Optimize Your Design Process

Speed up simulation-driven design by 6.9X to 17X with Altair's optimization software and Dell Precision workstations.

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DE Technology for Optimal Design Engineering

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This is the third 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

Some things are more than the sum of their parts. In the complex world of engineering, simulation software closely coupled with optimization capabilities makes for a dynamic duo that radically redefines design workflows. When simulation and optimization are powered by modern workstations, the benefits are multiplied, allowing design engineering teams to boost innovation, lower costs and speed time to market.

Embracing Simulation and Optimization

While many organizations have embraced simulation software, fewer have adopted optimization, and an even smaller number have melded both disciplines into a single, integrated workflow running on the latest computing hardware. The barriers to adoption are many. A majority of these software tools are still oriented toward an expert audience, making it difficult for the average engineer to tap into their full set of capabilities. Most organizations, under pressure to compress development cycles, cut back on the number of iterations and delay hardware investments to save time and short-term costs. Finally, simulation and optimization tools often hail from different vendors, introducing layers of complexity and incompatibilities that hinder the synergies of the two design technologies.

As a result, simulation and optimization are often put to work later in the design cycle, and often on older computing hardware. Doing so means design teams have already gone too far down the path to fully benefit from using the winning combination of simulation, optimization and current hardware. This late-in-the-game approach puts engineering organizations at risk of missing out on the promise of streamlined workflows and deep design exploration that gives way to higher quality products that might not have otherwise been discovered.

Streamlined Workflows + Deep Design Exploration = Higher Quality Products

Altair OptiStruct

Simulations were completed more than 17x faster when OptiStruct 14.0 was given access to the current workstation's 16 cores.

That's not the case with Altair's OptiStruct, a modern structural analysis solver for linear and nonlinear problems under static and dynamic loadings. Based on finite-element and multi-body dynamics technology, and through advanced analysis and optimization algorithms, OptiStruct promotes the development of innovative, lightweight and structurally efficient designs through tightly coupled use of simulation and optimization at each stage of the process.

Compared to conventional solvers, OptiStruct employs intelligent memory management techniques to gain added performance from its solution algorithms for linear, nonlinear and modal analysis problems. The tool can take advantage of the latest computer hardware advances to simulate structures with millions of degrees of freedom (DOFs) without any model size restrictions, providing more flexibility for extensive design studies.

Accompanying its robust solver portfolio are highly advanced optimization algorithms, enabling OptiStruct to solve complex problems with thousands of design variables in a short period of time. The optimization engine lets users combine topology, topography, size and shape optimization methods to create alternative concepts for structurally sound, but lightweight designs.

To attain the optimal performance out of OptiStruct, our benchmarks suggest organizations should consider investing in the latest release of the software and pairing it with the latest workstation hardware. Our benchmark tests show that OptiStruct version 14.0 running on a current Dell Precision workstation powered by Intel processors is up to 8X faster for some operations compared to running its predecessor, OptiStruct 11.0, on comparable three-year-old hardware using the same number of cores. When OptiStruct 14.0 was given access to all 16 of the current workstation's cores, some simulations were completed more than 17X faster. ●

Optimization Drives Design

By following a simulation-driven design and optimization path, engineers gain the ability to continuously fine tune designs to get the optimal outcome.

A simulation-driven design and optimization approach has become critical for organizations to develop competitive products in the current design landscape. Increasing product complexity has given rise to larger 3D models, stocked with data about system behavior, materials characteristics and other key parameters that go well beyond traditional geometric CAD data. To effectively consider the range of parameters affecting design, optimization needs to play a role throughout the process, allowing engineers to conduct powerful tradeoff studies in less time, at reduced costs and with minimal risk of encountering late-stage design problems.

However, given the rising complexity of optimization models, performance is critical for making these workflows a success. OptiStruct's efficient code, intelligent memory management techniques and ability to leverage parallel processing capabilities empower engineers to use the tool as an enabler for a variety of sophisticated design methodologies, including stochastic and design of experiment studies. With HyperStudy, a solver-neutral design study environment integrated into Altair's HyperWorks suite, users can perform optimizations and stochastic studies to explore and refine the performance and robustness of designs.

By following a simulation-driven design and optimization path, engineering organizations benefit from the ability to continuously fine tune designs to get to the optimal outcome. For example, OptiStruct, used in conjunction with other tools in the HyperWorks portfolio, allows teams to put optimization practices to work to refine shapes, including freeform shapes, sizes, and composite ply thickness and ply stacking.

Taking advantage of such capabilities on the latest hardware is a game changer, especially for complex applications. Here's how a handful of companies are putting simulation-driven design and optimization practices to work.

Structural Optimization

Developing a concept sports car that would resonate with Generation Y means striking the right balance between lightweight design and a structurally sound chassis roomy enough for a multi-friend road trip.

A team of graduate students in Clemson University's International Center for Automotive Research (CUICAR) did just that by leveraging Altair's HyperWorks simulation suite to maximize Body In White (BIW) stiffness and strength design targets while allowing for a unique look based on laminate composites. The Deep Orange 3 program, born from CUICAR's interdisciplinary research curriculum, tasked students to develop a six-seat vehicle based on the architecture of a mainstream hybrid. The configuration had to accommodate four 95th percentile male occupants in the outboard seats and two 50th percentile male occupants in the middle seats using a two-row, 3+3 seating configuration.

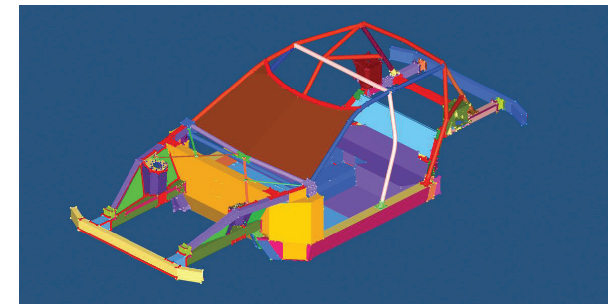
The Deep Orange 3 team built a cardboard mockup (top) to test the feasibility of Folded Metal Technology on its lightweight concept sports car before running simulations on their CAD model. Images courtesy of CUICAR.

The Deep Orange 3 team went with a BIW structural design concept that would leverage the Industrial Origami patented Folded Metal Technology (FMT) that enables the folding of lighter gauge materials into complex shapes to complete components in the body's structure. Developing the geometry, topology, and functionality of the BIW components was an exercise in carefully balancing design requirements for BIW stiffness, packaging space, cost, and weight, and Altair HyperMesh, OptiStruct and HyperView played a significant role in enabling those trade-off and optimization studies throughout each stage of the vehicle's design and manufacturing process.

The team first built a cardboard mock up to demonstrate the feasibility of the FMT, determining it could be applied to the front crush structure, the passenger compartment floor area and the rear crush structure. A CAD model was imported into HyperMesh for simulation preparation, and a series of in-depth analyses were run with the OptiStruct FEA solver to explore torsional and bending stiffness, natural frequency, and dynamic pothole and bump loads.

Using Altair HyperView post-processing capabilities, the FEA results showed that the BIW design met all the program requirements for body stiffness. Better yet, FEA exploration of the front sub frame — which involved applying dynamic loads representative of acceleration and braking as well as cornering maneuvers — showed that strength-critical areas also mapped to the stress allowable targets.

"Altair HyperWorks was a most useful tool for enabling our Deep Orange 3 body structures team to meet our BIW stiffness and strength design targets," noted Imtiaz Haque, executive director of CUICAR.



Altair HyperWorks was used to maximize Body in White stiffness of Clemson University's Deep Orange 3 Team's lightweight concept sports car. Image courtesy of Altair.

Optimization and 3D Printing

WITH ALL EYES ON LIGHTWEIGHTING and use of alternative materials like composites, designing complex lattice structures has become a top initiative for many design teams in industries ranging from automotive to aerospace & defense.

New solver capabilities in OptiStruct extend its topology and sizing optimization technology to make the design and optimization of these lattice structures far more intuitive and less time consuming. Used in conjunction with solidThinking Inspire, Altair's simulation and optimization tool aimed at non-experts, engineering organizations can create a seamless workflow that will result in innovative lattice design structures that can be produced far more efficiently and economically with 3D printing.

Inspire's concept generation techniques, which can be applied early in the cycle, take a free-form shape approach to design. Engineers simply define a space that represents the potential design volume while establishing loads and other boundary conditions, and Inspire comes up with an optimal shape. Once a concept is determined to meet basic performance requirements, OptiStruct's more advanced functionality can be put to work to further refine designs and take optimization to the next level. HyperStudy, Altair's multi-disciplinary design tool, can round out the workflow, helping teams examine tradeoffs between the various disciplines.

When the optimal shape and design is finalized, 3D printing is the natural choice to complete the job as it excels at producing hollow shapes with complex internal geometry compared to traditional manufacturing methods.

Altair's solidThinking Inspire can be used to 1. import or sketch a part, 2. defeature it, 3. assign materials and loads, and 4. then generate an ideal shape with the click of a button using mathematical optimization. Once a shape has been optimized, Inspire can help 5. confirm the part's performance so that the part can be 6. refined in a CAD program.

Multiphysics Optimization

SharkNinja (formerly Euro-Pro), a fast-growing consumer products manufacturer with well-known brands such as Ninja blenders and Shark vacuums, made a conscious decision several years back to formalize simulation best practices to bolster product performance and reduce the amount of physical testing.

While simulation was used in R&D to enhance physical testing and quality assurance processes, the practice hadn't gained a footing in product development, which primarily relied on the testing of physical prototypes to prove out design concepts. By increasing the role of simulation and optimization throughout the entire development cycle, the team hoped to gain insights from scenarios that would be impossible to test in the physical world. Early analysis would also precisely determine issues like the root cause of fracture or failure, giving the R&D and engineering teams better guidance on how to evolve a design on a variety of levels, from materials development and selection to durability.

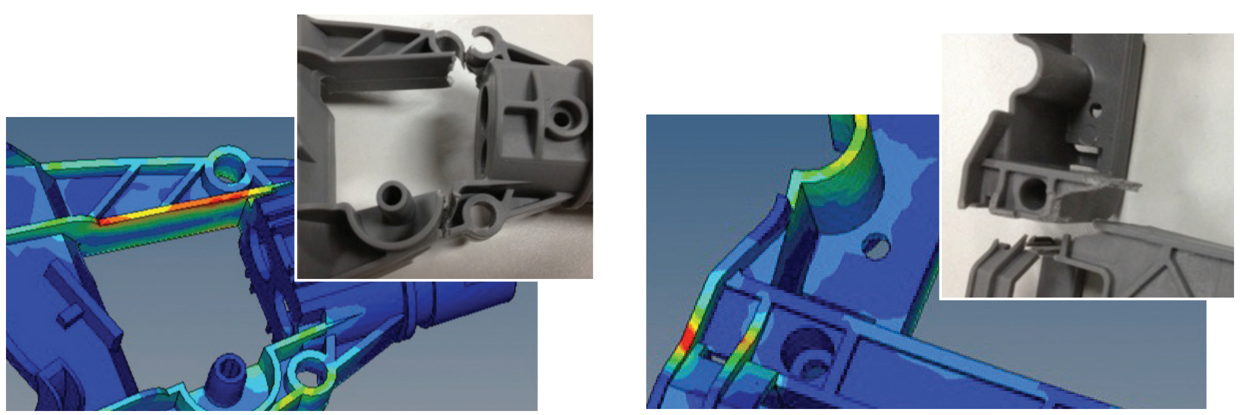
Structural analysis, and specifically drop simulation, was a top priority given that SharkNinja wanted its vacuum cleaners to be sturdy enough to withstand accidental drops or impacts during normal usage without resulting in mechanical failures or housing cracks. Using RADIOSS, a structural analysis solver that's part of the Altair HyperWorks suite, the SharkNinja team developed an FEA representation of the vacuum cleaner sections and subjected them to various drop and impact scenarios to gauge each design's durability in the virtual world. By understanding the root cause of potential problems early on in the design cycle, engineers were able to rectify issues without having to constantly build and test new models, which helped reduce design iterations and costs.

AcuSolve, a computational fluid dynamics (CFD) solver contained in the HyperWorks suite, offers greater accuracy for thermal and flow analysis than physical models for such use cases as increasing the suction power of vacuums and the mixing effectiveness of blenders. CFD also plays a role in assessing optimal nozzle shapes and testing different parameters to achieve more effective particle pick up.

Having both capabilities in single simulation suite, along with the HyperMesh tool for creating meshes and cleaning up geometry, was essential for SharkNinja to embrace simulation-led design and optimization best practices, according to Pu Zhou, senior mechanical engineer at the company. "I was not aware of Altair's additional solver capability," said Zhou. "The Altair business model was the clincher for me in terms of overall value and ease of implementation. One vendor means lower integration costs."

Since embracing simulation-led design and optimization practices with Altair's HyperWorks suite, the SharkNinja team is testing more designs, reducing costs thanks to the use of different materials, and making its physical test processes more scientific, which in turn, minimizes rework and design and improves time-to-market.

Zhou sees simulation-driven design as the wave of the future and his partnership with Altair as a key enabler. "I think HyperWorks is helping us design better products," he said.



SharkNinja performed static analyses with Altair's OptiStruct, which unveiled weak spots on plastic parts (validated in the inset photos), before they were produced. Images courtesy of Altair.

Laminate Composite Optimization

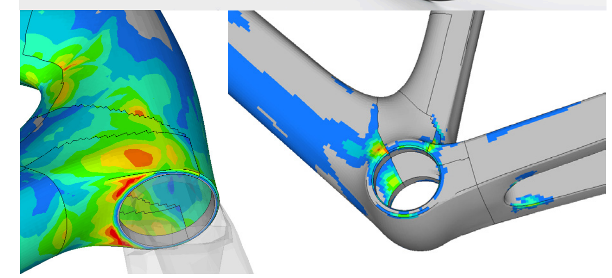
Carbon fiber has become the go-to material for ultra-high performance bicycles that are tailored to the individual requirements of the rider. Yet creating an optimal bike design with carbon fiber is where the rubber meets the road, especially for a newcomer like Rolo Bikes.

The Rolo team wanted to develop a bike frame with world-class strength and stiffness attributes while keeping weight to a minimum. Carbon fiber is perfect for that application, but it requires expertise to determine which direction the fibers should be aligned or how many layers are required in any given area of the frame.

Working with Altair's ProductDesign consulting arm, the team sped forward on its mission to design a frame with the desired strength and weight objectives while creating an ideal layout for the carbon fiber that didn't call for any unnecessary material. The partners were also aiming for an efficient and cost-effective virtual testing process that could be used to analyze the performance of future Rolo bike frames as well as those from other partner companies.

Initial analysis revealed the frame was difficult to manufacture and there were several high-stress areas of concern. Using the OptiStruct structural analysis solver, the team orchestrated a three-step approach that finessed the shape, thickness, direction and location of each layer of composite material until the optimal solution was reached. HyperWorks was also used further out to analyze and validate the optimized frame against the industry standard stiffness tests and to assess fatigue performance.

The resulting composite "layup" was manufacturable by Rolo's construction processes and well within all cost targets. The revised bike frame weighed in at 710g, and Rolo also got a highly accurate set of virtual test jibs for analyzing future bike frames, reducing its reliance on expensive physical prototypes while shortening development time. ●



Rolo Bikes used HyperWorks OptiStruct to determine the shape, thickness and direction of a carbon fiber bicycle's composite layers. Images courtesy of Rolo Bikes and Altair.

HPC on the Cloud

SIMULATION-DRIVEN DESIGN AND OPTIMIZATION are high-octane tasks that require a lot of processing muscle. However, given the stop-start trajectory of most design cycles, a scalable HPC resource can be a better option, particularly for small- and mid-sized shops. That's where cloud-based HPC comes in. Redirecting simulation and optimization work to the cloud provides a number of benefits, including scalability, ease-of-use, and a reduced need for on-staff HPC experts to manage computing resources and the scheduling of jobs.

Altair offers various approaches to HPC and CAE. The HyperWorks Unlimited Physical Appliance is a private cloud solution that includes unlimited use of all Altair software within a fully configured appliance, allowing for infinite virtual exploration while offering reduced operational expenses given that it's a single-vendor solution. The HyperWorks Unlimited Virtual Appliance serves up access to the HyperWorks CAE products along with a modern, scalable HPC environment through a simple web browser, thus requiring no IT involvement and providing the affordability of pay-per-usage. Altair software can take advantage of the speed and energy savings offered by clusters of servers as well.

Dell, Intel, and Altair recently collaborated to test Altair's drop test simulation software solution on a Dell cluster powered by Intel processors. The Altair Drop Testing Solution includes modeling, analysis and optimization software – RADIOSS, HyperMesh and HyperStudy. In addition, PBS Professional workload management software provided HPC job scheduling. The Dell PowerEdge M620 blade server based on the Intel Xeon processor E5-2600v2 was employed in the benchmark. Engineers were able to perform 21 drop test simulations on three different Intel processors, allowing the completion of the entire optimization study in less than 4 hours — 6X faster than other simulation software.

innovationintelligence.com/altair-dell-and-intel-drop-testing-study

The Benchmarking Study

Using the Dell Precision workstation and the latest Altair software, our Super Elements analysis went from 15+ hours to less than two, saving over a day's worth of work.

Many engineering organizations still run simulation studies on older workstations or even consumer-grade PCs as opposed to higher performance platforms. These outdated or resource-constrained hardware platforms can restrict simulation performance and outcomes, limiting the size of models or the amount of detail that can be explored. Moreover, with underpowered hardware, it can take hours, sometimes even days, to complete a robust simulation and optimization study, which limits how much time design teams are willing to invest in the process.

Altair, Intel and Dell collaborated with *DE* to explore the impact of outdated software and hardware on present-day simulation studies. The partners conducted a benchmark study to test vendor claims that a combination of state-of-the-art hardware and simulation software upgrades make a big difference in the scope and performance of simulation-driven design and optimization.

For the study environment, the partners employed a three-year-old workstation and a current-day workstation in addition to the older 11.0 version of OptiStruct software along with the most recent 14.0 release. The purpose was to compare performance of the same set of simulation studies running on the three-year-old workstation and older simulation software, on state-of-the-art hardware and older simulation software, and finally on the most current generation of both hardware and software.

As a basis for comparison, here are the two machines used in the benchmark:

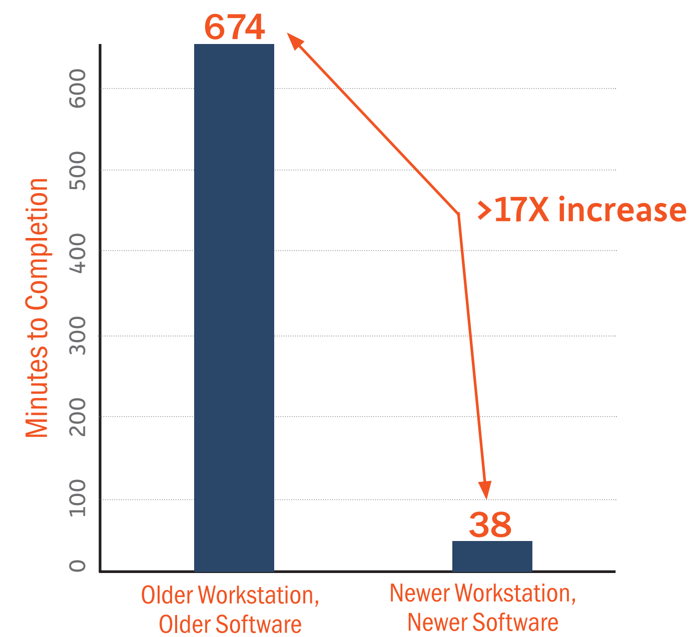
The Benchmarking Setup

	Dell Precision T7500 workstation (3 years old)	**Modern Dell Precision Tower 7910 workstation**
Processor	Dual Westmere Xeon X5672, running at 3.2GHz	Dual Intel Xeon E5-2667 v3, running at 3.2GHz
Cores	8	16
RAM	128GB	192GB
Hard Disk System	128GB SSD, no RAID	128GB SSD, RAID
Hard Disk Working Directory	1TB hard drive: 1500RPM SATA (RAID 0)	2x512GB SSD, RAID 0, PCIE adapter
Software	OptiStruct version 11.0	OptiStruct version 14.0
Operating System	Windows 7	Windows 7

Analysis of the Benchmarking Results

The reduction of run times (as much as an 17X boost in performance on some models) is a direct result of more powerful hardware and the more advanced algorithms in Altair's latest software releases. The newer workstation had double the amount of cores (16 cores) and two solid-state drives (SSDs) in a RAID 0 configuration, which allows for reading or writing to two drives simultaneously. The latter capability can nearly double the data transfer rate, and the new system's additional RAM means less data has to be stored on disk, providing a more robust data I/O cache.

On the software front, Altair has steadily improved existing algorithms over the years in order to reduce run times. In addition, new, more efficient algorithms have been developed, which also result in dramatic performance increases. Even when not taking advantage of all of the current Dell Precision workstation's cores, simulation run times were reduced by as much as 8X on some models.



The most impressive results were seen when running a contact analysis of a train rail car using the newer software and the newer workstation's 16 cores vs. the older workstation's 8 cores.

The Dell Precision Tower 7910 Workstation

THE DELL PRECISION TOWER 7910 WORKSTATION was used as the baseline for the current workstation in our benchmarking tests. It features a new generation of dual-socket performance with the Intel® Xeon® Processor E5-2600 v3 processor series with up to 18 cores per processor, the latest NVIDIA® Quadro® or AMD FirePro™ graphics and up to 512GB of system memory using the latest DDR4 RDIMM memory technology.

Dell has collaborated with Intel on the storage acceleration software application, Intel CAS-W, which improves workstation application performance. 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.

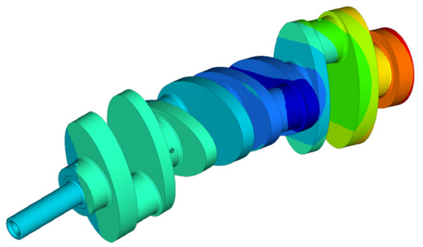
The Dell Tower 7910 can be configured with up to 4 actively cooled M.2 PCIe solid-state drives, which are up to 180% faster than traditional SATA SSD storage. Traditional hard drive options are also available. The Dell Precision Tower 7910 comes with an integrated 12 Gb/s RAID Controller (SAS), doubling the I/O speed of the company's previous generation workstation.

The Dell Precision Tower 7910 also features endpoint security solutions that include encryption, advanced authentication and malware protection from a single source. Plus, the Dell Precision Optimizer automatically tunes the workstation to run specific programs at the fastest speeds possible, enhancing productivity.

Dell.com/precision

Benchmarking Model Descriptions

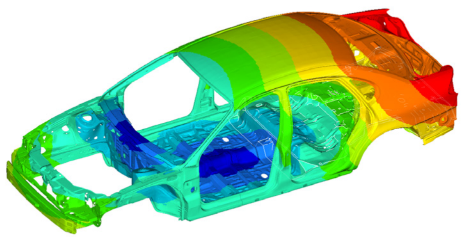
Flexible Body Generation of a Crankshaft
Degrees of Freedom: 12.2 Million
Modes Found: 845
Connection Degrees of Freedom: 2,272
Solution times:
Three-year-old workstation and three-year-old software: 921 minutes
Current workstation and three-year-old software: 493 minutes
Hardware speedup alone: 1.9X
Current workstation and current software: 111 minutes
Software speedup alone: 4.4X
Current hardware and software speedup: 8.3X



The fatigue life of engine components are routinely evaluated by creating a sub-model (Super Element) of each component, which in turn is developed using a Condensation algorithm. One of the most important vehicle components to analyze is the crankshaft, to ensure it can hold up after years of service. Given its complexity, however, creating the required Super Elements often cannot be completed in a working day.

With new hardware and the new Condensation algorithms in the latest version of OptiStruct, the Super Elements for this example were finished in just under two hours, ensuring that multiple crankshaft design modifications could be explored in a single day.

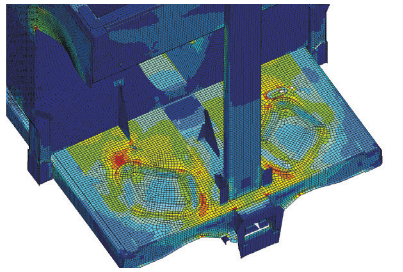
Modal Frequency Response of an Automobile Body in White (BIW)
Degrees of Freedom: 11.9 million
Modes Found: 8,963
Subcases: 84
Loading Frequencies: 501
Solution times:
Three-year-old workstation and three-year-old software: 226 minutes
Current workstation and three-year-old software: 149 minutes
Hardware speedup alone: 1.5X
Current workstation and current software: 29 minutes
Software speedup alone: 5.1X
Current hardware and software speedup: 7.9X



During automotive design, there are sound targets set for both engine and road noise to accommodate drivers and passengers. Typically, the more expensive the vehicle, the lower the sound level should be. During the development cycle, multiple sound level analyses of designs are made using a method known as Modal Frequency Response. These analyses need to run quickly as modifications are made, and as the number of normal modes of the automobile increase, the solution time can accelerate dramatically.

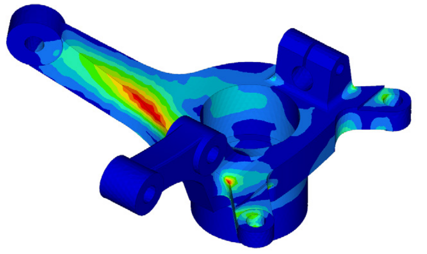
By using newer computer hardware and a Fast Frequency Response (FASTFR) solver in OptiStruct 14.0, the solution time can be reduced by a factor of nearly eight. This allows for many more design modifications to be analyzed in a single day, including Monte Carlo Simulations used to study the effect of manufacturing and assembly variables on sound levels of sample of vehicles coming off the assembly line.

Contact Analysis of a Train Rail Car
Degrees of Freedom: 5.3 Million
Contact Pairs: 10,060
Subcases: 1
Solution times:
Three-year-old workstation and three-year-old software: 674 minutes
Current workstation and three-year-old software: 284 minutes
Hardware speedup alone: 2.4X
Current workstation and current software: 38 minutes
Software speedup alone: 7.5X
Current hardware and software speedup: 17.7X



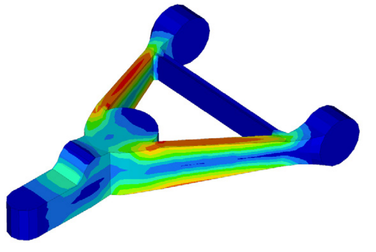
Contact analysis is used to determine the state of contact between multiple bodies. This is done by setting up contact pairs between the nodes of one body and the elements surfaces of the other body. This nonlinear analysis is iterative and can be slow as each contact pair affects the other. With the old workstation and old OptiStruct software, this analysis takes over 11 hours. Newer hardware speeds things up, requiring five hours of run time with the old version of OptiStruct. With OptiStruct 14.0 and taking advantage of the new system's 16 cores, along with a new algorithm designed for contact analysis, the analysis time drops to just 38 minutes.

Linear Static Analysis of an Automobile Steering Knuckle
Degrees of Freedom: 15.2 Million
Elements: 3.7 Million
Subcases: 1
Solution times:
Three-year-old workstation and three-year-old software: 803 minutes
Current workstation and three-year-old software: 369 minutes
Hardware speedup alone: 2.2X
Current workstation and current software: 68 minutes
Software speedup alone: 5.4X
Current hardware and software speedup: 11.8X



Linear static analysis of large bulky structures modeled with solid finite elements can take a long time due to the high bandwidth of the stiffness matrix. In this example, the run time on the older computer with the older software takes over 13 hours while upgrading to current hardware reduces run time to eight hours. For large, bulky solid structures, OptiStruct 14.0 now has an iterative solver that can be faster than direct solvers for solid structures. For this example, the iterative solver performs the analysis about one hour.

Nonlinear Static Analysis of an Automobile Control Arm
Degrees of Freedom: 3.6 Million
Elements: 0.8 Million
Contact Pairs: 8,456, Subcases: 2
Solution times:
Three-year-old workstation and three-year-old software: 497 minutes
Current workstation and three-year-old software: 413 minutes
Hardware speedup alone: 1.2X
Current workstation and current software: 72 minutes
Software speedup alone: 5.7X
Current hardware and software speedup: 6.9X



Nonlinear static analysis of elastoplastic structures with a tied contact can be time consuming due to the nonlinearity of the materials. In this example, the run time using the old workstation and software took over eight hours. Upgrading only the hardware reduced the analysis time to just seven hours. In OptiStruct 14.0 a Domain Decomposition solver was introduced for nonlinear analysis. The Domain Decomposition solver can deliver significant performance improvements. Using the current workstation's 16 cores, the structure could be broken down into eight domains, each using two cores — a setup that reduced solution time to just one hour and 12 minutes.

Optimal Benefits

The real-world experiences of the engineering organizations mentioned here and many others demonstrate the value simulation and optimization can bring to each stage of product development, fostering innovation while driving more efficient design workflows. As part of its simulation-driven design and optimization approach, OptiStruct supports composite optimization; multidisciplinary structural optimization to balance factors such as stress and stiffness requirements; system-level design optimization during multi-body dynamic analysis; and fatigue optimization in a computationally efficient manner.

The tight integration between products within the HyperWorks multiphysics simulation suite ensures that OptiStruct users can readily take advantage of functionality like the HyperMesh pre-processing capabilities for model set up, streamlining workflows and encouraging more extensive design iteration.

The built-in optimization techniques work in concert with the individual solvers to provide a seamless, highly efficient workflow compared to using third-party solvers and standalone optimization tools. While HyperWorks solvers allow companies to reduce their investment in third-party tools, the open architecture supports them if required. For example, OptiStruct's fast Noise and Vibration Analysis solver is one of the most advanced on the market. Its full NASTRAN compatibility enables the tool to serve as a cost-effective NASTRAN replacement, reducing the need to invest in third-party solvers.

With product complexity at an all-time high, there's too much at stake to ignore the advantages of simulation-driven design and optimization.

In addition, Altair's patented units-based licensing systems lets organizations pool and centralize their global software investment to maximize utility throughout the enterprise, providing a value-based option compared to traditional licensing programs.

The tight coupling between OptiStruct and HyperWorks, paired with Altair's unique licensing strategy, makes for a smarter investment for companies looking to build a foundation for simulation-driven design and optimization practices. With product complexity at an all-time high, there's too much at stake to ignore the advantages of simulation-driven design and optimization using current workstation technology. ●

Appendix

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Altair OptiStruct
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Dell Workstation Advisor and Configurator
Dell.com/solutions/advisors/us/en/g_5/Precision-Workstation-Advisor

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