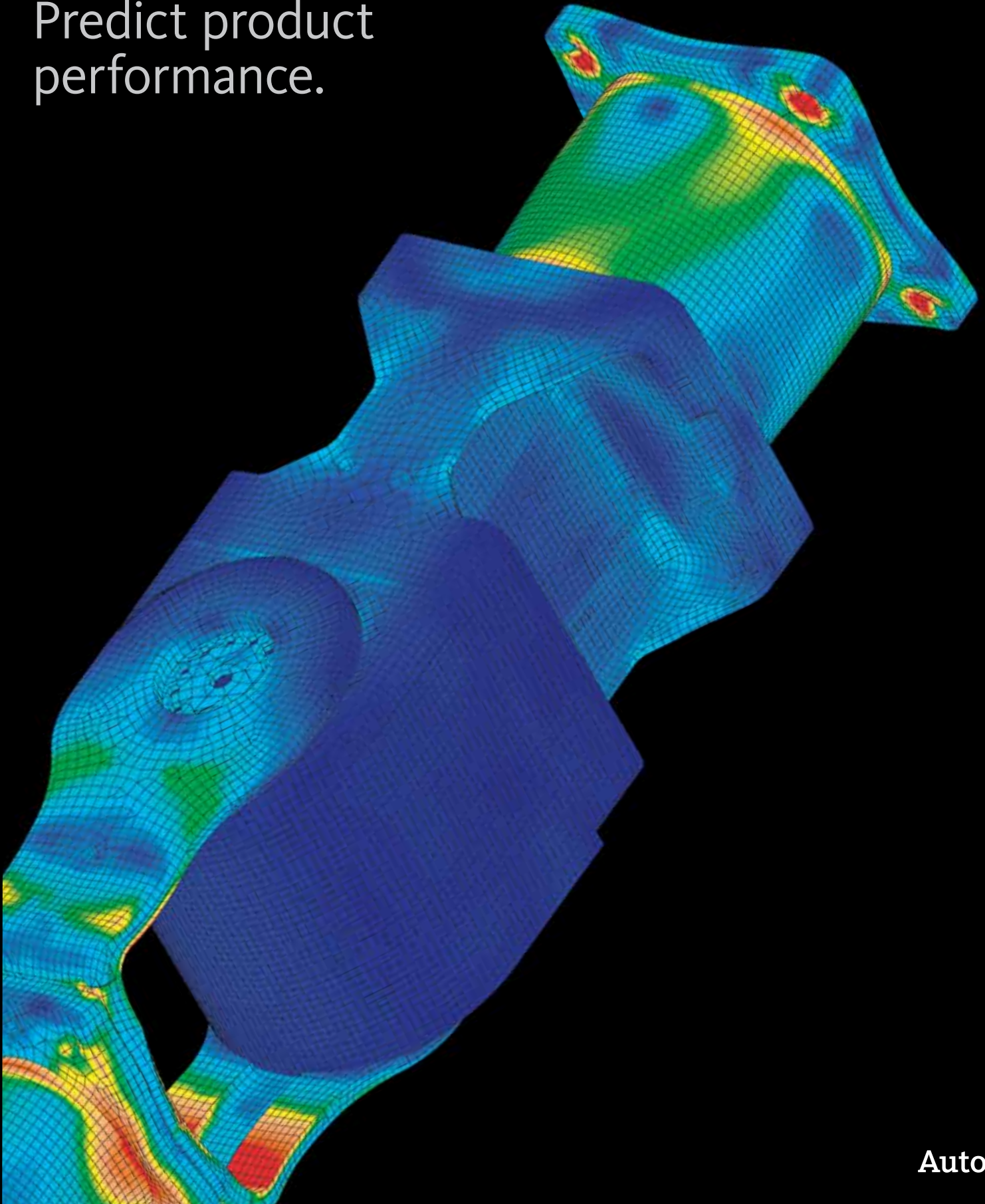# Autodesk®
Algor® Simulation

Predict product
performance.

Autodesk®

Design Validation and Optimization

Physical prototypes are costly. Optimizing designs and eliminating errors before manufacturing helps increase efficiency, productivity, and innovation for competitive advantage.

The Autodesk® Algor® Simulation product line, part of the Autodesk® solution for Digital Prototyping, provides a broad range of analysis tools that enable designers and engineers to bring product performance knowledge into early stages of the design cycle—helping to improve collaboration, design better and safer products, save time, and reduce manufacturing costs.

Perform Accurate Simulations Efficiently

Simulation enables critical engineering decisions to be made earlier in the design process. With Autodesk Algor Simulation software, designers and engineers have the tools to more easily study initial design intent and then accurately predict the performance of a complete digital prototype.

When working with CAD geometry, automatic meshing tools produce high-quality elements on the first pass—ensuring simulation accuracy within the areas of greatest engineering concern and helping to predict product performance in less time. Built-in modeling capabilities enable designers and engineers to directly edit the mesh to help with the accurate placement of loads and constraints or to create simplified geometry for proof-of-concept studies. In addition to increased productivity through modeling flexibility, design concepts can be quickly validated before resources are invested in significant design changes or new products.
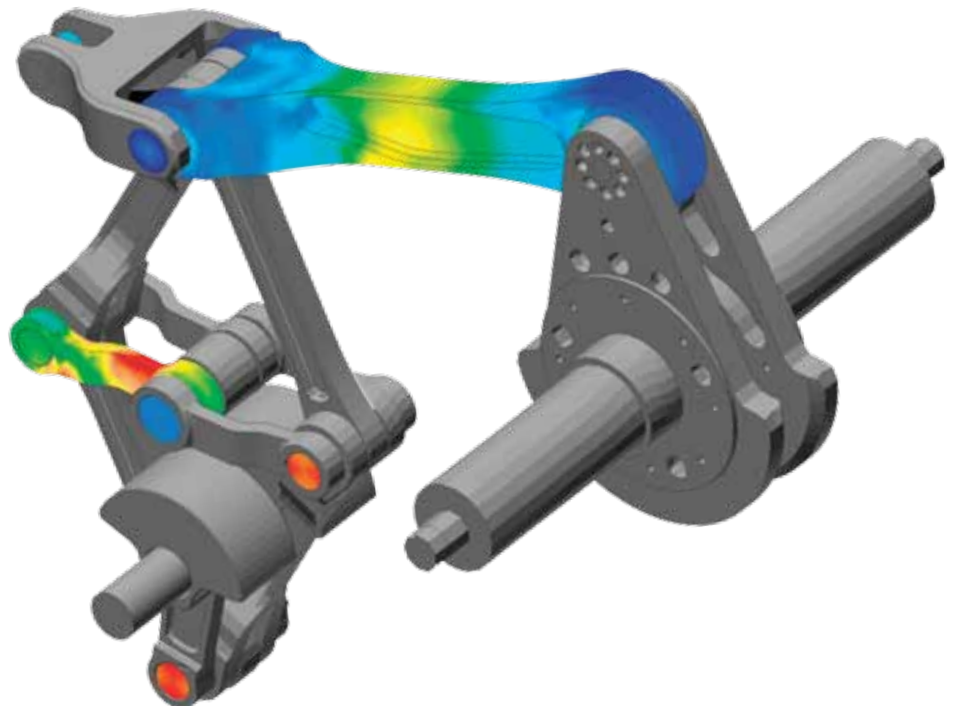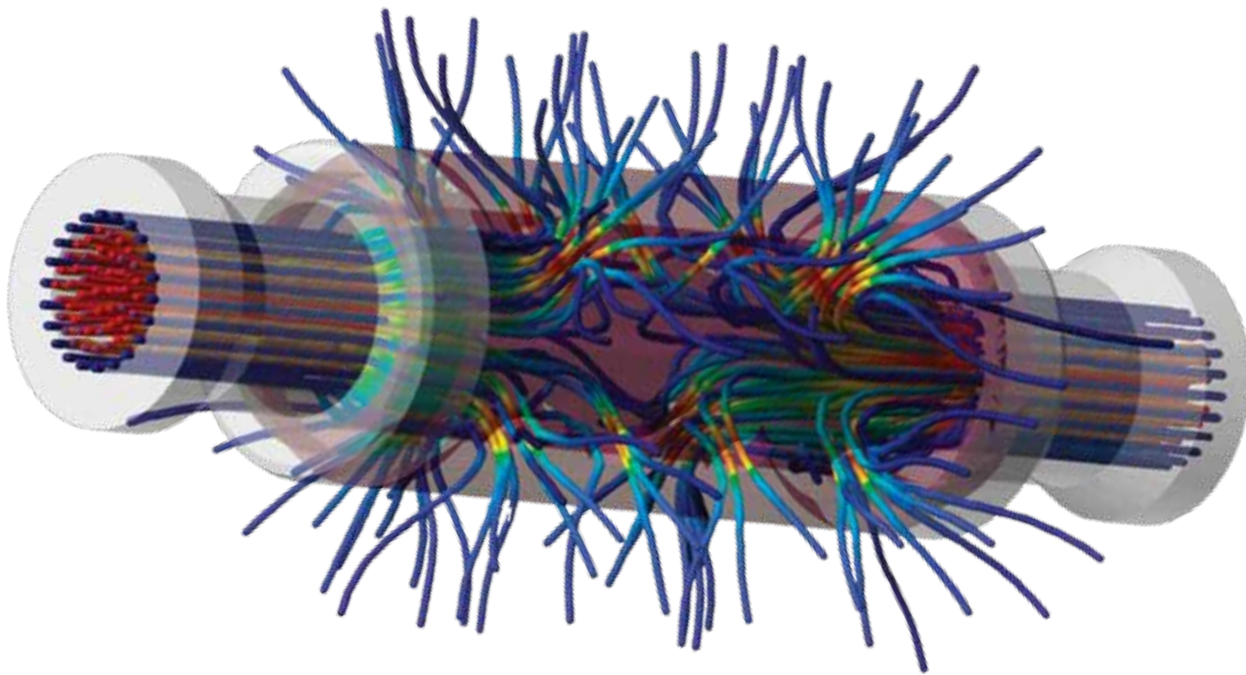
Choose the Right Materials

Support for a wide range of linear and nonlinear materials allows for better understanding of the real-world behavior of products. Whatever materials are included in a design, from metal to rubber, material data is vital to the accuracy of an engineering simulation—allowing designers and engineers to learn more about how a product will perform or even how it might fail.

Expand the Engineering Simulation Toolkit Easily

Decisions to further integrate engineering simulation into the design process often lead to unexpected costs and delays to retrain the product design team. By providing an entire range of validation and optimization tools within the same easy-to-use interface, Autodesk Algor Simulation software lets designers and engineers start with mainstream tools and then expand their toolkit to include more advanced analysis such as Mechanical Event Simulation (MES) and computational fluid dynamics (CFD)—without the need to learn new workflows.

### Combine Multiple Physical Effects in Advanced Simulations

Real-world product behavior is often the result of multiple physical effects interacting simultaneously. Advanced simulation setup is made easier through the use of standard engineering terminology, visual process guidance, and user-friendly tools and wizards that automate the transfer of simulation results between multiple analyses—focusing designers and engineers on product performance, not advanced numerical or simulation methods.

Collaborate in a Multi-CAD Environment

Manufacturers often create and share designs in multiple CAD software tools, making it difficult to integrate engineering simulation tools into an existing design process without requiring significant and costly changes. Autodesk Algor Simulation software supports efficient workflows in today's multi-CAD environment by providing direct geometry exchange and full associativity with Autodesk® Inventor®, Pro/ENGINEER, Solid Edge, SolidWorks, and other software.

Simulate More and Build Fewer Physical Prototypes

Necessary design changes become more apparent when a product's real-world environment is fully simulated, but computationally intensive analyses can be time and resource intensive. Fast solvers in Autodesk Algor Simulation software utilize the power of all available computing resources to perform parallel and distributed processing, allowing designers and engineers to study more realistic digital prototypes in a practical amount of time.
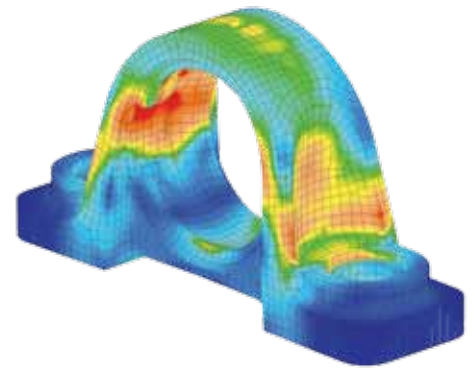
Learn More About Your Product's Performance

Through easy-to-use tools, extensive CAD support, and proven technology, Autodesk Algor Simulation software helps you predict the real-world performance of products while reducing reliance on physical prototypes. Design validation and optimization through extensive engineering simulation helps you bring better products to market faster and at less cost.
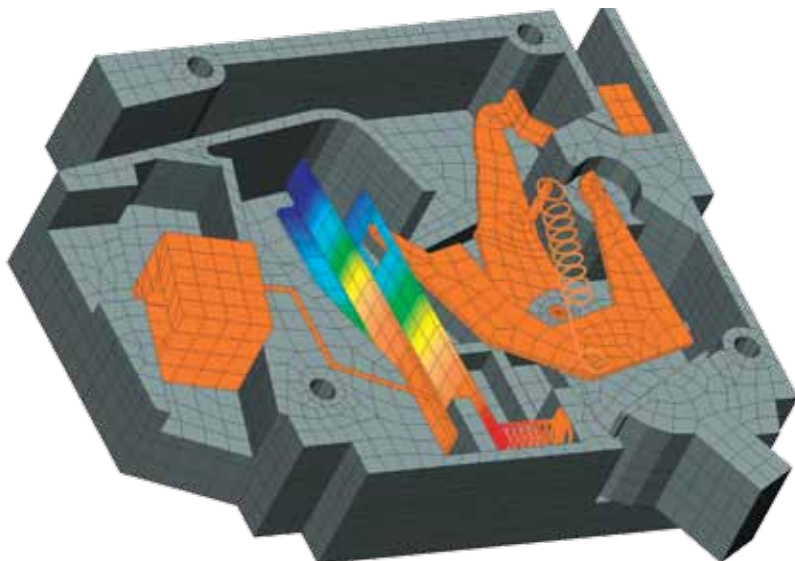
Modeling and Meshing

Create finite element models and meshes using tools and wizards designed to improve productivity and simulation accuracy.

Autodesk Algor Simulation software includes tools for creating finite element models and meshes, including solid models, thin-walled models, surface models, and line element models. Wizards automate finite element modeling and meshing tasks, boosting your productivity.

CAD Data Exchange
- Make iterative design changes without redefining materials, loads, constraints, or other simulation data by working with the native CAD format, exchanging geometry and related data directly with Autodesk Inventor software and most CAD solid modelers.
- Import 2D and 3D geometry through CAD universal file formats such as ACIS®, IGES, STEP, and STL for solid models and CDL, DXF™, and IGES for wireframe models.
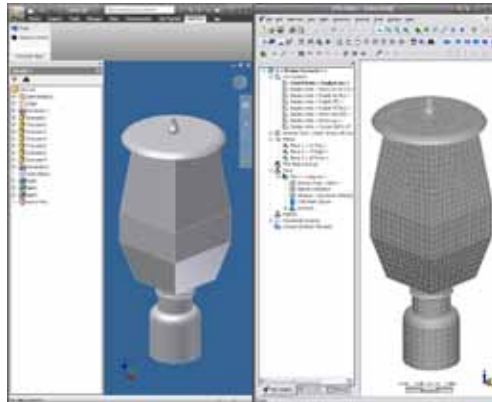
Model Simplification
- Simplify your CAD model by suppressing features in preparation for simulation.
- Reduce part geometry to minimize processing time.

CAD Solid Models
- Mesh CAD solid models to represent the physical volume of parts.
- Work with the same CAD models used throughout the design process, opening geometry and related data directly in Autodesk Algor Simulation software.

CAD Surface Models
- Build surface models in CAD software and automatically mesh using unstructured 3D quadrilateral or triangular elements and refinement.
- Reduce thin-walled geometry in a solid model to plate or shell elements with automatic handling of parts, assemblies, multi-thickness regions, and mixed element types.

User-Created Meshes
- Create planar sketches, and surface and volume meshes, using a variety of modeling and structured meshing tools.
- Develop an idealized assembly model to reduce simulation complexity and processing time.
- Directly edit the finite element mesh to further refine geometry.

Mesh Engines
- Produce high-quality elements for accurate simulation results on the first pass.
- Generate hex-dominant meshes using brick elements on the model surface and tetrahedral elements on the inside.
- Match meshes between parts automatically and produce a finer mesh in areas where results tend to be higher.
- Maintain extensive control over mesh type and size, helping accuracy and optimizing processing times.
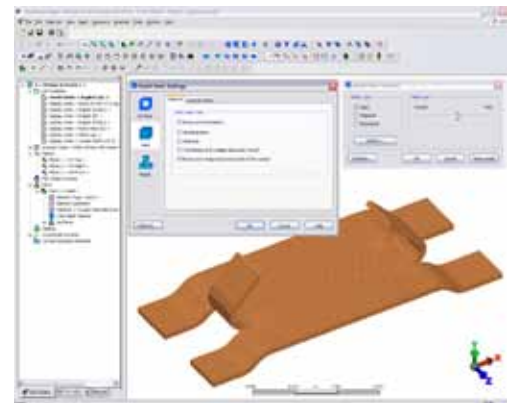
Modeling and Meshing

Line Elements
- Create idealized representations of slender structures, such as buildings and frames, using modeling tools and AISC section data.
- Create line elements for beams, pipes, and trusses for simple construction of complex structures.
- Quickly and easily change cross-section properties.

2D Modeling
- Create 2D profiles for first-pass or proof-of-concept studies.
- Use built-in 2D sketching, modeling, and meshing tools to validate your model and confirm simulation parameters.

Combined Element Models
- Combine element types in a single finite element model to reduce processing time.
- Build an entire assembly within CAD software, or idealize some parts with efficient element types such as springs, beams, trusses, plates, shells, membranes, composites, and more.

Mesh Seed Points
- Specify node location, allowing for exact placement of loads and constraints.
- Add a line element, inquire on results, and perform other nodal-based operations.
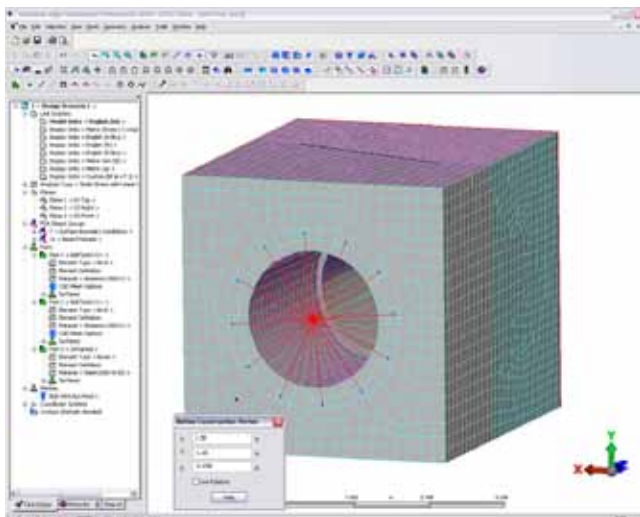
Mesh Study Wizard
- Automate mesh sensitivity studies by meshing the CAD model at different densities, running static stress analyses, and displaying the results in a graph.
- Determine the optimal mesh density required for accurate simulation results and verify accuracy with precision contours.
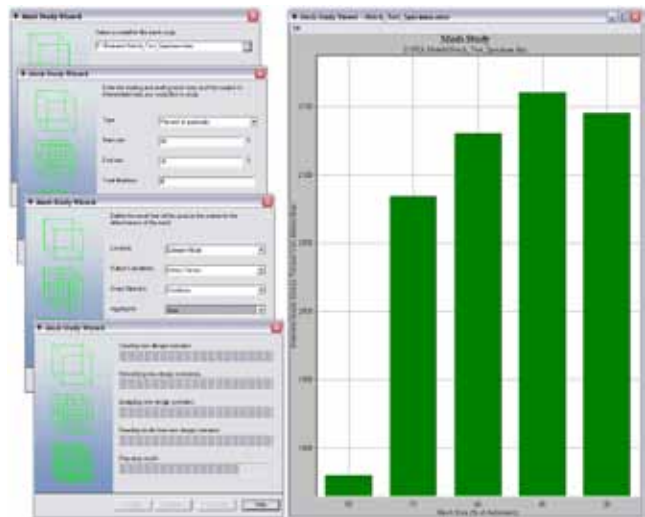
Modeling Wizards
Autodesk Algor Simulation software includes a range of wizards to help you:
- Create pin and ball joints.
- Create fasteners such as bolts, screws, nuts, and rivets.
- Create tapered beams.
- Reduce solid and surface geometry to line elements.
- Automatically model a fluid medium.
- Create pressure vessels and piping components.

Properties Definition

Define, group, and apply properties such as loads, constraints, and materials—making it easier to accurately predict product performance.

Autodesk Algor Simulation software helps you better understand the real-world performance of products by applying material data, loads, and constraints to your digital prototype. Numerous material models and a library of common engineering materials help you characterize and predict how parts will respond to loads.

Environment Definition
- Maintain full control over the definition of your simulation environment.
- Apply, modify, and delete loads, constraints, materials, and simulation properties using right-click functionality.
- Use context-sensitive menus tailored to particular steps in the modeling process.
- Use drag-and-drop capabilities for simulation data.
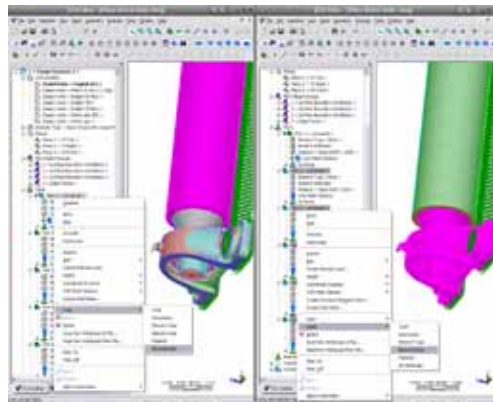
Easy Simulation Setup
- Use standard engineering terminology and visual process guidance for simulation setup.
- Manage time-dependent input parameters through simple, easy-to-navigate dialog boxes.
- Use mathematical expressions during data entry.

Load and Constraint Sets
Group loads and constraints into sets, making it easier to simulate multiple loading and constraint scenarios.

Design Scenarios and Studies
- Group properties together to study the full environment of a product to predict real-world performance.
- Batch-run multiple simulations using different analysis types, load sets, and constraint sets for the same model.

Loads
Easily apply loads—including centrifugal loads, gravity loads, heat generation, current density, pressure, convection, radiation, flow rate, force, temperature, and voltage—to the entire model, its surface or edges, or individual parts or nodes.

Variable Loads
- Apply variable loads—such as time- and results-based loads—to your model.
- View and edit multiplier data associated with time-dependent loading and easily import load curves from other sources.
- Adjust the magnitude of an applied load based on the results calculated in a Mechanical Event Simulation (MES) analysis.
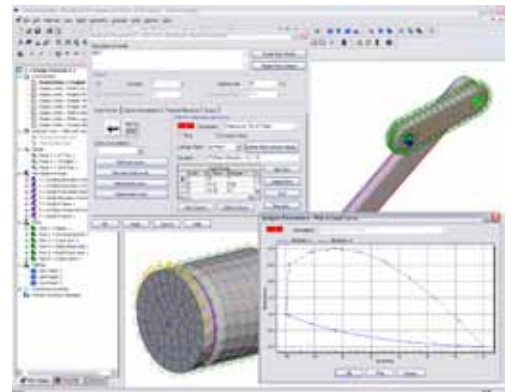
Properties Definition

Loading Wizards

Autodesk Algor Simulation software includes a range of wizards to help you:

- Calculate and apply remote loads to a structural model, such as torque.
- Estimate heat transfer coefficients for convection loads between a solid and the ambient environment.
- Calculate view factors for determining the amount of radiation passed between bodies.
- Automate application of results from one analysis type to another for multiphysics simulations.
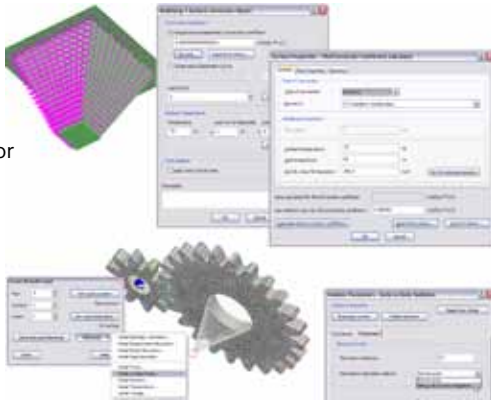
Material Library Manager

- Import, create, and manage customized material libraries to better simulate material behavior.
- Apply properties from a built-in library of common engineering materials, import properties from industry-standard material resources such as MatWeb, or create custom materials and save them for reuse.
- Apply the same material properties to multiple parts simultaneously or different properties to each part.

Material Wizard

- Automatically calculate material values by curve fitting stress-strain test data.
- Calculate constant values for hyperelastic material models and input the constants directly into the material property fields.

Material Model Capabilities

- Better understand the real-world behavior of parts by closely considering actual material behavior including foam, gasket, rubber, plastic, and other nonlinear materials.
- Choose from a wide range of nonlinear material models to get accurate results when a part's operation involves twisting, stretching, squashing, or buckling.
- Learn how a part will fail, especially when large deformation occurs.
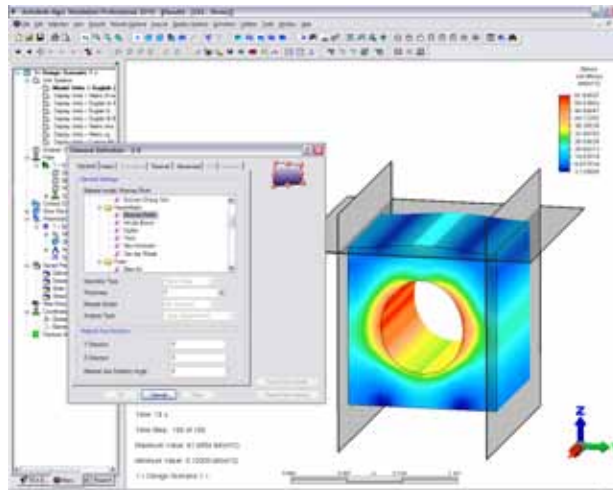
Static Stress and Linear Dynamic Analysis

Study the structural response of designs with tools for static stress and linear dynamic analysis.

Autodesk Algor Simulation software includes features for static stress and linear dynamic analysis. Study stress, strain, displacement, shear, and axial forces resulting from structural loading.

Static Stress Analysis
- Test designs for structural integrity, avoiding over- or under-designing.
- Study stress, strain, displacement, shear, and axial forces by applying known, static loads for linear or nonlinear stress analyses.
- Predict large deformation, permanent deformation, and residual stresses.
- Use the Riks method to simulate nonlinear buckling.
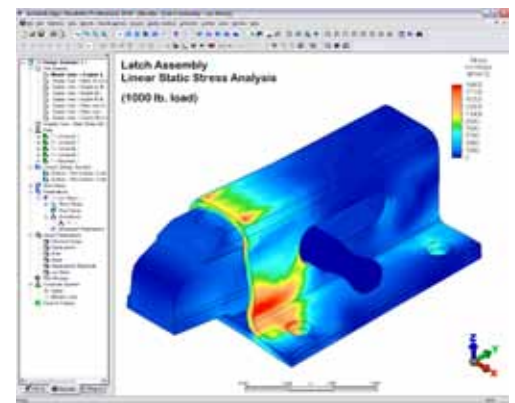
Natural Frequency (Modal) Analysis
- Determine a part's natural frequencies and mode shapes to avoid frequencies that are disruptive or harmful in your design.
- Use studies of oscillating modes to determine if a part resonates at the frequency of an attached power-driven device such as a motor.
- Make design changes to reduce the amplitude of oscillations and account for stiffening effects from applied loads.
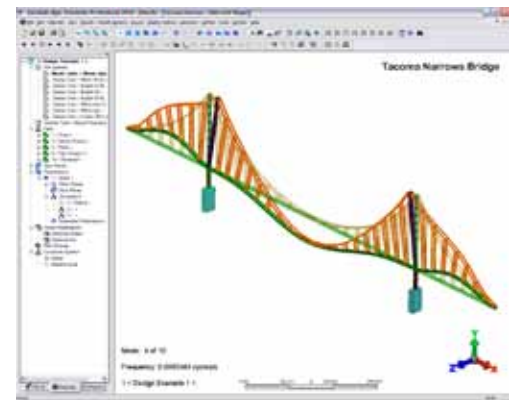
Response Spectrum Analysis
- Design structures to withstand sudden loads by determining the structural response to sudden forces or shocks, such as earthquakes.
- Use formulas recommended by the U.S. Nuclear Regulatory Commission, often used to design components for nuclear power plants such as nuclear reactor parts, pumps, valves, piping, and condensers.
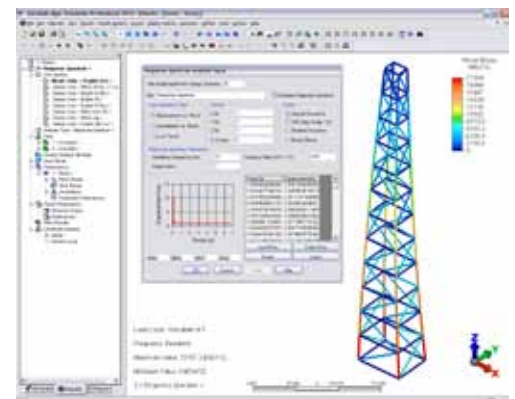
Static Stress and Linear Dynamic Analysis

Random Vibration Analysis
- Design structures to withstand constant, random vibrations by calculating the structural response to vibrations generated by motors, road conditions, jet engines, and more.
- Study a vehicle's structural integrity and effects of vibration on transported payloads.

Frequency Response Analysis
- Determine the steady-state operation of a machine, vehicle, or press equipment design subjected to continuous harmonic loading.
- Specify a constant frequency and amplitude to predict the vibration effects.
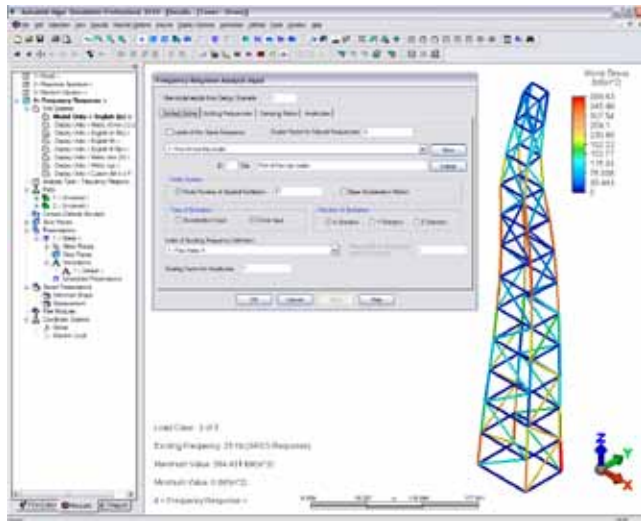
Transient Stress Analysis
- Calculate structural response to time-varying loads and ground acceleration.
- Conduct structural vibration and load testing for applications such as wind loading on towers or the cycling effects of air-purification equipment.

Critical Buckling Load Analysis
- Avoid structural failure by determining the amount of load that would cause a structure to buckle.
- Examine the geometric stability of models under primarily axial load and edge compression.
- Review the predicted buckling shape and then add supports and stiffeners to your design.
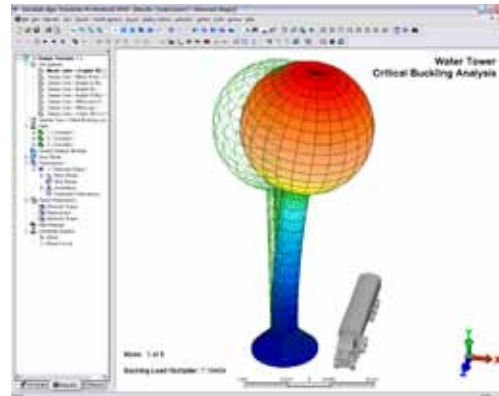
Dynamic Design Analysis Method Analysis
- Estimate the response of a component to shock loading caused by sudden movement of a vessel resulting from depth charges, mines, missiles, or torpedoes.
- Simulate interaction between the shock-loaded component and its fixed structure by accounting for equipment weight, mounting location, and orientation on the vessel.
- Validate designs for naval applications, including when input values need to remain confidential.
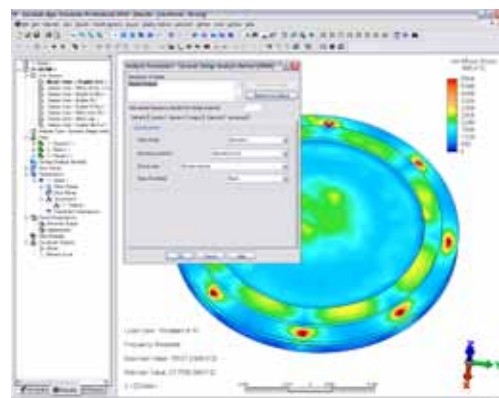
Mechanical Event Simulation

Enhance design decisions by using multi-body dynamics with support for large-scale motion, large deformation, and large strain with body-to-body contact.

With Autodesk Algor Simulation software, you can use multi-body dynamics with support for large-scale motion, large deformation, and large strain with body-to-body contact to enhance design decisions. Analyze models subject to dynamic loads and inertial effects involved in motion, drop tests, and impact. Study stress, strain, displacement, shear, and axial forces due to motion. Mechanical Event Simulation (MES) with linear and nonlinear materials automatically calculates loads and time-stepping based on physical data, helping you avoid costly, inaccurate assumptions.

Rigid-Body Motion

- Simulate kinematic motion of inflexible models. A model can include coupled mechanisms or be completely unconstrained, allowing movement in any direction.
- Use 2D and 3D kinematic elements when focused on rigid-body motion results and when stresses are unimportant.
- Determine stresses for kinematic element parts of the model at any time by using an inertial load transfer capability.
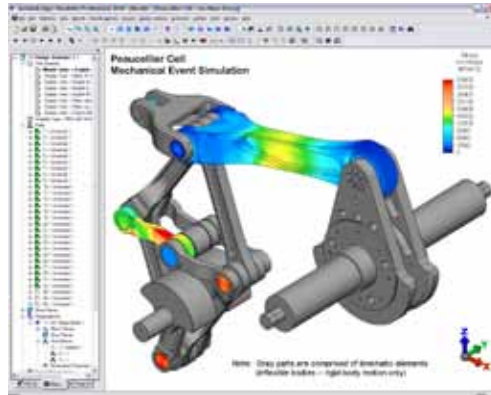

Flexible-Body Motion

- Account for bending, twisting, stretching, squashing, and inertial effects by conducting simultaneous motion and stress analysis to see motion and its results—such as impact, buckling, and permanent deformation.
- Account for flexible joints and links in a mechanism to produce accurate results.
- Simulate geometric and material nonlinearities, such as large deformation beyond the material yield point.
- Display a part's range of motion and resulting stresses in real time, helping to quickly identify yielding or failure.

Contact Analysis

- Accurately simulate interaction and the transfer of loads between multiple parts of an assembly for both linear and nonlinear contact scenarios.
- Study bonded, welded, free/no, surface, and edge contact for applications such as bolted connections and interference fits. Capabilities for nonlinear contact include additional contact methods such as coupling elements, dashpot elements, and surface-to-surface contact.
- Specify the surfaces and parts that may come into contact throughout an event, and choose whether to include friction effects. There's no need to estimate dynamic or contact forces for MES— Autodesk Algor Simulation software automatically calculates contact points, orientations, and related loads.
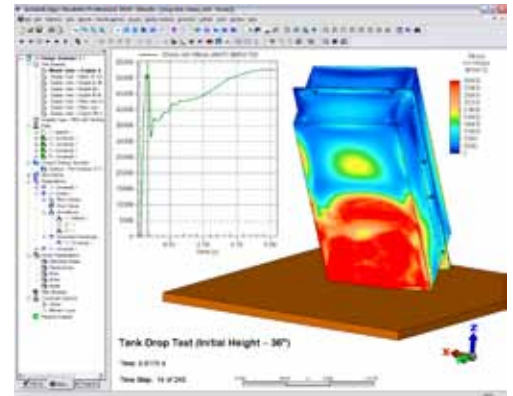
Computational Fluid Dynamics (CFD)

Study the thermal characteristics of designs and simulate accurate, detailed fluid flow behavior.

Use computational fluid dynamics (CFD) tools in Autodesk Algor Simulation software to perform heat transfer and fluid flow analyses.

Heat transfer analysis — Study changes in a product's temperature profile to reveal potential failure. Analyze linear and nonlinear thermal designs by considering conduction, convection, heat flux, heat generation, radiation, and thermal contact. Autodesk Algor Simulation software automatically handles variable material properties, making it easier to analyze the impact of temperature profiles on a design.

Fluid flow analysis — Analyze patterns in multiple independent fluids by calculating velocity and pressure that occurs within incompressible, viscous 2D and 3D flows. Predict laminar and turbulent flow simultaneously in a single model. Simulate accurate, detailed fluid flow behavior by leveraging boundary layer meshing.

Steady-State Heat Transfer Analysis
- Determine temperature distribution, heat flow, and heat flux in steady-state conditions.
- Consider thermal expansion and contraction to assess design performance.
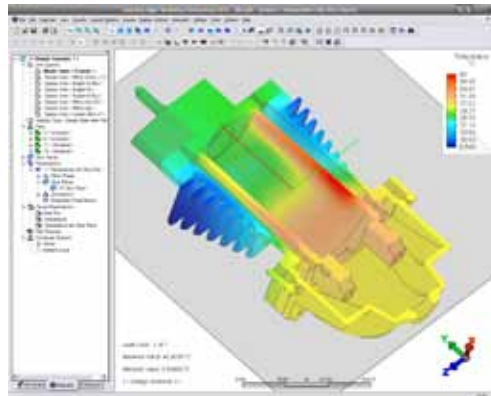

Transient Heat Transfer Analysis
- Calculate temperature distribution, heat flow, and heat flux when temperature or loads vary over time.
- Study varying heat transfer conditions prior to steady state.
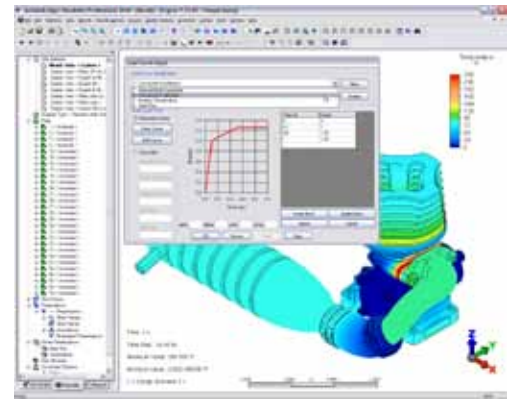

Steady Fluid Flow Analysis
- Determine the motion of a fluid due to steady loads.
- Perform fast simulations for flows in which velocities do not vary with time, such as lift and drag on a wing or flow through a pipe.
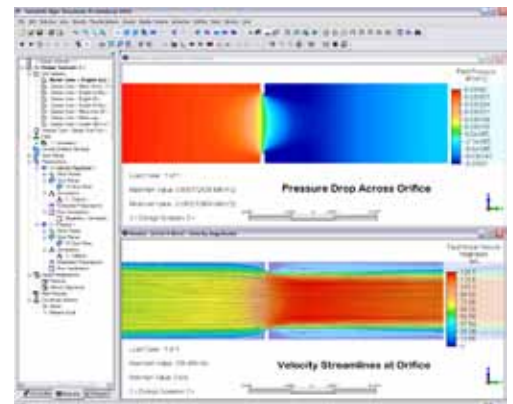
Computational Fluid Dynamics (CFD)

Unsteady Fluid Flow Analysis
- Study dynamic motion of a fluid due to time-varying loads or steady loads.
- Consider inertial effects and acceleration of fluids to calculate a flow field when direction and velocity change over time.
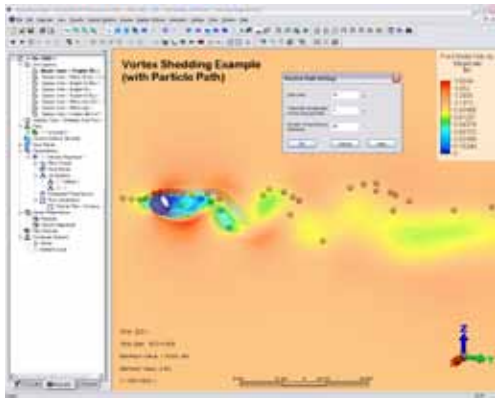
Flow Through Porous Media Analysis
- Simulate flow through ground rock, catalyst and packed beds, filters, screens, perforated plates, porous metal foam, flow distributors, tube banks, and more.
- Use both isotropic and orthotropic materials to calculate velocity and pressure fields.
- Study multiple parts with varying permeability and inertial effects for high Reynolds number applications.
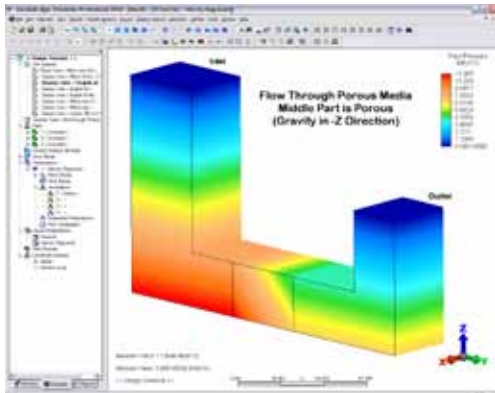
Open-Channel Flow Analysis
Determine dynamic motion of a fluid in a volume that is less than completely filled, simulating a free surface between a flowing fluid and a gas above it. Typical applications include marine systems, drainage systems, and liquid column gauges.

Mass-Transfer Analysis
- Simulate mass in transit due to gradients in the concentration of species within a mixture, where transfer is due to random molecular motion. A typical application is chemical species through a membrane.
- Determine species concentration distribution and corresponding species flux over time.
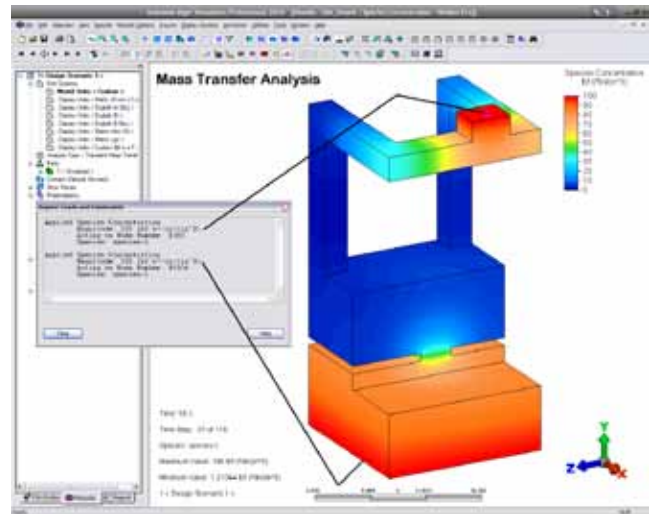
Multiphysics

Study the result of multiple physical factors acting simultaneously by combining results from different analysis types to predict a product's real-world performance.

Multiphysics features in Autodesk Algor Simulation software help you study the result of multiple physical factors acting simultaneously by combining results from different analysis types to predict a product's real-world performance.

Fluid and Thermal Analysis
- Calculate effects of fluid motion on the heat transfer of an assembly and effects of temperature distribution on the flow pattern. Applications include fan-cooled electronics, heat exchangers, and systems that operate at extremely high temperatures.
- Use natural convection (buoyancy) capability to account for flow changes caused by temperature differences in fluids.
- Use forced convection heat transfer capability to consider effects of fluid flow when solving for temperature distribution.
- Determine what fluid velocity is necessary to produce the desired temperature distribution and prevent part failure.
- View fluid flow and heat transfer results simultaneously for applications with both natural and forced convection (mixed).
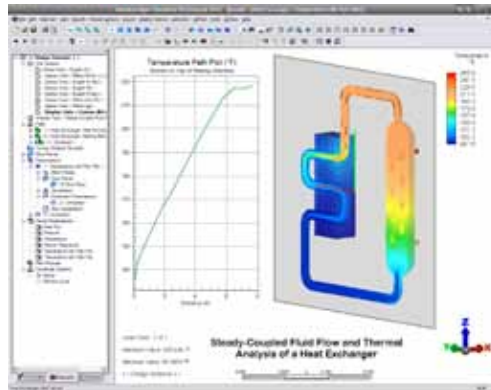
Thermal Stress Analysis
Apply temperature results from a heat transfer analysis as thermal loads in a structural analysis to determine if resulting deflections and stresses may cause otherwise suitable parts to fail.

Fluid and Structural Analysis
Input results from a computational fluid dynamics (CFD) analysis as loads in a structural analysis. This loosely coupled fluid-structure interaction lets you analyze effects of fluid flow on a structure.

Electrostatic Analysis
- Determine voltage and current distribution when an electric potential is applied to a conductive material.
- Study electric fields around objects and analyze dielectrics, insulating materials polarized by electric fields.
- Study an assembly's electric conduction properties and test whether designs exceed the dielectric strength of capacitors and surrounding media.

Joule Heating Analysis
Simulate joule heating effects by linking the results of an electrostatic analysis to a heat transfer analysis. This capability is useful when analyzing spot welding, circuit breakers, microelectromechanical systems (MEMS), and electronic devices.

Electromechanical Analysis
- Determine how voltage relates to structural response.
- Calculate the strain in a piezoelectric material due to voltage distribution.
- Link the resulting voltage distribution and electrostatic forces calculated by an electrostatic analysis to structural analysis tools.
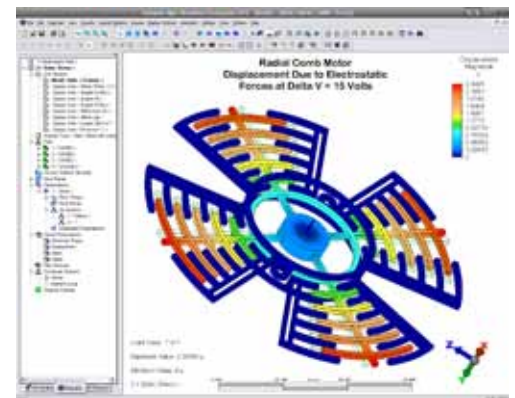
Results Evaluation

Visualize and evaluate simulation results, easily communicating via images, animations, and reports.

Autodesk Algor Simulation software provides a wide range of tools and wizards for model visualization, results evaluation, and presentation. Features include multiple-window displays, fast dynamic viewing controls, and customization options.

Visualization
- View animated visualizations of your digital prototype that are based on underlying physics.
- Hide parts of a model, slice it to view interior results, and use transparency to examine specific parts while maintaining proper context.
- Realistically visualize spring, beam, truss, 2D, plate, and shell elements in 3D.
- Create presentations that are realistic, vivid, and intuitive in order to understand product performance more fully.
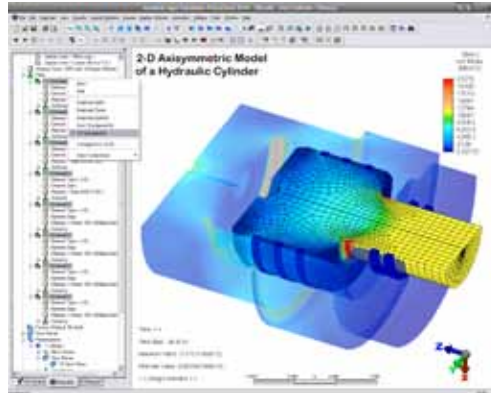

Result Types
- Understand how a product performs by viewing simulation results using a wide range of tools.
- Easily access pertinent results for any analysis type through a context-sensitive menu.
- Define your own result types, and display results for multiple load calculations.
- Add annotations to highlight the location of minimum and maximum results.
- Define probes at locations of specific interest.

Graphs and Plots
- Depict results as graphs that help you investigate how dynamic characteristics of a design vary through its operating cycle.
- Plot physical parameters—such as position, force, and acceleration—versus time.
- Use stream lines, path plots, and particle tracking to clearly illustrate fluid flow patterns.

Real-Time Monitoring
- Monitor dynamic visualization of a product's behavior during or after time-based simulations, providing insight into the early stages of complex simulations.
- Stop an analysis, adjust parameters, and restart the analysis as needed.
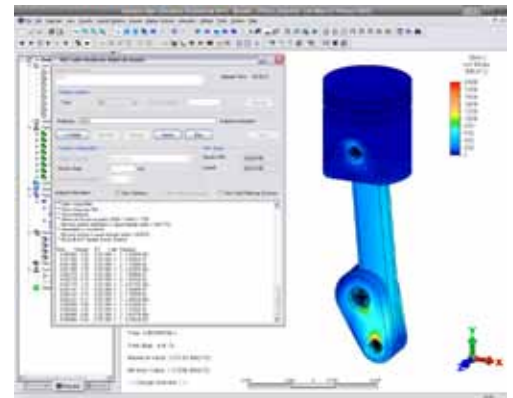
Results Evaluation

Volume and Weight Analysis
- Calculate center of gravity, mass moment of inertia, products of inertia, volume, and weight of any model.
- Quickly generate new values to view the impact of each design modification on volume and weight.
- Determine amount of material required for any proposed design, and make informed design decisions that consider the cost of materials.

Result Wizards
Autodesk Algor Simulation software includes a range of wizards to help you:
- Verify compliance with AISC's Specification for Structural Steel Buildings, Allowable Stress Design, and Plastic Design.
- Calculate linearized stress distribution in thin-walled pressure vessels to verify compliance with ASME Boiler and Pressure Vessel Code.
- Study fracture mechanics by calculating J-integral results and stress intensifications at cracks.
- Explore the impact of design changes and find the best solution by automatically seeking parameter values that meet design criteria.
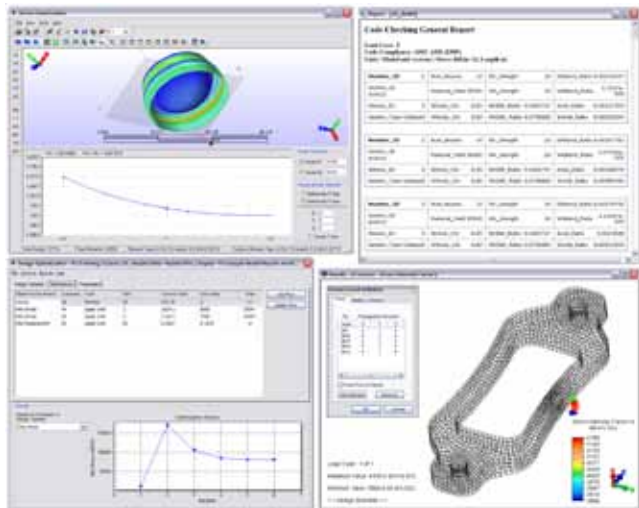
Images and Animations
- Communicate results to customers and team members through 3D web-based models, animations, and images.
- Save to popular formats, including AVI, BMP, JPG, TIF, PNG, PCX, TGA, VRML, and HOOPS Stream File (HSF).
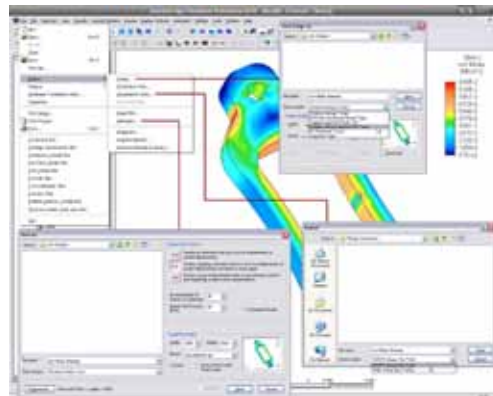
Reports
- Easily document and share simulation results, presenting them through automatically generated reports in HTML, PDF, DOC, and RTF formats.
- Control which sections to include.
- Add images, animations, and text-based results.
- Fully customize appearance and formatting.

Microsoft Office Data Exchange
- Export contour and graph data to Microsoft® Excel® worksheets, and then incorporate results into presentations and reports.
- Easily copy and paste results into other Microsoft® Office® applications.

Customization Options
- Control default settings, displays, annotations, reports, and more.
- Save settings for a results presentation and then use them with any model.

Digital Prototyping for the Manufacturing Market

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