ASME
SETTING THE STANDARD

A View From 2030

Pulse of the Profession: CAD in 2030

An Inflection Point for Digital Change

The instant that the first commercially available CAD programs became accessible to engineering and manufacturing firms in the mid-1960s, the old ways of working—rooms full of drafters staring at drawing boards—began to slip into history. It was a paradigm shift, to be sure, and it wasn't the last big change this now-essential technology would spark. CAD technologies and their applications have been steadily evolving ever since, ushering in a bevy of new techniques and approaches over the decades.

And that trend continues. In recent years, designers and engineers have been using CAD to add value in innovative new ways. These approaches have arisen in tandem with a wave of Industry 4.0 tech trends, such as additive manufacturing (AM), generative design, digital twinning, the Internet of Things (IoT), and artificial intelligence and machine learning (AI and ML). Increasingly, firms are looking to leverage these emerging technologies to enhance agility, productivity, and efficiency.

As we enter yet another new epoch of CAD innovation, the lines between design and manufacturing phases will continue to blur. Data streams from connected factories could support IoT-enabled CAD models, helping to validate design assumptions and unlock new insights. AI and ML-driven generative design algorithms integrated into CAD programs may automate repetitive

This is the fourth of ASME's multipart series on how the future is shaping—and will be shaped by—engineering professionals. Head here to check out earlier reports, on Career-Ready Soft Skills, Digital Transformation, and Design for Manufacturing.

Ready for Take-Off

The global computer-aided design (CAD) and the software-as-a-service (Saas) markets are both poised for big growth. And with cloud-based CAD platforms gaining ground in the worlds of manufacturing and engineering, there's plenty of overlap.

6.9% Global CAD market's projected compound annual growth rate, 2022-2030

Percentage of end users in the United States who prefer cloud-hosted and SaaS applications for communication and organization purposes.

80%

19.7% Saas market's projected compound annual growth rate, 2022-2029

Sources: Polaris Market Research report, 2022; FinancesOnline; Fortune Business Insights report, 2023

“We’ve come a very long way from the days when CAD was used in isolation to design a product on a computer screen. Now we connect CAD to every step of the [manufacturing] process.”

— Paul Miller, Forrester analyst, told 5 Minutes in the Future

tasks and consider real-world manufacturing methods and operating conditions, rapidly generating and evaluating scores of different potential designs for a product. Digital twins have the potential to enrich CAD models with real-time data from physical prototypes, offering engineers virtual tools for refining designs and improving performance. And cloud-based CAD platforms can unlock designs from fixed computer stations, allowing teams to collaborate via mobile devices and tablets from the factory floor and beyond.

This more high-tech approach will provide a much-needed boost in collaborative functionality within the field. “Access to 3D models and product data has been a major barrier for cross-functional teams for decades,” Dan Murray, CEO of Vertex, told ASME. “This [younger] generation expects that mobile devices and applications will exist in the workspace.”

As CAD evolves from a discrete design-centric methodology into one more inclusive of manufacturing, a growing number of mechanical engineers will find CAD skills highly valuable. Perhaps that’s why the global CAD market is poised to nearly double in size between now and 2030. Valued at $9.9 billion in 2021, it’s expected to grow to $17.5 billion by 2030, according to a Polaris Market Research report. “We’ve come a very long way from the days when CAD was used in isolation to design a product on a computer screen,” says Paul Miller, a principal analyst at Forrester whose research focuses on digital manufacturing and IoT. “Now we

connect CAD to every step of the process. We can control the milling machines. We control the 3D printers that take those design files and then produce the finished part. And when you add in machine learning, things get even more interesting."

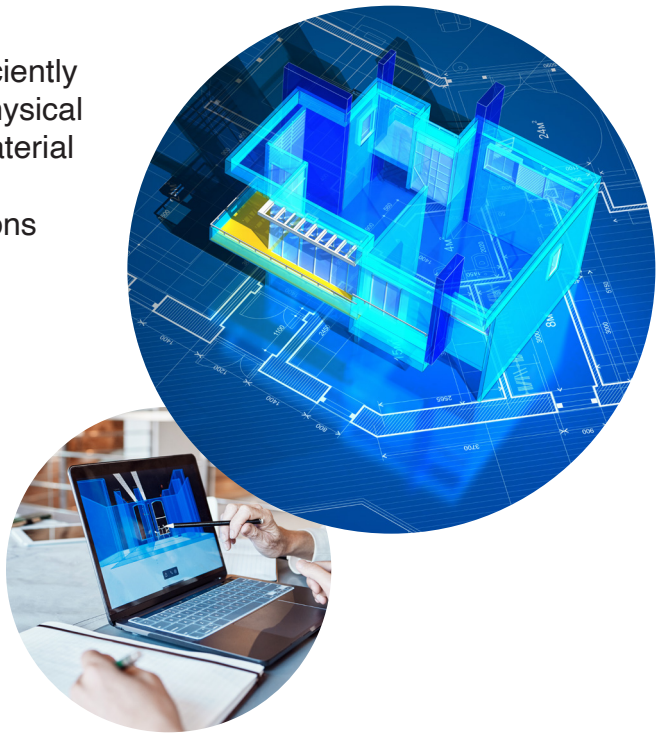
It all adds up to a future in which CAD is both more prevalent and more important to engineering and manufacturing firms. In other words, working knowledge of at least one CAD program is likely to become the norm—and a baseline qualification—for both mechanical engineers and many of the specialists with whom they collaborate. With the capabilities of these software programs rapidly expanding, engineering professionals will need to adopt an always-ready-to-learn mindset.

CAD at Work

Tasked with creating systems and products that meet technical requirements cost-effectively, engineers routinely turn to CAD. Creating physical models of components, machines, or products is generally impractical from both a time and cost perspective, but CAD's widely realized benefits go beyond the design process to include boosting manufacturability and quality control processes. Here's a quick look at key benefits CAD offers today's mechanical engineers.

Digital prototyping

CAD software allows engineers to strategically and efficiently work up preliminary designs—and to say goodbye to physical blueprints and prototypes. Within certain design and material constraints, designers can kick the tires on different approaches and iterations by simulating certain conditions and environments to test performance.



Quality control

Using CAD software, engineers can integrate quality control processes into the product development process earlier, saving time and money later. Users can simulate a variety of conditions, such as stress and temperature, to understand how a prototyped product or system will likely perform over time. That can surface design flaws or shortcomings before production begins, and help ensure that the product meets all structural and functional specifications.

Accelerated time to production (and market)

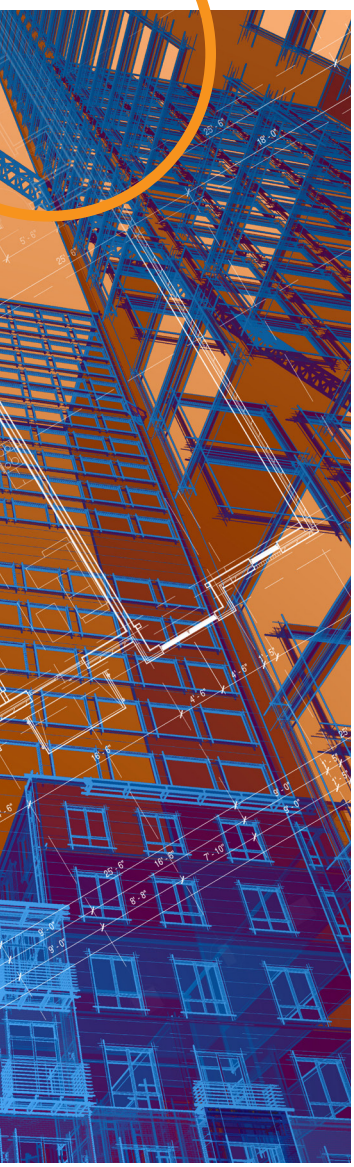
It's not just that CAD allows mechanical engineers to avoid time-consuming physical prototyping processes. It also lets them quickly perform tests, cutting out waiting times between iterative prototypes. Add a shortened design process to a shortened testing process, and the result is faster time to production and market—which allows firms to be nimbler in responding to market demands and customer needs.

Scott Harms, president of MetalQuest, which specializes in manufacturing precision machined component parts, says CAD is the essential starting place for the company's entire design and manufacturing process. "It makes us so much more rapid in terms of when we go out on the shop floor to produce something," he said. By that point, the component has already "been looked at from 50 different angles."

But CAD's wide array of applications comes with an important caveat: It's a tool, not a panacea. One of its greatest strengths is its ease of use for making two-dimensional and three-dimensional designs with detailed specification. But that aspect of the software can cut both ways. Less experienced engineers may create designs that appear manufacturable on a screen—but can't actually be made. For example, CAD programs allow a user to easily mate two parts, William Durfee, a professor of mechanical engineering and director of the design education department at the University of Minnesota in Minneapolis, told ASME. However, "in real life, they'd need to be welded, or adhesively bonded, or fastened with some type of fastener—it's easy to forget that on the screen."

But here's the good news. Next-gen CAD programs and teams, which are fed data from real-world facilities and which allow design and manufacturing engineers to collaborate, are more likely to address such manufacturability issues, helping to eliminate these potential pitfalls.

Seizing the Next-Gen Advantage



As discussed, CAD's value to mechanical engineers is expanding in new directions as software programs evolve and integrate with a range of fast-changing technologies, from AI and ML to the cloud. Here are three emergent ways that CAD is helping to redefine design and manufacturing processes, as well as the ways in which teams work together.

A more customized experience

As CAD tools have developed over recent decades, more and more capabilities and commands have been added. That makes the software more powerful. But it can also be unwieldy, overwhelming users with too many options. "We're now at the point where there are 500 different commands you could execute as you design a circuit board or mechanical piece of hardware," Chad Jackson, chief analyst & CEO of Lifecycle Insights, told ASME. "It's almost become too much."

AI and ML-driven CAD enhancement can help improve the user experience in a few different ways. An ML algorithm could be created, for example, that automates menial or repetitive CAD tasks. In fact, the software may automatically recognize such actions and step in to perform them, speeding up the design process. More dramatically, a CAD program might soon offer suggestions to the user based on his or her past designs and knowledge of similar parts in the firm's library of designs. The upshot? No need to keep entering the same geometric constraints or other requirements over and over—and a far more seamless design process.

"There is tremendous opportunity to use AI to unlock the creativity of engineers and supercharge their ability to innovate," Gurdeep Pall, corporate vice president of business AI at Microsoft, told ASME. "Modern systems are inherently getting more complex, and AI is perfectly suited to tackle complexity."

The ubiquitous shift to software-as-service and cloud-based platforms could also support a more customizable CAD experience. All those superfluous features and commands will fall away as vendors become more

attuned to the needs of specific organizations and even specific users, offering tools that can be better adapted to the needs at hand. With CAD tools able to evolve in such personalized ways, the barrier to innovation will likely be far lower.

Fewer walls between design and manufacturing

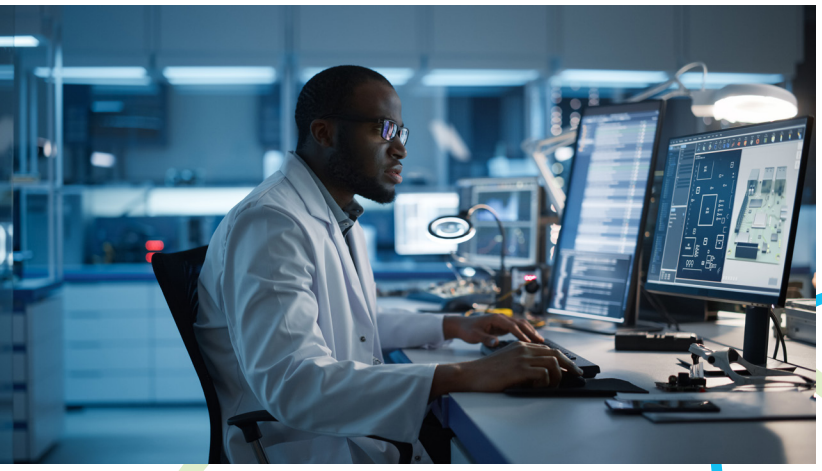
Historically, CAD and computer-aided manufacturing (CAM) were distinct processes—the former firmly planted in the design phase, and the latter in the manufacturing (e.g., CNC machining) phase. But momentum has for years been building to create a single CAD-CAM standard that would enable more seamless data transfer between platforms and programs. The hope is to avoid manufacturing delays and late-stage design revisions while gaining visibility into how specific design choices translate into manufacturing requirements. A similar goal underpins the idea of digital twins, which collapse the distance between the design environment and a manufactured product.

"We want to be able to change a product in CAD and have those changes propagate automatically to product and factory simulations. That way, we get immediate feedback on how design changes modify cost, time, and materials," Stephan Biller, GE Global Research's chief manufacturing scientist, told ASME.

Of course, fully integrated CAD/CAM software exists today. But while currently it's anything from standard across the industry, it—and digital twins—could become the norm in the years to come, both within and across organizations, as companies seek greater efficiencies, build IoT-enabled manufacturing facilities, and embrace Design for Manufacturing (DfM) principles.

Streamlined communication and collaboration
In essence, DfM unites the realms of design and manufacturing to prevent the need for redesign work and speed up value realization. In this kind of integrated environment, a CAD system that contains data on each prototype iteration and every test result is invaluable in part because it facilitates consistent, seamless communication between design and manufacturing engineers and other team members. Everyone can be on the same page, so to speak.

The shift to cloud-based, device-agnostic platforms will likely play a role in this respect. No more will there be a need to convert file formats or manually update to the latest software release. Whether working on a mobile device, tablet, or desktop, cross-functional team members can simultaneously work on the same design file maintained in the cloud. With technological barriers to collaboration and communication removed, problems can be flagged and resolved sooner, and solutions can be found faster.



An Evolving, Essential Skill Set

Soon, mechanical engineers will likely see an increasingly interdisciplinary design and manufacturing digital ecosystem. Leaning on AI and ML, CAD programs will soon offer more complex—and customizable—capabilities to make it easier to design cost-effective products.

As a result, mechanical engineers can expect basic coding and scripting to fall under their purview, and CAD may become more widely used across teams and organizations. In a sense, CAD could become a kind of lingua franca, bringing stakeholders and disciplines together.

“I believe that accessing CAD will not be a privilege of a small, highly trained group of engineers, but it will become a tool that all…can access,” Istvan Csanady, CEO of Shapr3D, told Develop3D last year.

About ASME

ASME helps the global engineering community develop solutions to real world challenges. Founded in 1880 as the American Society of Mechanical Engineers, ASME is a not-for-profit professional organization that enables collaboration, knowledge sharing, and skill development across all engineering disciplines, while promoting the vital role of the engineer in society. ASME codes and standards, publications, conferences, continuing education, and professional development programs provide a foundation for advancing technical knowledge and a safer world. In 2020, ASME formed the International Society of Interdisciplinary Engineers (ISIE) LLC, a new for-profit subsidiary to house business ventures that will bring new and innovative products, services, and technologies to the engineering community, and later established the holding company, Global Knowledge Solutions LLC. In 2021, ASME launched a second for-profit subsidiary, Metrix Connect LLC, an industry events and content platform to accelerate Additive Manufacturing in the engineering community. For more information, visit www.asme.org.

Your Step-by-Step Guide to Taking the Next Step

With this guide under your belt, you know plenty about CAD now--but are you ready to bring your computer design skills into the future? Download the members-only workbook now to deepen your knowledge.

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