

### Product Features

#### Structural Analysis

- ▶ Static analysis
- ▶ Modal analysis
- ▶ Harmonic analysis
- ▶ Transient analysis
- ▶ Spectrum analysis
- ▶ Buckling analysis

#### Geometric Nonlinearity

- ▶ Large strain
- ▶ Large deflection
- ▶ Stress stiffening
- ▶ Spin softening
- ▶ Coriolis effects

#### Contact Definitions

- ▶ Surface-to-surface
- ▶ Node-to-surface
- ▶ Node-to-node
- ▶ Beam-to-beam
- ▶ Beam-to-surface
- ▶ Deformable-deformable
- ▶ Deformable-rigid

#### Contact Formulations

- ▶ Penalty
- ▶ Augmented Lagrange
- ▶ Assembly contact (MPC)
- ▶ Lagrange multiplier
- ▶ Lagrange multiplier on normal and penalty on tangent

#### Contact Properties

- ▶ Contact with friction
- ▶ Thermal contact
- ▶ Electric and magnetic contact
- ▶ Spot welds

#### Boundary Conditions

- ▶ Solid and FE model BCs
- ▶ Initial conditions
- ▶ Tabular and function loads
- ▶ Structural and thermal loads
- ▶ Pre-stress loads

### Mechanical Solutions for Better Designs and Shorter Design Cycles

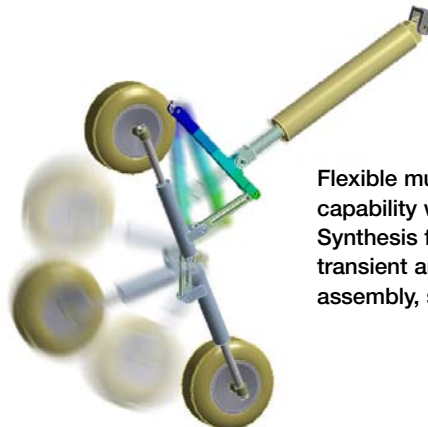
To stay competitive, meet customer demands and develop innovative and reliable products in ever shorter design cycles, designer and engineers require simulation tools that offer best-in-class integrated solutions. ANSYS® Mechanical™ solutions offer simulation tools to solve challenging engineering problems and create better products.

#### Meeting Industry Needs through Depth and Breadth of Functionality

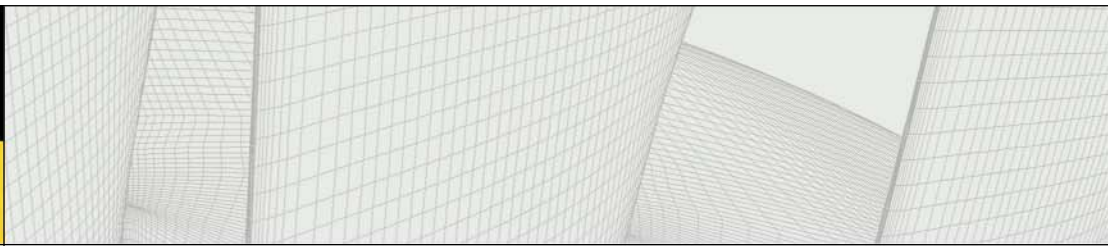
ANSYS Mechanical solutions offer products and capability that meet the demands of industry through:

- ▶ **Better design through innovation:** Advanced analysis capabilities offer better insight into product design and performance, leading to increased quality, lower costs and fewer rejected products.
- ▶ **Lower costs and shorter cycles:** Tighter product integration between geometry, meshing, simulation and optimization offers a one-stop solution for end users with reduced software training costs and shorter development cycles.
- ▶ **Optimized solutions and less prototyping:** Integrated optimization tools using Topological Optimization, Design Optimization and Probabilistic Design allow for tighter designs without repeated costly physical prototypes.

The ANSYS Mechanical family of products offers a full depth of analysis from concept simulation to advanced analysis; its breadth of simulation capabilities ranges from linear to nonlinear coupled physics analysis. The software provides simulation tools used widely across industry by designers to advanced analysts, providing a full complement of nonlinear and linear elements, material laws ranging from metal to rubber, and the most comprehensive set of solvers available.



Flexible multi-body dynamics capability with Component Mode Synthesis for large rotation allows transient analysis of landing gear assembly, shown here.



### Product Features

#### Material Modeling

- ▶ Linear elasticity
- ▶ Inelastic
  - Rate independent
  - Rate dependent
  - Non-metal plasticity
  - Shape memory alloys
  - Cast iron
- ▶ Hyperelasticity (isotropic/anisotropic)
- ▶ Viscoplasticity and viscoelasticity
- ▶ Creep and swelling
- ▶ Piezoelectric
- ▶ Density, specific heat, thermal expansion
- ▶ Thermal and electric conductivity
- ▶ Material damping
- ▶ User materials
- ▶ Temperature-dependent properties

#### Element Technology

- ▶ 2-D, 3-D structural solids
- ▶ Structural shells elements
- ▶ Structural beams elements
- ▶ Structural pipes elements
- ▶ Structural solid shell elements
- ▶ 2-D, 3-D hyperelastic
- ▶ Coupled physics elements
- ▶ 2-D, 3-D thermal solids/shells
- ▶ Multi-point constraint
- ▶ Gasket elements
- ▶ 2-D, 3-D surface effect
- ▶ Springs/dashpots elements
- ▶ Element birth and death
- ▶ Joint elements
- ▶ Rebars/reinforcement elements
- ▶ User element

#### Thermal Analysis

- ▶ Steady-state and transient
- ▶ Conduction
- ▶ Convection
- ▶ Radiation
- ▶ Phase change
- ▶ Mass transport
- ▶ Fluid elements

#### Coupled Physics

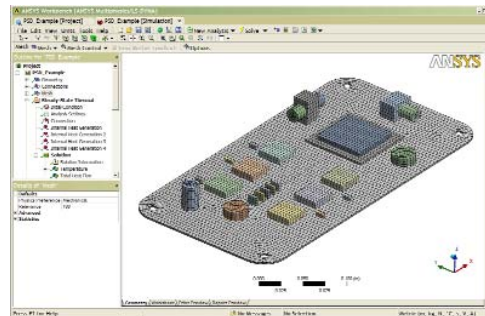
- ▶ Thermal-structural
- ▶ Acoustic-structural
- ▶ Thermal-electric
- ▶ Piezoelectric
- ▶ Acoustics

### Integrated Solutions in ANSYS® Workbench™ for Faster and Better Designs

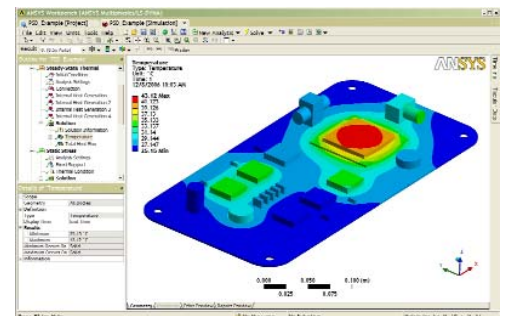
The ANSYS Workbench platform is a new-generation tool that offers an efficient and intuitive user interface, superior CAD integration, automatic meshing, access to model parameters and access to functionality available within the ANSYS Mechanical products — in one environment.

The ANSYS Workbench interface is the integration tool for ANSYS, Inc.'s advanced physics capabilities that enable users to model all applications, from very simple to very complex. The integration of these, and the user's own, solver technologies can take weeks out of a computer-aided engineering (CAE) process by eliminating manual file transfer, result translation and re-analysis time.

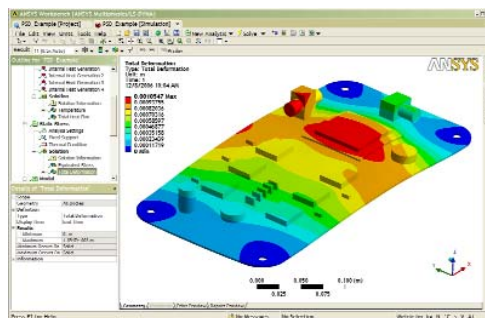
At organizations with many engineering professionals, the ANSYS Workbench platform allows experts to easily capture knowledge in the form of process wizards, vertical applications and standard simulation procedures, then share gleaned knowledge so others can benefit from quick adoption.



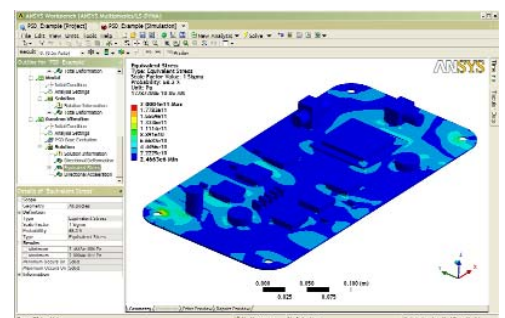
Robust and automated meshing



Thermal analysis environment



Structural analysis environment



PSD analysis environment

Linked environment in ANSYS Workbench allows use of single data models for PSD analysis of electronic packaging.

### Capabilities for Nonlinear, Dynamics and Coupled Physics Analysis

ANSYS Mechanical solutions offer a broad spectrum of capabilities covering a range of analysis types, elements, contact, materials, equation solvers, and coupled physics capability all targeted toward understanding and solving complex design problems.

The software offers a variety of analysis capabilities such as static, modal, harmonics, transient and linked analysis types as in pre-stressed modal, brake squeal and random vibration analysis.

### Elements, Materials and Contact Solutions

To represent complex real-world geometries, ANSYS Mechanical solutions support a range of elements including beams, shells, solids and solid shell elements. In addition, ANSYS offers special elements such as joint elements, gasket elements and rebars/reinforcements.

ANSYS Mechanical solutions offer a range of linear and nonlinear material models to handle composites, plasticity in metals, hyperelasticity of rubber components and specialized materials including cast iron, shape memory alloys and cohesive zone models.

ANSYS software offers a complete set of contact capability for surface-surface, line-surface, line-line contact for flexible and rigid bodies. Contact behavior can account for frictional and sliding behavior and is applicable for structural, thermal and multiphysics contact applications.

Mechanical solutions also offer coupled physics analysis capabilities to simulate a variety of physics phenomena including thermal-stress, electro-mechanical, structural-acoustics, mass diffusion and simple thermal-fluid analysis.

### Customization, Parallel Performance and Advanced Modeling

Customization capabilities through user elements, user materials and scripting using ANSYS Parametric Design Language (APDL) provide flexibility and extend the capability of applications for ANSYS Mechanical solutions.

With Distributed ANSYS, the entire solution phase runs in parallel, including the stiffness matrix generation, linear equation-solving and results calculations in both SMP and DMP.

ANSYS Mechanical solutions also offer advanced modeling for rotordynamics, component mode synthesis (CMS), cyclic symmetry analysis and submodeling techniques.

## Product Features

### Optimization

- ▶ Design optimization
- ▶ Topological optimization
- ▶ Probabilistic design
- ▶ Variational technology
- ▶ Parametric simulation

### ANSYS Parametric Design Language

- ▶ If-then-else constructs
- ▶ Do-loop features
- ▶ Array parameters
- ▶ Array parameter operations
- ▶ Macros
- ▶ Trigonometric functions
- ▶ Parametric modeling

### Additional Features

- ▶ Cyclic symmetry analysis
- ▶ Rotordynamics
- ▶ Flexible multi-body dynamics
- ▶ Submodeling
- ▶ Adaptive meshing
- ▶ Component mode synthesis (CMS)
- ▶ CMS for large rotations
- ▶ Substructuring
- ▶ 2-D rezoning (hyperelasticity/plasticity)
- ▶ Rigid body dynamics (ADAMS) interface



Rebar modeling capability allows modeling of reinforcements in complex tire structure, shown here, and reinforced concrete structures.

### Product Features

#### Solvers

- ▶ Iterative
- ▶ Sparse direct
- ▶ Distributed PCG
- ▶ Distributed JCG
- ▶ Eigensolvers
  - Block Lanczos
  - Subspace
  - Reduced
  - QR-damped
  - Unsymmetric
  - LANPCG

#### ANSYS Supported Platforms

- ▶ HP PA 8000 64-bit
- ▶ HP Itanium® IA64
- ▶ IBM® 64-bit
- ▶ SGI® 64-bit
- ▶ Sun® UltraSPARC 64-bit
- ▶ Fujitsu PrimePower
- ▶ Intel IA-32 Windows
- ▶ EM64T, AMD64
- ▶ Intel® IA-32 Linux®
- ▶ Intel® IA-64 Linux®
- ▶ Intel® Xeon® EM64T
- ▶ AMD AMD64

#### ANSYS Workbench Supported Platforms

- ▶ Intel IA-32 Windows
- ▶ EM64T, AMD64
- ▶ Sun UltraSPARC™ 64-bit
- ▶ HP PA 8000 64-bit
- ▶ Red Hat® 3.0

#### Additional Modules

- ▶ ANSYS® DesignModeler™
- ▶ ANSYS® DesignXplorer™
- ▶ ANSYS® Fatigue™
- ▶ ANSYS Mechanical HPC
- ▶ ANSYS® RigidDynamics™

### Product Spectrum with Depth and Breadth of Capabilities

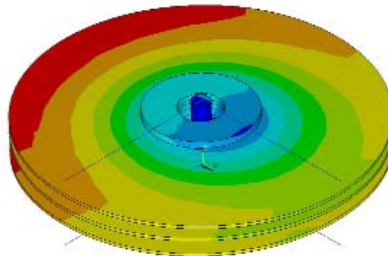
ANSYS Mechanical solutions offer a range of product subsets offering a depth and breadth of capabilities to meet current requirements as well as a seamless upgrade path for future needs.

**ANSYS Mechanical** offers a comprehensive product solution for structural linear/nonlinear and dynamics analysis. The product offers a complete set of elements behavior, material models and equation solvers for a wide range of engineering problems. In addition, ANSYS Mechanical offers thermal analysis and coupled-physics capabilities involving acoustic, piezoelectric, thermal-structural and thermal-electric analysis.

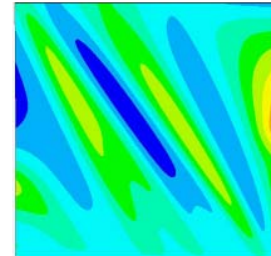
**ANSYS® Structural™** software addresses the unique concerns of pure structural simulations without the need for a lot of extra tools. The product offers all the power of nonlinear structural capabilities — as well as all linear capabilities — in order to deliver the highest-quality, most reliable structural simulation results available.

**ANSYS® Professional™** software offers a first step into advanced linear dynamics and the nonlinear capabilities of ANSYS Mechanical solutions. ANSYS Professional comes in two versions: ANSYS Professional NLT with linear structural and dynamics capability and nonlinear thermal capability, and ANSYS Professional NLS with linear structural dynamics and thermal capability as well as a basic structural nonlinear capability.

**ANSYS® DesignSpace®** is an easy-to-use simulation software package that gives designers tools to conceptualize, design and validate all their ideas right on the desktop. ANSYS DesignSpace software, a subset of the ANSYS Professional product, enables users to easily perform real-world, static structural and thermal, dynamic, weight optimization, vibration mode, and safety factor simulations on all designs without the need for advanced analysis knowledge.



Rotordynamics capability allows modeling of rotating structures using 3-D solid models, as in the hard drive model shown here.



Nonlinear stabilization is very effective in analysis of flexible structures such as the shell model with shear deformation.