ANSYS® AUTODYN®
Explicit Software for Nonlinear Dynamics

11.0 RELEASE

Product Features

Solver Methods
- Lagrangian (volume and structural)
- Eulerian (volume)
- Arbitrary Lagrange-Euler
- Meshfree (SPH)
- Block structured
- Unstructured
- Large deformation
- Nonlinear
- Solid mechanics
- Fluid mechanics
- Shock waves
- Coupled

Pre-Processing
- Interactive intuitive interface
- Integrated with solvers and post-processor
- Wizards for ease of setup
- Visual checking of data
- Data checking during model creation
- Comprehensive restarting capabilities: all valid data can be modified/added/removed at any stage
- Material data libraries (200+)
- Context-sensitive online help

Interfaces
- ANSYS® ICEM CFD™
- NASTRAN®
- ANSYS® LS-DYNA®
- TrueGrid®

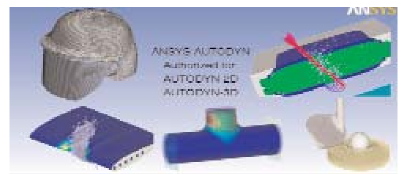
Post-Processing
- Visualization for large datasets
- Interactive intuitive interface
- Integrated with solvers and pre-processor
- Animation wizard and editor
- Stand-alone free viewer for 2-D and 3-D animations
- Contours and isosurfaces
- Element examine probe
- Vectors
- Material location and status
- Gauge time history plotting
- Part histories
- Results profile

Parallel Processing
- Shared/distributed memory
- Windows®, Linux®, UNIX®
- Automatic decomposition
- User-defined decomposition

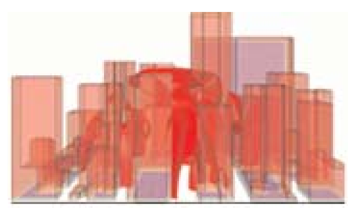
Supported Systems
- Windows®, NT/2000/XP, Linux®, UNIX®

ANSYS® AUTODYN® software is an explicit analysis tool for modeling nonlinear dynamics of solids, fluids and gases as well as their interaction. It is a versatile explicit numerical tool providing advanced capabilities backed by first-class support. ANSYS AUTODYN software has been used in a number of applications:

- Optimization and design of armor and anti-armor systems
- Mine protection scheme design for personnel carriers
- Building protection measures and insurance risk assessment for blast effects in city centers
- Aircraft impact risk assessment for power stations
- Performance studies of oil well perforating charges
- Decommissioning of offshore platforms
- Shielding system design on the International Space Station
- Safety assessment of particle accelerators
- Characterization of materials subjected to high dynamic loading



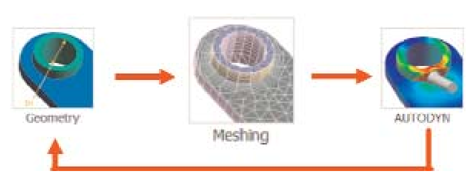
ANSYS AUTODYN in ANSYS Workbench at ANSYS 11.0



Blast analysis in city center

Based on continuous development since 1986, ANSYS AUTODYN software is a user-friendly package that includes:
- Finite elements (FE) for computational structural dynamics
- Finite volume solvers for fast transient computational fluid dynamics (CFD)
- Mesh-free/particle methods for large deformation and fragmentation (SPH)
- Multi-solver coupling enabling a wide range of multiphysics solutions
- Wide suite of material models incorporating constitutive response and coupled thermodynamics
- Models and data for metals, ceramics, glass, concrete, soils, explosives, water, air and many other solids, liquids and gases

New at ANSYS® 11.0 is the introduction of the ANSYS AUTODYN software into the ANSYS® Workbench™ family of products, creating the first explicit dynamics product in the world with:
- Bi-directional connectivity to parametric ANSYS DesignModeler and CAD models



Typical Workflow with parametrically linked ANSYS AUTODYN in ANSYS Workbench

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Product Features

Material Modeling

- Strength models
  - Elastic
  - Viscoelastic
  - Strain hardening models
  - Strain rate hardening models
  - Thermal softening models
  - Porous compaction models
  - Concrete/soil (Drucker-Prager, RHT)
  - Ceramic/glass (Johnson-Holmquist)
  - Third invariant dependence
  - Orthotropic yield
  - Orthotropic solid
  - Orthotropic shell
  - Laminated shell
- Equations of state
  - Linear
  - Ideal gas
  - Mie-Gruneisen
  - Analytic multiphase
  - Tabular multiphase
  - Two-phase liquid–vapor
  - Explosives
  - Tabular porous
  - P-alpha
- Failure models
  - Maximum stress/strain
  - Effective stress/strain
  - Shear damage
  - Orthotropic damage
  - Johnson-Holmquist
  - Johnson-Cook
  - Orthotropic stress/strain
  - Tsai-Wu, Tsai-Hil
  - Crack softening
  - Stochastic
- User-specified models can be defined in all aspects
- Virtually all models can be used in every solver
- Virtually all models can be used with erosion (element death)
- Five erosion criteria
- User-defined erosion

Analysis Techniques

- Explicit
- Transient dynamic
- Conditionally stable
- Hypoelastic
- Nonlinear
- Compressible flow
- Dynamic relaxation for quasi-static analysis
- Automated contact
- Automated fluid-structure coupling

Coupling of Solvers

- Euler-Lagrange coupling
  - Fast automated solver
  - Across arbitrary mesh interfaces
  - Coupling to thin structures
  - Doubly wetted thin structures
  - Porous structures
- Joins between structural elements

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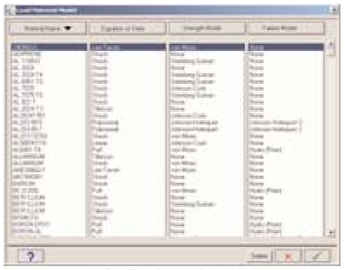
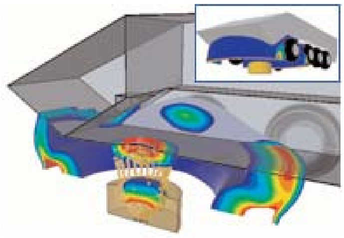
- Access to powerful meshing tools based in ANSYS Workbench
  - Explicit dynamics-specific mesh preferences
  - Tet/hex, shell, beam
  - Mesh sizing and refinement controls
  - High-quality hex meshes
  - Mesh smoothing/optimization
  - Manual mesh modification
  - Mesh operations (reflect, copy, transform)
- Persistent link to ANSYS AUTODYN
  - Updates to geometry/mesh feed directly back into ANSYS AUTODYN model
  - Realistic and practical explicit dynamics parametric studies



Material data libraries

ANSYS AUTODYN software is the platform of choice for structural dynamics, fast fluid flow, material modeling, impact, blast and shock response at many leading institutions worldwide. The loyalty and growth of the ANSYS AUTODYN user base is testament to:

- Excellence of ANSYS AUTODYN software support services
- Focus on developing products that help solve problems
- Ongoing emphasis on R&D and continuity of management and sales teams

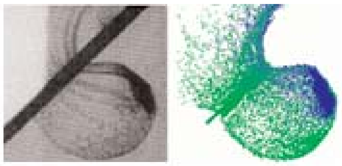


Buried mine blast and its effect on an armored fighting vehicle

An integrated product, ANSYS AUTODYN software tightly integrates the pre-processing, post-processing and analysis modules for maximum productivity. It can be run in serial or parallel mode on Microsoft® Windows® as well as Linux® and UNIX® systems. Both shared memory and distributed cluster are supported.

Compelling Features

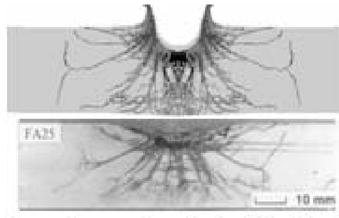
ANSYS AUTODYN software is not an average explicit finite element or computational fluid dynamics (CFD) program. From the very beginning, ANSYS developed this technology to handle — naturally and effectively — the nonlinear behavior of fluids and structures in an integrated fashion. A key component is the seamless way that users can couple sophisticated material models with a fluid structure program. ANSYS AUTODYN software is different from other explicit programs in a number of ways:



Oblique hypervelocity impact test (left) compared to analysis (right). Courtesy of UDRIS NASA.

- Integrated and coupled response of fluids, structures and materials
- Multiple solvers including FE, CFD and smooth particle hydrodynamics (SPH), as well as the coupling between FE and the other solvers
- Use of materials with strength, such as metals, in all solvers, in addition to fluids and gases
- Comprehensive remapping capabilities from FE to CFD and vice versa
- Interactive GUI with leading-edge visualization
- Solvers seamlessly integrated pre- and post processors

- Extensive material model library combining thermodynamic and constitutive responses
- Serial and parallel computation on shared memory and distributed memory systems
- Direct support from experienced developers
- Intuitive user interface with ANSYS Workbench integration
- Extensive validation with physical experiments

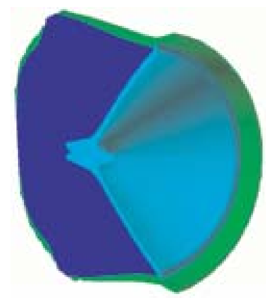


Ceramic armor impact: simulation (top)

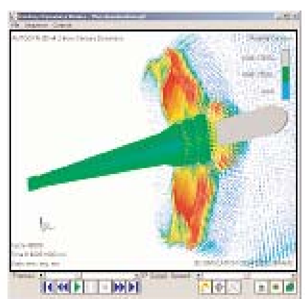
Applications

ANSYS AUTODYN software can be used in a vast array of real-world projects and nonlinear phenomena:

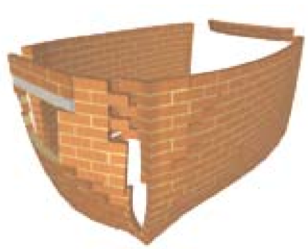
- Designing the shielding system on a space station
- Modeling a building's impact and structural collapse in forensic investigations
- Performing assessment of protection layers for foreign object damage on civil aircraft
- Conducting vulnerability assessment of composite aircraft components to fragmenting warheads
- Performing intercept of ballistic projectiles and lethality investigations for defense
- Modeling impacts on power stations
- Determining asteroid impacts on earth
- Designing mine protection schemes for personnel carriers
- Optimizing passive and reactive armor systems
- Designing, assessing and optimizing anti-armor devices
- Conducting performance studies of well perforating charges
- Assessing satellite damage from space debris impacts
- Determining blast effects in city centers
- Conducting safety assessment of a particle accelerator beam dump
- Analyzing fragmentation of solid bodies
- Performing optimization of mine disposal devices



Shaped change analysis using multi-material Euler



Stand-alone free viewer for interactive and 2-D and 3-D animations



Damage and collapse of a brick building due to an internal explosion

Fragmenting ring using stochastic properties

Product Features

Coupling of Solvers (continued)
- Joins between structural elements and SPH
- Subcycling
- Combined structured and unstructured FE meshes

Symmetries and Remapping
- 1-D Cartesian and spherical
- 2-D Cartesian and cylindrical
- 3-D Cartesian
- 3-D reflective (1/8, 1/4, 1/2)
- Remapping
  - Within solvers
  - Between solvers
  - 1-D to 2-D to 3-D
  - Dezoning

Structural Solvers
- Unstructured meshes
- Multi-block structured meshes
- Combined unstructured and structured meshes
- 3-D reflective (1/8, 1/4, 1/2)
- 2-D and 3-D solids elements
  - Axial and planar solids
  - Hexahedral (bricks)
  - Pentahedral (wedges)
  - Tetrahedral (tets)
  - ALE (adaptive rezoning)
- 2-D and 3-D surface elements
  - Axial and planar shells
  - Quadrilateral (quads)
  - Triangular (trias)
  - Layered shells
  - Membrane
- Beams
- Springs
- Dampers
- Fast large deformation elements
- Accurate extreme deformation elements
- Coupled heat conduction
- Erosion (death) of elements
- Rigid bodies

Fluid Solvers
- Eulerian solvers
- Lagrangian solvers
- ALE solver
- 2-D and 3-D finite volumes
- Fast accurate ideal gas solver (FCT)
- Multi-material VOF solvers
- Material viscosity/strength
- Free surfaces
- Multi-block structured

Contact
- Self contact
- Node to surface
- Edge to edge
- Deformable to deformable contact
- Deformable to rigid contact
- SPH to deformable structural and rigid contact
- Eroding contact
- Friction

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Product Features

Detonation Models
- Automatic detonation logic
- Multiple detonation points
- 2-D and 3-D

Nonlinearity
- Large strain
- Large rotation
- Elastoplastic
- Viscoplastic
- Fragmentation
- Shock capturing
- Phase changes

Boundaries and Loads
- Initial conditions
- Translational velocity
- Angular velocity
- Gravity
- Arbitrary time varying
- Energy deposition
- Pressure
- Point load
- Edge load
- Wave transmission
- Fluid/material flow inlet
- Fluid/material flow outlet
- Rigid wall
- Clamped
- Pinned
- Translational velocity constraint
- Rotational velocity constraint
- Angular velocity constraint
- User specified

Thermal
- Deformation heating
- Thermal expansion
- Thermal softening
- Multiphase transitions and states
- Heat conduction

Documentation
- Context-sensitive online help
- User's manual
- Installation
- Tutorials
- Theory manual
- Release notes

Product Support
- Ongoing support, maintenance and enhancement
- Training
- User group meetings
- Update seminars

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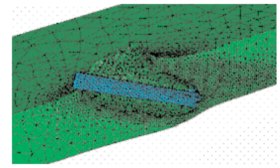
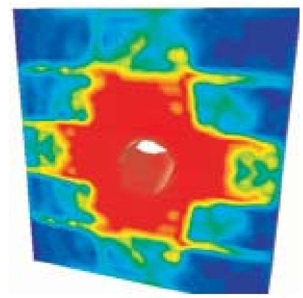
- Performing assessment and design of kinetic energy penetrators
- Determining blast propagation in underground tunnels and structures
- Improving sheet metal stamping
- Analyzing bird strike on aircraft
- Determining hydraulic ram effects in aircraft fuel tanks
- Performing structural response analysis of a containment vessel under hydrogen detonation
- Simulating response and breakup of glazing under blast loading
- Analyzing fuel slosh in racing cars
- Analyzing explosive welding and cutting
- Analyzing powder compaction of sintered metals
- Determining progressive damage of composite structures to impacts loads
- Analyzing explosive forming of aerospace components
- Performing perforation and behind-armor debris analyses of various armor configurations
- Developing water/sand barrier assessment for mitigation of explosives fragmentation and blast
- Predicting blunt trauma injuries
- Performing optimization of transparent armor on wheeled vehicles
- Performing safety distance assessments for hazardous storage sites
- Determining damage of (reinforced) concrete structures under impact and explosive loading
- Decommissioning of offshore platforms
- Analyzing blast-structure interaction assessment of onshore petro-chemical plants
- Determining structural damage of an offshore module to a dropped object
- Predicting blast-induced rock fragmentation
- Developing design of rockfall galleries
- Assessing concrete damage caused by high-frequency ground motions
- Modeling of cavitation and yawing of a supersonic projectile traveling in water
- Investigating pipe rupture incident at a nuclear facility
- Analyzing ceramic fracture under intense loading
- Assessing disturbed flow field during rocket stage separation



Armor/anti-armor analysis



Penetration in a masonry structure

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