by GPUs," Ramirez says, and it is a game changer.

Know More, See More, Do More

Simulation-led design and real-time rendering are capturing attention because the benefits are obvious. Time and cost savings compared with physical testing are a big one. The ability to quickly determine the best initial design to develop and the freedom to digitally experiment with "what-if" scenarios are also advantages.

The current environment of complex product design and development that includes smart products, autonomous vehicles, electric powertrains and digital twins is moving simulation further forward in the design process.

Mainstream CAD applications are now at the point where they can deliver on these benefits, thanks to the recent innovations in GPU technology and the willingness of software vendors to adapt to these advancements. DE

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→ MORE INFO

- **AMD:** AMD.com
- **Autodesk:** Autodesk.com
- **Dell:** Dell.com
- **Luxion:** Luxion.com
- **NVIDIA:** NVIDIA.com

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AI Software Sees Exponential Growth

More organizations are leveraging the power of artificial intelligence in engineering design.

BY JIM ROMEO

Artificial intelligence (AI) is pervasive and changing the entire landscape of engineering design. The technology is further being incorporated into generative design capabilities and adaptive user interfaces and predictive analytics. It helps provide features that can speed up engineering design and help engineers make better decisions faster.

The global AI software mark is on track to grow five-fold and reach $126 billion by 2025, according to data gathered by LearnBonds. The firm's research to date shows that one in five workers in a non-routine job will rely on AI for at least part of their role soon, noting that the growing volume and complexity of business data have forced many firms across a variety of industries to adopt AI to boost growth.

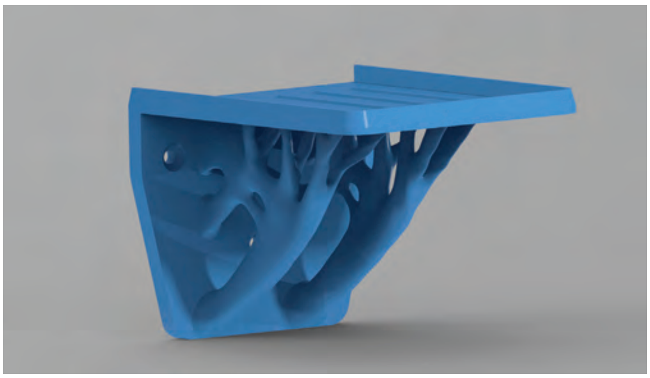
The research notes that AI has already begun to "revolutionize" industries globally, helping businesses to improve their efficiency, quality and speed. With the help of automation, deep learning and natural-language processing, LearnBonds indicates that AI can help streamline business operations and decision-making and predict trends.

Generative Design for Greater Efficiency

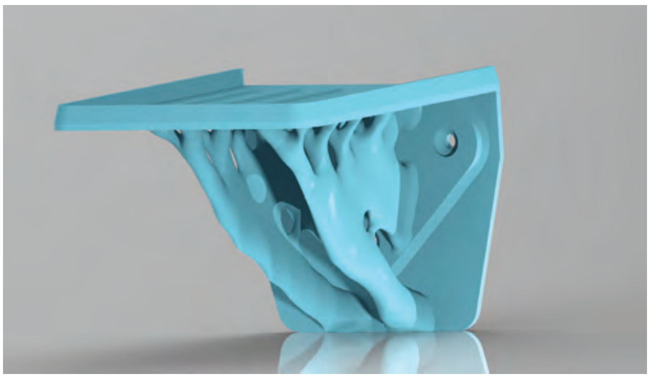
Streamlining business operations, making better decisions and predicting outcomes are all supported in generative design—a design process where iterations are created and analyzed virtually, using machine learning, deep learning and the deeper capabilities of AI.

Use of AI and deep learning, and subsequent integration into engineering design and simulation software, has been groundbreaking, according to Jesse Coors-Blankenship, senior vice president of technology, advanced development at PTC.

"With generative design, manufacturers can now drive workforce productivity by proactively addressing the skills gap," Coors-Blankenship says. "An entry-level mechanical engineer can now create a part through generative design



With generative design, manufacturers can now drive workforce productivity by proactively addressing the skills gap. *Image courtesy of PTC.*



Generative design with AI is a groundbreaking new technology and approach to design. Expect to see the technology mature greatly over the years. *Image courtesy of PTC.*


New data sets with AI and human intelligence are changing the game. *Image courtesy of Carbon Lighthouse.*

without extensive knowledge of manufacturing processes that a senior engineer would have from years in the field.

By approaching part ideation and creation through these new techniques, manufacturers can make smarter business decisions, according to Blankenship.

He notes that AI will afford engineers the ability to best execute generative designs when striving to achieve design objectives. Generative design with AI also allows engineers to explore traditional and advanced manufacturing techniques to get differentiated products, bringing value to productivity and to competitive differentiation.

"With generative [design], engineers can take advantage of advanced manufacturing techniques and embrace additive manufacturing," Coors-Blankenship adds.

A Simulation Evolution and Revolution

Incorporating AI and machine learning (ML) technologies—including deep learning—into engineering design and simulation software represents a significant evolution for the modeling and simulation industry, enabling highly precise designs to be created faster than ever, according to Prith Banerjee, chief technology officer at ANSYS.

AI- and ML-embedded simulation software delivers a capability that is truly disruptive as the software autonomously learns or teaches itself how to solve complex design problems to deliver highly precise products.

The same applies to the software. He explains that this embedded simulation is also disruptive for designers as it democratizes simulation, opening the door for practically anyone—even engineering novices—to create simulations.

Starting with a basic set of parameters, the software rapidly simulates a product and expedites its path to customers. He emphasizes that this new capability will greatly enhance the user experience for creating better and smarter designs—through four key benefits.

"First, it drastically decreases your workload and boosts your productivity as the software automatically chooses the best simulation solver parameter settings for each job," says Banerjee. "Second, its state-of-the-art inference capabilities produce designs with extraordinary speed, reducing thousands of hours of solving time to just a few minutes.

"Third, it powers generative design as it creates countless product designs and selects the top designs for consideration—empowering you to choose the best one for physical prototyping," Banerjee continues. "Lastly, integrated with digital twin data, the software helps you decipher how your product performs and improves simulation accuracy to enhance the design of next-generation assets."

Simulation capabilities are a big deal, a game changer for engineering design and they just keep getting better every year.

Jean-Simon Venne, chief technology officer at BrainBox AI, says his company has proven that data-driven models generate the same level of accuracy as complex simulation models. "More importantly, a data-driven model powered by neural networks will get you the same precision in terms of the simulation prediction but with a lot less effort in term of hours," he says.

In contrast, Venne says it would take a deep learning neural network half a day to do the same. "Due to this, AI will replace a significant amount of digital twin initiatives," he notes. "In addition, once a critical mass of metadata is created, it would become possible to actually generate plan and specifications for a building instead of having an engineer designing them."

With this support for digital twin initiatives and optimization capabilities, AI can bring time savings for engineers and allow them to work on the big picture.

The real benefits of AI and deep learning (DL), according to Tonya Custis, director of AI research for Autodesk, will be time and cost savings derived from "optimizing the combined powers of what computers are good at—ingesting lots of data, running lots of simulations, finding patterns in data, optimizing for physical, legal and cost constraints—and what people are good at—designing objects to fit a purpose, building things, seeing the big picture, making decisions."

She says AI will help engineers leverage available data to make smarter decisions, additionally enabling an automatic and seamless way to incorporate past decisions, learnings, observations and outcomes back into the design process. By revising AI algorithms with new data as it becomes available, design software will become smarter.

Becoming Smarter

Becoming smarter and using AI to create good things and positive change is what San Francisco-based Carbon Lighthouse does. The company uses AI in its pursuit to help commercial and industrial buildings become carbon neutral, says Brenden Millstein, CEO/co-founder, Carbon Lighthouse.

He says simulation models and software are powerful tools. His firm uses them to simulate building performance and gather data into a simulation engine called CLUES. It allows them to compare predictions to reality.

This is where AI, deep learning and cheap sensors from recent improvements of the Internet of Things (IoT) are of large value. By gathering data from existing buildings, and using AI to make sense of that data, Carbon Lighthouse can dramatically refine CLUES.

The main benefits are primarily from comparing real-life performance to simulation. Millstein says their simulation model helps determine equipment and its suitability for a system.

"Only by comparing predictions with reality can we continue to improve simulation and design, and thankfully [Internet of Things] and AI in combination allow us to do exactly that," Millstein says. "While water-cooled chillers are theoretically more energy efficient than water-source heat pumps, CLUES analysis of our real-world data shows that in actuality water-source heat pumps are more efficient. This is likely due to the complexity of water-cooled chiller systems.

"So even though the simulation software is accurate to begin with, real life shows equipment is used differently than designed," Millstein continues. "In the 100 million square feet of real estate Carbon Lighthouse has analyzed, these differences are large enough that most buildings would likely have been better off if they had been specified with water-source heat pumps in the first place instead of chillers!"

AI will could replace digital twin initiatives, and once a critical mass of metadata is created, it would become possible to generate plans and specifications for a building instead of having an engineer design them, says Venne. *Image courtesy of BrainBox.*

The Optimistic Future of Engineering Design

Custis argues that AI will ultimately augment, not replace, engineers, allowing them to make them better, faster and more informed design decisions. "AI will automate repetitive, time-consuming and low-level tasks, while giving engineers and designers more time to focus on the human and aesthetic elements of design," she adds.

Custis reminds organizations of an untold risk about AI and DL: not embracing it. The tools and technology are there. Incorporating it means change. It means learning and embracing the technology and putting it to use in your design practices and in the technology and software tools you use.

Doing nothing is a lost opportunity; innovative companies embrace simulation to reduce product development and systems risk, and allow AI to figure out solutions to problems that the human mind does not have the horsepower to figure out.

"The real game changer, in a negative light, would be not to incorporate AI and DL technologies into engineering design and simulation software," Custis says. "In five years, we won't be talking about 'AI features' in software—it will just be taken for granted that software includes and is powered by AI and DL. Companies that do not incorporate AI and DL will be left behind and won't be able to compete." DE

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➔ MORE INFO

- **ANSYS:** ANSYS.com
- **Autodesk:** Autodesk.com
- **BrainBox AI:** BrainBoxAI.com
- **Carbon Lighthouse:** CarbonLighthouse.com
- **PTC:** PTC.com

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The Art of **Distortion Compensation**

Automating an essential part in design for additive manufacturing.

BY KENNETH WONG

To those who work on injection-molded parts, distortion compensation is a familiar concept. These engineers learn to adjust their CAD geometry to compensate for the anticipated shrinkage that occurs when the liquid cools down inside the mold.

As more manufacturers explore additive manufacturing (AM), they're quickly learning that the same distortion compensation protocols, but with much greater complexity, play a critical role in design for AM.

Print materials and processes are the two primary factors that determine the nature of the distortion. The added complication in AM is the need for support structures. Certain fixtures must be added to the geometry to keep the part propped up in the print chamber during the print process. Because these supports aren't part of the intended design, they must also be removable.

All these considerations can discourage newbies from taking a stab at AM. But the good news is, many leading AM-specific design software packages have automation tools to help you shape the geometry to fit the intended print process.

Intersection of Machine, Material and Physics

Simulation software maker ANSYS offers the ANSYS Additive Suite, which specifically targets metal AM. Capabilities include thermal simulation, topology optimization, AM process simulation, and geometry editing and modification.

"Distortion compensation is one of the top reasons customers use our ANSYS Additive Suite," says Brent Stucker, director of AM for ANSYS. "The method is always machine- and material-specific. What you are doing is figuring out how the geometry will change during the production process, then modifying the geometry to account for that change using an algorithm."

Stucker explains that, in a typical workflow, the user prints a test part, measures the critical dimensions to ascertain the discrepancies, then uses the data as input for the software to calibrate distortion values.

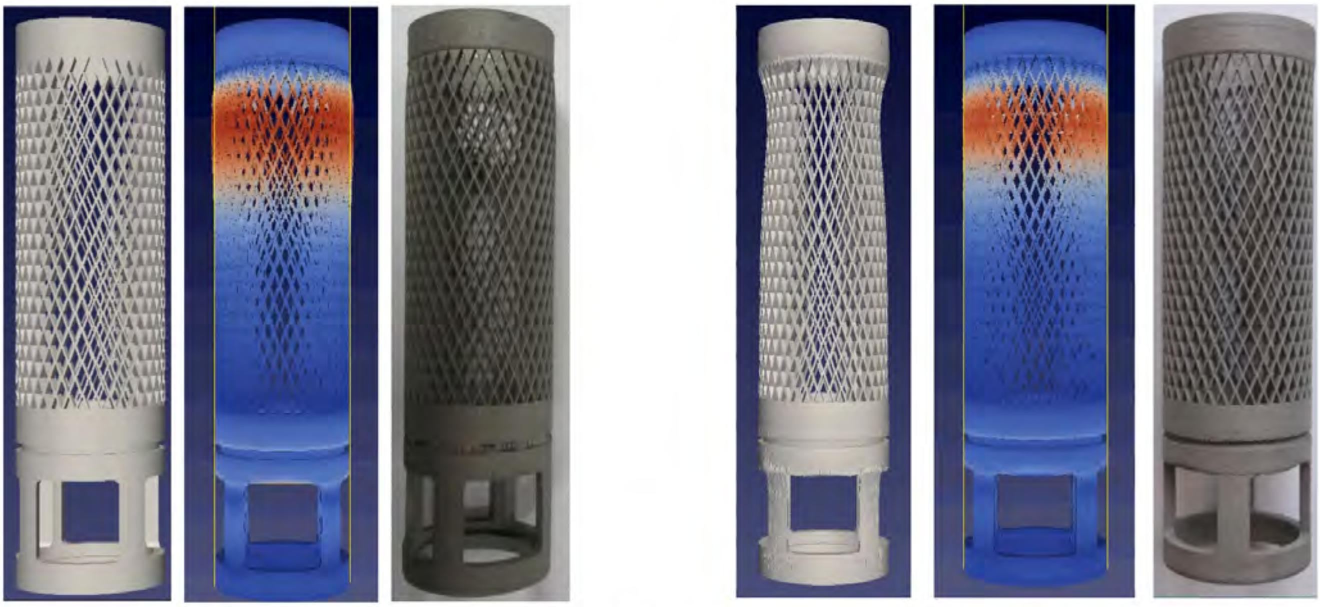
"If you print a reference part with simple geometry, you can measure the differences using a caliper," says Stucker. "For parts with sweeping curves and intricate geometry, eyeballing where to place the caliper might be a problem. That's where scanning is helpful."

As part of its distortion calibration, ANSYS' software incorporates machine behaviors provided by 3D printing system makers, and material characteristics from material suppliers. Accurate distortion prediction is facilitated by the simulation software's ability to digitally recreate the thermo-chemical changes that occur in the print process, based on the data from hardware and material makers.

Non-Uniform Distortion

With 3D printing, the orientation of the part—the way the part sits on the print bed while it's being printed—affects the distortion type. The changes that occur in the Z direction, for instance, are not necessarily the same as what happens in the X or Y direction. This has to do with, in part, the different heating, cooling and compression forces the part endures in different directions based on its position.

"It won't help to simply scale a part uniformly in all directions," says Maoz Barkai, 3DXpert product manager for 3D Systems. "With powder bed printing, the cooling that



With complex structures for 3D printing as shown here, print process simulation and distortion compensation are part of the design process. *Image courtesy of ANSYS.*

happens in the Z direction is offset by the powder buildup during the print process. So you may only need to scale your part in the X and Y direction."

3D Systems offers 3DXpert for SolidWorks, a plug-in to help SolidWorks software users design and simulate parts destined for AM.

"A click of a button in SolidWorks brings your native CAD data directly into 3DXpert for SolidWorks and provides you with an extensive toolset to easily analyze, prepare and optimize your design for additive manufacturing. Once completed, the ready-for-print data can be sent to any printer or back to SolidWorks," the company writes.

As a hardware maker without proprietary simulation technology, 3D Systems uses Amphyon software from its partner Additive Works for process simulation. According to Additive Works, the software focuses on laser beam melting processes commonly used for metal 3D printing.

Cell Growth and AM

AM system maker Desktop Metal's Live Parts software uses morphogenetic principles based on cell distribution to generate suitable AM parts. The company also provides Fabricate software to prepare and print metal AM parts in its office-friendly Studio System hardware.

"In metal, if you use binder jet or powder bed technology, you may end up with the need for post-processing. Typically, you need sintering to transform the printed part into a dense solid metal part, so you need to think about not only the effects of the print process but also the sintering process," explains Andy Roberts, VP of software, Desktop Metal.

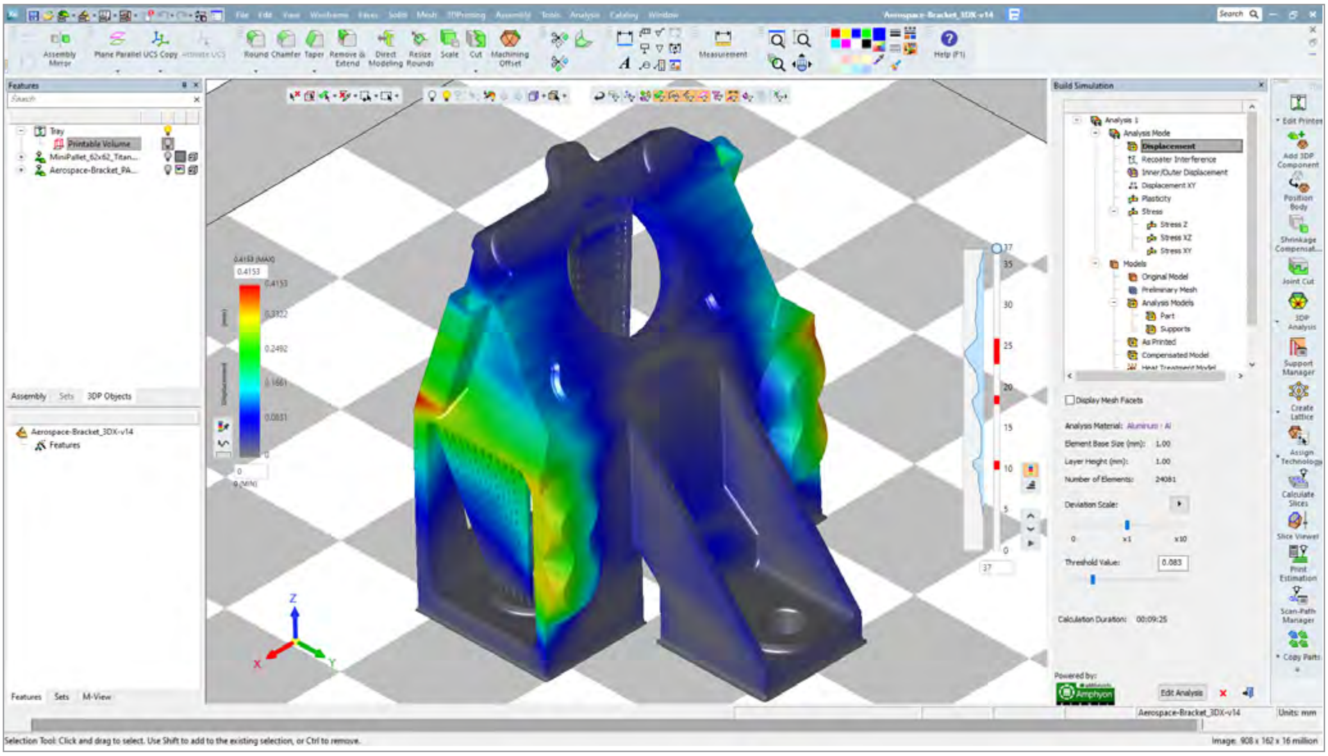
"If you use laser printing, you are essentially baking the part, so there's no need for sintering, but you need to think about the huge temperature gradients the part needs to be subjected to. These affect the shrinkages in non-uniform ways," he adds.

Roberts feels that the intimate knowledge his team has as hardware developers, and the tight integration between Desktop Metal's hardware and software, make their distortion prediction much more reliable.

"We know, for example, exactly how long it takes for the material flowing through the nozzle to stop after you pushed the stop button," he says.

For support structures, Desktop Metal employs a patented system of Separable Supports, introduced in 2018. The system "enables users, for the first time, to print large metal parts with complex geometries that can be easily removed from their support structures by hand or to print metal objects with separable interlocking structures," says Jonah Myerberg, CTO and co-founder of Desktop Metal.

Another potential problem in design for AM, ANSYS' Stucker points out, is blade crash—the collision between the printer's powder handling mechanism and the part itself. "Our software allows you to identify potential blade crashes, a feature other software packages might not have," he says.



The plug-in 3DXpert for SolidWorks lets you analyze and optimize your CAD parts for 3D printing. *Image courtesy of SolidWorks.*

Ultimately, distortion compensation is an algorithm-driven approximation. “With materials that are well-defined and processes that are well understood, we can eliminate 95 to 98 percent of the distortion problems,” says Stucker. “Even with outlier geometry involving anomalies, we’re still eliminating 85 to 95 percent of the issues.”

From Mesh to Parametric

Once the distortion-compensated geometry is printed and verified to satisfy the required specs in form and function, companies should keep an archival copy. Whereas classic CAD programs work in formats defined by mathematics (lines, arcs and parameters), simulation software typically works in mesh models and tessellated geometry.

This is where Stucker feels ANSYS has an advantage over some of its rivals.

“We use our SpaceClaim technology as the translator, so you can easily bring that distortion-compensated model back into your CAD package,” he says.

Different from a mesh model—which is not easily editable in CAD programs—the SpaceClaim-translated model will be editable in standard CAD tools, Stucker points out.

ANSYS acquired SpaceClaim, a direct-modeling software developer, five years ago. The technology is useful for editing a wide range of native CAD geometry without using the original authoring package itself.

“We worked hard on the transition to make it smooth. With our software, we map the changes [distortion compensation] back onto the original CAD model so you can keep that for your record,” says Stucker. **DE**

Editor’s Note: For more on this topic, also check out “Bridging CAD to Additive Manufacturing” in the April issue.

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.*

➔ MORE INFO

- **ANSYS:** ANSYS.com
- **Desktop Metal:** DesktopMetal.com
- **3D Systems:** 3DSystems.com

For more information on this topic, visit DigitalEngineering247.com.

Digital Twin Drives PLM Evolution

Though the foundation for digital twin development, PLM systems still require more functionality and interoperability than ever before.

BY TOM KEVAN

The past few years have brought dramatic changes to product lifecycle management (PLM) platform scope and functionality. These changes are, in part, the result of natural software suite evolution, but a significant part of these developments spring from the rise of digital twin technologies.

The increasing importance of the digital twin has prompted PLM providers and users to rethink the platform's role in product and process development. It is clear that if PLM systems are to play a vital role in future design processes, they must continually adapt to and support emerging digital trends.

In response to digital twin technology demands, the engineering community has started adopting new perspectives on PLM modeling, information storage and integration, and data management (Fig. 1).

As a result, companies deploying digital twin are shaping PLM's evolution by demanding that the developers expand the platforms' scope, modify its architectures and enhance software capabilities.

A Digitization Catalyst

These changes trace their origins to the growing digitization of enterprise and manufacturing systems. Not too long ago, most engineering and manufacturing activities relied on a mix of hardcopy and digital documents to convey engineering data. With the emergence of new manufacturing data format standards and increasingly powerful engineering software, it has become possible to perform many engineering functions using data models instead.

With this foundation, designers and developers have begun to embrace the model-based engineering (MBE) approach. Using this methodology, models rather than documents become the data source for many engineering activities throughout a product's life, and engineers have started to use these models to drive all aspects of the product's operating life.

The complexity that accompanies the digitization of products and manufacturing systems has made the development process even more of a multi-discipline effort. As a result, a fundamental tenant of the MBE approach is that development teams must be able to build a holistic system model to ensure the collaboration of all contributing disciplines.

From Digitization to Digital Twin

The latest manifestation of the digital transformation, digital twin, aggregates data and gives a virtual identity to physical assets. The goal is to leverage a broad variety of information—including the flood of data from the Internet of Things (IoT)—using it to evaluate, develop and monitor the performance of everything from new products to existing manufacturing processes.

The challenge for companies and their engineers lies in moving from theory to reality so that they can extract value from twin technology. This, however, is no small feat.

"[A] Digital twin is not something you buy," says Derek Neiding, engagement director at Razorleaf. "You must configure and tie multiple systems together. You don't do this overnight. It is a progressive process that systematically ties more and more information and systems together until you have a digital twin complete enough for your needs."

The trick is to identify the most effective software tools for the task. Currently, PLM systems seem to be the best platform available for model creation and management. That said, these platforms still fall short in key areas.

The problem is the constraints these systems operate under. Many are tailored for models consisting only of design

Fig. 1: PLM software suites and digital twin development share a tight bond, each influencing the other. To sustain this role, PLM environments will have to continue to respond to engineering demands for advanced modeling and data management functionality. *Image courtesy of Siemens Digital Industries Software.*

specifications, material properties and geometric models found in CAD, CAE and product data management solutions. Plus, conventional simulations can only handle tightly circumscribed problems.

Digital twins, however, represent much more, and are moved beyond a reliance on conventional simulations of geometry. As a result, engineers must seek PLM platforms agile enough to accommodate a broader range of data types and formats and powerful enough to support MBE.

In this context, engineers cannot stress the importance of this new type of model enough. "You need some sort of virtual model on which you can overlay the sensor and performance data that comes back from the field," says Bill Lewis, director of marketing, lifecycle collaboration software, at Siemens Digital Industries Software. "There is a lot of work being done there not just to figure out how you connect those two data but how you marry that with the low-volume data set that is the product record coming from PLM."

Value of the Closed-Loop Digital Twin

The ultimate test of a successful transition from concept to reality is the value digital twin delivers to engineers. Research and experience indicate that companies deploying digital twin begin to reap benefits when they connect the virtual model and the physical product and create a closed-loop digital twin.

Closed-loop digital twins allow customers to simulate and predict the behavior of the physical product in the virtual domain, as well as correlate a product's behavior against its virtual simulation.

"A closed-loop digital twin brings together the entire product lifecycle, so customers can design and manufacture more efficiently and accurately, leveraging real-world conditions to drive design and simulation," says Lewis.

Like so many other aspects of this technology, knowing the destination and getting there are two different things. A look at the market shows that many point solutions create and capture the digital twin dimensions. That said, companies still find it challenging to create a holistic, closed-loop digital twin.

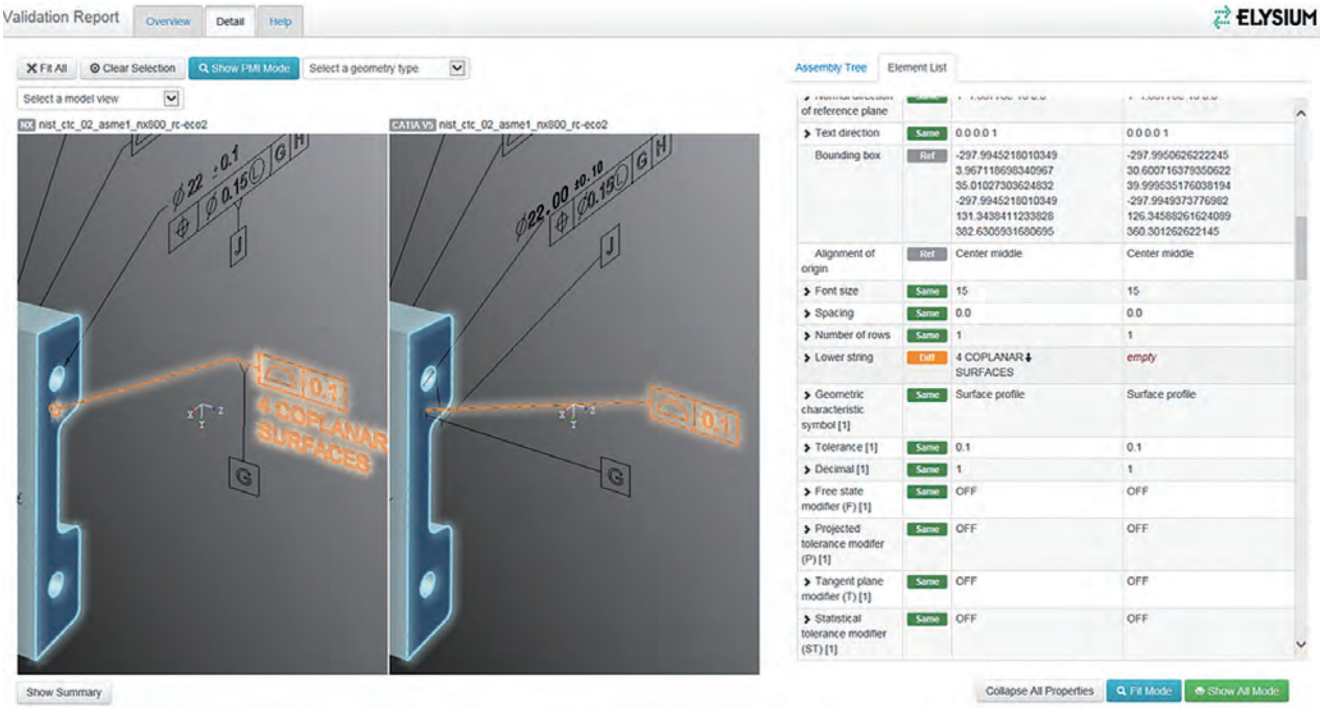


Fig. 2: Shown here is an example of an HTML validation report comparing a Siemens NX model that has been translated into Dassault Systèmes CATIA. The graphics area and the elements list identify a detected difference in which a lower string in NX could not be converted successfully to CATIA. *Image courtesy of Elysium.*

"The best way to bring a closed-loop digital twin together is to invest in a seamless digital thread that can connect product development, manufacturing and real-world performance information," says Lewis.

This requires a PLM system to manage the virtual product development and manufacturing information and then connect it with a high-volume industrial IoT system to collect real-time information from physical products and feed it back to product development and manufacturing.

Gathering the information, however, is only the first step. Companies then need the PLM system to manage the complexity of relationships and processes, as well as perform functions such as configuration and change management (Fig. 2). Some of the more advanced offerings offer solutions to accurately describe and simulate all aspects of the product and process in a multi-domain—mechanical, electrical and software—environment to represent the entire product performance (Fig. 3).

"Enterprises need to establish a broad PLM platform, with tightly integrated authoring and analysis applications—such as CAD and simulation—and complete digital threads to create sustainable, actionable digital twins supported by closed-loop feedback from multiple business and operational domains, that form the basis of the next product iteration," says Ken Amann, executive consultant for CIMdata.

A Single Source of Data

All this raises the question: How has the emergence of digital twin and all its associated technologies affected the way companies and engineers approach PLM? Perhaps one of the greatest shifts lies in the way those deploying digital twin perceive the concept of a single source of truth.

For many years, product data management and PLM software providers talked about creating a single source of the truth. This meant putting all—or as much as possible—product-related managed data into one management system. The rise of digital twin, however, has changed that.

"There is, and will never be, a single source of truth," says Jason Kasper, product marketing manager at Aras. "Going down the path of information centralization is doomed to fail at the start. This is an impossible goal because of the number of systems currently implemented across the lifecycle to support the development, manufacturer and maintenance of a product."

Reacting to the changes required to implement digital twin effectively, engineers and their companies are turning to develop a single, logical source of truth.

Using new and emerging search, aggregation and mashup technologies, PLM systems built on the new approach promise to deliver the requested product- and process-related data regardless of its type or format, the application in which it was created, or the system or repository in which it resides.

This is no small feat when you consider that a digital twin consists of data typically stored in many systems and repositories. These include software packages for requirements management, mechanical CAD, electronic CAD, simulation PDM databases and application lifecycle management, as well as industrial systems like enterprise resource planning and manufacturing execution systems.

Despite the distributed nature of the data repositories, the face of PLM systems supporting this new approach still presents a single access point.

"From the user's perspective, it is a single source of truth even though some or all of it may reside in physically distributed and diverse applications or repositories," says Amann.

Thus, one of the greatest strengths of PLM to support digital twin lies in its ability to access the contents of other data repositories. "There will not be a single system that houses all data related to the digital twin," says Razorleaf's Neiding. "The PLM system needs to be able to reach into other systems and display the data housed there and show the relationships between the data."

In Pursuit of Interoperability

The shifting view of the single source of truth driven by digital twin is causing companies and engineers to look to PLM software suites for greater interoperability with other applications and databases (Fig. 4). Even though PLM vendors continually improve their platforms in this area, problems continue to impede work on digital twins.

"The greatest hurdles in the digital twin-PLM relationship often deal with data interoperability and fault-free reuse of 3D information," says Annalise Suzuki, vice president of technology and engagement at Elysium.

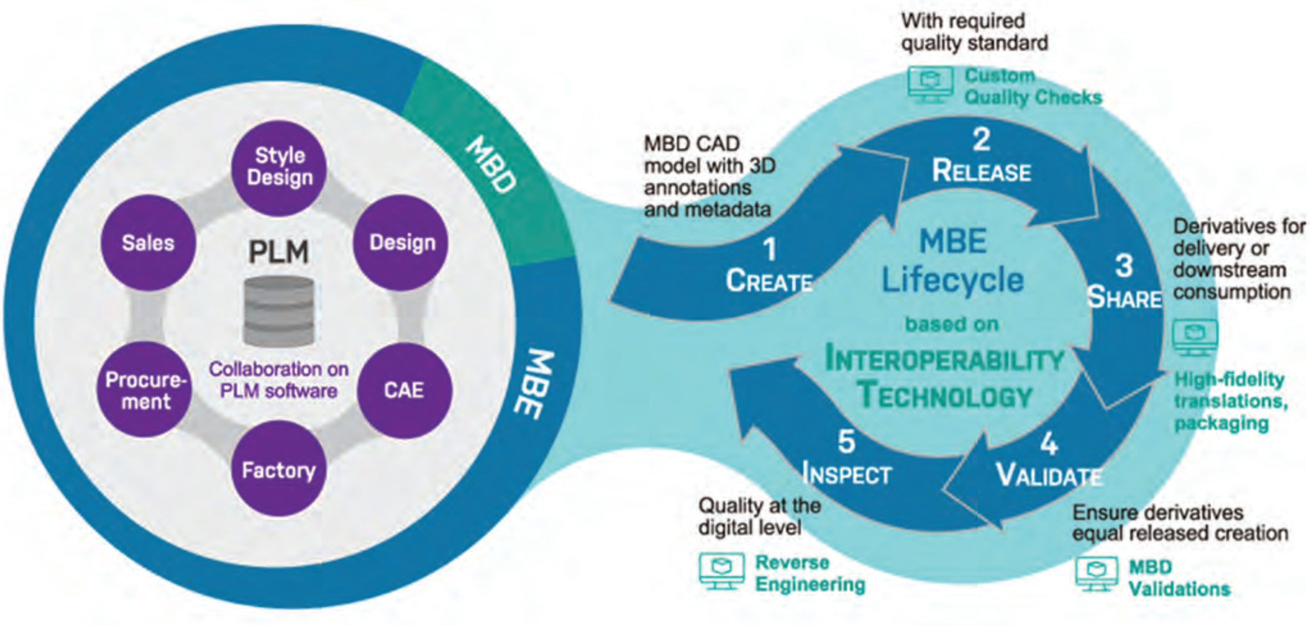
Engineers must contend with problems that occur at the most fundamental levels. "Proprietary file formats and closed systems rank among the most significant obstacles the industry must overcome," says Justin DiNunzio, marketing manager for Siemens Digital Industries Software. "Each island of information becomes a silo of trapped value and impedes the progress of one business function's ability to collaborate with other stakeholders."

Inability to fully collaborate when developing a digital twin creates a gap in the technology's value proposition. The ability to share data among a variety of disciplines seamlessly, with trust—including supplemental 3D translation and validation when necessary—is a key factor in maximizing benefits across the product lifecycle and the ecosystem.

"The value of a digital twin shines when the twin can be re-used across multiple domains," says Suzuki. "If the data cannot be shared across the multitude of lifecycle disciplines seamlessly, with trust, the benefits are suppressed."

To overcome this, direct integrations and mappings between databases must be developed. Often, however, this

Fig. 3: To meet the needs raised by the emergence of digital twin, PLM systems must be able to accurately describe and simulate all aspects of the product in a multi-domain environment. This means incorporating capabilities such as the advanced electronic systems and integrated circuit design tools shown here. *Image courtesy of Siemens Digital Industries Software.*



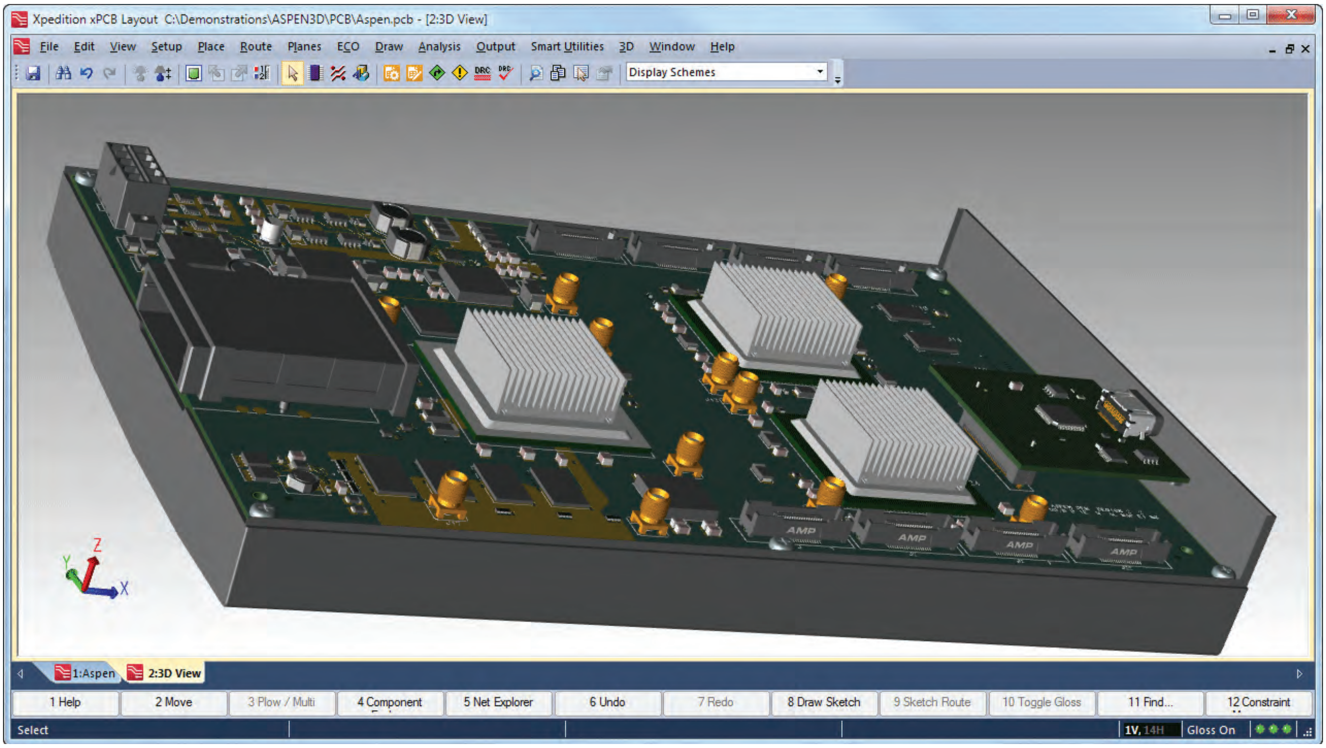


Fig. 4: Sharing digital twin data throughout the entire model-based engineering lifecycle requires strong PLM interoperability among various disciplines, departments and their respective software tools.
Image courtesy of Elysium.

can be a formidable challenge.

Industry leaders, however, hope that open standards—such as ISO 14306 and ISO 15926—can enhance the exchange of technical information between different software solutions within an organization, and also among project stakeholders who must collaborate.

PLM-Digital Twin Partnership's Future

PLM software suites and digital twin development share a tight bond, each one influencing the other, almost in a feedback loop. "PLM platforms provide the foundation and technologies that enable the definition and implementation of digital twins," says Amann.

To sustain this role, PLM environments must continue to respond to engineering demands for advanced modeling and data management functionality. The technology's developers must also vigilantly anticipate and react to changes in the product and process development arenas.

This means cultivating and advancing features such as the openness and flexibility required to incorporate new and evolving technologies required for digital twin creation. Keeping pace with demand will also require these platforms to provide for a comprehensive digital thread of data and processes, encompassing multiple functional and operational domains.

Digital twin implementers will also expect PLM platforms to strongly support dynamic updates and feedback, as well as deliver the accuracy and fidelity required to predict behavior and optimize the actual performance of the physical product it represents. **DE**

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→ MORE INFO

- **Aras: Aras.com**
- **CIMdata:** CIMdata.com
- **Elysium:** Elysium-Global.com
- **Razorleaf:** Razorleaf.com
- **Siemens Digital Industries Software:** Sw.Siemens.com

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HP ZBook 17 G6 Mobile Workstation: A Record Setter

This 17-in. system claims the prize for the world's most powerful mobile workstation.

BY DAVID COHN

Last year, HP unveiled its next-generation ZBook mobile workstation, the ZBook 17 G6. The company billed the system as the world's most powerful mobile workstation. With a claim like that, we were quite eager to put one through its paces. Equipped with the latest 9th-generation Intel Core i9 or Xeon processor and a discrete graphics processing unit (GPU), the system is clearly designed to handle complex, multi-threaded apps, single-threaded programs and virtual reality (VR).

The 17-in. mobile workstation comes housed in a magnesium/aluminum alloy chassis with a stylish metallic finish. The system measures 16.37x11.31x1.5-in. and weighs 7.59 lbs., plus another 1.37 lbs. for its external 200-watt power supply (6.5x3.0x0.94-in.) Although the ZBook 17 is neither thin nor lightweight, its heft belies the power within.

Stylish Design

The center of the lid has a stylized HP logo. Raising that lid reveals a spill-resistant 102-key backlit keyboard that includes a separate numeric keypad. Most keys are full size, except a row of half-height function keys above the number row and small arrow keys in the bottom row. A black point stick input device is nestled between the G, H and B keys and has its own set of three buttons, while a 4.5x2.250-in. touchpad is centered below the spacebar.

The touchpad has its own set of buttons, supports multi-touch and includes a dedicated scroll zone. For systems equipped with near-field communication, the touchpad also has an area that lets you wirelessly share information when you tap it with a near-field communication-enabled device.

There is also a small colorimeter sensor in the touchpad's upper right corner on systems equipped with a Dream Color display to help you recalibrate a color preset without the use of an external device.

A small power button, located in the upper left above the keyboard, glows white when the system is powered up. Function keys—that mute the volume of the Bang & Olufsen sound system, mute the microphone and enable airplane mode—glow amber when enabled. The caps lock and number lock keys also have their own white LEDs to indicate when they are selected. A fingerprint reader is located below the numeric keypad. A pair of function keys lets you answer Skype calls and hang up when you're done.

The grille above the keyboard conceals a pair of 74dB speakers. A webcam with an integrated privacy shutter is centered above the display, flanked by a pair of antennas for HP's extended-range wireless LAN. Physical shielding built into the system eliminates signal peaks and valleys as you move about to maintain a faster connection.

In addition to traditional front-facing microphones, the

Fig. 1: The HP ZBook 17 G6 packs amazing power into a stylish package. ***Images courtesy of David Cohn.***

ZBook 17 G6 includes a world-facing microphone on the back side of the lid. This is great for conference calls, but also works with the system's built-in noise cancellation circuitry to eliminate background noise. Our system also included a 1080p infrared webcam.

Fig. 2: A removable bottom panel makes it easy to access the interior.

Lots of Options

Prices for the HP ZBook 17 G6 start at $2,343 for a system equipped with a 2.6GHz Intel Core i7-9750H six-core processor, a full high-definition (1920x1080) display with a rated brightness of 300 nits, an NVIDIA Quadro T1000 GPU, 16GB of RAM and a 256GB PCIe NVMe solid-state drive (SSD). But that's just the starting point, and the evaluation unit we received included much more.

HP offers a choice of six different CPUs. Intel Core processors range from the quad-core 2.4GHz Core i5-9300H to the eight-core 2.3GHz Core i9-9880H. But our system included an eight-core Intel Xeon E-2286M processor. That 2.4GHz Coffee Lake CPU (5.0GHz max turbo) includes a 16MB cache and has a 45-watt thermal design power rating, adding $896 to the system price.

Our evaluation unit also included a 17.3-in. ultra-high-definition (3840x2160) Dream Color display. The improved color gamut (100% AdobeRGB) and 400 nits brightness was well worth the additional $588. A touchscreen version is also available for $164 more.

All ZBook 17 G6 systems include a discrete GPU plus integrated Intel graphics and HP offers a choice of five graphic boards. Our system came with an NVIDIA Quadro RTX 5000 with 16GB of dedicated GDDR6 memory. This GPU provides 3072 compute unified device architecture cores, 384 Tensor cores and 48 RT cores. Although it adds a whopping $2,780 to the price, it enables the ZBook 17 to power through any VR project.

The HP ZBook 17 G6 can support up to 128GB of memory. The Xeon-based system we received included 32GB of 2666MHz error-correcting code memory, which increased the cost by an additional $855. There is room for up to four storage devices. Primary storage is handled by solid-state M.2 drives ranging from 256GB up to 2TB, and the ZBook 17 provides two M.2 connections, which also support RAID.

You can add a third drive in the form of a standard SATA hard drive (up to 2TB) or a 1TB SATA SSD. There is also an optical drive bay that can house either a Blu-ray/DVD-writer or a 2TB 5400rpm hard drive. Our evaluation unit included a single 512GB PCIe NVMe M.2 drive and an optical drive, adding $270 and $109, respectively.

There is also an abundance of ports on the HP ZBook 17 G6. The right side includes the optical drive bay, a combo microphone/headphone audio jack, HDMI port, mini-DisplayPort, a pair of USB Type-C Thunderbolt ports, the power connector and a battery indicator. The left side provides a security cable slot, full-size RJ-45 network jack, three USB 3.0 ports, an SD card reader and a smart card reader.

HP continues to make interior access easy. A sliding latch releases the bottom of the case. Once removed, you can change the battery and access the M.2 slots, drive bays and memory sockets. Though the six-cell 95.6 Whr battery is pretty robust, with all the power-hungry components in our evaluation unit, it could only sustain our ZBook 17 G6 for 4.75 hours. Happily, the HP Fast Charge capability returned the battery to 50% in just 45 minutes.

HP also sells several accessories for the ZBook 17 G6, including a Thunderbolt dock that provides three USB 3.0 Type-A ports, two USB Type-C ports, a Thunderbolt 3 port, two DisplayPorts and a VGA port, while requiring just a

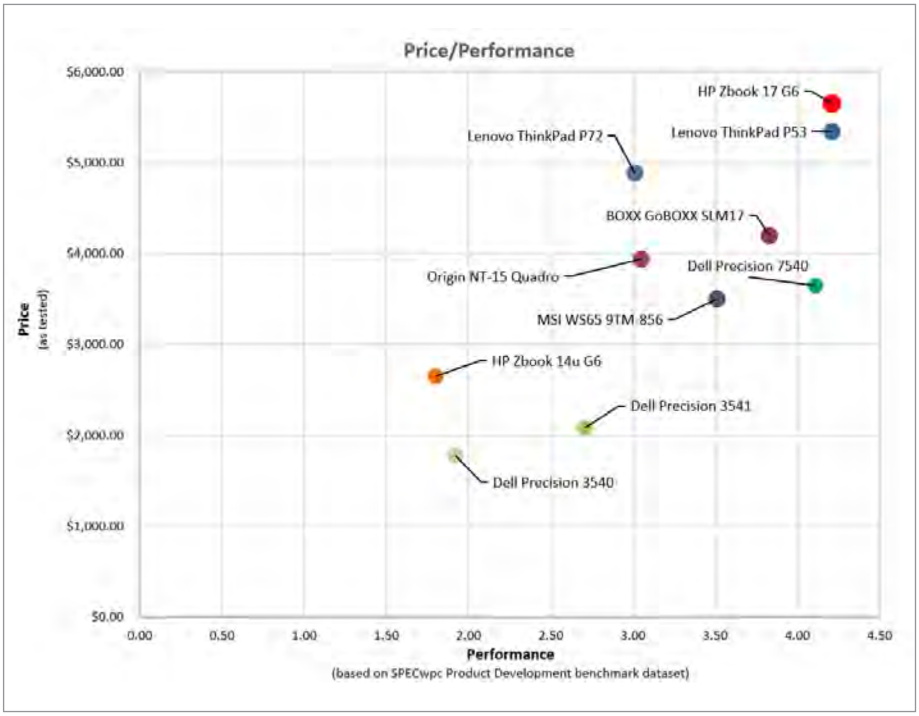


Fig. 3: Price/Performance chart based on SPECwpc Product Development benchmark dataset.

Mobile Workstations Compared

Mobile Workstations Compared	**HP Zbook 17 G6** 17.3-inch mobile workstation (2.40GHz Intel Xeon E-2286M 8-core CPU, NVIDIA Quadro RTX 5000, 32GB RAM, 512GBB NVMe PCIe SSD)	**Dell Precision 7540** 15.6-in. mobile workstation (2.40GHz Intel Core i9-9980H 8-core CPU, NVIDIA Quadro RTX 3000, 32GB RAM, 512GBB NVMe PCIe SSD)	**Lenovo ThinkPad P53** 15.6-in. mobile workstation (2.80GHz Intel Xeon E-2276M 6-core CPU, NVIDIA Quadro RTX 5000, 64GB RAM, 1TB NVMe PCIe SSD)	**BOXX GoBOXX SLM17** 17.0-in. mobile workstation (2.30GHz Intel Core i9-9880H 8-core CPU, NVIDIA Quadro RTX 3000, 32GB RAM, 512GB NVMe PCIe SSD)	**HP ZBook 14u G6** 14.0-in. mobile workstation (1.90GHz Intel Core i7-8665U 4-core CPU, AMD Radeon Pro WX3200, 32GB RAM, 512GB NVMe PCIe SSD)	**MSI WS65 9TM-856** 15.6-in. 2.60GHz Intel Core i7-9750H 6-core CPU, NVIDIA Quadro RTX 5000, 32GB RAM, 512GB NVMe PCIe SSD
Price as tested	$5,654.00	$3,646.00	$5,338.00	$4,200.00	$2,649.00	$3,499
Date tested	**1/24/2019**	10/25/2019	10/24/2019	10/23/2019	8/8/19	7/12/19
Operating System	Windows 10 Pro 64	Windows 10 Pro 64	Windows 10 Pro 64	Windows 10 Pro 64	Windows 10 Pro 64	Windows 10 Pro 64
SPECviewperf 13.0 (higher is better)						
3dsmax-06	185.09	155.08	181.47	148.65	36.42	169.25
catia-05	279.31	209.89	269.51	200.15	35.60	213.02
creo-02	243.95	187.29	255.96	185.52	34.17	210.09
energy-02	42.15	31.69	38.63	29.94	2.61	39.87
maya-05	272.88	183.66	261.90	187.67	34.17	206.74
medical-02	91.59	63.63	85.31	63.59	9.73	80.88
showcase-02	93.46	78.72	63.79	79.50	13.934	92.57
snx-03	361.04	217.45	223.64	218.39	52.78	288.08
sw-04	158.92	130.57	88.51	123.98	46.04	123.16
SPECapc SolidWorks 2015 (higher is better)						
Graphics Composite	5.24	4.27	5.47	5.03	2.27	3.73
Shaded Graphics Sub-Composite	3.23	2.55	3.53	3.01	1.39	2.23
Shaded w/Edges Graphics Sub-Composite	4.21	3.37	4.38	3.89	2.06	2.96
Shaded using RealView Sub-Composite	3.90	3.08	4.05	3.57	1.63	2.63
Shaded w/Edges using RealView Sub-Composite	4.54	3.83	4.73	4.35	2.98	3.12
Shaded using RealView and Shadows Sub-Composite	4.48	3.42	4.59	4.11	1.45	3.04
Shaded with Edges using RealView and Shadows Graphics Sub-Composite	4.85	3.92	4.71	4.56	2.47	3.30
Shaded using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	13.41	11.30	15.06	13.54	3.01	10.06
Shaded with Edges using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	13.20	11.13	14.58	13.35	4.58	9.59
Wireframe Graphics Sub-Composite	4.00	3.91	3.92	4.34	2.76	3.50
CPU Composite	3.06	3.76	5.32	5.33	1.85	2.71
SPEC Workstation v3 (higher is better)						
Media and Entertainment	1.87	1.88	2.07	1.98	0.80	1.82
Product Development	1.81	1.91	2.24	2.07	1.04	2.01
Life Sciences	1.94	1.67	1.77	1.99	0.87	1.97
Financial Services	1.96	1.75	1.69	2.16	0.70	1.49
Energy	1.32	1.36	1.37	1.32	0.54	1.28
General Operations	1.55	1.72	1.89	1.79	1.13	1.75
GPU Compute	3.34	3.20	3.31	3.09	0.60	3.41
Time						
AutoCAD Render Test (in seconds, lower is better)	35.40	34.80	49.20	45.90	140.40	43.80
Battery Life (in hours:minutes, higher is better)	4:45	7:51	5:30	8:37	5:30	6.07

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

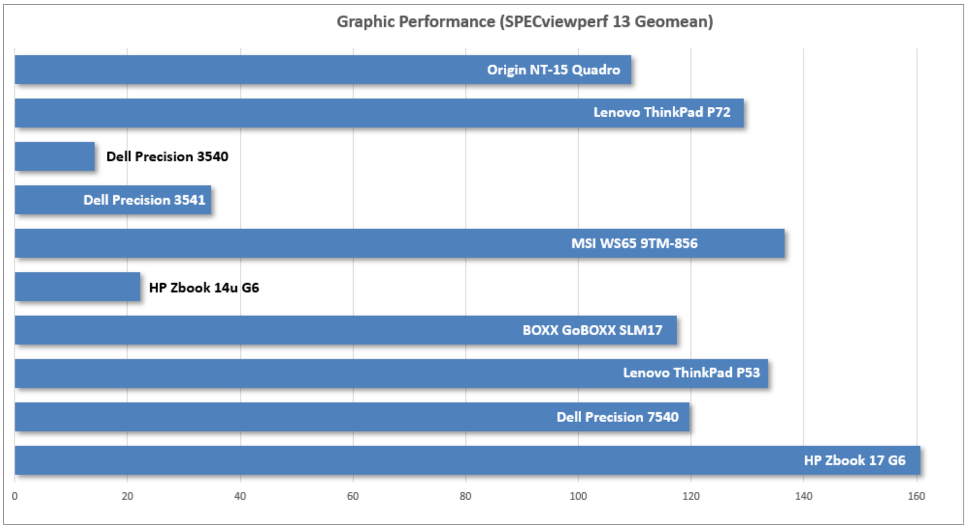


Fig. 4: Graphic performance chart based on SPECviewperf 13 Geomean.

single USB-C cable connecting the dock to the computer.

Record-Setting Performance

We expected great performance, but the HP ZBook 17 G6 exceeded our expectations. On the SPECviewperf test, which focuses on graphics, the ZBook 17 turned in the best results to date for a mobile workstation, thanks largely to its incredibly powerful NVIDIA RTX 5000 GPU.

On the SPECapc SolidWorks benchmark, it also scored at or near the top in every category. The HP ZBook 17 G6 also turned in excellent results on the very demanding SPEC workstation performance benchmark, with results near the top in every category, including most subsystem scores—except for its storage subsystem scores, which were the lowest we've recorded in the past year.

With an average time of 35.4 seconds to complete our multi-threaded AutoCAD rendering test, however, the HP ZBook 17 G6 missed the mobile workstation record by just 0.6 seconds.

Throughout our tests, the HP ZBook 17 G6 was nearly silent, barely exceeding the 29dB ambient background noise in our test lab. HP preinstalled Windows 10 Pro 64-bit. Windows 10 Home and FreeDOS 3.0 are also available.

Like all its other workstations, the ZBook 17 G6 is independent software vendor certified, has passed 21 military standard tests and more than 120,000 hours of testing, and is backed by a three-year warranty.

The ZBook 17 G6 also includes HP Sure Sense for enhanced ransomware protection, Sure Click to protect against malware entering your PC through a browser or common office files, and technologies like HP Sure Start (self-healing BIOS), Sure Run and Sure Recover.

With its powerful CPU, VR-ready NVIDIA Quadro graphics, lots of memory and ample expandability, the HP ZBook 17 G6 is clearly built for the most demanding workflows. Although its size and price may not appeal to everyone, it's difficult to beat its performance. We agree with HP's claims: the HP ZBook 17 G6 is currently the world's most powerful mobile workstation. DE

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

→ MORE INFO

HP: HP.com

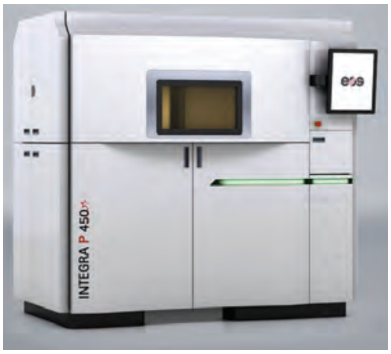
HP ZBook 17 G6 mobile workstation

- **Price:** $5,654 as tested ($2,343 base price)
- **Size:** 16.37x11.31x1.50-in. (WxDxH) notebook
- **Weight:** 7.59 lbs. plus 1.37 lbs. for 200W power supply
- **CPU:** Intel Xeon E-2286M 2.4GHz (5.0 max turbo) 8-core w/ 16MB cache
- **Memory:** 32GB DDR4 2666MHz ECC (2x16GB) 128GB max
- **Graphics:** NVIDIA Quadro RTX 5000
- **Display:** 17.3-in. UHD (3840x2160) Dream Color
- **Webcam:** 1080p plus IR
- **Storage:** 512GB M.2 PCIe NVMe SSD
- **Floppy:** None
- **Optical:** Blu-ray/DVD-writer
- **Audio:** Bang & Olufsen with built-in 74dB speakers, three-microphone array, combo audio jack, noise cancellation
- **Network:** Intel Wi-Fi 6 AX200 802.11AC 2x2 and Bluetooth 4.2
- **Modem:** None
- **Other:** Three USB 3.0, two USB 3.1 Type-C (Thunderbolt/DisplayPort), one min-DisplayPort, HDMI, RJ-45, SD card reader, SmartCard reader, fingerprint reader, colorimeter, NFC
- **Keyboard:** 102-key backlit spill-resistant backlit keyboard
- **Pointing device:** Touch stick and touch pad each with 3 buttons
- **Standard warranty:** Three-year parts and labor

For more information on this topic, visit DigitalEngineering247.com.

EDITOR'S PICKS

Each week, DE's editors comb through dozens of new products to bring you the ones we think will help you do your job better, smarter and faster. Here are our most recent musings about the products that have really grabbed our attention.



Flexible Print Production Options for SLS Polymers

EOS INTEGRA P 450 suitable for single print use additive manufacturing.

EOS North America introduces the INTEGRA P 450, an industrial polymer 3D printer. The INTEGRA P 450 is a mid-high temp powder bed 3D printer combining ease of use with flexible production features. It is suitable for both single print use and true serial production additive manufacturing.

The INTEGRA P 450 works at process temperatures up to 300°C. EOS says the 8-zone quartz heating system allows each zone to be independently controlled for enhanced precision.

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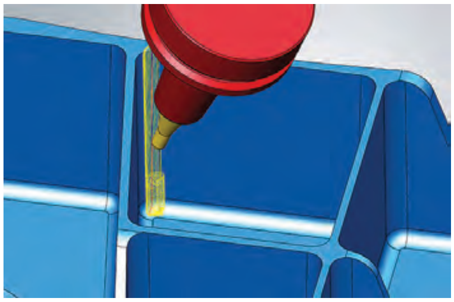
Update Adds 3D and 5-Axis Milling Enhancements

hyperMILL I 2020.1 CAD/CAD Suite features additive manufacturing capabilities.



OPEN MIND Technologies has released an update to its popular CAD/CAM software suite. Users will find new enhancements to existing milling strategies, new strategies and options, and a new set of processes for working with additive manufacturing (AM) or AM/milling hybrid operations.

New Corner Rest Machining strategies for 3D and 5-axis techniques, the company says, provide significant benefits in various machining applications, including mold and die.

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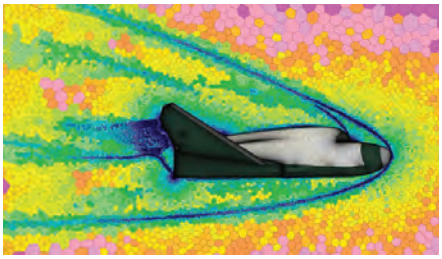
Next-Gen Parallel Meshing Speeds CFD Prep 30x

Siemens update said to be "rewritten from the ground up for parallel performance."



Siemens Digital Industries Software is now shipping a major update to Simcenter STAR-CCM+ that features all new technology for polyhedral meshing and adaptive mesh refinemen.

Also new in Simcenter STAR-CCM+ 2020.1 is an all-new adaptive mesh refinement (AMR) tool. Siemens says it is the industry's first model-drive AMR. This feature lowers computational time while providing equal accuracy by dynamically refining the mesh where needed.

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Industrial 3D Printer Made for Tough Plastics

The 3D printer can work with various plastics and carbon fiber-filled variants.

The AON-M2 2020 3D printer was designed for part accuracy and repeatability, as well as reliability in industrial settings. The chamber is all stainless steel with minimal thermal expansion, built around a new convective flow path. The unit can be ready for first print in less than 15 minutes, running at a constant 135-degree Celsius chamber temperature.

Dual independent tool heads allow the user to design parts requiring multiple materials.

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3D Printer Has "Designed for Designers" Feature

Stratasys offers full-color, multi-material photopolymer 3D printing capabilities.

Stratasys introduces the J826 PolyJet model, which it says is "designed for designers," combining part realism and productivity. The target market is mid-sized enterprises and educational institutions.

The J826 can print full PANTONE-Validated color and can print with up to seven separate materials. This latest model in the PolyJet J8-series comes in at about half the price of other models in the line.

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ANSYS Updates Its Engineering Simulation Platform

Product development workflow management enhanced with ANSYS Minerva.

There's a wide array of new features and capabilities in ANSYS 2020 R1. From major improvements to product development workflow management with ANSYS Minerva to running complex simulations with streamlined workflows with ANSYS Fluent to optimizing electromagnetic design processes with ANSYS HFSS, the company says ANSYS 2020 R1 enables companies to "pioneer trailblazing innovations and create highly cost-effective designs."

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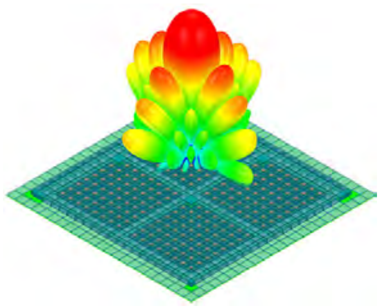
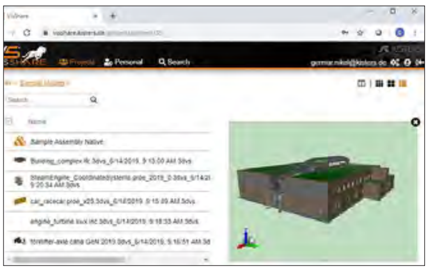


Try out browser-based CAD collaborative viewing

Kisters VisShare uses modern approach to 3D data collaboration.



Kisters introduces VisShare, part of the Kisters 3DViewStation product family. This corporate web environment for multi-CAD collaboration is suited for internal and external sharing of 3D CAD data.

VisShare can be configured on internal servers or a cloud service. All viewers need is a browser—no separate software to install. VisShare can be used by internal teams, partners, suppliers and customers using the same web portal.

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IronCAD 2020 Software Integrates Multiphysics

Package helps CAD designers adopt design analysis earlier in the prototyping cycle.

IronCAD's latest version of its integrated design module, Multiphysics for IronCAD 2020 (MPIC), features several new and improved features for in-CAD design analysis.

New technology for tolerance assembly analysis uses discrete boundary surface facets to smartly unite parts together for design analysis. This allows for the healing of CAD assembly models—whether the gaps are intentional or not—so they can be glued together for quick design analysis.

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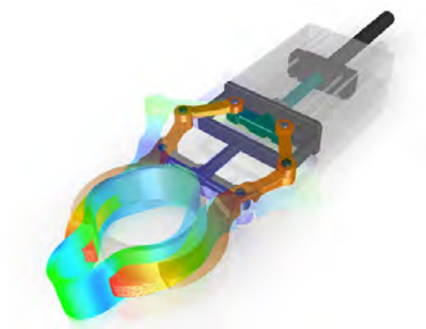


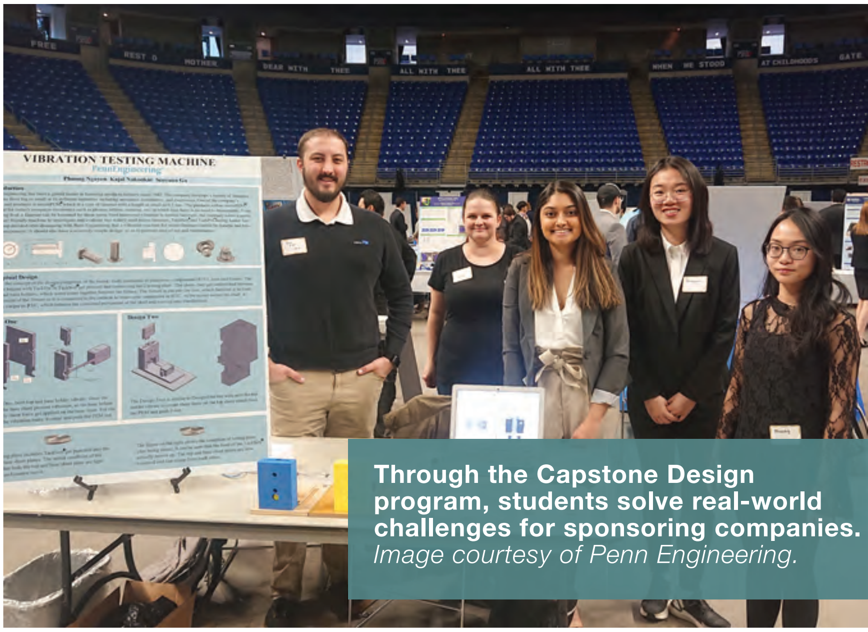
Next-Gen Engineers

Student Design Competition Profile: Penn State Capstone Design Program

Solving Real-World Engineering Problems

BY JIM ROMEO

The Bernard M. Gordon Learning Factory helps coordinate 200 senior Capstone Design projects from industry sponsors and professional clients each year within Penn State's College of Engineering. These semester-long projects give engineering students the opportunity to solve real-world challenges, such as PennEngineering's need to test a tiny fastener's functionality under vibration loads.



Through the Capstone Design program, students solve real-world challenges for sponsoring companies. *Image courtesy of Penn Engineering.*

Chris Aldred is the senior marketing communications manager at PennEngineering, and Zachary Light is the market manager for the company's MicroPEM fastener line.

We spoke with Aldred and Light to learn about PennEngineering's support of and experience with Penn State's Capstone Design program. Our conversation helped us gain further insight into their competition.

Digital Engineering: **Can you provide an overview of the Capstone Design program and why PennEngineering sponsored a project? What was the project, and who participated in the project?**

Chris Aldred: Penn State has the largest multidisciplinary Capstone program in the world. They had about 200 projects last semester. At most universities, mechanical engineers are usually grouped with other mechanical engineers in their Capstone program. Penn State's approach allows for engineering students from many different disciplines to work together on a project, and that was of interest to us because we had a problem that needed know-how from multiple disciplines to solve.

Zachary Light: As a company, we sell fasteners to the automotive electronics industry for things like sensors and backup cameras, and there is a trend toward smaller components packed into smaller spaces. Cars are subjected to long periods of intense vibration, and fasteners have to do their jobs even under these conditions. Screws have a tendency to back out under vibration, so a clinch fastener can be a good solution.

Automotive electronics manufacturers need to know the fasteners they're using won't fail, so it's necessary to test every component against vibration. In the past, it's been possible to vibration test fasteners, but the drive toward smaller components has resulted in fasteners that are too small for the existing vibration test machines to handle.

We challenged two Capstone groups last semester to devise a machine to test the ability of our micro fasteners to withstand vibration. The groups included mechanical, electrical and software engineering students, and that worked well because the mechanical engineering students could design the physical structure of the machine, while the electrical engineering students could supply the electrical expertise, and the software engineering students could write the code to run the machine.

DE: **Tell us more about the projects.**

Light: The smallest fastener that commercially available vibration testing machines can handle is 3 mm in diameter. At 1 mm in diameter, our micro fasteners are a third the size of that. There is no machine capable of holding the tolerances necessary to test such a small fastener. At the same time, the automotive electronics industry has very stringent requirements for component performance.

Our two student teams worked all of last semester coming up with a way to accurately test the performance of our TackPin and TackSert micro fasteners against self-loosening under vibration loads. The four-person team created one vibration testing prototype out of aluminum, and the five-person team 3D printed two variations of their vibration testing prototype.

This semester, we are sponsoring one group consisting of four industrial engineering students and one mechanical engineering student. Their task is to test our micro fasteners in the machines and collect and analyze the data as well as the performance of the three machines themselves.

***DE:* Can you provide some examples of what you expect the projects to produce?**

Light: Depending on how well the machines work during testing this semester, we might share the team's test results with potential buyers of our micro fasteners in the automotive electronics industry. Alternatively, we might find it would benefit us to develop a vibration testing machine refined from one of the prototypes.

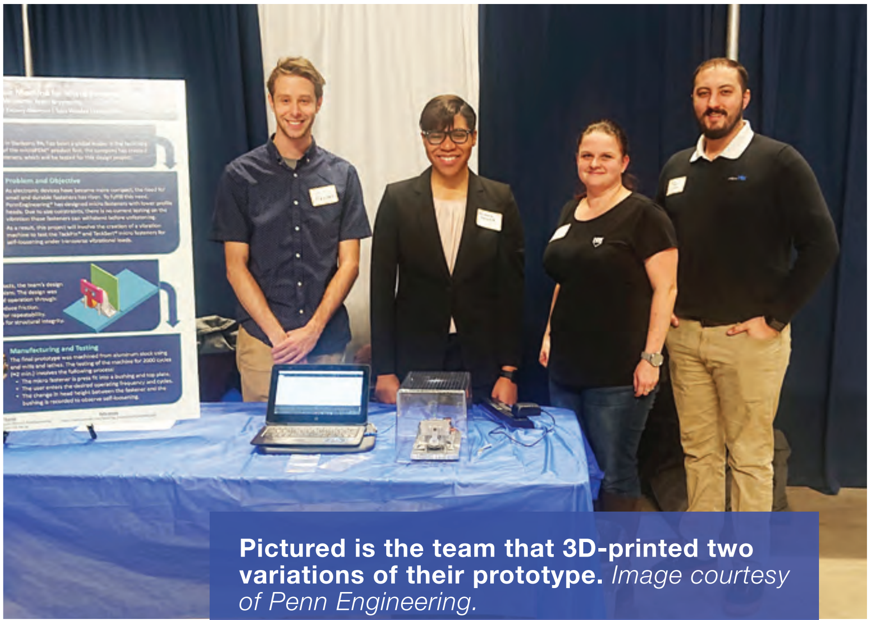
Moving forward, we anticipate supporting more Capstone Design projects to meet other engineering and business challenges.

***DE:* Does Penn State or the Learning Factory have a particular stance on adopting an innovation that is linked to the program?**

Aldred: Students participating in the Capstone Design program automatically hold intellectual property (IP) rights on anything they create unless the sponsor negotiates for the IP rights. Because we are trying to solve a specific business and engineering challenge, we negotiated for those rights.

The students knew about the IP agreement before they took on the projects. They get experience solving a real-world problem, they have the opportunity to interact with a potential future employer and they have something real to show for their effort.

The Learning Factory's main interest is in the education and experience the students are getting.



Pictured is the team that 3D-printed two variations of their prototype. *Image courtesy of Penn Engineering.*

***DE:* What drives firms to sponsor a project in the Capstone Design program?**

Aldred: We are interested in sponsoring projects in the program for a couple of reasons. First, we had a business and engineering challenge that we thought could be uniquely and economically addressed through a Capstone Design project. Second, we want to forge a long-term relationship with Penn State, which is only about three hours away from our headquarters in Danboro, PA.

Some of the finest engineering minds obtain their degrees from Penn State, and the multidisciplinary nature of the Capstone Design program means we have access to a tremendous mix of engineering skills. We are excited by the chance to work with these students and help the upcoming generation of engineers gain experience and learn about fastener technology. We may even identify potential future employees through our support of the Capstone Design program.

***DE:* Anything else you'd like to tell us about the program that the above questions haven't given you the opportunity to express?**

Aldred: Based on the experience we've already had with supporting the Penn State Capstone Design program, PennEngineering expects to expand sponsorship of such programs to other leading universities. This way, we can help provide real-world experience to more engineering students. DE

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