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July 2019

Digital Transformation Stalled?

Simulation Data Silos

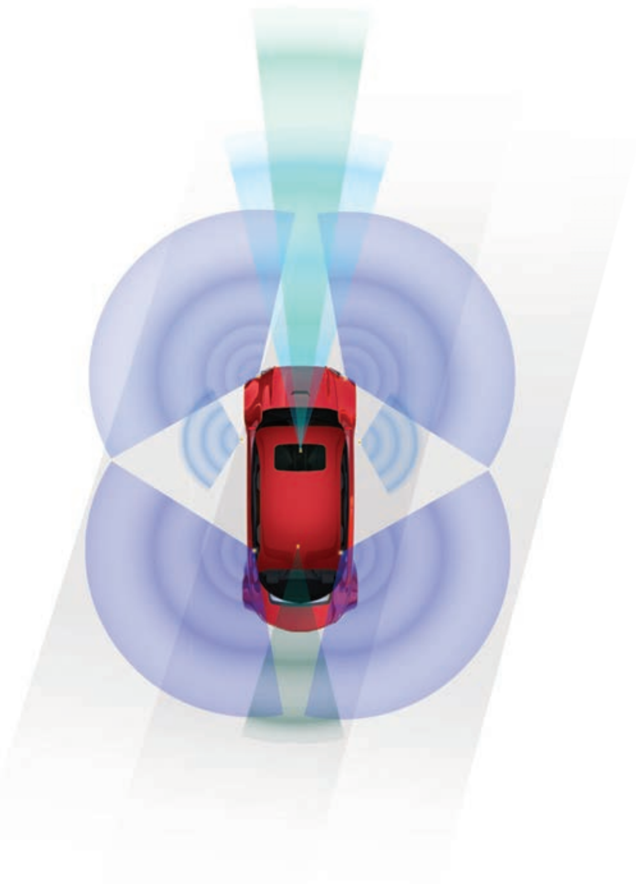
DRM for Additive Manufacturing

WHAT'S WRONG?

More tech, more data, more problems.

REVIEWS:

- AutoCAD 2020
- CorelCAD 2019
- Rhino 6



by Jamie J. Gooch

Software is Still Hungry

IN 2011, software pioneer Marc Andreessen wrote an essay titled "Why Software is Eating the World," which was published in *The Wall Street Journal* and met with much agreement among the technorati and established businesses at the time. It was one of the first highly publicized arguments that the relatively "new" technology companies were not only here to stay, but here to disrupt the old guard with software.

I hesitate to follow his "eating the world" analogy to its inevitable digestive end. What would that eventually make the world? Still, there's no arguing with the fact that software is a critical competitive advantage for companies and the products they create.

As Andreessen wrote eight years ago: "Over the next 10 years, the battles between incumbents and software-powered insurgents will be epic." Indeed they are, with some incumbents being acquired—or simply made obsolete—others acquiring the insurgents, and some still battling.

A similar fight is being waged at the product level, with mechanical and electrical engineers being overrun with requests for more and more software integration. But that war can't be won with acquisition. There simply isn't enough talent to acquire.

Andreessen noted the skills gap as a challenge in 2011, saying every company he works with is "absolutely starved for talent," adding to his culinary metaphors. Perhaps he was writing on an empty stomach. "This problem is even worse than it looks because many workers in existing industries will be stranded on the wrong side of software-based disruption and may never be able to work in their fields again," he continued. "There's no way through this problem other than education, and we have a long way to go."

Adding to the Menu

At the Siemens Realize LIVE event in Detroit last month, the CEO of a software company took the stage to explain an alternative solution to the long, slow approach of educating more software coders. Derek Roos, CEO of Mendix, said large enterprises were facing a "huge crisis" as they try to integrate software and embrace digital transformation.

Software engineers don't speak the same language as other engineers, much less colleagues outside the engineering department. That makes integration a difficult task with no obvious solution. Looking beyond the obvious led Roos and his team on a path to bridge business, engineering and IT.

Their idea was to create a visual software language anyone can understand, which would not only solve the communication gap, but help address the software developer resource issue. "That's what we set out to do," he said. "That's what became the Mendix platform."

Mendix was acquired by Siemens AG less than a year ago, and the company has already begun integrating Mendix's low-code solutions into its software, specifically MindSphere. Mendix for MindSphere promises to make it faster and easier to develop industrial Internet of Things apps, allow more people to participate in the process, and enhance business and IT collaboration. That seems like just the tip of the iceberg.

Eat with Your Eyes

Many mechanical and electrical engineers already know how to code somewhat. But writing a subroutine for a specific issue in your own work is a far cry from developing software that will be deployed in a system or a consumer-facing app.

Those who don't want to end up "on the wrong side of software-based disruption," as Andreessen put it, would do well to look into low-code software development platforms. Mendix and its competitors promise to make some software development tasks as easy as dragging and dropping visual representations of what you want software to do in the order you want it to do them.

Like templates and apps that make complex simulation tasks easier for non-experts, low-code/no-code software development solutions are facing the same questions. Are we 'dumbing down' critical tasks? Who creates (and checks) the automated approach? Education is one solution, but developing technology to solve the challenges of new technology is another. Either way, those challenges are being addressed one bite at a time. **DE**

Jamie Gooch *is editorial director of* Digital Engineering. *Contact him via jgooch@digitaleng.news.*

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Digital Engineering

TECHNOLOGY FOR OPTIMAL ENGINEERING DESIGN

INSIDE

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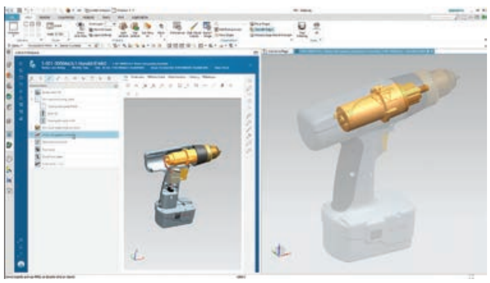

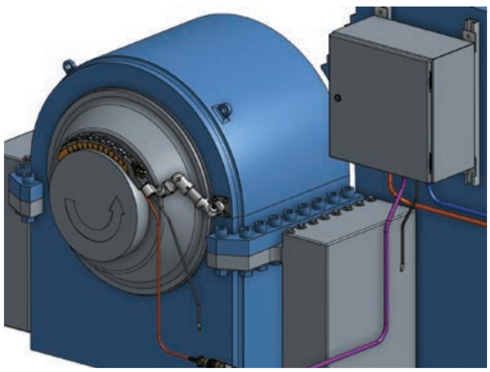

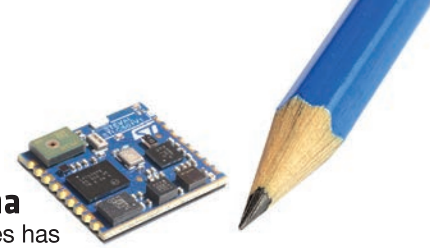

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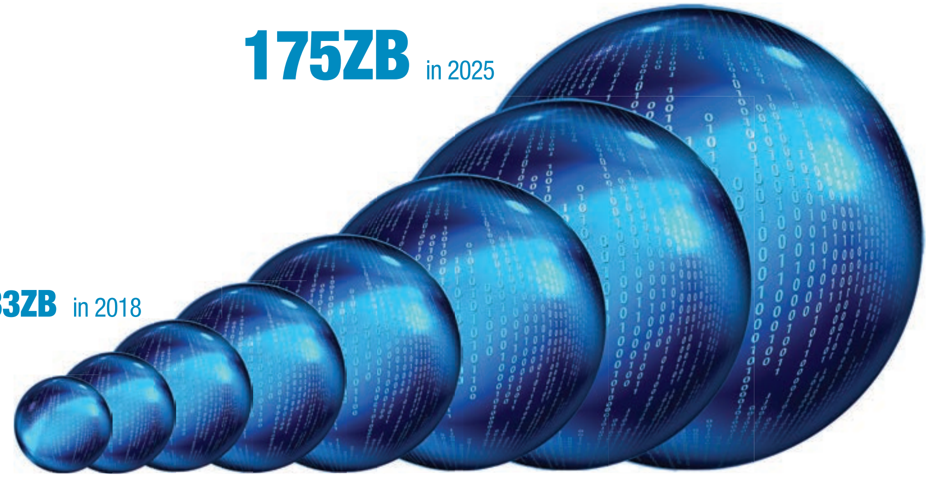
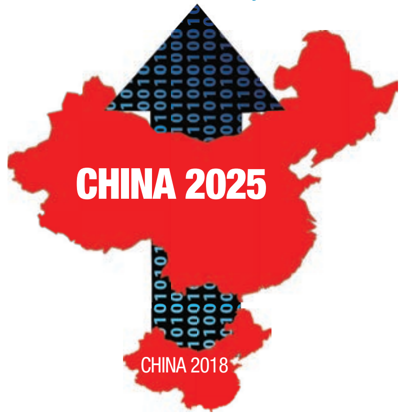
Data's Sphere of Influence

175ZB in 2025

33ZB in 2018



30% by 2025



The Global Datasphere will grow from 33 zettabytes in 2018 to 175 zettabytes by 2025. One zettabyte is equivalent to a trillion gigabytes.

— "Data Age 2025," sponsored by Seagate with data from IDC Global DataSphere, November 2018

China's Datasphere is expected to grow 30% on average over the next 7 years and will be the largest Datasphere of all regions by 2025 (compared to EMEA, APJxC, U.S., and Rest of World).

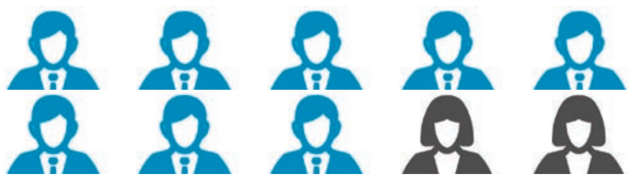
— "Data Age 2025," sponsored by Seagate with data from IDC Global DataSphere, November 2018

256% Data scientist job postings as a share of all postings on Indeed.com jumped 31% in December 2018, year-over-year. Since December 2013, data scientist postings have increased 256%.

— "Data Scientist: A Hot Job That Pays Well," January 17, 2019, Indeed.com

88.3% Data engineer is the top tech job posting on Dice.com, with an 88.3% increase in postings over the past 12 months.

— "Data Engineer Remains Top In-Demand Job," Dice, June 4, 2019



18% of data scientists are women, and 11% of data teams have no female members.

— 2019 Data & Analytics and Diversity Report, Harnham Inc., January 2019

Data in the Cloud

49% of the world's stored data will reside in public cloud environments by 2025.

— *"Data Age 2025," sponsored by Seagate with data from IDC Global DataSphere, November 2018*

Worldwide Cloud Services	Billions of Dollars				
	2018	2019	2020	2021	2022
Cloud Business Process Services (BPaaS)	45.8	49.3	53.1	57.0	61.1
Cloud Application Infrastructure Services (PaaS)	15.6	19.0	23.0	27.5	31.8
Cloud Application Services (SaaS)	80.0	94.8	110.5	126.7	143.7
Cloud Management and Security Services	10.5	12.2	14.1	16.0	17.9
Cloud System Infrastructure Services (IaaS)	30.5	38.9	49.1	61.9	76.6
Total Market	**182.4**	**214.3**	**249.8**	**289.1**	**331.2**

17.5% Public cloud revenue will grow 17.5% in 2019 to a total of $214.3 billion, with infrastructure services being the fastest-growing segment of the market at 27.5% growth.

— *"Forecast Analysis: Public Cloud Services, Worldwide," Gartner, April 2019*

Data for Dollars

The global Internet of Things data management market is expected to reach approximately $94.47 billion in 2024, growing at a compound annual growth rate (CAGR) of slightly above 19.51% between 2018 and 2024.

— *"IoT Data Management Market by Solution, by Deployment and by Application, 2017-2024," Zion Market Research, Aug. 31, 2018*

| MAKING SENSE OF SENSORS |

IOT MEMORY

By Tom Kevan

NAND Flash Finds a Home in the IoT

THE INTERNET OF THINGS (IoT) presents design engineers with a new set of challenges. These range from the need for specialized operating systems to dealing with extreme constraints on power consumption and form factor.

As inherent as its demand for new processor architectures, the IoT also requires designers to deploy fast, flexible and inexpensive memory to address the challenges for data-heavy use cases. As a result, development teams have begun turning to a form of non-volatile memory (NVM) called NAND flash.

Developers usually relied on volatile memory for primary storage when the memory frequently interacted with a system-on-a-chip, a practice that relegated NVM to secondary/mass storage applications. This rule of thumb, however, appears to be changing.

Advances in the technology now let NAND flash memory offer faster throughput, greater flexibility and better price points per byte, opening the door for its use as primary storage. All of these factors seem to be positioning the technology as a competitive option for IoT applications involving the collection and analysis of mass data pools.

Density vs. Endurance

NAND flash memory comes in various formats, defined by the number of bits that can be stored in a single cell. For example, a single-level cell stores 1 bit of data; multilevel cells (MLC) can store more than a single bit of information. The market also offers triple-level (TLC) and quad-level cells. Pushing the technology to the next level, chipmakers have begun offering 3D NAND devices in MLC and TLC formats. These new architectures stack storage elements in as many as 96 layers, offering capacities ranging from 128 MB to 2 TB.

NAND flash technology offers designers a number of density options, which enable developers to tailor their designs to meet application requirements. Trade-offs come into play, however, when designers try to strike the right balance between cell endurance and cell density. Here, the guiding rule of thumb is that the higher the cell's density, the lower its endurance.

The Problem with Frequent and Random Writes

Although NAND flash technology's flexibility and ability to handle data-heavy IoT applications holds great appeal, engineers also must factor its limitations into design deliberations. One such issue involves the frequency and manner in which users access and read/write data to memory. These factors impact NAND devices' endurance.

The underlying factor is that NAND flash differs from other memory technologies in that users cannot reprogram or write data to NAND devices at the individual byte level. The technology's architecture dictates that the storage elements be read and programmed only in pages. At the same time, these storage devices can be erased only in blocks. During this process, the block must be completely erased before it can be reprogrammed.

Because of the way these processes work, the engineer must be aware of the types of data in play, the order in which the data is read and the frequency that writes occur.

For example, log files captured from sensors can be numerous and are typically read/written in no particular order. Frequent and random writing of small data files reduces endurance and can eventually lead to failure.

A countermeasure for this condition is wear leveling. This evens out the erase count of all blocks, essentially leveling the wear across the entire flash storage device and extending its life expectancy.

Avoiding Data Loss

Overwriting, moving and deleting data are not the only operations that can give designers headaches. The frequent reading of memory block data can trigger threshold voltages in unread cells in the same block that shift the data to different logical states. These read disturb errors can cause data loss if the errors exceed the error-correcting code (ECC) threshold.

Fortunately, high-grade NAND flash memory typically includes read leveling and ECC that mitigates these problems.

NAND developers aim to extend its advantages by further reducing the cost per bit and increasing maximum chip capacity. They hope to make flash memory competitive with magnetic storage devices like hard disks. DE

Tom Kevan *is a freelance writer/editor specializing in engineering and communications technology. Contact him via de-editors@digitaleng.news.*

ROAD TRIP

Engineering Conference News

Behind the Scenes at Materialise in the Midwest

BY STEPHANIE SKERNIVITZ

MATERIALISE, a software developer and 3D printing company, hosted a meet-and-greet and factory tour at its facility in Plymouth, MI, on May 19, the night before RAPID+TCT 2019 in downtown Detroit.

Several dozen customers and partners of Materialise, including Siemens and Stratasys, along with the press, visited to get an insider's look at what's happening at the company's Midwest location, in operation since 2009. Materialise, headquartered in Leuven, Belgium, also operates facilities in 17 other countries, and has another U.S. operation in nearby Ann Arbor.

Materialise's products include software, medical applications of 3D printing, and stereolithography (SLA) and selective laser sintering (SLS) 3D printers for manufacturing. The industries it serves span everything from aerospace, architecture, art and automotive to consumer goods, eyewear, healthcare, machinery and service bureaus/contract manufacturers. In Plymouth, the focus is on medical production and sales/marketing for Materialise software for additive manufacturing and medical applications.

On this night, the focus was "3D in the D," accentuated by the "Built in Detroit" theme underpinning the evening's highlights.

Kicking off the Event

Bryan Crutchfield, vice president and general manager of Materialise North America, opened the evening with a Materialise highlights video, followed by some Detroit city history that set up

CEO and Founder Fried Vancraen shared his insights on the state of 3D printing and Materialise's role in the future of additive manufacturing.

Materialise Founder and CEO Fried Vancraen's insights on the current state of 3D printing and Materialise's role in the future of additive manufacturing.

"Build an organization built to last," Vancraen said. "This company is built on the core strong foundation of core competencies. We are always asking: What can we do in a meaningful way with these technologies?"

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RAPID+TCT 2019 Steers AM to Next Level

BY STEPHANIE SKERNIVITZ

The RAPID+TCT 2019 annual conference and trade show, produced by SME, convened on May 20-23. Several thousand attendees and 400-plus exhibitors had access to more than 100 additive sessions in the Motor City of Detroit, home to GM, Ford and Chrysler.

Though autonomous vehicle technology and 3D printing's role in automotive surfaced as relevant topics at the show, the auto sector was just one focal point among many on the 3D printing landscape being discussed at the event.

"This event is an annual celebration of additive manufacturing and the achievement and dedication of this community," SME President Mark Michalski said in his opening remarks. "In just one generation, this technology has moved from a product in concept to mainstream adoption."

In 2019, the buzzwords and ideas floating across the exhibit hall and threaded throughout the daily sessions included design for additive, mass customization, connectivity, partnerships, AI, nanoparticle jetting, the digital manufacturing transformation, data management, metal injection molding, industry 4.0, simulation-driven design, the renaissance of manufacturing and much more.

The event kicked off with a collaboration between Carbon and Riddell to create customized PrecisionFit football helmets via 3D scanning and 3D printing.

RAPID+TCT panel on Trends in Additive Manufacturing included leaders from Ford, Honeywell Aerospace, Jabil and Siemens.

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WHAT'S WRONG?

Looking for answers at the intersection of technology, process and business.

BY KENNETH WONG

THE FORD PINTO CASE, often cited in business ethics classes, is a piece of automotive history the carmakers would like to forget—but is important for consumers to remember. The car, as it turned out, had a fatal design flaw. Though technically it adhered to the industry standards at the time, the fuel tank's position made it prone to ruptures and leakage in rear-end collisions.

The defect became public in two landmark lawsuits: *Grimshaw v. Ford Motor Company and State of Indiana v. Ford Motor Company*. Subsequently 177 more cases were filed.

Tragic in themselves for the loss of lives and injuries involved, the cases also exposed something else. "Ford knows the Pinto is a firetrap … Ford waited eight years [to address the defect] because its internal 'cost-benefit analysis,' which places a dollar value on human life, said it wasn't profitable to make the changes sooner," reports Mark Dowie in his Pulitzer-winning exposé "Pinto Madness" (*Mother Jones*, September 1997).

It's one thing to miss a mode of failure, but quite another to find it and then miss the chance to fix it. For its economics-driven decision, the carmaker ultimately paid a much steeper cost in the erosion of consumer trust, negative brand image and punitive damages in litigations.

The technologies to identify and address different modes of failures have become much more robust, especially in the simulation-driven automotive sector. But the tug-of-war between profit margins and sound design decisions continues, and the process to eliminate blind spots in systems engineering remains incomplete. Beyond the automotive sector, engineering examples include the Samsung Galaxy Fold's cracked screen and the grounded Boeing 737 Max. Potentially brand-breaking product failures continue to make headlines. It suggests, somewhere in the design processes and decision-making practices, certain essential components and safeguards are still missing, making consumers vulnerable to a repeat of the Pinto madness.

Production versus Recalls

According to Allianz Global Corporate & Specialty (AGCS), a corporate insurance carrier operating in 34 countries, "More cars were recalled than ever before in the U.S. during 2016—the third year in a row this phenomenon has occurred. According to the National Highway Traffic Safety Administration (NHTSA), 53.2 million vehicles had to be returned—over three times as many as during 2012 (16.5 million). This trend is mirrored across Europe."

The data from the International Organization of Motor Vehicle Manufacturers (OICA) shows, in the last decade, U.S. car production for passenger and commercial models has increased 31%. In the same period, worldwide car production increased by 35%. But a similar increase is also shown in the number of compliance- and defect-associated recalls issued by the NHTSA. The U.S. agency's published numbers indicate an increase in recalls by 33% between 2008 and 2018.

Carmakers sometimes voluntarily recall their products when they discover risky flaws and defects. NHTSA described them as "uninfluenced recalls." Carmakers may also be ordered to issue a recall by the NHTSA, or prompted to do so when NHTSA launches an investigation. The agency calls them "influenced recalls." The data from NHTSA's 2018 annual report listing recalls from 1999 to 2018 shows a rise in voluntary recalls, while indicating a decrease in influenced recalls.

"Tougher regulation and harsher penalties, the rise of large multinational corporations and increasingly complex and consolidated supply chains, the socio-economic landscape, increasing threat of litigation, technological advances in product testing, as well as heightened consumer awareness—and growing use of social media," says ACGS, "are just some of the contributing factors, which means product recall exposures have increased significantly over the past decade."

> **"I think proper systems engineering would have allowed us to identify and avoid many of these failure modes."**
> – Keith Meintjes, CIMdata

The Promise of Systems Engineering

Keith Meintjes, a CIMdata fellow and executive consultant, is a veteran of the auto industry. Before becoming a consultant and industry analyst, he spent three decades at GM as a simulation manager, and then managed the automaker's global CAEIT infrastructure. For him, many of the headline-making product disasters can be summed up as the failure to identify a failure mode.

"We also have a failure to deliver on the promises of systems engineering," says Meintjes. "I think proper systems engineering would have allowed us to identify and avoid many of these failure modes."

With systems engineering, products are simulated and tested with all the disparate components included at the systems level. That means testing is done with mechanical, electrical and software components all in the loop. The last two pieces—electronics and software—take on more critical roles as Internet of Things (IoT) devices increasingly rely on sensors and software to trigger and execute functions powered by chips and processors. Some failure modes may not be uncovered during the individual component's testing, because it's triggered by the interplay between the electromechanical parts and the control software. Systems-level simulation and testing could expose such failure modes.

This June *The New York Times* published an article examining the root causes of the two fatal Boeing 737 Max crashes ("Boeing Built Deadly Assumptions Into 737 Max, Blind to a Late Design Change," Jack Nicas, Natalie Kitroeff, David Gelles, James Glanz, June 1, 2019). "The current and former employees point to the single, fateful decision to change the system, which led to a series of design mistakes and regulatory oversights," the reporters write. "As Boeing rushed to get the plane done, many of the employees say, they didn't recognize the importance of the decision. They described a compartmentalized approach, each of them focusing on a small part of the plane. The process left them without a complete view of a critical and ultimately dangerous system."

Systems engineering as a concept has been around for quite some time, but most of the software supporting the process began to appear about two decades ago. Though engineering and manufacturing communities have shown a growing interest in them, they haven't embraced the tools widely.

The reason? "It's the complexity of the tools," says Meintjes. "Tools like SysML [open source environment to model systems] are not executable, very difficult to use and require a large number of people at the end user companies to understand it."

Software for MCAD, ECAD and simulation address subassembly and electronic component testing and simulation, but not at the systems level. Tools like SysML give users a way to map out the interconnections between various components, but the diagram works more as a visual representation, less as an executable digital replica of the system. Vendors such as PTC, Dassault Systémes, Siemens PLM Software and others have begun to introduce digital twin solutions as a way to fill the gap in systems-level design.

Do You Know What to Look For?

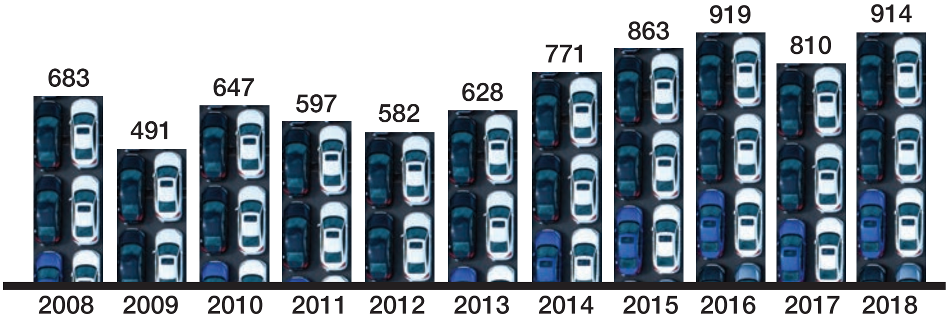
In 2007, NHTSA investigated two separate crashes involving a Lexus and a Camry. They both seemed to stem from stuck pedals that robbed the drivers of vehicle control. At the conclusion of its investigation, the U.S. safety agency put the blame on an all-weather floor mat, which caused the pedal to stick.

In its public records of the incidents, the U.S. Department of Transportation states, "The two mechanical safety defects identified by NHTSA more than a year ago—'sticking' accelerator pedals and a design flaw that enabled accelerator pedals to become trapped by floor mats—remain the only known causes for these kinds of unsafe unintended acceleration incidents." Following the findings, carmaker Toyota recalled 8 million vehicles in the U.S. to address the floor mat issue.

Under normal circumstances, CAE engineers might not have considered such a mode of failure as a possibility to verify and test. Even in systems engineering, it is doubtful those in charge would have thought of adding the dimension, texture and orientation of the floor mat into the overall simulation scheme to see if a problem could occur.

"Unless you are looking for this mode of failure and you specifically

Auto Recalls



Voluntary (uninfluenced) and mandated (influenced) automotive recalls in the last 10 years, based on NHTSA's annual figures. In the same period, worldwide car production increased by 35%. *Source: NHTSA. Image courtesy Michael H./Getty Images.*

The launch of Samsung's Galaxy Fold was put on hold this year after the folding screens failed in the hands of early reviewers. ***Image courtesy of Samsung.***

model it for testing, there's no way you would have captured it," says Marc Halpern, VP analyst, Gartner. "It would be a good safety exercise for carmakers to look at the various modes of failures listed at the NHTSA's site, then simulate them with their own products. And if you're a medical device maker, you should do the same by looking at public recall data from the FDA."

Take, for example, the well-publicized case of faulty Takata airbag inflators. At least 24 deaths and 300 injuries worldwide have led to the largest ever recall campaign. NHTSA says the root cause the use ammonium nitrate-based propellent in airbags without a chemical drying agent. Related settlements have cost automakers more than $1 billion so far.

People are generally more accepting of accidents that are caused by human error than those caused by errors in engineered systems, says John Browne, the author of "Make, Think, Imagine: Engineering the Future of Civilization" (August 2019, Pegasus Books). "Experts I spoke to while researching my book estimate that the public is only likely to welcome autonomous cars onto our roads when they are around 1,000 times safer than human drivers," he says. "This raises the bar considerably for safety and calls into question the validity of today's dominant testing regimes."

With higher expectation comes the need for new methods to detect and prevent failures in the era of autonomous car. "New proposals are being made for better ways forward, including Intel Mobileye's intention to build a logical mathematical framework that defines what situations on the road are dangerous, and ensures that autonomous automobiles will never make decisions that cause those situations to arise. It remains to be seen whether this promising idea will work in practice," Browne adds.

Calling for Robust Design

Once considered a good cautionary measure and safeguard against unanticipated failure modes, overengineering is now a dirty word, a design sin. In the era of lightweighting and fuel economy, the preference is to design products, parts and components to be as light and thin as possible. But could this trend be making products vulnerable to unforeseen failures?

Lightweighting by itself is not an issue, assuming it's looked at as part of the whole system when optimizing, says Halpern.

"The optimum should not be set at the cliff's edge of a failure," says Meintjes. "The solution is robust design, which ensures the product won't fail due to variable usage or manufacturing quality. In addition, it should also ensure the product's responses don't change drastically due to variations in usage or operating conditions."

In other words, the benchmark for optimization should be much more than the product's ability to merely survive normal wear and tear and routine use. The so-called "optimal design" should retain sufficient structural muscles to survive occasional misuses, accidents and failure modes yet to be uncovered.

Digital Technologies, Non-Digital Culture

Joseph Anderson, president, Institute for Process Excellence (IpX), believes CM2 makes a huge difference in reducing product failures. In the business management lexicon, CM2 means configuration management at the enterprise level rather than the subgroup or workgroup level. Whereas the engineering-centric vantage point focuses on the product, the CM2-empowered enterprise vantage point encompasses product, system and services.

Reflecting on the recent high-profile recall cases, he said, "a common theme is, they stem from a lack of enterprise change management and configuration management processes. The majority of these companies still work in silos; they tend to view things from a silo and legacy vantage point."

Part of CM2 is knowledge management, a critical mission for the manufacturing sector where the retiring veterans have intuitions and knowledge not formally recorded in any enterprise resource planning (ERP), customer relationship management (CRM), or product lifecycle management (PLM) systems.

"The day-to-day practical concerns of a business are learned over time," says Anderson. "You have to capture that knowledge and transfer it to the up-and-coming workforce. New employees may have the technical know-how, but they lack the experience. That could lead to recognizing an issue only when the product reaches the field or catching it only in the nick of time."

Catching a fatal design flaw in the nick of time usually presents a dilemma. With tooling and molds already fixed and orders waiting to be fulfilled, implementing a remedy comes at considerable cost and penalties. This is where the ethics of a manufacturer will be put to the test: Release a flawed product and hope that it won't fail in the field? Or fix it at a high cost?

"Releasing something dangerous is always unacceptable," says Browne. "It is vital that engineers consider both the intended and unintended consequences of the products they create. To create a world without risk would be impossible and counterproductive, but there is a great responsibility to manage that risk."

Crash and Burn in the IoT Era

In 2016, reported cases of battery fire and explosion in the Samsung Galaxy

> **"Many of these cases stem from the pressure to get a high-quality product to the market on time to make a profit."**
> — Stephen Bailey, Mentor

Note 7 prompted Samsung to suspend sales of the model and recall it. The cellphone maker's remedy was to replace the units the consumers had turned in with new units that supposedly addressed the battery hazard. But the replacement units themselves continued to exhibit a tendency to catch fire, prompting a second wave of recall. In the same year, Sony also recalled Sony VAIO laptops and Hoverboard LLC recalled its self-balancing scooter/hoverboard. In both cases, the culprit was the fire hazard of the lithium-ion battery pack.

Collectively, the cases were a wakeup call for the Consumer Product and Safety Commission (CPSC), which regulates and monitors consumer products, ranging from gym equipment and home furniture to electronic toys and communication devices.

In his public statement summing up the Samsung Galaxy Note 7 recall, CPSC Chairman Elliot F. Kaye noted: "In the aftermath of massive hoverboard and smartphone battery recalls, we added to the CPSC's 2017 operating plan a project for our technical staff to assess the state of high-density battery technology, innovations in the marketplace, gaps in safety standards and the research and regulatory activities in other countries."

"The lithium-ion battery has delivered many benefits to us, but it's also tricky to manage," says Stephen Bailey, director of strategic marketing, Validation Systems Division, at software provider Mentor, a Siemens business division. "You have to make sure the cell doesn't get damaged. You also need to prevent the cell from overheating. You have to figure out how it gets charged and how the heat dissipates."

In an IoT device's small form factor, the cell sits close—perhaps too close, in some cases—to nearby electronics components, causing fire hazard during charging and usage. These issues will likely intensify with the arrival of 5G, with demand for more power to perform connected activities in the background even when the device seems idle.

Just as the Galaxy Note 7 mishap was fading from the tech consumers' memory, Samsung once again ended up under the glaring spotlights of negative press. The Samsung Galaxy Fold, released this February, quite literally cracked when folded.

In the review aptly titled "Broken Dream," The Verge writer Dieter Bohn quipped, "The future is very fragile."

"Smartphone makers need to test their products under all the operating conditions, [and] do destructive tests to find out where the limits are," suggests Bailey. "But the pressure to be the first to go to market with a new kind of product is huge, so some make the mistake of rushing a product to the market. Besides, testing a game-changing product is difficult."

To uncover all the possible failure modes in an innovative product, a smartphone maker should let beta testers use the early units for a good amount of time in daily routines. But in the era of Instagram and Facebook live feeds, such a test comes with the risk that the prototype's form factor, functions and even design details potentially ending up on social media.

Connect at Your Own Risk

But hazard in the IoT era is not restricted to poor design and overheating batteries. Due to their connected nature, the devices invariably invite cyberattacks. In its June 2018 comments submitted to the CPSC, the Center for Democracy and Technology (CDT) writes: "While there is no doubt that the IoT presents enormous value, poorly designed and inadequately secured devices can present risks to consumers' safety and can be exploited for costly cyberattacks."

For example, in 2017, the radio frequency (RF)-enabled St. Jude Medical implantable pacemaker was found to be vulnerable to hacking, prompting a voluntary recall of 465,000 units of the product. The manufacturer later issued a software patch to close the security loophole, according to FDA records of the case ("Firmware Update to Address Cybersecurity Vulnerabilities Identified in Abbott's Implantable Cardiac Pacemakers: FDA Safety Communication," August 2017).

Err on the Side of Safety and Humanity

As the Ford Pinto case reveals, sometimes design decisions are overruled by economic concerns. Modern technologies and processes can help manufacturers identify and spot many more failure modes than before, but remedies come at a cost. The later the flaw is discovered, the more expensive the remedy will likely be.

"Many of these cases stem from the pressure to get a high-quality product to the market on time to make a profit," says Bailey. "If you have a good product but miss the market window, or if it's too expensive, then you won't succeed as a company. Humans are not infallible, so sometimes they make the wrong choice. With IoT devices, if you make the wrong choice, you may be looking at lawsuits; your reputation may suffer; but the consequences are far worse in aerospace or automotive."

Meintjes warns that manufacturers shouldn't gamble with consumer safety. "It's dangerous and unethical to compare the cost of a human life with the cost of design decisions," says Meintjes. "If your product has a failure mode that can kill or even harm people, you should design that failure mode out." **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.*

INFO → **Allianz Global Corporate & Specialty:** AGCS.allianz.com

→ **Consumer Product Safety Commission:** CPSC.gov

→ **National Highway Traffic Safety Administration:** NHTSA.gov/recalls

→ **CIMdata:** CIMdata.com

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→ **International Organization of Motor Vehicle Manufacturers:** OICA.net

→ **Institute for Process Excellence:** IPXHQ.com

→ **Center for Democracy and Technology (CDT):** CDT.org

Stuck in Neutral?

Engineering has an appetite for new technologies to digitally transform, yet traditional silos and culture remain obstacles to large-scale success.

BY BETH STACKPOLE

AUTOMAKERS ARE ACCELERATING development cycles by 3D printing prototype parts and tooling in lieu of traditional manufacturing processes. In the aerospace sector, players are leveraging the Internet of Things (IoT) to collect a vast array of sensor data to help proactively flag potential part failures or to determine when an engine is due for routine service. Even slower-moving industries like shipbuilding have their sights set on 3D modeling capabilities from simulation to augmented and virtual reality (AR/VR) to shore up and modernize traditional development practices.

Although companies in nearly every major sector have embarked on some leg of the digital transformation journey, there are still countless unexplored routes and many miles to travel. The reality is that despite the drumbeat of press reports and prominent user stories, successful and holistic transformation of engineering and product development processes still remain the exception, not the rule. Newer technologies aside, even product lifecycle management (PLM), the decades-old software platform and business process approach for syncing engineering with relevant stakeholders throughout the lifecycle, has not lived up to its full transformational potential.

Digital twins factor heavily into Team Penske's efforts to transform design and development. *Image courtesy of Team Penske.*

"If you're a product company and you want to do digitalization, then your PLM game needs to be pretty on point, but that's further than most people are," says Stan Przybylinski, vice president of CIMdata. "It's amazing how many companies adopt these core data and process management platforms with lofty goals and most remain stuck in PDM (product data management). Even while vendors add all these new capabilities, the majority of companies are just doing basic blocking and tackling."

Persistent Silos Are a Problem

Compared to other areas of the business like marketing or sales, engineering is more likely to lag behind in the race to digitize core processes—in part because of the complexity of the technology. However, the more acute stumbling block is not with established or even newer technologies, but rather the long-seated cultural norms that promote a siloed approach to workflow and product-related data.

"Most of the time companies get stuck due to organizational stuff," says Przybylinski. "Organizations are not necessarily structured in a way that promotes optimal collaboration. Instead, they are still operating as separate functions."

Engineering's inclination to guard siloed product data and reticence to share work-in-progress design materials are other big hurdles standing in the way of effective transformation.

"With PLM, we see a lot of complaining that others will see into their department or work product, and that comes from a silo mentality," notes Jonathan Scott, chief architect at Razorleaf, a consultancy specializing in PLM and engineering-related implementations. "If you work in product definition, you are supposed to work with people in other domains. You need to be in continuous integration mode where everyone is involved in evolving the baseline. Exposing work should not be viewed in a bad way, but in a good way that lets you move ahead."

In a similar vein, if transformation is all about changing business models (to product-as-a-service, for example) or redefining processes to bolster innovation, organizations need to extend their goals far beyond engineering. Specifically, they need to create a seamless flow of data along with integrated and automated workflows that encompass the full operational lifecycle. That's where the concept of the digital thread comes in.

Much like in the early days of PLM, there is plenty of high-

level posturing about how the digital thread will deliver untold insights and streamline processes leading to more innovative products, predictive maintenance services, even just-in-time, custom manufacturing practices. At the same time, however, there is still a lack of consensus on what the digital thread actually constitutes and far less clarity on how to effectively put the concept into play.

The digital twin, another crucial building block for digital transformation of product development and engineering, is also open to slightly different interpretations depending on the provider or the enterprise. Some vendors, like Dassault Systèmes and Siemens PLM Software, view the digital twin as a full 3D representation and systems model of a product and its behavior, while companies like PTC have a similar view, but associate a digital twin with a very specific, serial-numbered product.

At the same time, there can be glaring gaps of relevant data and loose ends in both the digital twin and the digital thread. For example, companies may have gone as far as to create a digital twin of a product, including collecting usage data while out in the field, but have not yet figured out how to create an effective closed-loop workflow that feeds that data directly back to engineering so it can leverage intelligence for future product iterations.

Similarly, while organizations have made good strides integrating mechanical and electrical CAD data, software development—a critical aspect of most modern-day products—is still often handled in a separate system as is service information. Without the totality of data and a seamless process, the utility of a digital thread is undermined.

"Companies need to focus on how the digital thread connects data used all the way through the lifecycle to generate better decisions and to get upgrades and better products out the door," says Mark Reisig, director of marketing at Aras. "If engineering is focused on one-off projects, they might improve the customer experience, but if they're not connecting processes throughout the end-to-end lifecycle, they are not helping the business."

Beneteau, a French boat manufacturer, is piloting its PLM foundation toward a seamless digital thread of data with the aim of promoting reuse, shortening development time and aiding workers in boat assembly, according to CIO Bertrand Dutilleul. The implementation of PTC's Windchill PLM platform, to take place over the next 18 months, is broken up into three 6-month phases: The first 6 months is focused on creating accurate work instructions for existing boat designs followed by a phase where the team builds a new boat that will be put into production and pushed to the shop floor to build familiarity and confidence with workers in the new digital approach. Once the kinks are hammered out, the digital workflows will be deployed plant by plant.

"It is very important to have a reference plant—the key to success is selecting the right team for your first project," Dutilleul says. "You need an energetic, visionary project leader to establish momentum and provide continued executive sponsorship."

With the core PLM foundation in place, Beneteau expects to evolve its digital transformation efforts over time with new capabilities like augmented reality to better define the product through engineering collaboration, help factory workers with digital work instructions and make it easier for customers to configure their boat designs. IoT will eventually come into play for preventive maintenance and to better understand how the boats are used in the field to inform future design decisions, he explains.

"These use cases are only made possible by first building a solid foundation through PLM," Dutilleul says.

Engineering organizations can get waylaid by focusing on projects that implement sexy new technologies like AR/VR or 3D printing without first taking on the heavier lifting to determine how to create that operational lifecycle view. "Oftentimes, organizations are buying technology with no particular plan," Aras' Reisig says. "They are not looking at the business horizontally and this is where they get stuck."

> **"So many folks in engineering talk in bits and bytes and that doesn't help people to understand what they're talking about. Executives won't fund what they don't understand."**
> – Jonathan Scott, Razorleaf

Beyond integrating siloed systems, a digital transformation effort is also about standardizing and harmonizing processes so everyone is operating from the same playbook. Yet asking people to change behavior and be open to other ways of working is always an uphill change management battle, especially if there aren't overt problems or active pain points crying out for a solution.

"The drive to harmonize processes is typically a company perspective, but engineers doing the work may not be dissatisfied enough, thus are not anxious to change what they do except in incremental ways," explains Mark Taber, vice president of marketing and go-to-market strategy for PTC.

For established companies in well-entrenched markets, transformation and disruption is exceedingly difficult when you have to balance your existing product portfolio and product development practices with incremental improvement. "You're thinking about how you get from here to there, not where you want to be," Razorleaf's Scott explains. "If you have to bring along the baggage of what you're always done, you've got an extra constraint to deal with, and it's a big one."

Guillaume Vendroux, CEO, DELMIA, Dassault Systèmes, agrees. "The projects I see failing never fail for technology reasons. They fail because of change management. That can be avoided. The problem of transformation is likely to happen when a business is not engaged. The business needs to engage. It needs to build digitally minded processes in order to leverage the technology to get the value out of it. I see that on a constant basis."

Best Practices for Change

To break down the silo mentality and thread the needle for seamless digital processes, organizations need to adopt systems engineering practices, including model-based systems engineering. The latter uses models as a framework to represent the shape, behavior and contextual information surrounding a product throughout the design process, across the full lifecycle and spanning all the different technical disciplines.

Beneteau's digital transformation is grounded with a PLM Foundation. *Image courtesy of PTC.*

"Systems engineering helps us see across discipline lines by looking at the design and definition of a product while things are still fuzzy," Razorleaf's Scott says. "Getting everyone in the various disciplines to look up higher in the process is how we become more holistic."

Embracing agile practices, especially as organizations roll out complex initiatives like PLM, is another important milestone, according to CIMdata's Przybylinski. Agile practices can help remove cost and complexity barriers to PLM implementations; however, the shift creates additional challenges.

"The agile methodology allows you make errors and correct them quickly because you learn from the errors," Vendroux says. "This is the reason why people are using agile, even though if you look on paper, it is significantly more complicated to manage and so therefore costs a bit more. But, it's so much more powerful at the end of the day."

Creating a product-centric delivery view as opposed to the traditional functional view also encourages cross-discipline collaboration. This extends to creating multidisciplinary teams internal to engineering but that also cross over to include non-engineering roles in manufacturing or supply chain, for examples.

"You need to create teams with multiple skills that have one common vision for product features," notes Vinod Subramanyam, head of the digital infrastructure practice at Brillio, which specializes in helping companies with digital transformation.

Along with new management and team collaboration structures, enlisting a key executive as a sponsor is critical to getting the necessary buy-in. To do so, engineering management needs to be able to effectively communicate the business case for digitizing processes and investing in new platforms.

"So many folks in engineering talk in bits and bytes and that doesn't help people to understand what they're talking about," Scott says. "Executives won't fund what they don't understand."

At Team Penske, an American professional motorsports organization, the push for digital transformation came from both top down and bottom up. The race team, which has to drive performance year-over-year, but also continuously throughout racing season, adopted an entirely new engineering platform in 2018 based on Siemens PLM Software's NX, Teamcenter PLM and simulation platforms. After a full year of planning, including migrating legacy engineering data, creating system architecture and end-user training, the race team went into overdrive with the new platform, which includes using digital twin methodology such as virtual models and simulation capabilities to quickly iterate and bring new prototypes to life before building any physical products.

"End users have become aware of what's possible with digital models, making their daily tasks more straightforward and allowing them to be more effective," notes Drew Kessler, design engineering manager for Team Penske. "Top management has been pushing for performance increases at a faster rate, which is also enabled by digital methods."

Team Penske plans to integrate Teamcenter Manufacturing with managing build processes to shrink the time between design and manufacturing while refining digital twins. "Having a functional digital twin and using virtual/digital development methods allows us to develop at a rate faster than our competition," Kessler says. "Time to market is critical in motorsports—there is a race on the track every weekend, but between the weekends, there is a race to develop and manufacture new parts."

In the end, however, companies need to remember that digital transformation is a marathon, not a sprint.

"You're talking about people modifying the way they've done things before," says Del Costy, senior vice president and managing director of Siemens PLM Software's Americas' digital industry software division. "Companies that set a vision and see it through end-to-end get great results identifying new business opportunities and driving profitability—and that's the holy grail of transformation." **DE**

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INFO ➜ **Aras:** Aras.com

➜ **Brillio:** Brillio.com

➜ **CIMdata:** CIMdata.com

➜ **Dassault Systèmes:** 3DS.com

➜ **PTC:** PTC.com

➜ **Razorleaf:** Razorleaf.com

➜ **Siemens PLM Software:** Siemens.com/PLM

➜ **Team Penske:** TeamPenske.com

TWO OF A KIND

Exploring how digital twins are shaping our digital fabric and engineering future.

BY JIM ROMEO

IMAGINE IF YOU COULD CLONE your machine, factory, process or device, and operate it before your eyes in real time. If you could monitor, measure and have an accurate, real-time aperture into all facets of a system or equipment, it could lead to a new frontier of operational efficiency. This imagined state is advancing to becoming a more widespread reality thanks to digital twins.

"Digital twins are in an early stage of their lifecycle," says John Renick, GE Digital senior director, Digital Twins. "The market has not congealed on a standard definition or nomenclature of twins; they continue to evolve. Many industry sectors see twins as a way to take advantage of existing data they have and gain new insights.

"In the near term, we can continue to expect to see some confusion in the market and in industry until some standardization is realized," Renick continues. "We will see more customers looking for ways to develop and deploy twins as part of digital transformation efforts."

Even with the tech in the development stage, there is excitement around the concept of the digital twin in many industry sectors. But at present, most organizations are still trying to understand what the concept is and how it might benefit them.

So, What Exactly Are Digital Twins?

There's a lot of talk about them. Companies are opening up new business lines around them. IoT (Internet of Things) rangers are planning on their success. But what exactly are digital twins, anyhow?

"At first, [digital twin] sounds like something from a Factory-of-the-Future display at a trade show where you navigate through a 3D model of a factory with [augmented reality] glasses while a robot with a British accent calmly warns you of a pending explosion," says Michael Kanellos, IoT technology analyst at OSIsoft. "But the bells and whistles aren't necessary.

"A digital twin is merely what occurs when you combine all of the relevant data streams from an asset or facility in a way that allows a technician or engineer see what's going on and solve problems," Kanellos continues. "Think of digital twin as the equivalent of an EKG [electrocardiogram] for equipment or facilities. It takes technology to synthesize and visualize the data, but the technology exists. Data is often there and being collected at facilities. It's just not being fit together so people can understand it and act on it quickly. That's what the digital twin does."

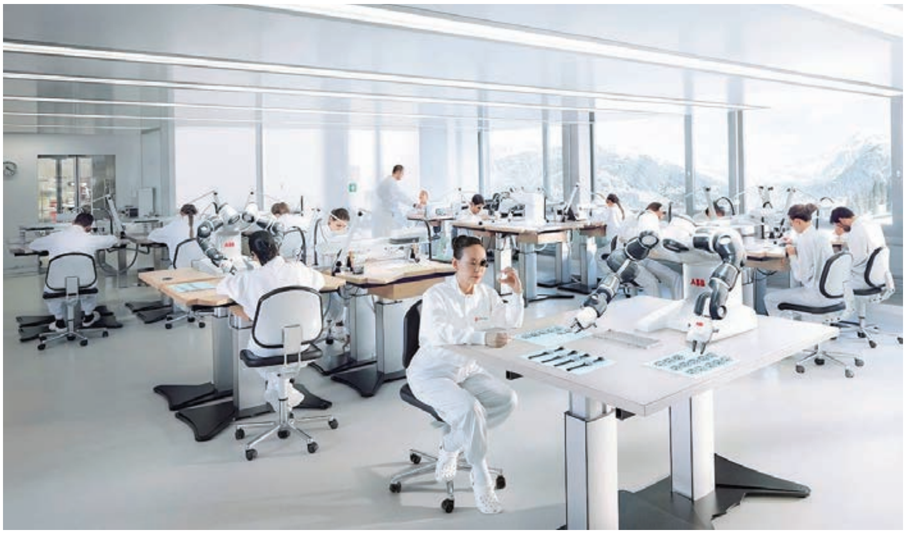
Preventive maintenance is one of the initial digital twin use cases. *Image courtesy of OSIsoft.*

"Digital twins have become particularly attractive to manufacturers with the emergence of IoT technologies," says Cathy Martin, vice president, BigLever Software. "Combined with IoT, manufacturers use a product's digital twin to understand what is contained in that product, track its current status and monitor its use and performance in the field. Digital twins play a significant role in enabling continuous engineering—the ability to dynamically improve products after they leave the factory with updates and enhancements—as well as allowing the manufacturer to more effectively perform predictive and preventive maintenance."

Moving Toward Implementation

Getting started may mean building a team and assigning leaders to move a digital twin effort forward.

"The best way to get started is to research solution providers who offer digital twin capabilities for networks, and implement a POC [proof of concept] on a relatively small portion of the network to test the functionality," says Lisa Garvey, vice president, Forward Networks. "It's wise to make sure your chosen vendor can support all of the various devices in your network—routers, switches, load balancers, firewalls and ensure that their software scales to meet your given size requirements. If you have a cloud/hybrid cloud environment, or specific virtualization and security requirements, look for a vendor who can address that level of complexity."



The factory of the future may rely on digital twins to track data on products and processes. *Image courtesy of ABB.*

This level of complexity, however, requires companies to invest in data. Data is at the core of modeling and building digital twins.

"Investing in the data to accurately model industrial processes is well underway and a big part of the digital transformation of the industry. Just in the past month, I've heard about digital twins that model everything from future electric powertrain factories at Ford, to better understand the breaking point of chocolate from Mondelez (Cadbury)," says Matt Turner, chief strategy officer, Media & Manufacturing at enterprise database company MarkLogic.

Turner adds that just aggregating data and putting it to work isn't always enough. It's all about the integrity of the data and ensuring it's accurate.

"An important factor in realizing the value of these twins is getting the data correct," says Turner. "With good data, when the model is used to greatly reduce development time (in the case of Mondelez) or truly envision a new process (like at Ford), it can be relied on and implemented in the actual physical process. If you don't have an accurate and complete picture of the part, component, product, assembly line and even worker skillset, you won't get the results you're hoping for."

Data Shapes a Virtual Model

The value of digital twins comes from their relation with physical objects and the virtual representation of them. "A digital twin is a powerful proxy, not only for a device, but for its function and relationship to other devices and objects in its vicinity," says Elena Vasconi, senior technologist and business strategist at Itron Outcomes. "Like all things, however, successful adoption of digital twin platforms will depend fundamentally on its design: An intuitive user interface, ready integration with open data sets, libraries of machine learning algorithms and useful reporting and monitoring dashboards."

Vasconi adds that in the longer term, as more cities upgrade and build out their energy, water and smart city infrastructure, digital twin "what-if" scenarios promise to identify and optimize spatial maps of existing, proposed and planned infrastructure enhancements and enable strong justifications to regulators, for example, for investing capital to optimize service to the community.

A Forward Look

Building digital twins is strategic. Firms seek to build operation efficiency with them, but that's the main challenge at this stage, where a lot of organizations are still building up a digital operational strategy.

"In the long term, the ability to implement effective digital twins will be a critical skill in writing the digital future of the automation landscape," says Guido Jouret, chief digital officer at ABB in San Jose, CA. "With an estimated 7.5 billion potential digital twins in global industry right now, there is also high value in making data available from all digital twins across all processes in an open, interoperable and vendor-independent manner."

But Jouret says it's important to keep in mind that the digital twin is just part of the evolution to autonomy. "From my perspective, domain expertise is the 'secret sauce' of autonomy," he says. "Smart and successful industrial companies and their partners have a strong grasp on what works in all sorts of environments and conditions. What will truly accelerate an organization's evolution to autonomy is combining this expertise with the right digital twin technology and ever-smarter AI [artificial intelligence] to maximize business outcomes and optimize operational efficiency." DE

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INFO → ABB: New.ABB.com

→ **BigLever Software:** BigLever.com

→ **Forward Networks:** ForwardNetworks.com

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→ **Itron:** Itron.com

→ **MarkLogic:** MarkLogic.com

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Bringing the Cloud into CAD and Product Data Management

Even as vendors create cloud-based PDM, organizations still face security and interoperability concerns.

BY RANDALL S. NEWTON

IF YOU DO A SEARCH ON THE PHRASE, "engineer hours spent looking for information," you'll find a bunch of reports that riff on the same tune: knowledge workers, including engineers, spend a significant part of their day looking for information.

In recent years, cloud-based product data management (PDM) has been promoted as a way to improve access to information by streamlining and centralizing all product data, whether it is CAD or other file-based data types.

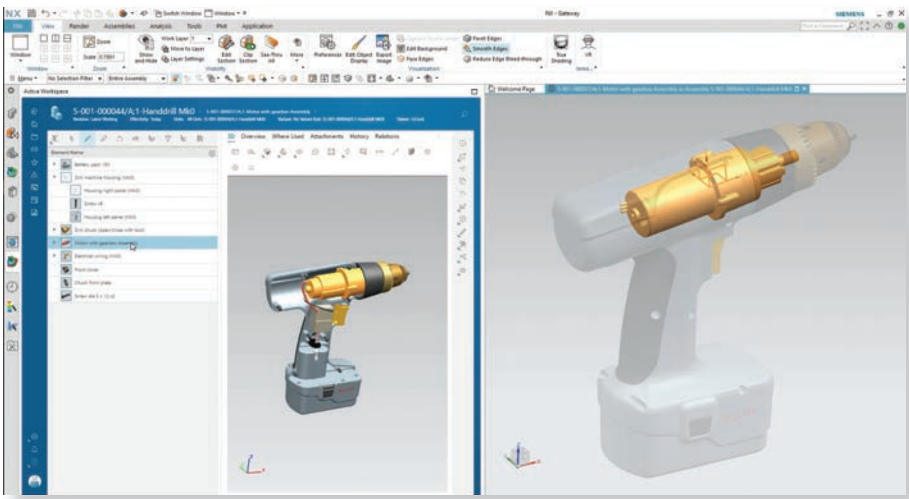
A 2017 study by Jon Peddie Research and Business Advantage says the engineering industry is looking at cloud technology, but for the most part companies were either still kicking tires or otherwise not investing in it.

The report examined both cloud-based CAD technology and cloud-based PDM.

"We believe there is more work that can be done to change attitudes toward CAD in the cloud," the report says. "At many sites, it is a top-down process as company executives opt for the predictability of subscriptions and cloud-based provisioning.

"CAD/CAM/CAE users are at the early stages of cloud-based workflows," the report continues. "Software vendors are confident of the benefits of leveraging the cloud and are developing products for their customers. However, there is a mismatch in definitions and expectations between customers and vendors, causing an adoption delay, but we are seeing customer attitudes change very quickly from entrenched positions to acceptance."

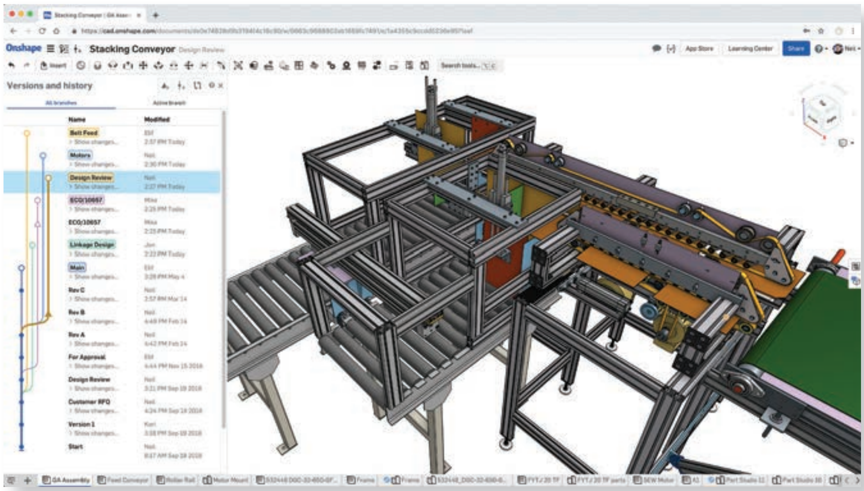
For this article, we are separating PDM from product lifecycle management (PLM) solutions. PDM systems provide deep control of CAD models, whereas PLM systems manage the broad knowledge about product definition and lifecycle issues such as configuration, regulatory management and audits.



Siemens PLM integrates PDM capabilities inside both of its CAD products: NX and Solid Edge. *Image courtesy of Siemens PLM Software.*

"I see a strong adoption for cloud file storage across many companies these days," says Oleg Shilovitsky, CEO and co-founder of OpenBOM, which straddles the boundary between PDM and PLM by providing a cloud-based platform for bill of materials (BOM) and inventory management. "PDM is still far from retirement, and there is no good candidate to replace it."

Shilovitsky sees growing ad hoc implementation of general purpose cloud storage tools including Dropbox, Microsoft OneDrive Enterprise and Google Drive. "The question if PDM systems can leverage this storage is a good one; you can find heated debates about it online," he says.



Onshape saves every change to a CAD model automatically. Version and revision management tools are accessible as needed. *Image courtesy of Onshape.*

Crawling to Cloud Services Adoption

Synergis Software sells Adept, which it describes as an Engineering Information Management platform that includes PDM capabilities. Today, half of Synergis Adept customers are in manufacturing, the other half are in utilities and architecture, engineering and construction (AEC). In 2018 Synergis introduced a new web-based architecture for Adept.

"Today most CAD data is on local networks," says Todd Cummings, the VP of research and development at Synergis. "We are seeing more IT departments hosting infrastructure on the cloud. Instead of purchasing new servers, they rent more space on Azure, AWS, [Amazon Web Services] and others and use hosted apps." Cummings says this gradual migration to cloud services by IT administrators will be a key driver of moving CAD collaboration to the cloud.

Cummings states manufacturers, especially the smaller companies, "are lagging behind other industries in becoming cloud-centric." Despite being "20 years after most of us moved to online banking," manufacturing companies are just now thinking of how to move to cloud-based collaboration.

He still hears criticisms regarding security, despite overwhelming research "that shows data in the cloud is more secure than data on your network," he says.

Cummings sees attitude and institutional biases as a strong factor that continues to impede adoption of cloud-based PDM, as well as generational bias. "As millennials become decision makers, adoption will grow."

He thinks the trend toward CAD and PLM in the cloud is inevitable: "Users expect to be delighted," says Cummings. "The generation who grew up with video games and mobile apps now has a really important voice."

More Than File Storage

Kenesto is a relatively new player in the engineering data space. It was founded by serial CAD entrepreneur Michael Payne as a "power user's document management system," says Leslie Minasian, Kenesto's VP for Partnerships and Alliances. "We don't serve just CAD; we serve anyone generating files ... we serve a PDM-like system."

Minasian also sees the trend of adopting consumer cloud file-sharing products, but thinks they are underpowered for engineering. For engineering Kenesto offers specific versioning and revision functions. "Save a part 100 times and it will appear as one file. Revisions are a snapshot in time, [and] versioning is like a grid of 100 saves. We manage permissions at the file level, and we offer collaboration and control options within a shared folder environment [that's] more complex than consumer products."

Why is adoption of PDM so low? "Peel the onion back and look at industry segments and enterprise size," says Bill Lewis, director of Teamcenter product management for Siemens PLM Software. "The largest companies have data management in place; go down the scale to smaller companies and the percentage drops."

In PLM, Siemens Teamcenter has more installed seats than all other PLM solutions combined. Yet Lewis acknowledges smaller companies lag far behind the titans of industry regarding use of data management solutions. For years the difference was primarily attributable to IT resources. Siemens is reaching out to small- to mid-sized business manufacturers with a Rapid Start version of Teamcenter that focuses on tools and applications immediately useful to smaller companies.

"Best practices are built in; service engagement is small and quick. We offer an environment that scales as needs grow," Lewis notes.

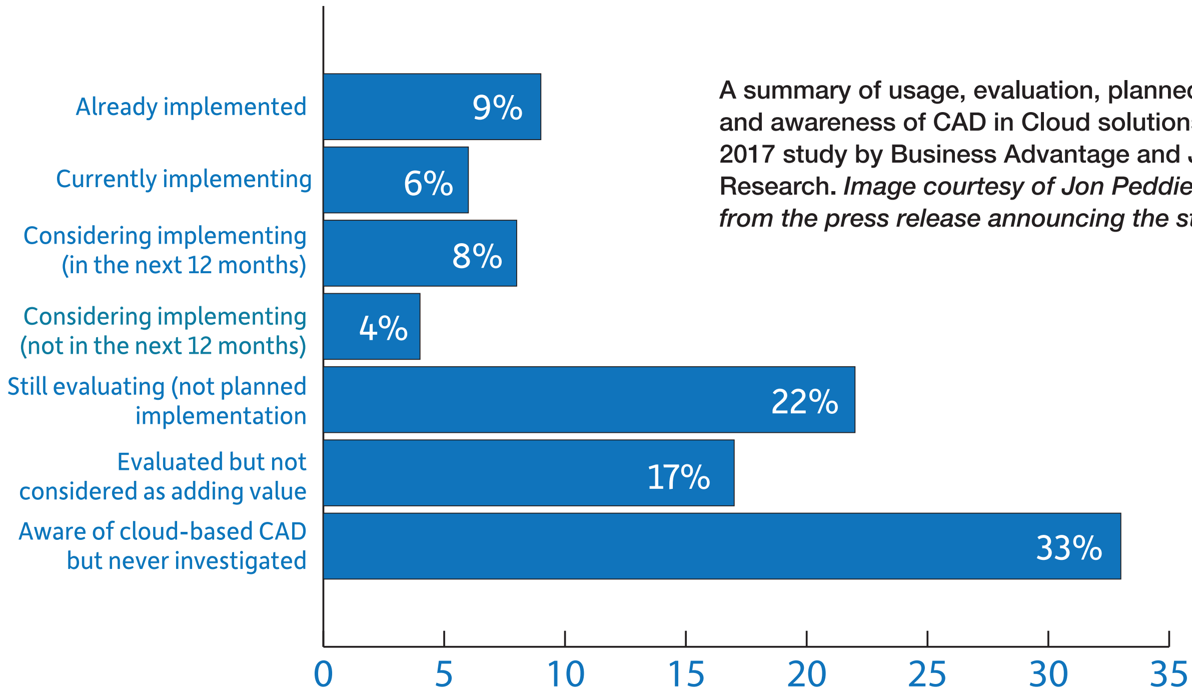
He adds that cloud technology is "removing adoption barriers." When a small company adopts a cloud-based PDM solution, they immediately reap the benefits of data elasticity. "If you deploy PDM on premise, you have to size it for a worst-case usage scenario. With cloud, you can scale as needed, not in advance," he says, even if that scaling is downward if business decreases.

Autodesk Joins the Game

Autodesk sells two manufacturing CAD platforms: Inventor and Fusion 360. Inventor is over 20 years old and came to market around the same time as most other Windows-based mainstream MCAD tools such as Dassault Systèmes SolidWorks and Siemens Solid Edge.

More recently, Autodesk has developed Fusion 360 as an integrated suite of cloud-aware and cloud-based applications that includes elements of simulation, CAM and PDM. "We do all the data management in an instant-on value proposition," says Daniel Graham, director of Fusion 360 product management. "When we speak to our customers, they want to get away from having a separate setup for CAD and CAM," he says.

Of course, needs differ across the market. CAM customers are especially interested in removing complexity. "Check-in and



A summary of usage, evaluation, planned usage and awareness of CAD in Cloud solutions, from a 2017 study by Business Advantage and Jon Peddie Research. *Image courtesy of Jon Peddie Research; from the press release announcing the study.*

check-out issues are more complex for CAM than for CAD," Graham says. "They often take STEP or IGES data out of CAD, and then they have to manage revisions or versions" of multiple files representing the same data.

This creates complexity, because Graham explains that there are just too many ways to make errors in the process, from generating STEP files that don't match the CAD geometry, to toolpath errors and more basic human-induced errors such as saving out the wrong data.

Graham says the concerns of some potential and current Fusion 360 users are typical of users on every CAD system. Some have concerns about regulations such as International Traffic in Arms Regulations; others mention the potential for vendor lock-in. "We are trying to have an open system," Graham says, noting the system supports a wide range of CAD file formats, neutral CAD data formats including STEP/IGES and STL, and common enterprise formats such as Microsoft Office and PDF.

Graham says a full collaboration platform for CAD users should include all the elements of engineering and product design, including validation, simulation, documentation and connection to BOM.

Many Fusion 360 users are in very small firms and want the system to grow with them, Graham says. "How do we create an instance that is extensible for teams with specific roles? We must make it super easy, because collaboration is for both generalists and discipline specialists."

The Need for Cloud-Native Apps

No discussion of cloud-based CAD collaboration can be complete without mentioning Onshape, the eponymous vendor of a browser-based mechanical CAD application that continues to expand its data management capabilities.

"Onshape has several aspects of PDM," says Paul Chastell, Onshape's VP of research and development. At its most elementary level, Onshape promotes CAD collaboration by the simple fact that it does not use files to store CAD data, but a database. Any number of users can simultaneously open an Onshape model.

Chastell says it is common for two designers working in different locations to get on the phone to discuss work, with both of them looking at the same live model.

"The simple act of no check-in or check-out means [users] can work on one part of a model and somebody else can work on another part," he says.

Collaboration with non-cloud users is more complicated for a cloud-native product, Chastell says. "Collaboration with desktop CAD users is a challenge we wish didn't exist," Chastell says. Onshape can peel off STEP files as needed, and has released in new tools that increase the automated collaborative aspects of such an exchange. DE

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INFO → **Autodesk:** Autodesk.com

→ **Kenesto:** Kenesto.com

→ **Onshape:** Onshape.com

→ **OpenBOM:** OpenBOM.com

→ **Siemens PLM Software:** Siemens.com/PLM

→ **Synergis Software:** SynergisSoftware.com

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Digitalization Reveals Product Data Management Gaps

Vendors are redefining data management capabilities to address the diversity and large-scale data requirements of the digital thread.

BY BETH STACKPOLE

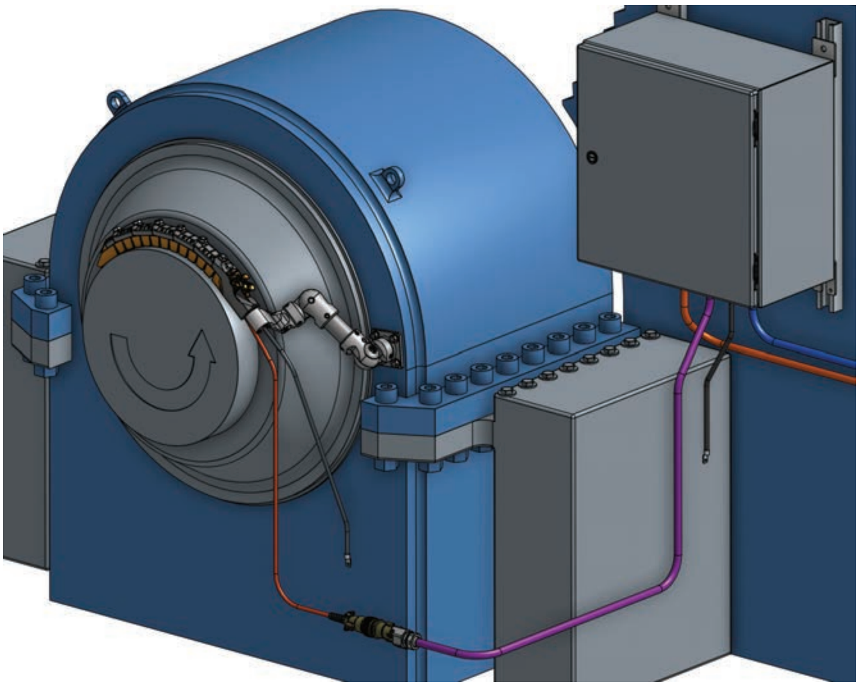
AT CUTSFORTH INC., a maker of power industry parts and systems, product development used to be a game of hurry up and wait. Using traditional CAD and product data management (PDM) systems, engineers typically were constrained by frequent system crashes and a burdensome check-in and check-out process that took too much time to manage while hampering design collaboration.

Of greater concern was the ripple effect that stops and starts had on the overall development process. Accelerating time to delivery of its brush holders and shaft grounding solutions is crucial for the Cutsforth engineering team as it strives to help power generation customers steer clear of any risk of downtime.

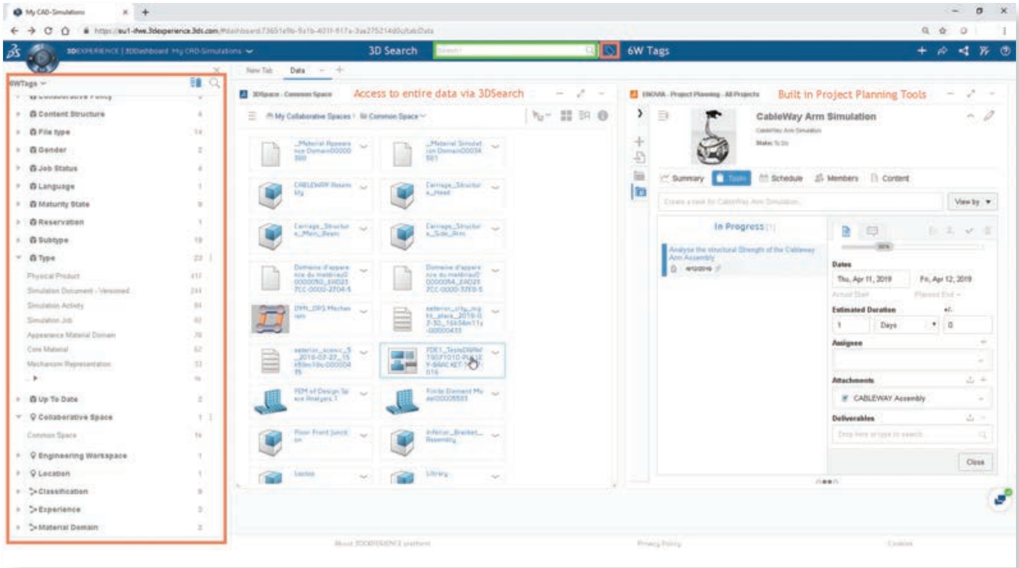
"Every time we'd open up a part, we'd have to interface with some completely different [PDM] program, which pulls you out of the workflow," explains Spencer Cutsforth, an R&D engineering technician at the company. "If you can reduce the amount of time spent pausing and breaking the workflow, you can move forward much more quickly."

Cutsforth eventually swapped out its traditional CAD and PDM system for Onshape, a cloud-based CAD platform that has integrated data management capabilities. Onshape is built on a new big data-styled database model that supports myriad forms of data and flexible schema, unlike many old-school PDM platforms, which use structured relational database architectures as their core foundation.

As manufacturers continue down the path of digitization, traditional PDM systems are buckling under the weight of stitching together larger CAD models, high-fidelity simulations, electronic CAD files and digital twin data models. These larger, more complex systems models need to be managed in the context of linkages to multiple design, document and simulation applications; have intricate relationships and interdependencies; and require highly sophisticated search capabilities beyond what's been widely available in conven-



Onshape's built-in data management capabilities allow Cutsforth to accelerate its product development cycle, including for its Shaft Grounding System. *Image courtesy of Cutsforth*.



The 3DEXPERIENCE platform features 3DSearch powered by EXALEAD, including 6WTags for contextual qualification of structured and unstructured data, and 3DSpace for creating and managing spaces dedicated to content storage and collaboration. *Image courtesy of Dassault Systèmes*.

tional PDM and CAD management solutions.

"The gradual digitization of more and more pieces of what we would like to store, manage and keep safe has grown," notes Stew Bresler, senior product manager for NX and Teamcenter integration at Siemens PLM Software. "The number of references and relationships that we have to track so we can pull in the right pieces of data has become far more complex."

The Evolution of PDM

The conventional paradigm for PDM systems as well as other CAD data management techniques, including shared network files or Excel spreadsheets, has been a file-based approach. However, 3D models and related data stored in a single file share or Excel spreadsheet can be easily lost, corrupted or overwritten and are highly insecure.

PDM systems were designed to tackle many of these issues, but the architecture still maintains models and product data in a file-based format, albeit with metadata to help track where files are kept along with a summation of what's inside to provide a level of visibility.

This approach gets harder to find more granular information bits as the volume and variety of product-related materials scales and more requisite data is managed outside of PDM software. Moreover, PDM systems leverage a check-in and check-out model to aid in version control; however, that singular process creates obstacles to an efficient engineering workflow since multiple users are locked out of working on the same file simultaneously.

This user restriction promotes a serial, not parallel, design workflow, which is often cause for bottlenecks and delays.

"Everything doesn't have to be in a monolithic part file," notes Bresler. "It bloats everything, makes it difficult to work and makes scalability hard."

To address the issue, Siemens Teamcenter PLM platform supports a common data model and linked data framework that spans cross-domain engineering functions such as ECAD, software and wire harness integration. The company's 4th Generation Design (4GD) software delivers a more flexible component-based design paradigm for working with large-scale product data.

Although 4GD is currently targeted at the shipbuilding industry where designs encompass millions of parts, Siemens is evaluating how the technology can be applied to handle large-scale data management problems for other industry-specific use cases, Bresler says.

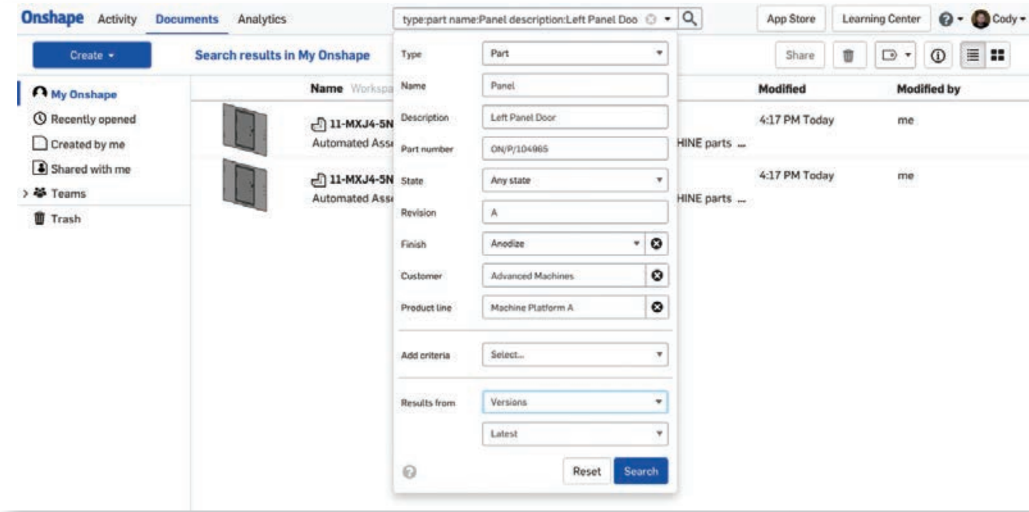
At Autodesk, interoperability between its Vault—its on-premise PDM system—and Fusion 360, is designed to mitigate some of the data management challenges associated with traditional PDM. The Desktop Connector for Fusion allows design teams to integrate an Autodesk data source like Vault with the cloud platform for streamlined collaboration without the constraints of traditional check-in and check-out processes.

At the same time, Autodesk AnyCAD, which allows any type of CAD data to be integrated into Inventor and Fusion 360 without the need for file translation, facilitates a data pipeline that promotes collaboration and aids in data management.

"We're not looking at products as independent, but rather as a collaboration story," notes Martin Gasevski, senior product manager for Autodesk Fusion 360. "Instead of the classic point-to-point integrations, we are trying to automate [the process] with a digital pipeline."

Newcomer Onshape is turning the traditional paradigm on its head with its cloud-based approach to CAD and integrated data management capabilities. A typical file-based system stores data in a single "lump," making it hard to change any one individual piece of data. With a database-driven design, data is not stored in big lumps, but in small chunks. That allows engineers to work on a design simultaneously because what is changed on one area of the design does not affect the rest of the model.

Advancing a model-based and platform approach is part of how Dassault Systèmes is addressing many long-standing data management limitations. A common data model accessed by a range of apps as opposed to point solutions accommodates different data types, including structured (CAD or simulation models) and non-structured data (social collaboration feedback).



Onshape never locks access to data, making granular search results available for modification or viewing, regardless of whether someone else is also working with them. *Image courtesy of Onshape*.

"Everything is model-based—there is no file check-in or check-out and no multiple versions or copies of data," notes Srinivas Tadepalli, SIMULIA Strategic Initiatives and director of strategic initiatives for cloud at Dassault Systèmes. "Everyone is working on the same data model so there is no discontinuity in the digital thread."

Simulation Raises the Stakes—Again

Data management gets even trickier when new data types like simulation models get thrown into the digital thread. Typically, simulation has been handled as a separate process, in part because it has been governed by a different user base and because it involves a wide assortment of physics applications and file types, often coming from different vendors. As a result, the unique needs of simulation taxes traditional data management capabilities.

"A single engineering workflow can involve tools from multiple vendors, each with its own data format that must be transferred from one application to the next and with full traceability from the simulation results back to the upstream requirements and CAD designs," says Andy Walters, director, software development at ANSYS. "Workflows are often automated and replayed in optimization loops that greatly amplify any inefficiencies in file storage, retrieval and translation, and large files exacerbate what is already a complex process management problem."

One way ANSYS is avoiding storage waste is by promoting reuse of existing CAD and CAE models through sophisticated search capabilities. For example, the ANSYS Simulation PDM (SPDM) system supports flexible keyword and property search, with filtering based on model and project type, user or team ownership or additional parameters.

"Search is only possible if the system automatically extracts simulation properties and other metadata from archived files, if it allows for custom fields and if it works equally well for all commercial and in-house file types," Walters says.

Aras is addressing the simulation data management wrinkle with its acquisition of Comet, an SPDM vendor-neutral process automation platform. Aras is incorporating the Comet data model as an integral part of Aras Innovator. Plus, Innovator's federated services approach also allows the Aras database to connect with external data sources via a link or file connection without extracting specific data from it.

"There are a number of areas that require data to be distributed and managed in multiple pools and this ends up being big data," explains Malcolm Panthaki, Aras' vice president of analysis solutions. "You need a way to seamlessly and securely deal with information distributed within multiple data stores … because we don't want the digital thread to be broken."

In the end, successful data management in the age of the digital thread may have less to do with technology and more to do with getting engineering organizations to change the way they work.

"The biggest challenge is not the technology—it's the fundamental process change for how customers have typically done their business," says Mark Fischer, director, product management and partner strategy at PTC. **DE**

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INFO ➜ ANSYS: ANSYS.com

➜ **Aras:** Aras.com

➜ **Cutsforth:** Cutsforth.com

➜ **Dassault Systèmes:** 3DS.com

➜ **Onshape:** Onshape.com

➜ **PTC:** PTC.com

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Image courtesy of Getty Images/antpkr.

As access to compute resources expands, and new tools shift simulation to engineers and designers, the volume of simulation data has increased.

BY BRIAN ALBRIGHT

SIMULATIONS ARE NOW CONDUCTED earlier in the design process and more frequently, and new tools have helped integrate different types of analysis into the daily workflows of designers. The amount of data has increased, which means the task of managing that data effectively so that it can be shared, stored, searched and reused in the future is even more challenging.

Simulation data management has become more critical as companies look for ways to better leverage existing simulations to improve designs or create new products, or because they must be able to access the data for compliance or regulatory purposes. However, many companies have done a poor job of properly categorizing and storing the data, which impacts their ability to meet rapidly accelerating design cycles.

"If you can cut down simulation times and the amount of time needed to respond to a requirements change, that has an impact on how fast you can meet deadlines," says Sanjay Angadi, director of product management at ANSYS. "Being able to catalog best practices, manage them and deploy them through a data management solution can directly impact the product lifecycle, and how well you are able to manage, share and redo that work on the next program."

Why not use traditional product data management (PDM) or product lifecycle management (PLM) tools? Simulation data is a much different animal than traditional product data. Designs often have multiple configurations, changes or iterations. A single version may have been subject to hundreds of simulations, and not all versions or tests may be worth keeping.

Simulation data is not only voluminous, but may also have a short lifecycle depending on the product or industry. Simulation cuts across multiple physics domains, each with different solvers and different ways to represent the product geometry. Even the data itself can be quite complex. Engineers often have to simultaneously conduct multiple types of simulations, in addition to accessing past simulation runs either for compliance purposes or to reduce redundancy.

"Almost every customer you can speak to faces problems of not being able to find data easily, not being sure the data is current when starting simulations, or if each person doing simulations may be using a different version of the design," says Ravi Shankar, global simulation product marketing director at Siemens PLM Software. "Secure transfer of data across different sites is also a problem."

Simulation data management also requires not just tracking results, but tracing the design information used to create the simulation, the input data used and the version of the application software that created the simulation.

Simulation models are often generated by various different tools from multiple vendors, often over lengthy periods of time during product development and updates. In some cases, accessing that data may require using the older hardware or software used in that particular simulation. Locating data is also a challenge—ensuring that companies not only have access to the right models, but also the right data input and information that analysts used to make their decisions can be nearly impossible without some accurate and automated way to tag and store that data.

Evolving Simulation Data Management Tools

Software providers have responded with many tools that target the organization, storage, management and retrieval of this simulation data. ESTECO's Simulation Data Management solution provides a way to access, organize and share simulation data, for example, while Altair offers SimData Manager to provide access to CAE data via a partnership with PDTec AG. The solution traces CAD geometries throughout the design process so that engineers can know which geometry formed the basis of the simulation models, and analysts can be notified of CAD model updates during simultaneous engineering processes.

ESI Group offers the Vdot simulation data management software to help organize and provide access to data. The company's VisualDSS solution also makes it easier to share models and resolve conflicts so that engineers can identify the optimal designs based on different physics and parameters. Users can build and maintain a bidirectional link between CAD data stored in PLM systems and simulation domains. Design and engineering changes can be propagated across the virtual tests, while maintaining data traceability.

"You can combine dynamically the impact of a modification from one domain to another, and the conflict is managed by default," says Jean Louis Duval, innovation and discovery business unit director at ESI Group.

"You can see what the impact is of one parameter on all domains," Duval. "This type of approach changes the way you perceive the management system, because now you don't need to manage thousands of inputs and versions. You can track those modifications back to the model. It changes our vision of SPDM, because you don't need to manage those conflicts any more, and you don't need to have a specific tool. You can reuse existing simulations to build your plan on the fly."

The types of challenges that companies need to address with SPDM will vary by company. Shankar says that some customers are interested in streamlining simulation processes so that it's easy to retrieve analysis results and create reports, and to ensure that this process is executed the same way no matter who is involved. Model re-use is another issue—data management can help ensure that different groups analyzing different physics can start from the same

CAD version or re-use existing meshes.

"If you look at the auto industry, you may have teams of engineers working on a single product, and there may be 10 or 20 variants of the same analysis," says Mark Lamping, SimCenter 3D business development manager at Siemens PLM Software. The Siemens Teamcenter Simulation Management tool provides control over CAE processes in the context of a PLM environment.

"Each crash simulation is a unique model, but a lot of that data can be shared," Lamping explains. "You don't have to recreate the same data over and over again. Teamcenter gives you the ability to share that data efficiently, and with confidence [so] that you have the data you need for your model."

The ANSYS Engineering Knowledge Manager is a web-enabled system that can integrate heterogeneous simulation tools and improve the management and sharing of simulation data.

"Our No. 1 challenge was making sure we could leverage multiphysics in an efficient way," says Angadi. "Customers are using dozens of tools. We take a very holistic view, because this not just a data management issue. You need a domain-specific view. We're providing optimization and robust design tools that allow them to be more productive. We're not just handing them a data management tool, but looking at how effectively they are using those tools, and what are the best mechanisms for automation."

The tools also have to fit into the engineers' daily processes without impacting their productivity. "That is critical," Angadi says. "You need a combination of data and process management tools that will fit into their existing processes and integrate into their day-to-day activities."

That's why manual tagging or metadata creation is usually a non-starter. "You need automated routines of getting smart metadata," Angadi adds. "Things relevant to simulation get indexed, and then users can come in and find them quickly."

Relevancy also comes into play when it comes to managing the large volume of simulation data now being generated. It may not be possible to move all simulation data into a central repository; in some cases, large analysis files may be discarded fairly quickly after they are generated. The SPDM tool should help ensure that key results are added to the database, as well as helping to automate the process of sorting that data.

"There are mechanisms for doing this if you don't want to store all the files forever," Angadi says. "You can use a lightweight visualization that doesn't keep the large files, but does keep the input deck and some of the important information. Some customers have a 90-day policy. In some fields, like aerospace, there might be a need to carry the data forward."

"Depending on the type of simulations, the files can be huge," Shankar says. "Companies need to make a decision where to store the data. For example, in Teamcenter, the storage can be online, nearline, and the data can be stored in external databases if need be.

"There are certain types of data that you might want to always access within the system, while other types could be archived," Shankar says. "What would be stored within the system is a link or a subset of data extracted from the simulation. You can do quick comparisons when making design changes. The flexibility needs to be in the system so each company can address their specific needs."

Cultural Hurdles

There are still some gaps in SPDM that vendors are working to address. Shankar sees an emerging need for a simulation data management system that can encompass electronic and software content in addition to mechanical simulation. "That's an area that is evolving, and perhaps along with that is an opportunity to bring in IoT data and feed that into the development process," he says. "I think a lot of work has yet to be done there."

According to Duval, the biggest challenge remains getting analysts and engineers to shift away from siloed operations to processes that make it easier to access and share simulation data.

"The biggest challenge is not on the technology side for SPDM, but on the human side," Duval says. "Organizational workflow processes are still one of the biggest bottlenecks."

With a robust data management tool in place, engineering firms can improve simulation processes and compliance, while lowering the cost of finding information and creating reports. This can ultimately improve designs and reduce redundancies with updated designs or similar designs that are being created.

"Our customers know that they can't continue to do what they were doing before," Angadi says. "Simulation is so critical to the design process, that they have to look at the re-use and collaboration piece more holistically." DE

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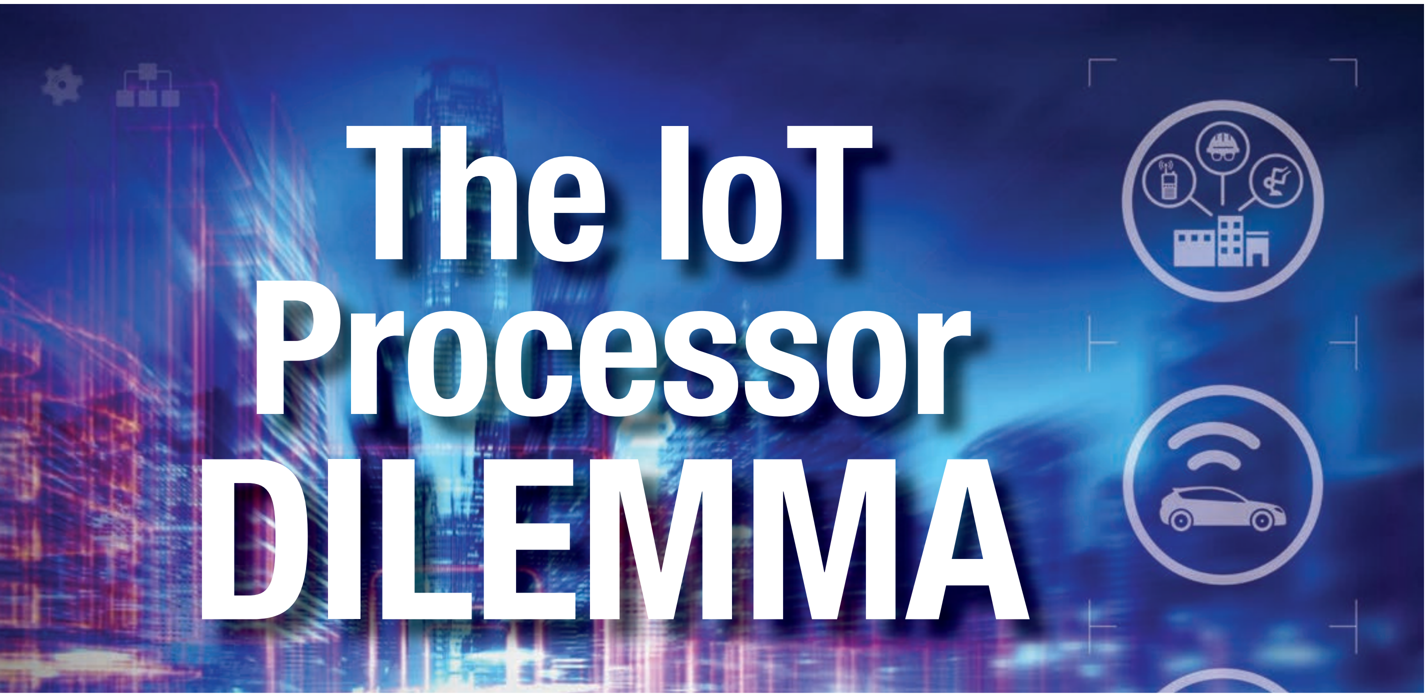


The IoT Processor DILEMMA

Proliferation of connected devices has led to increased complexities in product design.

BY TOM KEVAN

THE INTERNET OF THINGS (IoT) and edge computing have triggered the proliferation of connected devices, products that perform a rich assortment of functions and sport expanded capabilities. This, in turn, has increased the level of product design complexity engineers must tackle. The complexity becomes particularly evident when selecting processing resources for one of these devices.

The problem is that engineers must not only meet a growing variety of seemingly conflicting design demands—like low-power operation and high performance—but they must do so using a bewildering assortment of processing options.

Unfortunately, there are few easy answers. For processor architectures and technologies in the era of the IoT, one size never fits all. It's true that all the devices populating the network perform certain fundamental and universal tasks, which general-purpose, single-processing architectures can handle. The catch is that the IoT now requires chips that can perform specialized tasks, such as machine learning, voice or gesture recognition and security. These demands have caused designers to turn to a growing and evolving class of accelerators. Market forces further complicate the designer's task of demanding shorter development cycles and reduced development costs, making the processor selection process even more critical.

Single-Purpose vs. Multi-Function Processors

One of the first decisions an IoT device designer must make is whether to create a system using a collection of function-specific chips or a single chip that integrates multiple functions.

Although a function-specific chip may increase the board space and bill of material (BOM) costs, the approach offers several advantages. By keeping the application functions separate from the specialized tasks, the developer minimizes code complexity. The integration of the two software pieces can be challenging, especially with a single-core architecture.

This approach also affords access to richer feature sets. Products embedding the specialized tasks and general-purpose features often come with fewer options because of memory size and peripherals. Separating application and specific functionality means developers avoid real-time issues, such as conflicts between running a motor and handling a Wi-Fi communication stack.

On the other hand, a multi-function chip approach clearly takes up the smallest printed circuit board (PCB) space and pos-

ABOVE: The sheer diversity of the applications encompassed by the IoT, along with the variety of operating parameters and processing technology options available to address these needs, creates a daunting challenge for IoT device designers. *Image courtesy of NXP Semiconductors.*

sibly comes at a lower cost. As a result, it is well suited for simpler applications that target lowest cost and higher integration.

One solution to this dilemma may pertain to a technique that compartmentalizes functions. STMicroelectronics uses this approach in its STM32WB family of wireless microcontrollers (MCUs). With this product, ST has built a multicore series of MCUs and has "walled off" the connectivity MCU to protect it from interruption from the application processor.

"This dual-core architecture allows concurrent execution of the two pieces of software and provides greater flexibility to the software teams developing each function," says Renaud Bouzereau, marketing manager for STM32 high-performance products, microcontroller division, STMicroelectronics.

Finding a Balance of Power

Because of the proliferation of mobile wearable and remotely operating devices, power efficiency has assumed particular significance in IoT product development, often defining key aspects of the system processors' specifications.

Improving a processor architecture's power efficiency often comes at the expense of performance, die area or both. The most basic factors that influence the choice of a power efficient processor for a given task or application include the instruction set architecture and clock speed.

"A complex instruction set architecture, like Intel x86, utilizes many complex instructions and more hardware compared to a reduced instruction set architecture (RISC) like ARMv8," says Nihaar Mahatme, technology lead for the microcontroller business line at NXP Semiconductors. "The simplified hardware of RISC chips requires fewer transistors to be powered, reducing the power consumption. This has made ARM chips popular for battery-powered mobile devices and wearables, while higher performance x86 processors are better suited for personal computers, laptops and servers."

For a given microarchitecture, a lot of trade-offs between power and performance are made through choices such as processor pipeline depth, out-of-order execution, size of the address and data bus, multi-core architectures, frequency of operations and memory hierarchy. Each of these options requires a careful trade-off between power, performance and area.

Designers should also recognize that many IoT devices require always-on performance, which relies on the implementation of a sleep mode. Under these conditions, leakage current becomes a problem when it wastes energy.

"One area often overlooked is leakage current because many IoT devices are often sleeping, so the leakage current dominates," says Paul Washkewicz, co-founder and vice president of marketing of Eta Compute. "In fact, the real-time clock is completely dominated by leakage and is often the main function that is always on to keep the IoT device synchronized. Often the gains made going from 90 nm to 40 nm—for the SoC [system on a chip] to get more performance or shrink the die for cost—lock the SoC out of markets dominated by off leakage currents."

Designers seeking greater energy efficiency must consider power dissipation, which varies with the processing platform used.

"Power dissipation is very important in microprocessor–based applications because the power dissipation is much higher than on most MCUs," says Bouzereau. "However, on high-performance MCUs, the power dissipation becomes more important and requires more attention from the developer. The key point is the maximum junction temperature, and how the package can help dissipate this power."

Developers have a number of techniques at their disposal to mitigate the effects of power dissipation. They can limit the power inside the chip by limiting the operating frequency and the activity of the chip (peripherals activity) and by leveraging low-power modes between high-processing periods.

Designers also can select an ultra-low-power processor and a package with lower thermal resistance. Additionally, they can improve the power dissipation capability of the package by using heat sinks or air circulation, but things get more challenging when the processor is inside a sealed casing.

Power Benchmarks

One way to track and compare targets for processor power consumption and performance is the EEMBC CoreMark benchmark, which helps board and system designers to compare energy efficiency. The benchmark measures the performance of microcontrollers and CPUs deployed in embedded systems using the following algorithms:

- list processing (find and sort);
- matrix manipulation (common matrix operations);
- state machine; and
- cyclic redundancy check (CRC).

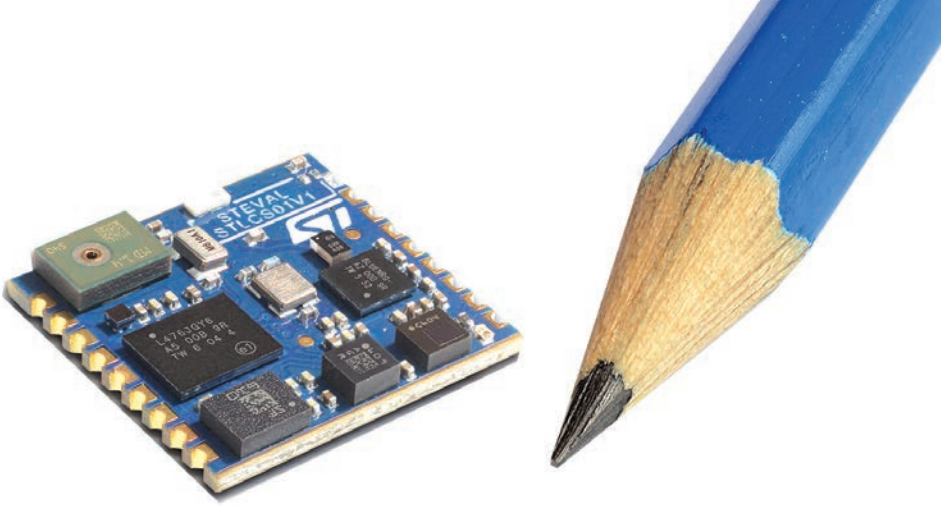
The CRC algorithm provides a workload commonly seen in embedded applications and ensures correct operation of the CoreMark benchmark, essentially acting as a self-checking mechanism. This process performs a 16-bit CRC on the data contained in elements of the linked list to verify correct operation. The system is designed to run on devices from eight-bit microcontrollers to 64-bit microprocessors.

Supporting Artificial Intelligence

The relationship between power consumption and the implementation of artificial intelligence (AI) will pose more challenges to IoT developers. Here, again, no single processor architecture or technology fits all use cases.

Most AI-enabled IoT applications target speech recognition and response, image classification, tracking video features and processing sensor data to analyze behavioral patterns. Each of these applications can have widely different requirements for performance, response latency and power.

"The common underlying theme for all the architectures is that they require arithmetic logic units or multiply-accumulate units (MACs) to perform arithmetic operations, as well as large amounts of on-chip and/or off-chip memory to hold input data



STMicroelectronics' SensorTile IoT module includes an 80 MHz microcontroller, as well as a wide spectrum of MEMS sensors. To better manage the volume of sensor data that the processor must handle, the unit supports advanced functions such as sensor data fusion and accelerometer-based real-time activity recognition. *Image courtesy of STMicroelectronics.*

and intermediate computation results," says NXP's Mahatme. "A higher number of MACs corresponds to higher performance. This must be complemented with the right kind of memory hierarchy to ensure that the processing elements are never starved of data, or become bandwidth-limited. Often a right mix of hierarchical on-chip RAMs, tightly coupled memories and DRAM are employed to manage the performance and minimize power consumption due to memory accesses."

In addition to these factors, designers should note that software plays a crucial role in how the processing element is programmed. Flexible application programming interfaces (APIs) simplify deploying and optimizing ML models on diverse hardware, especially those models built on different frameworks, such as TensorFlow, Caffe and Pytorch.

One of the biggest trade-offs a designer must make is the decision to use a fixed accelerator or a programmable one. A case may be made for one over the other, depending on the segment.

"But for the hundreds of thousands of applications in small, energy-constrained devices, it's best to have programmability along with any accelerator in order to target the many applications of IoT," says Washkewicz.

From Sensor Data to Real-Time Decision-Making

The conversion of real-time sensor data brings a clash between competing demands for power efficiency, high performance, AI implementation and cost. Large volumes of data are being generated from sensors in distributed settings like smart cities, industrial plants and autonomous vehicles. For fast real-time response, developers increasingly turn to edge computing. This raises the bar for computing resources in edge nodes. As a result, hardware must be complemented with real-time operating systems and fast-response software to handle interrupts and events swiftly.

ML for continuously changing real-time sensor data will also require learning on the fly because real-time systems cannot deploy and forget. For this adaptability, new hardware and software features that can be updated or reconfigured may be required for machine learning inference. With vast amounts of data being generated from multiple sources, it has become critical to extract just enough information required to perform the given AI task to minimize time and energy spent on redundant information processing. Such features are built into customized accelerators today.

In selecting the right processor architectures for such systems, some of the key considerations include the kind of scheduling algorithms and their effect on system performance, how the processor prioritizes and responds to interrupts and the different constraints on scheduling interrupts of varying priority.

Some developers challenge the ability of current digital processing architectures to handle fast-response challenges. "Most systems that digitize and require a high-speed bus will not be able to perform high-speed, closed-loop processing because of latency issues," says David Schie, CEO of AIStorm. "Most digital systems will be unable to perform high-speed, real-time decision-making because they have no information about the sensor data until it is digitized and communicated to the AI system, by which time it is too late to make a data pruning decision."

The Analog Alternative

The crux of this challenge is in the contention that the current generation of specialized accelerators are not up to providing the real-time processing, low power consumption and low cost required to use AI in many IoT applications. According to the challengers, the solution is to eliminate or minimize digitization by processing input data from sensors in analog.

Chipmakers recognize that by adopting analog computing or approximating it, both analog and in-memory processing avoid the power-hungry binary weighted arithmetic multiply-add operations that conventional ML accelerators need. They do, however, have concerns about the approach.

"Both analog and in-memory processing will be welcome for energy-efficient machine learning," says Mahatme. "However ... the dependence on specific charge-based storage, memristive or resistive elements, limits their applicability to only certain technologies. Analog processing similarly requires sense-amplifiers, A/D and D/A for processing, and interfacing with the rest of the chip, making it less scalable. Secondly, digital communication to and from these architectures will still consume power."

Mahatme says interest in the alternative has been rising, but it may be a few years before IoT devices reap the benefits. **DE**

Tom Kevan *is a freelance writer/editor specializing in engineering and communications technology.*

INFO ➜ AIStorm: AIStorm.ai

➜ **Eta Compute:** EtaCompute.com

➜ **NXP Semiconductors:** NXP.com

➜ **STMicroelectronics:** st.com/content/st_com/en.html

Printing Permissions

Coming soon to an additive manufacturing shop near you: digital rights management.

BY KIP HANSON

OK, I ADMIT IT: I once ripped my entire "Star Wars" DVD collection so I could watch it on my iPad. There was a long flight coming up and a certain well-known media store wanted 100 bucks for the download. Please don't tell anyone though; I've since learned that I violated Title I of the Digital Millennium Copyright Act. 17 U.S.C. 1201 and could face a $500,000 penalty and up to 5 years of imprisonment.

I get it. Intellectual property theft is a serious offense, but really, paying for "The Phantom Menace" a second time would be adding insult to injury. All kidding aside, digital rights management (DRM) is an important concept, not only for musicians and movie producers, but also for companies that develop products using additive manufacturing.

As one of the largest printing factories in the world, Materialise is working closely with its many machine vendors to close the DRM loop. *Image courtesy of Materialise NV.*

Navigating the Ecosystem

DRM is a broad, end-to-end strategy, one that promises to help control product designs and documentation as well as part quality and equipment use, explains Koen Neutjens, business development manager at Belgium-based Materialise NV. Perhaps more importantly, it assures that people can only print parts on authorized machinery at authorized facilities.

To a machine shop or fabricator, it might seem silly to ask for permission before manufacturing a part, but for those who 3D print parts, the concept isn't all that far-fetched. The chances are good that the copy machine in the front office is at least capable of asking for a username and password, ensuring that employees aren't using the equipment for non-business needs, and that costs get allocated to the correct department.

There's one catch. Unlike media-centric DRM, where encryption or file encoding mechanisms are all that's needed to curtail illegal copying and distribution activities, additive DRM requires the support of everyone who touches the 3D printing process.

"That means the part designers, the 3D printing software developers, the end users and their managers, and especially the machine builders," says Neutjens. "Without their cooperation, DRM will be difficult to enforce."

Despite the challenges, Materialise is moving full steam ahead. "We find that our customers' understanding and requirements for DRM are application-driven and diverse," he explains. "Today, with our additive manufacturing software suite, we offer our customers file protection for targeted applications, within a secure digital manufacturing environment. For these application-specific workflows, DRM-related "metadata" is incorporated into a protected file before being transferred to a 3D printer. DRM will become an integral part of the global distributed manufacturing networks that our customers are creating."

Delivering Data Integrity

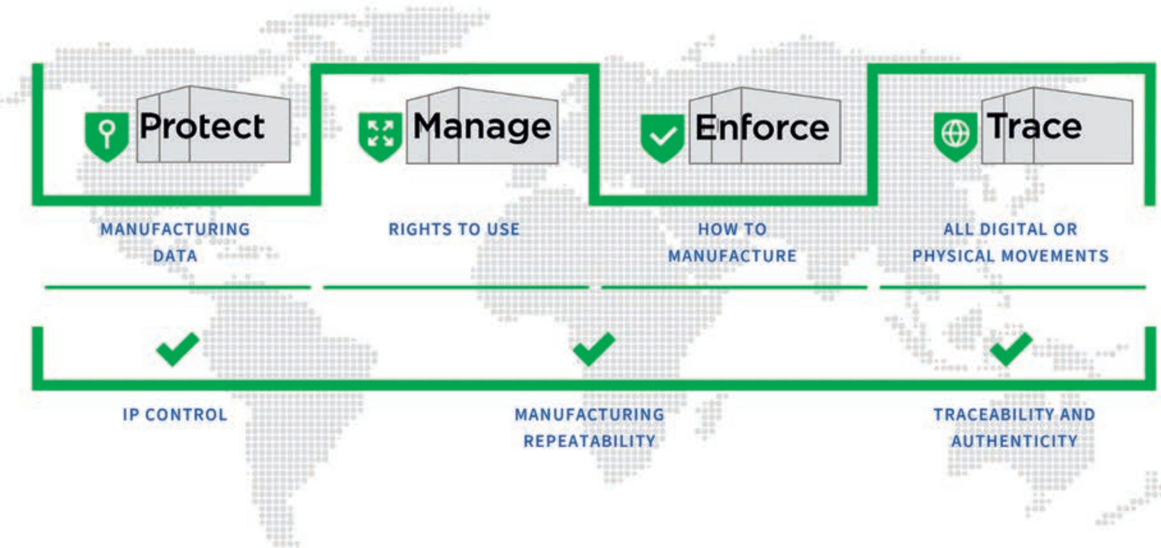
Some say it takes a village to raise a child—with DRM, it's no different. That's why Materialise works with its partners to establish a true end-to-end, secure 3D printing manufacturing process, where part designs are processed on an approved machine, using the approved build file and parameters, and where they can only be printed as many times as is specified in the file. Yet Neutjens is quick to point out that another element is needed: a third-party DRM provider to apply the necessary access rights and to encrypt the files.

Joe Inkenbrandt is delivering that third party, even though he doesn't care for the term DRM. The founder and CEO of Identify3D says traditional DRM is about protecting revenue streams, whereas additive DRM embraces more than that.

"The primary goal is to make certain that this complex man-

Identify3D

Protect, manage, enforce and trace are the four pillars of any sound DRM strategy. *Image courtesy of Identify3D.*



ufacturing technology is applied correctly, and that consumers receive what they paid for—namely, good parts," he says.

It works by containerizing all of the relevant data, Inkenbrandt says. A company such as GE, Boeing or anyone that needs tight product control—including where and how they're manufactured—uploads its files to one of Identify3D's servers along with information specifying what assets and processes should be tracked. This metadata is then encrypted together with the relevant files and placed within a secure digital container. Only someone with the correct license key can access the data within this container.

Like Materialise, Identify3D is partnering with machine tool builders. Yet Inkenbrandt says DRM goes much deeper. It might pull raw material suppliers into the loop, as well as quality control providers, design and manufacturing software developers, post-processing equipment manufacturers and especially service bureaus. All must be part of the additive DRM ecosystem if this burgeoning technology is to be made as robust as possible.

Herding Cats

And yet, DRM will never be hackproof. "Any security expert will tell you that nothing's unbreakable, period," Inkenbrandt says. "Whether it's fine jewelry or a product design, pour enough money and effort into stealing something and you'll ultimately be successful. It's our job to analyze the threats and understand where the attacks are going to come from, and then safeguard against those threats to the level that theft is no longer economically feasible."

So why should organizations bother? If the manufacturing industry will always have a certain flavor of the Wild West, one might argue that DRM isn't worth the effort. Jonathan Scott, chief architect at consulting firm Razorleaf Corporation, disagrees, suggesting that DRM shares many of the same attributes as a product lifecycle management (PLM) system, and that both are becoming invaluable tools in controlling what could be chaos.

"PLM and DRM are like partners in the perfect marriage," he says. "Where PLM does a great job of managing product definition from cradle to grave, DRM protects some of the different phases of that physical product's lifecycle."

Scott adds that DRM shares some similarities to a manufacturing execution system (MES), in that it controls various elements of the manufacturing process, albeit more securely.

The question becomes: With all these different systems available, shouldn't additive manufacturing as a whole run like the proverbial well-oiled machine? Unfortunately, we're not there yet. Most of the additive shops that Scott talks to have none of these systems, though interest is growing.

"Companies are beginning to realize the power of additive manufacturing, and a number of them have recognized that PLM is every bit as important here as it is with traditional processes—in some ways, even more so," Scott says.

"The design potential and part complexity are far greater with additive, never mind the fact that you're determining many of the material properties as you build the part—the possibility of developing a truly unique product design is significant," Scott continues. "So whether it's your part design or the customer's, what happens when they ask you for the entire set of build parameters when you deliver the finished part? There's a great deal of intellectual property involved—are you just going to give it away? That's where DRM becomes a game-changer." **DE**

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

INFO ➜ **Identify3D:** Identify3D.com

➜ **Materialise NV:** Materialise.com

➜ **Razorleaf:** Razorleaf.com

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

What's NEW in AutoCAD 2020

The new release offers a short but significant list of enhancements.

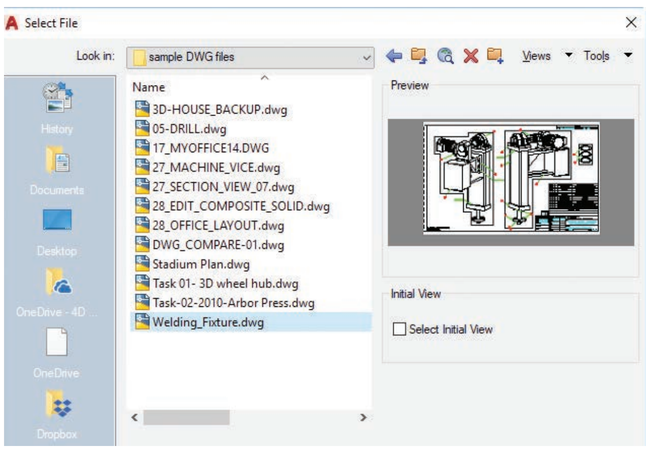
BY DAVID COHN

AUTODESK'S AUTOCAD 2020 is the 34th major release of its flagship CAD software. Users were able to download the latest version on March 27, as well as the seven specialized toolsets—AutoCAD Architecture, AutoCAD Electrical, AutoCAD Map 3D, AutoCAD Mechanical, AutoCAD MEP, AutoCAD Plant 3D and AutoCAD Raster Design—starting that same day. Although you must separately download each of the additional toolsets, they are all available as part of a single annual AutoCAD subscription.

Beginning last year, an AutoCAD 2020 subscription now includes free access to the AutoCAD Web and AutoCAD Mobile apps. You can use the Save to Web and Mobile command to save drawings to Autodesk's A360 cloud-based service, open them in the field using a browser or a mobile device and save any changes back to the cloud. Then, when you get back to the office, you can use the Open from Web and Mobile command to reopen the cloud-based version of the drawing in your desktop version of AutoCAD.

Additionally, external references are now included when you save drawings for web and mobile access. For those companies that require drawings to remain within their organization's network, AutoCAD's CAD Manager Control Utility now includes the ability to disable the Save to Web and Mobile and Open from Web and Mobile commands.

New in AutoCAD 2020, however, is the ability to also work with other cloud-based storage solutions, such as Box, Dropbox and OneDrive. Depending on what cloud-based storage apps you have installed on your workstation, the Places list in AutoCAD file selection dialog boxes now include those services.



Cloud-based storage solutions now appear in the Places list in file dialogs if you have installed their respective desktop app. ***Images courtesy of David Cohn.***

New Look, Better Feel

What most users will likely notice first about AutoCAD 2020 is its new look. The "dark" theme, which is the default when you first start the program, has a more modern-looking blue background that is much easier on the eyes. Icons stand out better, and context-sensitive ribbons retain the same consistent look. Of course, you can still switch to the "light" theme, and give the ribbon an off-white background.

Users may also notice that the overall performance of AutoCAD 2020 has been improved. Most users should see marked improvement when saving drawings, with most saves taking less than half a second, compared to 1.5 seconds on average in the previous release. In addition, installing the new release should be up to 50% faster for solid-state drives.

Significantly Improved Block Insertion

Although the new look and faster performance are nice perks, the most dramatic change is a new, incredibly intuitive method for inserting blocks. AutoCAD already had several methods for inserting blocks: the Insert command, Tool Palettes and DesignCenter. AutoCAD 2020 introduces a Blocks palette that replaces the old Insert dialog. This is the most significant change to the way blocks work since Autodesk added the block gallery in the 2015 release.

The new Blocks palette makes it extremely simple to select and insert any block at any location, scale or rotation angle regardless of whether the block was defined in the current drawing or in some other drawing.

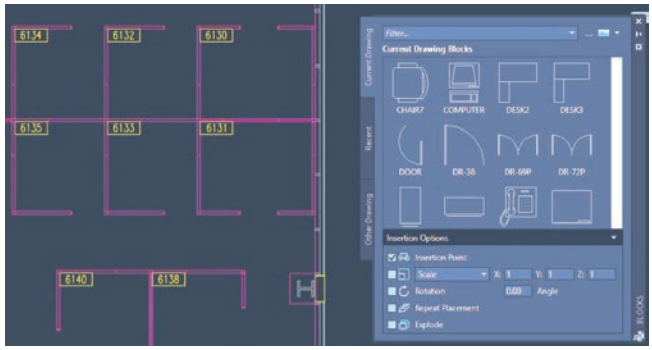
Now, when you expand the Insert tool in the ribbon, in addition to displaying a gallery of blocks in the current draw-

The "dark" theme in AutoCAD 2020 has a dark blue background with crisper-looking icons.

ing, you can click the Recent Blocks or Blocks from Other Drawings tools to open the Blocks palette.

The Blocks palette has three tabs. The Current tab displays all block definitions in the current drawing. The Recent tab displays the most recently inserted blocks. And the Other Drawing tab provides an easy way to navigate to any folder where you can choose drawings either to insert as blocks or to choose from defined blocks in those drawings. The drawings you select in the Other Drawing tab persist between drawings and sessions.

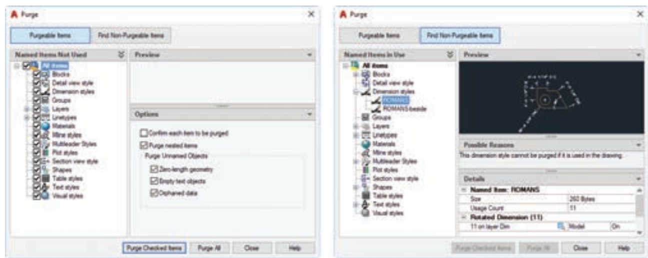
To insert a block, you simply click it in the palette. The top of the palette also includes controls for applying wildcard filters to block names as well as options for displaying blocks as either different size icons or as a list. Controls in the lower portion of the palette let you control insertion options such as insertion point, scale and rotation angle. If you select Repeat Placement, you can quickly insert multiple instances of the same block. And, since it is a palette, it can be anchored, docked, floated or resized, so that the Blocks palette is readily available whenever you need to insert a block.



The new Blocks palette makes it easier than ever to insert blocks, even if they are defined in some other drawing.

More Intuitive Cleanup

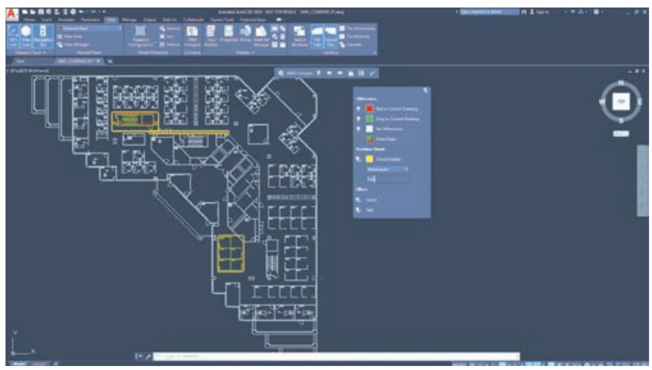
The Purge command has also been redesigned for easier drawing cleanup. Although the options remain nearly the same as before, the appearance and organization of the Purge dialog are all new and provide much better feedback. For example, you can now view purgeable and non-purgeable items, with a resizable preview area. Checkboxes provide a better way to select purgeable items by category as well as individual items. You can also now purge zero-length geometry without also purging empty text objects.



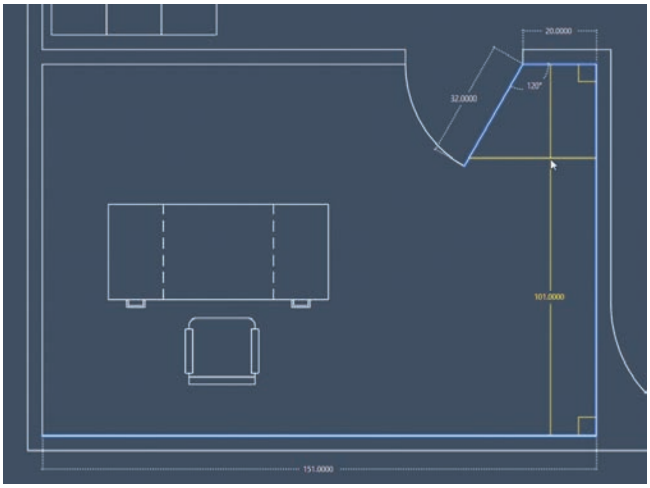
The updated Purge dialog makes it easier to remove unused items and better understand why other objects cannot be removed from a drawing.

But the biggest change is the ability to display non-purgeable items with a single click. You can then see explanations for why items cannot be purged, how many times a non-purgeable item has been used, what layers those items are on and their effect on file size.

In addition, with a non-purgeable item selected, you can click a Select Objects button to quickly zoom to those objects, which are also selected in the drawing so that you can easily make changes. For example, you could change the properties of the selected non-purgeable objects to move them to a different layer so that you could then purge the original layer.



Enhancements to the DWG Compare tool make it easier to compare the current drawing to another drawing, with changes updated in real time.



A new quick measure mode lets you quickly review distances and angles within a 2D drawing.

Better Comparisons

The DWG Compare feature has also been enhanced. Now, you can easily compare the current drawing to another specified drawing and import desired changes into the current drawing at any time. Any changes you make in either the current drawing or the compared drawing are dynamically compared in real time.

Although most of the comparison options remain the same, instead of a ribbon, the DWG Compare tool now appears on a docked toolbar at the top of the drawing area. Most options have been combined into a Settings control panel that can be pinned open and relocated on screen, so you can easily change the default comparison colors, toggle the comparison categories on and off, swap the order of drawings and adjust revision clouds.

You can also now export both drawings into a new "snapshot drawing" that combines the similarities and changes between both drawings. This operation provides the same result as performing a drawing comparison in AutoCAD 2019.

New Measure Tool and Other Improvements

AutoCAD 2020's measure tools include a Quick mode, which is active by default. Now, when you click the Measure tool in the ribbon, dimensions, distances and angles are dynamically displayed as you move your mouse over and between objects in a drawing. The cursor displays all nearby measurements, inside and outside the nearest geometry. Of course, the other command options are still available for explicitly measuring distance, radius, angle, area and volume.

AutoCAD also now correctly launches with different DirectX drivers, high-resolution (4K) displays and dual monitors. And the graphics display settings have been consolidated into three modes, which include gradient hatches and images.

In addition, all of the new tools and enhancements—including the Blocks palette, improved Purge and DWG Compare commands, Quick measure mode, and improved performance—are available in AutoCAD LT 2020 as well. You can download a 30-day free trial of either AutoCAD 2020 or AutoCAD LT 2020 from the Autodesk website.

Although AutoCAD 2020 may not bring the quantity of improvements we have come to expect, the quality of its enhancements should benefit all users, regardless of what they create. **DE**

David Cohn *has been using AutoCAD for more than 35 years and is the author of over a dozen books on AutoCAD. As senior content manager at 4D Technologies, he creates the CADLearning courses for AutoCAD and AutoCAD LT (cadlearning.com). He is a contributing editor to* Digital Engineering, *and also does consulting and technical writing from his home in Bellingham, WA. You can contact him at david@dscohn.com or visit dscohn.com.*

INFO → Autodesk, Inc.: Autodesk.com

AutoCAD 2020 and AutoCAD LT 2020 are only available by subscription. Upgrade pricing and perpetual licenses are no longer available. Customers can trade in R14 through 2016 perpetual licenses for discounts of up to 20% on a 1-year subscription or 25% on a 3-year subscription.

AutoCAD 2020

Monthly: $200   1 Year: $1,610   3 Years: $4,345

AutoCAD LT 2020

Monthly: $50   1 Year: $400   3 Years: $1,080

SYSTEM REQUIREMENTS

- **Operating System:** Windows 10 (64-bit), 8.1 (64-bit), or 7 SP1 (64-bit)
- **CPU:** 2.5GHz processor or faster (3.0GHz or faster recommended)
- **Memory:** 8GB (16GB recommended)
- **Disk Space:** 6GB free disk space for installation
- **Display Resolution:** 1920x1080 with True Color (resolution up to 3840x2160 supported on Windows 10 64-bit systems
- **Display Card:** 1GB GPU with 29GB/s bandwidth and DirectX 11 compliant (4GB GPU with 106GB/s and DirectX 11 compliant recommended)
- **Other toolsets have additional system requirements:**
  - AutoCAD Plant 3D (8GB additional disk space; 64-bit OS only)
  - AutoCAD Map 3D (16GB additional disk space; 16GB memory; 64-bit OS only)
  - AutoCAD Architecture (10GB additional disk space)
  - AutoCAD Electrical (12GB additional disk space)
  - AutoCAD MEP (12GB additional disk space)

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

Budget CAD Gets Better

CorelCAD 2019 adds more AutoCAD compatibility.

BY DAVID COHN

THE CANADIAN SOFTWARE COMPANY Corel has been around since 1985. Its CorelDRAW software, introduced in 1989, was one of the first graphics programs available for Windows, and at one time, Corel was the biggest software company in Canada. In 1996, it acquired WordPerfect and attempted to compete against Microsoft Word. More recently, Corel has acquired programs in markets such as design, illustration, photo editing and video editing.

In 2013, the company released CorelCAD. Unlike many of its other programs, however, CorelCAD was not an acquisition. Instead, it was built using the ARES CAD kernel from German developer Graebert. That same CAD engine powers Graebert's own ARES Commander and Dassault Systèmes' DraftSight software.

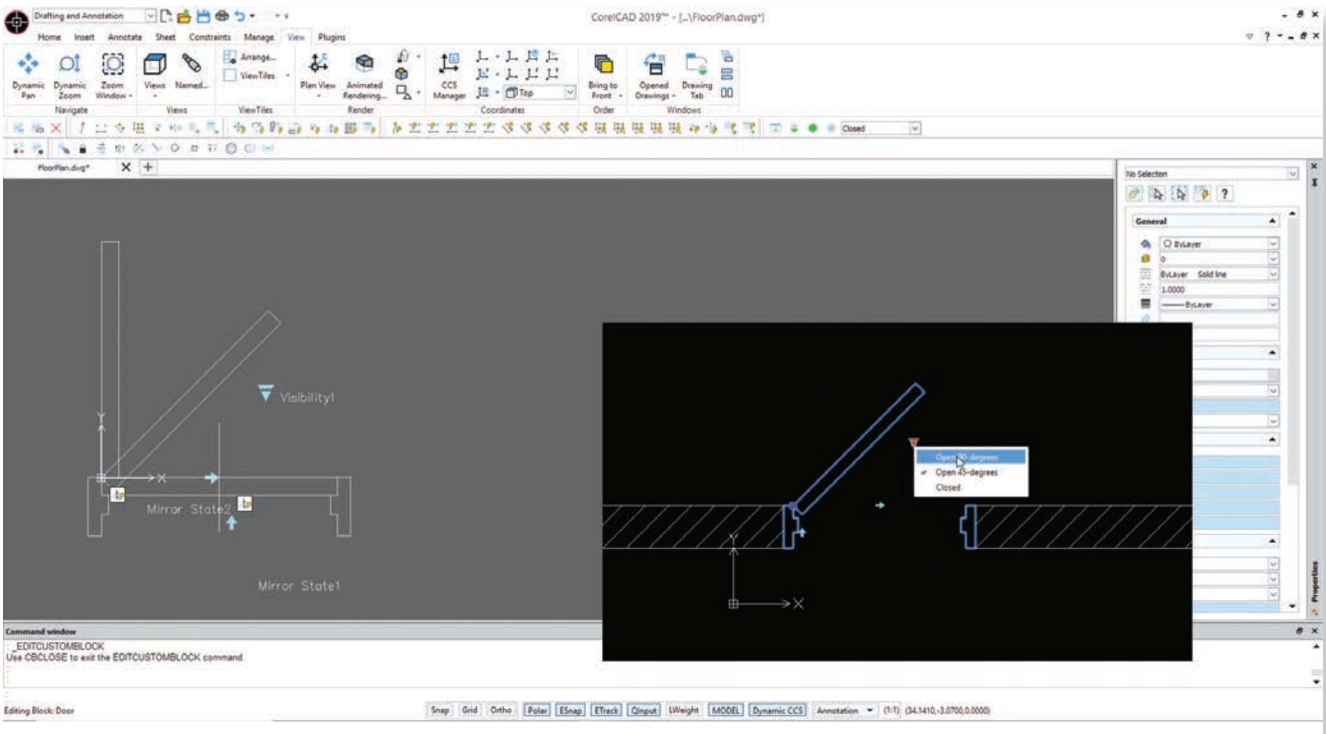
CorelCAD is positioned as an affordable alternative to AutoCAD as well as a way to bring CAD tools to its CorelDRAW users. CorelCAD uses DWG as its own native file format.

With CorelCAD 2019, the program can now open and save drawings in the latest AutoCAD 2018 DWG format, whereas the previous release could open the newer format but saved drawings in the older 2013 format.

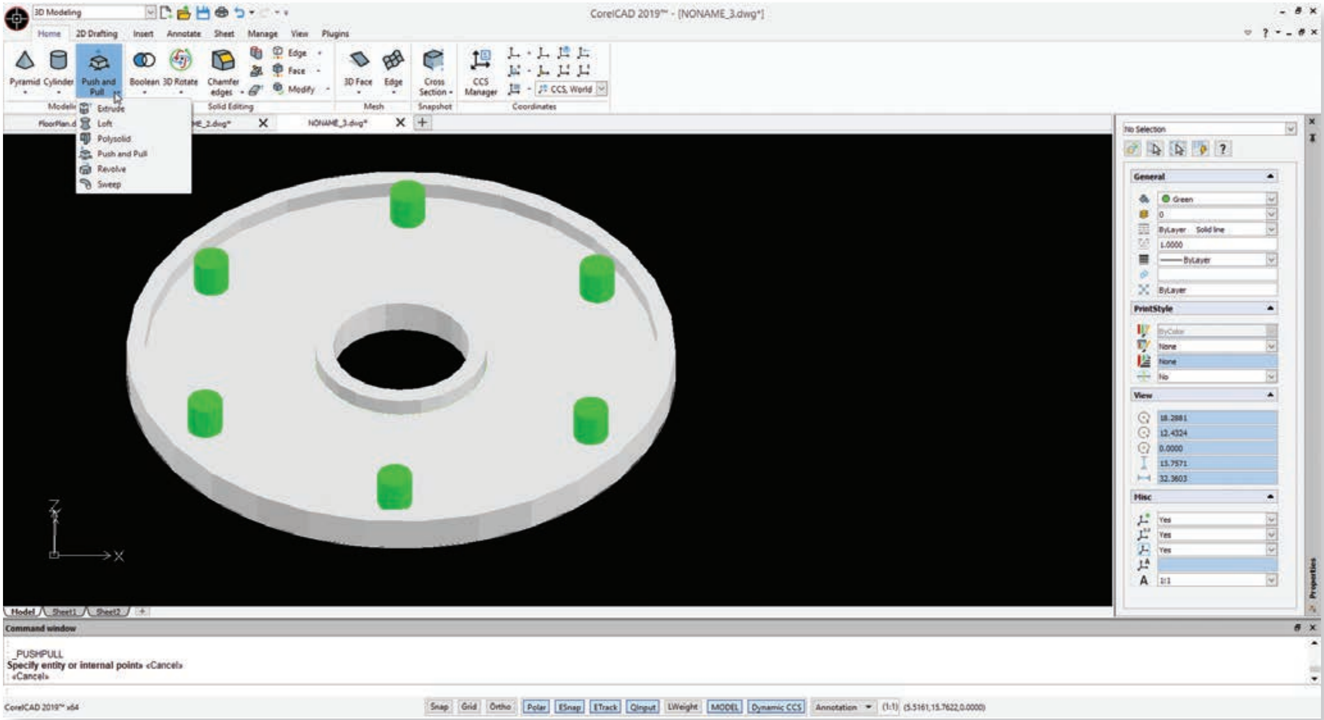
CorelCAD 2019 is available for Windows and Mac OS; mobile versions are available for Android and iOS devices. CorelCAD 2019 offers productivity improvements as well as new and enhanced tools for 2D drafting and 3D solid modeling.

Familiar Interface

When you first start CorelCAD, the program displays its "Classic" user interface, which includes pull-down menus and a host of toolbars with icon-only buttons docked around the perimeter



CorelCAD 2019 includes a Custom Block Editor for adding dynamic behavior to existing blocks. Once created, custom blocks work like dynamic blocks in AutoCAD. ***Images courtesy of David Cohn.***



The new PushPull command in CorelCAD 2019 is very similar to the PressPull tool in AutoCAD.

of the screen, much like very old versions of AutoCAD.

As soon as you switch to the "Drafting and Annotation" or "3D Modeling" workspaces—equivalents to the similarly named workspaces in AutoCAD—CorelCAD changes to a ribbon interface quite similar to that of AutoCAD.

Like AutoCAD, each drawing appears in its own window, identified by a file tab across the top of the drawing area. You can use the drawing file tabs to easily switch between drawings or start a new drawing, and use tabs in the lower-left corner of the window to switch between model space and multiple sheets, which is similar to paper space layouts in AutoCAD.

Other aspects of CorelCAD are strikingly similar to AutoCAD. For example, CorelCAD has a command window and you can start commands by typing, just like AutoCAD. A few commands have different names—such as PATTERN instead of ARRAY—but thanks to command shortcuts, you can type the AutoCAD command name to start almost any CorelCAD command.

Some Features Miss the Mark

Although CorelCAD doesn't include every function found in AutoCAD, the list of missing features has been shrinking, a trend that continues with the release of CorelCAD 2019. For example, while the previous version could open dynamic blocks, CorelCAD 2019 adds Custom Blocks, an authoring tool for creating dynamic blocks.

But there are significant differences between CorelCAD and AutoCAD. In AutoCAD, you can open the block editor to define a dynamic block on the fly. In CorelCAD, you must first use the MakeBlock command to define a block based on existing objects and then use the EditCustomBlock command to open that block in the Custom Block Editor.

Once in the block editor environment, you can draw additional geometry and add elements. "Activities" help to specify how the block will change when manipulating grip point (like actions in AutoCAD), and constraints. While working within the Custom Block Editor, you see only the objects that are part of the block. CorelCAD supports capabilities like some of those in AutoCAD, including the ability to define different visibility states—so that a single block can have several appearance variations—and to control custom blocks using tables.

But CorelCAD lacks the ability to test block behavior while in the custom block editor. You must first save your changes, exit the block editor and then test an instance of the block within the drawing.

Within the drawing, the controls for manipulating blocks are nearly identical to those in AutoCAD. But when working in the Block Editor, tools used to modify custom blocks in CorelCAD are not as intuitive as those in AutoCAD, owing largely to user interface differences between the two programs.

For example, AutoCAD provides a Block Editor contextual ribbon and a block authoring tool palette. But since CorelCAD lacks both context-sensitive ribbons and tool palettes, the tools for editing custom blocks appear in a collection of icon-only toolbars, even when using a ribbon-based CorelCAD workspace.

What's more significant is compatibility issues. In CorelCAD, if you open an AutoCAD drawing containing a dynamic block previously defined using AutoCAD, the block functions perfectly in CorelCAD. But if you open that dynamic block in CorelCAD's custom Block Editor and then save it, the block loses all dynamic functions, even if you made no changes to the block.

Working in the other direction, if you define a custom block in CorelCAD and then open that drawing in AutoCAD, the custom block lacks custom capabilities. But if you save the drawing and reopen the DWG file in CorelCAD, the custom block capabilities are once again present.

3D Improvements

The new release brings several improvements to CorelCAD's 3D capabilities. For example, CorelCAD 2019 introduces a new PushPull command to extrude 2D entities into surfaces and solids. If you push and pull linear objects, such as lines or arcs, you create surfaces, whereas using the command on closed objects, such as circles and polylines, creates 3D solids. The tool works very much like the PressPull tool in AutoCAD. Suppose you drew a circle on the side of a cube. If you pull that circle out from the face of the cube, you add a solid cylinder to the cube. But if you push the circle through the cube, you create a cylindrical hole through the cube. But while you can press the CTRL+SHIFT+E on the keyboard to initiate a press or pull operation in AutoCAD, in CorelCAD you must explicitly start the PushPull command.

CorelCAD 2019 also now includes a Polysolid tool for creating 3D solids in the shape of a wall or series of walls. This tool is identical to the Polysolid command in AutoCAD, including the ability to specify the height, width and justification options as well as the ability to convert an existing entity into a polysolid.

A new Chamfer Edge command lets you bevel the edges of 3D solids, including options to specify a face or loop, and the existing Fillet Edge command has been updated to include Face, Chain and Loop options. Plus while you could export STL files from previous versions of CorelCAD, you can now import them into CorelCAD 2019 as well.

Other Enhancements

Other new features in CorelCAD 2019 include a Layer Manager palette, a Merge Layers tool that displays a dialog box for merging one or more layers to a destination layer, support for 4K monitors and improved preview and selection highlighting.

CorelCAD 2019 also adds the ability to digitally sign a drawing as well as tools to validate or remove those signatures.

CorelCAD continues to provide good support for AutoLISP and ARX, and it offers some capabilities not found in AutoCAD. For example, you can insert audio recordings into a drawing and then play them back later. Although AutoCAD does not support these VoiceNotes, it can open drawings containing them.

CorelCAD also supports other industry-standard formats, including SVG, ACIS and SAT, enabling users to import files from other CAD programs. You can also export PDF and include PDF files as underlays, although you cannot import PDF geometry into a CorelCAD drawing. Further, you can import CorelDRAW (CDR) and CorelDESIGNER (DES) files as model space objects and export CorelCAD drawings to both formats, but only in the Windows version.

At $699 for a perpetual license, CorelCAD is much less expensive than AutoCAD or even AutoCAD LT, which are only available by subscription. You can also upgrade from any previous version of CorelCAD for $199. If you prefer a subscription, however, Corel now offers the Mac and Windows versions for $35 per month or $300 per year from the Apple and Windows app stores, respectively.

Although there remain several AutoCAD features that are still not available in CorelCAD, that list continues to get shorter. Its low cost and similarities to AutoCAD continue to make CorelCAD an attractive alternative for those on a budget. DE

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

INFO → Corel: Corel.com

CorelCAD 2019

PRICE

- **Full version (includes 1-year mobile license):** $699
- **Upgrade (from any previous CorelCAD version):** $199
- **Subscription (via the Mac App Store or Microsoft Store):** $35/month; $300/year

SYSTEM REQUIREMENTS

Windows:

- **OS:** Windows 10, Windows 8 or Windows 7 (32-bit or 64-bit)
- **CPU:** Intel Core 2 Duo or AMD Athlon x2 Dual-Core or higher
- **Memory:** 2GB minimum (8GB or more recommended)
- **Disk Space:** 500MB
- **GPU:** 3D graphics accelerator with OpenGL v1.4 (OpenGL v3.2 or higher recommended)
- **Display:** 11280x768 minimum (1920x1080 recommended)

Mac:

- **OS:** Mac OS Sierra (10.12) or higher (including MacOS Mojave 10.14)
- **CPU:** Intel Core 2 Duo processor (or better)
- **Memory:** 2GB minimum (8GB or more recommended)
- **Disk Space:** 500MB
- **GPU:** 3D graphics accelerator with OpenGL v1.4 (OpenGL v3.2 or higher recommended)
- **Display:** 11280x768 minimum (1920x1080 recommended)

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

Lightweight and Powerful, but Pricey

Origin PC NT-15 Quadro mobile workstation is a 15.6-in. laptop that delivers good performance at a premium price.

BY DAVID COHN

WE HAVE REVIEWED several workstations from Origin PC over the years, most recently its top-performing M-Class workstation (*DE* August 2018; digitalengineering247.com/r/19073). So, when the Miami-based system integrator sent us a laptop to review, we were intrigued.

Founded in 2009 by former employees of Alienware as a builder of high-performance gaming computers, Origin PC typically assembles its computers in the U.S. using imported parts. But you can't build a laptop the way you can a tower—by choosing a case and a motherboard and then assembling components into a roomy tower case. A laptop, on the other hand, is highly optimized, packing an array of parts into a compact chassis.

For this first-ever review of an Origin PC laptop, the company sent us its NT-15 Quadro, a thin and lightweight 15.6-in. system that certainly qualifies as a professional mobile workstation. The system we received came housed in a fairly utilitarian-looking aluminum case measuring 14.96x10x0.73 in. and weighing 5.02 lbs. Its 150-watt power supply (5.0x2.5x0.87 in.) adds an additional 1.29 lbs.

With a starting price of $2,569, the base configuration is already well-appointed, with a 2.2GHz Intel Core i7-8750HQ 6-core CPU—the only CPU offered—an NVIDIA Quadro P3200 with 6GB of GDDR5 memory, a 3840x2160 display, 8GB of RAM and both a 250GB M.2 boot drive and a 2TB Seagate FireCuda flash-accelerated hard drive, all covered by a one-year warranty. Extending the warranty coverage to three years brings the base price to $2,838.

You should note that the base system typically includes a 250GB Seagate BarraCuda solid-state drive (SSD). The 2TB data drive and a $57 price reduction were part of a promotion available at the time of our review.

Options Outside and Inside

As we have seen when reviewing Origin PC's tower workstations, there are lots of customization options, starting with the exterior. The charcoal gray surface color on the NT-15 we received is standard, but you can add laser etching for $50, a metallic paint finish for $175 or an artistic theme for $249.

Although the only display option is the UHD 3840x2160 in-plane switching (IPS) display, the screen in our evaluation unit had been professionally calibrated to ensure the most accurate color spectrum available, which added $29. Our NT-15 also came with the more powerful NVIDIA Quadro P4200 graphics processing unit (GPU), with 8GB of GDDR5 memory plus Max-Q design, adding $679.

This laptop GPU provides 2304 compute unified device architecture (CUDA) cores, a 256-bit interface and a bandwidth of 224GB/s while drawing a maximum of 115 watts. Max-Q is a new approach that enables original equipment manufacturers (OEMs) and system builders to design laptops that are thin and power-efficient, while still delivering high-end graphic performance. The P4200 is also virtual reality ready.

Although the Origin PC NT-15 Quadro base system fills its two memory sockets with a pair of 4GB DDR4 2400MHz memory modules, the system we received was maxed out with 32GB of RAM, installed as a pair of 16GB Kingston HyperX Impact 2666MHz small outline dual in-line memory modules, which added $213.

The base model also includes a Samsung 970 EVO Plus

The Origin PC NT-15 Quadro is a powerful 15.6-in. mobile workstation with a 3840x2160 display powered by an NVIDIA Quadro M4200 GPU. *Image courtesy of David Cohn.*

PCIe NVMe M.2 data drive as well as a 250GB SSD. But Origin PC offers options, including PCIe drives of up to 1TB, SATA drives up to 2TB and SSDs of up to 4TB capacities.

Our evaluation unit included a 1TB Samsung 970 EVO Plus PCIe NVMe M.2 boot drive, a $179 option and the 2TB Seagate FireCuda Flash Accelerated drive, which normally adds $134, but was free, thanks to the aforementioned upgrade promotion.

Great Display and Lots of Ports

Lifting the lid reveals the 15.6-in. UHD display and an excellent backlit keyboard with 102 keys, including a separate numeric keypad. A rectangular power button is located in the upper-right corner, above the keyboard, with an LED light that glows white when the system is on. A 1920x1080 webcam, centered above the display, includes an adjacent LED that illuminates when the camera is active.

Instead of LEDs on the keyboard, however, messages briefly appear on screen when you use the Caps Lock, Number Lock or Scroll Lock keys. A 4.25x2.5-in. touchpad with multi-touch capabilities and two dedicated buttons is centered below the spacebar, with a fingerprint reader located in its upper-left corner.

The right side of the case provides microphone and headphone audio jacks, a USB 3.1 Gen 1 Type-A port, a multi-card reader and a standard RJ-45 jack for the built-in gigabit LAN. The left side of the case includes two additional USB 3.1 Gen 1 Type-A ports—including one that can be powered when the system is off but still connected to the AC adapter or when the battery charge is above 20%—a pair of USB 3.1 Gen 2 Type-C ports, two mini-Display Ports, an HDMI port, the connection for the AC adapter, an air vent and a security lock slot. The front edge of the case provides power, battery, hard drive and airplane mode status LEDs.

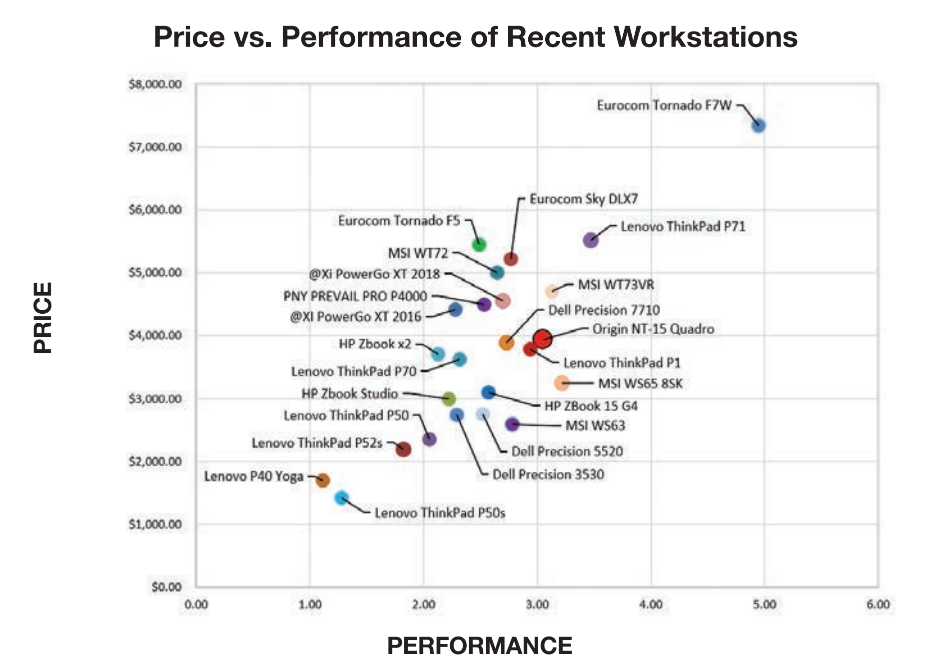
The NT-15 includes a Control Center app that lets you monitor the CPU, GPU and memory; adjust fan speed settings; select a performance profile; toggle selected components on and off; adjust the keyboard backlighting and assign keyboard shortcuts.

Like other laptops we have recently received, the battery

Mobile Workstations Compared	**Origin PC NT-15** Quadro 15.6-inch 2.20GHz Intel Core i7-8750HJ 6-core CPU, NVIDIA Quadro P4200, 32GB RAM, 1TB NVMe PCIe SSD, 2TB 5400rpm SATA HD	**MSI WS65 8SK** 15.6-inch 2.90GHz Intel Core i9-8950HJ 6-core CPU, NVIDIA Quadro P3200, 32GB RAM, 512GB NVMe PCIe SSD	**Eurocom Tornado F7W** 17.3-inch 3.60GHz Intel Core i9-9900K 8-core CPU, NVIDIA Quadro P5200, 64GB RAM, 500GB NVMe PCIe SSD, 2TB HD	**Lenovo ThinkPad P1** 15.6-inch mobile 2.70GHz Intel Xeon E-2176M 6-core CPU, NVIDIA Quadro P2000, 32GB RAM, 2TB NVMe PCIe SSD	**Dell Precision 3530** 15.6-inch 2.7GHz Intel Xeon E-2176M 6-core CPU, NVIDIA Quadro P600, 32GB RAM, 512GB NVMe PCIe SSD	**@Xi PowerGo XT 2018** 17.3-inch 4.0GHz Intel Core i7-8086K 6-core CPU, NVIDIA Quadro P4200, 32GB RAM, 500GB NVMe PCIe SSD
Price as tested	$3,938	$3,249	$7,346	$3,788	$2,738	$4,558
Date tested	3/11/19	12/12/18	12/12/18	10/24/18	8/28/18	8/7/18
Operating System	Windows 10	Windows 10	Windows 10	Windows 10	Windows 10	Windows 10
SPECviewperf 12 (higher is better)						
catia-04	108.43	115.38	183.15	64.58	38.67	165.95
creo-01	108.98	97.82	151.79	52.95	42.99	138.65
energy-01	12.39	12.46	20.03	6.50	3.12	14.87
maya-04	75.34	91.69	139.69	41.74	38.42	128.84
medical-01	51.25	60.10	94.74	27.81	12.61	63.65
showcase-01	76.38	61.83	80.91	29.91	19.70	73.41
snx-02	118.76	137.83	214.49	61.50	37.25	172.95
sw-03	124.44	123.80	201.96	76.73	70.59	181.61
SPECapc SOLIDWORKS 2015 (higher is better)						
Graphics Composite	3.80	4.67	5.84	2.58	4.77	5.32
Shaded Graphics Sub-Composite	2.26	2.98	4.03	1.33	3.17	3.48
Shaded w/Edges Graphics Sub-Composite	3.08	3.88	4.99	1.91	4.06	4.38
Shaded using RealView Sub-Composite	2.70	3.37	4.49	1.76	3.59	3.87
Shaded w/Edges using RealView Sub-Composite	3.19	3.89	5.08	2.29	4.07	4.36
Shaded using RealView and Shadows Sub-Composite	3.13	3.87	5.11	2.05	4.10	4.46
Shaded with Edges using RealView and Shadows Graphics Sub-Composite	3.39	4.11	5.28	2.45	4.26	4.61
Shaded using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	10.11	12.97	13.83	6.35	11.20	14.75
Shaded with Edges using RealView and Shadows and Ambient Occlusion Graphics Sub-Composite	9.80	12.14	13.68	6.87	11.01	13.51
Wireframe Graphics Sub-Composite	3.50	3.69	4.45	3.06	3.85	4.15
CPU Composite	2.78	4.58	3.86	2.85	4.55	5.40
SPECwpc v2.0 (higher is better)						
Media and Entertainment	2.89	3.22	5.15	3.13	2.23	4.14
Product Development	3.05	3.22	4.95	2.94	2.29	2.70
Life Sciences	3.21	3.60	6.19	3.66	2.26	4.40
Financial Services	3.73	4.11	6.16	4.20	3.34	5.37
Energy	5.37	3.56	5.62	5.02	2.28	4.08
General Operations	1.37	1.38	1.96	1.67	1.30	1.55
Time						
Autodesk Render Test (in seconds, (lower is better)	63.80	35.50	34.10	46.40	63.10	29.30
Battery Life (in hours:minutes, higher is better)	4:05	9:01	4:40	7:08	9:26	3:56

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

in the Origin PC NT-15 is not removable and the manual does not address any user-serviceable components. During our tests, the system remained cool and relatively quiet, although the fan noise reached 56dB during some of our tests. The four-cell 55Whr battery kept the system running for just over 4 hours on our battery run-down test.



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

Workstation-Class Performance

The Origin PC NT-15 performed well on all our benchmark tests. Thanks to its optimized GPU, its results on the SPECviewperf graphics performance benchmark placed it ahead of most of the other 15.6-in. mobile workstations we have tested.

On the SPECapc SolidWorks benchmark, the NT-15 also did very well, although here its slower CPU placed it behind many of the other comparable 15.6-in. systems. On the very demanding SPECwpc workstation performance benchmark, the Origin PC system also lagged behind similar systems, again due to its more modest six-core processor. Similarly, on our AutoCAD rendering test, the 68.4-second average rendering time was the slowest we've recorded in quite some time.

Origin PC preloads Windows 10 Professional 64-bit and typically backs the system with a one-year part replacement warranty with 24/7 lifetime support and free labor. Longer warranties are available, and our as-tested price includes a three-year warranty.

Origin PC is unique in that it has an option to ship systems in a wooden crate. Our evaluation unit did indeed arrive in such a crate, which would have added $41 to the system cost, and increased the shipping weight by more than 11 lbs.—something that seems unwarranted for such an otherwise lightweight mobile workstation. We did not include the cost of the crate in our as-tested price.

Once we tallied everything, our system priced out at $3,938, making the Origin PC NT-15 Quadro one of the more expensive 15.6-in. mobile workstations we have reviewed. Although it delivers good performance and a great display, its price and less-than-stellar battery life tempered our opinion.

The MSI WS65 we recently reviewed delivered better performance, longer battery life and less weight for a bit less money. The Origin PC NT-15 Quadro is a powerful, lightweight mobile workstation, but there are other systems out there that deliver more bang for the buck. **DE**

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

Origin PC: OriginPC.com

Origin NT-15 Quadro

- **Price:** $3,938 as tested ($2,838 base price)
- **Size:** 14.96x10x0.73-in. (WxHxD) notebook
- **Weight:** 5.02 lbs. plus 1.29 lbs. power supply
- **CPU:** 6-core 2.2GHz Intel Core i7-8750H w/9MB Smart Cache
- **Memory:** 32GB DDR4 at 2666MHz (2X16GB), 32GB max
- **Graphics:** NVIDIA Quadro M4200
- **Hard Disk:** 1TB Samsung 970 EVO Plus PCIe NVMe M.2 boot drive, 2TB Seagate FireCuda Flash Accelerated data drive
- **Floppy:** None
- **Optical:** None
- **Audio:** Integrated SoundBlaster Cinema 3 HD audio, built-in speakers, two audio jacks (microphone, headphone), built-in microphone
- **Network:** Intel Dual Band Wireless-AC 9560 + Bluetooth
- **Network:** None
- **Other:** Three USB 3.1 Gen 1 Type-A, two USB 3.1 Gen 2 Type-C, two mini-DisplayPorts, HDMI, RJ-45 LAN, 1080p webcam
- **Keyboard:** Integrated 102-key backlit keyboard
- **Pointing device:** Integrated touchpad with fingerprint reader
- **Warranty:** One-year parts, free lifetime labor and support, 45-day shipping standard (three-year parts replacement warranty added to price)

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

Rhino 6: A POWERFUL Creature

The popular NURBS-based modeler continues to grow.

BY DAVID COHN

SINCE ITS INITIAL RELEASE at SIGGRAPH in 1998, Rhinoceros—or, more commonly, Rhino or Rhino3D—has won a very loyal following. The program can create, edit, analyze, document, render, animate and translate Non-Uniform Rational B-Spline (NURBS) curves, surfaces, solids, point clouds and polygon meshes.

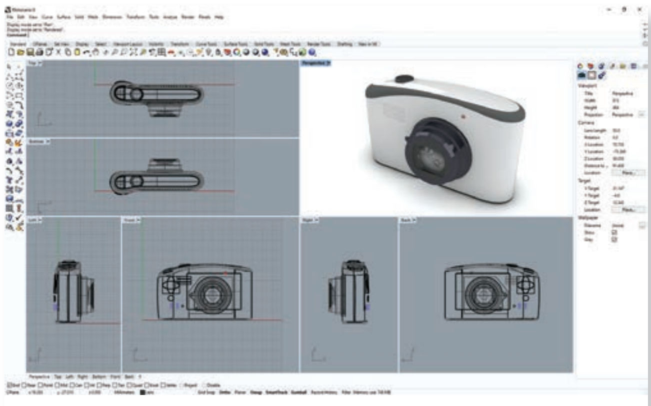
Primarily a surface modeler, but with many related features, Rhino is developed by Robert McNeel & Associates. The software evolved from a 1992 program called Sculptura. From its inception, Rhino was designed to be easy to learn, easy to use, low-cost and extensible.

Like AutoCAD, Rhino has always featured a command line where users can type commands. Geometry in Rhino is based on the NURBS mathematical model. As such, Rhino allows users to start with a simple sketch and generate complex 3D shapes—virtually any shape imaginable. Always affordable, Rhino today costs just $995 (or $195 for a student version).

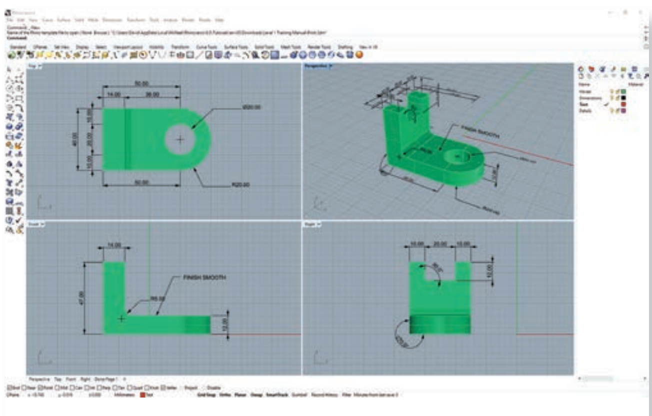
And like AutoCAD, users and third-party developers can create add-ons to extend the power of Rhino. McNeel offers several such add-ons, including Flamingo (a near photorealistic renderer), Bongo (design animation), Penguin (a scan-line renderer for creating stylized images of Rhino models) and Grasshopper (a visual programming language). More than 100 other third-party Rhino plug-ins contribute to the program's popularity.

Clean, Customizable Interface

Rhino 6 for Windows, released in February 2018, retains all the features that have made Rhino a success, while offering numerous improvements. When you first start Rhino, a menu across the top of the screen groups all Rhino commands by function. Below this, a command line lets you type commands and displays prompts and clickable options for the current command. Like AutoCAD, Rhino displays a filtered list of commands that automatically updates as you type, and you can repeat the last command by pressing ENTER when no other command is active.



The Rhino interface features a menu, command line and toolbar groups across the top, a toolbar on the left and panels on the right. The screen is initially divided into four viewports that can be further subdivided and resized. *Images courtesy of David Cohn.*



You can create dimensions in any viewport. Dimensions are created parallel to the viewport's construction plane and appear on those planes in 3D viewports.

Below these elements, a toolbar extends across the width of the screen. This toolbar is divided into toolbar groups, each with its own tab, and initially 15 different groups are shown. There is also a second toolbar docked to the left edge of the screen. When you select a different toolbar group at the top of the screen, the toolbar below it changes, and sometimes the side toolbar also updates. To start a command from a toolbar, you click (or sometimes right-click) the tool. For example, only the Undo tool appears on the Standard toolbar. To redo, you simply right-click the same tool.

The main drawing area is initially divided into four viewports that display perspective, top, front and right views of the model. One viewport is active at a time, but you can easily switch between viewports even while in the middle of a command. You can also press the right mouse button to orbit the perspective view and press CTRL and right-click to zoom or SHIFT and right-click to pan in any of these views.

Each viewport has its own drop-down menu that lets you select the display mode for that viewport, as well as the construction plane and other associated features for that viewport. You can quickly maximize any viewport or restore to one of the four standard viewports.

To the right of the viewports are a collection of panels with tools to control viewports, adjust layers and change properties. Below the viewports, an Osnap toolbar lets you select active object snap modes. A status bar across the bottom of the Rhino window shows the current cursor coordinates and drawing units. You can also use tools on the status bar to select the current layer color, toggle drawing aids such as grid snap and ortho, and apply filters. Any of the toolbars, the command window and the panels can be floated, hidden, docked or regrouped. And you can resize viewports, create new floating viewports, split viewports horizontally or vertically and close viewports.

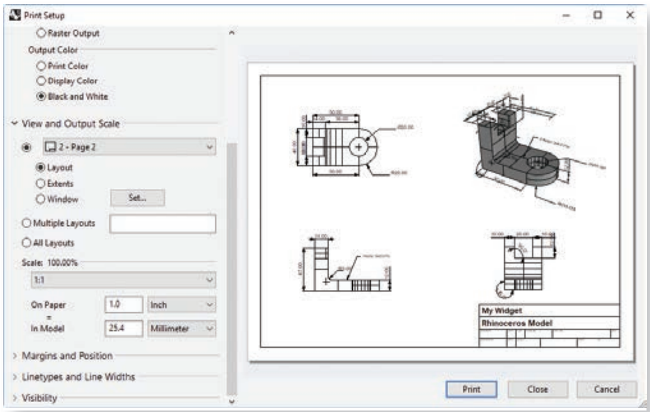
Versatile 3D Modeling

Although the primary entity in Rhino is a surface—an infinitely thin, infinitely flexible, mathematically defined membrane—you can also begin by creating 2D curves, meshes or solids. Any curve can be converted into a surface (by extruding, lofting, revolving or sweeping), surfaces can be joined to form polysurfaces, and solids can be created by joining multiple surfaces to enclose a space. Rhino provides an extremely broad set of tools for creating and manipulating objects.

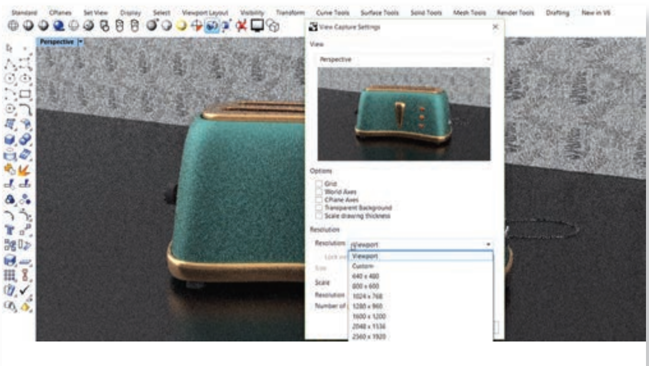
The Gumball tool—somewhat like the TriBall tool in IronCAD—is particularly powerful. When enabled, this widget displays on a selected object and lets you perform move, scale and rotate transformations around the gumball origin as well as copy objects as they are being manipulated.

Rhino also offers SmartTrack, which are temporary reference lines and points that are drawn in the viewport using implied relationships among 3D points, other geometry and the direction of coordinate axes. You can also turn on history recording prior to performing operations such as surface lofting, so that you can go back later and update objects by editing the input curves.

Because models are based on NURBS, you can display control points on an object and then adjust its shape rather than manipulating the entire object at once. Point editing can be performed on meshes, curves and surfaces, but not on polysurfaces or solids.



You can create a Layout to print multiple views of a model on one sheet, complete with a border and title block.



Tools for capturing views now have a dialog to control various settings.

Broad Compatibility

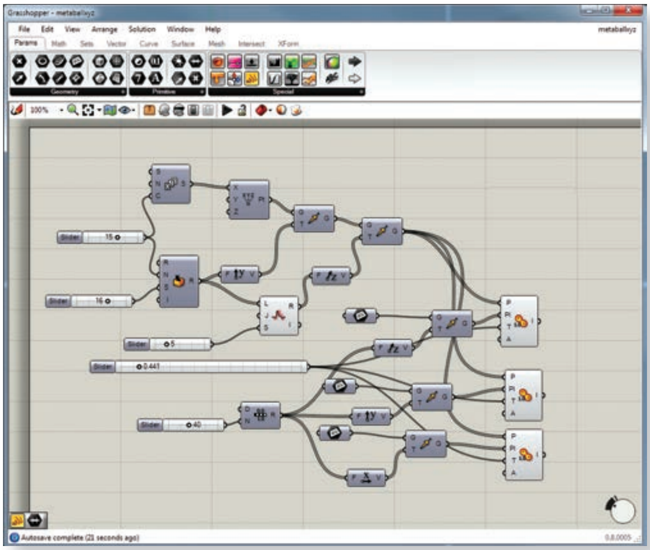
In addition to modeling in Rhino, you can import files from numerous sources, including AutoCAD, DXF, IGES, MicroStation, OBJ, SketchUp, SolidWorks, STEP and STL. Rhino also supports 3D digitizers and imports 3D-scanned point cloud data.

Once you create a model in Rhino, you can add dimensions in any viewport. Dimensions are created parallel to the viewport's construction plane and appear on those planes in 3D viewports. Annotation styles control the appearance of both annotation text and dimension objects. You can also generate a two-dimensional drawing from a three-dimensional model by projecting the geometry to the world coordinate plane and aligning the views.

In addition to the three orthographic views, a two-dimensional perspective drawing is also generated. Hidden lines are removed and placed on a separate layer. The 2D drawings are created on the Top construction plane near the origin on the world XY-plane and can be viewed in the Top viewport.

Rhino's Print command lets you print one viewport at a time. There is also a Layout feature that prints multiple details of the model on one sheet. The details can have different scales, sizes, layer color, layer visibility and object visibility. You can add borders and title blocks and then print the finished sheet.

You can also add customizable materials to objects in the model, place lights and render those models, saving the results in several bitmap formats. And you can create sun-study, fly-through, path and turntable animations.



The Grasshopper visual programming language, now included as part of Rhino 6, lets you create programs by connecting the outputs from one component to the inputs of other components.

Completed models can be exported as mesh models in many different formats, including ACIS, AutoCAD, Google Earth, IGES, Parasolid, SketchUp, STEP and STL.

New in Rhino 6

Rhino 6 incorporates the Grasshopper visual programming language, formerly an add-on. Grasshopper is often used to build generative algorithms to create 3D geometry. You can create programs by dragging components onto a canvas and connecting outputs from one component to inputs of other components.

Other changes in the new release include improvements to the Make2D command, a faster display pipeline that includes a real-time ray-traced viewport mode and documentation workflow improvements. For example, you can now use multiple fonts with bold, italic and underline, in a single block of text. Rhino 6 also boasts faster, crisper on-screen display of text in model views and layouts; better control of annotation styles; the support of fields to display data from the document or objects; enhanced tolerance options; support of stacked fractions in all annotations and double-click editing of annotations.

The tools for capturing views now have a dialog to control various settings. A new AddGuide tool lets you create infinite lines that can be used for temporary modeling aids. Meshes can now have facets that are triangles, quads or N-sided polygons. You can distribute selected objects evenly between two points or at a specified distance. You can generate a mesh from a line network. And the Gumball tool can now extrude points.

Capturing Rhino

Though it's easy to get started with Rhino, the sheer number of tools and the variety of uses means that it can take time to become proficient. There are several resources available to help you learn Rhino, including free downloadable tutorials complete with sample files. There are also numerous online training resources.

Rhino 6 is available as a free 90-day evaluation. After the trial, you lose the ability to save files, and plug-ins stop working unless you purchase a license. There are three ways to license Rhino: Single-Computer activates Rhino on one computer; Zoo lets you float a set of Rhino licenses within your private network; and the new Cloud Zoo option makes your license available anywhere in the world through a login.

Cloud Zoo offers many benefits, including the ability to use Rhino on any computer, create a pool of licenses to share among team members, and automated license provisioning with no client configuration and no servers to maintain. Robert McNeel & Associates also sells add-ons. In addition to purchasing individual licenses for Rhino and these add-ons, the company also sells bundles. Apple users can purchase Rhino 5 for Mac for $695.

It's no wonder that Rhino has continued to improve and attract new users for more than 20 years. Its power and flexibility mean that the things you can model in Rhino are limited only by your imagination. **DE**

[DISCLOSURE: Until its dissolution, David Cohn was the president and sole stockholder of Eclipse Software, Inc. Robert McNeel & Associates was a reseller of Eclipse's Façade software and Eclipse sold a Façade software bundle that included McNeel's Accurender software. In 1995, Eclipse sold all rights for Façade to McNeel. David Cohn has had no further business relationship with McNeel since that sale.]

David Cohn *is the senior content manager at 4D Technologies. He also does consulting and technical writing from his home in Bellingham, WA. He is a Contributing Editor to DE and is the author of more than a dozen books. Contact him via david@dscohn.com or via dscohn.com.*

INFO ➜ Rhino3D: Rhino3D.com

Rhino 6

PRICING

- **Rhino 6 for Windows:** $995, **Upgrade:** $495

SYSTEM REQUIREMENTS

- **OS:** Windows 10, 8.1 or 7 SP1
- **Processor:** Intel or AMD CPU (no more than 63 CPU cores)
- **Memory:** 8GB minimum (more recommended)
- **Disk Space:** 600MB required for installation
- **Display:** OpenGL 4.1 capable video card is recommended

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Advertiser Index

EDITOR'S PICKS

Each week, DE's editors comb through dozens of new products to bring you the ones we think will help you do your job better, smarter and faster. Here are our most recent musings about the products that have really grabbed our attention.

Tap Into Production-Ready Thermoplastic 3D Printing

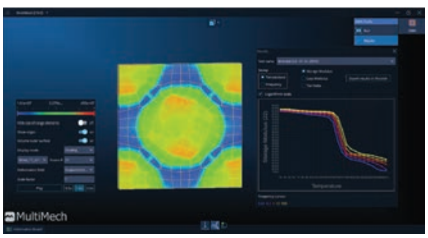
HP's Production System offers repeatability, economies of scale and more.

HP's Jet Fusion technology works line by line, not point by point as in other 3D printing methods. Now HP offers a complete volume production platform. There's the printer, Build Unit, Natural Cooling Unit and a Processing station. Also, a community of strategic partners extends the system's value. Sstrategic alliances have been made with Siemens, Materialise and BASF. Custom software integrations are from Autodesk Netfabb and Siemens NX AM for HP MJF. **MORE ➜** digitalengineering247.com/r/22626

Open Source 3D Printer is Horse of a Different Color

LulzBot TAZ Workhorse Edition brings open source to the engineering desktop.

For this latest model, Aleph Objects focused on professional user needs, starting with hardware. The body was redesigned for more strength and the motion mechanics were upgraded with a new belt-driven Z-axis. The business end of an STL printer, the hot applicator, is now a modular system with three options. Print heads are designed for 360-degree cooling, which Aleph Objects says offers improved performance for overhang and bridge printing. **MORE ➜** digitalengineering247.com/r/22598



Software Boosts Features for Product Development

Composite simulation software specializes in FEA of carbon fiber, other composites.

This update features a new bi-modulus elastic model, to ease engineers' ability to realistically predict carbon fiber mechanical behavior.

MultiMechanics says its solver is 1.5 times faster than the previous version. Also boosting the total speed of simulation is the ability to conduct parallel runs in its Optimizer module. MultiMechanics has redesigned the material database as well, in line with the solver improvements. **MORE ➜** digitalengineering247.com/r/22567

Multi-domain Systems Analysis Just Got Easier

Siemens updates Simcenter Amesim with new features in four broad categories.

Siemens says the goal of this update is to democratize access to system simulation. Features are in four categories: vehicle electrification; aircraft systems performance engineering; controls engineering; and system simulation efficiency and ease of use. Vehicle electrification includes support for Simcenter Motorsolve. Aircraft systems performance engineering benefits from new CAD integration. Controls engineering is enhanced with real-time components. **MORE ➜** digitalengineering247.com/r/22543

Next-Gen Engineers

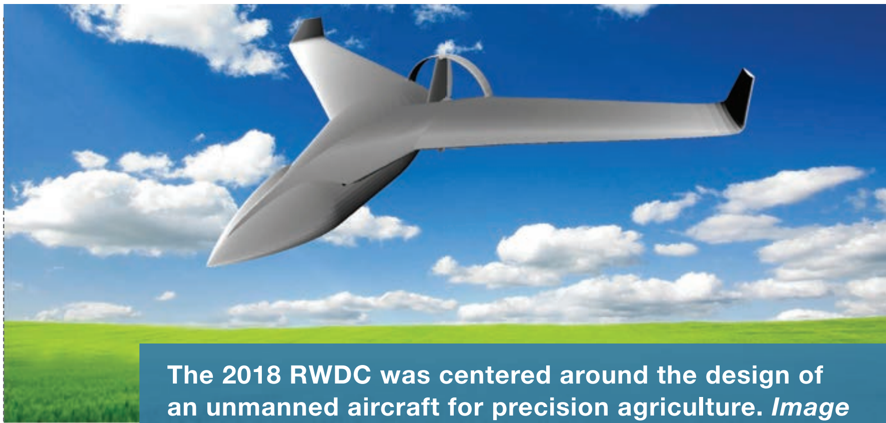
Student Design Competition Profile: The Real-World Design Challenge

Building the U.S. Stem Workforce

BY JIM ROMEO

THE REAL WORLD Design Challenge (RWDC), which began in 2008, readies participants for employment in science, technology, engineering and mathematics (STEM) fields. It was created to help build the U.S. STEM workforce with a focus on aerospace and defense.

Dr. Ralph K. Coppola is the president of RKC International and founder of the RWDC, associated with the Embry-Riddle Aeronautical University Worldwide in Daytona Beach, FL. We spoke to him to learn more about the competition.



The 2018 RWDC was centered around the design of an unmanned aircraft for precision agriculture. *Image courtesy of RWDC.*

Digital Engineering: Can you provide an overview of the Real World Design Challenge competition?

Dr. Ralph Coppola: Through a rigorous academic program and judging process, the RWDC is building a pipeline of the "best and brightest" students that will become STEM professionals.

The RWDC supports STEM education in high schools through an annual competition that provides students with the opportunity to apply the lessons of the classroom to the technical problems currently faced in the engineering field; the academic goal of the RWDC is to motivate and prepare students for the STEM workforce and teach innovation.

With training and support by mentors, students learn the technical elements of aircraft design. Through their participation in RWDC each year, students develop STEM and business skills through work on an engineering problem.

DE: What's behind the title "Real World Design Competition"?

Coppola: The research that impacted the design of RWDC included the finding that industry wanted STEM employees that possess an excellent academic background and 7 to 10 years of "real-world" experience. The name "Real World Design Challenge: The Innovation Engine" was chosen based on the research and the goals set for the program.

When industry leaders were asked if it was possible to provide the "real-world" experience to the students at the education level, they responded in the affirmative. So one of the program goals was to design a program that provided "real-world" experience at the education level. If this goal could be accomplished, it would be possible to cut almost 10 years off the STEM pipeline.

You cannot teach engineering without teaching the engineering design process. That is why the word "design" is in the name of the program. In order to have students rise to higher levels of achievement, it was necessary to challenge the students with an academically rigorous problem and have them compete to come up with the best solution. Thus, the word "challenge" was included in the name of the program. Another program goal was to develop the next generation of innovators by design. Today, innovation has happened in society by chance. The RWDC was developed to create innovators by design thus increasing the number of innovators.

DE: What was the goal behind the 2018 Challenge?

Coppola: Design unmanned aircraft systems (UAS), create a theory of operation and develop a business plan for the commercial operations of the system, based on the following scenario:

Your company has been tasked with making a case whether or not the FAA part 107 regulations are restricting the ability to improve crop yield while minimizing profits. You will be comparing your aircraft to two aircraft that do precision agriculture in the U.S.

The UAS design should perform spraying and/or surveying better than one or both of the aircraft given. While you may choose to have capabilities of both UAS designs given in your design, you must do better than the DJI Agras MG-1 at spraying, do better than the eBee SQ at surveying or do better at both.

The cost of performing the additional tasks that your UAV design does not complete must be accounted for in your costs for servicing the field. You must, however, have at least one UAV that completes the survey and/or spraying tasks of the DJI Agras MG-1 or the eBee SQ. **DE**

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