January/February 2021

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The New Normal for Design

DigitalEngineering247.com

Peerless MEDIA, LLC

By Brian Albright

What Will the New Normal Look Like?

In January, we reached an astounding anniversary. It had been 300 days since COVID-19 related restrictions were put in place in many states and communities in the U.S. Those have been very long days indeed for a lot of us, and the turmoil the pandemic has wrought will likely reverberate right through 2021.

There are, however, bright spots on the horizon. The delivery of multiple vaccines (in record time) and the end of a tumultuous election cycle should help move us further toward a post-pandemic era and, hopefully, economic recovery.

Here at *Digital Engineering*, we have spent much of the past year evaluating how the pandemic affected the working life of our engineering audience, and the way they use technology. This year, we are looking ahead to how that experience could change the way companies use simulation, 3D printing, CAD and other solutions moving forward. I have spoken to a number organizations across multiple sectors over the past few months, and the majority expect that remote work will continue through the summer, and that many engineers and designers could be working from home or remotely even after pandemic-related restrictions are no longer necessary. How will that change the design cycle? What will this new normal really look like? We evaluate some of those potential changes in this issue.

We will also focus more on how the engineering technology we cover can be leveraged to help companies achieve their sustainability goals. Sustainability initiatives are increasingly prominent among manufacturers and within the design and simulation technology companies that serve them. How can engineering innovation be used to design more efficient products and manufacturing processes, and reduce the environmental impact of that production? We take a look at 3D printing sustainability efforts in the current issue, as well as the activities of the PLM Green Global Alliance.

Our team has other big plans for 2021. It is still not clear when we can all start traveling to conferences again, so we are currently planning two virtual conferences that will showcase innovative uses of simulation, CAD, additive manufacturing, digital thread and other technologies.

This year provides us all an opportunity to make use of the lessons we learned in 2020. Engineering technology will play a key role in helping us to build on that abrupt and unexpected education.

On June 16, NAFEMS Americas and Digital Engineering will present the one-day virtual Conference on Advancing Analysis & Simulation (CAASE21). Then in October, *DE* will launch our own inaugural Design and Simulation Summit, a one-day virtual conference focused on the key technology areas that we cover. More details will follow as we get closer to the event launches.

This year provides us all an opportunity to make use of the lessons we learned in 2020. Engineering technology will play a key role in helping us to build on that abrupt and unexpected education.

Brian Albright, Editorial Director
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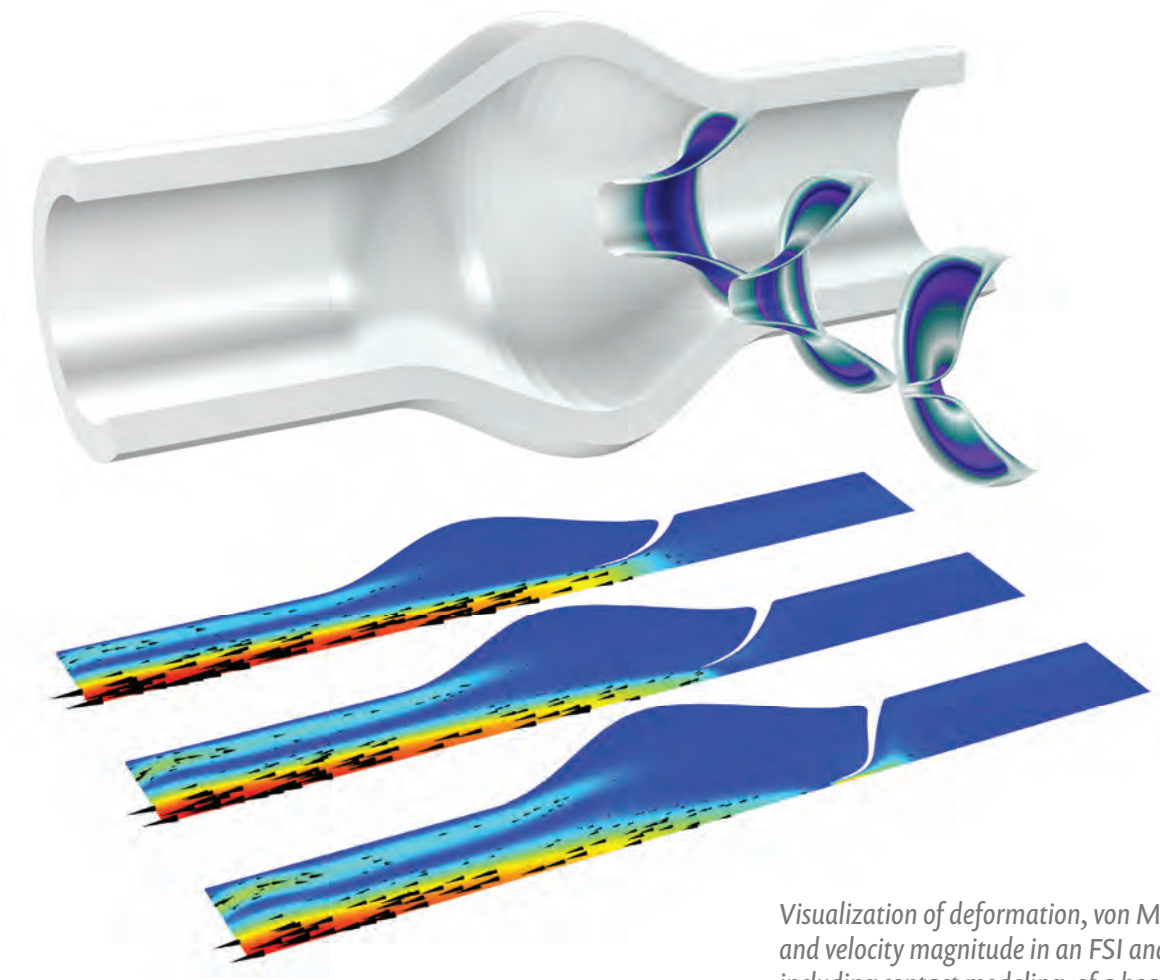
Visualize and predict heart valve behavior with multiphysics simulation.



Visualization of deformation, von Mises stress, and velocity magnitude in an FSI analysis, including contact modeling, of a heart valve.

Open fully, close tightly. The four valves in the human heart are expected to do this with each beat. When the valves do not function properly, cardiac health issues arise. In the quest for more effective treatments, medical researchers are studying heart valves to understand and predict their behavior. To accurately visualize a heart valve, you need to account for many coupled effects. Multiphysics simulation is up for the task.

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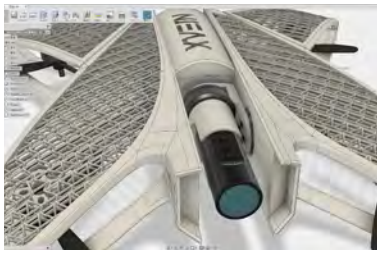
FOCUS ON THE NEW NORMAL FOR DESIGN



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Editor's Pick, Page 43

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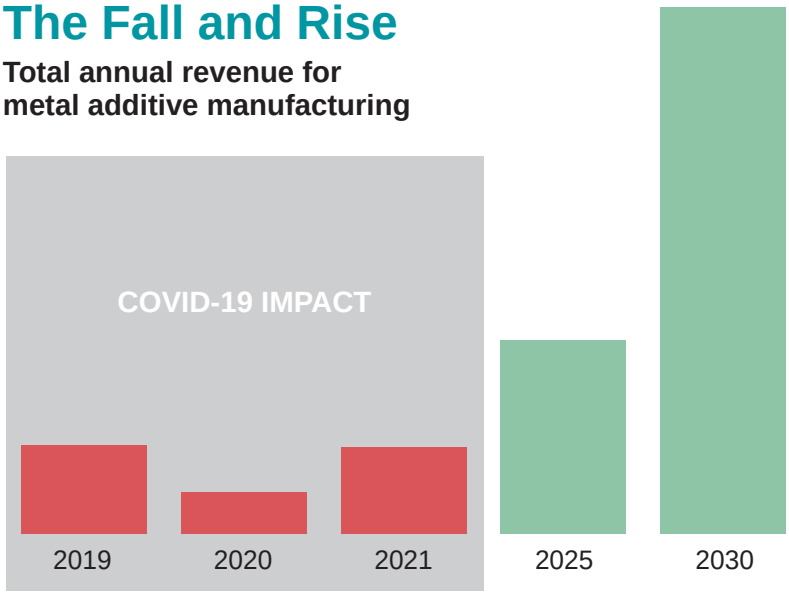
BY THE NUMBERS | A LOOK AHEAD

The Fall and Rise

Total annual revenue for metal additive manufacturing

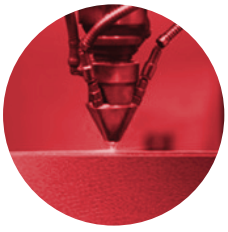


Although the COVID-19 pandemic interrupted the 3D printing sector and many of its end users, it also opened up **new opportunities** in some sectors like **healthcare** and **on-demand manufacturing** applications.

Source: IDTechEx.

EXPANDING MATERIALS CAPACITY AND PORTFOLIO

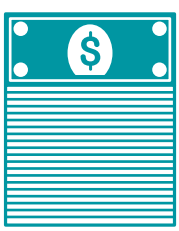
NEW APPLICATIONS



ESTABLISHED AND EMERGING PROCESSES

> *"In **2021**, **simulation** will provide firms with an overview of their operations and **stress-test** them to build **resilience**. Projects will look to simulate scenarios and run what-if analyses that cover **downstream** events (in end markets or individual customers) and **upstream** events to simulate how to **accommodate** supply chain events in engineering and production departments."*
>
> ***—MICHAEL LARNER, Industrial & Manufacturing principal analyst at ABI Research, 68 Technology Trends that Will Shape 2021***

$5.8 BILLION



Expected worldwide spending on PLM software in **2026**, according to ABI Research.

Source: Industrial Product Lifecycle Management (PLM) Software: Gaining Insights from the Cradle to Grave, January 2021.

19

The number of GPU suppliers expected to be active in **2021**

Up from **16** suppliers in **2020**, according to Jon Peddie Research's annual GPU Developments report

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AMD Radeon VR Ready Creator Products are select Radeon Pro and AMD FirePro GPUs that meet or exceed the Oculus Rift or HTC Vive recommended specifications for video cards/GPUs. Other hardware (including CPU) and system requirements recommended by Oculus Rift or HTC Vive should also be met in order to operate the applicable HMDs as intended. As VR technology, HMDs and other VR hardware and software evolve and/or become available, these criteria may change without notice. PC/System manufacturers may vary configurations, yielding different VR results/performance. Check with your PC or system manufacturer to confirm VR capabilities. GD-101

ROAD TRIP

AU2020 Comes Home to Users

BY KENNETH WONG

As 2020 came to a close, the Autodesk users who would normally fly to Las Vegas, NV, went online instead. The year-end Autodesk University (AU) 2020 was another of the separate-but-together virtual events that had become the standard during the pandemic.

"What we all consider normal has changed," said Autodesk CEO Andrew Anagnost, who appeared in a video keynote recorded at Autodesk's Pier 9 tech center in San Francisco. "Wherever you are, each and every one of you have seen how important resilience is, how fragile our processes and supply chains are ... Early in the pandemic, especially with none of us going anywhere, product demand took a hit, from phones to cars ... Now production is ramping up as demand grows again. But production will be forever more distributed."

The key to survival and resilience, Anagnost suggests, is data and digitization.

AI Acquisition and AEC Digital Twin

One big announcement during the show was the acquisition of Spacemaker, an AI-powered generative design software for urban design. The Norway-based company "uses cloud-based, artificial intelligence and generative design to help architects, urban designers and real estate developers make more informed early-stage design decisions faster and enables improved opportunities for sustainability from the start," the announcement stated.

In the era of social distancing, many existing spaces had to be reconfigured and repurposed to prevent the spread of coronavirus and overcrowding. The emergence of a number of promising vaccines suggests social distancing may relax, but space optimization will likely remain a challenge. In that sense, Spacemaker is a timely, smart acquisition.

The conversion of the London ExCeL conference center into the NHS Nightingale modular hospital is one such example. In the project, Autodesk customer BDP employed Autodesk's generative design technology and Autodesk building information modeling (BIM) software Revit.

"Revit's ability to have a design change propagate across the system was extremely helpful," said James Hepburn, BDP's principal engineer. "We were designing spaces where sick people would be cared for, so we had to make sure every part of the space was accounted for."

During the keynote, the company also announced Autodesk Tandem, an architecture, engineering and construction (AEC) digital twin software.

According to the announcement, "Autodesk Tandem connects the digital world with the real world, creating an up-to-date reflection of a model's physical self. This provides unique operational insight into a facility, building, bridge or any structure, as well as its components, including, for example, the performance of heating and cooling systems, escalators and electrical systems."

In the online Q&A with the press, Anagnost was asked about plans for a similar digital twin offering for manufacturing. He offered no details but said it's part of the company's vision.

Fusion with CFD-Based Generative Design

Up to now, generative design solutions allow users to investigate the best (or optimal) topology based on stress loads and structural deformation, but Anagnost revealed computational fluid dynamics (CFD) studies may soon become the basis for generative design.

"Until today generative design was focused on structure forces. Now you can explore fluid forces," he said in the keynote.

In the Product Design & Manufacturing keynote, Stephen Hooper, VP and GM of Autodesk Fusion, also pointed out, "This year we added a fluid solver, enabling generative designs to include pumps and valves."

To bolster the software's tools for electronics design and manufacturing, Autodesk has also incorporated its Moldflow solver, SPICE analysis, automatic circuit routing and instant connections to on-demand manufacturer Xometry into Fusion 360.

The keynote speakers included Charles Cambianica, advanced design project lead for the sporting goods manufacturer Decathlon.

Autodesk CEO Andrew Anagnost delivered his keynote for AU2020 in a prerecorded video, highlighting the role of design data and digitization in the pandemic era.

In designing the frame of its iconic bike, Cambianica said he and his team considered "what the performance bike of the future world would look like, from how they might unbox the bike to how they might ride it."

Aside from design aesthetics, the company is also devoted to minimizing environmental impact.

"The dirty secret about carbon fiber is, it's wasteful to use and difficult to recycle," he remarks of the material many might consider ideal for lightweighting. "We think we can cut the carbon footprint by printing [the bike frame] in metal instead."

Decathlon designers use Autodesk Fusion 360's generative design to explore ideas for "the frame and fork, initially taking into consideration the significant dynamic forces the fork would be subjected to under braking and at speed, as well as aerodynamics, and many other factors," according to a recently published case study.

Autodesk Vault Goes Mobile

The company also announced the launch of Vault Mobile, a mobile-friendly version of its team-level product data management (PDM) product Autodesk Vault.

"There are now hundreds of thousands of Vault users, managing 1.5 billion files in Vault globally—models, spec sheets and simulation data," said Derek Cooper, VP of Product Development and Manufacturing. "But teams are more distributed than ever, and product development doesn't happen in the usual places anymore. The amount of work done away from traditional workplaces is rapidly accelerating."

Vault Mobile gives users the ability to examine part history, review work, approve change orders and do more from mobile devices. The product launch anticipates the growing use of smartphones and tablets in addition to the traditional mobile and desktop workstations in engineering and manufacturing.

Along with Vault Mobile, Autodesk also launched a service called Vault Connect, which allows you to securely store, share and collaborate on design files.

A Four-Legged Vehicle

Another speaker, John Suh, VP, Hyundai Motor Company, showcased a car that can stand up and walk. In conceiving a futuristic off-road vehicle called Elevate that can operate on various terrains, the design can transform itself from a four-wheeled vehicle to a four-legged walking transporter.

"It can overcome obstacles, cross gaps and go where even off-road vehicles will have a difficult time going," he says. It can be deployed in resource delivery, search-and-rescue missions and even lunar exploration, he points out.

The project involves the use of lattice structures, additive manufacturing and multidisciplinary collaboration, facilitated in Autodesk Fusion 360.

"Generative design allowed us to tackle a lot of complex problems that would have taken somebody a long time to solve manually," he said. "I call it a mind multiplier."

Elevate is a marriage of robotics and automotive technologies. It's currently a scale model and a concept, not yet a product.

Note: *An earlier version of this report was published at digitalengineering247.com/r/24604.* 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.*

The Right Choice in GPUs

AMD's Radeon™ Pro GPUs can provide enhanced performance for demanding design and engineering scenarios.

Demand for graphics processing unit (GPU) power is increasing rapidly. This is particularly true in the design sector, where engineers are taking advantage of the GPU for rendering, visualization, and simulation. Software vendors have incorporated GPU acceleration into their products to help designers increase productivity and optimize their designs.

At the same time, the GPU market is more competitive than ever before, with a variety of faster and more powerful chip options available to end users that are trying to configure an optimal engineering workstation.

The question then becomes: How do you select the GPU with the right balance of capability and cost? The AMD Radeon Pro family of GPUs has emerged as an ideal solution for these demanding workflows, with power efficiencies, reliability, multitasking and performance advantages.

Why choose a Radeon Pro GPU?

There are a number of features that make the AMD Radeon Pro GPU line an excellent choice for engineering applications. Specifically, the AMD Radeon Pro GPU family are certified with leading engineering applications, provide superior multitasking performance, heat and power management, and remote workflow capabilities.

Superior Multitasking: Simulation-driven design is placing greater demands on engineering workstations. Engineers need to be able to utilize multiple applications and work on multiple files simultaneously in order to remain productive and efficient. The GPU can provide additional resources when the CPU is being overtaxed by demanding rendering or other activities. In testing, a mid-range Radeon Pro W5500 GPU can provide almost 11 times better application multitasking performance compared to a competitive graphics card. This is a critical element to consider when selecting a GPU. Engineers are taking on more frequent simulation, rendering and visualization tasks on their own workstations as more companies embrace generative design techniques, institute more frequent simulations earlier in the design process, and require engineers to render and test multiple designs and accelerate the entire design lifecycle. Reliable GPU compute power during these workloads is the only way to confidently enable these new processes.

Certified for Success: For designers, a key advantage of the Radeon Pro line is the AMD Day Zero Certification Program. When the GPUs are released, they are already certified and tested for use with a wide variety of software products like Ansys Mechanical, SOLIDWORKS, COMSOL Multiphysics, AutoCAD, and others. This helps ensure that users have access to the latest driver benefits, and that they can be productive as soon as they've launched the programs on their workstations.

Power and Heat: Power consumption is another key area where Radeon Pro graphics cards provide efficiency, cost and environmental advantages. AMD Radeon Pro Software's Intelligent Power Management can improve system power consumption by more than 40% in some solid modelling instances, and provides optimal power configurations for compute-hungry simulation and rendering programs.

In addition to power efficiency, Radeon Pro GPUs use a high-performance fan to cool the card, helping protect against failure-inducing hot spots. The GPU was also designed for uniform heat spread. In testing, a Radeon Pro card up to 10% cooler than an equivalent card under the same workload. These features (along with a design that minimizes shock and vibration) safeguard against physical damage to the GPU, helping ensure a longer life and reduced total cost of ownership.

Display Workflows: The entire Radeon Pro GPU range supports the transition to larger modern displays, and multi-display environments. Designers frequently find themselves working in multiple application environments simultaneously, or examining large, complex models that require much more screen real estate.

Radeon Pro GPUs provide access to unique capabilities that can support these workflows, such as AMD Eyefinity multi-display technology that can allow users to open multiple applications and projects across as many as six high-resolution monitors from a single GPU, like it was a single screen. Radeon Pro Image Boost technology helps ensure a clear, sharp high-resolution image, regardless of the resolution of the native display. AMD Radeon Pro helps engineers evaluate accurate images in the high resolutions required for design and product reviews, marketing, advertising, and other workflows.

In addition, all Radeon Pro GPUs support DisplayPort™ 1.4 for compatibility with up to 8K UHD, High Dynamic Range and other modern monitor types. Several of the Radeon Pro GPUs can also be equipped with standard DisplayPort, Mini-DisplayPort (mDP), or a combination of the two for greater flexibility.

Engineering on the Go: This year engineers all over the world were forced into work-from-home or remote work environments that many companies were not equipped to

support. This presented a number of challenges, including access to adequate compute resources, security, and software licensing. The AMD Radeon Pro GPU line has proven it's up to the task of supporting remote work scenarios via the AMD Remote Workstation[1] solution. With this technology, engineers can confidently run workstation-based applications on mobile devices by remotely connecting to their desktop solutions and compatible GPU.

The Right GPU for Design

The GPU has emerged as a critical enabler of modern engineering workflows, providing the speed and compute power necessary to enable real-time design, simulation, rendering, and other tasks reliably and efficiently.

AMD Radeon Pro GPUs can help engineers and designers improve productivity with superior speed and performance, as well as outstanding power and heat management, multitasking capabilities, and support for current visualization and display workflows. The GPUs also provide out-of-the-box certifications with leading design, simulation and rendering tools engineers need to meet the requirements of simulation-driven design. The AMD Radeon Pro range is available from major workstation providers, and for those looking for an on-the-go mobile solution the Radeon Pro WX 3200 is an excellent choice.

To learn more about AMD Radeon Pro GPUs, and to identify the right graphics card for your application, visit amd.com/ProGPUselector.

1: Learn more at amd.com/remoteworkstation
Compatible with AMD Radeon™ Pro WX 2100, 3100, 3200, 4100, 5100, 7100, 8200, 9100, and AMD Radeon™ Pro W5500, W5700, and VII GPUs. Remote Workstation functionality requires purchase and installation of Citrix Virtual Apps & Desktops™, Microsoft® Remote Desktop Services or VMware Horizon®. Citrix and Microsoft require Enterprise driver 18.Q4 or newer, VMware requires Enterprise driver 20.Q3 or newer. RPS-50

Thick Client, Thin Client and Clientless CAD

Different shades of cloud solutions emerge as vendors offer more than desktop CAD.

BY KENNETH WONG

Last November, when PTC prepared to buy Onshape for $470 million, PTC's President and CEO Jim Heppelmann noted it would be "the biggest acquisition PTC has ever done thus far."

But this was more than the typical big-fish-swallows-small-fish acquisition.

"We believe CAD and PLM will go to SaaS [software-as-a-service]. We just can't understand why that won't happen," Heppelmann says.

If Onshape's browser-based CAD represents the future and the way things will be, desktop products mostly represent the status quo. But it's a tradition that won't go quietly into the night.

Legacy data and desktop classics are expected to remain. Though virtualization, remote software and other cloud solutions have gained a foothold, when it comes to 3D modeling, the desktop products with their stable, consistent, predictable performance still remain the norm in many design and engineering firms.

Nevertheless, hybrid desktop-cloud products are emerging. Perhaps they are the necessary steppingstones for those who are not ready take the leap of faith into the unknown. For most users, it's all about the market's current choices and use cases that determine their preference.

Clientless or Browser-Based

Onshape is built from the ground up to run in the cloud from the browser. The team behind it feels it makes a difference compared to desktop programs that were subsequently converted to run on a cloud-based architecture.

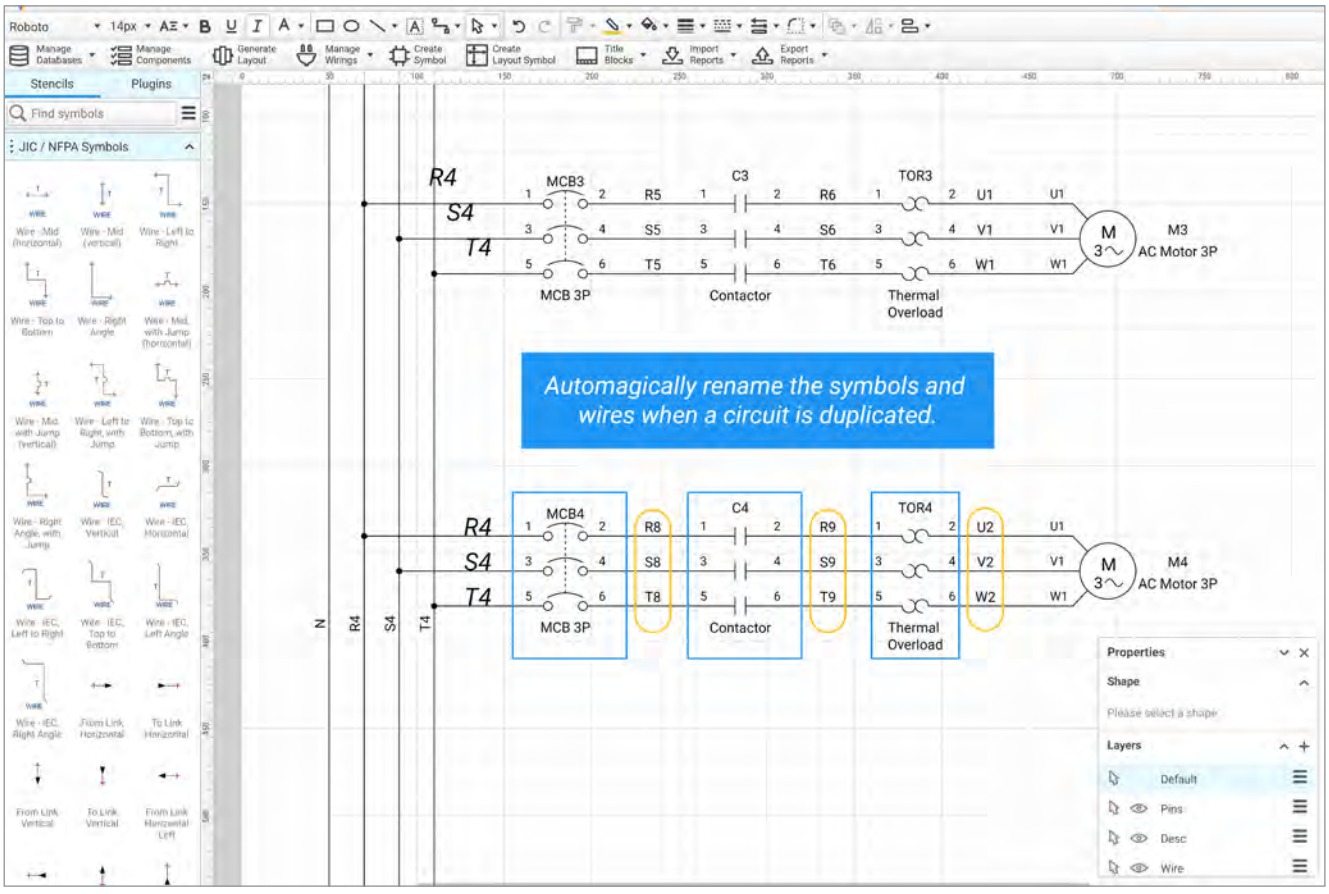
As a browser-based product, Onshape runs on any device—lightweight or heavy-duty, consumer grade or professional, Windows or Mac—but it might surprise you to know the graphics processing unit (GPU) in your local machine can boost its performance.

"If you have a better machine, the software gives you better performance. That's because it's architected to take advantage of your local GPU," says John McEleney, co-founder of Onshape.

Modeling on the iPad

Most people might not think of the Apple iPad as a 3D modeling device, but Shapr3D is poised to change that. The software follows the direct-modeling method, pioneered by products such as Ansys' SpaceClaim.

Shapr3D on iPad: Shapr3D takes advantage of the iPad's Apple Pen for a more natural way to draft and draw. *Image courtesy of Shapr3D.*



Radica's Electra Cloud software shares the same code based on its on-premise product Electra E9. *Image courtesy of Radica Software.*

It also offers ways to interact with parametric modelers through support of neutral 3D formats (OBJ, DWG, DXF, IGES, STL, STEP and more). The key to its user interface (UI) is the Apple Pen, which gives you a more natural way to draft and draw complex 2D profiles, splines and curves.

Regarding choosing iOS, István Csanády, founder and CEO of Shapr3D, says, "iPads are incredibly powerful and their performance is doubling every year. The latest iPad is as powerful as a few years' old desktop workstations."

Now, he is also looking toward Windows OS, the territory of mainstream CAD programs.

"We plan to release Shapr3D for Windows by the end of 2021," says Csanády. "The iPad, Mac and Windows versions are going to be feature-comparable, except, of course, some OS-specific features, like AR [augmented reality] on the iPad."

With tools for Boolean operations, constraints and snaps, Shapr3D is a robust environment for geometry modeling. What it lacks are the basic simulation and rendering tools included in many mainstream CAD programs. But then again, most mainstream CAD programs don't come with a $20-per-month price tag like Shapr3D Pro. The Basic version is free, and even the Pro version is free for one year for students and faculty members of educational institutions.

In its current form, Shapr3D is not a replacement for a standard CAD program such as SolidWorks or Autodesk Inventor. Still, as a quick concept modeler, Shapr3D is more than adequate, an ideal pre-CAD modeler.

"Over the next few years Shapr3D will mature to a full-featured CAD system. We plan to add many more features, including more sophisticated modeling workflows, photorealistic rendering and others," says Csanády.

Many feel a full-featured CAD program is too much of a hassle for quick concept exploration. In architecture, construction and engineering, the widespread appeal of SketchUp, a concept modeler, surpasses that of other professional building information modeling tools such as Autodesk Revit.

By the same token, the mechanical modeling market may need a pre-CAD concept-design tool. Recognizing this, Dassault Systèmes recently revealed its cloud-hosted software 3D Creator, a complementary offering to its mainstream CAD program, SolidWorks.

ECAD in the Cloud

Radica Software's flagship electrical CAD package comes in two flavors: on-premise and cloud-hosted versions. The latest on-premise version Electra E9 is available under perpetual licensing for $2,999 per user. The cloud-hosted version is available under subscription licensing, starting at $99 per user per month.

"In 2015, we made a decision to fully commit to cloud and developed an editing engine at vecta.io. We wanted to bring the best of cloud computing, including easily sharing,

modern JavaScript-based technology and all the advantages of the cloud to electrical engineering," says Thomas Yip, CEO of Radica Software.

The cloud version runs best from a browser over high-speed connections, but, according to Yip, "when there is no internet connection, Electra will save the data locally so that it can sync the data when it is back online. We also designed Electra to be able to work on low bandwidth, yet still achieve desktop performance."

Electra E9 and Electra Cloud share the same code base; therefore, you can exchange native files between the two. Electra can also exchange data with mechanical CAD programs via DXF export, as well as DXF and DWG import.

From Desktop to Thick Client

Thick client products such as Autodesk Fusion 360 run primarily from a workstation that meets the software's requirements, but also offer optional cloud-hosted services, for example, on-demand computing power to speed up generative design exploration, simulation or rendering.

The latest offerings from Dassault Systèmes unveiled as part of its SolidWorks brand update include 3D Sculptor, a browser-based subdivisional modeler; and 3D Creator, a cloud-based 3D modeling and collaboration program.

"The next generation of designers and engineers are growing up with instant access to everything from a variety of devices—documents, spreadsheets, videos and TV. There is no reason for them to expect any different when it comes to product development software. In fact, it isn't restricted to just the next generation; this is being demanded and utilized today," observes Mark Rushton, Dassault Systèmes SolidWorks product portfolio manager.

Dassault Systèmes also offers a trial version of its mainstream CAD package SolidWorks from the cloud (SolidWorks.com/online-product-trials), proving it has the ability to deliver the whole product from the cloud if it chooses to. The product is also available for short-term subscription licensing, mirroring the way SaaS products are marketed. But don't expect the company to offer browser-based SolidWorks anytime soon.

"Doing this is great for a trial but as a solution, it's missing out on a lot of opportunities," Rushton says.

Dassault believes it needs to offer new products built from the ground up to address different problems.

"The browser-based 3D Creator and 3D Sculptor are the precursors of a new lineage of SolidWorks products—many more to come. We are not simply re-engineering CAD applications but literally inventing a modern way to develop virtual twins that rely on generative and AI-assisted algorithms and automation, tight integration with multiphysics simulation all the way into material science and manufacturing," Rushton says.

The Many Shades of Cloud CAD

Desktop CAD software is the established norm; it still remains the preferred option for many CAD users. It has to be fully installed on the user's hardware, most likely a workstation. Its performance is determined by the CPU and GPU horsepower and the memory footprint of the hosting hardware. It's designed to be used on a personal machine; it's not typically accessible from the web.

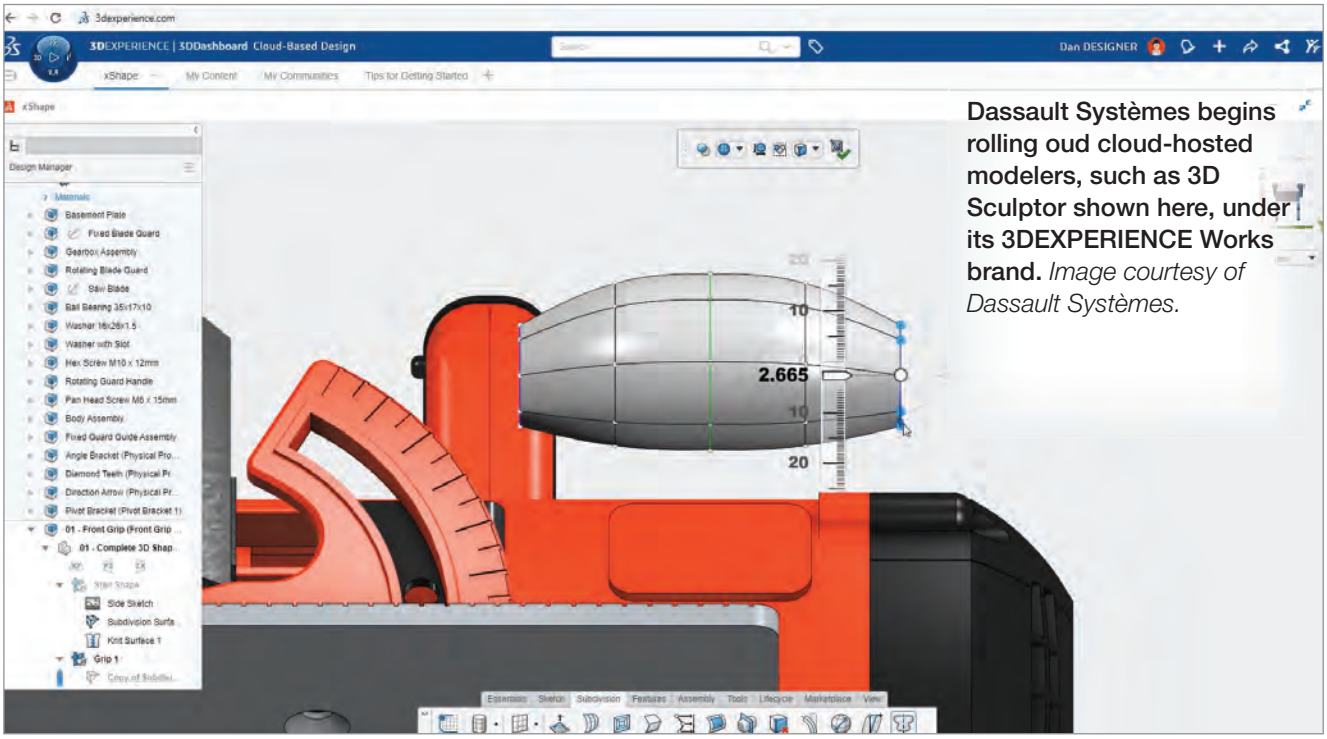
Browser-based CAD software, such as PTC's Onshape, needs no installation. It's architected from the start to run from a browser, much like Facebook or a Google Doc. Therefore, its performance depends more on the internet connection than the horsepower of the user's own hardware. Browser-based CAD tends to come with cloud storage, which allows users to upload and manage their project files online. It can be accessed anywhere, using any device, provided it connects to the web.

Thin-client CAD, or app-style CAD software works much like a smartphone app. A small program—the absolute minimum required to operate the product—is installed on the user's machine, but most of the functions are delivered remotely over the web. Typical consumer PCs, mobile tablets and smartphones can host the client app, but they need a good internet connection to run the app. Without an internet connection, the features available are limited to a bare minimum, or none at all.

Thick-client CAD software such as Autodesk Fusion 360, must be installed on the user's machine, with additional features made available from the cloud. The locally installed program facilitates the software's primary functions; therefore, the program's performance is dictated by the user's hardware specs. The user can run the software offline, but specific cloud-driven features will be inaccessible during that time.

Related story:

"PTC Snatches Up Cloud CAD Pioneer Onshape," October 2019, https://www.digitalengineering247.com/article/ptc-snatches-up-cloud-cad-pioneer-onshape/



Dassault Systèmes begins rolling oud cloud-hosted modelers, such as 3D Sculptor shown here, under its 3DEXPERIENCE Works brand. *Image courtesy of Dassault Systèmes.*

Just like its closest rival Autodesk Inventor giving birth to Autodesk Fusion 360, SolidWorks is also morphing into something tightly coupled with cloud-hosted features.

"Our latest version of SolidWorks fits by all accounts the definition of thick client. It is licensed, installed, updated and fully connected to the cloud services of the 3DEXPERIENCE Platform," notes Rushton.

Converting a historically desktop-installed product to a thick-client product does entail some compromises, but for the better for many, Rushton believes.

"For instance, you lose the need to manage who has which licenses assigned to them. It's all handled through the 3DEXPERIENCE Platform Administrator Dashboard. You also lose the requirement of an on-premise server to store all the data securely and manage its revisions. I doubt anybody would regret these losses since you gain the efficiencies and security of data in a state-of-the-art cloud infrastructure with the highest security standards," he says.

Then the Pandemic Happened

The move from the desktop to the cloud is gradual and incremental, but the pandemic might be behind its acceleration.

"A confluence of existing factors driving cloud transition has been further accelerated by the COVID-19 crisis: Cloud spending rose 37% to $29 billion during the first quarter of 2020. This trend is likely to persist, as the exodus to virtual work underscores the urgency for scalable, secure, reliable, cost-effective off-premises technology services," according to PricewaterhouseCoopers.

Rushton says, "Work has to continue when people are not in the office, and companies want to benefit from talent that is not necessarily centrally located, so leveraging knowledge and knowhow from wherever it may be, is where the 3DEXPERIENCE platform on the cloud comes into its own. And the best part of the new 3DEXPERIENCE Works Portfolio is that, whether our customers decide to stay on desktop, connect to the cloud, or run in a browser, they are guaranteed that all assets are compatible." 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

- **Autodesk:** Autodesk.com
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- **Radica:** RadicaSoftware.com
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Closed-Loop Digital Twin on the Factory Floor

A manufacturing closed-loop digital twin can use analytics and data to cut costs and avoid unplanned downtime.

BY TOM KEVAN

Though the digital twin is still in the early developmental stages, the concept generates great interest, promising unprecedented visibility into the state and performance of products and processes throughout their lifecycles. Though a full spectrum of industries can apply the technology, the concept called a closed-loop digital twin seems to hold great potential for the manufacturing sector (Fig. 1).

The technology raises the prospect of dramatic changes in how machine makers and manufacturers hone their products and optimize equipment and processes. A manufacturing closed-loop digital twin aims to use analytics and data from a broad spectrum of business and operational sources to minimize costs, avoid unplanned downtime and optimize quality, yield and efficiency.

Industry watchers see closed-loop digital twins tightening the connection between the machine builder, line planner and manufacturing organizations. The goal is to help manufacturers learn to use their lines better—to enhance speeds and quality—and promote more efficient supply chains.

"By having a closed loop, one can ensure that insights get into the hands of plant personnel in real time, enabling running of the day-to-day operations most effectively," says Ranbir Saini, senior director, digital product manager, at GE Digital.

Integrating Manufacturing

The idea behind these closed-loop digital twins is to achieve real-time integrated manufacturing.

The main vehicle for this integration is the virtual model,

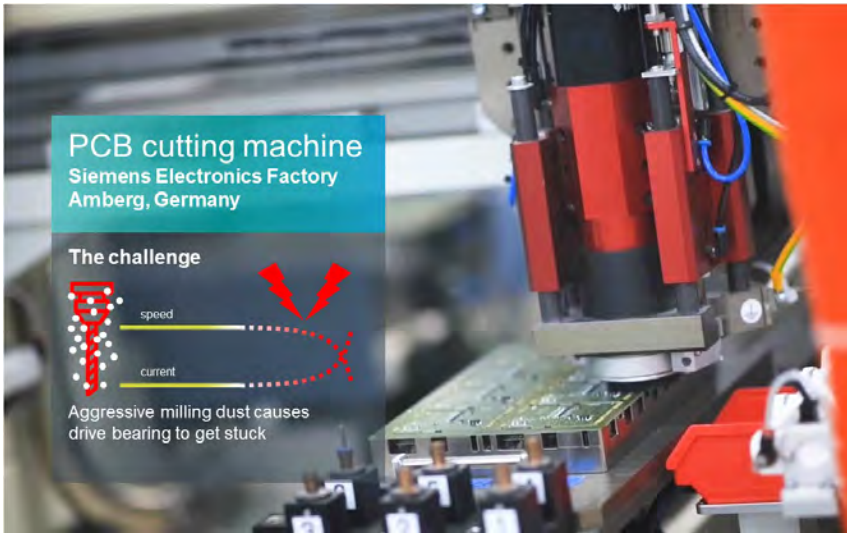

Fig. 1: Closed-loop digital twins provide manufacturers and machine makers with "living" models of everything from individual production machines to plantwide operations. In the image here, dust from a milling operation on PCB boards causes drill bits to get stuck, causing unplanned downtime. To remedy, automation engineers added sensors to the machine; readings were fed to a closed-loop digital twin. With artificial intelligence, the twin can predict machine breakdowns well before they occur. *Image courtesy of Siemens Digital Industries Software.*

which promises to enable automation engineers to benchmark production metrics in real time. Ideally, these models include all of the factors that affect efficiency and profitability of production, including data on machines, processes, labor, incoming material quality and order flow.

This level of closed-loop control has become practical as a result of advancements in hardware, software, sensors and systems technologies. These enhancements provide engineers with a more complete data set, including real-time information captured by a broad spectrum of sensors, which play an increasingly important role in the creation and maintenance of closed-loop digital twins.

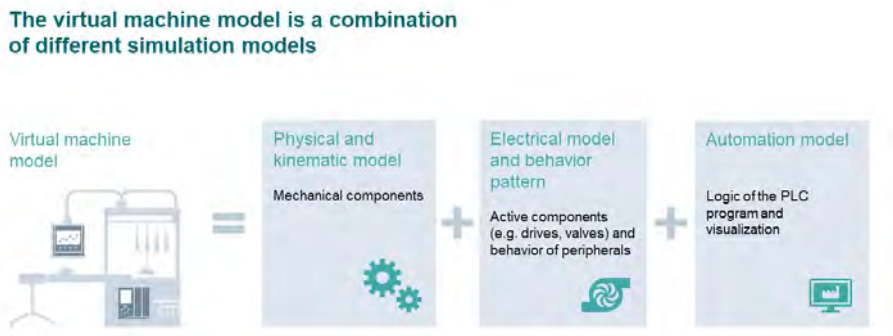

Fig. 2: A closed-loop digital twin of a machine should approximate the physical machine to rapidly confirm the machine can perform consistent with the engineer's design and can use physical data from the real machine to confirm. The diagram shows a virtual machine model, a combination of three simulation models. *Image courtesy of Siemens Digital Industries Software.*

Leveraging these new capabilities, proponents contend, data modeling will be able to provide a single source of truth, as well as the kinds of data required to support analytics and real-time decision-making.

How to Develop a Closed-Loop Digital Twin

Manufacturers can use closed-loop digital twins on many scales, including individual pieces of machinery, entire production lines or plantwide operations.

To learn how an engineering team creates a closed-loop digital twin for individual manufacturing machines, it's best to look at the development process as it moves through the various phases of the asset's lifecycle, building the closed loop, layer by layer.

"We tend to describe the machine digital twin lifecycles in three phases—design, manufacturing and production," says Bill Davis, solution director of industrial machinery and heavy equipment industry at Siemens Digital Industries Software.

"It is important to have a digitalization strategy that covers all these phases because information is often created in one phase and leveraged in another. This is a holistic view of the closed loop, but it's just as important to recognize that each phase has information created, managed and leveraged within it as well."

A first step in building a closed-loop digital twin in the design phase is the identification of the key elements required to support the digital twin. Here, the engineering team builds a model or a set of models that describe the behavior and capabilities of the machine.

A 3D representation of the machine often meets this requirement, but the reality is that all engineering domains involved produce their own specific models, such as electrical and pneumatics schematics or programmable logic controller/human machine interface (PLC/HMI) programs.

To accommodate this, the engineering team needs a single simulation model that represents all engineering domains, along with the expected machine operations that connect intended use cases to expected outcomes. This virtual machine model combines automation, electrical and kinematic software simulation models (Fig. 2).

The combination of the three software models is referred to as "software in the loop." This means that engineers can simulate the behavior of the machine as close as possible before anything is physically built.

In this case, the code running in the virtual PLC and HMI triggers the simulations in the physical or kinematic models, so engineers can graphically see the movement of machine components, as well as product moving through the machine.

This allows the engineers to verify the sequence of operations and error handling. The goal is to prove out the automation code virtually before it is loaded into the physical PLC controlling the machine.

Complementing the digital side of the simulation, the model should also internalize sensor readings to approximate the physical machine's performance, and confirm that the virtual model is consistent with the engineer's design. The engineer can then use physical data from the real machine to establish performance.

Once the real machine is built, the engineers have the first opportunity to use the closed-loop digital twin by connecting the physical or kinematic model to the PLC in the machine.

"Here, data from the running machine is triggering the simulations, and the model mirrors the real machine behavior," says Davis. "We can then verify if the physical or

kinematic models are correct and ultimately fine-tune the running of the machine."

The Larger Picture

When developing closed-loop digital twins on larger scales—such as for production lines or plantwide operations—it's important to mind the distinctions between implementations for individual machines and those for broader applications. Each case has very different practical considerations.

For example, with broader implementations, the information flow should be directed at the productive output of the line or plant as a total.

"We can collect data over a period of time," says Davis. "For example, what was the data from last night's 8-hour shift? This data can then be used for bottleneck analysis and as the basis for a more accurate simulation of how the next shift will run when combined with the new orders for that day."

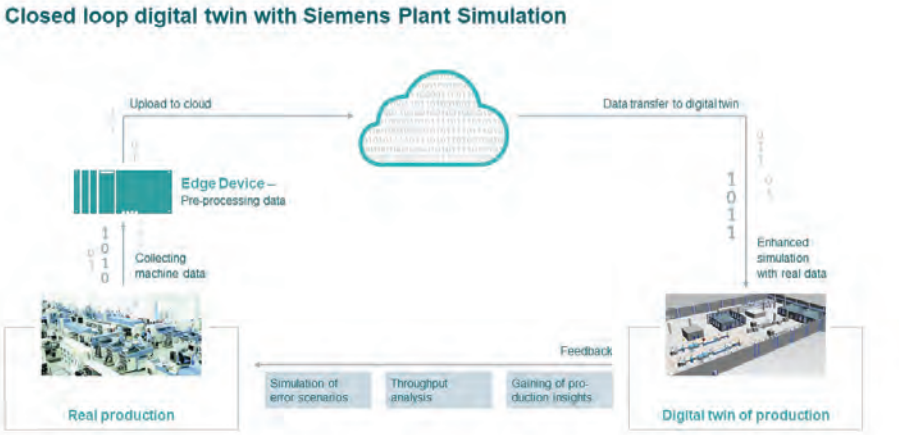

Fig. 3: Manufacturers sometimes use a combination of edge and cloud technology to collect and preprocess data before sending it to the closed-loop digital twin, which then feeds the data from remote locations into the simulation models. Connecting running data to a digital twin provides more insight as data is directly linked to assets and can be visualized in a 3D factory environment. *Image courtesy of Siemens Digital Industries Software.*

Many factors can complicate large-scale closed loops. For instance, a production line often consists of equipment from multiple machine manufacturers, with varying degrees of complexity and maturity, especially in the case of Internet of Things technology and controls. Simple machines tend to have less control sophistication, and the same is true of older machines.

Further, many manufacturers deploy proprietary manufacturing processes, and they closely guard the technology, and choose to design their own machines. In these cases, organizations must create benchmarks and analytics from scratch, tailor data to the asset's unique features and set aside some general rules of thumb.

Windows on the Physical World

Sensors are a key underlying component of a closed-loop digital twin; they provide physical data on the asset's condition throughout its operating life. These bridges to the real world enable engineers and plant managers to remotely monitor, diagnose and resolve service issues, often in real time.

"With the power of sensors, service managers have unprecedented capabilities when it comes to taking proactive maintenance steps in real time," says Steve Dertien, executive vice president and chief technology officer at PTC.

"By implementing sensors within an existing IIoT [Industrial Internet of Things] system, maintenance engineers have an instant connection to assets across the manufacturing floor, enabling their digital twins to automatically detect anomalous readings and forcing decisive action, thereby reducing downtime and optimizing maintenance planning/execution."

In one of the first steps in closed-loop digital twin development, engineering teams leverage sensors that are already installed in machines and production lines. This requires an architecture that supports legacy data protocols that existing sensor systems use.

"Here, a case can be made for choosing popular data protocols, such as MQTT [message queuing telemetry transport] or OPC-UA [open platform communications unified architecture], for compatibility with modern analytics software," says Saini.

"This becomes especially important for near-real-time systems because data protocol translation is a big factor when measuring latency. The system used to collect data should provide modern containerized architecture to provide customers with the ability to vertically scale to provide support for new data protocols on an on-demand basis."

If the developers want to go one step further and add new sensors to the mix, the process becomes more complicated.

"In some brownfield situations, it may not be possible to add new sensing devices to existing control systems," says Colm Gavin, portfolio development manager at Sie-

mens Digital Industries Software.

"So, the simplest way to start would be to connect any new sensors to a small PLC, which can be used to feed the data up to a higher-level system, such as a SCADA [supervisory control and data acquisition] system," he says.

Once an architecture is in place to ensure adequate access to sensor data, development teams must contend with sensor data noise and relevance issues. Noise and relevance problems arise from the fact that sensors and data acquisition tools often generate more data than is needed to support a digital twin.

"Imagine having sub-second time series data for a collection from 100-plus different sensors on a product," says Jonathan Scott, a digital transformation evangelist at Razorleaf. "Some of those data points are useful in characterizing the digital twin, but most are just noise. Tools like Hadoop for summarizing big data are useful for this challenge."

Engineers must also normalize the data. This means expressing complex environmental inputs in terms that analytical models can use. These issues arise because of the heterogeneous nature of the data streams that the sensors and machines on production lines generate.

"It is not simple to feed sensor data into simulation tools until some normalization takes place," says Scott. "Evolving standards and multidiscipline analysis and optimization tools should help in this area."

A Place for Edge Devices

A technology closely linked to sensor use in closed-loop digital twins is the edge device. These local systems can capture data from a broad range of sensors and pass it on to higher-level systems, such as enterprise and cloud applications. When coupled with edge devices, sensors gain access to previously unavailable local data processing resources, and provide greater local control than simple store-and-forward devices. Edge devices also give sensors efficient entry points to manufacturers' operational technology and information technology networks.

In addition, edge devices provide good entry points to any cloud setup (Fig. 3).

"The best tools available for connecting sensor data to the cloud are edge gateways and devices," says Davis. "Gateways offer a sense of security in that they aggregate and condition the data for cloud analytics. If immediacy is needed, edge devices that can communicate either directly to the machine or through an intermediate PLC are ways to minimize the data leakage and enhance local response when sensors indicate fast response is necessary."

All these features make edge devices extremely helpful for plant engineers adapting and incorporating existing equipment with the broader plant closed-loop process.

Challenges, Tradeoffs and Solutions

Given that closed-loop digital twin technology is still new, it should be no surprise that implementing a closed-loop digital twin entails significant challenges and tradeoffs. Some of these stem from conditions on the manufacturing floor. Other concerns involve how time-bound the feedback loop must be.

Many challenges that arise from the manufacturing environment are a result of the age of technologies in play.

"Accessing, standardizing and analyzing the physical and digital data may not be as easy as anticipated, considering that many machines on a factory floor have been there for 20-plus years and their digital definition—including CAD files—may not exist. And on the physical experience end, the sensor data can be corrupted by incomplete information," says David Immerman, senior research analyst at PTC.

Other challenges stem from the diversity of technologies that go into the digital twin. For example, developers establishing a closed-loop digital twin of a machine in a production line must contend with a daunting mix of hardware platforms with which the machine must interact and support.

Complicating matters further, most hardware manufacturers offer their own proprietary code and authoring tools. As a result, often machine integrators and line builders find themselves writing PLC, HMI and even SCADA integration code from scratch.

Two technologies offering the best prospects for overcoming these hurdles are standards and open tools and architectures.

"The heterogeneity of platforms and interfaces remains the single biggest challenge to overcome," says Sameer Kher, senior director of R&D at Ansys. "Relying on standards and encouraging open ecosystems is essential to address this challenge." DE

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MORE INFO

- **Ansys:** Ansys.com
- **GE Digital:** GE.com/digital
- **PTC:** PTC.com
- **Razorleaf:** Razorleaf.com
- **Siemens Digital Industries Software:** sw.siemens.com

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Frontline 3D Printing

Additive manufacturing comes to the rescue in earthquake, tsunami and even war.

BY KENNETH WONG

In the early days of the pandemic, 3D-printed face shields and ventilator components grabbed the spotlight in the media, revealing the technology's potential to swiftly respond to unforeseen disasters.

But this isn't necessarily a new use case of additive manufacturing (AM). Over the course of the technology's adoption, 3D printing hardware and materials have gained traction in regions of earthquakes, conflict and a variety of natural disasters.

A Carry-On Printer

Eric James, executive director of Field Ready, occasionally flew with a 3D printer as part of his allowable carry-on luggage. Over the years, he had to figure out how to fit a 3D printer into a commercial jet's overhead bin and how to operate it in war-torn, disaster-hit regions where electricity and high-speed internet connection are not always guaranteed.

In the summer of 2012, he decided to take a break from his humanitarian projects. His vacation destination happened to be Mountain View, CA, in the heart of the Silicon Valley. This was his introduction to 3D printing.

"That's when I realized there's an opportunity to do something meaningful here," he recalls. "How could I use this technology to make things that are useful in a refugee camp for example?"

That became the central tenet of Field Ready. The organization's emphasis is in local manufacturing—using locally available talent and raw materials for humanitarian needs. Over the years, as he and his team race across Nepal, Syria, Iraq and more to save and rebuild lives, 3D printing became an integral part of their strategy.

The MacGyver in War Zones

Fast Company magazine describes Field Ready as "the MacGyver of tough problems in war zones" in an article. In the aftermath of Haiti's 2010 earthquake, James and his team found themselves printing batches of umbilical-cord clamps for the local hospitals on-premises.

"You can learn to print things in an afternoon. Then the rest is entirely up to you and your ingenuity. On the same day, you may print something to fit a pipe or repair a medical device, or a toy to encourage children to wash their hands with soap," James says.

During the recruitment process, Field Ready looks for those with 3D modeling skills to take advantage of AM. The organization has also developed a catalog of ready-to-print parts that range from a trickle-water filter and air dehumidifier to scalpel-truss handles, each illustrated with a CAD model and marked with the appropriate material type for printing. The latest catalog lists 133 items.

At the same time, the team develops the necessary skills in the local population as part of its capacity building that

Ram Chandra, Field Ready's first hire in Nepal, inspects a 3D-printed waterpipe fitting part.
Image courtesy of Field Ready.

Hyundai uses a mix of generative design and 3D printing to develop Elevate, a concept car for search and rescue. *Image courtesy of Hyundai and Autodesk.*

allows others to continue using the technology for the long haul.

"We have a thriving program in Iraq to support local maker spaces," says James.

3D Printing in Kathmandu

In April 2015, Nepal was ravaged by the Gorkha Earthquake. The disaster killed nearly 9,000 people and injured nearly 22,000 ("2015 Nepal earthquake offers clues about hazards," June 2019, Stanford Earth). Field Ready was on the ground shortly thereafter.

One of Field Ready's first hires in Nepal, James recalls, "had studied 3D printing in university as an engineering student but had never used it in real life. It was only when he joined us that he was able to use it for real."

In 2016, Ram Chandra Thapa, Field Ready's Nepal-based staff member, launched a local 3D printing company called Zener Technologies to offer printing, scanning, reverse engineering and design services.

Portability, affordability and durability often determine what printer Field Ready would use. The team has used machines from MakerBot, Ultimaker and Formlabs, among others.

"It benefits us to have a number of similar machines, so we can reuse the same spare parts, materials and expertise for our projects," James says.

James recognizes big-name printer makers likely devote most of their resources to supporting automotive and aerospace customers—an economic reality. However, he hopes they also consider the needs of niche users like Field Readyin their hardware designs.

Equipping all 3D printers with Wi-Fi and web connectivity is fine, but requiring a software download as part of the setup, James points out, could be quite a hassle in certain parts of the world.

"With one of our brand-new machines, we had to bring it from the field to a nearby hotel with internet connection to be able to set it up," he recalls. On behalf of those trying to print critical parts in the frontiers of humanitarian works, James says, "Make them easier to use, and don't assume all your users have 24/7 web connectivity."

Drones for Disaster

Like many Japanese adults, Yuki Ogasawara and Ryo Kumeda remember the 2011 Great East Japan Earthquake followed by tsunami waves that prompted a nuclear plant meltdown in Fukushima.

Naoto Kan, Prime Minister of Japan at the time, said, "In the 65 years after the end of World War II, this is the toughest and the most difficult crisis for Japan" ("Anxiety in Japan grows as death toll steadily climbs," CNN, March 2011).

At the time, Ogasawara and Kumeda were 15-year-old students with an interest in robotics. They had won the Fighting Spirit Prize at the National High School Programming Contest with a smartphone-controlled robot; they also earned seventh place in the RoboCupJunior Japan Open rescue division.

In discerning how to apply their talent to help the country, Ogasawara and Kumeda formed Team ROK as students at the National College of Technology. Their brainchild was X VEIN, a search-and-rescue drone, which made its public debut at Maker Fair Tokyo 2016.

Japanese students Yuki Ogasawara and Ryo Kumeda developed the search-and-rescue drone after the 2011 Great East Japan Earthquake. *Image courtesy of Team ROK and Autodesk.*

Winged for the Future

"Most parts in X VEIN were printed with a 3D printer, except the electronics component such as the cameras, motors and PCBs [printed circuit boards]," Ogasawara says. "I chose nylon plastic (PA 12) for its material. SLS [selective laser sintering] was the method we used to print in the nylon material as it's suitable for very complex structures like X VEIN, and there was no need to use support material."

Ogasawara and his co-creator Kumeda used Autodesk Fusion 360 and applied generative design to keep the drone as light as possible for aerodynamics.

"For a drone to hover in midair, the lift it generates must exactly match its own weight," explains Ogasawara. "Variations of even 5% of overall weight change how operators must control the drone. It is crucial we make our drone as light as possible."

Because of Japan's strict laws governing the use of unmanned aerial vehicles, X VEIN didn't get to prove its potential in actual rescue missions.

"Looking at examples of the latest drones, there is no other example of an aircraft that has a propeller coverage area as large as that of the X VEIN, while keeping the aircraft compact," observes Ogasawara.

Team ROK never intended X VEIN to be a commercial product, so it was never mass-produced. Ogasawara still hopes, with local government approval and support, he may one day get the chance to send X VEIN on a real mission.

A Walking Car

John Suh, VP and founding director of New Horizons Studio, Hyundai Motor Company, thinks cars should have not only wheels but also legs—that is, if it's intended for search and rescue. The studio he runs launched in September 2020 with the goal "to create the world's first transformer-class vehicle, also known as the Ultimate Mobility Vehicle," he says.

He recently presented his concept car at Autodesk University (AU) Virtual 2020, an online version of the annual Autodesk user conference. The futuristic off-road vehicle he and his team came up with is called Elevate.

"It can overcome obstacles, cross gaps and go where even off-road vehicles will have a difficult time going," Suh says.

"The software forced us to look at different manufacturing processes—3D printing versus cast-magnesium," says David Byron, manager of Design & Innovation Strategy from the Elevate project partner Sundberg-Ferar. "There are different cost factors, strength and performance considerations."

Generative design was a good fit for the project because "it changes my mentality from subtractive method to growing mentality. It's a different way of creating a sculpture," Byron adds.

In an interview with the press, Suh revealed, "the structural elements of the next generation legs for Elevate are under Generative Design study." He believes Elevate can be deployed in resource delivery, search-and-rescue missions and even lunar exploration.

The project involves the use of lattice structures, additive manufacturing and multidisciplinary collaboration, facilitated in Autodesk Fusion 360.

"Generative design allowed us to tackle a lot of complex problems that would have taken somebody a long time to solve manually," Suh says. "I call it a mind multiplier." 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

- **Autodesk:** Autodesk.com
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- **MakerBot:** MakerBot.com
- **Ultimaker:** Ultimaker.com
- **Zener:** Zenertech.com

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Sustaining the Future of 3D Printing

Experts share their sustainability approaches for manufacturing the way to a more planet-friendly future.

BY STEPHANIE SKERNIVITZ

3D printing has many merits, two of which are its ability to generate less waste in the final product compared to other manufacturing processes, and that it lends itself to functional design. Yet it's not enough to rest on past environmental achievements if companies expect to remain successful green leaders well into the 21st century. Manufacturers that anticipate not only surviving but thriving in the future are constantly seeking ground-breaking ways to "green" their processes. Under the sustainability umbrella, there's a push toward more recyclable materials, green-certified best practices and an enhanced global supply chain to name a few. In what follows, experts across the industry share their recipes for a future filled with planet-friendlier processes.

State of the Industry

Manufacturing comprises up to one-fifth of emissions worldwide, according to Bryan Crutchfield, vice president and general manager, Materialise. "AM is often one of the first technologies that comes to mind when considering sustainable alternatives." Yet practices that companies implement don't always qualify as truly sustainable.

COVID-19 actually helped advance the sustainability conversation in additive manufacturing in particular in taking sustainable suggested practices from good ideas to implementable actions.

"The COVID-19 crisis created momentum for additive manufacturing in 2020," Crutchfield says. "3D printing stood out as a viable way to make a difference and provide an alternative way to produce vital goods and supplies in a fast, local, cost-efficient and safe way. Now that people understand there is a choice for AM, there will be an increased need to produce these products in a sustainable way.

"Additive manufacturing can be a powerful tool for localizing and creating efficiencies in global supply chains to help improve manufacturing sustainability. By bypassing transportation requirements of a global supply chain, and in the small-batch manufacturing itself, companies can use local AM production to create less waste," Crutchfield adds.

Image courtesy of AMGTA.

RIZE's Andy Kalambi sees the sustainability discussion as a split between environment and socioeconomic aspects. "The world is grappling with two aspects of sustainability—environment and socioeconomic. With sustainability, additive can enable organizations to reduce waste by reducing lot sizes, enabling personalization and improving material science. Emissions-free additive manufacturing with low-energy intensity processes can significantly reduce the carbon footprint of manufacturing.

On the economic front, Kalambi points to how additive manufacturing can "drive inclusive practices to enable creation of new supply chains which empower micro-manufacturing. This can enable self-sufficient production, drive employment and diversity for significant societal impact."

Building Sustainable Manufacturing Strategies

Some experts suggest company leadership that endorses an open culture where all employees have a voice can lend itself to some worthwhile sustainability initiatives. In fact, the most effective sustainability strategies aren't always born out of high-level, boardroom meetings. To Sherry Handel, executive director, Additive Manufacturer Green Trade Association, the employee with the winning sustainability strategy at

An example of 3D printed stereolithography parts. *Image courtesy of Xometry.*

your company can be anyone from the shipping clerk, engineer, on up to the CEO.

"Sustainability initiatives can come from any employee within the company sharing an idea on better ways to do things that [have less negative impact on] the environment," she says. "The key to creating a sustainable culture within a company is for leadership to continually encourage employees to voice these ideas and suggest initiatives that will improve the environmental footprint of their operations."

To transition from idea sharing to implementation, Handel suggests that a formal process is necessary where employees can offer ideas, ideas are carefully considered, ones that make the cut are implemented and then the entire workplace is involved in carrying them out.

"Companies that consistently evaluate and improve sustainability efforts on an ongoing basis generally achieve the most success," Handel says.

Over at RIZE, safety is near the top of the list of concerns when tackling future-forward sustainable practices. "As the pandemic has clearly shown, a major issue facing manufacturers and indeed all businesses today is the need for us to work flexibly and [be adaptive] in the current and future crisis. Being safe anywhere—home, school or office—will be key in staying productive," Kalambi says.

Large Scale versus Localized Production

Simply relying on AM alone to increase sustainability efforts won't work, acknowledges Materialise's Crutchfield. He cites how BASF and Materialise recently conducted a Lifecycle Analysis (LCA) for the production of 1 million pairs of midsoles, assessing the environmental impact in all stages of the product cycle. The analysis concluded that for large series of identical products, "3D printing is currently not the most sustainable choice and has a bigger impact on climate change and the depletion of fossil fuels compared to the conventional manufacturing technology when printing in a large scale."

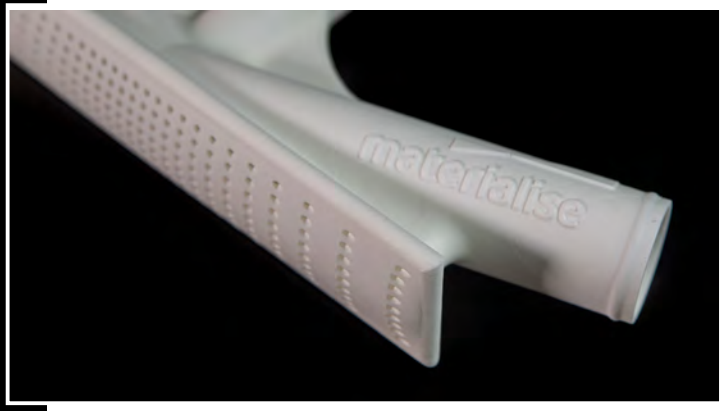
Though this analysis reviewed large series of identical products, Crutchfield says, "3D printing typically offers advantages for the production of smaller or customized series that can be produced locally. This helps to balance the environmental impact in favor of 3D printing. However, it remains crucial that the 3D printing industry continues to invest in technologies to make the 3D printing process more sustainable."

Prepping for Incoming Challenges and Hurdles

To stay one chess move ahead of your competitors by anticipating disruptions such as the supply chain lessons learned of 2020, Xometry's Greg Paulsen, director of application engineering, says organization of your plans is critical.

"Companies need to keep organized technical data and requirements around their products, so if there is any disruption on critical goods (e.g., part models or drawings), they can quickly change roles from a buyer to a sourcing agent. During the first few months of the pandemic, with shutdowns across the globe, many manufacturers were willing to step up to the challenge, but the technical needs were often not fully defined. Moving to 2021 and beyond, a product's digital information will be just as important as the product itself for continuity and building alternative suppliers," he explains.

Companies that are ready to create a more sustainable product with the aid of 3D printing, but don't know where to begin, should consider consultant services, according to Materialise's Crutchfield. "Experienced AM consultants can help minimize the risk associated with investments and accelerate timelines by sharing their knowledge of the technology's



Examples of parts created with Materialise Bluesint PA12 recycled materials. *Images courtesy of Materialise.*

strengths and identifying the right manufacturing method needed for each unique case."

Notable Tried-and-True Solutions

In 2020, Xometry in part focused on offsetting its carbon footprint for domestic shipping through collaboration with Dot Neutral. For instance, Xometry's GoGreen initiative allows customers to offset their manufactured goods' carbon footprint through an instant quoting opportunity. Customers can select methods of their choice, such as funding wind farms, solar arrays or forest conservation.

At Materialise, Crutchfield shares, in the past, when using only recycled material in AM, manufacturers would face a common issue known as the "orange peel effect," where material does not cool properly between layers. This results in a rippled surface and a final product largely unusable for manufacturing. That leads to manufacturers using a mix of new and reused material, which is not sustainable.

Materialise's Bluesint PA 12 offers a solution to the orange peel issue by using a two-laser process to keep the previous layer's material above a specific temperature while the next layer is printed. This results in a printed object with similar mechanical and visual properties, but printed with 100% recycled powder. In 2021, Materialise aims to have several laser sintering machines running with Bluesint PA12.

"In the start-up phase alone, the company aims to re-use more than five tons of powder that would normally become waste," Crutchfield says.

RIZE is "purpose-built for sustainability," according to Kalambi. "Every aspect of our technology and user experience is designed for sustainable and green practices. This includes UL GREENGUARD certified printers and materials, which ensure an emissions-free environment, recyclable and non-toxic materials." As recently as December 2020, RIZE achieved its fifth RIZE GREENGUARD certification, as a leading provider of GREENGUARD certified products in the 3D printing industry.

RIZE also is actively developing new business models that enable what the company refers to as "inclusive" additive manufacturing. "Our focus on Safe Anywhere Manufacturing of functional parts—both industrial and full-color consumer—makes us unique in the industry," Kalambi notes.

At UL, a certifier of environmental product declarations and creator of product category rules programs, the company considers itself on a joint mission alongside customers and stakeholders to make the world safer, more secure and sustainable—no small feat.

"We're committed to reducing our worldwide energy and water usage, to finding new ways to recapture and reuse water and divert waste from our landfills, and to improving efficiency in our buildings and laboratories," says Fred Arazan, senior business development manager, UL. Critical to achieving these goals, according to Arazan is its team of in-house expertise with dedicated task forces who are created to devise solutions. The company also supports and encourages the advances of employee-led environmental pilots and initiatives.

"UL has many different ways to help clients achieve their sustainability goals through certification and validation programs based on meaningful metrics and science," Arazan says.

Trends to Watch

Back at Xometry, their company has been integrating the need for distributive supply chains without the need for searching.

"Xometry has built a global supply chain that is accessed as if it was a single supplier," Paulsen explains. "Supply chain consolidators help get the best of both worlds: by reducing

the search effort needed by supply chain managers while ensuring that thousands of manufacturers have access to work even if their local customers are disrupted."

In Materialise's corner of the world, experts there suggest that the growing use of customized and personalized 3D printing will lead to adaptation of sustainable practices into new industries. Additionally, the company points to increased demand for recycled materials in products being created.

Kalambi at RIZE points to zero waste, low-energy intensity and low emissions as the top three focus areas where organizations that are "first-movers in sustainable production" are heading. "Readers should also look the new business models and changing consumer behaviors, which will make long-term secular shifts to such technologies," he adds.

Lessons Learned

The supply chain took a hit this past year in unprecedented ways, leaving room for ample takeaway applications. "2020 was a wake-up call for many businesses in understanding how sensitive supply chains are, and most of us do not believe this is a one-off event. Business models like Xometry have demonstrated how distributed manufacturing services can help mitigate disruptions to keep both buyers and suppliers up and running," Paulsen concludes.

Adds Crutchfield, "At Materialise, sustainability is not just a nice thing on our to-do list.

Currently, Materialise's 3D printing facilities use solar panels and recover heat from printers for its internal heating systems. In 2020, the company switched to 100% green electricity at Materialise HQ and aims to boost its own electricity production to 20% of total electric consumption by installing a solar field.

"[Sustainability is] necessary to achieving our mission of creating a better and healthier world," Crutchfield adds. "As we move into a post-pandemic world, sustainability will be a major battle to keep our planet on track. It takes all industries, not just additive manufacturing, but others will hopefully be able to learn from our example."

"Creating new sustainable production networks is an ecosystem play and needs active involvement and participation by multiple stakeholders—producers, supply chains, technologists and consumers," Kalambi says. "Working on only parts of the solution lead to suboptimal and sometimes counterproductive results. DE

Stephanie Skernivitz *is associate editor of DE. Send e-mail about this article to sskernivitz@digitaleng.news*

MORE INFO

- **AMGTA:** AMGTA.org
- **Materialise:** Materialise.com/en
- **RIZE:** RIZE3D.com
- **UL:** UL.com
- **Xometry:** Xometry.com

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

How to Keep **Work-From-Home** Engineering Secure

New technologies have become synergistically powerful enough to serve up engineering for remote, virtual use.

BY RANDALL S. NEWTON

When the pandemic response forced engineering departments to move to dispersed operations, at first there were probably as many work-from-home plans as there were engineering IT managers. Companies were spinning up solutions quickly, usually on an ad hoc basis. Collaboration tools like Microsoft Teams or the eponymous Zoom replaced in-house meeting rooms. File-sharing tools like Box, Dropbox and Google Drive became the common way to share data. No one realized work from home would last for months.

Almost a year later, product development is still coping with the myriad issues created by moving to dispersed engineering teams. The initial use of collaborative meeting and file sharing was relatively simple to deploy, but awkward for IT departments to manage. There were new employee-owned notebook computers as well as computers deployed for home use by companies. Companies like Zoom quickly implemented security features.

"It is a tangled spaghetti mess" for IT, notes Mike Leach, workstation portfolio manager for Lenovo.

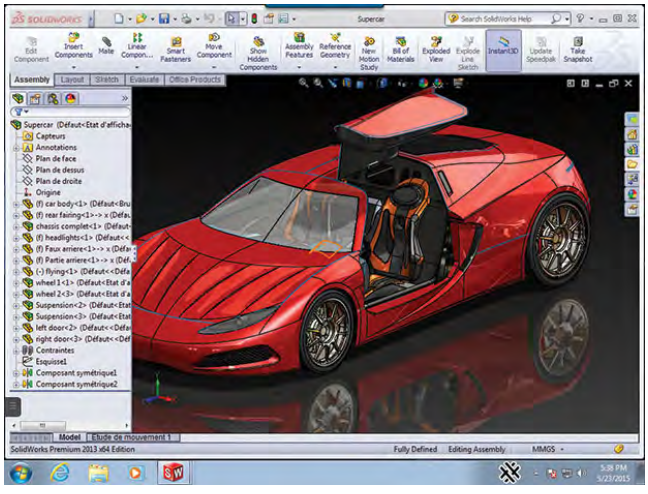
Such ad hoc connectivity for collaboration means there are many more potential gateways into the engineering network—gateway cybercriminals are eager to exploit.

"The best approach is a hybrid," says Lenovo's Leach. "[It should be] a mixture of the right hardware configured the right way. For IT decision makers, it sounds complex—and it is. We see multiple ways our users are responding. But the challenge is not fixed, it is constantly moving."

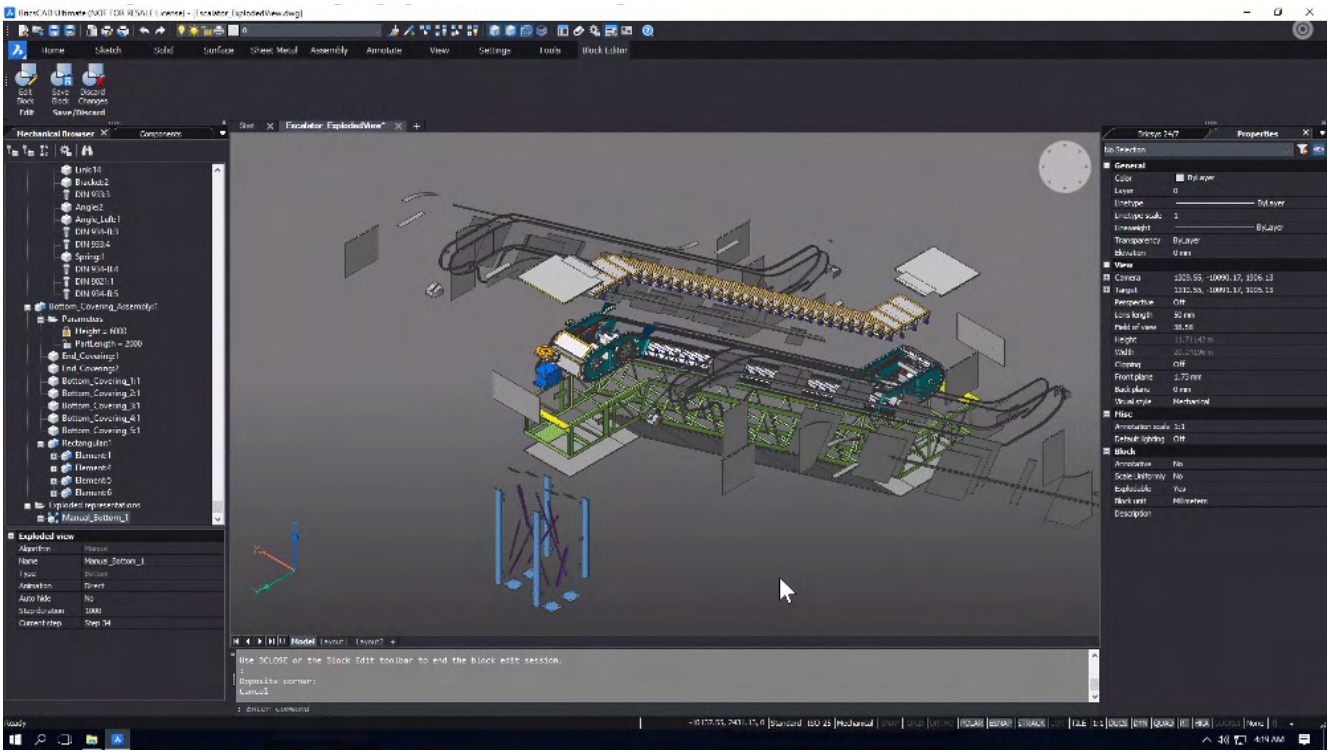
Three Mature Technologies

Only a few years ago, engineering was considered too complex and graphically intense for virtualization, which is defined as the use of one computer environment to host an environment that resembles a separate service (a Windows-based server can host a virtual instance of Linux, for example). Transfer times were too slow, processing power was decreased by the extra layers of software, there were limits on how many users could be online and security was not considered robust.

All that has changed. Three technologies have become more robust and synergistically powerful enough to serve



One of the first presentations of using CAD using virtual machine technology was a demonstration of SolidWorks running from a server, using Nutanix Frame technology. *Image courtesy of David Cohn.*



Bricsys Mechanical running in a session of DesignAirSpace, a CAD-specific virtual machine application running on NVIDIA GPU technology. *Image courtesy of DesignAirSpace.*

up engineering for remote, virtual use. Server-side rendering considerably speeds up the process of using graphics in remote sessions. Remote visualization performs intensive graphics operations on a high-end graphics server then generates a 2D pixel version that can be sent quickly to the remote users. Both NVIDIA and AMD offer technology for creating virtualized GPU sessions on a server, which can be fed to individual remote users.

The more an IT department can keep the actual computation work of engineering behind the company firewall, the more secure the remote computing session. A remote user on a virtualized CAD session can't plug in a USB drive and download engineering data—on the user's computer, the "data" is just pixels. Thus virtualization becomes the new technology that allows work from home for even the most intense computational activities—including product development—to work as well remotely as in the office.

Several virtualization platforms suitable for product development are now available. Here is an overview of a few leading products.

Mechdyne TGX

Mechdyne TGX is a desktop utility that connects remote computers with their servers back in the home office. TGX transmits only pixels between the two computers, allowing data to stay in the office while work continues remotely. It is designed specifically for graphics-intensive applications at up to Ultra HD (or 4K) resolution. The remote user can connect to either a physical or virtual machine as needed.

Lenovo sells TGX preloaded on its workstations; it is also available directly from Mechdyne. Leach says TGX "allows engineers to connect to the office workstation and get an 'as local' user experience." The version of TGX Lenovo ships is custom designed with NVIDIA to work with GPUs; the standard version is a CPU-based experience.

A copy of TGX must be running on each end of the transaction. TGX supports NVIDIA Quadro GPUs, using a built-in encoder to compress and send information from the host to the client, where the data is decoded.

"It is a low bandwidth, low latency solution," Leach says. "Other remote software is very 'laggy' by comparison." Mechdyne claims sub-10 ms response time, subject to the user's bandwidth.

AMD Remote Workstation

Another approach to connecting to a server back at the office is AMD Remote Workstation, included with every professional AMD GPU. Remote Workstation works with Citrix Virtual Apps & Desktops or Microsoft Remote Desktop Services to support remote workstations. The product was first released in 2018, when AMD realized it could "borrow" code from its server unit that would benefit remote users. Like Mechdyne TGX, Remote Workstation transmits pixels, not data. For users of AMD-equipped workstations, there is no extra software to install and generally no changes to settings are required.

Nutanix Frame

Nutanix Frame is a desktop-as-a-service (DaaS) solution that hosts every part of the desktop experience on the cloud.

Frame offers cloud-based virtual desktops for any application, and has a keen interest in CAD and related engineering technologies.

Frame allows an engineering group to set up, in the cloud, all the applications it currently uses. In creating this service, Frame didn't reinvent the wheel, so to speak. Instead it "leverages the best of existing technologies, packaging them up with a focus on performance, stability, flexibility and simplicity," says Alex Herrera, senior consultant at Jon Peddie Research and primary author of JPR's Workstation Report.

Frame can use Amazon, Microsoft, Google or Nutanix AHV as the hosting cloud provider. The service supports single sign-on technology popular in enterprise computing, and supports connections to file-sharing applications including Dropbox, Google Drive and Box. Several authentication services are supported, including Okta, Ping Identity and Auth0. Users connect through any HTML5-capable browser, whether it runs on a mobile workstation or a smartphone, with no special client software required.

Any Windows or Linux application will work in a Frame session, running on a virtual machine hosted in the cloud. Named customers who use the service include engineering software vendors Siemens and Autodesk. One of the first demonstrations of Frame showed an instance of Dassault Systèmes SolidWorks running in a browser, from a Frame remote session.

Zscaler Secure Web Gateway

Consulting firm Gartner lists Zscaler as the only company in its Leader category in its 2020 Magic Quadrant report on secure web gateway technology. Zscaler takes various web services to another level, offering a "zero trust" cloud-based platform for remote work.

Simply put, Zscaler provides a platform that securely connects any user, any device and any application over any network, using its own cloud-based technology. It offers "cloud-scale artificial intelligence," which allows it to treat SaaS solutions such as SalesForce or Microsoft Office 365 the same as an instance of a CAD or CAE product. It is compatible with a wide range of existing IT providers, including Microsoft, AT&T, Accenture, Okta, Amazon AWS, VMware, Crowdstrike and Silver Peak. Zscaler is designed to be used at enterprise scale, which may not be suitable for smaller engineering groups seeking its own solution within a larger company IT environment.

Teradici PCoIP Remote Workstation Card

The services listed already are software solutions. Teradici offers a hardware solution, the PCoIP Remote Workstation Card. PCoIP is short for personal computer over internet protocol. Users connect to a server or workstation with the PCoIP card installed, and then work using their software hosted on the remote workstation. The card converts and encrypts the transmission, sending only pixels. PCoIP uses AES-256 and NSA Suite B cryptography for security. Applications using Teradici's PCoIP card include most engineering applications, but also broadcasting, digital asset creation and other high-value visual applications.

Simplifying the IT Overhead

Using virtualizing solutions, whether hosted in an internal data center or from the cloud, offers IT departments a way to maintain security and keep costs down. Instead of issuing new mobile workstations to all creative staff, IT can deploy less expensive enterprise or consumer-class personal computers. Leach at Lenovo says some of their customers are issuing small form factor desktop units, like their P340 Tiny, and one or more monitors.

Each P340 Tiny is "configured like a thin client, running Windows and TGX." Remote users can attach up to four monitors to their P340, matching the home environment with their office setup. In daily use, each remote engineer connects to the office using a live virtual private network (VPN) to use typical enterprise software, but then switches to using TGX to connect to the specified engineering workstation. The remote computer's screens then become a window to the workstation. CAD drawings can be spread across multiple screens.

"How does productivity change?" asks Leach rhetorically. "An engineer can render on one screen and use CAE on another." For large engineering teams, each user can connect to their own workstation in the office, or to a designated workstation for each application, like CAD or a simulation program. "All of it stays inside the corporate firewall." DE

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MORE INFO

- **Jon Peddie Research:** JonPeddie.com
- **Lenovo:** Lenovo.com

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

Higher Performance, Lower Power

AMD provides advanced, system-level power management that improves engineering workstation performance.

Power management and efficiency is especially important when it comes to enterprise-class engineering workstations. How the various components of the workstation (including the GPU and CPU) consume power can affect the temperature of the computer, noise and vibration, system longevity, total cost of ownership, and overall performance.

And while all GPU manufacturers provide data on their components' specific power efficiency, AMD provides system power efficiency as well, which is a much more important consideration. The GPU does not operate in isolation; how the entire system utilizes power during compute-intensive operations will affect performance of more than just the GPU consumption alone. Because AMD has deep experience in developing both CPUs and GPUs, the company better understands how both processors work and how to make them work efficiently together. For example, a medium CAD workload AMD GPU like the Radeon™ Pro W5500 GPU in a system can use as much as almost one third less average system power than matching systems with a competitive P2200 GPU included, when under a typical SOLIDWORKS[1] solid modelling workload or up to nearly 20% less in Autodesk AutoCAD® model rotation workflows[2].

"When we measure power, we measure it at the wall, at the system level to see just how much power the product is consuming," says Glen Matthews, Director of Software Product Management at AMD. "We look at the entire workstation and how it performs with professional applications. We design the GPUs so applications run at the lowest possible power levels without sacrificing performance."

AMD Radeon™ Pro Software Intelligent Power Management capabilities allow the entire range of Radeon Pro GPUs to choose the optimal power for different professional application workflows. That can provide big benefits in terms of efficiency. For example, thanks to intelligent power management, high end GPUs like the Radeon Pro W5700 GPU can deliver up to 42% improvement in power efficiency in SOLIDWORKS Solid Modeling workflows, and up to 18% better system power efficiency overall versus the competition[3].

"The new 7nm-based AMD RDNA Architecture of the Radeon Pro W5700 GPU, combined with the intelligent power management software, allows the GPU to select the optimal power for leading design, rendering and simulation solutions. Compared to previous generations, the latest AMD RDNA architecture provides a substantial generational leap in performance per watt", according to Matthews.

Intelligent Power Management

Matthews goes on to explain, the AMD technology is able to adjust the GPU as workloads fall so that compute resources can be quickly allocated.

"We are not revving the engine, so to speak," he says. "We adjust the GPU power consumption dynamically, while monitoring the needs of the application. We can scale up and down in terms of the number of cores we are using on demand to deliver the required performance."

AMD's system-level expertise is on full display when it comes to managing power between the CPU and GPU when compute-intensive engineering applications are in use. "Most CAD applications put a lot of demand on the CPU," Matthews says. "If the CAD application is asking the GPU to draw something, but it is also calculating something, there is a significant amount of power consumption happening. For example, if you are doing solid modeling and also want to do something graphically, you are consuming memory on the CPU while the GPU is

Resources

- **AMD Radeon Pro Software Power Management**
  https://www.amd.com/en/technologies/radeon-pro-software-power-intelligence
- **AMD Radeon Pro Graphics Cards**
  https://www.amd.com/en/graphics/workstations
- **PDF on the importance of Thermal efficiencies**
  https://www.amd.com/system/files/documents/radeon-pro-thermal-efficiencies.pdf
- **Interactive tool for selecting the right GPU for your software**
  https://www.amd.com/en/graphics/pro-gpu-selector
- **PDF on why you should choose Radeon Pro GPUs**
  https://www.amd.com/system/files/documents/why-choose-radeon-pro-gpus.pdf

ramped up, and that can spike utilization."

In that scenario, AMD is able to keep all of the utilization on the GPU. The AMD software driver can look at what is happening, and recognize that the CPU is already occupied. Since the CPU consumes more power in the system, it is more effective to keep the workload on the GPU and keep the overall system power lower.

Why Does Power Consumption Matter?

Although the AMD architecture has advantages when it comes to power efficiency, much of the power management activity goes on in the background. Why should engineers and designers care about how power efficient their workstations are?

"Properly managing power consumption delivers many benefits to workstations," Matthews says. "Better power management leads to lower temperatures in the platform. When the workstation gets hotter, all of the fans in the system have to run as high as they can. That creates noise that you do not want to have in the system, and the fans contain moving parts that can wear out."

Movement and heat can impact system reliability as well. While the components of a professional workstation are designed to withstand relatively high temperatures, running at a lower average temperature means the system can last longer.

Finally, the system will consume less power, which can not only help lower utility bills, but also reduce the environmental impact of a large fleet of workstations—all without affecting performance for you, the end user.

1: Testing conducted by AMD Performance Labs as of January 21, 2020 on the AMD Radeon™ Pro W5500 graphics card and AMD Radeon™ Pro Software for Enterprise 20.Q1 and the NVIDIA Quadro® P2200 graphics card with the NVIDIA Quadro® Optimal Driver for Enterprise (ODE) R440 U4 (441.66) driver, on the same test system. Power was measured using the average of second-by-second value readouts from a Kill-A-Watt P3 P4400 wattmeter over a 5-minute timespan spent in the AMD internal SOLIDWORKS 2020 solid modeling workflow test. PC manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and other variables. RPW-273

2: Testing conducted by AMD Performance Labs as of January 21, 2020 on the AMD Radeon™ Pro W5500 graphics card and AMD Radeon™ Pro Software for Enterprise 20.Q1 and the NVIDIA Quadro® P2200 graphics card with the NVIDIA Quadro® Optimal Driver for Enterprise (ODE) R440 U4 (441.66) driver, on the same test system. Power was measured using the average of second-by-second value readouts from a Kill-A-Watt P3 P4400 wattmeter over a 30 second timespan spent in an AutoCAD® 2018 model rotation workflow. PC manufacturers may vary configurations, yielding different results. Performance may vary based on use of latest drivers and other variables. RPW-272

3: Testing conducted by AMD Performance Labs as of October 24th 2019 on AMD Radeon™ Pro Software for Enterprise 19.Q4 with Radeon™ Pro W5700 and NVIDIA Quadro® driver 440.97 with NVIDIA Quadro RTX™ 4000, on a test system comprising an Intel® Core™ i9-9900K, 32 GB 2133 MHz DDR4 RAM, MSI Z370-A Pro motherboard with BIOS version 7B48v2A, 512 GB Intel 760p SSD, and Windows 10 May 2019 Update. Power was measured using the average of second-by-second value readouts from a Kill A Watt P3 P3IP4400 wattmeter over a 30 second timespan spent in a SOLIDWORKS® 2019 solid modelling workflow. Results may vary. RPS-110

Democratizing Simulation Insights

A focus on post-processing capabilities and creative use of emerging technologies takes the democratization of simulation to the next level, boosting accessibility of analysis-driven insights.

BY BETH STACKPOLE

When designing a product such as a high-precision ski, it's often hard-core enthusiasts and non-engineering team members who have the most astute insights into what tweaks can recalibrate performance.

At Rossignol, simulation is emerging as the unlikely lingua franca to drive design decisions in near real time. An extended team of engineers and designers use Ansys Discovery Live to glean insights from simulations far earlier in the design process while making the findings available to non-experts in business roles.

Simulations are also instrumental in soliciting customer feedback to assess and drive design changes. The result: Simulation has become the shared language for exploring product performance and vastly accelerating Rossignol's time-to-delivery process from idea to prototype to release of the season's hottest ski.

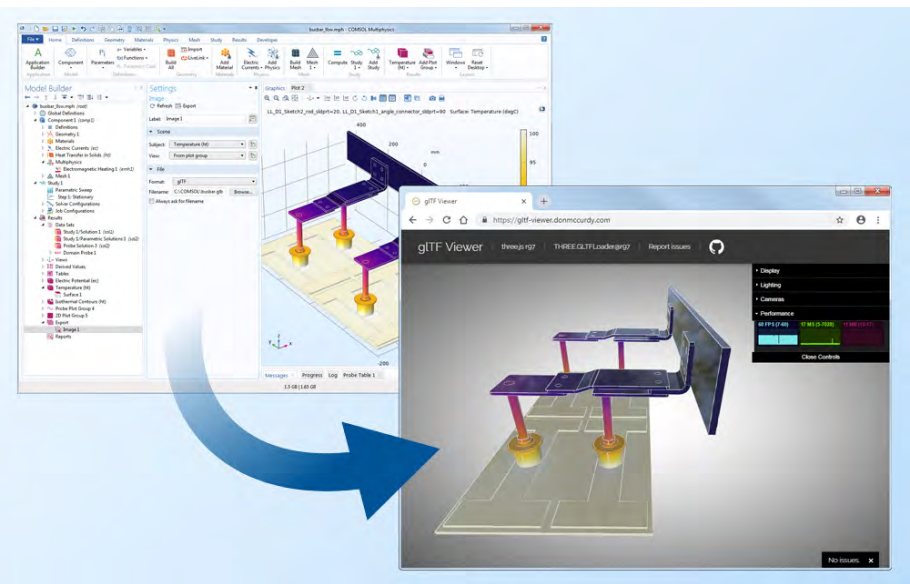
"We can immediately see how parties are going to react [to changes] and we don't have to wait a week to make a prototype," says Pierre Vauge, R&D project manager at Rossignol. "Within an hour, we can see five or six different parts and make a decision. With normal software, we can't do that."

The insights that Ansys Discovery Live produces create a visual way to demonstrate the benefits of the Rossignol technology to those who lack formal training in simulation or any background in physics model interpretation, he adds.

Companies are turning to simulation far earlier and more frequently as they try to work out kinks in a virtual world when it's easier to make design changes and far less expensive than building physical prototypes.

Making simulation tools easier to deploy has been one of the hallmarks of democratization, and intended to allow non-Ph.D.s and engineers not fluent in simulation tools to use the software without having to rely on experts and simulation specialists.

Moving forward, vendors are building all kinds of new post-pro-



COMSOL Multiphysics enables users to export 3D plots as gITF files for sharing in a variety of web-based graphics viewers, including Facebook posts. *Image courtesy of COMSOL.*

Simcenter STAR-CCM+ employs virtual reality to better understand flow patterns, which help to deliver critical performance insights to non-experts. *Image courtesy of Siemens Digital Software Industries.*

cessing functionality, from visualization tools to creative use of virtual reality and audio capabilities, into their software to democratize insights from simulation so a larger audience can use them to make smarter product-related decisions.

"There is a wealth of knowledge and insights that are hidden inside of simulation models—in the past, those insights were restricted to people who are experts, who know how to look at and interpret results, and make recommendations to someone else," says Ravi Shankar, director for Simcenter product marketing at Siemens Digital Software Industries. "Because of the imperatives digitization brings forth and because companies need to move quicker, insights need to be propagated throughout the enterprise so others in the organization can experience what simulation is revealing."

Immersive Experience

One way to surface simulation insights is to make the results more immersive using newer technologies such as virtual reality (VR). Siemens has embraced this strategy with a variety of offerings, including the idea of collaborative VR with Simcenter STAR-CCM+. With this capability, a less experienced simulation and VR user can tether themselves to someone with more experience and simultaneously navigate the simulation model results.

With collaborative VR, team members can confirm the correct assemblies and parts are in place before they build a full mesh; review and refine mesh strategies together to save time; and navigate a structure such as a large ship to understand how upstream airflow disruptions can impact what passengers experience at deck level.

"One person guiding and another following is a great way to experience the results of simulation," Shankar explains. "The insights are so much deeper than if you were just looking at some charts."

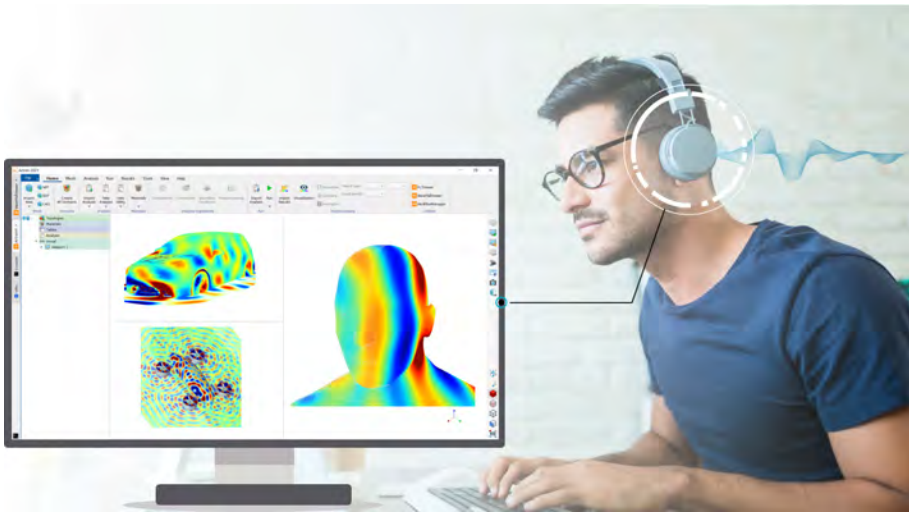
Screen Play is another Simcenter STAR-CCM+ capability, which delivers advanced animation capabilities to help users craft simulation insights into a compelling narrative—for instance, to showcase the transient process of particle separation in a cyclone or to communicate the placement and flow of AC units in a room to optimize temperature.

In Simcenter 3D 3.0, a new post-processing capability lets engineers explore acoustic simulation results with actual sounds, instead of frequency plots and charts, so they can understand the impact of changes on designs.

"Think about it as taking things away from an engineering-centric perception to a perception that everyone knows and understands because it's what you experience," he says.

Making simulation accessible to anyone, anywhere, on any device is a key focus of MSC Software. Now a division of Hexagon AB, the company is connecting its simulation software to its manufacturing and quality engineering software as part of a broader strategy around manufacturing intelligence.

For instance, the company has embedded a costing model



By allowing the generation of audio files, Actran, acoustic simulation software from Hexagon, helps non-experts accurately hear their products' sound and make relevant decisions to improve it. *Image courtesy of MSC Software.*

into its additive manufacturing simulation tools; engineers can explore how to optimize part positioning and the build strategy to minimize warpage and improve quality, while a manager could leverage the same simulation results to get insight into which printer to use or which materials lead to less expensive output.

"Knowing which combination of printer and material will lead to less cost is something that can come from simulation and it's interesting to the person doing the quotation—not just the engineer printing the part," says Roger Assaker, MSC Software's CEO. "It's the same simulation, but the post-processing is very different. You're translating simulation into actionable data that people can make decisions on."

To provide more engineering insights, MSC Software has created integrations and workflows to leverage simulation results in the tools manufacturing engineers and managers know how to read. One such integration is between Simufact, MSC's tool for simulating manufacturing processes, and eMMA, software that handles metrology data across the product lifecycle for industries like automotive stamping and car body assembly.

The integration lets a quality assurance engineer use what they are comfortable with—in this case eMMA, to look at tolerances, but instead of the results coming from a physical metrology device, they come from simulation software.

"It lets the trial-and-error process be done in simulation instead of in the design stage when you have the first prototype," he explains.

Moving forward, MSC Software is also working to integrate augmented reality/VR capabilities to make simulation results more life-like and interactive as well as serving up simulation results in an app-style format so they can be accessed from anywhere on a mobile device, Assaker says.

At Ansys, democratizing insights is based on allowing engineers to interact with findings in normal engineering terms, not just numerical analysis, and in being able to visually represent and manipulate 3D data on demand.

Ansys Discovery Live software enables stock-like tickers that provide easy-to-read interpretations of key design metrics such as safety factors or the likely breakage of a particular material, and the values are updated with every design change.

"We call these engineering insights," says Mark Hindsbo, general manager and vice president of Ansys' design business unit. "You get away from specialized language … and heighten an abstraction layer into engineering qualities that everyone in the domain is familiar with."

COMSOL's strategy for democratizing simulation data is centered around Application Builder and COMSOL Server. The platform allows simulation specialists to deliver insights to domain experts and non-simulation users in a language that's familiar.

For example, a domain expert in battery manufacturing knows exactly what's important to understand about thermal management as does someone building optical products in terms of tolerances or part placement. What they don't know is how to create and refine models, run tests or configure complex simulation software to deliver the desired insights.

COMSOL App Builder enables internal specialists to create highly customized modeling apps that domain experts can easily manage and run on their own, streamlines the workflow, allows feedback from collaborators that don't have a COMSOL Multiphysics license, and ensures simulation insights are pervasive throughout the entire design process without requiring everyone to understand simulation.

"Non-COMSOL users speak a different language than us," explains Bjorn Sjodin, vice president of product management at COMSOL. "We can't give them what they want, but users working with our tools and technologies can get the software to produce an output in the way they want it rather than the abstract representations we would create."

COMSOL has also steadily added new capabilities for easily sharing simulation. The Multiphysics software enables users to export 3D plots as gITF files for sharing in a variety of web-based graphics viewers, including Facebook posts, and

Ansys Discovery Live serves as a joint language for engineers, designers and skiers to explore product performance as they ideate and create future ski models. *Image courtesy of Ansys.*

to easily output reports in PowerPoint, which promotes self-service and encourages widespread distribution of insights.

Support for the cloud and its 3DEXPERIENCE platform are crucial to Dassault Systèmes' strategy to move simulation to a regular part of all product-related workflows.

The 3DEXPERIENCE platform makes simulation data easily accessible to all program stakeholders on the platform while the cloud enables collaboration, according to Christian Whiting, senior director of structural simulation for Abaqus on the 3DEXPERIENCE platform. The tools help a range of users understand results by serving them up in key performance indicators (KPIs) that are relevant for their particular role.

Other capabilities that make it easier for Dassault users to consume simulation data include a compare results tool, which allows users to easily do a side-by-side review of results from different design alternatives and a performance trade-off capability in 3DEXPERIENCE, which helps users compare multiple simulations in a dashboard via a web browser against a customized set of KPIs.

"This enables teams to share performance trade-off analysis with customers and partners and use simulation as an insight for business decisions," explains Delphine Genouvrier, portfolio manager on the SIMULIA R&D team.

AI and the Road Ahead

Beyond KPIs, dashboards and immersive post-processing capabilities, artificial intelligence (AI) will play a role in democratizing simulation software and key insights. On one hand, AI will enable a paradigm shift where CAE is used for design of experiments (DOEs), and helps feed models that allow for faster run times, improved productivity and better optimization of products.

AI can help generate synthetic data with characteristics similar to physical data from the original dataset when there is too little available data and, conversely, be used to develop reduced order models (ROMs) of finite element analyses when there is too much data to churn through.

AI can also be used to generate automated recommendations for how to configure a system, including selecting the optimal model.

"Most engineers know turbulence, but they don't know which numerical model will provide the best answers," says Ansys' Hindsbo. "AI can drive the software to configure the best set up and drive more accurate results and insights."

Though the efforts to make simulation insights more accessible are important, experts caution that democratization efforts should have some limits.

"If you are responsible for a department that has to design an aircraft or an engine, you wouldn't open the door to make design decisions to someone that doesn't understand the physics of the product," says Charles Hirsch, president of NUMECA. "You can't think of the concept of democratization as allowing anyone without knowledge of the physics to do the design work on an engine. That is not possible." DE

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

MORE INFO

- **Ansys:** Ansys.com
- **COMSOL:** COMSOL.com
- **Dassault Systèmes:** 3DS.com
- **MSC Software:** MSCSoftware.com
- **NUMECA:** Numeca.com
- **Siemens Digital Industries Software:** SW.siemens.com/

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

Greener **Futures**

Cummins' PLANET 2050 initiative aims for net-zero emissions by 2050.

BY KIP HANSON

Climate change. Greenhouse gases. Carbon emissions. Scientific evidence aside, these remain controversial—though clearly important—topics for many. Yet few of us on planet Earth would argue about the merits of waste reduction.

Engine, filtration and power generation company Cummins is actively on board as well, which is why this 100-year-old manufacturing company has set an ambitious goal: achieve net-zero emissions throughout its global organization by 2050. And they're using next-generation simulation, process and data management (SPDM) software from Ansys to undertake such a task.

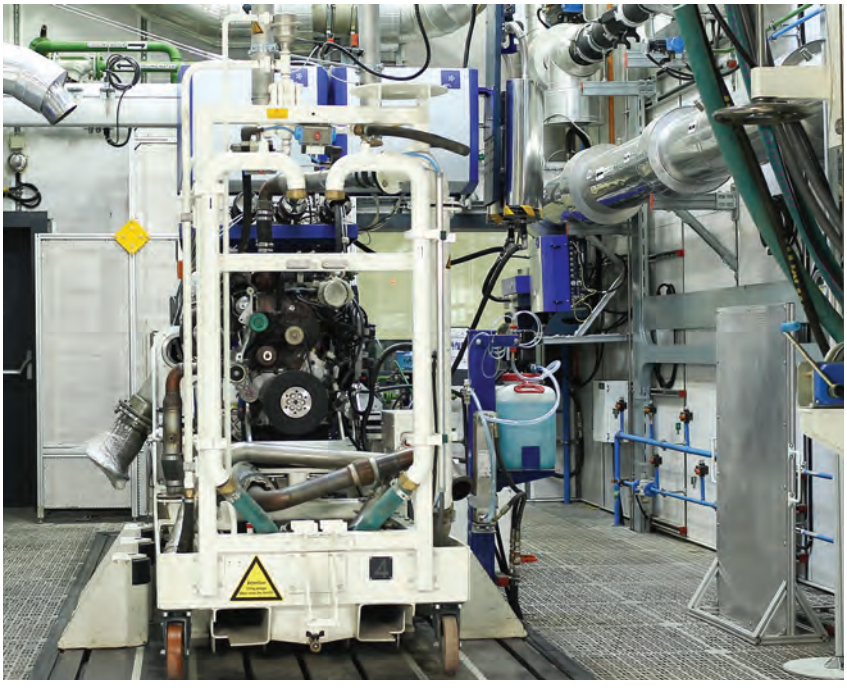
Responsible Stewardship

The initiative is called PLANET 2050, and it goes well beyond cleaner, more fuel-efficient engines and power-generation systems. An acronym that stands for Prosperity, Leadership, Advocacy, Nurture, Environment and Together, PLANET 2050 is a comprehensive plan to address and accomplish the topics listed here well before the self-imposed 2050 deadline.

In fact, the manufacturer has established eight interim goals that it is striving to reach by 2030. These include:

- Cut greenhouse gas (GHG) emissions from facilities and operations by half, and that of newly sold products by 25%.
- Partner with customers to reduce Scope 3 GHG emissions (indirect emissions that occur within the value chain of the reporting company) from products in the field by 55 million metric tons.
- Reduce volatile organic compounds emissions from paint and coating operations by 50%.
- Generate 25% less waste in facilities and operations as a percent of revenue.
- Eliminate single-use plastics in dining facilities, employee amenities and events, and reuse or recycle all plastics used in product packaging.

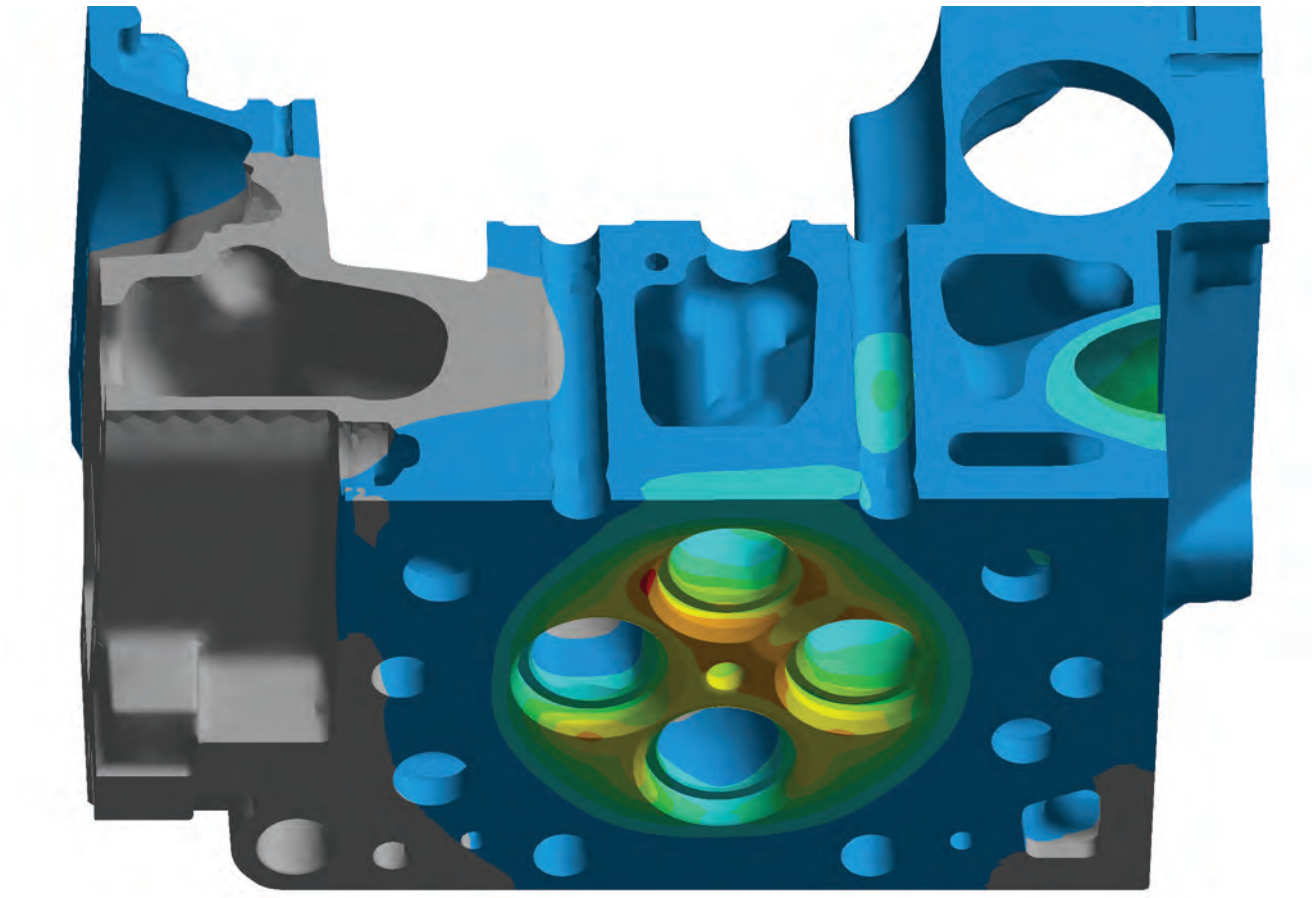
The company also has endorsed the CEO Water Mandate, a U.N. Global Compact initiative that seeks to "mobilize business leaders on water, sanitation and sustainable development goals." As a result, the Cummins community has conserved more than 16 million kL of water in its first two years alone, with plans for additional savings.



Though simulation plays an increasingly important role at Cummins, test benches like the one seen here remain a critical aspect of performance analysis. *Image courtesy of Cummins.*

Build It, Test It

Bob Tickel has been with Cummins for more than three decades. The director of structural and dynamic analysis, he and his team are not directly in charge for the PLANET 2050 project, but like the rest of Cummins' 61,000 employees, they are



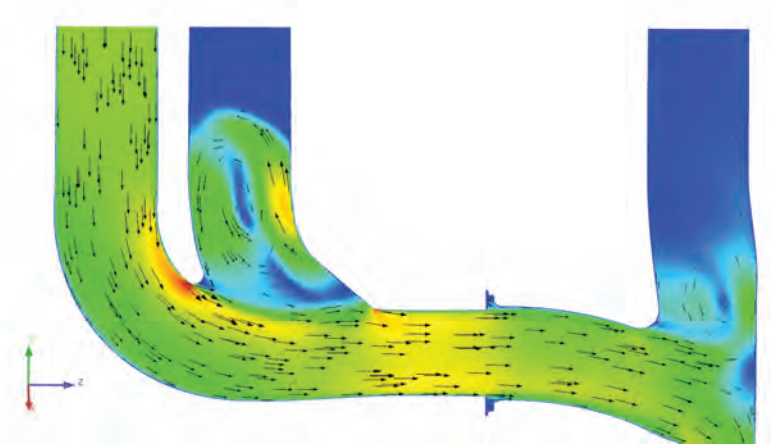
Shown here: a cross-section of a cylinder head, illustrating temperature increases around the port area. *Image courtesy of Cummins.*

focused on its goals; the best way to accomplish this is to develop robust, cost-effective methods of evaluating proposed design changes.

"We're on the support side," Tickel says. "The product teams are always coming up with plans on how we're going to achieve our goals—what technologies, components and materials might be used to reduce emissions, for example, their operating temperatures and pressures, and how much weight reduction is required to meet fuel efficiency targets. It's our job to model and simulate what effect those changes will have on product performance."

As with virtually all companies that design and manufacture complex systems, Cummins has long relied on physical testing of its products. Tickel noted that there are 88 test cells in Columbus, IN, alone, with comparable testing capabilities around the globe.

"Our first 80 years had a successful history of 'build it and test it,'" he says. "That's how the business got started with Clessie Cummins, our founder, and quite honestly, it's how the industry has operated for decades."



Analysis of gas flow through an exhaust manifold helps Cummins design more fuel-efficient products. *Image courtesy of Cummins.*

As with the rest of this 61,000-employee company, those working at the Cummins technical center in Columbus, IN, are committed to the manufacturer's PLANET 2050 goals. *Image courtesy of Cummins.*

Going Virtual

Physical testing remains an essential part of engine and powertrain development to date, but software-based analysis began assuming a leading role around the turn of the century. Prior to this, Tickel explains, modeling and simulation were very focused on individual components or disciplines rather than complete systems.

Several factors led to a fundamental change in this siloed approach during the early 2000s—among them an economic downturn, greater product complexity, expanding globalization and a general need for increased competitiveness amidst these obstacles. This change brought on analysis-led design (ALD) at Cummins.

The top-down initiative focused on accelerating Cummins' use of multidisciplinary modeling and simulation with Ansys software. Although physical testing would still play a key role, it would not be performed until analysis results became available, which minimized the need for such testing. With that came the decision to invest heavily in design, computational fluid dynamics and structural analysis capabilities, starting with the hiring of 500 engineers and analysts for a new technical facility in Pune, India.

ALD continues to this day, and thanks to high-performance computing and extended licensing agreements with providers such as Ansys and others, multidisciplinary optimization has now become the standard by which Tickel and his group operate. And yet, he's quick to point out that the company's many test benches aren't going anywhere.

"Simulation is great, but you still need tests," he says. "The goal should not be to eliminate them but to coordinate tests and simulation together, so as to get the most value out of each."

Simulating for Sustainability

Tickel mentions yet another acronym: simulation-based product development, or SBPD. He admits that it doesn't yet roll off his tongue like its predecessor ALD, but it is clearly the path forward and logical progression of simulation maturity at Cummins.

They have even assigned a corporate leader for simulation, Bob Sharpe, who's responsible for coordinating the testing and simulation mentioned here while also gathering as much data as possible from both.

"It's a functional excellence approach," Tickel says. "It's a very good one, with people deep in their disciplines, but we also need to put more focus on increasing our systems-level thinking across the organization. That means going beyond modeling the engine or the transmission and modeling the vehicle as a whole. What's more, it means looking to the future, where vehicles communicate with one another, or form platoons for greater fuel efficiency. Modeling these and other scenarios is something we're definitely going after."

The challenges are great. Cummins has already implemented numerous supercomputers and high-end workstations to support the intensive compute cycles needed to simulate thermal, chemical and fluid dynamics and is continuously evaluating future systems to meet increasing demands, including the possibility of a 46,000-core supercomputer or small quantum computer in 2022.

Until then, they will continue to push for engine and powertrain efficiency wherever possible, all of which will help the company on its path toward PLANET 2050.

"We've had great success in this space due to our capabilities and corporate leadership," Tickel says. "Now it's time to reach for a higher level of performance." DE

Kip Hanson *writes about all things manufacturing. You can reach him at kip@kahmco.net*

MORE INFO

- **Ansys:** Ansys.com
- **Cummins:** Cummins.com

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

Lenovo ThinkPad P1 G3 OLED: Still Nearly Perfect

The next step in the evolution of an excellent 15.6-in. mobile workstation does not disappoint.

BY DAVID COHN

Since our first glimpse in 2018, we have been extremely impressed with the ThinkPad P1, Lenovo's lightweight 15.6-in. mobile workstation. When we reviewed that first iteration, we concluded that it was the perfect combination of performance, portability and price.

The second generation (*DE, August 2020; digitalengineering247.com/r/24795*) reinforced that opinion, so we had high expectations when Lenovo sent us a third-generation system to review. Happily, the new ThinkPad P1 Gen 3 OLED exceeded those expectations.

From the outside, there is no discernible difference between the second and third generations. The Lenovo ThinkPad P1 Gen 3 is housed in a charcoal gray carbon fiber and magnesium alloy case with the same carbon fiber weave introduced in the previous release.

The Lenovo ThinkPad P1 Gen 3 OLED. *Image courtesy of David Cohn.*

The system has the exact same dimensions as its predecessor—14.25x9.69x0.87 in.—and weighs 3.75 lbs., nearly identical to the Gen 2 release (which was already a few ounces lighter than the first-generation ThinkPad P1). It is powered by a 135-watt power supply, which measures 5.0x3.0x0.87-in. and weighs 1.03 lbs. The lid features the same ThinkPad logo with a glowing red dot over the "I."

The ThinkPad P1 Gen 3 base configuration now has a starting price of $1,259, nearly $200 less than its predecessor. That base system comes with a 10th-generation Intel Core i7-10750H 6-core 2.6GHz processor, an NVIDIA Quadro T1000 discrete graphics processor, a 1920x1080 in-plane switching display with a rated brightness of 300 nits, 8GB of 2933MHz RAM, a 256GB M.2 PCIe non-volatile memory express (NVMe) solid-state drive (SSD), a 720p webcam, a fingerprint reader, Wi-Fi, Bluetooth and a copy of Windows 10 Pro 64, backed by a one-year warranty.

Superb Keyboard and Display Choices

Raising the lid reveals the same seamless spill-resistant keyboard with 84 mostly full-size keys as in previous generations. Two levels of backlighting can be toggled by pressing the Fn key and spacebar. Although the ThinkPad P1 lacks a separate numeric keyboard, the Lenovo keyboard offers perhaps the best typing experience available in any laptop.

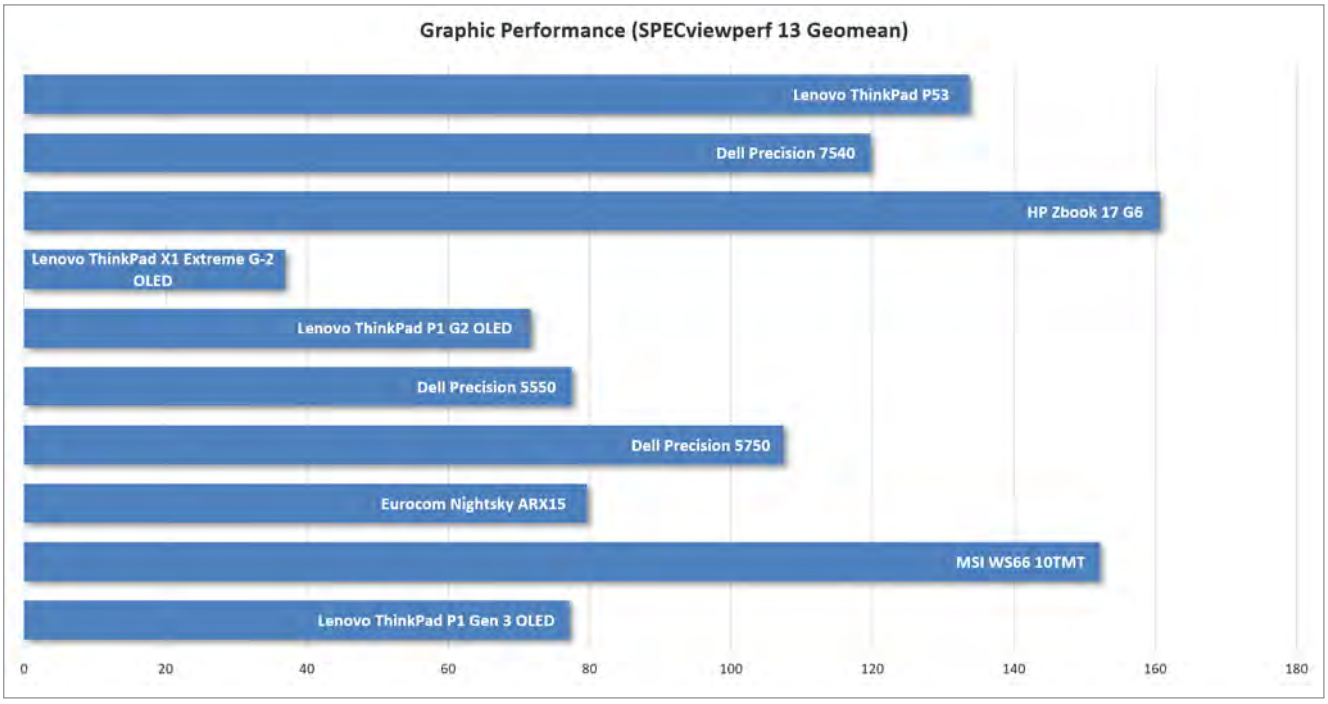
A round power button is located to the upper-right of the keyboard and a 4x2.75-in. touchpad with three buttons is centered below the spacebar. There is also the familiar red Lenovo pointing stick nestled between the G, H and B keys. The caps lock key has its own LED, as do the keys dedicated to the speakers, microphone and function lock.

A narrow bezel surrounds the display panel, yet still provides space above the panel for the webcam, which includes a privacy shutter. Lenovo offers a choice of four display panels, including a brighter (500 nits) full high-definition (1920x1080) display and two different ultra high-definition (3840x2160) displays.

Mobile Workstations Compared

	Lenovo ThinkPad P1 Gen 3 15.6-in. mobile workstation (2.7GHz Intel Core i7-10850H 6-core CPU, NVIDIA Quadro T2000, 32GB RAM, 1TB NVMe PCIe SSD)	**MSI WS66 10TMT** 15.6-in. mobile workstation (2.4GHz Intel Core i9-10980HK 8-core CPU, NVIDIA Quadro RTX 5000, 64GB RAM, 1TB NVMe PCIe SSD)	**Eurocom Nightsky ARX 15** 15.6-in. mobile workstation (3.5GHz AMD Ryzen 9 3950X 16-core CPU, NVIDIA GeForce RTX 2070, 64GB RAM, 2x 4TB NVMe PCIe SSD)	**Dell Precision 5750** 17.3-in. mobile workstation (2.40GHz Intel Xeon W-10885M 8-core CPU, NVIDIA Quadro RTX 3000 w/Max-Q Design, 32GB RAM, 1TB NVMe PCIe SSD)	**Dell Precision 5550** 15.6-in. mobile workstation (2.30GHz Intel Core i7-10875H 8-core CPU, NVIDIA Quadro T2000, 32GB RAM, 1TB NVMe PCIe SSD)	**Lenovo ThinkPad P1 G2 OLED** 15.6-in. mobile workstation (2.80GHz Intel Xeon E-2276M 6-core CPU, NVIDIA Quadro T2000, 32GB RAM, 1TB NVMe PCIe SSD)
Price as tested	$2,795	$3,999.00	$8,512.00	$5,219	$4,355	$3,133
Date tested	11/2/20	10/1/20	9/2/20	8/28/20	6/24/20	2/16/20
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	84.10	174.60	183.08	132.73	91.74	76.32
catia-05	140.38	256.00	109.70	173.75	147.96	126.46
creo-02	113.82	233.21	178.81	159.58	116.59	101.20
energy-02	17.60	40.50	19.94	29.78	17.31	17.11
maya-05	115.32	228.70	249.96	153.66	112.25	102.12
medical-02	50.96	103.67	53.19	73.08	51.11	47.95
showcase-02	44.65	95.62	101.02	74.54	43.99	36.50
snx-03	147.97	291.91	15.25	189.01	144.50	191.81
sw-04	105.23	156.49	87.13	110.18	100.81	86.57
SPECapc SolidWorks 2015 (higher is better)						
Graphics Composite	2.82	5.43	n/a	3.82	3.43	2.81
Shaded Graphics Sub-Composite	1.43	3.36	n/a	1.94	1.77	1.41
Shaded w/Edges Graphics Sub-Composite	2.04	4.25	n/a	2.88	2.67	2.03
Shaded using RealView Sub-Composite	1.92	3.92	n/a	2.62	2.42	1.91
Shaded w/Edges using RealView Sub-Composite	2.54	4.69	n/a	3.47	3.28	2.60
Shaded using RealView and Shadows Sub-Composite	2.21	4.49	n/a	3.04	2.85	2.23
Shaded with Edges using RealView and Shadows Graphics Sub-Composite	2.70	4.94	n/a	3.67	3.45	2.76
Shaded using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	7.35	15.06	n/a	9.86	7.51	6.92
Shaded with Edges using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	7.82	14.68	n/a	10.68	8.64	7.79
Wireframe Graphics Sub-Composite	3.08	4.08	n/a	3.85	3.53	3.13
CPU Composite	3.45	7.13	n/a	3.55	3.09	3.19
SPEC Workstation v3 (higher is better)						
Media and Entertainment	1.72	2.33	3.43	2.20	1.93	1.63
Product Development	1.80	2.38	1.56	2.29	2.09	1.62
Life Sciences	1.52	2.35	2.91	2.15	1.59	1.54
Financial Services	1.31	1.76	4.72	2.13	1.54	1.53
Energy	1.02	1.50	2.33	1.43	1.30	0.99
General Operations	1.96	2.07	2.15	1.92	1.96	1.90
GPU Compute	1.85	3.61	3.77	3.09	1.91	1.79
Time						
AutoCAD Render Test (in seconds, lower is better)	43.70	28.70	27.10	35.60	38.9	49.00
Battery Life (in hours:minutes, higher is better)	7:04	9:50	0:55	10:30	10:22	7:14

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



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

All three high-priced panels include Dolby Vision high dynamic range and infrared cameras. The top-of-the-line display, included in our evaluation unit, uses OLED technology, and also includes a touchscreen. That panel, with a rated brightness of 400 nits, added $660 to the cost.

Lots of Options

Lenovo offers a choice of five CPUs, including 2.3GHz and 2.4GHz 8-core Intel Core i-7 processors and the six-core 2.8GHz Intel Xeon W-10855M CPU. The system we reviewed included an Intel Core i7-10850H, a 6-core 2.7GHz Comet Lake CPU (5.1GHz max turbo), which added $310 to the base price.

Although the base configuration comes with only 8GB of RAM, the ThinkPad P1 Gen 3 can accommodate a maximum of 64GB of memory. For our evaluation, we received 32GB, installed as a single 32GB memory module, which added $430. Systems equipped with a Xeon CPU can accommodate error-correcting code (ECC) or non-ECC memory; a similar ECC memory module would cost $510.

The Lenovo ThinkPad P1 Gen 3 supports up to two SSDs. In addition to the 256GB OPAL SSD in the base model, Lenovo offers three other choices—512GB, 1TB and 2TB—for a maximum storage capacity of 4GB. The system we received included a single 1TB PCIe NVMe M.2 OPAL drive, which added $395.

Though the base configuration includes an NVIDIA Quadro T1000 with Max-Q, you can also omit the discrete graphics processing unit (GPU) to save $340 or upgrade to the more powerful Quadro T2000, a GPU with 4GB of dedicated GDDR5 memory.

Based on the TU117 graphics processor, the Quadro T2000 has 1024 compute unified device architecture cores and a 128-bit interface, with a bandwidth of 128GB/second while consuming 60 watts of power. This higher-end board came with the system we reviewed, adding $210 to the cost.

Though other manufacturers have reduced the number of available ports, Lenovo continues to provide an ample assortment. The right side includes a security lock slot, a pair of USB 3.2 Type A ports—including one that is always on when the system is plugged in—and a media-card slot. The left side provides the power input, a pair of USB-C/Thunderbolt 3 ports, HDMI and a headphone/microphone combo audio jack.

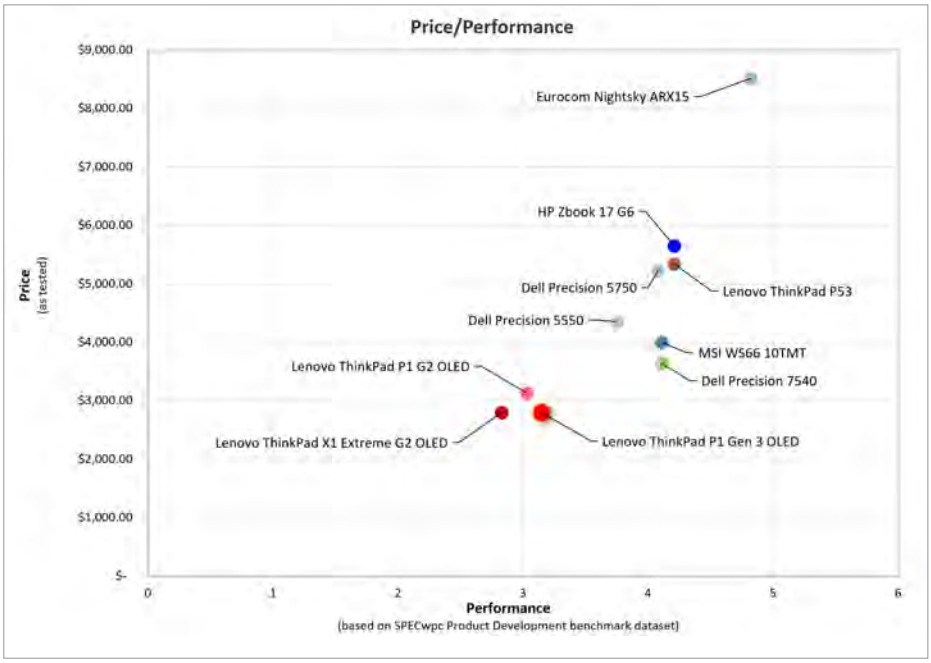
All Lenovo ThinkPad P1 Gen 3 systems include an Intel Wi-Fi 6 AX201 802.11AX adapter with vPro and Bluetooth 5.1 and a 4-cell Li-Polymer 80Whr battery with Lenovo's Rapid Charge technology that can bring the system back up to 80% capacity in just an hour.

Battery life for the third-generation ThinkPad P1 declined slightly. Our evaluation unit lasted 7.06 hours on our battery run-down text, compared to 7.23 hours for its predecessor. The system remained cool and nearly silent throughout our tests, even when under heavy compute loads.

Continuing a History of Great Performance

Since both previous iterations of the Lenovo ThinkPad P1 delivered excellent performance, we expected the same from the third generation, and we were not disappointed.

On the SPECviewperf text, which focuses almost exclusively



Graphic Performance chart based on SPECviewperf 13 Geomean.

on graphic performance, the ThinkPad P1 Gen 3 OLED again outperformed the previous generation. It also edged out its predecessor on the SPECapc SolidWorks benchmark.

The Lenovo ThinkPad P1 Gen 3 OLED also performed well on the SPEC workstation benchmark, easily surpassing the results of the previous generation. And while the 43.7-sec. average to complete our AutoCAD rendering could not beat the 27.1-second mark set by the Eurocom Nightsky ARX 15 we recently reviewed, it still beat the ThinkPad P1 Gen 2 by more than 5 seconds.

All Lenovo ThinkPad P1 Gen 3 workstations come with Windows 10 pre-installed, although you have a choice of Windows 10 Home or Windows 10 Pro. Other optional accessories include a USB-C Dock ($185), a Thunderbolt 3 Workstation Dock ($355) and a Lenovo ThinkPad Pen Pro with Wacom AES 2.0 pen support ($55) for use with systems equipped with a touchscreen.

The standard warranty covers the system for just one year, with depot or carry-in service. Additional coverage is available at the time of purchase that can extend the warranty for up to five years. The $2,795 as-tested price for our evaluation unit includes $85 to extend the warranty coverage to three years. Other warranty options include onsite repairs and premier support for one to five years. Lenovo also offers accidental damage protection and battery replacement warranties.

The Lenovo ThinkPad P1 Gen 3 is independent software vendor certified for a wide range of applications from Autodesk, Dassault Systèmes, PTC and Siemens. It has also passed military certification tests and other quality checks to ensure it can perform in extreme conditions.

After having tested all three generations of this system, we continue to reach the same conclusion. The Lenovo ThinkPad P1 Gen 3 offers engineers and designers a perfect combination of performance, portability and features at a very attractive price. DE

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

MORE INFO

- **Lenovo:** Lenovo.com

Lenovo ThinkPad P1 Gen 3 OLED

Price: $2,795 as tested ($1,259 base price)

Size: 14.25x9.69x0.87-in. (WxHxD) notebook

Weight: 3.75 lbs. (plus 1.03-lb. external 135-watt power supply)

CPU: Intel Core i7-10850H 2.7GHz 6-core w/ 12MB cache

Memory: 32GB DDR4 at 2666MHz

Graphics: NVIDIA Quadro T2000 w/4GB GDDR5 and 1024 CUDA cores

Camera: 720p with IR

Storage: 1TB Samsung M.2 PCIe NVMe

Audio: Built-in Dolby Atmos speakers, microphone/headphone jack, built-in microphone array

Network: Intel Wi-Fi 6 AX200 plus Bluetooth, Thunderbolt 3 RJ-45 adapter included

Ports: Two USB-A 3.2, two USB-C Thunderbolt 3, HDMI 2.0

Other: SD card reader, fingerprint reader

Keyboard: 84-key spill-resistant backlit keyboard

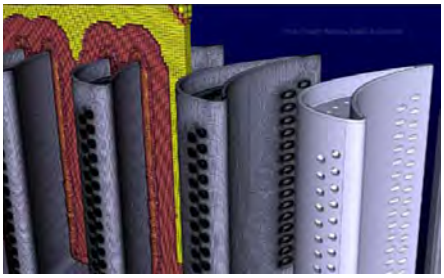
Pointing device: Pointing stick and touchpad with three buttons

Standard warranty: One-year parts and labor (as-tested price includes three-year warranty)

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.



Automated Mesh Generation in CFD Software

Pre-processing software features new utility for automated surface meshing.

Pointwise debuts Version 18.4 of its computational fluid dynamics preprocessing software with a new utility for automated surface meshing.

The meshing feature takes as input a geometry model and a few user-defined goals for the mesh, and automatically generates a geometry-resolving hybrid unstructured mesh, with anisotropy (property of substances to exhibit "grain" on varying molecular axes). Version 184 supports Windows, Linux and MacOS 64-bit systems.

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CPU Replete With 64 Cores

Threadripper equipped with storage, memory capacity, and expansion capabilities.

AMD introduces the AMD Ryzen Threadripper PRO 3995WX professional workstation CPU, which the company says is the first 64-core workstation CPU.

Its base speed is 2.70 GHz, but can be boosted up to 4.20 GHz. Sixty-four cores and 128 threads allow it to perform CPU tasks that previously required two CPUs. Eight DIMM slots support up to 64GB DDR 4 3200MHz ECC RAM, for a total addressable RAM of 512 GB.

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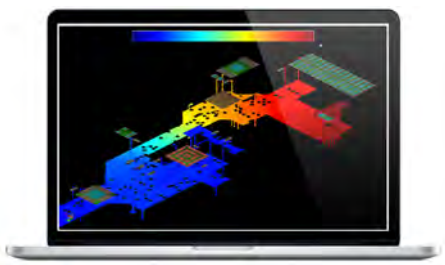

Broad Toolset for Electronics Design and Testing

PathWave said to offer consistent user experience and common data formats.

Keysight Technologies introduces an update to its PathWave comprehensive platform for electronics design and testing. The update includes five new modules to help engineers remove computational limitations that traditionally make electronics design more complex. It also adds cloud computation to streamline data workflow between modules. New in this update are five modules said to leverage the power of cloud processing in electronics design/test environments.

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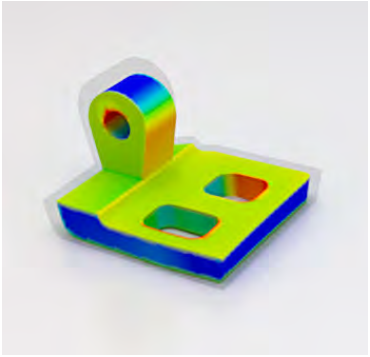
Limiting Complexity of Metal Binder Jetting Printing

Additive Module for Metal Binder Jetting uses company's simulation technology.



Hexagon Manufacturing Intelligence offers the Simufact Additive module to prevent distortions and other issues related to the metal binder jetting (MBJ) additive manufacturing process. MBJ offers ability for larger lot sizes, and does not require support structures to be applied to parts during printing.

These advantages make it a natural for replacing low-volume, high-cost metal injection molding processes for a variety of industries including aerospace, automotive and medical.

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Next-Gen Engineers

Student Competition Profile: XPRIZE

Competing for Conservation Comprehension

BY JIM ROMEO

The Rainforest XPRIZE is a competition from the XPRIZE foundation that aims to tackle how engineers, biologists and ecologists understand the rainforest ecosystem.

The Duke Rainforest XPRIZE team "Blue Devil Forest Divers" has received university support for students and clubs to develop large heavy-lift drones that can fly deep into impenetrable rainforest regions and then drop remotely piloted forest imaging and sensor drones to collect images, sounds and samples from the over-story, canopy and under-story layers.

Digital Engineering spoke to Martin Brooke, an associate professor of electrical and computer engineering at the Pratt School of Engineering about the competition and Duke's involvement.

Digital Engineering: **Can you provide us with a brief overview of the competition?**

Professor Martin Brooke: The large drones are in construction and the team has several working prototypes for both long-range flight capability and the radiofrequency (RF) data link needed to remotely control the data collection process. The team is using commercial drones from Parrot as the main forest data collection devices and have already started collecting images in both visible and infrared from local forest sites.

This project unites students from various disciplines including public policy, conservation sciences and engineering.

Duke's classes Rainforest Engineering and Ocean Engineering provide a structure for students to earn credit working on XPRIZE competitions. This model has worked well for Duke in the past with classes aiding an Ocean XPRIZE team to a $111K winning finalist place.

The large drones are in construction and the team has several working prototypes for the long-range flight capability and the radiofrequency data link needed to remotely control the data collection process. *Images courtesy of Duke University Pratt School of Engineering.*

DE: **What do you think students get out of these classes? Why use XPRIZE competitions as challenges instead of general design projects?**

Brooke: I do not intentionally choose [to do] only XPRIZE competitions; however, I do find that global challenges to solve hard problems that could have a major impact on the whole world really excite students. The fact that philanthropists have put up millions in prize money and support funds for the XPRIZE contests also gets students' attention.

The contests we enter cover a very broad range of fields and technologies; this gives the students an exposure to the type of multidisciplinary teams that exist in most real-world companies. Students tell me it gives them something interesting to talk about on job interviews. The XPRIZE really likes that students within the contest have gone on to jobs in the field and graduate school.

I think the multiyear nature of the contest really helps to build a community of students that strive together to make the team succeed.

DE: **Do you think your students might ever win an XPRIZE, or have one of their solutions adopted by the competition's sponsors?**

Brooke: I hope so. We have come quite close to winning twice, getting into the final round. However, we lose many of our most experienced students every semester. Imagine running a company where you fired all the skilled workers every six months! Additionally, we are typically up against companies and organizations that are much better funded and much more experienced than us. In the last Ocean XPRIZE, a high school team won $850K, so there is hope for us.

I always say we are not in the contests to win; we are in to compete towards completing the goal. We want to make it as far as we possibly can and consider just competing in XPRIZE each semester a victory. DE

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MORE INFO ➜

- **Rainforest XPRIZE:** Rainforest.xprize.org/prizes/rainforest

| COMMENTARY |

By Robert Farrell

Intersection of Product Lifecycle Management and Climate Change

A new international collaboration called the PLM Green Global Alliance is emerging to help advance PLM toward a more sustainable, lower carbon economy.

Until recently, initiatives to advance sustainability and combat climate change have primarily focused on improving product performance to minimize energy usage and lower greenhouse gas emissions. Product lifecycle management (PLM) is enabling technologies and supporting software applications that are contributing to a greener global economy in many ways.

For decades, product development organizations and manufacturers were often forced to choose between product performance and environmental stewardship without regard to externalized costs or long-term harm to the planet. As a result, sustainability practices were often implemented at the minimum levels required to satisfy regulatory requirements and shareholder expectations.

Today, many organizations are taking initiative to repair an ailing planet. Designing sustainability into a product's lifecycle offers a holistic and integrated solution—and PLM is a critical tool.

When fully embraced as a part of mainstream product development, sustainability initiatives have a measurable, lasting impact on the environment and a company's bottom line. Product quality, innovation and profitability are ultimately enhanced while optimizing cost, quality, aesthetics, performance and manufacturability.

An Emerging Alliance

Motivated by opportunities and challenges to create a sustainable circular economy and green future, a new initiative, the PLM Green Global Alliance (PGGA) was recently formed. The coalition's mission is to connect and unite the global community of professionals who use, develop, market or support PLM-enabling technologies that can address the causes and consequences of climate change that stem from human-generated greenhouse gas emissions.

The idea for the global collaboration was created from discussions in North America and Europe between PLM industry consultants Richard McFall of PLM Alliances and Jos Voskuil from TacIT.

"My personal motivation to help start the PGGA was driven by a wish to combine my PLM world with interest to create a more sustainable global society," says Voskuil. "It is a challenging combination. For example, PLM was born in aerospace and defense, probably not the most suitable industries, but now they are driving the development of new technologies to drastically reduce carbon emissions from aviation."

McFall, a PLM industry veteran and PGGA co-founder, observes that there are many examples of how PLM-related technologies are being used to combat climate change and improve sustainability. Yet, there are few venues where organizations can research, share, discuss and promote professional resources and application case studies for the collective good. PGGA's goal is to change that with an open platform where professionals can begin to integrate their personal values into their own career development.

"We face an urgent challenge to create a more sustainable future for our industries, economies, communities and all life forms that depend on healthy interdependent ecosystems," explains McFall. "Through this alliance, we seek to educate, advocate and collaborate for greater recognition of the role of PLM to help assess, reduce, mitigate and adapt when necessary to the effects of climate change now being experienced across the world."

Putting PLM to Work

In understanding PLM's value in a greener economy, it is helpful to remember that PLM is not a single software application. Industry analysis firm CIMdata defines PLM with this in mind:

"PLM is not a definition of a piece, or pieces, of technology. It is a definition of a business approach to solving the problem of managing the complete set of product definition information —creating that information, managing it through its life, and disseminating and using it throughout the product's lifecycle. PLM is not just a technology but is an approach in which processes are as important or more important than data. It is critical to note that PLM is concerned with 'how a business works' as with 'what is being created.'"

With that broad definition, PLM-enabling technologies that can help combat climate change far exceed what most may initially think. No longer is it limited to CAD, product data management, CAE or simulation and analysis.

Now, newer technologies and software used for additive manufacturing, digital twins, product portfolio management, augmented reality/virtual reality, model-based systems engineering, multidisciplinary design optimization, multiphysics simulation, configuration management, Industrial Internet of Things, high-performance computing and enterprise innovation management all have a role to play.

Through the PGGA, PLM professionals, researchers, teachers, students, users, consultants and solution providers can share case study examples, best practices and other resources illustrating how PLM technologies can specifically be used to:

- make products and processes more efficient;
- find and develop new sources of renewable energy;
- store and transmit alternative energy supplies;
- reduce or sequester human-made carbon emissions;
- capture naturally produced greenhouse gasses such as methane;
- develop green manufacturing processes;
- recycle, reuse and repurpose assets and natural resources;
- simulate and test global geoengineering strategies;
- monitor a warming planet and the impact of climate change; and
- enhance the resiliency of infrastructures and communities.

The group has defined numerous research themes in which to organize their collaboration. These topics currently include the intersection of PLM with: climate change, sustainability, circular economy, renewable energy and Industry 4.0.

For example, the group recently hosted a global-spanning meeting to discuss the Exponential Roadmap Report on Scaling 36 Solutions to Halve Emissions by 2030.

We All Can Make a Difference

The pandemic has taught us that we can live, work and collaborate more simply with a lower carbon footprint, all without sacrificing productivity. Today's product development organizations have the opportunity, insights and tools to help address climate change within existing and new markets in numerous ways.

Billions of dollars are being invested worldwide right now to help communities, industries and nations transform their economies. And while big-budget projects may get all the attention, meaningful progress can also be achieved through smaller innovative multinational initiatives like the PGGA.

Participation in the PGGA, which is non-commercial, is open and free. Those interested can join the PLM Green Global Alliance LinkedIn Group. The alliance has recently published a new website to begin collecting and sharing examples, thought leadership, white papers and other resources submitted from around the globe as nations confront the emerging climate crisis.

Stay tuned for an update in *Digital Engineering* in 2021 profiling some examples that industry practitioners nominate. DE

Robert Farrell *is president of Farrell MarCom Services and media representative for the PLM Green Global Alliance.*

MORE INFO

- **CIMdata:** CIMdata.com
- **PLM Green Global Alliance:** PLMGreenAlliance.com
- **PLM Green Global Alliance LinkedIn Group:** LinkedIn.com/groups/12304531

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