June 2024

DE247 Digital Engineering

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Generative Design

DigitalEngineering247.com

PEERLESS MEDIA

By Brian Albright

Making Simulation Pay

AT THE RECENT ASSESS SUMMIT I ATTENDED in Georgia this spring, several presenters touched on a topic that probably doesn't get enough attention in our pages: making the business case for simulation. ASSESS, which is part of NAFEMS, published a paper on the topic late last year (*Understanding the Path to Realizable Business Benefits through Engineering Simulation*), which you can download here.

The idea is that chief engineers and managers need a way to show value for simulation to decision makers, because advanced simulation is often time, resource, and cost intensive. Mark Meili of Modeling Enabled Innovation, Leadership, and Insight, gave a presentation on some of the findings.

He emphasized that there are measurable benefits in time reduction, cost reduction, increased innovation and safety. Some of these benefits are easy to see. If you do more virtual experiments and less physical testing, the time/cost savings are fairly evident. But he said that it's important to baseline existing development costs so that you can show a real improvement, and to be aware of company politics when building this business case; one person's cost reduction is someone else's embarrassing budget cut.

A McKinsey presentation at the event reinforced these ideas, noting that in a (still uncompleted) automotive industry survey, simulation users experienced double-digit improvements in time to market and product performance.

This month's issue focuses on Generative Design, which remains a topic with a lot of reader interest, even though adoption remains relatively low. Senior Editor Kenneth Wong takes a look at how natural language processing (NLP) and artificial intelligence can augment these tools and make them easier to use. Longtime contributor Randall Newton, meanwhile, provides a look at the types of engineering workstations needed to run these tools.

We also have features on simulation software interoperability, hybrid additive/subtractive manufacturing processes (and the design challenges they present), and a look at Autodesk 2025 from David Cohn.

There are measurable benefits in time reduction, cost reduction, increased innovation and safety as a result of using advanced simulation.

In other news, the virtual Digital Engineering Design & Simulation Summit will return on Oct. 31, 2024. The keynote panel this year will focus on how artificial intelligence (AI) is being integrated into simulation software and related workflows to optimize results and offer fast, simplified analysis throughout the design process. While AI is not going to replace complex simulation and analysis, it can provide easy-to-use design validation earlier in the process for non-experts, which can increase the value of more robust simulations later in the workflow. We also plan to have industry leaders on hand to provide additional insights in four additional sessions focused on engineering computing, digital twins, design and additive manufacturing. You can find out more at the Design & Simulation Summit website.

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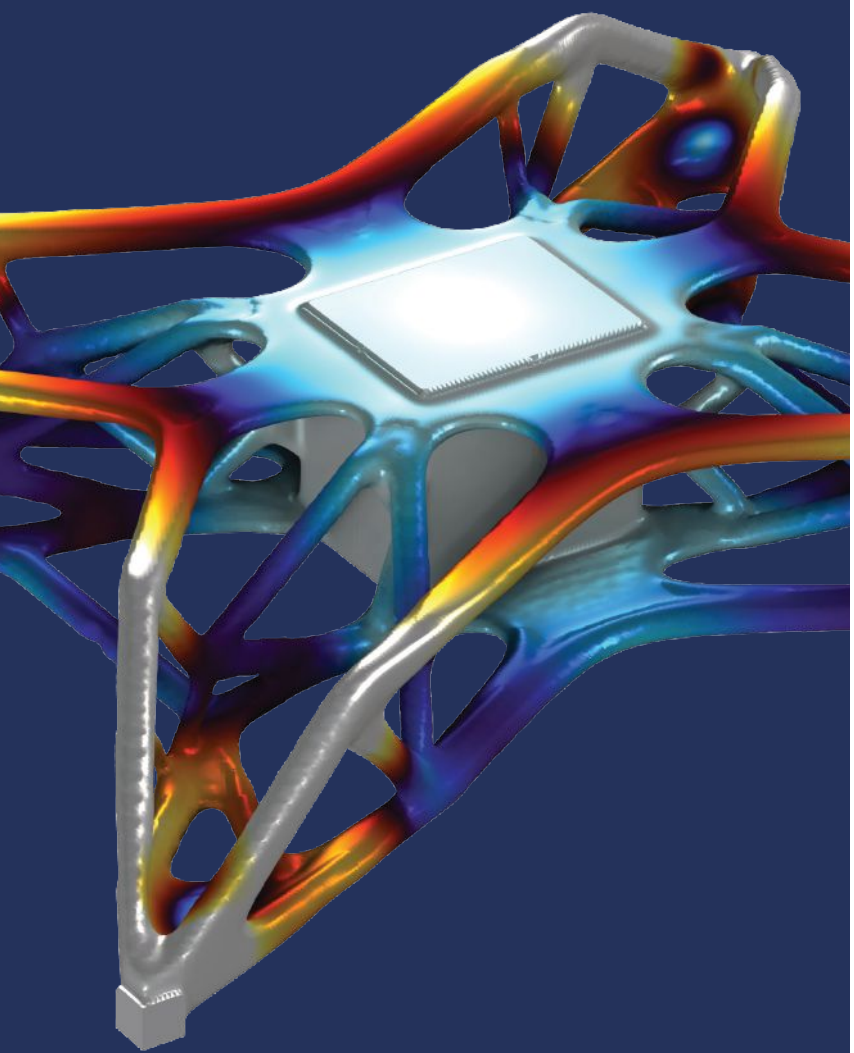

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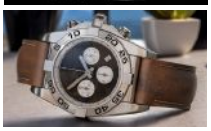
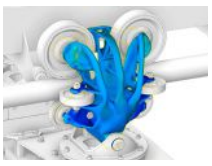
TECHNOLOGY FOR OPTIMAL ENGINEERING DESIGN

FOCUS ON GENERATIVE DESIGN





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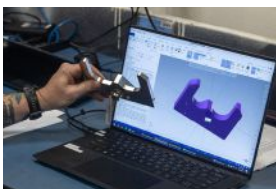

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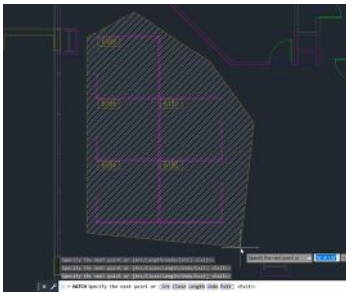
By David Cohn



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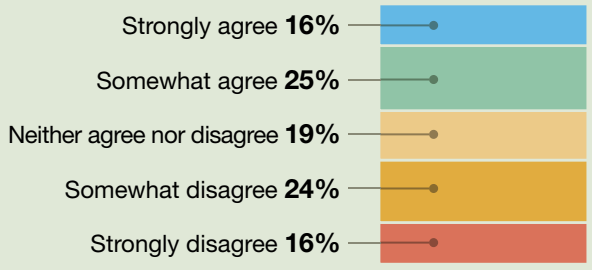
The Future of Product Development

Opinions are Split on the Destabilizing Effect of AI

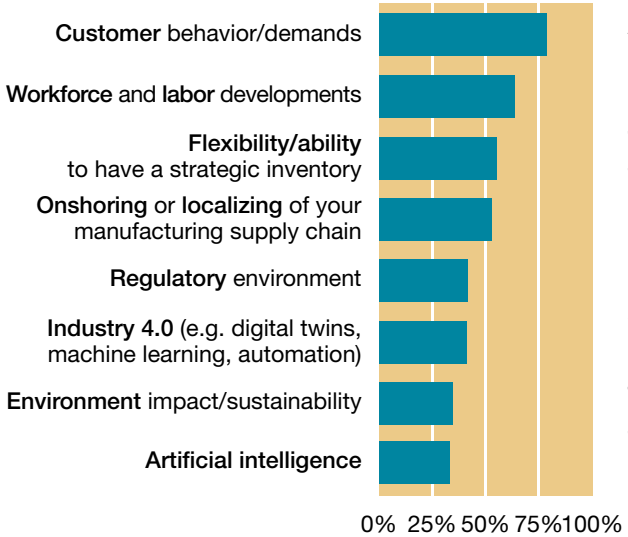
35% of design and manufacturing companies report using AI to produce **informed design options**. More than half of all companies report approaching or already achieving their goal of **incorporating** AI into their companies, and **79%** agree AI will make their industry more **creative**.

Source: Autodesk State of Design & Make Report

Percentage of respondents who agree that AI is a **threat**



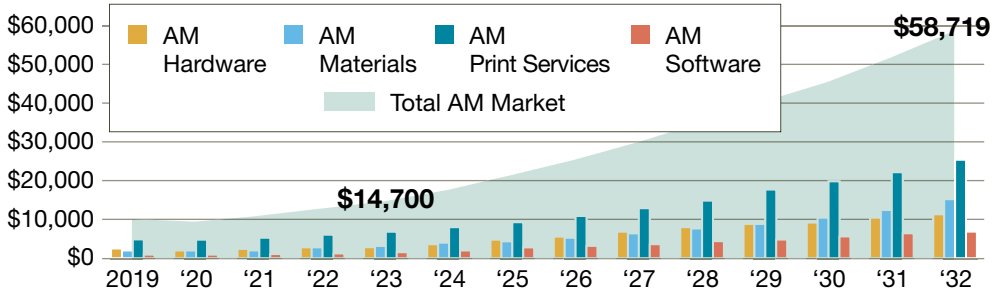
Future Factors Influencing Development Time



According to the Product Development Outlook report from Protolabs, **53%** of engineer respondents report they are developing products **faster than ever**, and more than **80%** reported they are looking for ways to be **even faster.** Nearly **70%** of respondents reported that material **shortages** had a significant effect on meeting late prototyping **goals** during the last year, and **74%** reported supply chain **disruption** affected ongoing **production** in the last year. The top factors that will influence development times in the future included customer behavior, workforce developments, and flexible inventories.

Source: Protolabs

Total AM Market Revenue Forecast ($USM, by segment, worldwide)



The additive manufacturing (AM) market reached **$14.7** billion in **2023** after a **challenging** year for manufacturers, according to AM Research. The **growth rate** for all 3D printing hardware, materials, software and services is estimated to be **13.5%** for **2023** compared to **2022**.

$36 BILLION

The current value of the metaverse, according to ABI Research, which forecasts the market to reach $66.7 billion by 2030, with a CAGR of 9.7%

NEWS

SIMULATION

Emotors Adopts Siemens' Simcenter NVH Solutions

Company selects Siemens solutions for NVH testing of next-generation automotive e-drives.

Siemens Digital Industries Software reports that Emotors, an independent e-drive manufacturer, is using test solutions from the Siemens Xcelerator portfolio of industry software to aid in the development and improvement of its e-drive systems for hybrids, plug-ins and full electric vehicles (EVs), Siemens reports.

Headquartered in Carrières-sous-Poissy, France, and formed in 2018 as a joint venture between Stellantis and Nidec Leroy-Somer, Emotors is an independent e-drive manufacturer. Emotors has created a series of next-generation electric drive (e-drives) units for Stellantis brands like Peugeot, Opel, DS Automobile and Jeep.

"A key part of our knowledge is not just about good development—being able to design and prototype next-generation e-drives for our EV customers, but also manufacturing them en masse. This is where platform development, a very well-known strategy in automotive, helps us be competitive," says Cédric Plasse, chief technology officer, Emotors. "We design many things digitally but cannot do everything with just our digital models. To be quick to market and accurate, we need to calibrate our models with test measurement data."

One of Emotors' challenges is meeting customer specifications—especially in noise vibration harshness (NVH) acoustic—when tailoring a new range of sounds for EVs, electric drivetrains and e-drives. These include customized interior and exterior soundscapes, enhanced "silent" driving experiences and pedestrian warning systems (PWS) or acoustic vehicle alerting systems (AVAS).

To meet these challenges, Emotors is using solutions from Siemens, including Simcenter Testlab software for test-based engineering, combining high-speed data acquisition with integrated testing, analytics and modeling tools, Simcenter SCADAS hardware, which provides test data acquisition solutions for multiphysics measurement for acoustic, vibration and durability engineering.

Emotors is also using a suite of sound and vibration excitation systems designed to measure driving points and structural and vibroacoustic frequency response functions.

"To meet our customers' NVH requirements, we perform classic experimental modal analysis in Simcenter Testlab. We extract modal parameters, like frequency, modal shape and damping. And provide this information to the simulation team to confidently predict the NVH behavior of our Emotors' products. The Simcenter testing solution easily takes us through the main tasks, step by step, from the channel setup to final measurement analysis," explains Bonaventure Ndong Gumedzoe, NVH testing manager, Emotors.

To learn more about the technology's use, click here.

Emotors picked Siemens' Simcenter solutions for NVH testing of next-generation automotive e-drives. *Image courtesy of Emotors.*

ADDITIVE MANUFACTURING

GE Additive Relaunches as Colibrium Additive

Company also retires Concept Laser and Arcam branding.

GE Additive has officially been rebranded as Colibrium Additive—a GE Aerospace company. As part of the transition, it was also announced that the Concept Laser and Arcam EBM legacy brands will be retired.

Part of GE Aerospace's Propulsion & Additive Technologies (PAT) division, Colibrium Additive, previously GE Additive, was established in 2016

when GE acquired additive manufacturing machine makers Concept Laser and Arcam EBM. It also acquired metal powder producer AP&C, a division of Arcam since 2014.

"While we are changing our name, we maintain our unwavering focus on our customers, quality and reliability. We will continue to lead the additive manufacturing industry from the front and positively disrupt it," says Alexander Schmitz, CEO of Colibrium Additive.

The name Colibrium Additive is said to incorporate the words collaborative and equilibrium and reportedly is intended to reflect the company standing shoulder to shoulder with customers, while educating regulators, partnering with academia and helping advance the next generation of AM talent.

"We were ready for a change. GE becoming three standalone companies provided an ideal opportunity to review our corporate identity," says Shaun Wootton, head of communications at Colibrium Additive. "Our new name and brand identity are both modern and dynamic. Both were designed to reflect our focus and company values, the pace of change in the additive industry, while accruing to GE Aerospace's overall brand identity."

Colibrium Additive builds industrial metal additive manufacturing machines, metal powders and provider of services. *Image courtesy of Colibrium Additive.*

DATA SCIENCE

Altair Acquires Cambridge Semantics

Cambridge Semantics is a modern data fabric provider and creator of one of the industry's analytical graph databases

Altair has acquired Cambridge Semantics, a modern data fabric provider and creator of one of the industry's analytical graph databases. Cambridge Semantics' graph-powered data fabric technology accelerates the creation of comprehensive enterprise knowledge graphs, integrating the web of structured and unstructured enterprise data together into a single, simplified view, Altair explains.

Bringing together Cambridge Semantics' graph technology with Altair's tools for data analytics and data science offers companies the capability to work with advanced analytics ecosystems that inject artificial intelligence (AI) into day-to-day business operations, according to Altair.

"Knowledge graphs are key pieces of data fabrics. They put the right data in the right hands at the right time. We believe Cambridge Semantics brings the fastest and most scalable knowledge graphs to organizations who have significant data volumes and deep questions," says James R. Scapa, founder and chief executive officer, Altair. "Additionally, knowledge graphs are critical for successful generative AI applications as they provide the business context necessary to ground generative AI models, eliminate hallucinations, and dramatically improve response quality."

Cambridge Semantics' technologies will be integrated into the Altair RapidMiner platform, adding knowledge graph, data governance, data virtualization, and data discovery technology to the platform's existing data preparation, ETL, data science, business intelligence, MLOps, workload management and orchestration tools.

"Joining Altair is a natural transition for Cambridge Semantics as we seek to accelerate the pace of our technology adoption," says Charles Pieper, chairman and chief executive officer, Cambridge Semantics. "Cambridge Semantics has historically been successful with Fortune 500 government, defense, life science and manufacturing organizations. Bringing Cambridge Semantics to Altair's broad customer base through the Altair Units business model—and integrating it into Altair RapidMiner—is an exciting prospect for us and for our customers."

Cambridge Semantics was founded in 2007 by an innovation and engineering team from IBM's Advanced Technology Group with a shared belief that semantic graph data models were a technology made to help organizations exploit their data: fueling analytics, revealing new insights, and enabling competitive differentiation.

"This acquisition adds deep data warehousing expertise to our already strong analytics and data science team, creating an enhanced core group of engineers that understand the entire data lifecycle—from data creation to real impact," says Srikanth Mahalingam, chief technology officer, Altair.

For more information about Altair RapidMiner, visit https://altair.com/altair-rapidminer.

Generative AI Enters Next Phase with **Natural Language**

It's not about typing or shouting executable commands.

BY KENNETH WONG

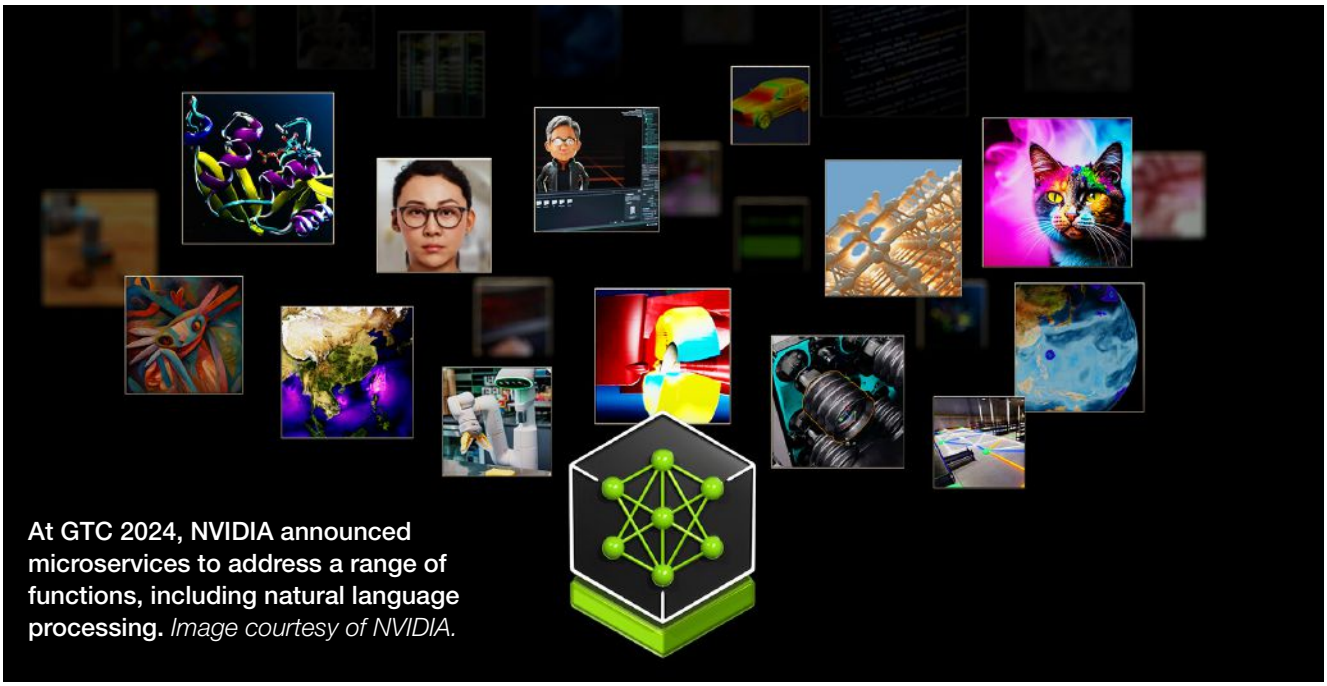
Generative design (GD) made finite element analysis (FEA) and computational fluid dynamics (CFD) much simpler, by automating and hiding many aspects of the simulation workflow. Instead of manually setting up boundary conditions one parameter at a time and constructing scenarios one at a time, users can use the desired outcome (a target percentage in weight reduction, for example) to identify the best topology.

Now, the introduction of natural language in design and simulation software is about to further transform the process. Users might expect simpler, easier user interfaces (UIs), driven less by menus and dialog boxes, and more by text or voice input. But it's not about typing or shouting commands you use to select from a menu.

Does Your FEA Speak English?

In July 2023, Ansys launched AnsysGPT, a limited beta version of its AI-powered chatbot for tech support. "Developed using state-of-the-art ChatGPT technology available via the Microsoft Azure OpenAI Service, AnsysGPT uses well-sourced Ansys public data to answer technical questions concerning Ansys products, relevant physics and engineering topics within one comprehensive tool," states Ansys in its announcement.

NVIDIA Edify, a generative AI program, will likely become part of 3D content generation based on natural language prompts. *Image courtesy of NVIDIA.*



At GTC 2024, NVIDIA announced microservices to address a range of functions, including natural language processing. *Image courtesy of NVIDIA.*

This April, Ansys released its AnsysGPT officially. "The updated release follows rigorous testing of response accuracy, performance and data compliance. AnsysGPT captures knowledge from new public sources, including product documentation, product and engineering-related training documentation, FAQs, technical marketing materials and public Ansys Learning Forum discussions. Additionally, the upgraded infrastructure offers enhanced security and scalability to accommodate thousands of users," Ansys reports.

"AnsysGPT acts as a virtual assistant providing instant responses to customer's support questions in their preferred language," says Ilya Tolchinsky, lead product manager, Ansys. "It's useful, but basically, it's just fetching information."

For the software to move beyond answering how-to type questions and begin performing user-requested tasks, Tolchinsky believes it needs to be able to generate executable code based on natural language input.

"Any user action within Ansys products can be translated and represented as executable Python code," Tolchinsky says.

As it turns out, Ansys has already laid the groundwork for it. In 2022, Ansys developed PyAnsys, a family of Python libraries that lets users interact with Ansys products. "We've already built a version that can generate 80 percent of the required code and will be able to make it available soon. But the rest takes time, because we need to make sure all the commands are executed well and reliably. We will get there soon. When we get there, it will be like having an expert co-pilot that can perform tasks for you," says Tolchinsky.

Tech giants working with large language models (LLMs) include NVIDIA, Microsoft and Amazon. As a partner, Ansys can also have access to their LLM-driven features.

Tolchinsky says, "We're developing some of our own technology, but where it makes sense, we'll also leverage what's available from our partners."

An Advisor by Your Side

The standard interface in CAD and FEA programs present objects in a 3D view. The mouse has proven to be quite efficient at rotating objects and selecting topology features, such as for selecting a hole on the top surface.

"We're going to augment it partly with natural language input, be it voice or text, but I suspect nobody wants to be talking or texting the software all the time. When you need to select or rotate, you'll mostly want to do it by pointing and clicking," says Tolchinsky. "But once you've selected an item, you may want to just say or type, 'double its size,' for example."

The typical GD input parameters, such as temperatures and pressures, will still be required, but in some instances, users may be able to give verbal or text commands to move the process along, as Tolchinsky sees it.

"It would be like having a colleague who is an advanced user sitting next to you. Natural language input will certainly reduce the amount of clicking," says Tolchinsky. "But what's more interesting is, when you get back the GD results, you could have a conversation with the chatbot. You might ask, for instance, why is there a temperature spike in a certain spot, and how do you reduce it?"

For new users, Tolchinsky thinks the ability to chat or text will make GD less intimidating. "Let's say you want to

perform a drop test on a design. You can just ask, 'How do I do this?,' and the chatbot can guide you through it, step by step," he says.

The integration, Tolchinsky expects, will be welcomed by both experienced users as well as new users.

"For the expert, we can eliminate a lot of the boring, repetitive tasks; for the new users, it will be like having an expert guide," he says.

Omniverse APIs

At the GPU Technology Conference (GTC) in May, NVIDIA CEO Jensen Huang announced cloud application programming interfaces (APIs) to Omniverse, its immersive visualization and simulation environment. Partners like Siemens, Cadence and Ansys are expected to take advantage of these APIs.

The APIs are part of NVIDIA's long-term strategy for Omniverse, according to Mike Geyer, head of digital twins at NVIDIA. "Omniverse is finding success in the market through integrations with software from NVIDIA [independent software vendor (ISV)] partners. Natural language processing is among the many microservices we provide at NVIDIA," he says. With natural language input, Geyer believes user interaction with complex CAD and FEA programs will become much more natural—"like talking to a chatbot."

At GTC 2024, Siemens announced it will be integrating NVIDIA APIs into two of its products.

"In collaboration with NVIDIA, we will bring accelerated computing, generative AI and Omniverse integration across the Siemens Xcelerator portfolio," says Roland Busch, CEO of Siemens.

Dassault Systèmes, another ISV partner, also demonstrated how it was incorporating NVIDIA APIs into 3DEXCITE. In a web-accessible interface, the app allows users to generate automotive designs and the desired backdrops using natural language. The app is powered by NVIDIA Edify, trained on Shutterstock's licensed creative data, according to Dassault.

VIDEO

"We think generative AI will have the biggest impact on the interface between people and machines," says Tom Acland, CEO of 3DEXCITE, a Dassault Systèmes brand. "It will power more fluid, [and] more natural collaboration with computers."

Some SIGGRAPH 2023 conference attendees already saw a glimpse of what natural language-powered design might look like. At the conference, NVIDIA invited a select group of automotive designers to showcase a new workflow based on Stable Diffusion. The prototype application accepts both text strings and images as input to generate professional-looking 2D automotive sketches, complete with backgrounds.

"The AI-generated design sketch may not be 100 percent of what you want, but it's going to create new and unexpected directions critical to design exploration," Peter Pang, senior product manager, virtual and augmented reality at NVIDIA, says.

Thinking Beyond Dictation

VIDEO

Converting voice into text is no longer a technical barrier; it's a feature available in many office productivity software offerings today. For design and simulation software developers, replacing the mouse and keyboard input with text or voice command (for example, saying or typing "extrude" instead of selecting the "extrude" command) is not the best use of natural language. Rather, it shortchanges the true potential of the new paradigm.

The goal should be to allow users to "have a natural conversation with the software," says Geyer. "It reduces the learning curve for programs like FEA or CFD." Since NVIDIA microservices are cloud APIs, "for ISVs with cloud architecture, it can be much more approachable to implement these APIs," Geyer adds. "One issue they need to address involves training data—you need a good collection of data for training purposes."

At the moment, if you want to run a CFD study, you would likely be required to specify the surfaces and regions to apply the load, with specific numerical values. This approach demands expert knowledge. But imagine being able to ask the software, "Based on the geometry I have uploaded, what setup should I use for an external airflow analysis?" 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.*

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- **Ansys:** Ansys.com
- **Autodesk:** Autodesk.com
- **Dassault Systèmes:** 3ds.com
- **NVIDIA:** NVIDIA.com
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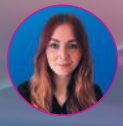

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Generative Design Pushes **Workstation Performance**

The design process requires the right hardware to support higher data and simulation workloads.

BY RANDALL S. NEWTON

The process known as generative design (GD) has been around for many years, primarily as an early design exploration tool for geometry optimization and aesthetics based on selected constraints. In recent years, its use has grown as vendors added artificial intelligence (AI) capabilities, making the software more powerful.

Today, it is not uncommon for new projects to start with GD even before specifications are set. This is especially true if the product is produced using additive manufacturing (AM), if there is a high aesthetic element, or if the part or product will require extensive CAE work.

Autonomously and Optimally Yours

As CAD vendors recognized the value of GD, senior management did the traditional buy-or-build math. Autodesk's architecture, engineering and construction (AEC) division bought its way into GD, for example, but then the mechanical CAD unit borrowed and adapted from it. PTC bought the fast-growing GD startup Frustum in 2018, and now includes the technology in its Creo platform.

GD's roots go back to topology optimization (TO), but the two are not synonymous. TO is used to converge on a single solution using functional objectives. By contrast, GD creates and compares many possible solutions, then sorts through them for the best examples that meet both functional and nonengineering requirements.

As researchers from the University of Florence note, TO is about removing material from the design volume, while GD "maintains the possibility of adding material, and generally, to deviate from the initial [starting shape] provided."

Some researchers refer to the merging of GD and AI as augmented reasoning, including Frustum founder Jesse Coors-Blankenship, now senior vice president of technology at PTC. He says thinking of GD as augmenting the design process optimizes "designs for multiple objectives simultaneously" while "providing a designer with several novel design alternatives, which enable companies to substantially reduce engineering cycles."

The software augments the designer's expertise by optimizing multiple objectives simultaneously, offering up several novel alternatives. AI can also create and evaluate unintuitive constraint options, which an experienced engineer might know but someone with less experience would not consider.

Great Responsibility Requires Great Power

GD is much more computationally intensive than traditional two- or three-dimensional design work. A computer that might be fine running AutoCAD or SOLIDWORKS can slow to a crawl if GD is added. Also, most CAD vendors offer GD features as a separate software module. It may look like part of your basic Creo or Fusion 360 desktop, but behind the scenes it is generating extra work that must be processed either locally or in tandem with cloud computing. Either way, there's a

The Dell Precision 5490 mobile workstation was introduced earlier this year as one of several new workstations in the Precision line with specific AI optimization technology, including a neural processing unit. *Image courtesy of Dell Technologies.*

NASA uses GD software for a variety of applications. NASA Research Engineer Ryan McClelland shows a structural mount designed using GD, and 3D printed in titanium. *Image courtesy of NASA.*

mountain's worth of calculating and moving data taking place.

Part of that data is being created by new synergies between the various forms of simulation.

Prith Banerjee, chief technology officer of Ansys, says we are entering a new era of digital engineering.

"Digital engineering is how you engineer future products, which includes hardware, mechanical and electrical parts, as well as software," he says.

The recent acquisition of Ansys by Synopsys is one example of this trend. Another is the new approach to providing software tools in this artificial intelligence (AI) era. Ansys SimAI "lets you take any of our black-box solvers and train an AI model," Banerjee notes. "Once trained, it will run a simulation hundreds of times faster."

"Employing AI and machine learning in CAE not only enables process automation but also accelerates the development of simulation tools accessible to non-experts," says Jon Peddie, president of Jon Peddie Research. "New business models are emerging to transform product development processes."

"Every company that wants to remain competitive will have to implement AI in some way, and AI PCs will be central to that," says Sam Burd, president, client solutions group at Dell Technologies. "From running complex AI workloads on workstations to using day-to-day AI-powered applications on laptops, the AI PC will be an important investment that pays dividends in productivity and paves the way to a smarter, more efficient future."

There is a spillover effect in adding new technology like AI-enhanced GD to the engineering overhead. More advanced initial solutions drive the need for more advanced simulation of the proposed design.

Zihan Wang, high-tech strategy and operations manager for NVIDIA, notes that as AI speeds up processing, engineers will expand the use of simulation.

"With AI-embedded HPC [high-performance computing], you can process more data points to make a better decision," says Wang. "If you want to simulate the motion of granular materials in the mining industry, like particles on a conveyor belt in a mixer, double-precision [graphics processing units (GPUs)] are required to speed up the simulation." says Wang.

Workstation vendors are lining up with new models to address these computational challenges. For example, in addition to announcing several new models in its Precision workstation line, earlier this year Dell announced it is working with NVIDIA to introduce a rack-scale high-density liquid-cooled architecture based on the NVIDIA Grace Blackwell superchip.

Every Component Counts

When considering the purchase of engineering workstations to be used often or primarily for GD, every subsystem will be given additional stress. For example, HP recommends the following as a minimum configuration for any workstation running generative design in either product design or architecture, engineering and construction:

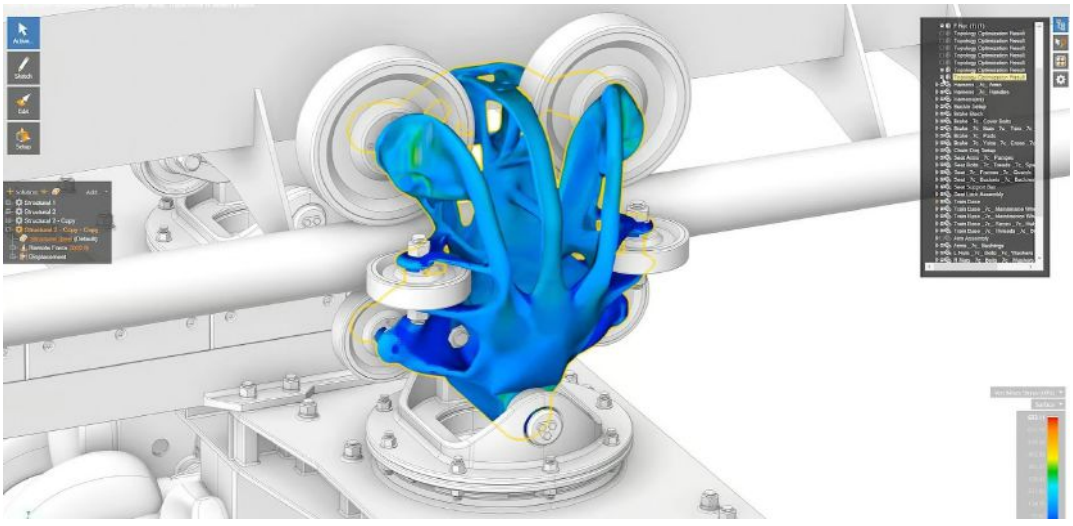
- 64-bit, 6- to 12-core processor running at a minimum of 2.6GHz
- 32 or 64 GB of RAM
- 512GB—2TB NVMe storage
- Mid- to high-end graphics card certified for the application(s).

What follows is a system-by-system overview of what needs to be considered.

Central Processing and Graphics Processing

The CPU and GPU are collaborators in GD. Many generative solutions divide the workload between the CPU and the GPU. In addition, many AI products are now written to take advantage of GPUs. A mainstream GPU that runs typical CAD just fine may not have the capability to run GD at a respectable speed.

Altair and NVIDIA have published benchmark data showing an 8x speed improvement for training physicsAI models when using an NVIDIA RTX A4000 GPU, compared to an eight-core laptop CPU.



Ansys Discovery is a simulation-driven design tool that varies from other CAD products in that it considers generative design and topology optimization to be one and the same in practical use. *Image courtesy of Ansys.*

Memory and Storage

Datasets can become gigantic when using GD. The workstation must store not just one design in progress, but hundreds of them as the GD algorithms bounce around—so to speak, from one design to the next, looking for the optimal solution. This puts extra stress on both the RAM and storage. A total of 64GB of high-speed RAM provides enough space for typical applications. The more RAM available, the larger the design space GD and simulation software can explore simultaneously, leading to faster convergence on the solution.

Many GD workflows involve handling a large number of small files. NVMe storage (nonvolatile memory express) is more efficient in managing this kind of data than traditional storage solutions such as SATA solid-state drives or hard disk drives.

A software process known as checkpointing is common in AI workflows. The model's state is periodically saved to allow resuming from that point if needed. NVMe storage offers higher write speeds, enabling faster checkpointing.

Cooling

All this extra algorithmic dancing generates a substantial heat load. A cooling subsystem is a necessity, not a luxury. There are three types of cooling subsystems: air, liquid and hybrid. Liquid cooling offers superior heat dissipation compared to air cooling. Hybrid solutions include self-contained liquid GPU coolers, immersion systems to submerge components in dielectric fluid and direct-to-chip liquid cold plates.

Motherboard Throughput

The GD algorithms work with the CAD algorithms and other software modules. The newest peripheral component interconnect express (PCIe) bus standards are designed for these intensive workloads. It takes years from the release of a PCIe specification to its widespread adoption by workstation vendors. PCIe versions 3 and 4 are currently shipping on new workstations. Version 4 provides up to 16 giga-transfers per second (GT/s) per I/O lane at 32GB/second. The latest specification is PCIe 6, introduced in 2022; the first workstations using this version are expected later this year. Version 6 offers 64 GT/s per lane. New PCIe specifications are always backwards compatible, allowing existing devices to work in workstations using the newer standard.

Visualization Issues

GD is often used in combination with contemporary visualization equipment, including virtual reality or augmented reality. Acquiring the hardware for these visualization solutions is generally not a part of the workstation specification process, but should be considered to make sure there are no bottlenecks from idea to visualization due to a slow subsystem. **DE**

Randall S. Newton *is principal analyst at Consilia Vektor, covering engineering technology. He has been part of the computer graphics industry in a variety of roles since 1985. Contact him at DE-Editors@digitaleng.news.*

MORE INFO

- **Ansys:** Ansys.com
- **Dell:** Dell.com
- **Jon Peddie Research:** JonPeddie.com
- **NVIDIA:** NVIDIA.com
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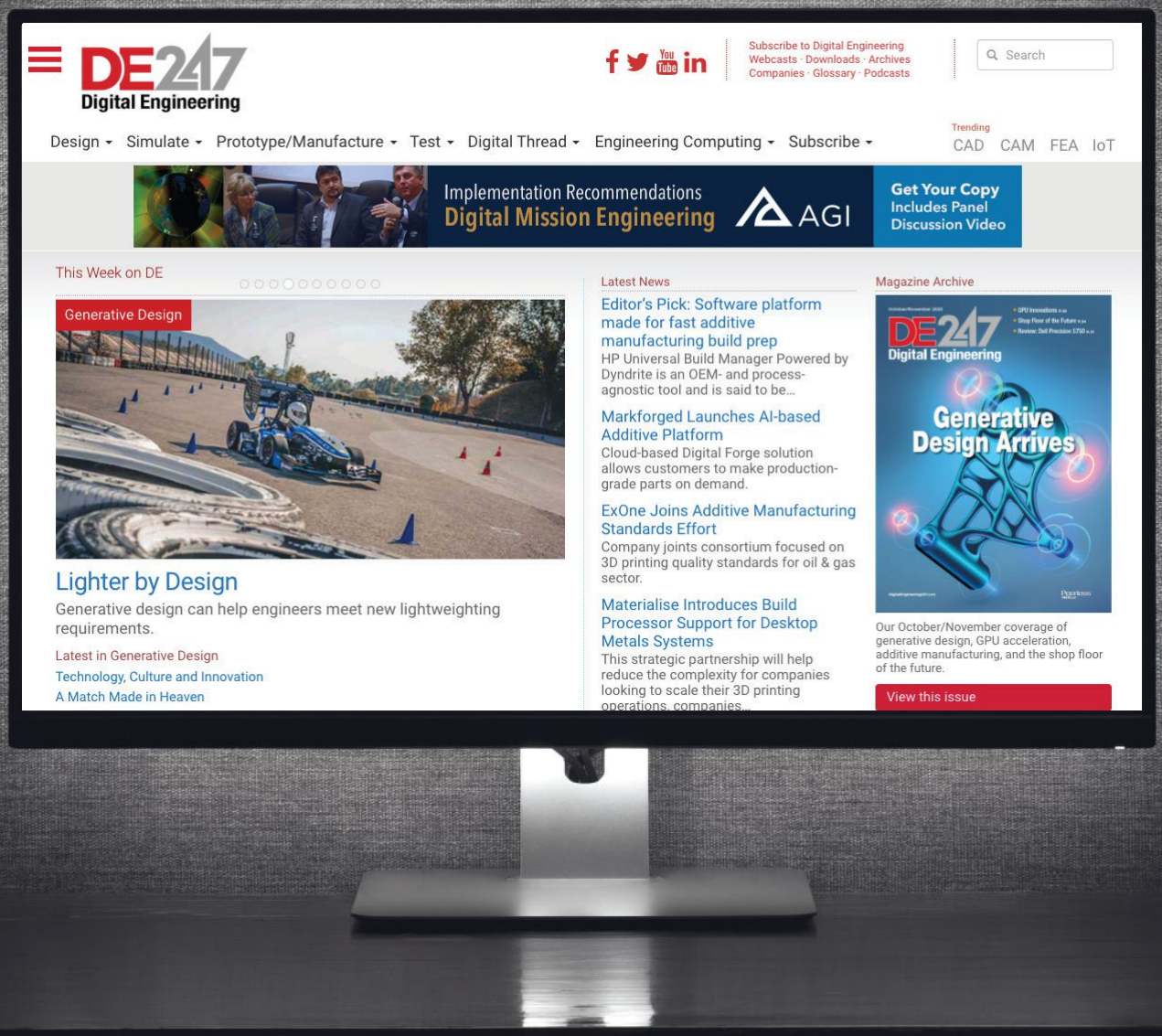

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Collaborative Simulation

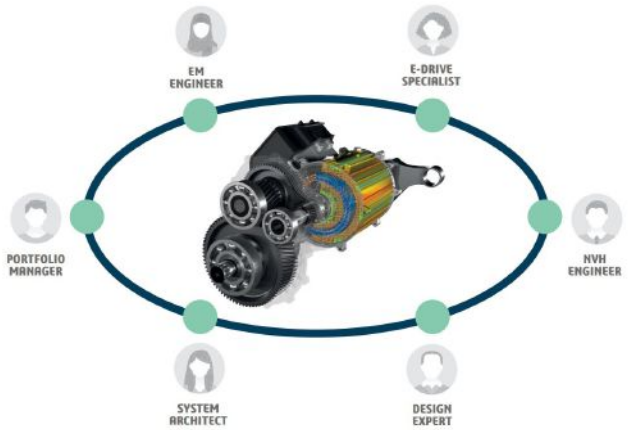
Interoperability in simulation improves accuracy, reduces development times and fosters innovation.

BY JIM ROMEO

Engineering design interoperability is crucial for the seamless integration of different simulation systems and software tools, enabling more effective and efficient development processes. By ensuring compatibility across various platforms and technologies, interoperability facilitates the sharing and exchange of data and functions.

This collaborative environment enhances the accuracy of simulations, reduces development times and fosters innovation, which makes it indispensable in tackling complex engineering challenges across diverse disciplines.

Chris Harrold is the program director, developer tools, for Ansys. He says there are two schools of thought about interoperability in software in general. Simulation, he says, is no different. These two things are: everything open and working together; everything closed and protecting its integrity.



In this example of an electronic drive, interchanging design and simulation models and data seamlessly between multiple teams is critical to improving efficiencies, accuracy and expanding the value of simulation throughout the development process. *Image courtesy of Dassault Systèmes.*

"Even with significant advances in interoperability via the developer tools we are building (common language across all simulation tools and physics), the fact remains that data from one type of simulation does not, nor can it, move seamlessly from one type of solver to another," says Harrold. "A lot of this is by design and some of it is just the nature of the data involved and the complexity of simulation as a discipline."

Harrold continues, "Is it viable? Of course, and arguably, would be something users would want, provided it was effectively invisible to them (if it requires significant effort, it is no better than the current situation). Is it critical? In true developer fashion, the answer is, 'it depends.' I can name a half dozen places where all the big simulation tools exist side by side doing different things and customers do not seem to have an issue so great it prevents their success. So, until that pain catches up, there's little incentive to be that open from any software provider."

Interoperability in simulation is a means to help reduce design risk and overall cost in product and system design. Dan Papert is a project engineering advisor for the American Society of Mechanical Engineers (ASME) and product manager for its verification, validation and uncertainty quantification (VVUQ) portfolio.

He says that simulation operability is seeing widespread adoption in the engineering world for various reasons.

"From a business perspective, computational models significantly help reduce risk and cost associated with prototype construction and testing, accelerating product development," Papert says.

He notes that improvements in computational efficiency and fidelity enable better quality visualization, especially in complex use cases. The tools that develop these models open up collaboration on common platforms.

"Interoperability and credibility in modeling and simulation is crucial for product development, particularly for high-risk applications," Papert explains.

He shares an example of how nuclear power plant com-

SIMULIA Simpack driving simulator enables product development teams to experience real-time vehicle performance in a range of operating conditions by integrating software-, hardware- and driver- in-the-loop capabilities. *Image courtesy of Dassault Systèmes.*

putational models are validated through experimental data gathered from scaled facilities where conditions are similar but scaled down. "This validation may include operating the experiment at lower powers and pressures, at a reduced size, or using other fluids. Best practices for scaling analysis during model validation are critical for determining applicability of these computational models to real-world conditions," he says.

Challenges of Interoperability

Interoperability offers advantages in digital engineering, but is not without its challenges. An obvious challenge is the compatibility of one engineering design solution or tool with another.

Ed Fontes is the chief technology officer for COMSOL. He says that just working in different formats is a foremost challenge.

"Generally, a challenge with interoperability is compatibility of different formats," according to Fontes, who explains that CAD involves various industry standards that most software platforms adhere to.

"It is relatively straightforward to read and write in standard formats between different platforms, even though you may lose some information about the sequence of operations and the parameterization of the geometry design," Fontes says. Likewise, it's not equally straightforward for other types of interoperability, he adds. "There are simply no widespread standards that work for modeling and simulation files in general. Ideally, the data or underlying data would be compatible, but in order for interoperability to manifest, there must be compatible standard formats covering the different steps in an engineering workflow, for different branches of engineering."

The additive effect of combining the strengths of different software is a big advantage in achieving interoperability. But the data exchange must be well-managed. Alex Graham is a senior marketing manager with Siemens Digital Industries Software's Simcenter. He says that interoperability means connecting simulation models from different tools and engineering domains.

"These could be managing header alignment between export and import of data originating from multiple sources, coordinating data exchange during live co-simulation between two or more models, or in tracking, documenting and communicating the human process followed and parameters used in a complex study involving multiple models that are continuously evolving," says Graham.

CAD model of a brake assembly. *Image courtesy of COMSOL.*

Siemens Digital Industries helps engineers tackle such challenges arising from model interoperability in two ways. "The first, and an underlying principle of Siemens software, is to provide an open ecosystem which does not tie users into a particular software suite or vendor offering," he says.

"This is achieved with a highly customizable framework and by supporting standard model and data exchange formats such as the functional mock-up interface (FMI) and the Open Neural Network Exchange (ONNX) format," Graham says. "The second is to equip engineers with highly capable tools that can manage simulation processes and data and orchestrate data exchange connections between different CAE software packages."

Interoperability With a Digital Twins Strategy

A notable benefit of interoperability in building simulation is a pathway to more effective digital twins. Digital twins have certainly come of age and are used in many different areas across many different industries. Many firms are building and relying on a digital twin strategy. This is one area where interoperability in simulation may play a prominent role.

Wesley Hand is a systems design solutions segment manager with Keysight Technologies. Hand points out that simulation operability is not only viable, but crucial to the modern digital twin strategy needed for a shift-left design approach.

"Designers need to use the best-in-class simulation tools to drive complex designs," he says. "Simulation tools often have a focus where they excel, and by combining the various simulators, the designers can achieve maximum fidelity and accuracy in simulation results, which reduces the overall need to produce multiple prototype iterations [and dramatically reduces] the costs of development and accelerates time to market."

He adds that product development involves both design (e.g., simulation) and verification (e.g., testing) as it applies to interoperability and for digital twins development.

"A critical concept of digital twins is the continuous feedback loop between these two components," says Hand. "The better aligned the tools are between design and verification, the more accurate the simulations become. We use the same IP for driving simulations and verifications, from algorithms that predict the designs to the measurement science used to validate the results, to the analysis tools to visualize the results from both. This gives the designer the ability to do apples-to-apples comparisons. The interoperability among simulators also extends into the field of verification using hardware-in-the-loop techniques to more accurately take measurements using best-in-class measurement tools and simulation data."

In building digital twins and bringing a virtual model forward, interoperability depends on a confluence of so many different factors in the design phase. To efficiently engineer innovative products with confidence, original equipment manufacturers (OEMs) require a modern, vir-

The NAFEMS ASSESS-ESMS Specification

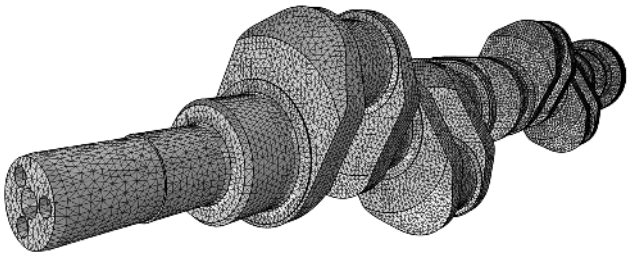
The NAFEMS ASSESS Initiative Engineering Simulation Metadata Specification (ASSESS-ESMS) is meant to standardize metadata across the entire range of engineering systems models. While focused primarily on standardizing the vocabulary of modeling, it could serve as the basis for future standards that could improve interoperability across tools.

"This is an attempt to define a comprehensive set of model characteristics of interest for the complete range of engineering simulation models that can be used across all approaches for implementing engineering simulation in all applications," said ASSESS Director Joe Walsh when announcing the development of the specification in 2023. "Once we have that, then we can start sharing things."

According to NAFEMS:

"Engineering Simulation Metadata (ES Metadata) structures are currently being proposed by multiple initiatives, each of which takes a different approach to defining a pragmatic Metadata structure based on its own perspective and goals. ASSESS-ESMS defines a comprehensive set of common model characteristics of interest for the complete range of ES Models that can be used across all approaches for implementing ES Metadata structures. The ES Metadata is assigned to an ES Model to support processes, activities, business purposes, and higher-level models."

You can download the first released edition of the specification here.



A NASTRAN mesh of a crankshaft used for an eigenfrequency analysis. *Image courtesy of COMSOL.*

tual approach to industry processes that facilitates a holistic, interdisciplinary way of working during the design phase, involving concurrent engineering of electronics, electrical and mechanics domains, and collaborative teamwork including extensive virtual testing and validation, says Emmanuel Leroy, who is the executive vice-president and chief product and technology officer at ESI Group (a part of Keysight Technologies) in France.

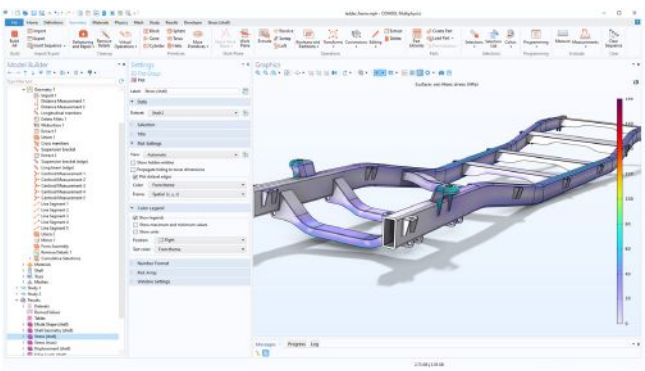
"We are entering a golden age of product development," says Leroy. "The latest generation of solutions combined with a properly designed digital thread is enabling practically sci-fi-level capabilities. We've come a long way from hand-coded [finite element analysis (FEA)] meshes to now working with virtual reality and the metaverse and ESI Group has participated in every step along the way. Manufacturers and vendors commonly focus on building a digital thread that unites the different product realization disciplines bringing simulation onto the critical path and ensuring that the right trade-offs between accuracy and time to market are made."

Dean Palfreyman is the senior director for SIMULIA strategy at Dassault Systèmes. He says that data interoperability is extremely important for performing coupled-multiphysics simulation, model-based systems engineering (MBSE) as well as integrating the simulation applications with 3D design and data management applications.

"There is a critical need within the manufacturing industry to improve efficiency and simulation reliability by bringing design and simulation technologies closer together. At Dassault Systèmes, we are meeting this demand through unified modeling and simulation, which we refer to as MODSIM."

Palfreyman says that it is an ongoing issue for product development and manufacturing companies to seamlessly unify product designs with multiphysics simulation to evaluate complex product and system scenarios and gain deeper insight into their product and system behavior.

"Interchanging data seamlessly between multiple teams (such as designers interacting with simulation analysts) throughout the product development process is key to expanding the use of simulation. The success of 'simulation democratization' hinges on transparent, seamless and trustworthy data interoperability."



A ladder frame layout imported into COMSOL Multiphysics® to be used for multiphysics analysis. *Image courtesy of COMSOL.*

Interoperability, Simulation, and Confidence in Design

Simulation, analysis and interoperability lead to better designs, better products, and better systems. It's all about using solutions and tools at hand via interoperability, and then building confidence in a design via testing and validation.

"Simulation and analysis must reflect this reality, allowing designers to clearly visualize the consequences of their design decisions across multiple systems," says ESI Group's Leroy. "Otherwise, the verification and validation results are not aligned, [and] engineers will need to continue relying on physical testing thus undermining the entire commitment to the safety certification process and sustainability goals.

He says the key is virtual prototyping and concurrent collaborative engineering. "Validating the performances at a system-level as manufactured and even being able to include as early as possible the constraints from the final assembly line and from the serviceability of the product." DE

Jim Romeo *is a freelance writer based in Chesapeake, VA. Send e-mail about this article to de-editors@digitaleng.news.*

MORE INFO

- **Ansys:** Ansys.com
- **ASME:** ASME.org
- **COMSOL:** COMSOL.com
- **Dassault Systèmes:** 3DS.com
- **ESI Group:** ESI-Group.com
- **Keysight Technologies:** Keysight.com
- **Siemens Digital Industries Software:** SW.Siemens.com

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From **CAD** to **Digital Twins** to **XR**

Is a continuous digital thread possible or necessary?

BY KENNETH WONG

NVIDIA's metaverse, called NVIDIA Omniverse, is a critical building block in Siemens' digital twin vision. Accompanying that vision, in April at the NVIDIA GPU Technology Conference (GTC) in San Jose, CA, Siemens announced, "In the next phase of our collaboration with NVIDIA, the company will release a new product later this year—powered by NVIDIA Omniverse Cloud APIs [application programming interfaces]—for Teamcenter X, our industry-leading cloud-based product lifecycle management [PLM] software, part of the Siemens Xcelerator platform."

NVIDIA released a Beta version of Omniverse in 2019, then officially launched it in 2021. This year, the company revealed its plan to offer components of it as microservices, or cloud APIs, available to other software vendors. These services address a range of functions applicable to digital twins, from collaborative design review to visualization in XR (extended reality, mixed reality) devices. In this article, we examine whether it's possible to maintain an unbroken digital thread from computer-aided design (CAD) to metaverse to XR.

CAD to Metaverse

Mainstream CAD design programs describe geometry primarily in mathematically accurate lines, arcs and surfaces, along with parametric history. On the other hand, metaverse platforms tend to favor lighter mesh models. NVIDIA Omniverse, for instance, uses Universal Scene Description (USD), a format pioneered by the animation studio Pixar.

The number of mainstream CAD software supporting USD is growing. Autodesk, NVIDIA, Pixar, Adobe and Apple are founding members of Alliance for OpenUSD, which

Sony and Siemens partnered to develop a way to design and edit in NX using Sony VR headsets.
Image courtesy of Sony.

Siemens and NVIDIA demonstrated the ability to visualize large industrial datasets in NVIDIA Omniverse at GTC 2024. *Image courtesy of Siemens.*

functions as the steering group for the format. General members include Ansys, Siemens and Hexagon.

CAD models imported into NVIDIA Omniverse—or any metaverse, for that matter—usually go through a detail reduction as part of the transformation.

"It's reasonable to reduce these details, if it aligns with your objective. A purist might insist on always looking at the model with full details, but if you don't need these details for your metaverse usage, you're carrying a lot of overhead in computing," says Dale Tutt, vice president of industry strategy for Siemens.

In the rare cases where a manufacturer needs to visualize, simulate and interact with a large model—a ship or a plane, for instance—with all the engineering details, metaverses will likely be able to accommodate using graphics processing unit (GPU) acceleration. At GTC, Siemens and NVIDIA demonstrated that it was possible to visualize in real time a massive dataset from Siemens customer HD Hyundai, which develops ammonia- and hydrogen-powered ships.

VIDEO

Game engines are also expected to become metaverse enablers. The two leading game engines—Epic Games and Unity—address the CAD-to-metaverse connection in their own ways. Starting in late 2022, Epic Games began using Tech Soft 3D's HOOPS software developer kit (SDK) to facilitate the conversion. Unity uses the PIXYZ plug-in to allow CAD users to import models.

Spawning More Twins From Digital Twins

Tutt says a continuous syncing of changes from CAD to metaverse may not be necessary. However, "when the CAD model changes, there should be some triggers that alert you and ask you if you want to update the downstream models. You may choose not to, if you decide the change is not critical, but there should be a mechanism to maintain these live linkages; that's the only way to ensure you're always working with the latest design."

The alerts to updates—and the choice to decide when to adopt these changes—are essential features of what Tutt considers "the industrial metaverse." Such a setup, he feels, allows digital twin operators to spawn various versions of a product, place or process for simulation and testing.

"Let's say you have a factory up and running, and you're planning to make changes to it. While version 1.0 of your factory is up and running, you may also be evaluating the changes you want to make in context. So you need to have the ability to manage these versions separately in the metaverse," says Tutt.

CAD to XR

For collaboration around large digital twins NVIDIA offers various SDKs for XR. Among them is CloudXR, for streaming virtual reality (VR) or augmented reality (AR) content from a remote server. NVIDIA VRWorks is a set of APIs and libraries for VR hardware and software developers to create applications. At the same time, many CAD vendors are also enabling the CAD-to-XR workflow with various solutions.

Siemens describes its approach as "one click to VR." With it you can "inspect and review designs in full scale using a selection of familiar tools all connected directly through NX to the digital thread," according to Siemens.

"What you're looking at [in VR] is a stripped-down version of the original CAD model," says Tutt. "You can still see the details, but internal parts and the parametric history may be removed. Considering the computing power available in the headsets today, it's better to use that approach so you can run VR experiences in real time."

The built-in memory and computing power in the XR headsets are usually limited due to space constraints and the need to keep the headsets from overheating. To interact with highly detailed models, users tend to choose headsets powered by workstations, via wired connections or backpacks.

CAD-to-metaverse or CAD-to-XR workflows are mostly a one-way street. In other words, changes made in CAD may be pushed to the metaverse, but bidirectional connection is currently not the norm. Siemens, however, is making it possible in an application developed for Sony head-mounted display (HMD) users.

"When you're in the Sony HMD with NX Immersive Designer app, you are effectively designing in Siemens NX," says Tutt. "There are still some intermediary steps required, but if you make a change in your design in XR in the Sony headset, you're in fact modifying the NX model."

Go Through the Metaverse or Take a Shortcut?

Unlike the CAD-to-metaverse-to-XR route, the direct CAD-to-XR route bypasses the need to rely on the metaverse. With one less step in the digital thread, this approach arguably gives a more faithful rendition of the original CAD design. But Tutt points out that the path through the metaverse, though circuitous, serves a special purpose.

"With the metaverse approach, you can bring in data from many different sources besides CAD," he says. "For example, if you're operating a plant, there may be data analytics you need to incorporate."

Other industrial metaverses may emerge to address the digital twin operators' needs, but for Tutt, "With what it has been able to accomplish with GPU computing, NVIDIA is the market leader. That's why we're partnering with it." 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

- **Alliance for Open USD:** AOUSD.org
- **NVIDIA:** NVIDIA.com
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CAM Meets AM to Enable Hybrid Manufacturing

Combining metal AM and CNC milling in a single hybrid system can give manufacturers a cost and flexibility advantage, but there are trade-offs.

BY BETH STACKPOLE

The ability to source replacement parts while out at sea is challenging, especially with space at a premium and many decades-old parts near obsolescence. The U.S. Navy ship USS Bataan is tackling the problem by being the first to deploy a hybrid manufacturing system that provides sailors with industrial-grade manufacturing capabilities that enable self-sufficiency while also increasing efficiency and reducing waste.

The solution, the Phillips Additive Hybrid system, pairs the Meltio wire-laser metal 3D printing platform with Hass TM-1 computer numerically controlled (CNC) machining capabilities. The system was used to 3D print and fabricate a replacement sprayer plate for a de-ballast air compressor (DBAC) in only five days as opposed to taking weeks, potentially, to source through conventional Navy supply channels. Moreover, by combining additive and subtractive capabilities within the same system, the Navy crew was able to manufacture critical parts when and where it needed to while minimizing valuable on-board real estate.

"The impact technology like this can have on operational readiness, particularly in a combat environment where logistics capabilities will be challenged is critically important," stated Rear Admiral Joseph Cahill, commander, Naval Surface Force Atlantic (SURFLANT), in a press release (tinyurl.com/mry8swht) on the deployment.

While nowhere near mainstream, hybrid manufacturing solutions that combine metal AM and machining capabilities are gaining traction as system prices fall and organizations recognize the efficiencies of merging production workflows in a single system. While some, like the U.S. Navy, are purchasing systems that converge additive and subtractive production capabilities in an all-in-one, multipurpose unit, others are leveraging software and automation technologies to create custom scenarios that streamline disconnected processes into an integrated and optimized hybrid manufacturing workflow.

Phillips' Hybrid UMC 1000 integrates the laser metal deposition technology of Meltio with the Haas CNC vertical machining center to create a hybrid AM solution. *Image courtesy of Phillips.*

Hybrid manufacturing solutions make sense because 3D printing constitutes only a portion of the production workflow and is often not sufficient on its own to create a finished product. Combining additive manufacturing (AM) and subtractive capabilities in a single unit requires less labor and in many cases, enables

Phillips hybrid manufacturing system is helping the U.S. Navy produce spare parts on the USS Bataan ship. *Image courtesy of Phillips.*

companies to deliver parts more quickly because they don't have to be passed between systems to take advantage of secondary operations.

"In many cases, machining, welding or another industrial process is required, and the closer a solution can get towards delivering the final product, the more value it can provide," says Tripp Burd, director of new platforms at Markforged. "This allows the greatest strengths of manufacturing processes to be combined to create the best possible part."

Best of Both Worlds

Phillips, one of the pioneers embracing hybrid manufacturing, touts its system for a range of applications across industries, including aerospace & defense, automotive, and tool & die/mold making. The offering leverages the Meltio wire laser directed energy deposition (DED) engine, which produces high-density parts with high resolution in addition to offering other benefits over metal powder AM technologies, including a clean and safer working environment and 100% use of the lower-cost metal-wire material. The Haas CNC system, integrated into the solution, handles three-, four-, or five-axis machining, and Phillips is on tap to deliver services and expertise to ensure a smooth implementation.

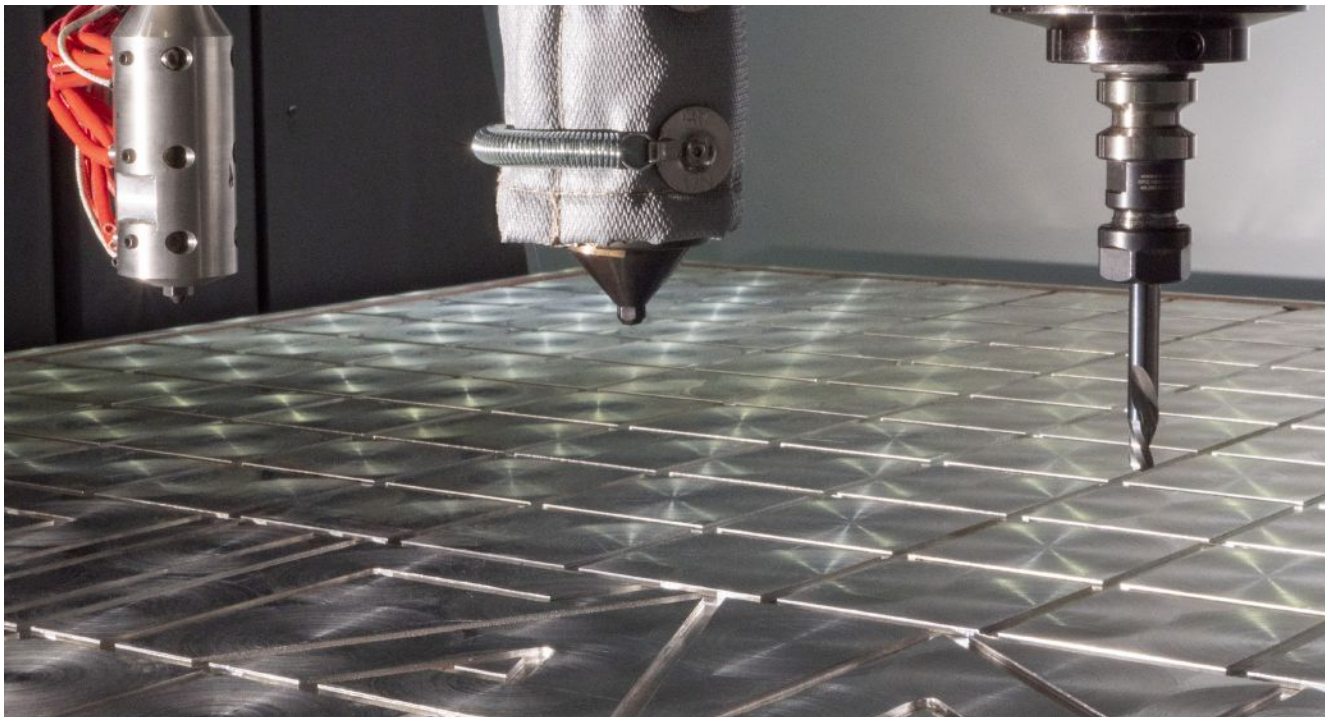
"We've taken both technologies and married them together from an integration and programming point of view," says Brian Kristaponis, general manager of the hybrid division at Phillips. CNC milling systems are a good complement to metal AM, as the complex geometric designs output by those systems often require extensive postprocessing to smooth out rough surfaces.

Phillips' first foray into hybrid manufacturing came by way of a special system built for Autodesk. Autodesk saw potential market interest in hybrid manufacturing and was looking for a system with a price point and software capabilities that mapped closely to its Fusion 360 design platform, Kristaponis says.

"It was about creating a hybrid system that any machine shop could afford, integrated with turnkey software," he explains, adding they signed up quite a number of university customers as well.

Today, Phillips' hybrid manufacturing group has been spun out as a separate entity with much of the demand coming from government and Department of Defense (DoD) customers. Repair applications like what the crew on the USS Bataan is doing are a primary use case for hybrid manufacturing technology as well as parts that require a lot of back and forth between machining and 3D printing, Kristaponis says. "Not having to go from CNC machine to AM machine results in huge time savings and is beneficial from an accuracy standpoint," he adds.

Consider the use case of a large propeller on a ship or a part on a complex piece of equipment where certain areas or bearings are worn thin. Instead of scrapping the entire part for replacement, a hybrid manufacturing solution enables personnel to add material and fill in pits on worn areas using



CNC spindle heads transform 3D Systems' Titan Pellet AM system into a true hybrid option for producing molds and tooling in a lights-out shift. *Image courtesy of 3D Systems.*

AM following up with integrated CNC capabilities to create a more precision surface, explains Markforged's Burd. "You can repair defects instead of scrapping the entire thing," he says. "In that way, you create a replacement part more quickly and cheaply than creating a new one from scratch."

Training personnel on an integrated set of capabilities is also more efficient and can help close some of the talent and skills gaps that remain a challenge for manufacturers. Customers accustomed to outsourcing machining capabilities to pattern shops are potential candidates for hybrid systems because it enables independence and increases productivity, adds Haley Stump, application engineer lead for the Application Innovation Group, at 3D Systems. 3D Systems acquired Titan Additive in 2022, and its large-format pellet extrusion systems are the basis of the company's hybrid manufacturing platform.

"Less outsourcing is always better," says Stump, adding that the technology lends itself to tooling, thermoforming, and sandcasting applications. "It's really cutting lead times in half or more, especially if the customer is outsourcing to a pattern shop. It's significantly less than machining something out of a block of aluminum."

The EXT Titan printers, available in two build volume sizes, are offered standard with a single high-throughput pellet extruder, but systems can be configured with up to three toolheads, including a second pellet extruder, a filament extruder and a milling spindle for true AM/subtractive hybrid manufacturing scenarios. Both platforms are designed for lights-out manufacturing, another advantage of a hybrid manufacturing model that can lead to shorter cycle times, cost reductions, and increased uptime for production processes.

"We provide a way to combine printing and machining runs in one file, enabling customers to reduce labor costs and utilize overnight builds, coming into a finished part in the morning," Stump explains. "Typically you wouldn't leave a CNC build unattended because metals are more risky to machinery. We don't have that same level of risk."

A hybrid system can also smooth over some of the gaps engineers face as they reorient design sensibilities to a design for additive manufacturing (DfAM) mentality. For example, designs don't necessarily need the tight tolerances required for a standalone AM system because onboard milling capabilities can compensate for a highly accurate part. "You don't have to be as aggressive about DfAM like you do with an AM-only process," says Phillips' Kristaponis.

Choosing the Right Approach

That said, hybrid manufacturing isn't a fit for many applications and the model comes with its own set of challenges. Parts that require longer print times and are less reliant on machining for final output are better suited for

separate systems and processes while those parts output with higher mass lend themselves to a hybrid approach, explains Lukas Hoppe, director of R&D at Meltio. "If your interest is in repairing parts or outputting smaller parts that integrate some new feature addition then it makes sense to do it in a single machine," says Hoppe, who estimates that around 30% of Meltio's sales now involve hybrid manufacturing systems.

A single machine setup saves on real estate and in some cases, cost, but there are also limitations. Combining two complex operations in one environment comes with challenges, including finding skilled operators who properly understand the workflow sequence as well as best practices for each production method. For example, high-performing machining operations require tools to be kept clean and cool, which can be at odds with best practices for AM.

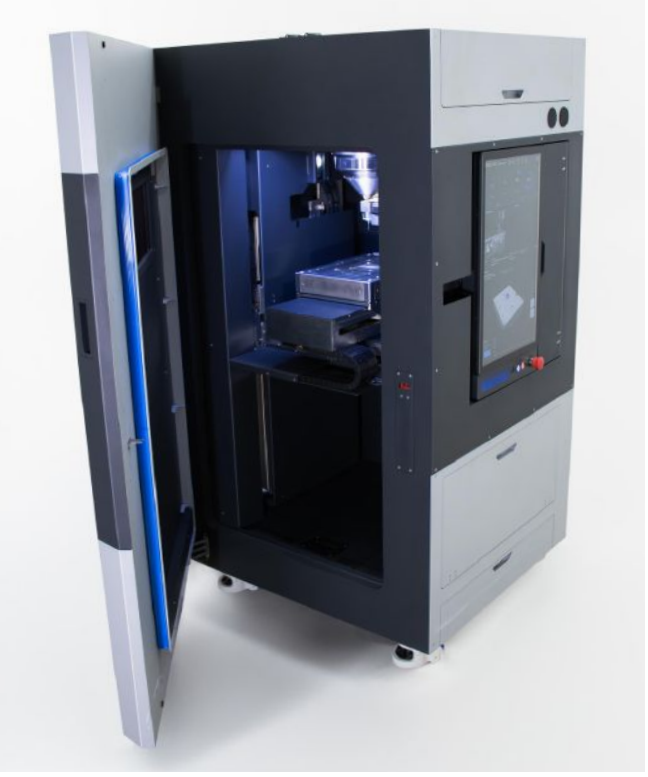
There are also issues related to downtime—if the combined system encounters a problem, there's the possibility of taking the equivalent of two systems offline rather than one. "Hard-coupled manufacturing processes can limit agility if you're looking for maximum throughput in a product environment," says Markforged's Burd.

Markforged AM technology is not currently suited for the classic interpretation of hybrid manufacturing due to the need to sinter metals and perform depowdering and debinding post-processing steps. However, Burd says the company takes an alternative view of hybrid manufacturing through its ability to combine quality and inspection processes in a single machine—another way to reduce reliance on secondary operations.

Markforged AM systems incorporate machine vision camera systems and onboard laser micrometers to automatically capture information about a part's surfaces and fiber placement as it's printed while in-situ monitoring detects and adjusts for alignment issues. The Markforged AM platforms also incorporate laser inspection data into automated quality reports that compare the geometry of the input STL file to the measured geometry of the printed part. "Quality is a major part of production workflows, and we're integrating it into our hybrid machines," Burd says.

As far as the more conventional take on hybrid manufacturing, in addition to the 3D Systems and Phillips' offerings, DMG Mori offers a platform that melds DEDAM capabilities with CNC milling while Matsuura Machinery Corp.'s LUMEX series repeats metal laser processing and high-speed, high-precision milling to form metal powder into shapes. The system makes deep ribs in a single process, resulting in dimensional accuracy that's comparable to machining centers, officials claim.

Before moving forward, companies need to take the time to consider what applications, if any, would benefit from combining processes in a single machine. The reality is that most parts demand multiple production processes—the question is whether integration is economically or strategically beneficial. "There's always a hybrid workflow—the question is whether to accommodate the process in one machine," says Meltio's Hoppe. DE



The Meltio Engine enables metal 3D printing and machining of complex geometries in a single process step. *Image courtesy of Meltio.*

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

MORE INFO

- **Autodesk:** Autodesk.com
- **DMG Mori:** US.DMGMori.com
- **Markforged:** Markforged.com
- **Matsuura Machinery:** Lumex-Matsuura.com
- **Meltio:** Meltio3D.com
- **Phillips:** Phillipscorp.com/hybrid
- **3D Systems:** 3DSystems.com

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

What's New in AutoCAD 2025

Even more AI tools are added to the latest release of AutoCAD.

BY DAVID COHN

The latest release of AutoCAD 2025 arrived in late March, marking the 39th major version of its flagship CAD software. As we have come to expect, the announcement lacked fanfare, and the new release offers just a handful of new features, most of which are enhancements to tools previously introduced over the past several years—understandable for a program that has been around for nearly 40 years. Still, the improvements will likely benefit all users regardless of what types of drawings they create.

Building on Machine Learning

Building on the company's machine learning initiative, Autodesk has once again enhanced AutoCAD's Activity Insights tools. First introduced in the 2023 release as My Insights, Activity Insights is a palette that records events and filters them by event type, user and date, which enables users to track the evolution of their drawings as well as compare the drawing history.

The 2024 release enabled users to control where the program stores the events activity database, to track "out-of-band" events (activities that take place outside of AutoCAD, such as renaming a drawing in Windows Explorer), and to identify referenced drawings.

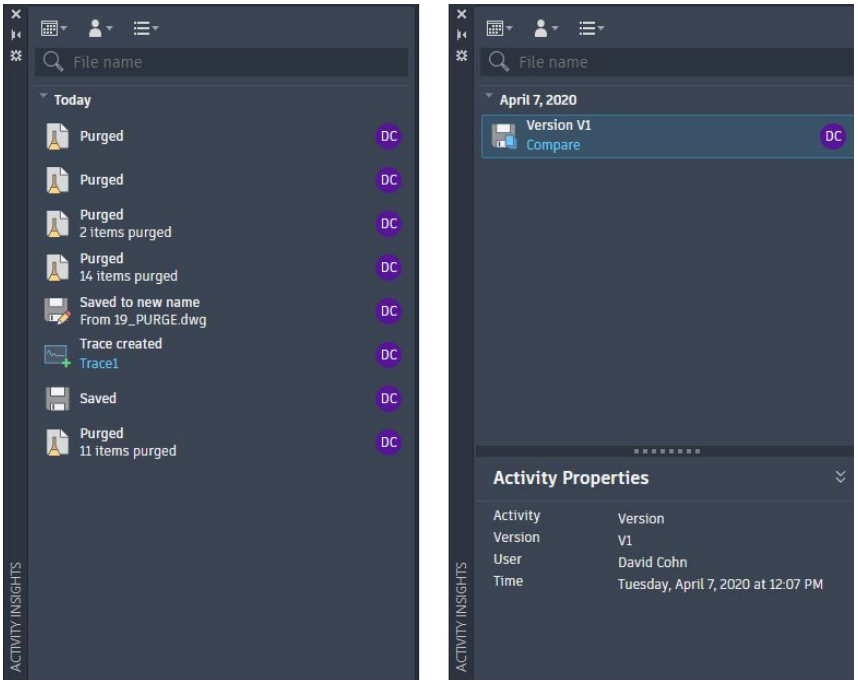


Fig. 1: The updated Activity Insights palette now logs more types of activities and provides detailed information, such as the number and types of objects Purged. *Images courtesy of David Cohn.*

In AutoCAD 2025, Activity Insights now logs more types of activities and provides detailed information in the new *"Activity Properties"* panel. For example, users can now see detailed information about the number and types of objects removed from a drawing using the Purge command.

The drawing history has also been merged into Activity Insights for files that have been saved to supported cloud storage providers, such as Autodesk Docs, Google Drive, OneDrive, Box and Dropbox. When a save is initiated to one of these cloud storage providers, a new file version will appear as a Version activity. From the Version activity title, you can then click *"Compare"* to view the differences between the current and previous drawings.

You can also now view the activities

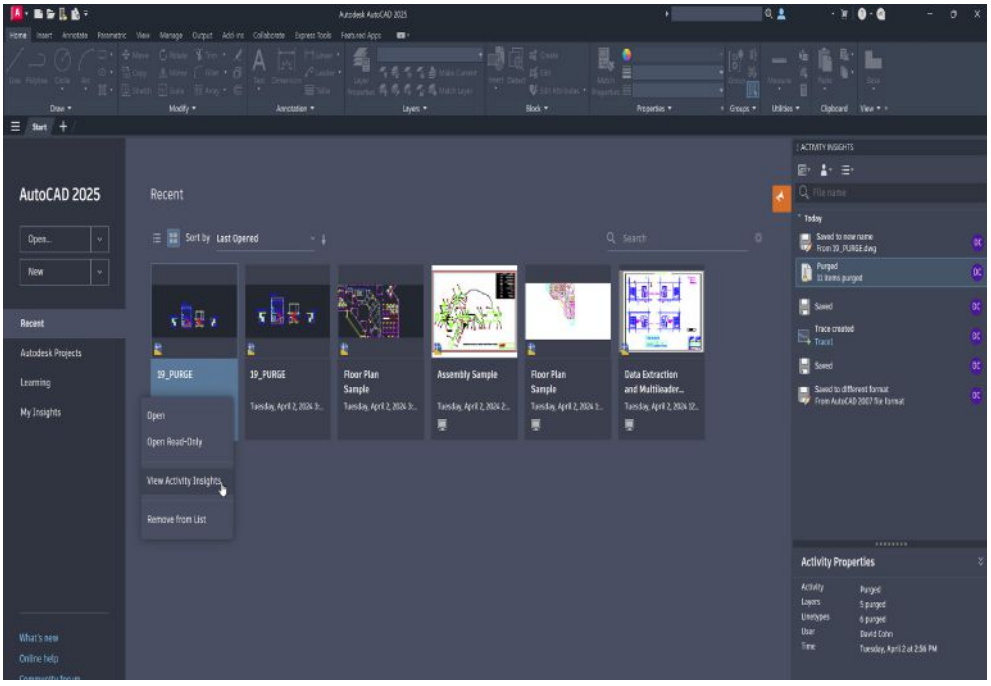


Fig. 2: A shortcut now enables you to view activities associated with a drawing without first opening the drawing.

associated with a drawing without having to first open the drawing file. On the *"Start"* tab, when you select *"Recent"* and then select a drawing, you can click a vertical ellipsis and then choose *"View Activity Insights"* to see a list of the drawing's activities in the adjacent docked Activity Insights palette.

Improved Markup Import

Two other machine learning tools, Markup Import and Markup Assist, first introduced in AutoCAD 2023 and improved in AutoCAD 2024, have also received some updates. For example, after saving a scan or photograph of a drawing containing hand-drawn or computer-drafted markups as a PDF, PNG or JPG file, you can use Markup Import to overlay those markups in a new trace. Markup Assist then identifies those markups as multiline text, multileaders and revision clouds and inserts them into the drawing as actual geometry.

AutoCAD 2025 adds to those capabilities. PDF markup files can now connect from Autodesk Docs to AutoCAD to help users easily view and incorporate revisions. You can create markups on a PDF in Autodesk Docs and then sync the PDF so that the markups can be viewed by collaborators in the AutoCAD Trace workspace. The PDF markup file is continually connected to the AutoCAD drawing, which means that as you add changes to the markup file, collaborators will see those changes in AutoCAD.

Scan and Convert Objects Into Blocks

AutoCAD 2024 introduced new smart block functionality that offered placement suggestions based on where you previously placed instances of a block in a drawing. For example, when inserting a block using the Blocks palette, the block placement engine uses machine learning to identify the existing pattern of blocks and infers the placement of the block based on those existing patterns.

AutoCAD 2025 offers even more smart block solutions to streamline the design process. When you start the new Bconvert command, the program prompts you to select objects to convert into blocks. Once you specify geometry, AutoCAD identifies and highlights all instances of the same geometry. You can then choose to convert all instances of that geometry into a block or choose specific instances to include or remove from the conversion process.

Next, the program displays a Convert dialog, in which you can convert the source object or selected instances into an existing block or a new block (defined by specifying the block name and insertion point).

AutoCAD 2025 also includes a technology preview that leverages ML to scan your drawing for objects that can be converted into blocks. When you start the new object detection tool, the drawing's content data is sent to the AutoCAD machine learning service for recognition. The detection results are then displayed in a palette. You can then click *"Review Objects"* to enter the review mode. A Detection toolbar appears at the top of the drawing. This toolbar contains various tools for navigating through sets of objects. Within each set, the primary instance (shown with a blue border) defines the object and orientation when converting the detected instances into new blocks. You can then click the *"Convert"* tool to open the Convert dialog so you can use its tools to convert

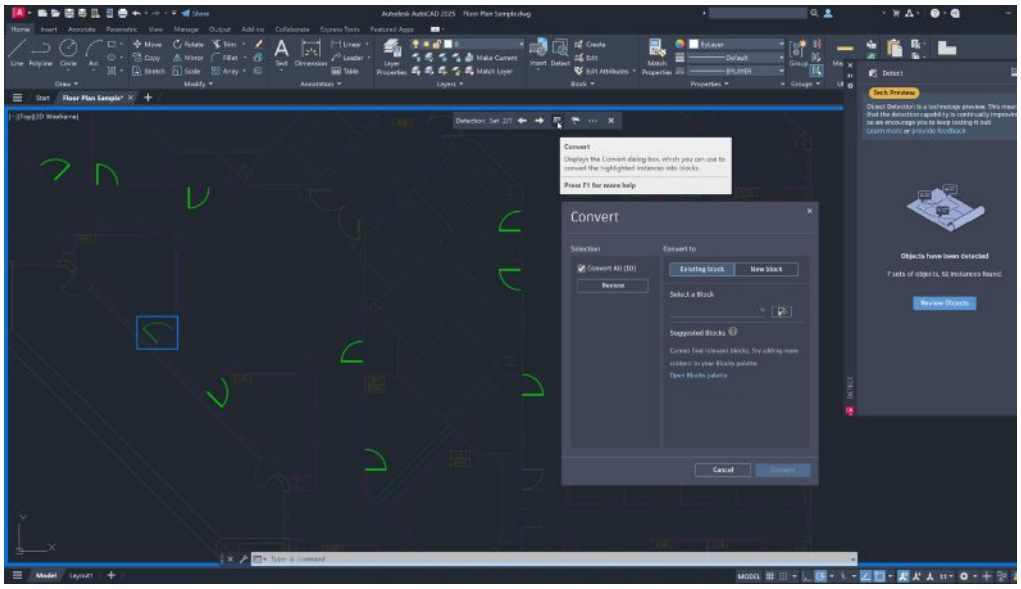


Fig. 3: A new command identifies and highlights all instances of the same geometry and then helps you to convert all instances of that geometry into a block.

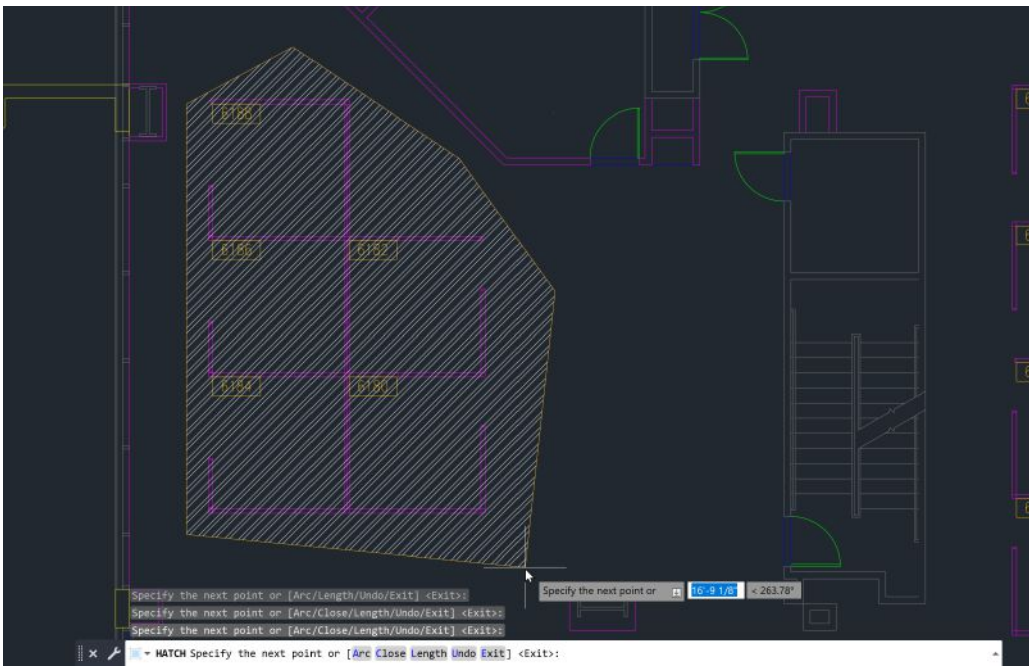


Fig. 4: The Hatch command now provides a convenient option to draw hatches without the need to first create boundary geometry.

the detected geometry into an existing or new block.

If you encounter incorrect sets or instances during the detection review, you can click a tool on the Detection toolbar to report such errors. In this way, users will be able to contribute to improving the overall performance and accuracy of the ML service. The documentation clearly states that the detection capabilities will continue to improve and notes that, at present, detection works best on architectural objects in floor plans and that, for now, not all objects may be detected accurately.

Hatch Without Boundaries...and More

There are other more subtle enhancements. For example, the Hatch command now provides a convenient option to draw hatches without the need for pre-existing boundary geometry. Now, when you start the command, in addition to picking a point inside a closed boundary or selecting an existing closed object, you can create a circular or rectangular boundary or specify points defining a polyline boundary. The hatch immediately fills the area inside the path you specify, without having to first create the hatch boundary.

Esri Maps are now integrated into AutoCAD. Now, when you set the Location for a drawing, in addition to being able to select From Bing Maps or From File, you can choose one of five additional types of Esri maps to assign geographic location information to a drawing file.

In addition to all these changes, AutoCAD 2025 boasts font display improvements, a 3D wireframe visual style to facilitate cross platform 3D graphics system performance, and

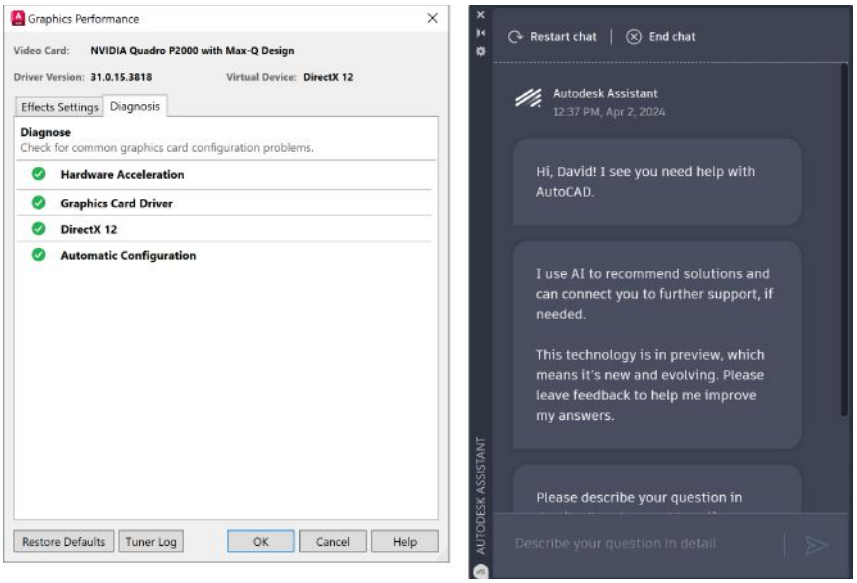


Fig. 5: The Graphics Performance dialog now includes a Diagnostics tab to help pinpoint configuration problems, and the new Autodesk Assistant uses conversational AI to quickly deliver support solutions.

improvements to reduce the amount of time it takes to open large and complex drawing files. The Graphics Performance dialog now includes a Diagnosis tab to help you pinpoint configuration problems so that your system can deliver optimum performance. And the new Autodesk Assistant uses conversational artificial intelligence (AI) to quickly access helpful AI-generated support solutions related to AutoCAD.

The 2025 release continues to use the same drawing file format as AutoCAD 2018, so DWG files remain 100% compatible. As has been true for many years now, in addition to AutoCAD itself, your subscription purchase also gives you access to seven additional specialized toolsets: AutoCAD Architecture, AutoCAD Electrical, AutoCAD Map 3D, AutoCAD Mechanical, AutoCAD MEP, AutoCAD Plant 3D, and AutoCAD Raster Design. You can download a 15-day free trial of any of the AutoCAD 2025 products from the Autodesk website.

The cost of the software has again gone up slightly. In addition, occasional users can take advantage of the Flex option, where they can purchase usage tokens ($300 for 100 tokens or $1,500 for 500 tokens) and then use those tokens to pay as they go (7 tokens per day for AutoCAD).

Tokens expire one year from the date of purchase and are charged every 24 hours while a product or service is in use, and tokens can be used for most (but not all) Autodesk products. For example, Flex tokens cannot be used for AutoCAD LT. And some features, such as Markup Assist, are still not available in AutoCAD LT or AutoCAD for Mac.

Although the list of new features in AutoCAD 2025 is again relatively short, the new features should benefit most users regardless of what they create. And since AutoCAD and AutoCAD LT are only available by subscription, there is no reason not to upgrade. DE

Contributing editor **David Cohn** *has been using AutoCAD for 40 years and is the author of more than a dozen books on AutoCAD. You can contact him at david@dscohn.com or visit dscohn.com.*

MORE INFO

- **Autodesk:** Autodesk.com
- **Prices:**

AutoCAD 2025 and AutoCAD LT 2025 are only available by subscription. Upgrade pricing and perpetual licenses are no longer available.

AutoCAD 2025
Monthly: $255 (up from $245)
1 year: $2,030 (up from $1,955)
3 years: $6,090 (up from $5,865)

AutoCAD LT 2024
Monthly: $65 (up from $60)
1 year: $505 (up from $485)
3 years: $1,515 (up from $1,455)

System Requirements

Operating System: 64-bit OS that follows Autodesk's Product Support Lifecycle policy
CPU: 2.5GHz processor or faster (3.0GHz or faster recommended)
Memory: 8GB (32GB recommended)
Disk Space: 10GB free disk space for installation (solid-state drive recommended)
Display Resolution: 1920x1080 with True Color (resolution up to 3840x2160 supported on Windows 10 64-bit systems)
Display Card: 2GB GPU with 29GB/s bandwidth and DirectX 11 compliant (8GB GPU with 106GB/s and DirectX 12 compliant recommended)

Specialized toolsets and large datasets require additional memory and disk space.

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

Next-Gen Engineers

Students Envision Future of EV Charging Design

Student Competition Profile: Auburn University Industrial & Graphic Design Awards

BY JIM ROMEO

Engineering students at Auburn University win awards of up to $3,000. Students explored concepts focusing on accessibility, ergonomics and user experience. Winning concept by Abby Freeman. *Images courtesy of Jim Romeo.*

ABM, a leading provider of facility services, infrastructure, electric vehicle (EV) charging solutions and parking and transportation management, recognized six graduating students at Auburn University School of Industrial & Graphic Design with awards of up to $3,000 for their work designing innovative EV charging station concepts through their senior projects.

As part of ABM's commitment to continuous innovation within the eMobilty sector, these designs will join the company's other future-forward concepts informing the next evolution in EV infrastructure.

As ABM continues to explore new charging station designs and applications to their current range of offerings in the coming years, the six winning concepts help inform these new innovations and integrations. Having installed over 30,000 chargers in the U.S., ABM is at the forefront of furnishing fleet operators, site hosts, solution providers and local charging network providers with cutting-edge EV hardware and software technology through ABM EV charging stations and ABM EV OS.

Alex Drouillard is a product manager at ABM. We spoke to Alex and some members of the Auburn team to learn more about their design development for the program. Here's our conversation.

Digital Engineering: **Can you provide an overview of the partnership and what it sought to accomplish?**

Alex Drouillard: ABM launched their own branded charging solutions earlier in 2023 to bring new solutions to address the needs of drivers today. Looking to further enhance that driver experience, ABM invested in its partnership with Auburn University to explore new solutions that could improve and enhance current charger design, with emphasis on ease, ergonomics, and accessibility. Thirteen Auburn students participated in this project, each bringing forth a unique concept for their own variation of a charging station design.

Auburn was a natural choice for this project given their leadership in industrial design, and they were a great partner throughout, with each student providing exciting new ideas and perspectives. We went in with the plan to offer only five prizes, but the outcomes were so strong we needed to add an additional prize to recognize these efforts and for us to consider them all for our future charger designs.

Along with receiving a design briefing from ABM's experts, participating students rented an electric vehicle to use and experience the locally available chargers first-hand. Over the course of nine weeks, they worked closely with ABM's team, as well as their professor, to finalize their designs. Afterward, they were judged by a panel of those experts along with their professor to score each design based upon a range of factors, including accessibility, aesthetics and manufacturing cost.

Abby Freeman, overall winner of the competition: ABM was a great partner, providing regular feedback and encouragement to our designs. They regularly reiterated how to use the design process, and it was interesting to see that process in action as we designed our chargers.

DE: **How did the design challenge benefit your students and curriculum at Auburn?**

Jerrod Windham, associate professor of industrial design, Auburn University: ABM was a great partner to work with, both in bringing a real-world application to our students, but also in providing a tangible design brief that gave them a lot to work with and, ultimately, resulted in a range of different outcomes from the students. The cash prize offer was also unique, allowing our students the opportunity to be rewarded monetarily for their work and understand the value of their designs. DE

Jim Romeo *is a freelance writer based in Chesapeake, VA. Send e-mail about this*