

3D Modeling Software Spots a New Paradigm

No matter your engineering discipline, 3D modeling can improve the way you work.

BY ROBERT GREEN

Most of us perform our engineering tasks without a whole lot of thought about the tools we use to accomplish the job. Sure, we all have a computer, and most of us use CAD programs of some sort, but how much attention do we really pay to these tools and how they've changed the way we work? So, what does the future hold for CAD? And a more probing question: Why should engineers even care?

For every change we've seen in the past (drafting boards morphing into CAD machines, for example), there will be an equally large change in the future as these CAD tools that become more functional. Therefore, the more we all know about the CAD tools we'll use in the future, the more likely it is that we'll be able to use those tools to better our careers. With that in mind, let's take a look at how the CAD market is changing and what to expect.

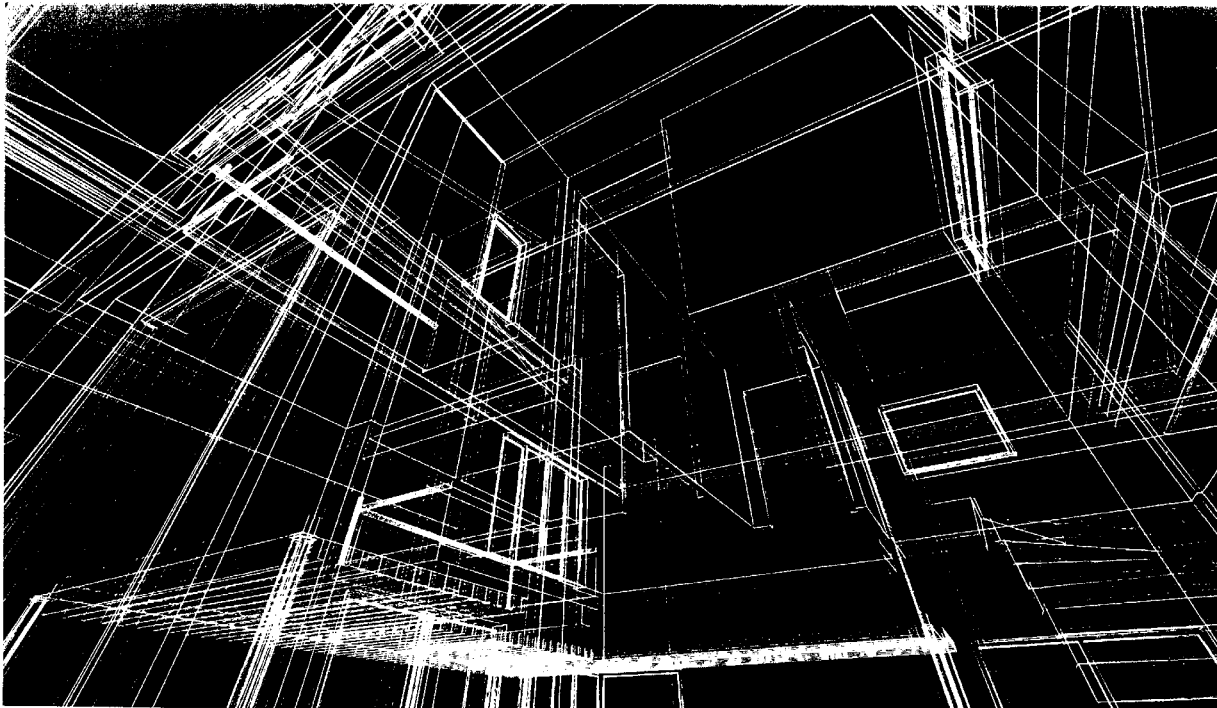
In the past, engineers drew their designs, but today modeling the designs in 3D software is more the norm and will certainly be

so in the near future. When engineers input design criteria and physical properties into 3D software, a model emerges instead of drawings, and engineering can be performed directly in the 3D design software instead of with tools, like pencils, calculators, drawing sets, and manual calculations.

And while 3D software may have been overly complex or hard to learn in the past, today's software vendors are striving to make program interfaces familiar and design capabilities a natural extension of the tool. As an example, consider Autodesk Inc.'s Civil 3D tool for civil engineers. Civil 3D is based on the familiar AutoCAD platform to facilitate user acceptance, yet it provides a wide palette of optimized design tools for tasks such as survey data collection, point management, alignments, profiles, grading, and piping. Autodesk has made Civil 3D seem like AutoCAD, which means user training can be minimized while the powerful feature set makes the transition to 3D modeling worthwhile.

For mechanical engineers performing product design with tools like Autodesk's Inventor or Solidworks Corp.'s Solidworks, product design continues to become more and more modeling based. At the same time, more engineering is done on the computer instead of in destructive testing or prototyping environments.

For architects and the MEP engineering communities, the paradigm known as building information modeling is now allowing the 3D modeling of buildings so that energy loads and mechanical systems can be properly sized and correctly fit into building shells without the fear of collisions and construction access problems that have plagued building design in the past. And, as structural engineering tools, such as Bentley Structural, become more integrated into the BIM process, it is entirely conceivable that entire buildings will be conceptualized, optimized, qualified, and fitted with mechanical systems in a computer model.



It's About Optimized Design

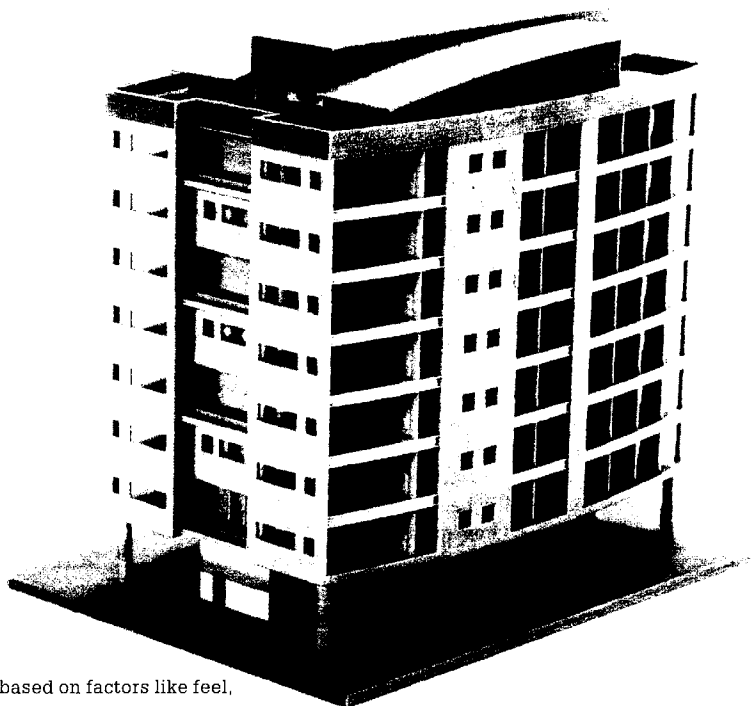
What's the payoff for modeling in 3D then, you may be asking? In a word; design. When the computer has all the physical parameters of what we're designing, the computer can start helping us with our design tasks. Let's say you've modeled a new site for development and need to forecast the amount of fill dirt you'll need. The 3D model can effortlessly calculate what you'll need. Need to apply a 4,000-pound load to a dielectric standoff you're designing? The 3D models identify the section moduli of the members in question and the material properties of the alloy you're using. The models also apply the correct bending stress equations to calculate if you're in compliance.

Don't worry, design software in the near term won't replace engineers, but it will help them be more productive by limiting the drudgery of repetitive calculations and code compliance. Using modeling software simply allows engineers to worry more about what they're designing and less about the detailed calculations that have historically been done on a notepad. And since we can now examine many more scenarios in greater detail in the same amount of time, modeling-based design allows us to optimize our designs more thoroughly.

Digital Prototyping

Another benefit of modeling in the virtual world is that 3D printing from companies like Z Corp. will now allow you to create a scaled-down (at least for land plats or buildings) representation of your design for manual inspection. In the mechanical engineering and product design areas, these rapidly produced prototypes are revolutionizing design by allowing immediate examination of designs without the manufacturing overhead.

As an example, imagine running a focus group to see which cell-phone design consumers prefer. With digital prototyping, you could simply "print" several design versions of the phone and then allow the test group to judge them



based on factors like feel, size, and heft rather than have them try to imagine what the phone might feel like. If fast changes were to be made (say slight design tweaks to be considered after lunch), it would be feasible to create new prototypes in a matter of hours. This rapid prototyping methodology is cutting product-development cycles for consumer electronics and packaging projects like never before. And since prototyping is completely under the engineer's control, there are no costly mistakes to be made during tooling and no lengthy delays for companies that use foreign production sites or prototyping shops.

Mechanical software companies like Autodesk and Solidworks tout digital prototyping as the best way to derive maximum benefit from 3D modeling software packages precisely because of the immediacy of the results.

Drawings Just Happen

So, once we've modeled the physical characteristics of whatever we're designing, assigned material attributes, performed the mass computations, and even prototyped our designs via 3D printing, we're ready to proceed to the drawing phase and build something, right? Well, the real story is that once the design is optimized,

Z CORP. MANUFACTURES PRINTERS THAT ARE BASED ON A 3D PRINTING TECHNOLOGY DEVELOPED AT MASSACHUSETTS INSTITUTE OF TECHNOLOGY IN 1993. THE COMPANY'S PRINTERS ACCEPT ALL MAJOR 3D FILE FORMATS.

the usual production drawings are simply a view or section of geometry that is already modeled in 3D, so the computer can simply generate that view for us to annotate. And if we have to change our design geometry, the 2D projections and sections will be recomputed for us with no manual drawings to keep up with.

While annotation has become pretty effective in mechanical design packages, engineers and drafters will still be tweaking dimensions and adding text annotations to drawings for some time. But at least the drudgery of drawing is becoming less of a burden as the software manages more of the task for us.

Fully Digital Interoperability

Consider a non-CAD example of digital interoperability, like an iPod. The human experts (musicians) encode the information (the music) into a digital recording that is then saved into a digital file. From that point on, all aspects of moving the file to your iPod work together to move the MP3 encoded file to the iTunes site, to iTunes on your computer, to

the USB interface on your iPod, which receives the file that you can listen to. The thing to grasp in this scenario is that once the music was encoded, it never left the digital realm. There was no packaging, no CD to burn, and nothing to keep track of other than your iPod. This example shows the full digital model of information management.

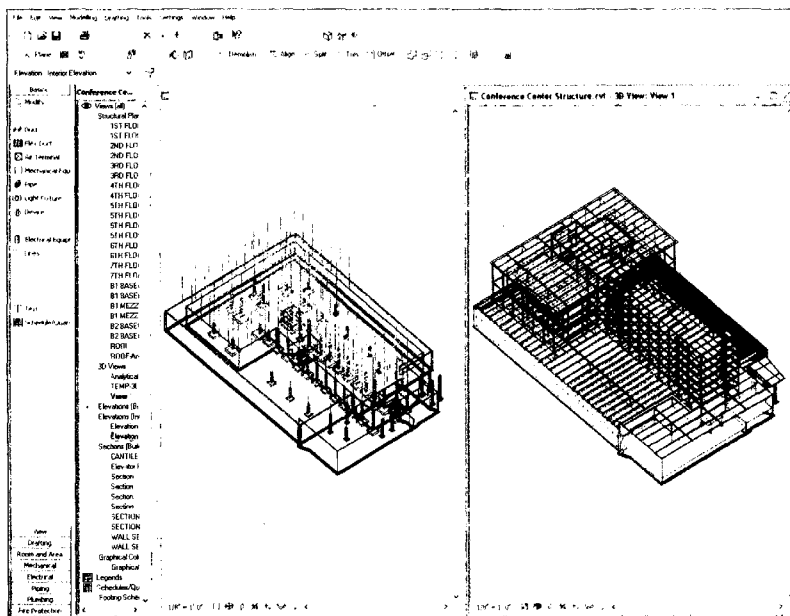
The CAD world is attempting to get to the same point in engineering where we model information for a building, a subdivision, or a machine, and then the entire design process takes place in interoperable digital files. In this world, field instruments for surveyors move data into design software with no transposition or data input at all. And the drawings that we ultimately have to produce for documentation purposes essentially fall out at the end of the design process, like the MP3 file that finally made it onto our laptop.

While this method of work is unfamiliar to most engineers, it is now possible, and it's used in more companies every year. In fact, in product-design environments, holistic shapes that defy classical dimensioning are increasingly produced directly from mold/surface design software and uploaded to machine tools without the need of a single paper print. In these cases, a dimensioned print simply doesn't exist, as there's no need for it. As a bonus, the actual dimensions of the parts are transferred to the machines that make the parts without error or tolerancing build up that would be present in manual machining environments.

As more surveying instruments, digital measuring tools, scanners, printers, and machine tools interface with these new 3D design information standards, it will be easier and easier to maintain the entire design process in computer files with just a printout for presentations or for checking purposes. Like the MP3 file and iPod example, there's just no more reason to have design information in anything but digital form.

Computing Power!

Now that software is doing more, "thinking" more, analyzing more, and creating visual



AUTODESK'S REVIT MEP IS A DESIGN AND DOCUMENTATION TOOL USED BY MECHANICAL, ELECTRICAL, AND PLUMBING ENGINEERING DESIGN TEAMS. IT IS BASED ON AUTODESK'S PLATFORM FOR BUILDING INFORMATION MODELING.

representations of your designs, this software is ravenous for computing power. And the hardware designers at Hewlett-Packard Co., Dell Inc., and Alienware Corp., to name a few, are obliging with computers that sport anywhere from two to eight central processors and up to 16 gigabytes of RAM—as much as a decent-sized laptop hard drive contained four years ago.

And as this level of hardware becomes widely available and affordable, the software companies will create software programs that can take advantage of the multiple processing architectures. In fact, the power requirements of these new software platforms are so pronounced that high-end hardware will now be assumed and buying new machines every 24 months will be the norm. Gone are the days of running the old single processor machine for another year—unless you just enjoy watching your engineers sit at machines that grind away in slow motion.

Summing Up

Recent trends in the CAD industry clearly point toward a more virtual-engineering design environment that will require engineers to embrace 3D CAD and analytical tools. It seems equally clear that those engineers who capitalize on these tools first will produce more cost-effective designs, and thus find themselves in more demand and less likely to become professionally obsolete.

Now that you've seen some of what's new, what will you do to upgrade your skill set and secure your future? Whether you're a mechanical, civil, electrical, or any other sort of engineer, these new CAD tools will either change the way you work or leave you behind, just like 2D CAD did to the drafting board. **PE**



Robert Green is a CAD consultant who works with a variety of clients throughout the U.S. and Canada to implement custom CAD tools. You can contact him through his Web site, www.cad-manager.com.

Web Links

Alienware: www.alienware.com

Autodesk Inc.: www.autodesk.com

Bentley Inc.: www.bentley.com

Dell Computer: www.dell.com

Hewlett-Packard: www.hp.com

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