Stay Current, Be More Productive

Speed simulation-driven design by more than 9X by using modern Autodesk software and the latest hardware.

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DE Technology for Optimal Design Engineering

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This is the fourth in a series of benchmarking studies produced by Desktop Engineering *with Intel, Dell and independent software vendor sponsors that is intended to explore the benefits of embracing simulation-led design.*

Executive Summary

By now, most engineers are well versed in the virtues of computer-aided engineering (CAE) software. They know simulation helps analyze and predict product performance in the virtual world, minimizing the need for building costly prototypes. They are aware that use of simulation is crucial for identifying weaknesses in potential designs, for the selection of materials, and as a means of optimizing products to hit specific cost and lightweighting targets.

What engineers are now starting to recognize is that use of simulation early on and throughout the development cycle elevates that value proposition even further. In the following pages, you'll see how companies such as Norgren, Parker Hannifin, Cessna Aircraft and Advanced Consulting and Engineering Services invested in analysis tools to explore many more design concepts in richer detail. At the same time, they can predict the implications of design changes quickly, circumventing (or at least, condensing) the traditional, highly iterative cycle of building and testing physical prototypes. For example, Cessna used Autodesk Nastran's Tension-Only Quad Element to avoid creating redundant models and repetitive work functions. Likewise, Norgren developed a diverter valve in Autodesk Inventor and used Autodesk CFD simulation capabilities to cut time-consuming physical prototyping out of its design process. "We're under short deadlines so the more we can use Digital Prototyping to simulate all the stuff and gain confidence in the designs before we produce them, the better," says Chris Narborough, design engineer at Norgren.

Early Analysis Yields Optimal Design

The case for ongoing simulation gets even better when the practice is used to zero in on potential problem areas in the early design stages. This allows engineering teams to make adjustments far more easily and protects them from costly missteps that can lead to major product delays or the expense of scrapping physical prototypes and manufacturing tooling on the heels of late-stage design changes. Simulation also plays a key role in allowing engineering teams to validate designs before testing, once again limiting reliance on physical prototyping and helping to shorten product development cycles and accelerate time-to-delivery.

There is no disputing the role simulation plays in advancing design, but its benefits can be severely undermined without investing in the proper hardware and software.

Autodesk CFD running on a modern workstation will run certain analyses more than 9X faster than they would run on three-year-old hardware and software.

While there is no disputing the role simulation plays in advancing the full spectrum of design practices, its benefits can be severely undermined without an investment in the proper hardware and software platform. What engineers might not realize is that simulation software and hardware technologies are evolving at a rapid pace. Today's modern workstations from Dell and Intel come standard with such state-of-the-art capabilities as multi-core processors, solid-state drives (SSDs), and both CPU embedded and high-end plug-in graphics processing capabilities, which provide a powerful platform for CAE applications and large-scale simulation models, making a world of difference in their performance. At the same time, CAE software is also undergoing significant improvements, bringing new solvers, algorithms, intelligent memory management techniques, and improved parallelism to better embrace the current Dell/Intel platform and deliver enhanced user performance that rewards hardware upgrades with faster and more reliable pre- and post-processing functionality.

Improvements Speed Simulation

Autodesk Simulation, as part of the company's Digital Prototyping solution, offers a portfolio of mechanical, computational fluid dynamics (CFD), composite, structural, and plastics simulation capabilities that have been optimized to exploit modern hardware for optimal performance. The latest versions of Autodesk CFD 2016 and Autodesk Nastran 2016, include algorithm enhancements, meshing improvements and across-the-board solver upgrades that deliver a higher level of performance for both routine and complex simulation tasks.

As the benchmarking results in this report show, Autodesk CFD 2016 running on a modern workstation with dual, multi-core processors (up to 10 cores) will run certain large-scale fluid and thermal analyses more than 9x faster than they would run on a three-year-old workstation. Read on to see how much faster both CFD and Nastran problems can be solved via the latest versions of the Autodesk software running on a modern Dell Precision workstation. ●

The Benchmarking Study

As a result of outdated simulation environments, many engineering organizations are unable to perform analysis on large-sized models.

Many engineering organizations are stuck in a performance rut because they are still running simulations on older workstations or consumer-grade PCs as opposed to higher performance platforms. This underpowered hardware is constraining their simulation efforts, discouraging teams from taking full advantage of the power of analysis-led design simply because they can't afford to wait around for results or they can't commit wholesale use of their computing resources to simulation for extended blocks of time. As a result of outdated simulation environments, many engineering organizations are unable to perform analysis on large-size models and are discouraged from attempting more complex and challenging simulation problems due to the associated costs and significant time requirements.

Autodesk, Intel and Dell collaborated with *Desktop Engineering* to explore the impact of outdated software and hardware on present-day simulation studies. A benchmark study was conducted to test vendor claims that state-of-the-art hardware and simulation software upgrades can make a big difference in the scope and performance of simulation-driven design and optimization. For the study environment, three-year-old and a current-day Dell Precision workstations were deployed to compare performance of the same set of simulation studies running on the older workstations and current CFD simulation software, on the older workstations and older Nastran software, and finally on the current generation of both hardware and software. Autodesk CFD Flex 2016 was used for CFD testing purposes on both the old and new systems while NEi Nastran 10.03 was run on the old machines and Autodesk Nastran 2016 on the new system. NEi Nastran was acquired by Autodesk in 2014. ●

The Benchmarking Setup

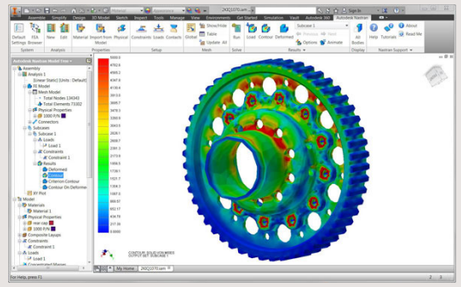
	Dell Precision T1600 workstation (3+ years old)	Dell Precision T5600 workstation (3+ years old)	Dell Precision Tower 7810 workstation
Software	NEi Nastran 10.3	Autodesk CFD Flex 2016	Autodesk CFD Flex 2016 and Autodesk Nastran 2016
Processor	Quad Core Xeon E3-1270, 3.40 GHz Processor	Quad Core Xeon E5v1, 1.333 MHz Processor	Dual Intel Xeon E5-2687W v3 3.1GHz
Cores	4	4	10
RAM	32GB	32GB	128GB
Hard Disk System	500GB 7200RPM	500GB 7200RPM	256GB SSD Hard drive

Introducing Autodesk Simulation

JUST AS SIMULATION is an integral part of the product development process, it's an equally important component of Autodesk's digital prototyping solution.

Autodesk offers a full simulation portfolio, from mechanical and structural simulation capabilities to help predict product performance through linear, nonlinear, thermal stress and dynamic analysis to CFD simulation for fluid flow and heat transfer analysis exploration. With an eye towards the total product design lifecycle, Autodesk Simulation also encompasses simulation capabilities for plastic injection molding processes (Autodesk Moldflow) as well as for analyzing the structure and component behavior of laminates and other composite materials (Autodesk Helius Composite)

While Autodesk offers CAD-embedded FEA tools like Nastran In-CAD, the Simulation portfolio is competitive with standalone analysis tools, covering the full spectrum of simulation functions for complex



analysis and delivering the highest accuracy results.

With its comprehensive set of solutions, Autodesk Simulation is key for helping engineers solve today's challenging design problems, allowing for a greater number of potential designs to be explored, more often, and in richer detail.

autodesk.com/products/simulation/overview

The Dell Precision Tower 7810

THE CURRENT GENERATION OF DELL WORKSTATIONS INCLUDES THE DELL PRECISION TOWER 7810, which features a new generation of dual-socket performance with the Intel® Xeon® Processor E5-2600 v3 processor series featuring up to 14 cores per processor, the latest NVIDIA® Quadro® or AMD FirePro™ graphics and up to 256GB of system memory using the latest DDR4 RDIMM memory technology. Plus, the innovative, toolless chassis makes it easy to access and upgrade internal components.

On the storage front, the Dell Tower 7810 has an actively cooled PCIe solid-state drive, which is up to 180% faster than traditional SATA SSD storage. Traditional hard drive options are also available, and with the Intel CAS-W software solutions, users can enable I/O speeds close to that of solid-state drive configurations at the storage and price of traditional drives.

All Dell Precision workstations are independent software vendor-certified with AutoCAD, Autodesk Inventor, Autodesk Revit, and others to ensure engineering design applications run smoothly. Also free with Dell Precision workstations, the Dell Precision Optimizer automatically tunes the workstation to run specific programs at the fastest speeds possible, enhancing productivity.

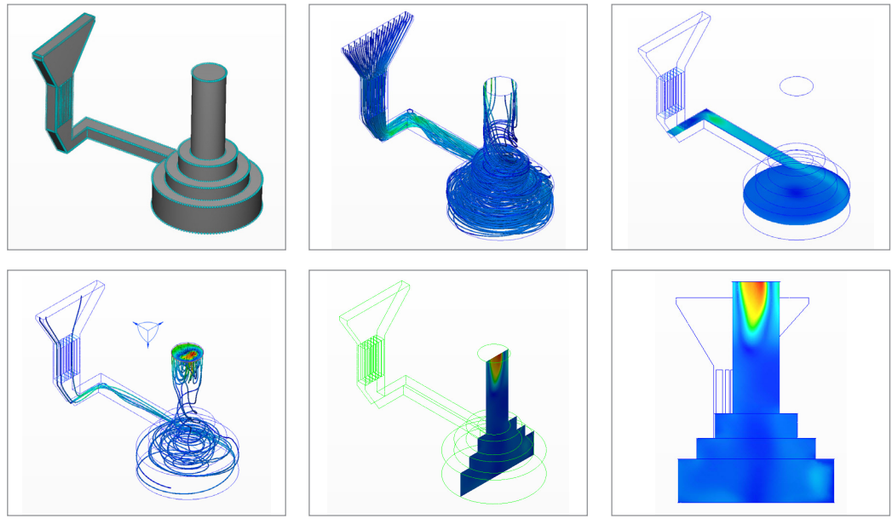
The Dell Precision 7810 also features endpoint security solutions that include encryption, advanced authentication and malware protection from a single source.

Dell.com/precision

Benchmarking Results

CFD Problem Descriptions

The first study involved a fluid flow analysis of how water moves through a structure, determining velocity, pressure and other results throughout the system. As the model increased in element count, the simulation software was able to take advantage of the new systems' multi-core processors for greater speedup, allowing for more iterations of the design.



Fluid Flow – Small

Elements: 1,299,034
Nodes: 236,231
Solution times:
Three-year-old workstation and current software:
95.3 minutes
Current workstation and current software: 37.5 minutes

Total Speedup: 2.54x

Fluid Flow – Large

Elements: 12,604,248
Nodes: 2,336,594
Solution times:
Three-year-old workstation and current software:
1,237.6 minutes
Current workstation and current software: 409.4 minutes

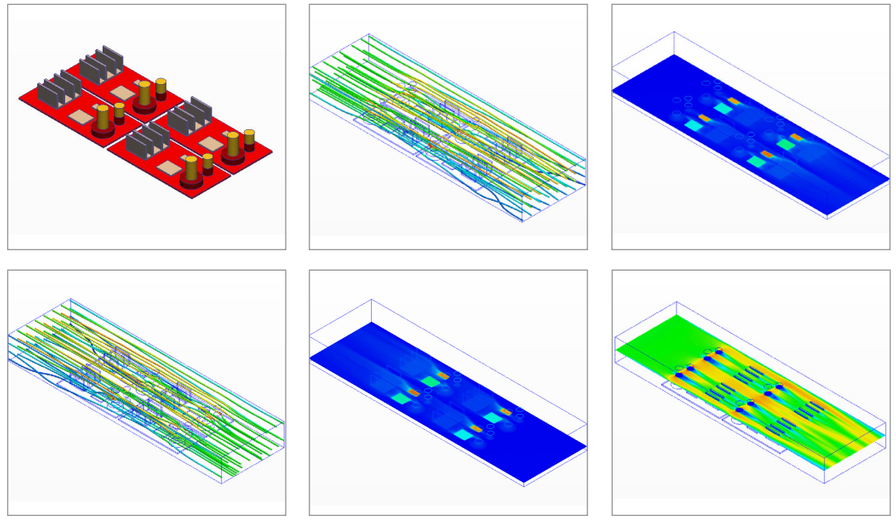
Total Speedup: 3.02x

Fluid Flow – Medium

Elements: 4,896,880
Nodes: 931,752
Solution times:
Three-year-old workstation and current software:
456.6 minutes
Current workstation and current software: 166.1 minutes

Total Speedup: 2.75x

The second CFD study involved a coupled analysis to consider both fluid velocity and thermal properties. The 3D heat transfer analysis of a circuit board with heat generation applied to various chips being cooled with external air at room temperature was studied. The more complex analysis was able to leverage the multiple cores and processors of the new workstation to achieve dramatic speed increases, particularly with an increasing number of elements and nodes as part of the model.



Fluid / Thermal - Small

Elements: 1,255,800
Nodes: 244,691
Solution times:
Three-year-old workstation and current software:
35.8 minutes
Current workstation and current software:
15.2 minutes

Total Speedup: 2.36x

Fluid / Thermal - Medium

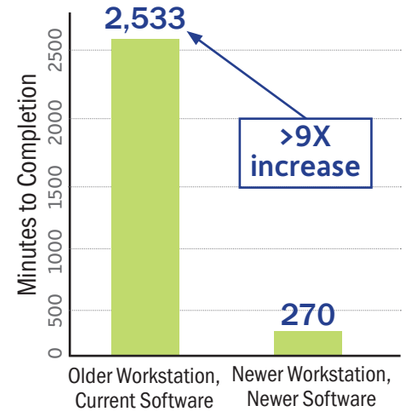
Elements: 6,333,748
Nodes: 1,208,891
Solution times:
Three-year-old workstation and current software:
469.5 minutes
Current workstation and current software: 150.6 minutes

Total Speedup: 3.12x

Fluid / Thermal – Large

Elements: 14,440,153
Nodes:
2,806,317
Solution times:
Three-year-old workstation and current software:
2,532.8 minutes
Current workstation and current software:
269.7 minutes

Total Speedup: 9.39x



Nastran Problem Descriptions

Static Analysis of a Cargo Ship Container

A static analysis of a large cargo ship container using the full 10 million degree of freedom model. By upgrading to a newer machine and current simulation software, this large-scale model can complete its run time during a short coffee break as opposed to taking an entire lunch break to run the same model on an older machine with older software.

Degrees of Freedom: 10,000,000
Solution times:
Three-year-old workstation and old software: 28.0 minutes
Current workstation and current software: 12.4 minutes

Total Speedup: 2.26x

Static Analysis of a Bracket

This static analysis of a bracket is a study on how mesh size impacts run time, giving engineers a better understanding of how they can create detailed models while still staying within time constraints. The combination of a modern workstation and current simulation software can drastically speed up analysis, allowing a large model with a detailed mesh to be run over a long lunch break versus having to consume the processing horsepower of an old machine for an entire day.

Degrees of Freedom: 66 million
Solution times:
Three-year-old workstation and old software: 541 minutes
Current workstation and current software: 85 minutes

Total Speedup: from 6.4x

Modal Analysis of an SUV

This analysis of a full car model is used to find the natural frequencies in order to improve the noise, vibration and harshness (NVH) qualities of the vehicle. The ability to tap a greater number of processors combined with the faster read/write speed of the SSDs resulted in cutting the analysis time by nearly half. Improvements to the Nastran software's solvers and meshing functionality also contributed to the performance boost.

Degrees of Freedom: 1,200,000
Number of Modes: 20
Solution times:
Three-year-old workstation and old software: 13.3 minutes
Current workstation and current software: 7.5 minutes

Total Speedup: 1.8x

Modal Transient analysis of BIW model

This is an automobile body in white (BIW) modal transient analysis. This analysis is used to explore the response of the structure under excitation loads. Cutting the run time from 52 minutes to 15 minutes will have a huge impact of the ability to iterate on the design.

Degrees of Freedom: 3,100,000
Solution times:
Three-year-old workstation and old software: 52.6 minutes
Current workstation and current software: 15.5 minutes

Total Speedup: 3.4x

Maximize Your Software Performance

THE DELL PRECISION OPTIMIZER IS A FREE, AUTOMATED TOOL that ensures your software from Autodesk runs at its maximum potential by fine tuning your system beyond factory settings. When the Optimizer was applied to our Precision Tower 5810 running AutoCAD and the catalyst 2015 2D Graphics Index performance boosted by 9% without changing hardware components. This extra performance allows engineers to design faster and stay more competitive...for free.

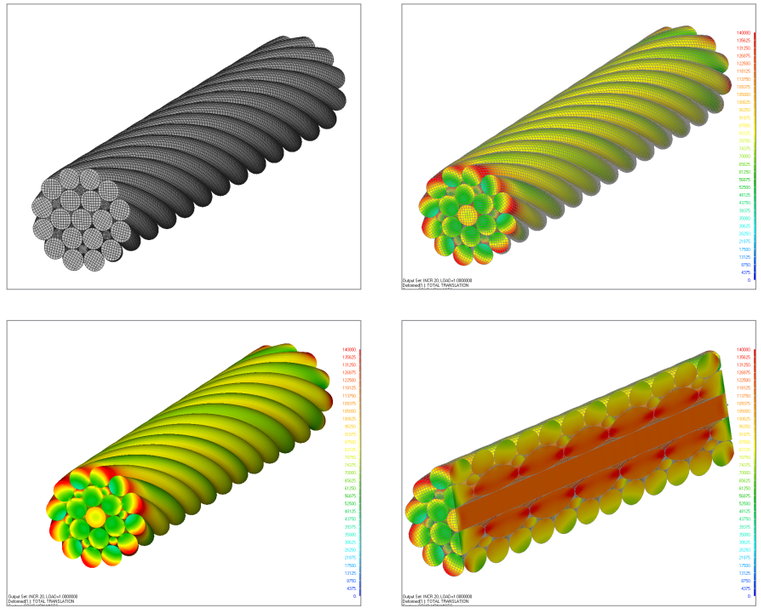
Learn more about the Dell Precision Optimizer and what ISV applications are supported at Dell.com/optimizer.

Nonlinear Cable

This is an analysis of a cable model for a suspension bridge. The model consists of 25 individual cables twisted together to form a single larger cable. There is complex surface contact between all cables. Nonlinear analyses typically take much longer than linear solutions so cutting the solution time in half (or less) can have a big impact on efficiency.

Degrees of Freedom: 1,300,000
Solution times:
Three-year-old workstation and old software: 127.1 minutes
Current workstation and current software: 55.6 minutes

Total Speedup: 2.3x

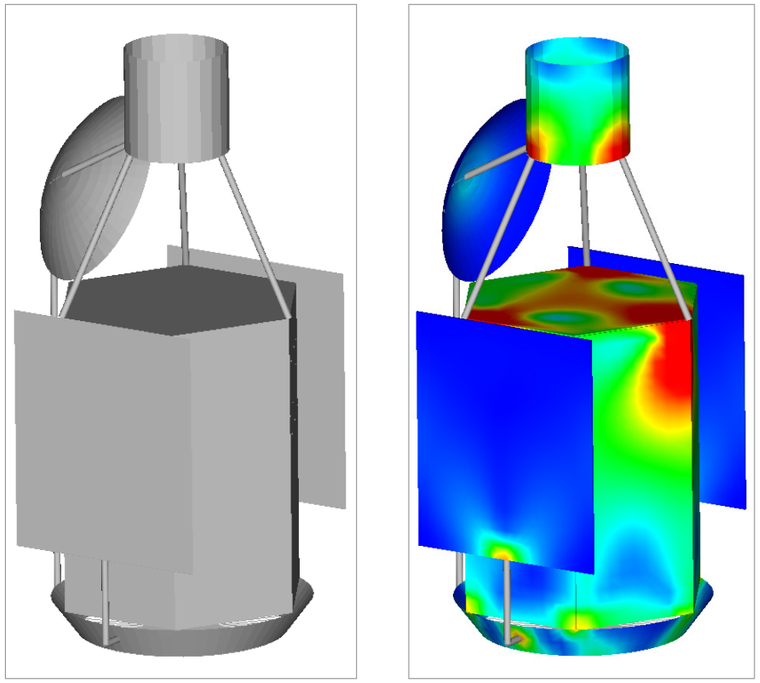


Direct Frequency analysis of a satellite model

This is a direct frequency analysis of a satellite structure used to find excitation frequencies of the structure. The current version of Nastran's improved meshing capabilities and new solver options were instrumental in the performance boosts as was the faster read/write time of the SSDs and number of additional processors.

Degrees of Freedom: 1,200,000
Solution times:
Three-year-old workstation and old software: 24.5 minutes
Current workstation and current software: 13.8 minutes

Total Speedup: 1.8x



Faster Simulations is a Current Event

The combination of increasing product complexity coupled with shrinking time-to-market cycles is raising the stakes for product development for companies across most industries. Simulation, conducted on a widespread scale and used continuously throughout the development cycle, is proving to be a powerful tool in companies' ability to innovate and compete on a global scale while mitigating the risks associated with cost-effectively bringing products to market.

Armed with the latest simulation software running on the latest Dell and Intel platform, companies are assured of having a well-calibrated platform at their disposal to optimize simulation studies, resulting in more possibilities and ultimately arriving at the optimal design much faster than traditional processes. Below are the stories of how four companies are leveraging simulation to their best advantage

Fast Tracking Time to Market

Traditional exhaust valves on truck diesel engines are leaky and thus not highly energy efficient. Norgren, a global fluids control manufacturer, was aiming for a way to absorb the wasted heat and convert it into useful energy, yet it needed to come up with a design in fairly short order.

Using Autodesk Inventor 2013 and Autodesk CFD as part of a digital prototyping strategy, the Norgren team developed the Diverter Valve, part of its waste heat recovery system for truck engines. The objective was to create a solution that was small, compact and light, but could also optimize fluid flow and minimize leakage and pressure drop.

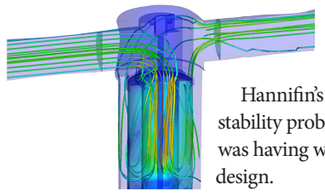
Upfront analysis was a standard part of the design process, used in tandem with Inventor for the CAD design work and 2D drafting. Throughout the development effort, Autodesk CFD was used to model and check the flow through the various valve components and to also keep tabs on the pressure drop and flow path. Once an initial prototype was designed, the team relied on Autodesk CFD to verify the design to ensure it could handle the waste heat recovery application.

Norgren was under pressure to supply samples to customers in pretty tight window, therefore it couldn't afford to waste time and money creating multiple, physical prototypes. With Autodesk digital prototyping — and more specifically, its CFD simulation capabilities — Norgren was able to cut all of that time-consuming iteration out of its processes and get to the optimal design quickly.

> "Autodesk CFD gives us a better understanding of product performance and in turn, allows us to develop cost-effective, innovative and more reliable designs in less time ..."
>
> — Bruno Fairy, Parker Hannifin

"We're under short deadlines so the more we can use Digital Prototyping to simulate all the stuff and gain confidence in the designs before we produce them, the better," says Chris Narborough, design engineer at Norgren.

Virtual Problem Solving



Looking for a needle in a haystack is how you might describe Parker Hannifin's quest to unearth an instability problem one of its customers was having with a wheel loader spool design.

The Hydraulic Controls Division kept building and testing physical prototypes, but after 18 months of the conventional process, it still couldn't effectively pinpoint the problem. Eventually, engineers decided to shift gears and take a virtual approach in the hopes of unlocking the mysterious source of cavitation.

Using Autodesk CFD, the team was able to develop a model, analyze it and finally visualize the problem. The team designed the solution in Autodesk AutoCAD and ran CFD tests once again to confirm the new design would yield better results. Not only did the solution work, the simulation also provided a deeper level of insight into what was actually going on inside the wheel loader to cause the problem.

"In certain situations, virtual product development technology is the only way to solve a problem," said Bruno Fairy, a simulation and analysis engineer for the Hydraulic Controls Division. "Autodesk CFD gives us a better understanding of product performance and in turn, allows us to develop cost-effective, innovative and more reliable designs in less time than using conventional methods of building and testing physical prototypes."

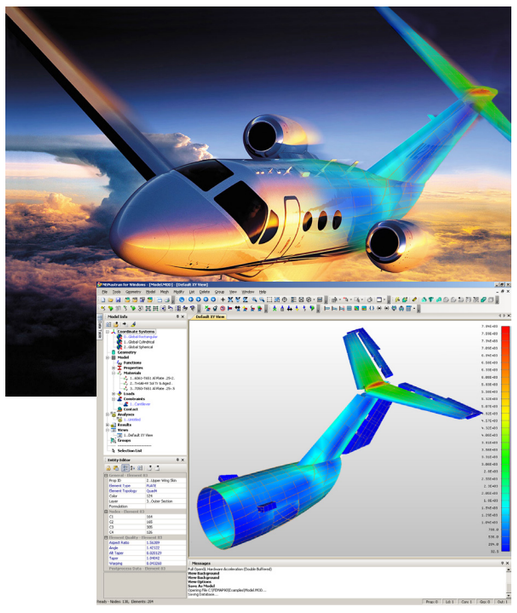
Reducing Analysis Cycle Time

Cessna Aircraft Company is an American aviation icon best known for its small, piston-powered aircraft and business jets.

The company's new Citation CJ3 and Citation Mustang business jets took flight in part thanks to use of Autodesk's Nastran FEA simulation tool. Autodesk Nastran was essential for optimizing the airframe components on both aircraft, but also for streamlining the development cycle to ensure the new planes were released in a timely manner.

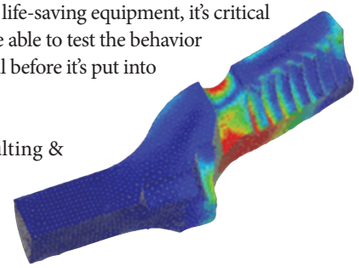
Using Autodesk Nastran's Tension-Only Quad Element, the Cessna team was able to avoid creating redundant models and repetitive work functions. In addition to the advanced FEA functionality, Autodesk Nastran allowed for complete access to Cessna's legacy data, critical for this development effort, while Autodesk's technical support was a key resource for the firm's line engineers.

"Tension-Only Quad Elements eliminates redundant models and repetitive work functions, resulting in reduced analysis cycle time," says Gene Paulsen, a senior Cessna engineer.



Predicting Product Behavior

When developing life-saving equipment, it's critical for engineers to be able to test the behavior of the product well before it's put into action.



Advanced Consulting & Engineering Services (ACES), a German engineering services company, helps its medical industry clients achieve that goal through extensive use of simulation. As part of its collaboration with medical implant manufacturer Schäfer Micomed GmbH, ACES turned to Autodesk Nastran to help examine the performance of spinal implant screw and hinge well before building a physical prototype.

With Autodesk Nastran, the design team was able to analyze the behavior and load performance of a titanium hinge, part of the spinal implant, using a nonlinear static solution with contact and material nonlinearity. Following that analysis, Autodesk Nastran was used for linear static analysis to compare bone screws as part of the overall design effort.

The Nastran analysis helped the team develop a better design, which resulted in less stress. By predicting the behavior of the spinal implant screw, the team was able to determine that excess thread would be broken off with a force of approximately 120N. Going back to the drawing board with this insight allowed the team to modify the notch to have a maximum effective plastic strain of approximately 10% due to an applied end force.

"The two main advantages we gain through use of FEA are shorter time to market and optimized designs to avoid vibrations or to reduce weight and cost," says Thilo Trautwein, managing director at ACES. ●

The Cost of Falling Behind

Widespread use of simulation is a critical component of design success. Those companies that remain at a standstill with simulation or haven't made a commitment to keeping both hardware and software up-to-date are at risk of losing their competitive edge by constraining their design practices, which results in sub-optimal products.

Companies will be hard pressed to accommodate increasing product complexity or meet the demands for lighter weight, cost-optimized structures without a commitment to expanding use of simulation throughout the product design lifecycle. Substandard simulation practices also make it more difficult to make ongoing improvements to existing offerings, let alone delve into the exploration necessary for launching whole new categories of products.

Although there are costs associated with hardware and software upgrades, those investments are far outweighed by the resulting benefits of infusing simulation into design practices.

Although there are obvious costs associated with hardware and software upgrades, those investments are far outweighed by the resulting benefits of infusing simulation into design practices at both large and small enterprises. Widespread use of simulation has productivity benefits for individual engineers who are empowered to solve tougher design problems in less time. That has huge repercussions well beyond the engineering department. Just imagine what it would mean if you get to market ahead of your competition. What would pulling in a car model a year early, for example, mean for a company's revenue? ●

Flexing the Cloud

AS ENGINEERING ORGANIZATIONS DIVE DEEPER into analysis-lead design, they often run up against the constraints of their hardware, which may not be equipped for simulation's heavy lifting.

The Autodesk Simulation portfolio solves that problem with its flexible cloud solving options, which increase productivity by allowing engineers to solve multiple simulations simultaneously while keeping local computer resources free for other tasks. The cloud solving options are available for Autodesk Simulation Mechanical, Autodesk CFD, and Autodesk Moldflow.

Unlike a traditional use case, where an engineer taps local resources to solve one simulation before moving on to analyze results or perform other work, Autodesk's Simulation Flex options let users deploy simulations in the cloud, reclaiming their local computer for other tasks. With this option, engineers can solve multiple simulations simultaneously in the cloud while working on other projects, enhancing overall productivity and reducing design cycles. This compares to traditional simulation practices, which can tie up a system for hours or longer depending on the complexity of the simulation and the number of iterations.

In addition to leveraging the cloud for simulation flexibility, Autodesk also offers Fusion 360, its next-generation cloud-based CAD offering that also incorporates simulation functionality.

On top of its mobile, desktop and rack-based workstations, Dell's enterprise solutions can help in the cloud planning, adoption and management process, Dell consultants can help develop a winning strategy for hardware, software, and enterprise deployments.

Visit Dell.com/cloud to learn more.

Appendix

Autodesk Nastran In-CAD
Autodesk.com/products/nastran-in-cad/overview

Autodesk CFD
Autodesk.com/products/cfd/overview

Autodesk Simulation Gateway Page
Autodesk.com/products/simulation/overview

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