ALGOR

Mechanical Event Simulation

Mechanical Event Simulation (MES) combines large-scale motion and stress analysis and includes linear and nonlinear material models. The combination of motion and stress analysis considering full inertial effects allows engineers to see motion and its results, such as impact, buckling and permanent deformation. These analysis capabilities are all available within FEMPRO, an easy-to-use, single user interface for finite element modeling, results evaluation and presentation.

MODELING

A suite of modeling capabilities includes:

- InCAD technology for direct CAD/CAE data exchange with Alibre Design, Autodesk Inventor, Inovate, IronCAD, KeyCreator, Mechanical Desktop, Pro/ENGINEER, Rhinoceros, Solid Edge and SolidWorks
- full associativity with each design change for most CAD solid modelers
- CAD support for 2- and 3-D CAD universal files
- Superdraw 2- and 3-D sketching tools
- 2- and 3-D parametric structured meshing
- automatic, unstructured 2- and 3-D meshing
- automatic, intelligent, feature-based mesh refinement and point-and-click definition of areas where a finer mesh is desired
- a midplane mesh engine for reducing thin, solid features in a CAD model to plate/shell elements with automatic handling of parts, assemblies, multi-thickness regions and mixed element type models
- an automatic, hex-dominant hybrid solid meshing tool to produce higher quality elements on the first pass and more accurate results

ANALYSIS

MES provides:

- rigid-body motion and flexible-body kinematics that account for the bending, twisting, stretching, squashing and inertial effects of a model while simultaneously calculating motion
- support for flexible joints and links in a mechanism
- linear and nonlinear material models for real-world behavior of parts
- an automatic time-stepping scheme that incorporates an implicit timestep method to produce an efficient and accurate solution
- results based on physical data, rather than calculated or assumed loads and constraints
- freedom from estimating dynamic or contact forces or inputting constraints that do not exist in the real world (i.e., free-falling objects)
- automatic calculation of contact points, orientations and stiffnesses
- Timeline technology for managing time-dependent input
- dynamic visualization of the part's behavior during or after the event

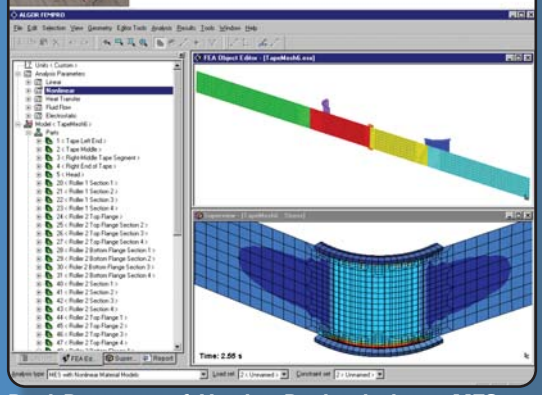
RESULTS EVALUATION AND PRESENTATION

Extensive results evaluation and presentation capabilities include transparent display options, multiple-window displays, fast dynamic viewing controls and customization options including user-defined color palettes and annotations. All analysis results can be:

- displayed graphically as contours or plots
- output in the BMP, JPG, TIF, PNG, PCX and TGA formats
- animated with AVI creation and display tools
- presented in text or HTML reports

"Calculating the stress levels with MES enabled me to make adjustments and optimize the design [of a back-up tape drive]."

Paul Poorman
Hewlett-Packard



Paul Poorman of Hewlett-Packard chose MES to predict stress levels in the magnetic tape within a back-up tape drive. This data was used to develop a solution for reducing stresses in the tape.

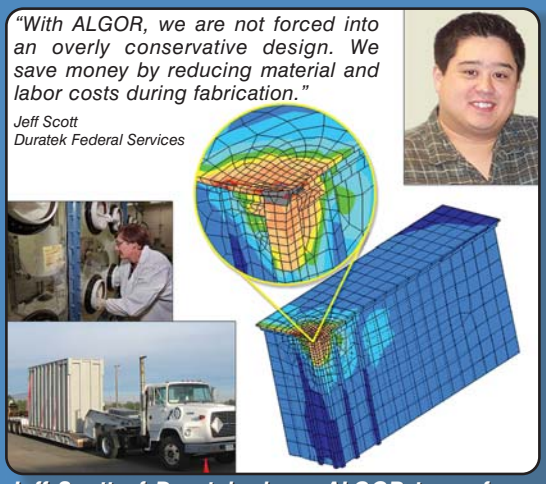
"ALGOR helped us keep our commitment to high-quality, innovative and robust games that challenge game users but won't break during use."

John Rotharmel
Stern Pinball, Inc.

John Rotharmel of Stern Pinball used MES to model and analyze the action of a pinball striking a plastic drop-target assembly. The ALGOR results confirmed that the part needed strengthened before use in a new pinball machine.

"With ALGOR, we are not forced into an overly conservative design. We save money by reducing material and labor costs during fabrication."

Jeff Scott
Duratek Federal Services



Jeff Scott of Duratek chose ALGOR to perform drop-test simulations on a radioactive waste container. The MES results complied with the Code of Federal Regulations and eliminated the need for physical prototyping.

MECHANICAL EVENT SIMULATION FEATURES

Analysis Capabilities
- Static stress with linear and nonlinear material models
- Rigid-body motion
- Flexible-body motion with linear and nonlinear material models
- Automatic determination and application of inertial loads generated during an event
- Multiple-body contact and interaction
- Hertzian contact
- Elastic deformation
- Permanent deformation
- Local buckling
- Pre-stress
- Residual stress analysis
- Thermal stress
- Creep analysis
- Failure analysis
- Sub-modeling
- Inertial effects
- High- and low-frequency effects
- Hydrodynamic effects
- Voltage-induced effects
- Load stiffening
- Damping
- Geometric nonlinearity
- Weight, center of gravity and mass moment of inertia

Modeling
- KinePak mechanism wizard to define links and then dynamically examine the motion of various types of basic mechanisms
- See the FEMPRO (Part No. 3201.326) and CAD Support (Part No. 3201.331) product data sheets for additional modeling features

Meshing
- See the CAD Support product data sheet (Part No. 3201.331) for the complete list of meshing features

Element Library
- 2- and 3-D kinematic element
- 2- and 3-D hydrodynamic element
- General contact element
- Contact element
- Coupling element
- Dashpot element
- Translational and rotational actuator element
- Slider element
- Pipe element
- Spring element
- Pulley element
- 2-D element (planar, axisymmetric)
- 3-D truss element
- 3-D beam element
- 3-D membrane element
- 3-D membrane plane stress element
- 3-D plate element
- 3-D shell element
- Thin composite element
- Sandwich (thick) composite element
- Motion-enabled composite element
- 3-D brick element
- 3-D tetrahedral element
- Gap element
- Cable element
- Rigid element

Material Models
- Elastic
- Plastic
- Variable tangent
- Curve description
- Curve description with cutoff tension
- Drucker-Prager
- von Mises with isotropic hardening
- von Mises with kinematic hardening
- von Mises curve with isotropic hardening
- von Mises curve with kinematic hardening
- Temperature-dependent orthotropic
- Thermoelastic
- Thermoplastic
- Viscoelastic (thermal-creep)
- Viscoplastic (thermal-creep)
- Mooney-Rivlin (2, 5 and 9 constants)
- Ogden (1st - 6th order)
- Arruda-Boyce (thermal and finite-strain viscoelastic)
- Blatz-Ko (thermal and finite-strain viscoelastic)
- Hyperfoam (1st - 6th order)
- Linear elastic isotropic
- Linear elastic orthotropic
- Linear temperature-dependent isotropic
- Linear temperature-dependent orthotropic
- Piezoelectric
- General piezoelectric
- Anisotropic
- Temperature-dependent composite
- Composite laminate

Loading and Constraints
- Initial velocities and rotations
- Impact planes
- Point-to-surface and surface-to-surface contact
- Static and dynamic friction
- Forces (nodal, follower, surface, edge, gravitational and centrifugal)
- Moments
- Temperatures (nodal, surface, initial and applied)
- Voltages (nodal and surface)
- Prescribed displacements (nodal, surface and edge)
- Prescribed rotations (nodal, surface and edge)
- Pressures (surface, follower and hydrostatic)
- Tractions
- Variable surface and distributed loads
- Global and off-axis constraints (nodal, surface and edge)
- Variable-stiffness off-axis constraints (nodal, surface and edge)
- End releases
- Local coordinate system support
- Lumped masses
- Mass moments of inertia
- Curing and mean temperature difference

Solver Options
- Symmetric sparse
- Skyline
- Algebraic multigrid (AMG) iterative
- Banded
- Riks method
- Restart capability
- Automatic time-stepping
- Parallel processing for multiple processors

Results Evaluation
- Result displays of:
  - Displacement
  - Stress
  - Strain
  - Plastic strain
  - Strain energy density
  - Reaction force
  - Factor of safety
  - Vector plots of principal stress directions
  - Plate/shell thickness
  - Isosurfaces
- Built-in, virtual instrumentation through Monitor for result graphs
- Fast Fourier Transform (FFT) display
- See the FEMPRO product data sheet (Part No. 3201.326) for additional results evaluation features

Results Presentation
- See the FEMPRO product data sheet (Part No. 3201.326) for the complete list of results presentation features

User Interface
- Timeline editor/viewer for viewing and editing the multiplier data associated with a time-dependent loading event
- See the FEMPRO product data sheet (Part No. 3201.326) for the complete list of user interface features

Note: For complete details on our Mechanical Event Simulation features, see the "Products" section of www.ALGOR.com. ALGOR's web site contains additional information about our wide range of simulation capabilities including static stress and Mechanical Event Simulation (MES) with linear and nonlinear material models, linear dynamics, fatigue, steady-state and transient heat transfer, steady and unsteady fluid flow, electrostatics, full multiphysics and piping.

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