DE Digital Engineering

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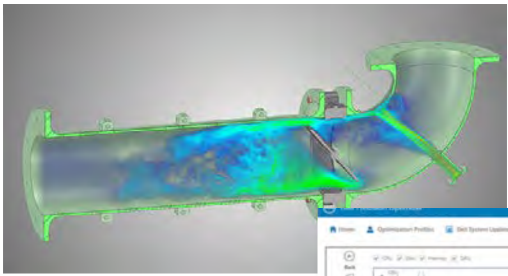
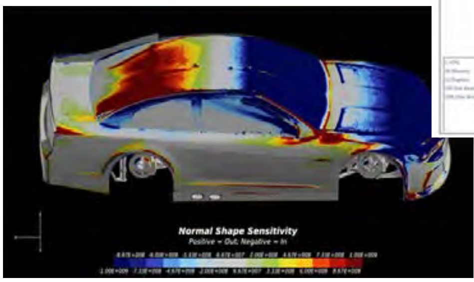
CONTENTS





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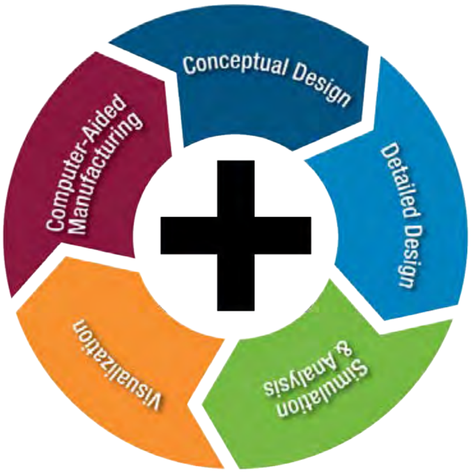


Advanced PRODUCT DEVELOPMENT Resource Center

In Partnership with

DELL NVIDIA

PRODUCED IN partnership with Dell and NVIDIA, the Advanced Product Development Resource Center (APDRC) is an ever-growing repository of information to help design engineering teams capitalize on digital disruption through the use of today's most advanced computing, design, simulation and visualization technologies. The articles in this special issue have been compiled from the APDRC.

Our coverage of immersive design, design complexity, mobility, digital disruption, collaboration, and increased productivity is divided among five stages of the product development cycle.

Conceptual Design

Even the napkin sketch to get initial ideas onto paper has gone digital. Designers and engineers can sketch out concepts for form, fit, function and interactivity on the screen. Digitization means those concepts can be easily stored for future use so no idea is lost, quickly shared with collaborators and, when the time is right, exported into CAD. Conceptual design software has advanced to the point where generative design algorithms can recommend designs they may never have considered.

Detailed Design

Traditional computer-aided design (CAD) software has taken advantage of ever-increasing computing power to enable globally dispersed design engineering teams to work with larger, more complex components that comprise the interconnected mechanical, electrical and software systems of today's products. As CAD programs have expanded to include useful initial simulation functionality, data visualization, data management, rendering features and more, workstations, servers, clusters and cloud-computing advances ensure design engineers can innovate at the speed of thought.

Simulation & Analysis

The lines separating CAD and computer-aided engineering (CAE) simulation & analysis software continue to blur, but experts employing numerical engineering simulation techniques such as structural finite element analysis (FEA), computational fluid dynamics (CFD) and multibody simulation save significant time and money that would otherwise be spent on physical testing, engineering change orders from manufacturing and even product recalls. Predictive engineering technologies driven by advances in computing and graphics are allowing engineers to optimize product design spaces to meet specific requirements, which enables true simulation-led design.

Visualization

Simulation can predict how a product will perform under various conditions, but in today's experience economy, the way a product looks, feels and interacts with users is just as important. Visualization software uses powerful graphics processing advances to create photorealistic renderings of the product, including the varied materials inherent in products and how they react to different real-world lighting conditions. Visualization also improves collaboration by showing stakeholders how a product will look and perform—even to the point of allowing users to experience the product in virtual reality (VR) and augmented reality (AR). Today's virtual prototypes have become so realistic that products can be marketed before they're even physically produced.

Computer-Aided Manufacturing (CAM)

Advances in 3D printing/additive manufacturing and computer-aided manufacturing are having a significant impact on the design cycle. Design engineers use hardware and software that can simulate CAM toolpaths and ease design for additive manufacturing (DfAM) learning curves to create functional prototypes and short-run products to help avoid any design issues that could bottleneck the manufacturing process.

Plus +

The design cycle is not a simple circle. It consists of a multitude of data points flowing in many different directions along the product lifecycle that prompt decisions to be made and actions to be taken in parallel. Connected products that make up the digital disruption driving businesses today—the internet of things (IoT), the industrial IoT, autonomous cars, digital twins and the factory of the future—all start with design engineering, but design engineering doesn't end at manufacturing. Those connected products are collecting big data about how and where they are used that can be parsed using artificial intelligence (AI) to help design engineers develop the next generation of improved products.

The Advanced Product Development Resource Center's mission is to help design engineers capitalize on the amazing technological advances in product design that are driving digital disruption in manufacturing. Visit the resource center at APDRC.com for the latest developments on technological advances, videos, white papers and more from *DE*, Dell and NVIDIA.

Enjoy the Digital Issue

The articles in this special digital edition were selected to help guide you through the process of optimizing your workflow for specific design engineering tasks. Whether you focus on design, simulation, visualization or computer-aided manufacturing (CAM), the articles that follow will explain the market forces driving design engineering teams to develop high-quality products faster, and how the latest technologies can help you achieve those goals. By configuring your computing hardware to match the engineering design software you use, you can boost productivity and focus on innovation. **APDRC**

APDRC Technology Drivers

Designers and engineers are tasked with developing better products faster and cheaper using modern technologies to optimize the product design and development process. The APDRC was created to help meet that challenge by addressing the market drivers below with specific design engineering technology solutions.

Immersive Design

- virtual and augmented reality
- real-time rendering
- real-time simulation
- photorealistic material rendering
- toolpath simulation
- design for additive manufacturing

Design Complexity

- larger models
- system design
- multiphysics
- cyber-physical systems
- generative design
- design for additive manufacturing

Mobility

- mobile workstations
- cloud computing
- virtual machines

Digital Disruption

- big data
- internet of things
- digital twins
- digital thread
- artificial intelligence/machine learning
- Automation/smart factories

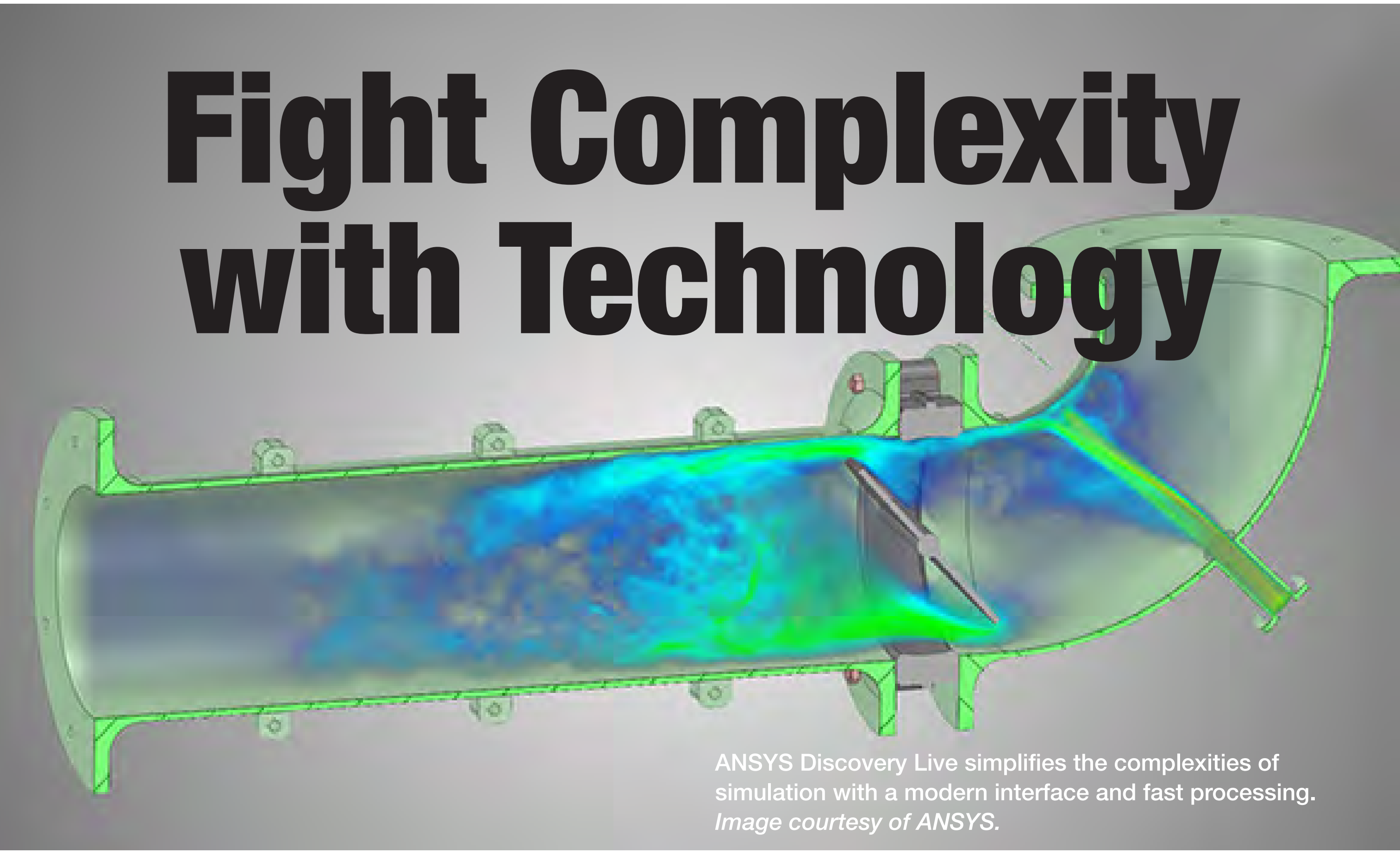
Collaboration

- product lifecycle management
- 5G connectivity
- virtual and augmented reality

Increased Productivity

- value-added reseller software certification
- workstation configuration
- GPU-accelerated computing

Fight Complexity with Technology



ANSYS Discovery Live simplifies the complexities of simulation with a modern interface and fast processing. *Image courtesy of ANSYS.*

HERE'S AN OLD SAYING: Fight fire with fire. New technologies such as artificial intelligence, internet of things, embedded processing, and digital twins are great innovations, unless they become a new source of complexity. When hindrances to efficiency are rooted in technology, sometimes it takes technology to break the logjam.

Keep Complexity Beneath the Surface

It is a sad axiom of product development that the most technically demanding engineering assignments are usually supported by the most complex software products. But it doesn't have to be that way.

One of the newest simulation products on the market, ANSYS Discovery Live, reduces the complexity typical of simulation in two ways: It offers a modern user interface (UI) that includes direct editing of geometry, and it takes advantage of parallel processing. The modern UI comes from SpaceClaim, a 3D CAD product acquired by ANSYS in 2014. The result is a product that offers new freedom in design exploration by allowing changes to form as part of the simulation process. Discovery Live also takes advantage of the massive processing power of NVIDIA GPUs. Real-time visualization of flows, deformations, and other physics are possible because the software makes use of CUDA, NVIDIA's parallel computing and programming platform.

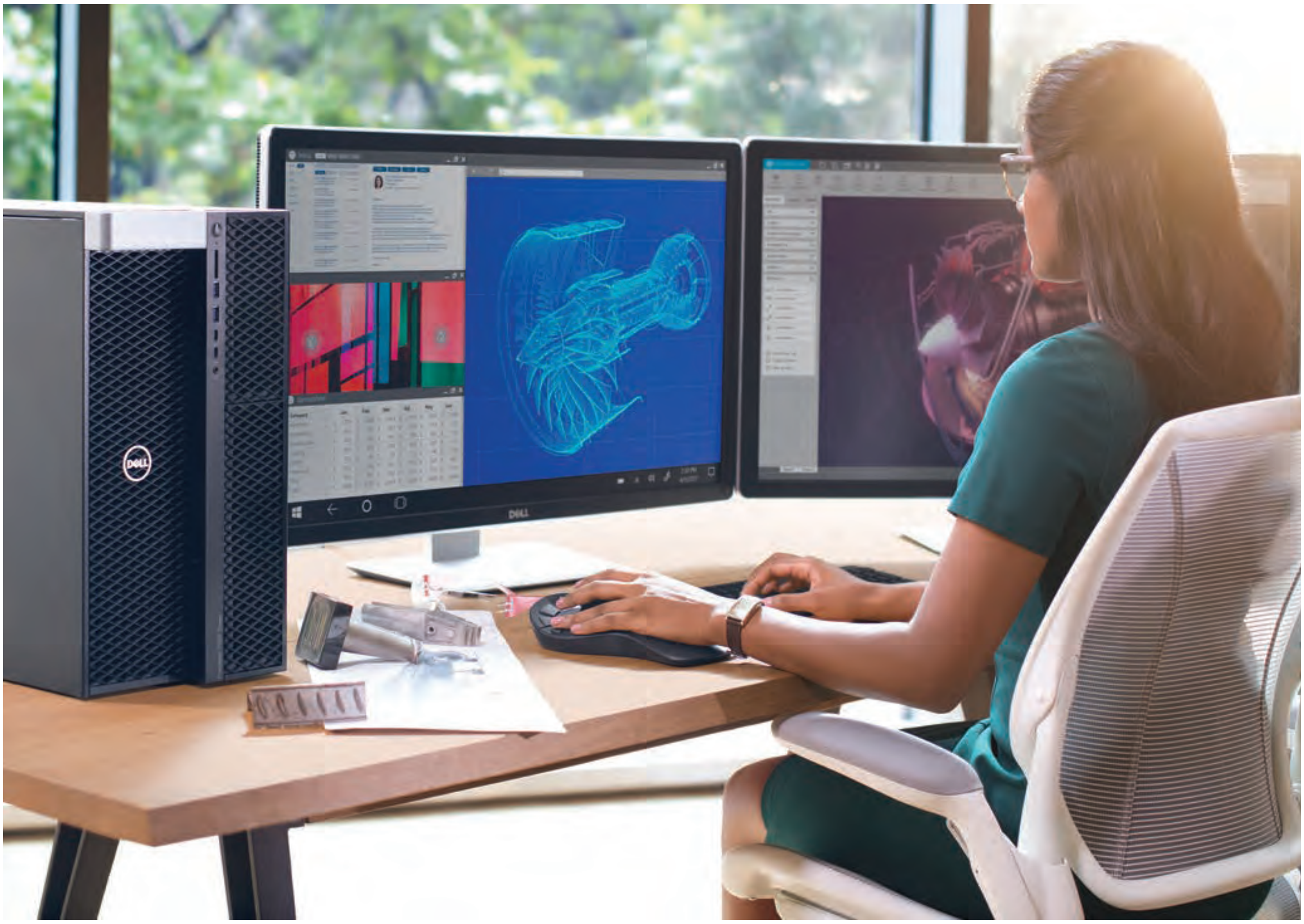
The result is a product that does multi-physical analysis in real-time, in a UI accessible to design generalists. The software automatically decides the appropriate meshing strategy and processes the model, greatly simplifying one of the most complex parts of simulation. It took the combination of new CAD technology and GPU-driven parallel processing power to delivery a simplified yet powerful approach to upfront product simulation.

See More, Do More

Dr. Jon Peddie is a widely respected industry analyst who has been closely aligned with the graphics side of computers since the mainframe days. He can explain with a series of charts and tables why graphics are the most important aspect of any computer-based work process, but he only need four words to summarize it: "See more, do more."

"There are so many ways to see more," says Peddie. "Multiple monitors, big monitors, rear projectors, and even headsets."

Peddie's research firm (Jon Peddie Research) regularly studies productivity as it relates to visual computing. In its most recent survey, JPR found that users of multiple monitors have an average expected productivity increase of 42%, when compared to users doing similar tasks but with only one monitor.



Studies show the use of multiple monitors increases productivity by up to 42%. ***Image courtesy of Dell.***

To power multiple displays, especially high-resolution 4K monitors, a workstation with a discrete graphics card is recommended. Even in motherboards that do support more than one monitor, there can be lag when moving between displays. Professional graphics cards support multiple, high-resolution monitors without lag, and include software to streamline the process. For example, NVIDIA says its Mosaic multi-display technology, featured in NVIDIA Quadro graphics cards, allows any application to span across up to 16 high-resolution panels or projectors from a single workstation, without sacrificing performance or power. NVIDIA nView desktop software can be used to manage a system's single or multi-monitor workspace, according to customizable usage models.

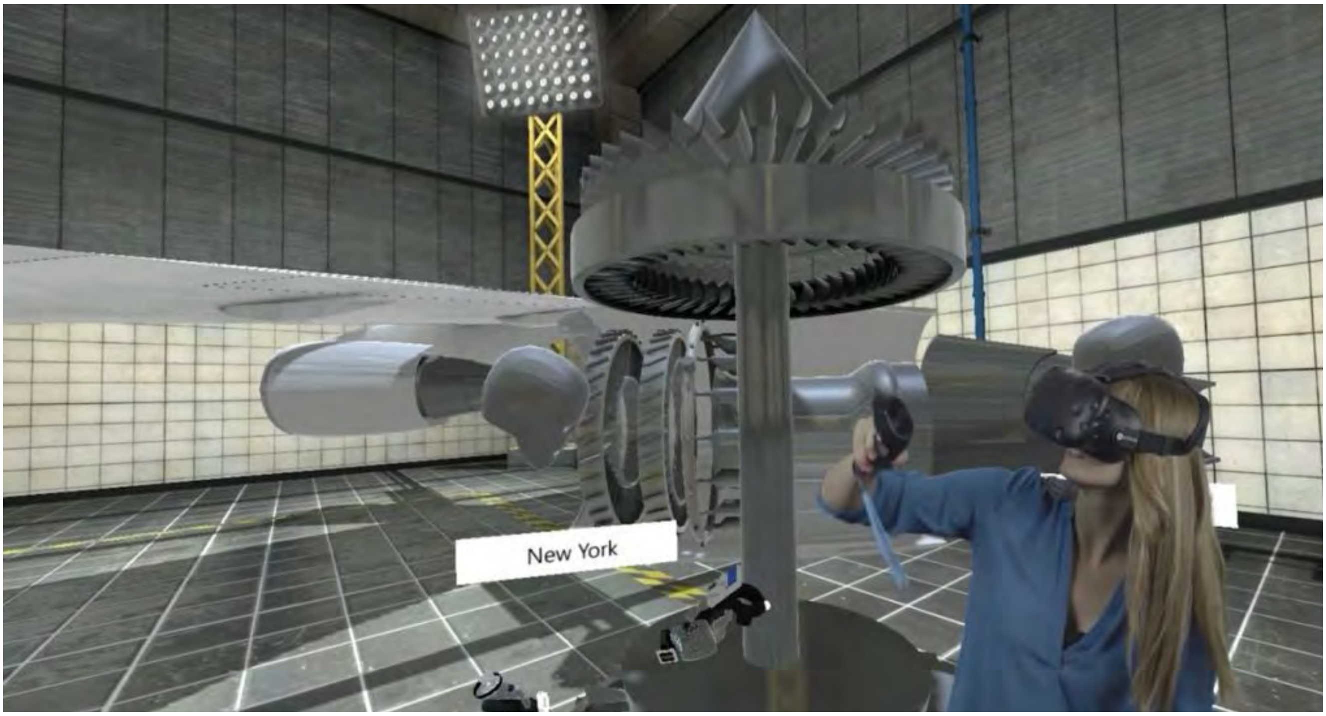
The next frontier of fighting complexity and improving productivity through increased visualization is with virtual reality and augmented reality. VR startup WorldViz sees increased adoption of VR "throughout every step of the product development lifecycle," according to CEO Andrew Beall. At first, companies use VR to visualize prototypes as 3D models. "This gives stakeholders a way to see and even interact with early prototypes at scale while saving significantly on the cost and waste of creating physical mock-ups."

For global companies with distributed teams, Beall says VR products like WorldViz Vizible "allows groups of people to join together in a virtual space without the need for travel to visualize products, provide feedback and tackle problems before costly mistakes arise." Going forward, Beall foresees extending VR through the value chain, working with suppliers, distributors, and customers for both sales and training.

Too Much of a Good Thing

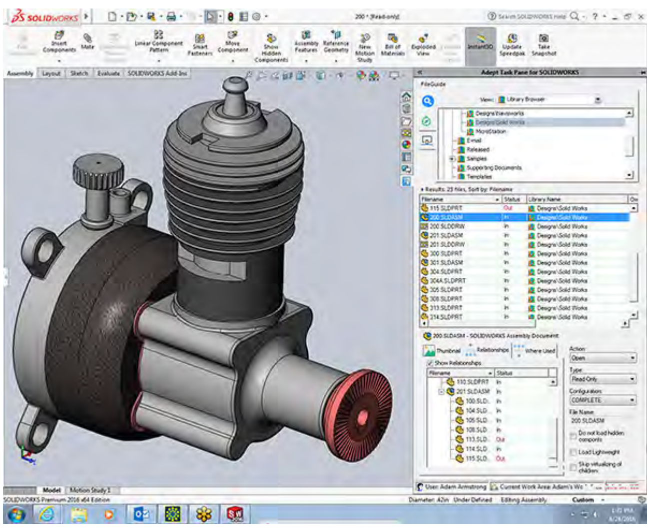
Dow Chemical is a widely diversified global manufacturer. It was one of the earliest enterprises to adopt electronic document management (EDM) in the 1990s. Over the years, the company grew rapidly by acquisition. A recent internal Six Sigma audit revealed document management had become a significant problem; there were more than 25 separate systems in use, including many departmental home-grown solutions.

"We had usability issues, constrained access, limited ability to collaborate across sites, and inefficiencies from not easily finding the right document versions," says Dow executive Gregg Schuler. "One system took 45 minutes to sign in a document."



Product development teams in multiple locations can do virtual walkthroughs simultaneously with enterprise VR tools such as WorldViz Vizible. ***Image courtesy of WorldViz.***

The company decided the answer was not to add one more system, but to replace all the existing document management solutions with one that best matched the company's needs. The new document management system would need to work with both discrete and process plant design and operations, and both 2D and 3D CAD data. To match a corporate directive, the new system needed to offer an "asset view" within each plant, and needed to work with the wide range of existing metadata sources, legacy and current.



Synergis Adept streamlines the process of working with a wide variety of data types and file formats, including CAD. ***Image courtesy of Synergis Software.***

Two products were selected for an in-house trial. Each vendor was required to load 100,000 existing Dow documents. One system took weeks. The winning software — Synergis Adept EDM/PDM — did it it in six days. Adept offers a "wrapper" approach to existing data, unlike other document and data solutions that require a separate conversion process.

The original purpose was to replace existing functionality, but Dow discovered the more it trusted the capabilities of Adept, the more ways they found to extend its use. When they started using Adept's replication service to share data between locations, instead of relying on existing corporate servers and methods, time of access to information improved by 80%.

With all of the complexity that comes with today's product design and development process, it's important to challenge the status quo and look for solutions that can counter it. Engineering teams that continue to struggle by applying yesterday's tools to today's product design and development challenges are putting themselves at a significant disadvantage. **APDRC**

This article originally was originally posted on the Advanced Product Development Resource Center.

Configure Your Workstation for CAD, Step by Step

LIKE PLACING ONE FOOT in front of the other, the continuous advancements in hardware and software are what move engineering productivity forward. Lose the balance between them when configuring your workstation for CAD, and you'll be tripped up by overspending on hardware or underperforming on critical software tasks.

Configuring a workstation for CAD today is different than just a few years ago because CAD software has changed to keep pace with design engineers' evolving workflow. For example, being able to run simulations or perform rendering without leaving the CAD program is now a standard feature. Complexity has gone from 2D to 3D to modeling systems of systems. CAM and design for 3D printing functionality is also baked into most popular CAD platforms.

The typical CAD user's computing workflow extends beyond a single CAD application. Many design engineers are proficient in multiple CAD programs, viewers and translators to ease collaboration. Some also take advantage of stand-alone simulation and visualization tools geared toward design engineers, such as COMSOL Apps or the new ANSYS Discovery Live. Topology optimization and generative design tools are also becoming increasingly common in design engineers' workflow. And, of course, there are the office applications, such as email, Excel and web browsers, all of which must be considered when determining the best workstation configuration for the best productivity.

Thankfully, workstation hardware continues to advance on a number of fronts, exceeding the needs of CAD users in many cases. It's gone from fast solid-state drives that have increased in storage while dropping in price, to new CPUs and GPUs, to monitors with high enough resolutions to make your eyes forget you've been cleaning up part geometries for 10 hours. And, because technological and workflow disruptions seem to be happening at an increasingly faster pace, CAD users need to decide what will be the best computing configuration two years from now, when next-generation technologies like augmented or virtual reality may be added to their responsibilities.

Whether you need help determining the right components, or help justifying why an engineering workstation needs to be configured differently than the PCs used in the accounting department, the steps below will guide you through the process.

The Dell Precision Tower 3630 and 3431 are configurable for CAD and ISV certified. *Image courtesy of Dell.*

Step 1: What is Your Workflow?

Begin by taking an inventory of the software you use and how often you use it. Check the recommended system requirements of each, not the minimum requirements. The minimum requirements are just that: the bare minimum needed for the software to function. Professional design engineers need their software to perform at the speed of thought. The recommended requirements will get you in the ballpark.

Hardware requirements can vary based on software application, usage and dataset sizes. To help you get detailed information on how your Dell workstation is performing and determine true requirements, use the Dell Precision Optimizer (DPO) tool Analysis reports.

When looking for hardware that meets those recommended requirements, focus your attention on software certification. Independent software vendor (ISV) certification of hardware is more than just a rubber stamp of approval that the software will work well.

"Thousands of hours are invested in certification to provide a stable and reliable platform for engineering applications," says Dell's Scott Hamilton. "Hardware and software vendors work closely to identify and fix problems before the user sees them, which makes the user experience much better and dramatically reduces downtime. ISV certification is important to dramatically reduce problems."

Those problems could range from annoying quirks that combine to cripple productivity, to full crashes that can result in lost data.

"CAD software certification is one of many key reasons why enterprises rely on professional GPUs," says NVIDIA's Andrew Rink. "Manufacturing companies generally prefer to avoid the productivity losses resulting from graphics related CAD software performance issues or crashes that impact critical product design work by valuable employees."

With all of the workstation improvements made in recent years, chances are exceedingly good that the recommended requirements of the software you use won't be out of the range of modern, professional mobile workstations. The pros of going mobile are obvious: you can work on the road, in the upstairs conference room or at clients' sites. The traditional cons continue to be minimized, but take battery life, screen size, upgradability, cost and performance into account.

Step 2: Pick Your Processors

Depending on your software requirements in step 1, it's unlikely you need the latest central processing unit (CPU) or the most powerful graphics processing unit (GPU) for a typical CAD workflow. Opting for the previous generations of CPUs and GPUs can save some money that might be better invested in more RAM or storage. However, if your workload includes simulation or photorealistic rendering—or if it will in the near future—let that guide your processor choices.

"If all you're doing is CAD, then a high clock speed, 4-core CPU is ideal," says Hamilton. "If you're doing simulation, go for more cores and possibly a dual-socket workstation. If you're doing both CAD and simulation, then go for a configuration that has a high turbo boost and many cores."

On the GPU side, most CAD software vendors recommend a discrete graphics card. Choosing among entry-level, mid-range and high-end graphics cards depends on the work you're doing now and expect to be doing in the future, as well as the resolution you require.

"The sweet spot for traditional 3D CAD is a mid-range graphics card like the Quadro P2000 or P4000," says Hamilton. "For GPU rendering, a Quadro P4000 or above is recommended, and multi-GPU configuration allows for extreme performance.

NVIDIA has posted benchmarks showing Dassault Systèmes SOLIDWORKS performance using different


Precision Workstation
Storage Classification

The *Precision Workstation Storage Classification* paper provides an in-depth description of the different types of SSDs and how Dell classifies them via benchmarking. It can be downloaded here.

Quadro GPUs in desktop and mobile workstations here.

GPU-hungry applications such as photorealistic rendering and even augmented and virtual reality are growing in popularity among CAD users.

"The NVIDIA Iray rendering engine is natively integrated in numerous CAD tools, such as CATIA, SOLIDWORKS and Siemens NX," says Rink. "That's a big proportion of the CAD tools being used, so more and more engineers are being exposed to and getting comfortable with photorealism earlier in design. As a result, they can make better informed design decisions earlier in the design process."

Rink recommends purchasing the most advanced technology your budget can afford to make your current workflow smoother and prepare for the future. "Even if you don't currently render photorealistic images or perform simulation to optimize your designs, with the expanded availability of easy-to-use tools for that, you very well might begin to do so in the next year or two," he says. "And model sizes continue to grow as product complexity increases, so it's often worth buying a higher level professional GPU than you think you need today."

Investing in the future now opens up more options for increased productivity. For example, designers can use one display for editing a CAD model and another to interactively display a photorealistic visualization. As the designer modifies the CAD model on one display, he or she can immediately see how it will appear in real life on the other display. Such a workflow can greatly improve productivity and reduce rework, but it does require a more powerful GPU to ensure very fast rendering, especially on 4K displays.

Step 3: Speed and Storage

The Precision Workstation Storage Classification paper provides an in-depth description of the different types of SSDs and how Dell classifies them via benchmarking. It can be downloaded here.

If you haven't upgraded to a solid-state drive (SSD) by now, you don't know what you're missing. Having the operating system and applications boot from an SSD is a guaranteed productivity enhancer. SSDs do cost more per gigabyte than traditional spinning hard disk drives (HDDs), so if your local storage needs are great you might want to opt for a workstation that uses both—an SSD for booting and an HDD for storage.

However, not all SSDs are created equal. For example, "PCIe drives are much faster due to enhanced bus speeds capable of utilizing full performance of modern SSD technology," says Hamilton. "The SATA interface is limited to 6.0 GB/s," which can create a bottleneck.

"SSDs may have descriptive information in their product sheets, but it has become increasingly difficult to correlate SSD interface, flash memory type, and flash controller model to application performance," according to the white paper "Precision Workstation Storage Classification," which provides an overview of how Dell classifies storage devices for Dell Precision workstations. "SSDs provide significant advantages over hard disk drives, but without measuring drive model performance in some systematic way, it can be difficult to differentiate SSD models based on their 'back-of-box' specifications."

According to Hamilton, users often underbuy when it comes to storage. "CAD and simulation files are fairly large, and take a long time to read and write," he says. "What we've found in testing is that when you put in a faster storage system like an SSD, you get much better CPU utilization. If you can get that data faster, you get the processor going faster and see overall better performance."

Configure your workstation for CAD: DPO can also optimize hardware settings to maximize performance for many popular software applications. More details here.

GPUs Power Real-Time Simulation Visualization

ANSYS made news with the release of ANSYS Discovery Live, an interactive, CAD-agnostic application intended to help designers and engineers explore and refine product designs with real-time simulation visualizations.

ANSYS Discovery Live leverages NVIDIA's GPUs and CUDA parallel computing and programming technologies, so you need an NVIDIA GPU-powered workstation to use it.

According to ANSYS research, one out of every 22 engineers used simulation software during design workflows in 2005; today that ratio is one out of six engineers, and with this latest release, ANSYS is aiming to make the practice accessible to every engineer by 2020, says Mark Hindsbo, vice president and general manager at ANSYS. Moreover, because 80% of product costs are tied to the early design phase, Hindsbo contends that introducing analysis-led digital exploration capabilities at that point in the workflow should greatly reduce mistakes and eliminate unnecessary expenditures.

"We certainly see adoption of pervasive simulation during early design evaluation growing rapidly because of the benefits it brings to the product design process," adds NVIDIA's Andrew Rink.

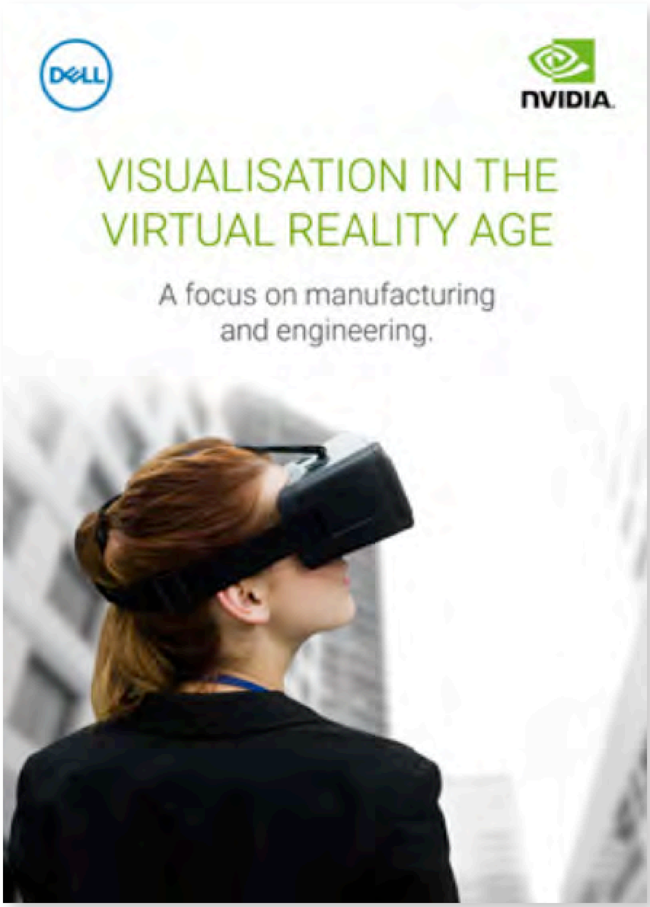
Step 4: Don't Forget the Memory

One thing that hasn't changed is that RAM delivers a great performance bang for your buck. For example, 8GB of RAM is recommended for SOLIDWORKS 2018, 16GB for Siemens NX and "20GB or more" for Autodesk Inventor. But a little extra doesn't hurt the pocketbook much and can cure many ills.

When physical RAM runs out, Windows turns to virtual memory—a combination of RAM and a portion of your hard drive—to temporarily store files and swap back to the physical RAM when it is available. This swapping slows down CAD operations, so it's best avoided by having the appropriate amount of RAM for your engineering work, plus some extra for everything else.

Running into RAM shortages is especially common as systems get older and software memory requirements increase. "If you want to upgrade later, then buy the highest density DIMMs (dual in-line memory modules) now and leave some slots open for future expansion," Hamilton says.

If your workflow includes simulation, Hamilton recommends 4GB to 8GB of RAM for each processor core.



Check out the free e-guide: [Visualisation in the Virtual Reality Age](#).

The sweet spot for traditional 3D CAD is a mid-range GPU like the NVIDIA Quadro P2000 or P4000 (shown here). ***Image courtesy of NVIDIA*****.**

"Error correcting code (ECC) RAM is good for simulation and analysis, but not really that important for CAD," he says. ECC RAM is designed to detect and correct data corruption.

Step 5: Configure Your Experience

Two of the most important, but also most often overlooked workstation configuration considerations are the monitor and mouse. They are the fundamental means of interacting with your workstation, day in, day out. System requirements aren't much of a concern when choosing mice, even those with programmable functions specifically built for different CAD applications. Monitors, on the other hand, can drive GPU considerations.

"The amount of GPU memory used by 3D CAD applications when viewing on 4K displays compared to using an HD monitor increases substantially, so users should be aware that they may need a GPU with a larger frame buffer, depending on the complexity of their models," says Rink.

If your visual workflow goes beyond the monitor to include virtual reality, then you need "seven times more graphics performance than PC gaming" for an immersive VR experience, Rink says. "I recommend any product designer or engineer planning to bring immersive VR into their workflow ensure their workstation is configured with a Quadro VR Ready GPU, so that they're guaranteed to have a smooth VR experience." **APDRC**

This article originally was originally posted on the Advanced Product Development Resource Center.

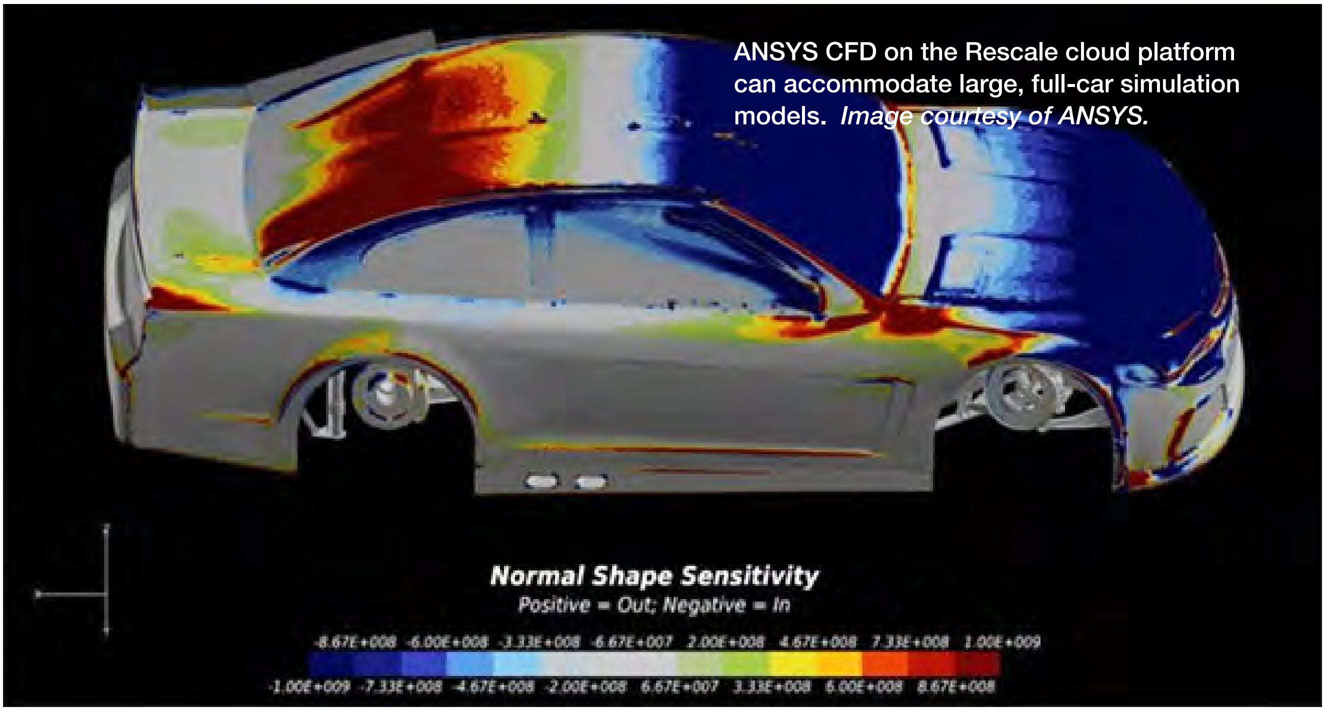
Work Smarter, Not Slower with Simulation and Analysis

ACROSS INDUSTRIES, DESIGN COMPLEXITY is on the rise: In aerospace, lattice structures are helping to lightweight parts while breakthroughs in battery technology are fueling more environmentally-friendly forms of transportation. The behind-the-scenes problem solver is advanced simulation, but the catch is that complex simulation models require considerable computing resources.

Larger, high-fidelity simulation models, coupled with more widespread use of CAE tools by a broader swath of users, has pushed simulation into the forefront of the design process. In addition, the rise of the digital twin, enabled by the Internet of Things (IoT) and connected products, is also fueling more sophisticated simulations to help capture insights on the behavioral characteristics of potential prototypes that would allow engineers to predict failures as well as identify flaws and inefficiencies well before ever building a costly physical prototype.

While simulation helps engineering organizations pinpoint potential glitches when it's far cheaper to make changes and encourages the experimentation necessary for optimized designs, the iterative process grinds to a screeching halt if the platform is insufficient to handle sophisticated processing needs. It's not uncommon for engineers with an out-dated workstation to be bogged down for hours, if not days, as their systems try to churn through a backlog of advanced, resource-intensive simulations.

Modern computing hardware can speed simulation and analysis tasks. *Image courtesy of Dell.*



ANSYS CFD on the Rescale cloud platform can accommodate large, full-car simulation models. *Image courtesy of ANSYS.*

Without a platform tuned for high-performance modeling and analysis, engineering organizations are left with no choice but to rein in simulation efforts, either vastly scaling back design exploration or narrowing the scope of the problems they're trying to solve—both scenarios that undermine the product development process and ultimately put competitive advantage at risk. According to a Digital Engineering survey, 68% of respondents are forced to limit model size and the amount of detail in their simulations at least half of the time.

"We live in a highly competitive landscape where customers are challenged to drive innovation and increase product quality while at the same time having to reduce development cycle times and shorten time to market," notes Wim Slagter, director of the High Performance Computing & Cloud Alliance group at simulation software maker ANSYS. "Engineers are pressed to produce more and better designs faster than ever, and accelerating simulation workflows is critical not only for considering more design ideas, but to make more efficient product development decisions based on the understanding of performance tradeoffs."

Simulation's Need for Speed

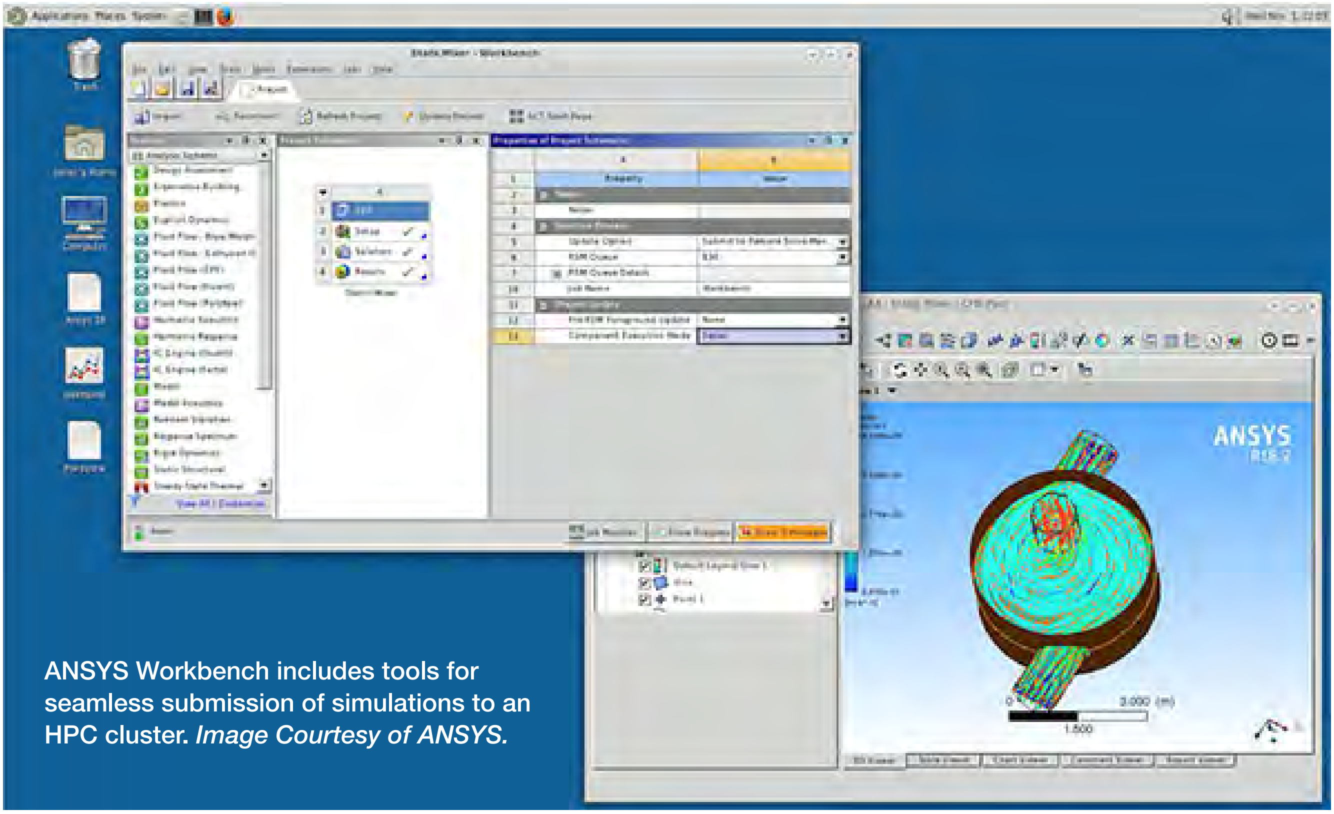
Beyond upgrading to a state-of-the-art engineering workstation complete with multi-core processors, the latest dedicated graphics and systems memory, and SSD storage, there are other ways to amp up scalable compute power and accelerate simulation performance. Next-generation GPU appliances,software-as-a-service-based (SaaS) simulation solutions, cloud-based high performance computing (HPC) resources, and new families of clusters are just some of what's available today to push the pedal on simulation workflows.

"It doesn't matter what technology is used—ultimately the idea is to increase engineers' productivity, whether that's accomplished through a dedicated GPU appliance or a cloud computing cluster," Slagter says. "It's all a matter of what fits best in an individual environment."

One solution is to dedicate large jobs to servers, freeing up workstations for other tasks. For example, the Dell Precision 7920 Rack is a 2U form factor rack-mount workstation. Because servers are supposed to run 24 hours a day, seven days a week, 365 days of the year, the Precision 7920 offers lots of redundancy. For example, the front of the system provides eight hot-swappable hard drive bays. If a drive fails, you can swap in a new one without having to first shut down the system. The front panel also provides a USB 3.0 port, space for an optical drive, a USB management port, a pair of USB 2.0 ports and a 15-pin VGA port. The Precision 7920 Rack can also be equipped with a second power supply, so that even if one of those fails, it too can be swapped out without interrupting work.

For graphics-intensive workflows, dedicated GPU appliances, typically rack-mount server systems that can be scaled out with professional-class GPUs like NVIDIA Quadro and Tesla, can accelerate simulation workflows and serve as effective tools to speed up rendering and visualization workflows. The high-density, fully integrated clusters are typically appointed with dozens, if not hundreds of CPU cores and GPUs to achieve in the neighborhood of teraflops of computing performance. Most of these systems also support Virtual Desktop Infrastructure (VDI) capabilities, allowing globally dispersed engineering teams to securely collaborate on modeling and design problems regardless of where they are located.

"Accelerating simulation is not just about reducing time to solution for calculations or simulation, but also about



ANSYS Workbench includes tools for seamless submission of simulations to an HPC cluster. *Image Courtesy of ANSYS.*

shortening processing time and the end-to-end workflow," Slagter adds. "A VDI environment lets you leave the data where you computed it and do the pre- and post-processing remotely." To that end, ANSYS release 18.2 offers support for a range of remote displays and virtual desktops.

Cloud-based HPC offerings are another way to wring faster performance out of simulations. Companies like Rescale and Penguin Computing offer system-as-a-service HPC platforms preconfigured with leading simulation software unlike general purpose cloud platforms like AWS or Google, which still require engineering organizations to do the work of configuring and managing HPC environments, a difficult task even in the cloud. Rescale's ScaleX platform offers turnkey access to over 250 vendors, including simulation software heavyweights like ANSYS, SIMULIA, COMSOL, Siemens PLM Software, Altair, MSC Software, and others. The platform provides engineering teams with a turnkey, full stack HPC cloud solution and the ability to spin up CAE applications from anywhere with a Web browser with just a few clicks, gaining access to the latest technologies without requiring a dedicated staff of IT experts to configure, manage, and schedule jobs in a demanding HPC environment.

Cloud HPC resources are an especially good option for those companies that need bursts of compute capacity to accommodate special projects or the occasionally extra large-scale simulation. "When those special projects fall out of the sky that require large amounts of horsepower for a month or two to win new business and you can't justify buying all the capability and bringing it on-premise, the cloud is a good option for burst capabilities," says Rodney Mach, CEO and founder of TotalCAE, which offers hybrid, turn-key HPC simulation services combining both public cloud and private clusters. "It enables you to quickly bring on capacity in hours instead of months."

TotalCAE's customers are typically engineering departments grappling with existing systems that are under powered for sophisticated simulation workflows and that don't have enough support from their IT departments, which are overwhelmed with enterprise IT responsibilities, Mach says. The company offers the choice of a managed HPC Cluster Appliance, essentially a private cloud for finite element analysis (FEA)/computational fluid dynamics (CFD) workloads, or a public cloud option, also managed by the firm and featuring its simple-to-use web portal, which lets engineers submit jobs without any special training.

"We offer turn-key simulation as a service," he explains. "We are trying to minimize the amount of time engineers spend on setting up computing. We want them to push a button and get answers back so they can focus on engineering things—not IT technology."

A hybrid computing approach, where the latest workstations and graphics technologies are supported by on-demand HPC when it's needed, is a workflow that suits many design engineering teams' simulation workflows. **APDRC**

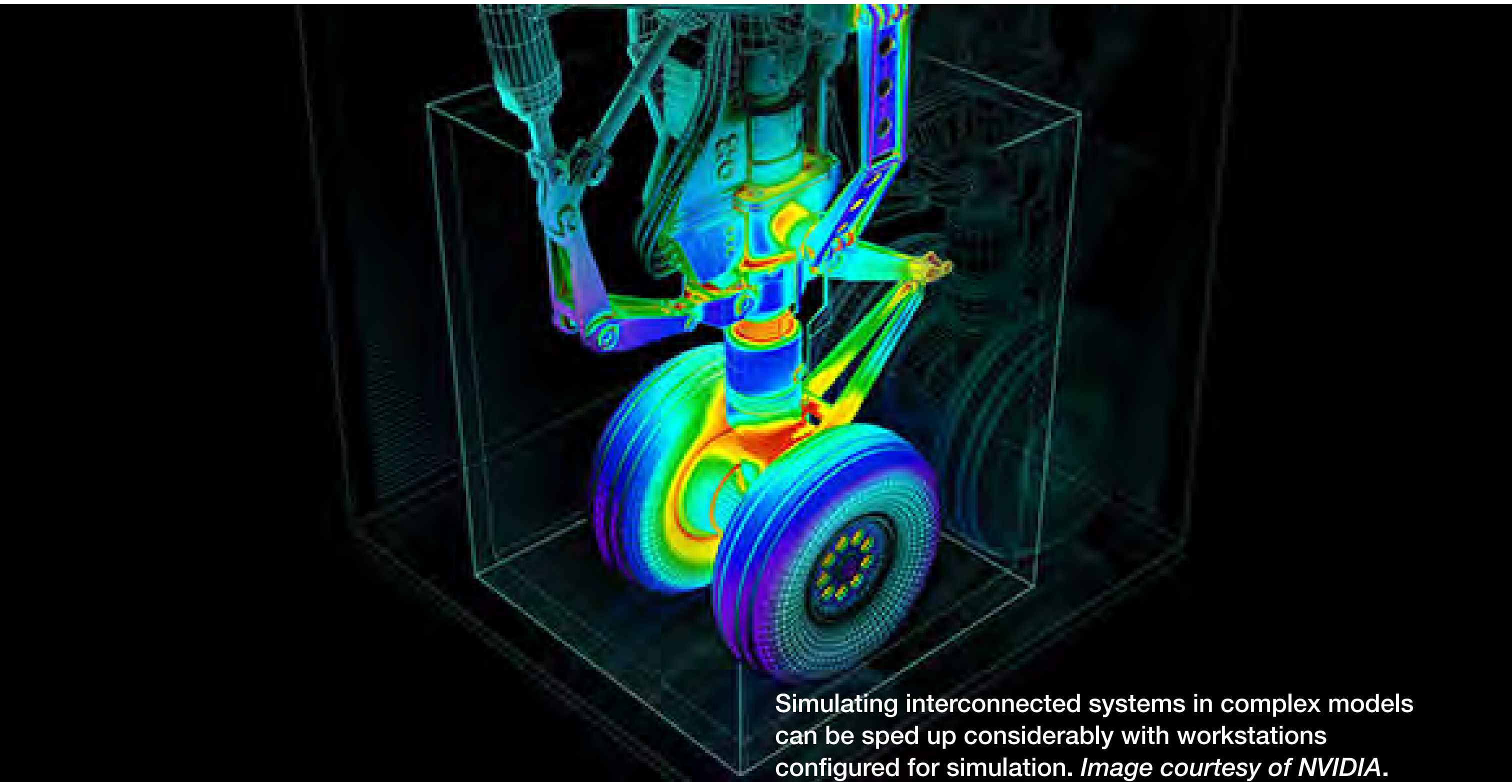
This article originally was originally posted on the Advanced Product Development Resource Center.

How to Configure Your Workstation for Simulation

THE INCREASINGLY COMPLEX engineering required to keep up with the demand for products with Internet of Things (IoT) connectivity, topology-optimized lightweighting, additive manufacturing alternatives, and/or digital twin initiatives is mind boggling. Even without such cutting edge projects, the ever-present pressure to design more product iterations and perform more systems engineering in less time means design engineering teams need to take advantage of every efficiency.

Simulation-led design promises to provide that efficiency by allowing engineers to explore concepts before detailed design work, perform more virtual tests than time-consuming and expensive physical tests, and even evaluate how a design change will affect processes further down the line, such as in manufacturing and maintenance and repair operations. However, the benefits of upfront simulation are often countered by two significant drawbacks: 1. the need for simulation analysis expertise and 2. the time it takes simulation jobs to run.

Simulation software vendors have made great strides in flattening the learning curve needed to make simulation an integral part of the design workflow. More and more CAD experts are able to make use of simulation tools to help relieve the bottleneck traditionally faced by relatively few simulation experts analyzing models from a large pool of CAD experts. The democratization of simulation allows a more streamlined workflow to be adopted in which analysts



Simulating interconnected systems in complex models can be sped up considerably with workstations configured for simulation. *Image courtesy of NVIDIA*.

This e-guide provides key principles for choosing a workstation best suited for engineering simulation. With proper configuration, workstations can help drive significant productivity gains for users, enable digital transformations across organizations, and, ultimately, deliver greater competitive advantages. [Download the free e-guide](#).

spend their time on more complicated issues and/or models that have already been vetted by design engineers.

Still, as more engineers realize the benefits of upfront simulation, they may be left with a bad first impression if their workstations aren't properly configured. It's hard to understand how simulation can boost productivity when your computer bogs down overnight with a simulation run. To overcome this obstacle, design engineers need to understand how to configure their workstations for simulation and when even more powerful on-demand computing resources may be needed.

The Shifting Simulation Landscape

Today's professional workstations are well equipped to handle many types of simulation jobs, when properly configured. Performing simulation directly on the workstation used for design is more convenient. It also frees up centralized resources, such as a shared cluster or server, for the most computationally demanding simulations. And while on-demand access to incredible computing power is now readily available in the cloud, the cost and procedures for accessing cloud computing is not warranted for every situation.

Properly configured workstations address the simulation sweet spot for many design engineers who value interactive simulations to quickly see how changes to a CAD model affect thermal, stress or aerodynamic properties; and occasionally need to solve more computationally intensive simulation problems. More intensive simulations, such as those involving more degrees of freedom, larger, more complex assemblies, and/or multiple types of physics have traditionally benefited more from additional CPU cores, while interactive simulations benefit from more powerful GPUs.

With NVIDIA's recently released Quadro GV100 GPU, however, the traditional computing paradigms are shifting. Based on its Volta architecture, known for high-performance computing applications, the GV100 combines compute and graphics capabilities into one GPU designed for workstations. The GV100 was built to address next-generation workflow bottlenecks that can slow real-time ray tracing for photorealistic rendering, deep learning training, immersive virtual reality, and high-fidelity simulation.

Another prime example of how GPU computing is shaking up engineering simulation can be found in ANSYS Discovery Live. The new software uses the NVIDIA CUDA infrastructure for massively parallel computing to unlock the power of NVIDIA GPUs and conduct simulations in real time. Up-front engineers can use it to pose what-if questions, explore design scenarios, and get immediate feedback through instantly updated simulations. ANSYS Discovery Live only needs a dedicated NVIDIA mobile or a desktop GPU with at least 4GB of memory and the latest graphics driver, but a Quadro P5000, P6000 or GP100 is recommended for the best visualization performance. More complex models, especially, will benefit from more powerful GPUs because ANSYS Discovery Live scales simulation fidelity based on the available GPU memory.

Getting Specific with Specs

Despite the ever-advancing state of the art in hardware and software, there are still tried-and-true methods you can use to configure a workstation for simulation.

1. Configure your hardware to match the current and future capabilities of your software.

The most impressive hardware specs don't mean much if the software you're using cannot take advantage of them, or won't soon.

As hardware capabilities advance, software vendors release updates to capitalize on those advances. For example, vendors are constantly updating their software to more efficiently divide tasks among cores, so if you haven't upgraded your simulation software in awhile, you won't get all the performance out of newer hardware. In benchmark testing, DE found that moving to the latest generation of hardware and software provided a 4X to 9X increase in speed when running certain simulation jobs in Altair OptiStruct, ANSYS, Autodesk CFD, COMSOL Multiphysics, and Siemens Simcenter simulation software packages.

Scalability is an important factor when determining which CPU and GPU environment is right for your workstation. Consult with hardware and software vendors to see how your software scales across cores and multiple processors. There is typically a performance plateau that will help you determine the processor you need. When looking ahead, ask your simulation software provider for a roadmap of features they plan to release. Configure your workstation to take advantage of the software you will have, not just the version you're using today.

The NVIDIA Quadro GP100 enables advanced visualization and simulation capabilities for professional engineering workflows. ***Image courtesy of NVIDIA.***

Of course, it should go without saying that your hardware should be certified for the simulation software you plan to use. Certification solves many hardware-software incompatibilities before you ever see them.

2. **Buy more RAM.**

One of the constants in workstation configuration is that more RAM makes everything run smoothly. Simulation is no exception. High-fidelity simulations need a lot of RAM. Without enough, the solver may start to access the hard drive (known as swapping or paging), which drastically reduces the speed of the simulation and could simply crash the solver. There is, theoretically, no limit to how much RAM a simulation can consume. It all depends on how many elements are being simulated, and at what fidelity.

Let your typical workload and simulation software recommendations be your guide to RAM, but remember that workstations are multi-tasking marvels. When configuring a workstation for one task, you need to take into account all the other tasks that will be running in the background. That's why the rule of thumb for memory is to invest in as much RAM as you can afford.

Memory bottlenecks can occur not just because you don't have enough RAM, but also because the RAM you have isn't accessible. To increase that accessibility, choose a workstation with more memory slots and have RAM installed in as many of those slots as possible. A workstation with 8GB of RAM in each of eight DIMMs is better than installing 16GB of RAM in four DIMMs.

Lastly, investigate how RAM and processors are related. Some types of RAM, such as error-correcting code (ECC) RAM or RAM caching technologies only work with specific versions of CPUs. Don't invest in more expensive RAM that your processor won't support.

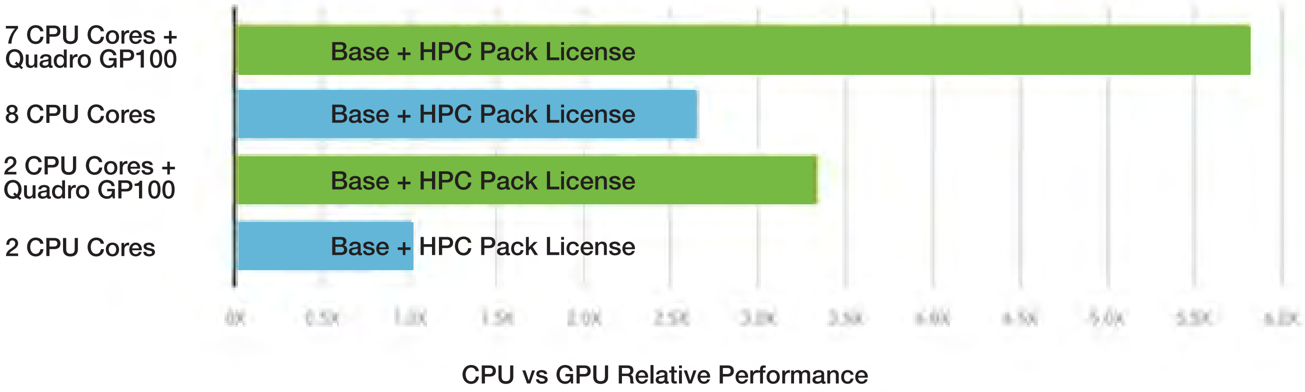
3. **Storage Goes Beyond SSDs.**

Solid-state drives (SSDs) have become standard hard drives in workstations for good reason. They're faster than traditional spinning hard drives and their costs have fallen significantly to bring them in line with traditional drives. Capacities have increased as well.

However, simulation file sizes increase with their complexity and fidelity. When working with simulations, you often save multiple simulation outputs to study and compare them. As such, if you're working with large simulation files, your storage needs will be different than occasional simulation users. Your IT environment will

NVIDIA Quadro GPUs for Workstations

ANSYS Mechanical 17.2



Tests run on a workstation with 2x Intel Xeon Broadwell-EP [Xeon E5-2690 v4 w.6 GHz] 14-core CPU. Quadro GP100, 256 GB RAM, Win 10 64-bit. Benchmark Model: Power Supply Module, JCG solver, symmetric matrix, 5300k DOFS, static, linear, thermal analysis

also affect workstation storage choices, given policies for network storage and the frequency with which you check files in/out.

Thankfully, workstation manufacturers understand flexible storage is key. For example, the Dell Precision 7920 workstation has a FlexBay design that accommodates up to 10 2.5- or 3.5-inch SATA/SAS drives, or as many as four M.2 or U.2 PCIe NVMe SSDs. With the hot-swap feature on the M.2 and U.2 PCIe NVMe SSDs, you can remove drives without shutting down the workstation.

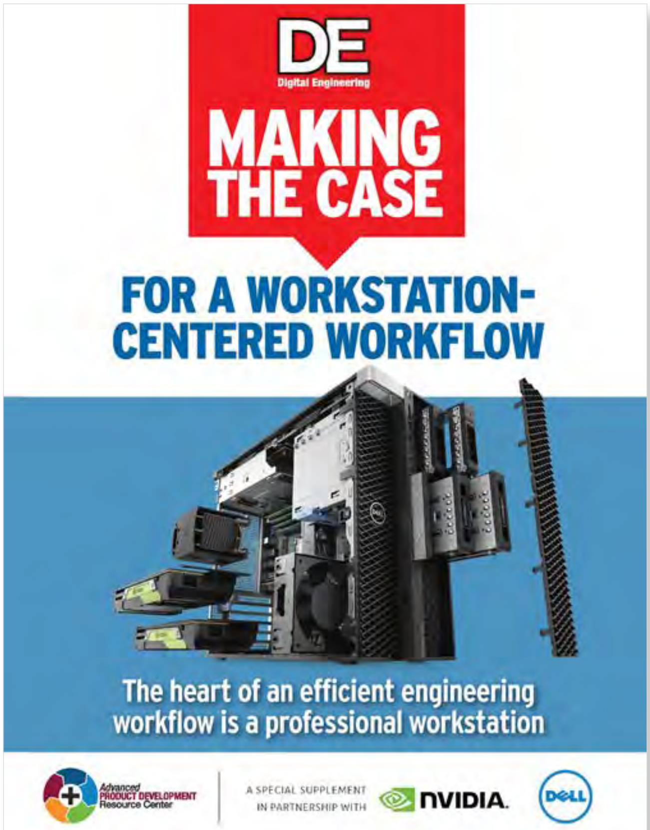
Ignore Feature Fatigue

With all of the simulation software and workstation options available, it's easy to get into the "if it ain't broke, don't fix it" mindset. That path leads to a dead end. It means you're being lapped by other engineers who are taking advantage of the latest improvements while you're ignoring the latest software update because you're afraid your old hardware will balk at it.

The latest hardware and software enable greater engineering productivity by letting valuable employees get more done in less time. That extra time can pay dividends when used to explore new ideas or simulate that extra variable that yields surprising results. Simulation is a key technology in today's fast-paced product design and development environment, make sure your workstation is up to the task.

For in-depth recommendations, download the e-guide: "Selecting the Right Workstation for Simulation." **APDRC**

This article originally was originally posted on the Advanced Product Development Resource Center.



Learn how workstations provide immediate feedback for a more interactive experience, which is critical for fast-paced design environments where design engineers are expected to quickly simulate, render and iterate. Download the free paper.

Digital Design Technology: a New Dawn

THERE WAS A TIME when digital renderings were easily distinguished from photographic counterparts. Then came the amazing realism seen in big-budget Hollywood movies — with a sizable chunk of those budgets going to computer-generated imagery. Realistic rendering was a painstaking, expensive process done on large render farms. Those days are gone. Today, design engineers have access to affordable, photorealistic rendering, 3D animations and simulation, as well as immersive design technologies like augmented and virtual reality.

New visual technology has made this new design engineering workflow possible. Professional workstations equipped with graphics processing units (GPUs), which can handle multiple streams of data fed to them by software designed to take advantage of their parallel processing capabilities, as well as ultra-sharp 4K and even 8K monitors have become the norm for design engineers. Consequently, today's visual design workflow has entered a new realm. These advances improve team collaboration by easily sharing realistic digital prototypes, data visualizations and simulations with team members unaccustomed to technical drawings.

Dell UltraSharp 49 Curved Monitor has a wide 32:9 aspect ratio that is designed for multi-screen productivity. *Image courtesy of Dell. Screen render copyright Roborace/Daniel Simon, via NVIDIA.*

Enhancing the Entire Design Process

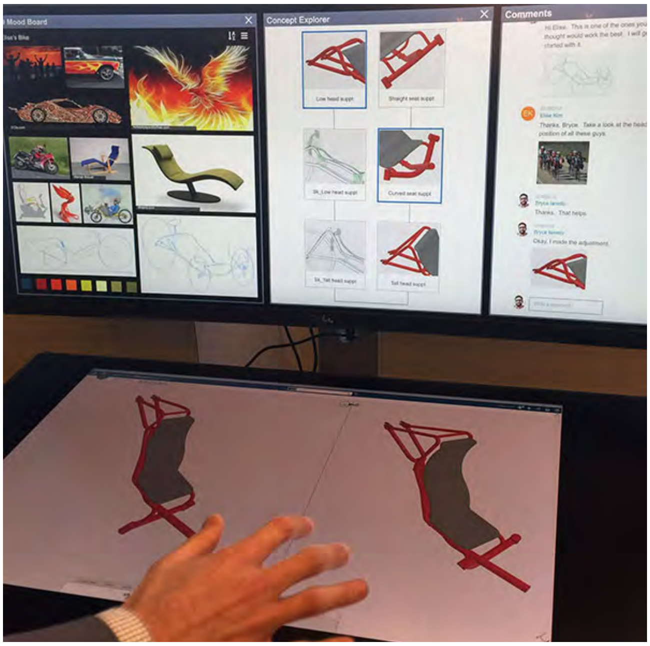
The latest GPUs on the market, the NVIDIA RTX family, make use of the company's new Turing architecture. NVIDIA says its dedicated ray tracing processors render film-quality effects 30X faster than CPUs; save time with deep learning-accelerated denoising, resolution scaling and video re-timing using AI; and improve raster performance by up to 50% over previous-generation GPUs for more interactivity and virtual reality.

In his SIGGRAPH 2018 keynote, NVIDIA CEO Jensen Huang introduced the first Turing-based products—the Quadro RTX 8000, 6000, and 5000 GPUs and Quadro RTX Server—by demonstrating a trailer Porsche created to show off its 70th anniversary 911 Speedster Concept. As it turns out, the trailer was not a video but a real-time, ray-traced render. See it here.

"You can't do that with rasterization," Huang said as moving lights dynamically reflected off the car. "Everything is all ray-traced."

The Art of Display

But visuals are only as good as the hardware you're using to see them. Enter a new generation of monitors with what just



Dell Canvas combines an interactive screen with a view screen. *Image courtesy of Dell.*

a few years ago would have been thought of as insanely high resolutions. For example, the Dell UltraSharp 49 Curved, 32 4K USB-C and 34 Curved USB-C monitors come with significant features to enhance productivity. Picture-by-Picture allows for multi-tasking content from two different PCs. A built-in keyboard, video and mouse (KVM) help users toggle between and edit content using a single keyboard and mouse. The new portfolio of monitors also offers USB-C connectivity that charges a connected laptop while transmitting data and video signals, all from one single cable to reduce cable clutter.

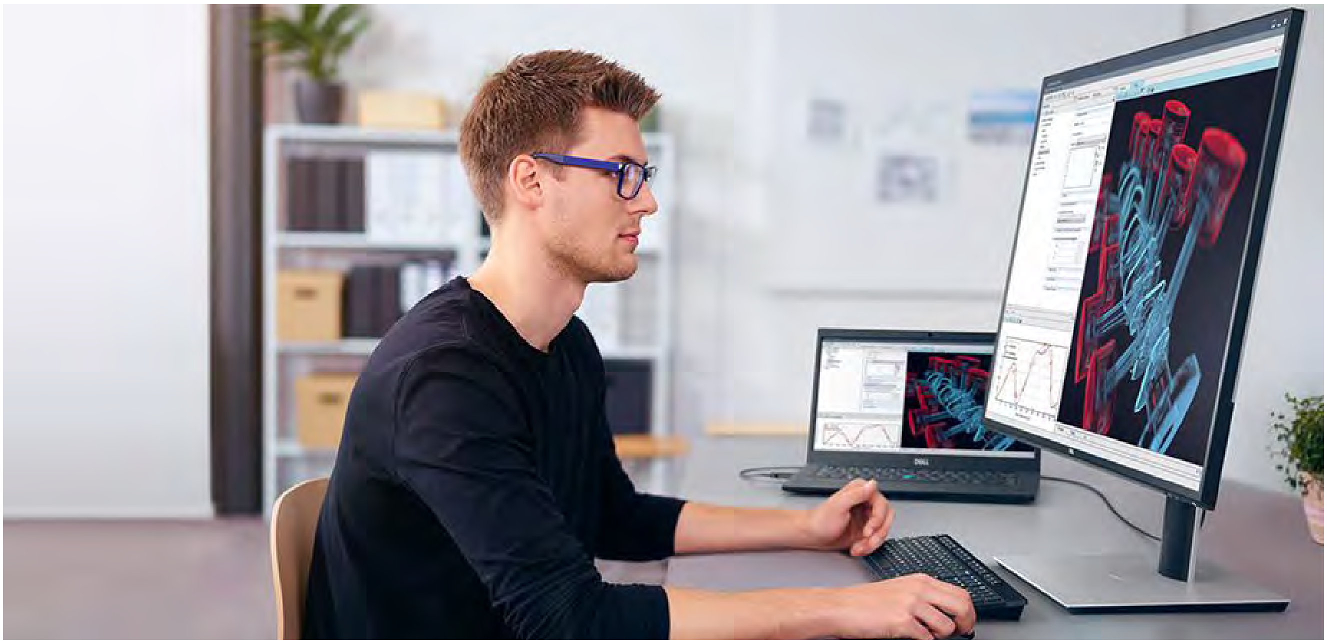
Dell introduced the UltraSharp 49 Curved Monitor in October, calling it "the world's first 49-inch curved dual QHD monitor." It has a wide 32:9 aspect ratio for seamless multi-screen productivity. It is intended to replace two 27-inch QHD monitors. The large onscreen space with 5120x1440 resolution and IPS technology allows users to view more content and see fine details with consistent color across a wide viewing angle, according to the company.

Bringing It All Together—On Canvas

As yet another example of how visual technology is advancing, Dell Canvas offers a new way to digitally design. The 27-inch workspace empowers natural digital creation and features an electro-magnetic resonance pen that can operate without cords or batteries, a totem to dial in graphic software menu preferences, and a touch surface.

Nike is using the digital canvas to design its next generation of footwear. Ken Black, vice president of Digital Design Transformation at Nike, described Dell Canvas as a tool to help them "inspire the world" with their footwear creations. "At the heart of things, we've always been makers," said Black at Dell EMC World. "From the beginning, we've been craftsmen, tinkerers, innovators. That [point of view] has enabled us to drive the performance and aesthetic of what we call modern sports."

The NVIDIA Quadro RTX 8000, Quadro RTX 6000 and Quadro RTX 5000 bring hardware-accelerated ray tracing, AI, advanced shading and simulation to creative professionals. *Image courtesy of NVIDIA.*



The Dell UltraSharp 32 4K USB-C Monitor: U3219Q features four times more detail than Full HD with 3840x2160 Ultra HD 4K resolution, as well as Picture-In-Picture (PIP) and Picture-By-Picture (PBP) capabilities. ***Image courtesy of Dell.***

Advances in visual technologies signify a new dawn in visual technology, one that is changing and positively charging 3D design teams. Black characterized this movement when he said: "How do we get the brilliant idea that exists in each designer's head out and in the world—to you—faster, better, more beautifully, and more seamlessly? It's about the visualization. But being a physical product company, it's also about the realization of that end product." **APDRC**

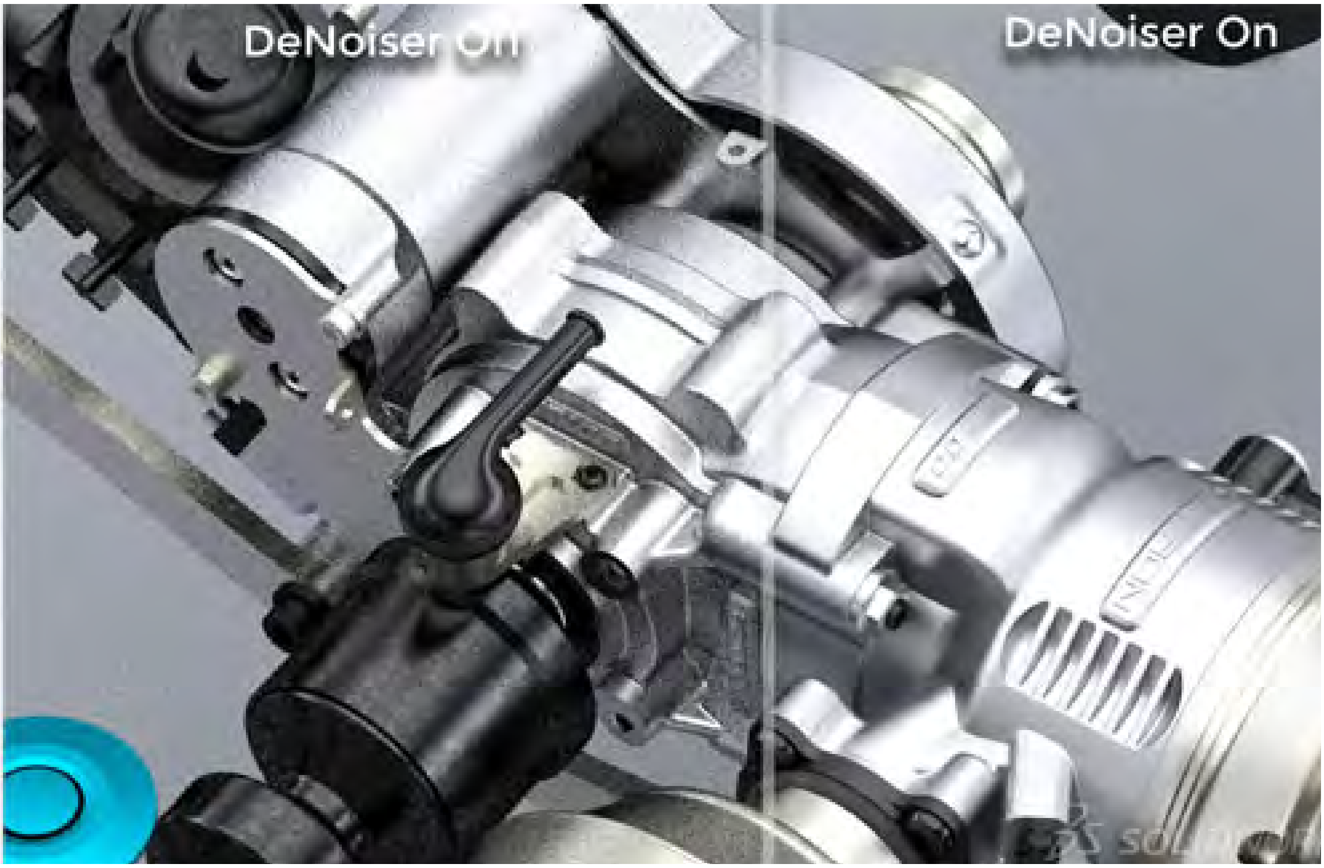
This article originally was originally posted on the Advanced Product Development Resource Center.

Watch this video to see how Dell, Nike, Meta and Ultrahaptics push the boundaries on immersive creativity.

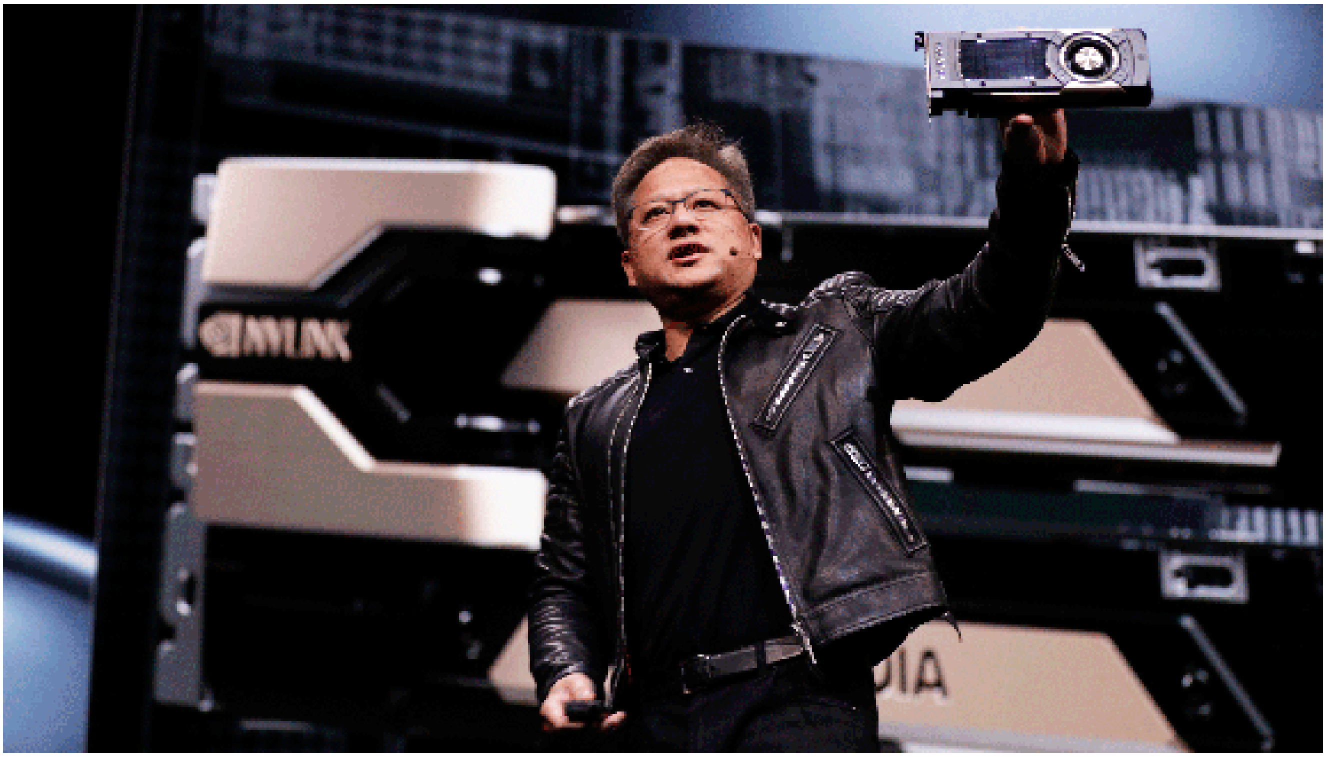
Configure Your Workstation for Rendering

PHOTOREALISTIC RENDERING is a matter of manipulating variables to trick the eye into mistaking pixels for reality—say those glints of sunlight off a sports car's rims or the deepening shadows beneath the latest consumer appliance sitting on a virtual granite countertop. That manipulation of transparency, refraction, shading, translucency, texture mapping, motion blur and more are increasingly being handled by graphics processing units.

In the not-too-distant past, rendering was an afterthought of design. Something done after the product was finalized, mainly because it was too slow to do concurrent with design. That has changed thanks to technology advancements that enable interactive rendering and visualization. Interactive rendering relies on ray tracing and global illumination, and the physics of light and materials. Ray tracing means firing light rays into the scene and allowing them to bounce on and through materials as they would in the real world. As the light rays bounce around, they fill the volume of the scene with secondary bounces, so objects act as light sources themselves. This bounced light can illuminate all of the nooks and crannies of the scene, even objects that aren't directly in the path of the



A preview of a feature in SOLIDWORKS 2019, showing SOLIDWORKS Visualize rendering an assembly with AI-powered noise removal from NVIDIA. *Image courtesy of SOLIDWORKS.*



NVIDIA CEO Jensen Huang showcased the new GPU Quadro GV100, based on Volta architecture, at the year's GPU Technology Conference. *Image courtesy of NVIDIA.*

sun or a light bulb. It's called global illumination (GI).

The rub of physically based rendering is that it is much more expensive computationally. Simulating billions of light rays, bouncing around in a scene many times before they expire, requires a lot of computer power. Fortunately, GPUs have advanced photorealistic rendering.

Many GPU-based renderers are built on CUDA, NVIDIA's massively-parallel supercomputing programming language, but designers don't need a supercomputer or top-of-the-line CPUs to use these them. They run on the same Quadro graphics cards design engineers already use to power their professional CAD and simulation applications. Users can leverage the cost of computing hardware by optimizing their systems to use lower-end CPUs coupled with more powerful GPUs, which provide more benefit in terms of real-time display performance and rendering compute performance.

Workstation Configuration Suggestions

Rendering speed comes down to the software you choose and the hardware it is designed to use. Renderers were initially created to use the CPU. KeyShot and Chaos Group's V-Ray Adv, for example, scale with a CPU's clock speed and core count. If you are using a CPU-based renderer, then CPU choice is the critical factor to consider when configuring a workstation. If you have a demanding CPU rendering workload and your budget allows, then invest in dual, multi-core CPUs. With V-Ray-Adv or Keyshot, your choice of graphics card would be determined by the other software you plan to use on the the workstation.

To take advantage of the massively parallel nature of GPUs for rendering, many rendering software providers now offer GPU-based rendering. Next Limit's Maxwell Render, for example, began supporting GPUs with Release 4 in 2016. Upon its release, the company stated that GPU rendering can be up to 10X faster than CPU rendering. Chaos Group's V-Ray RT GPU renderer was officially renamed to V-Ray GPU in March because of significant improvements the company made to the software's architecture.

Like NVIDIA's Iray, OTOY's OctaneRender, and Redshift Rendering Technologies' Redshift, V-Ray GPU was created to make use of NVIDIA GPUs. Many of these rendering engines are available as stand-alone products or as plug-ins to popular design software, including Maya, 3ds Max, Modo, Rhino, Revit, Blender and more. Rendering via GPUs is more cost-effective than on CPUs because as you scale, you get more rendering bang for your buck.

Because GPU rendering scales well across multiple

GPUs, the choice of which video card and how many to use comes down to form factor and budget. If you prefer a portable workstation, you likely must forego the option of multiple graphics cards for the benefits of mobility, extended battery life and thin, lightweight design. Still, portable workstations equipped with even mid-range NVIDIA GPUs exceed the minimum requirements for GPU-based rendering. If your rendering needs are greater, then larger workstations like the Dell Precision 7920 Tower can be configured with multiple graphics cards, all the way up to 3 x NVIDIA Quadro P6000s or even GV100s. Each NVIDIA Quadro P5000 card features 2,560 CUDA cores.

As a general rule of thumb, scaling across multiple, lower-cost GPUs is the most cost-effective means of rendering and will meet the demands of most design engineers. There is now also the option to use both CPUs and GPUs to render. Last year's release of V-Ray 3.6 introduced hybrid rendering. V-Ray GPU allows you to take advantage of the power of GPUs for rendering, and with hybrid rendering you basically get an added speed boost from the CPU for free that would otherwise be sitting idle.

If you're looking for the latest and greatest, and rendering speed is crucial enough to your workflow to support the investment, look no further than NVIDIA's new Quadro GV100. The first workstation-class GPU based on the AI-powered Volta architecture was announced at the GPU Technology Conference in March. "The new Quadro GV100 packs 7.4 TFLOPS double-precision, 14.8 TFLOPS single-precision and 118.5 TFLOPS deep learning performance, and is equipped with 32GB of high-bandwidth memory capacity," writes NVIDIA's Bob Pette in a blog post. "Two GV100 cards can be combined using NVIDIA NVLink interconnect technology to scale memory and performance, creating a massive visual computing solution in a single workstation chassis."

The GV100 represents the state-of-the-art in real-time, GPU-based rendering on the workstation. It provides deep learning-accelerated denoising performance for ray tracing and a significant speed boost.

"V-Ray GPU is 47% faster on NVIDIA's new Quadro GV100 GPU than it is on their previous Quadro GP100 flagship," writes Chaos Group's Phillip Miller in a blog post. "It's also 10 to 15 times faster than an Intel Core i7-7700K — which is pretty impressive given we do our best to ensure the CPU performance of V-Ray GPU stays on par with that of V-Ray. Through our continued support of NVLink, a system housing two GV100s provides 64GB of memory for handling large scenes — all interactively."

GPU-acceleration makes rendering so fast that it can be used interactively. This means design engineers can work normally, but evaluate the appearance of materials and lights, as well as changes to the geometry of the designs, with almost no disruption to the design workflow at all. GPUs are easily ganged together, so if one graphics card isn't fast enough, a second graphics card will make the render almost twice as fast. What used to take a farm of computers running overnight can now be done interactively on a desktop. **APDRC**

This article originally was originally posted on the Advanced Product Development Resource Center.

Monitors Matter

You can have the latest rendering software and top-of-the-line GPUs, but if your monitor is not up to par, you're not getting the whole picture when you render. Fortunately, today's 4K and even 8K monitors are up to the task. For example:

• The Dell 43 Ultra HD 4K Multi Client Monitor: P4317Q is like having four monitors in one. The 43-in. monitor supports up to four simultaneous inputs, from Full HD to Ultra HD 4K.

• The Dell UltraSharp 32 Ultra HD 4K Monitor with PremierColor: UP3216Q provides precise, accurate colors right out of the box, according to the company.

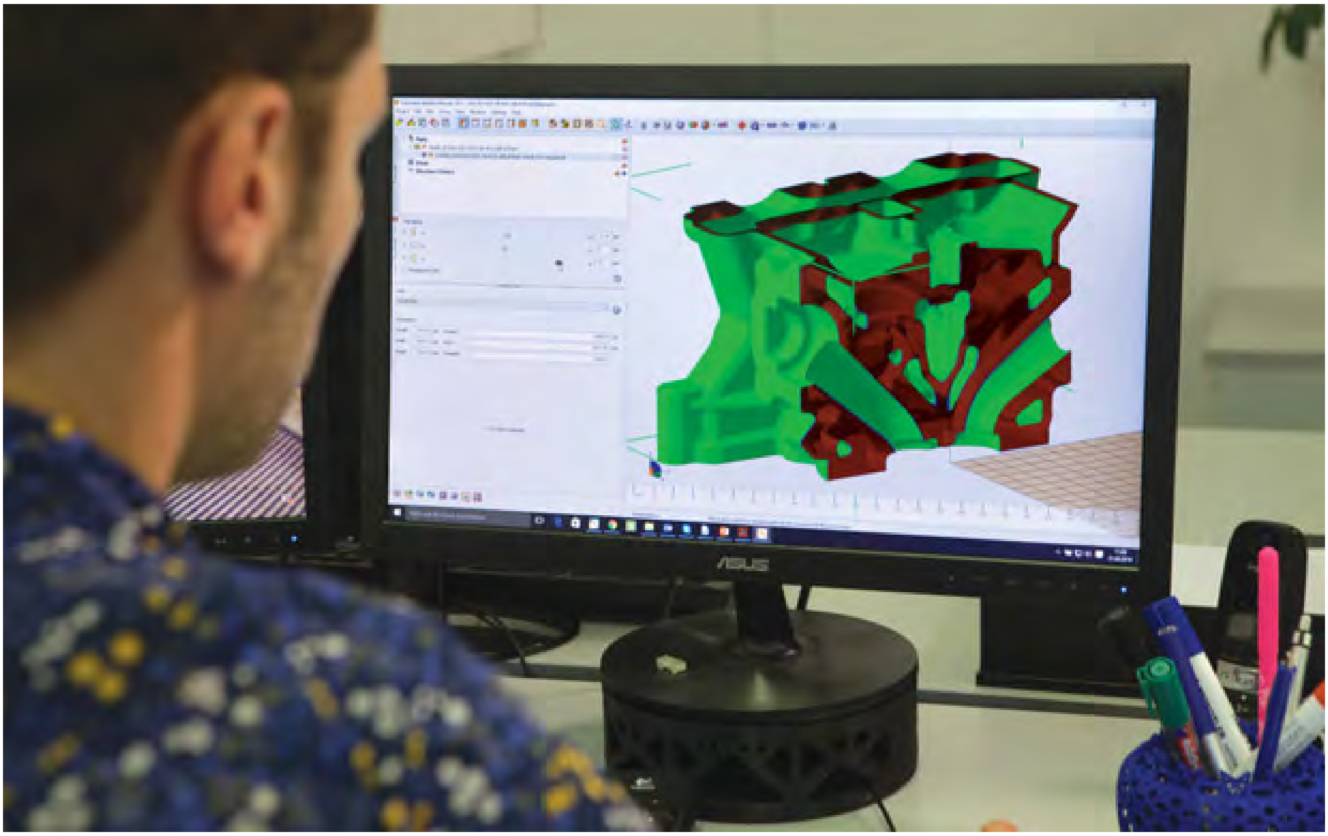
• The Dell UltraSharp 27 4K Monitor: U2718Q features a color depth of 1.07 billion as well as the InfinityEdge thin bezel that is well-suited for multi-monitor setups.

• The Dell UltraSharp 32 8K Monitor: UP3218K is the world's first 32-in., 8K monitor, according to Dell. It features a 33.2 million pixel resolution and a pixel density of 280ppi for incredibly sharp, realistic visuals.

When CAD, CAE and CAM Collide

DESIGN ENGINEERS WHO ARE A WHIZ at 3D CAD modeling typically have little aptitude for the CAE tools to run structural analysis on those designs, let alone the expertise to man a CAM solution to gauge manufacturability. But as new manufacturing methods like 3D printing and advanced generative software pave the way for more complex designs, mainstream engineers require a tool bench that combines elements from CAD, CAE and CAM — a convergence now underway thanks to the advent of increasingly powerful computing.

Next-generation, high performance CPUs boasting dramatic increases in both the number of cores and amped up clock speeds, coupled with the accessibility of lower-cost GPU horsepower, create a platform on which design tool vendors can modify their software portfolios to address demand for CAD, CAE and CAM convergence. The industry has traditionally passed through cycles where the focus alternates between making deep-dive improvements to individual CAD, CAE and CAM packages to establishing more robust integration between the individual silos.



Since acquiring Netfabb in 2015, Autodesk has been busy adding advanced technologies–including enhanced simulation, optimization and advanced toolpath capabilities–that will provide engineers and designers with a broad collection of additive design and manufacturing tools. ***Image courtesy of Autodesk.***

Today, the pendulum has swung back to an emphasis on integration, and as a result, convergence, according to Ken Versprille, executive consultant for CIMdata, a PLM and engineering consulting firm.

“Teams are always working to produce better products, but it can be difficult to do sometimes because the software fights against them,” Versprille explains. “The fact that you can throw clusters of CPUs in the cloud or powerful GPUs at a problem opens the door to more performance.”

AM Drives CAD, CAE and CAM Convergence

By harnessing modern hardware advances like GPUs, more powerful processors, and new memory media and storage technologies, engineering organizations gain access to the computational horsepower necessary for accelerating 3D modeling applications, enabling real-time analysis and simulation, and rendering complex visualizations. One of the key drivers for convergence of such CAD, CAE and CAM capabilities is the growth of additive manufacturing (AM), which enables the production of previously impossible designs while allowing for new workflows that place an emphasis on optimization.

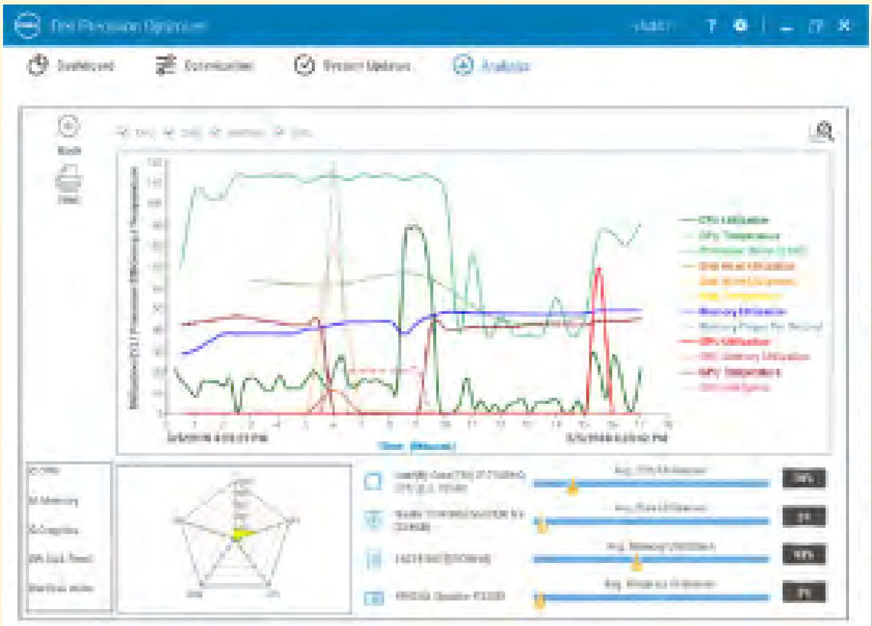
For example, AM allows for new design concepts that achieve specific structural properties by mixing materials or varying materials usage throughout a part or by redefining multiple parts into a single unit. That kind

Optimizing Dell Precision Performance

One of the biggest challenges to reaping the full potential of a converged CAD/CAE/CAM platform is ensuring the workstation hardware is fully optimized to support new and more efficient design workflows.

To facilitate that task, Dell offers the Dell Precision Optimizer, a free software tool that comes installed on Dell Precision workstations used to dynamically adjust system settings so they are tuned to run at top performance for specific applications and workloads. Based on profiles built and tested by Dell engineers, the software automatically tunes application performance and adjusts system settings at the BIOS, driver, and operating system layer to maximize how an application runs on a particular system. Profiles are used to automatically make adjustments to capabilities such as number of CPU cores used, GPU settings, and power settings.

The Dell Precision Optimizer also delivers system maintenance capabilities to download critical updates, another way to maximize performance, and provides utilization analytics and reporting on CPU, memory, storage, and graphics in real-time and over a defined tracked period. Through an analysis feature, users can monitor utilization of a Precision workstation so they understand exactly where bottlenecks occur and what system resources are over-utilized.



DPO can optimize hardware settings to maximize performance for many popular software applications. *Image courtesy of Dell.*

“Say a system starts to run out of memory swapping to disk and performance drops—this makes it easy to identify what’s happening and optimize the performance of the workstation beyond what’s offered out of the box,” says Scott Hamilton, senior worldwide industry strategist, Engineering and Manufacturing, at Dell. “Dell Precision Optimizer allows you to run at full cylinder for what you are trying to do, especially when different applications place different demands on the computer.”


Voxel-based 3D printing with NVIDIA GVDB, where the inside structure is optimized based on stress and automatically generated. *Image courtesy of NVIDIA.*

of design freedom relies on sophisticated optimization studies that require significant compute power.

"When you look at the whole process of optimization, you need to understand all the properties and how they'll vary in design and you need to do that early in the process—not after the fact," explains Scott Hamilton, senior worldwide industry strategist, Engineering and Manufacturing, at Dell, who notes that historically, most engineers didn't have access to the workstation muscle to deliver on optimization in any significant way. "For the optimization process, ideally you want to run thousands of simulations, not a handful, and the limiting factor to doing that has been computational horsepower."

Moreover, as AM eliminates the many design constraints of traditional manufacturing, engineers need to think differently about design. Tapping new generative design tools to explore lattice structures or to create organic shapes that combine what were previously separate parts into a single entity requires that engineers have access to capabilities that span traditional CAD, CAE and CAM domains, which is more fuel for convergence, notes Stephen Hooper, senior director, business strategy and marketing for manufacturing, at Autodesk. "You can't separate the design from manufacturing any more without expecting some pretty adverse effects in terms of cost and time to market," Hooper says.

In response to the need, Autodesk has transformed the way it offers software, shifting from a collection of bundled technologies to providing an end-to-end product development solution directly inside of Inventor, he explains. "We want to provide everything you need for full product development from initial ideation all the way through manufacturing and finish," he says. On that note, the acquisition of HSMWorks, a CAM plug-in that works with mainstream CAD packages, gave way to Netfabb digital manufacturing capabilities, but also for specific 2.5-, 3-, 4-, and 5-axis milling capabilities to be folded into the foundational Autodesk Fusion 360 offering.

Other leading CAD vendors are following suit. Dasssault Systemes released SolidWorks CAM (SW CAM), an add-on to all desktop versions of the CAD tool that is based on technology from long-time partner HCL. Siemens PLM Software has continuously bolstered the CAM and coordinate measuring machine (CMM) programming capabilities of its NX CAD package, including applications that simplify the creation of smart tool paths. For its part, PTC offers CAM extensions for specifying tools and tool paths along with capabilities for simulating and visualizing material removal directly within the Creo CAD environment.

Looking further down the pike, Desktop Metal, a manufacturer of metal 3D printers, sees opportunity for the advances in computational horsepower, particularly more powerful, less expensive GPUs, to enable on-the-fly checks and course corrections that promote first-time accuracy for 3D prints.

"The goal is to create a closed-loop system that is constantly monitoring what you are creating and compensating in real time," explains Andy Roberts, head of generative design tools at Desktop Metal. "That's a computationally expensive task to perform because there's lots of image and sensor data coming in in real-time. But as the cost of GPUs come way down, it's realistic to have that kind of processor making sure everything comes out right."

Voxel-Based 3D Printing, Optimization, and Simulation

Typically, when you work with topology optimization software, you supply the program with loads, stresses, and material characterization, then let the software identify the best shape or geometry that meets your design objectives. But there's a different kind of optimization that additive manufacturing pioneers — especially those experimenting with large-scale, industrial AM — have been looking for: Given the anticipated stress and loads on a certain shape, what is the best internal structure to use to counteract them while maintain the general outer shell?

In that regard, the introduction of NVIDIA GVDB Voxels at the GPU Technology Conference in 2017 and the updated version 1.1 shown at GTC 2018, offers some tantalizing possibilities. With GVDB-based simulation, the demo showed you could build a program to automatically populate the interior of a 3D model with lattice or honeycomb structures, with varying densities in different regions to account for the anticipated stress loads.

Currently, CAD users prepare the geometry in CAD software, then export the model as STL or another 3D printing file format for printing. "If software vendors begin adopting it, you'd probably start to see GVDB as part of the data flow between STL to the print-preparation tools," said Andrew Page, NVIDIA product manager. "In longer view, what we'd like to see is CAD applications sending voxels directly to the printer [without going through an intermediary file format] and printing the job based off voxel information." **APDRC**

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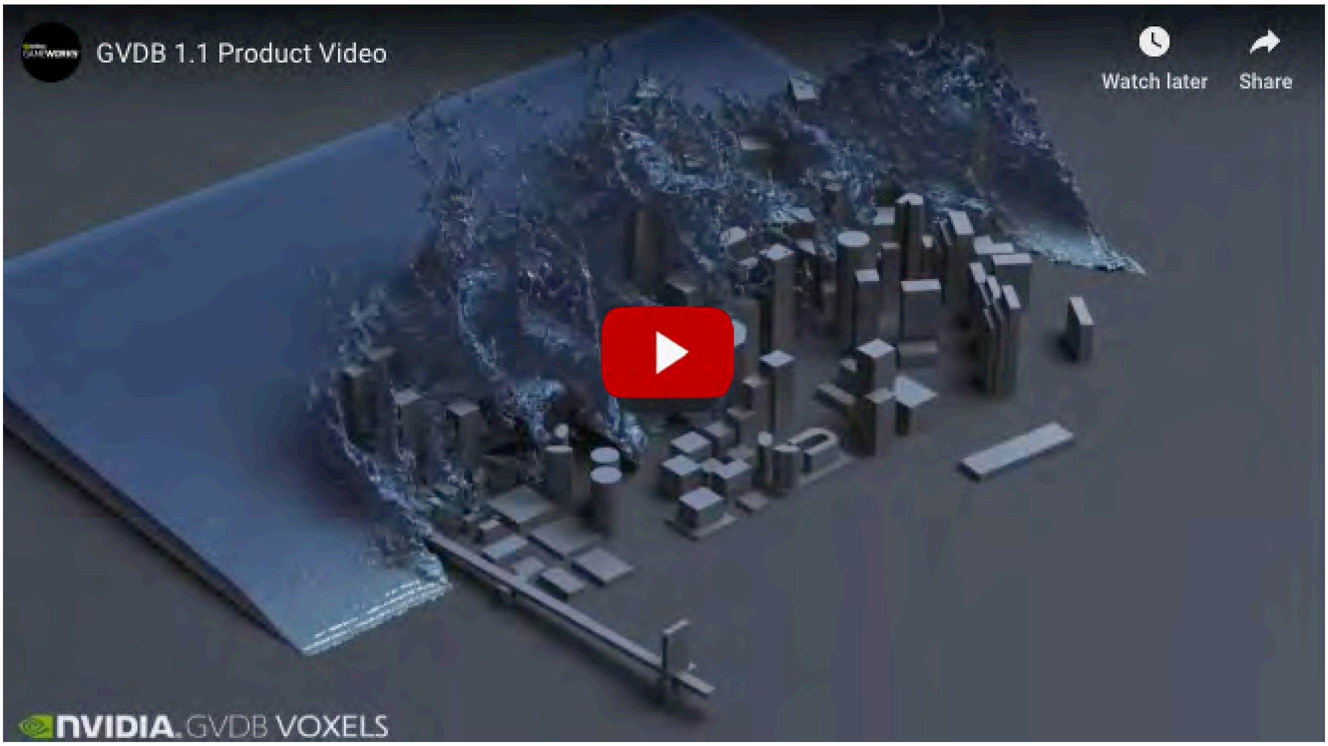


Watch this video to learn more about NVIDIA GVDB Voxels, a new developer library for voxel data.

Visual Manufacturing

THERE WAS A TIME—not that long ago—when using a computer for milling meant learning how a specific toolpath would work out in the finished part. Computer-aided manufacturing (CAM) required an apprenticeship because not everything about the process was visible on the computer screen; intuitive knowledge was required. The tremendous variation in both software processes and milling equipment mean one-on-one training was needed to gain the required insight.

The last few years have brought many changes to CAM processes. The milling machines are more complex, offering four or sometimes five separate axes to program. There is more standardization in processes, allowing software vendors to automate more of the process. Manufacturers expect these new complex mills and CAM programs to create more complex parts. CAM software has become more visual, taking advantage of advancements in monitors, increased processing power, and the complex visualization capabilities of today's graphics processing units (GPUs).

The result is the need for a full visualization of the milling process, says Michael Buchli, a senior product and portfolio manager for Dassault Systemès SolidWorks. "The key to running toolpaths today is to know when the tool comes in and goes out," he says. "The visualization of this is more important than ever."

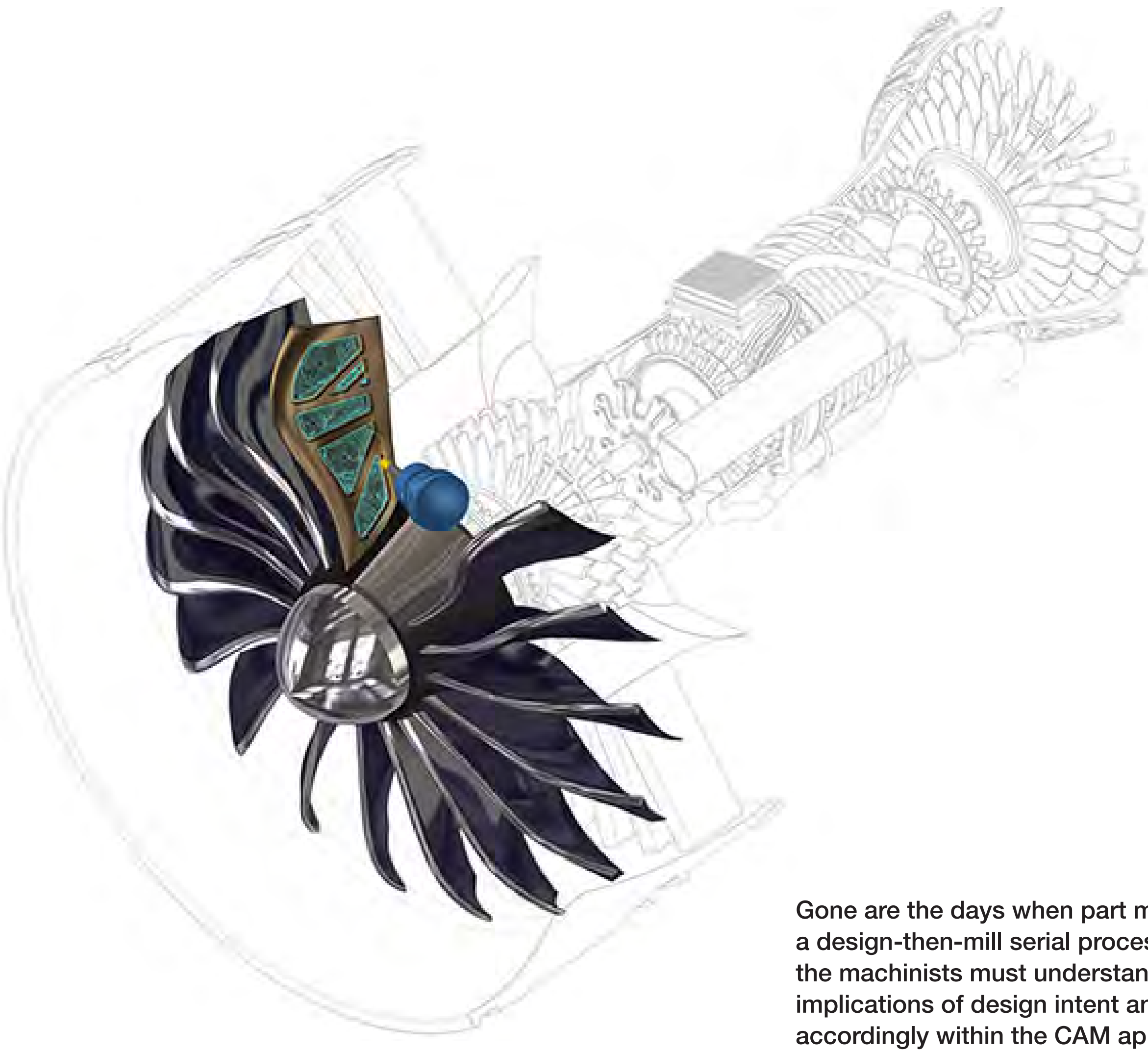
Buchli describes the process of a top-end mill like the Matsura 330 as challenging for both the designer and the shop floor machinist. The designer needs to understand the mass issues, to prevent an unmillable design from moving forward.

"I want to see the finish, like a basic simulation in finite element analysis," Buchli says, speaking as if he were the designer. "It is about comparing the real part with the toolpaths" using visualization. "I want to see the stresses, the gotchas," he adds.

For the machinist, running a five-axis mill means being in charge of a cutting device moving very fast, "much faster than mills from 25 years ago." The machinist needs the visualization to understand the complexities of the project ahead of time. "You can't afford trial and error in the shop," Buchli says.

The evolution of CAM in daily practice means users need repeatability and consistency. "The companies really taking advantage of manufacturing technology have their processes dialed in," says Buchli.

High resolution monitors are essential to understanding the complex toolpaths of today's 4- and 5-axis tools. ***Image courtesy of MasterCAM.***



Gone are the days when part milling was a design-then-mill serial process. Today the machinists must understand the implications of design intent and respond accordingly within the CAM application. ***Image courtesy of MasterCAM.***

In general, these are the larger companies, who have kept pace with software and hardware trends. The small, independent shops are less likely to have the computation horsepower to drive complex milling with full visualization.

Visualization is Vital

A contemporary graphics processing unit (GPU) in a workstation means you have the equivalent of a second processing system under the hood. The CPU is best at running multiple algorithms and working with constantly changing data. The GPU excels at running a single algorithm simultaneously on thousands of processors.

Ben Mund with MasterCAM says CAM software vendors have found it easier to program CAM software to take advantage of GPUs than computer-aided design (CAD) software vendors, because of the nature of the process. The better graphics from a high-end GPU don't make the mill run faster, but they do provide faster generation of complex toolpaths. "When you generate a toolpath in CAM, the visualization is generated after the process," says Mund. CAD must "always be immediately visual," which is a much more complex task.

Mund says MasterCAM works closely with leading GPU vendor NVIDIA. "Toolpath visualization is complex; having the best GPU is critical," says Mund. "The better and faster you can display the information, the better you will understand what is happening."

CAD programs are generally up to date with screen resolution standards, and already support 4K resolution. When CAM programs offer 4K, it becomes much easier for both the designer and the machinist to "finesse the operation," Mund says. "You can really dig into the model"

You can fill the Dell UltraSharp 49-inch curved monitor with display input from one or two workstations. *Images courtesy of Dell and MasterCAM.*

from a machining standpoint, to improve throughput or to provide a more aesthetic outcome.

4K Enters the Engineering Mainstream

When 4K resolution monitors were first introduced, their hefty price tag meant only the largest companies could afford to place them strategically within the organization. Today 4K monitors like those from Dell are mainstream, and should be considered the primary monitor for all engineering staff. The company offers many different 4K and 8K monitors, ranging from 24 inches all the way to 86 inches, including the new Dell UltraSharp U4919DW, a QHD 49-inch ultra-wide monitor. The curved, widescreen monitor has a resolution of 5120 x 1440 pixels and can display signal inputs from two different computers.

"4K" refers to the horizontal screen resolution of 4,000 pixels, double the resolution of FHD (Full High Definition) monitors. The increased pixel density means intricate details are revealed in very high fidelity without the need to zoom in.

A powerful visual subsystem driven by GPUs and high-resolution monitors is "a big benefit to MasterCAM," says Ben Mund. "The better you can display the information, the better you will understand what is happening." **APDRC**

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Getting Data Back from the Shop Floor

As the idea of connected devices in the factory becomes more common, there will be a sharp increase in the amount of data coming back to designers and machinists from operations. CAM procedures will be able to provide feedback that can be used to improve both toolpath planning and design. Such data will be primarily visual in nature, making it imperative that the CAM workflow have access to the best visualization technology possible. That means high-end GPUs and 4K resolution monitors.

Researchers at Georgia Tech have experimented with using the open factory data standard MTConnect to collect data from machine tools and CAM stations. Traditionally, such data was only accessible to manufacturing execution systems (MES) to monitor process control, consumable usage and productivity. The research team took it a step further with development of an Android app to create a shop floor digital twin, accessible for both production control optimization and to create an "as built" full loop back to engineering. The research has not yet been commercialized.