ANSYS®

Mechanical Products

Transient analysis of rigid/flexible suspension mechanism using kinematic joints, springs and contacts

The trusted ANSYS mechanical suite rapidly solves complex structural problems with ease.

Confidently predict and optimize how your product will behave with ANSYS advanced physics.

Use of ANSYS composite material models can lead to lightweight and strong products. Our solutions define layered composites and help your R&D team to understand potential failure.
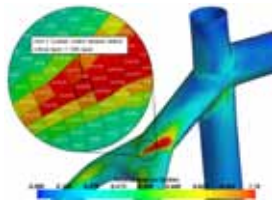
Predictability is Paramount

Computing the response of a structural system involves analyzing a wide range of physics: stresses, deformations, vibration characteristics, reaction forces and residual strains. To get an accurate answer, simulation must take into account all interactions between the various parts of a product, its working environment (such as thermal conditions), and the effects of other forces such as electromagnetics and fluid dynamics. And capturing materials is critical. All of this complexity must be handled efficiently by advanced solver techniques that reliably capture all subtleties, such as material properties changes, contacts status and erosion of parts.

Structural mechanics solutions from ANSYS set the industry standard in engineering, providing you and your team with the ability to simulate every structural aspect of a product using linear and nonlinear static analyses or mechanisms analysis. Our products incorporate extensive dynamic solution capabilities, including modal analysis for calculating natural frequencies and mode shapes, harmonic analysis for determining harmonically time-varying load response, linear and nonlinear transient dynamic analysis, and spectrum analysis for random vibrations.

Using the ANSYS® end-to-end solution, you can model any type of geometry, from slender and thin structures to massive parts, using the latest generations of beams, shells and solid finite elements formulations. Nonlinear geometric effects assist in performing large deformations or nonlinear stability analyses.
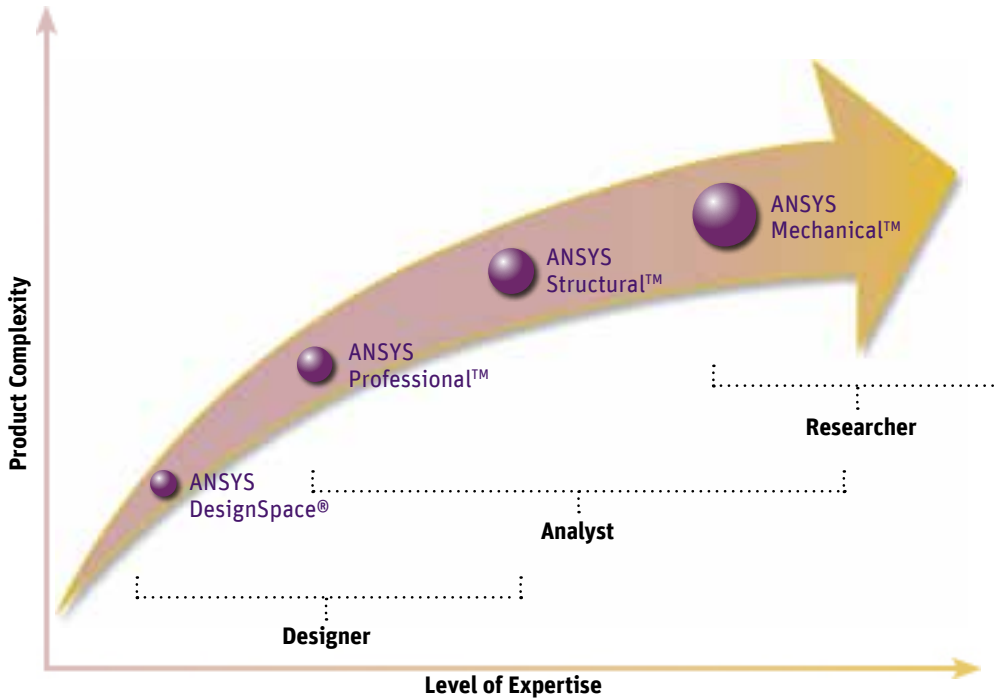
Characterizing material behavior is intuitive through use of our vast library of mathematical material models, no matter what your structure is made of — including composites.

Because complex systems are made of multiple parts, ANSYS tools enable you to capture the critical interactions between parts. Whether using contacts, special connections (including springs, dampers and spotwelds) or joints defining the kinematic relationship between bodies, our solutions lead to insight into the most complex interactions.

ANSYS structural mechanics solutions offer a range of products that help users meet current requirements and plan for a seamless upgrade path for future needs. Designers and experts can share common databases while using different product levels.

Nonlinear stability analysis of stiffened structure subjected to internal pressure

## Productivity: In-Depth Understanding in the Shortest Possible Time

Without the right tools, simulating your most complex products can be beyond challenging. After all, structural engineers should focus more on the physics of the model than on the underlying mathematics. The mechanical simulation interface based on the ANSYS Workbench™ platform enables users to model all applications, from very simple to very complex. The interface can take weeks out of a CAE process by eliminating manual file transfer, results translation and re-analysis time.

Within this highly productive environment, you can take advantage of a wide range of very advanced technologies. For example, the bidirectional link to all major CAD systems removes the need for model repair and provides automated model updates upon design changes.

Automatic meshing capabilities for all types of geometries as well as automatic contact detection save hours in model setup. Our tools offer a wide choice of loads and boundary conditions, leading to an accurate prediction of real-world product behavior.

A comprehensive set of post-processing tools ensures in-depth design analysis. Further automation capabilities include simulation report generation to highlight technical data and user-defined figures, data exchange via spreadsheets (such as the widely used Microsoft® Excel®), and engineering knowledge capture though wizards and templates.

Finally, parametric capabilities help you to efficiently perform sensitivity or optimization studies.
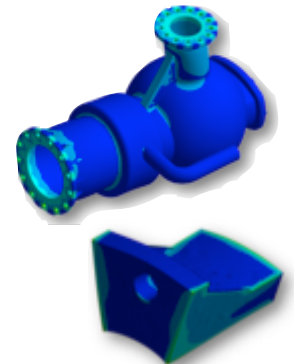
Submodeling saves time by providing accurate results on a detailed portion of the model.

"The ANSYS smoothing algorithms and control tools allow us to ensure the quality of the interpolated data as well as the robustness of the mapping procedure. Ultimately, this saves time in setting up our simulation models."
Hervé Chalons
Mechanical and Structural Analysis Engineer
Turbomeca
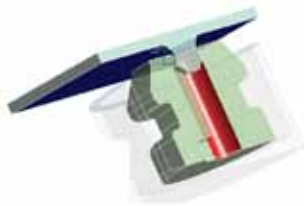
Automated contact detection saves time during model setup.

Performance to Solve Large Models Faster

Current trends in simulation show the use of increasingly larger models, no matter the industry. Our structural solution incorporates parallel algorithms for a faster computation time: The entire solution phase runs in parallel, including stiffness matrix generation, linear equation solving and results calculations in both shared and distributed memory processing.

We also offer unique solutions based on GPU board utilization. The combination of parallel computing and performance via GPU can further speed up your simulations.

Additional advanced techniques such as component mode synthesis (CMS), submodeling methods and proprietary acceleration techniques can contribute to efficiently handling large models.

All these techniques allow you to increase the number of design variations you can compute in a given period, therefore leading to better, more optimized products. The end result of an ANSYS simulation is confidence that your product will thrive in the real world.
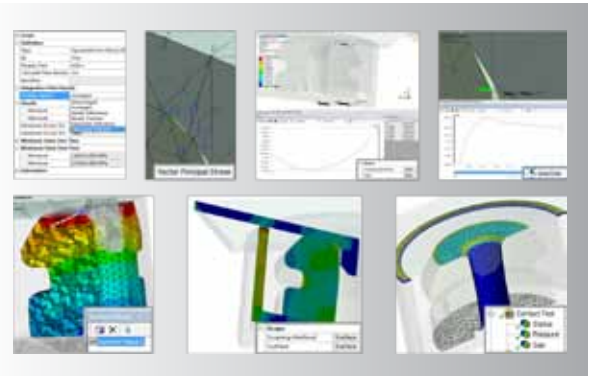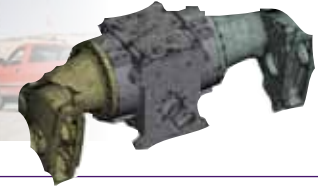

Comprehensive post-processing capabilities include color plots, results scoping or geometries of FE entities, graphs, tables, and regulation checks. You can also export capabilities to spreadsheets.

Gasket material from advanced material models library

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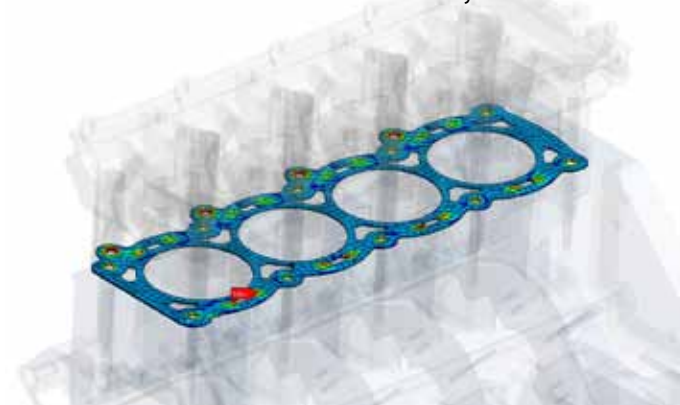
Assemblies require modeling contact between parts as well as specific interfaces, such as gaskets.

"We use ANSYS tools to calculate stress, stiffness, deformation and natural frequencies of critical vehicle components and subsystems. An important capability is advanced analysis of a variety of nonlinear materials."

Vladimir Pokras
Analysis and Simulation Manager
Liebherr Mining Equipment Co.

ANSYS state-of-the-art technology empowers you to simulate every aspect of your product, from straightforward to complex.

Robust Nonlinear Analysis

The Right Material Model
To understand and accurately characterize material behavior, ANSYS provides a vast library of mathematical material models that aid in simulating materials. You can apply these constitutive models to metal, rubber, plastic, glass, foam, concrete, biotissue and special alloys. ANSYS structural tools include model capabilities for moisture diffusion as well as initial strain and stress states.

Interaction between Parts
Our robust, complete set of contact capabilities includes surface–surface, line–surface and line–line contact for flexible and rigid bodies. Contact behavior can account for constant or orthotropic friction as well as sliding behavior; these are applicable for structural, thermal and multi-disciplinary contact applications. Fast, automatic contact detection backed by powerful algorithms leads to fast and accurate solving of models involving contacts.

Robust Solvers for Complex Problems
ANSYS structural mechanics solutions offer a large library of out-of-the box equation solvers. The compilation contains the sparse direct solver, preconditioned conjugate gradient (PCG) iterative solver, Jacobi conjugate gradient (JCG) solution and others.

You can be confident of a robust solution, since ANSYS uses default settings for both elements and solver. You can override the default options; however, our many years of fine-tuning have resulted in an efficient solution to your most complex problems — without having to manually set required controls and options.

Creating Your Own Elements or Materials
Very advanced applications and research activities require user-defined materials or a new element formation. With ANSYS tools, you can extend native capabilities through user elements, user materials or user routines to create your own models, such as friction.
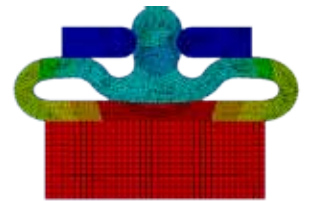
Large deformations and contact analysis of a rubber seal. ANSYS material models include elasticity as well as visco-elasticity, plasticity, viscoplasticity, cast-iron plasticity, creep, hyperelasticity, gaskets and anisotropy.

"Contact behavior strongly impacts lip seal performance. ANSYS provides a powerful tool for gaining insight into optimizing seal design and improving product quality and reliability."

Zhichao Wang
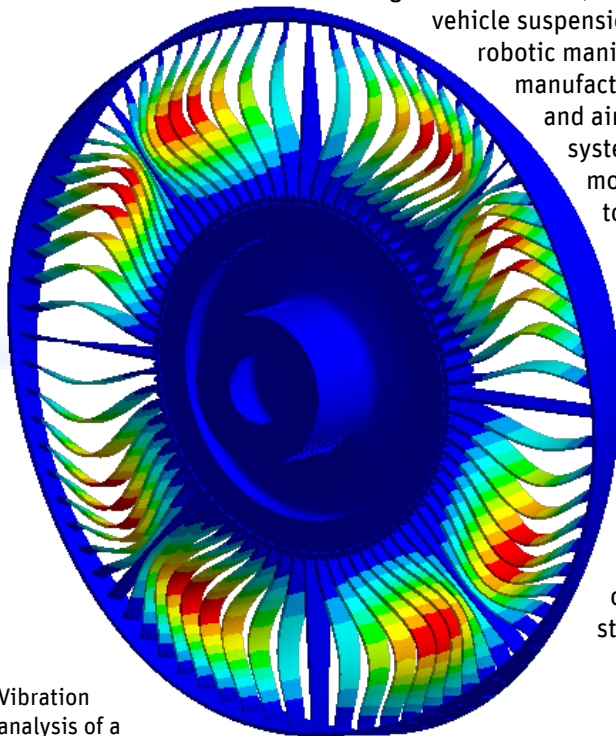Manager, Analytical Services
Emerson Climate Technologies, Inc.

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Advanced Solutions

Rigid and Flexible Bodies

Mechanical systems can contain complex assemblies of interconnected parts undergoing large overall motion, such as in ground vehicle suspension assemblies, robotic manipulators in manufacturing processes, and aircraft landing gear systems. For a faster, more efficient solution to this problem class, ANSYS provides a rigid multibody dynamics module. With minimal investment in model setup and computational resources early in development, you gain deep understanding of motion and stability of

mechanical systems. Then, if more fidelity is required with detailed designs, you can easily convert the model to a partially or fully flexible representation, one capable of capturing large deformations and material nonlinearities.

Rotating Structure Dynamics

Rotordynamics applications serve to identify behavior and diagnosis of rotating structures. The capability is commonly used to analyze behavior of structures ranging from jet engines and steam turbines to auto engines and computer disk storage. Rotordynamics can effectively compute critical speeds and the effect of unbalanced loads on a structure.

ANSYS solutions provide modal and transient analysis capabilities. They allow creation of Campbell plots to identify critical speeds of single or multiple spool systems, for beams, shells and solid elements. Bearings models are available; an interface enables importing bearing characteristics from outside sources. For static, modal or harmonic analysis of rotating parts with geometric patterns, cyclic symmetry modeling reduces computation time.

Vibration analysis of a bladed disc using cyclic symmetry
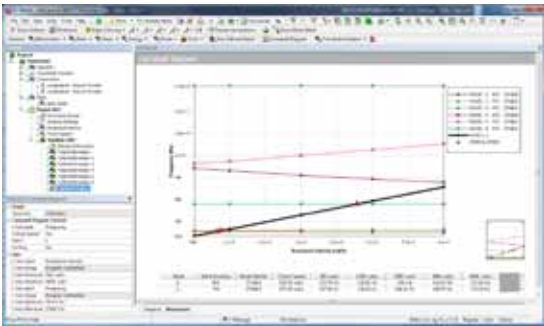
Campbell diagrams identify critical speed of rotating structures over a range of variations of a system's rotational velocity.
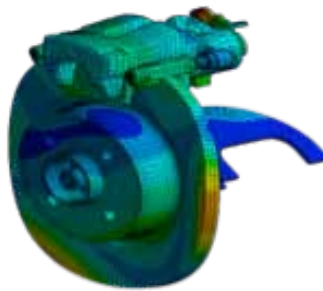
Analysis of brake assembly for brake squeal: Combining nonlinear pre-stressing of structures and complex unsymmetric eigensolvers leads to accurate analysis.

"The ANSYS environment represents a milestone in allowing simulation to be perceived as a standard and required activity in complex product development."
**Riccardo Testi**
CAE Analyst
Piaggio & C. SpA

Brake Squeal Analysis: Vibration with Complex Contact Conditions

Brake discs develop large and sustained friction-induced oscillations, referred to simply as brake squeal, a challenging issue for engineers and researchers.

Using ANSYS technology, you can analyze squealing via complex eigensolvers to identify unstable modes. Three different methods provide various levels of accuracy and computation speed by including various levels of pre-stress on the model.

Lufthansa Technik AG leverages ANSYS simulation software to gauge wear and tear of aircraft components.
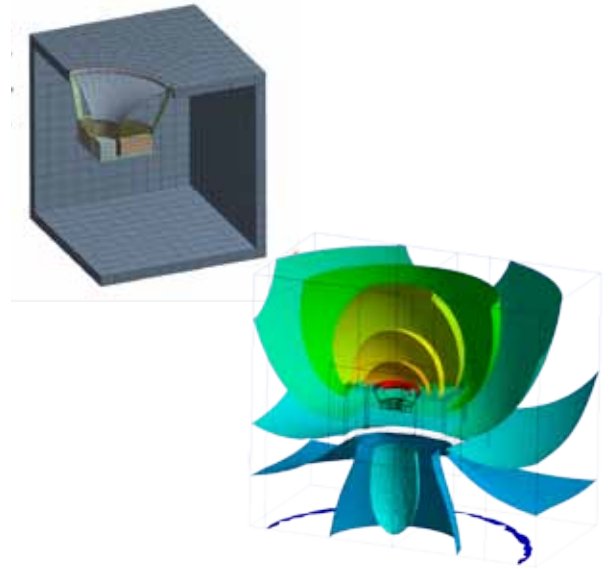
Acoustics modeling of speaker using coupled field analysis

Beyond Standard Applications

Combining Other Physics

To accurately model a product, you must consider its environment. For example, will the product experience thermal loads that affect the structure? Will it be part of a system controlled by electric or piezo-electric components?
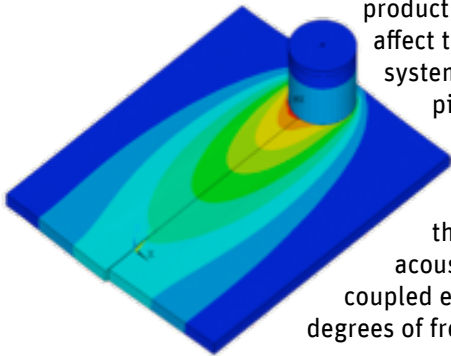
ANSYS tools enable you to compute thermal–structural, thermal–electric, piezo-electric and acoustics impacts. Strong couplings use coupled elements that carry all necessary degrees of freedom.

Friction stir welding including heat generation due to friction and plastic deformation; model uses coupled element with thermal and structural DOF.

Easy Data Exchange

In some product analyses, weak coupling is appropriate; this can entail transferring data from one simulation to another. Mapping data between physics is a painful process without the right tools.

The ANSYS Workbench platform allows a seamless data transfer from one physics area to another, and it automates the mapping between dissimilar meshes. Workbench easily imports data from external sources, such as point clouds, and maps them onto your current structure. You can modify scaling, units and orientations to match the point cloud data to your model. Visual quality controls check the accuracy of the mapped data.

Powerful Scripting Automates Tasks

The unique ANSYS Parametric Design Language (APDL) provides flexibility and extends the capability of mechanical applications. It serves as the foundation for accessing sophisticated features of the structural mechanics solver. Engineers can leverage APDL to automate common tasks, build their own parametric models, perform design optimization, and construct adaptive meshing, since the capability offers many convenient features: parameters, macros, branching, looping, and repeating and array — features you can apply in everyday analysis.

REpower relies on the ANSYS suite in developing revolutionary composite materials for wind energy applications.

For clarity and insight, look to ANSYS as a single resource for your advanced technology needs.

The ANSYS structural mechanics suite delivers functionality — depth, breadth, a plethora of advanced capabilities and integrated multiphysics — providing confidence that your simulation results reflect real-world parameters. The comprehensive range of engineering simulation software provides access to virtually any field of engineering simulation that a design process requires. Organizations around the world trust ANSYS to help them realize their product promises.

Importing and Preparing Geometries

Creating design models is a core part of the product development process. Once you import geometry from your CAD system through our unique bidirectional interfaces, you may need to defeature, modify or convert to simplified components such as beams or plates. ANSYS geometry tools allow you to fully prepare the model for simulation.

Composites Structures

Engineering layered composites involves complex definitions that include numerous layers, materials, thicknesses and orientations. Engineers must understand potential product failure using key indicators of resistance. ANSYS Composite PrepPost provides all necessary functionalities for the analysis of layered composite structures.

### Explicit Solutions for Severe Conditions

When a product is subjected to very large nonlinearities, instabilities, and rapid and severe loading conditions, explicit solutions can accurately capture all transient phenomena. You can expand your structural solution with ANSYS capabilities that include drop test, impact, explosion or penetration analysis.
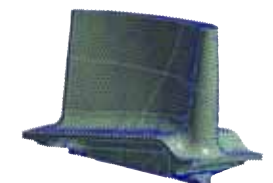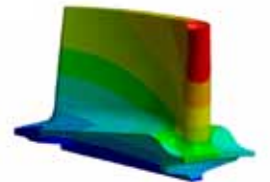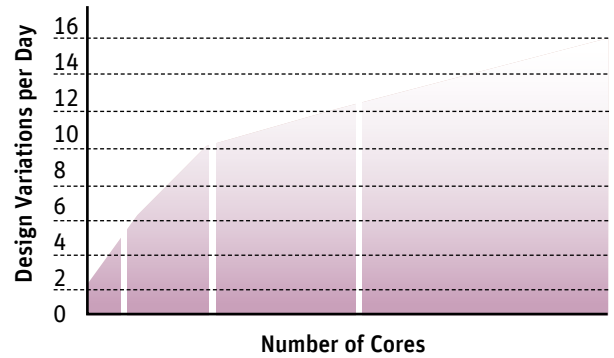

Temperatures mapped from point clouds (top); visual controls help user check quality of mapping process (bottom).

Automatic meshing of assemblies
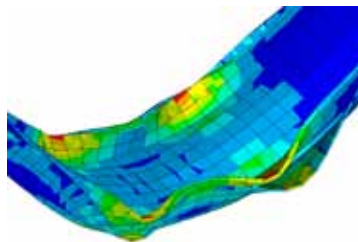
Debonding of composite beam
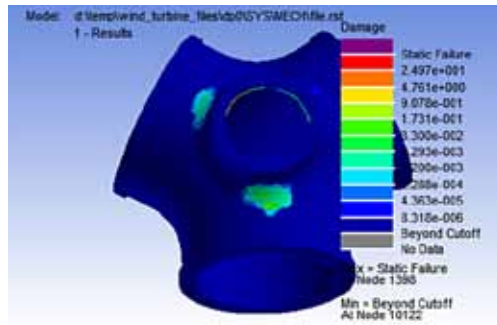
Fatigue analysis of wind turbine hub subjected to cyclic loading with varying direction and amplitude

Design variations accomplished per day of 4 million DOF mode with contacts and nonlinear materials. Eight cores can compute nine models. The process helps designers learn about product variations with multiple design parameters.

Design Analysis and Optimization

To understand a design's performance, you must identify the effect of all design parameters — which can easily lead you to all changes required to meet product requirements. ANSYS DesignXplorer™ provides that in-depth product understanding, illustrating the relationship between design variables and product performance.
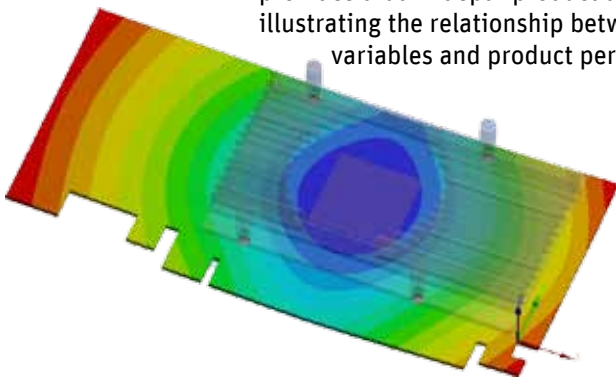
NVIDIA, a leader in visual computing technology, applies ANSYS tools to printed circuit board analysis.

### Fatigue Analysis for Life Assessment

To avoid costly repairs, legal liabilities or recalls — or to minimize product failure risks and maintain high-quality products, brand and company image — product durability is critical. ANSYS Fatigue™ solutions integrate durability calculations with your current simulation tools so you can optimize the life of your product.

Managing Simulation Data

Simulation engineers generate large volumes of data that need to be archived in a searchable format. ANSYS Engineering Knowledge Manager™ (EKM) enables capture and management of your simulation data along with workflows and best practices. The tool can improve the efficiency and productivity of simulation teams.
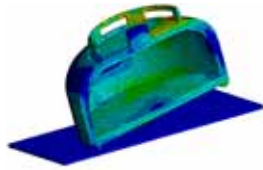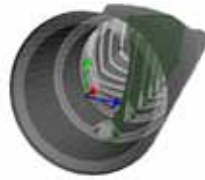
ANSYS Mechanical Suite

Geometry
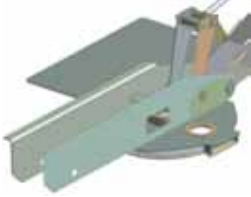
Midsurfacing operations on a thin structure
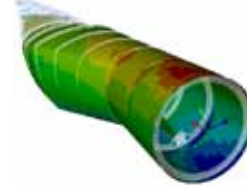
Stress Analysis

Drop test of gas container using explicit tools

Composites Tools

Definition of ply layup on turbine blade

Fatigue and Composites

Composite failure analysis of turbine blade

Erosion effects

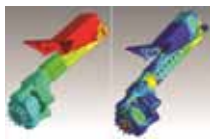Pre-Processing   Simulation   Post-Processing   Archive

Other ANSYS Engineering Simulation Capabilities

CAD

ANSYS DesignModeler™ provides modeling and geometry - creation functions as well as tools for importing CAD data from various sources. In addition, we collaborate with leading CAD developers to ensure an efficient workflow.

Integration

ANSYS Workbench is the framework for the industry's broadest and deepest suite of advanced engineering simulation technology. It delivers unprecedented productivity, enabling Simulation-Driven Product Development™.

Multiphysics
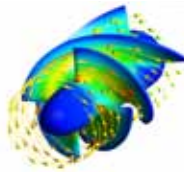
To help ensure a successful product, R&D teams must accurately predict how complex products will behave in a real-world environment. The ANSYS suite captures the interaction of multiple physics: structural, fluid dynamics, electromechanics and systems interactions. A single, unified platform harnesses the core physics and enables their interoperability.

HPC

High-performance computing enables creation of large, high-fidelity models that yield accurate and detailed insight. ANSYS offers scalable solutions and partners with hardware vendors to ensure that you get the power and speed you need.

Design Optimization
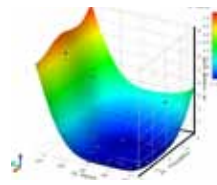
Good design starts with identifying the relationship between performance and design variables. ANSYS DesignXplorer enables engineers to perform design of experiments (DOE) analyses, investigate response surfaces, and analyze input constraints in pursuit of optimal design candidates.

Data Management

ANSYS EKM addresses critical issues associated with simulation data, including backup and archival, traceability and audit trail, process automation, collaboration and capture of engineering expertise, and IP protection.

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ANSYS

ANSYS, Inc.
www.ansys.com
ansysinfo@ansys.com
866.267.9724

ANSYS is dedicated exclusively to developing engineering simulation software that fosters rapid and innovative product design. Our technology enables you to predict with confidence that your product will thrive in the real world. For more than 40 years, customers in the most demanding markets have trusted our solutions to help ensure the integrity of their products and drive business success through innovation.

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