



AUTODYN

Explicit Software for Non-Linear Dynamics

www.century-dynamics.com

Version 6.0 Product Features

Solver Methods

- ▶ Lagrangian (volume and structural)
- ▶ Eulerian (volume)
- ▶ Arbitrary Lagrange Euler
- ▶ Meshfree (SPH)
- ▶ Block structured
- ▶ Unstructured
- ▶ Large deformation
- ▶ Non-linear
- ▶ 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
- ▶ LS-DYNA
- ▶ TrueGrid

Post-processing

- ▶ Visualization for large datasets
- ▶ Interactive intuitive interface
- ▶ Integrated with solvers and pre-processor
- ▶ Animation wizard and editor
- ▶ Standalone free Viewer for 2D and 3D animations
- ▶ Contours, isosurfaces
- ▶ Element examine probe
- ▶ Vectors
- ▶ Material location and status
- ▶ Gauge time history plotting
- ▶ Part histories
- ▶ VRML
- ▶ Results profile
- ▶ Context sensitive online help

Parallel Processing

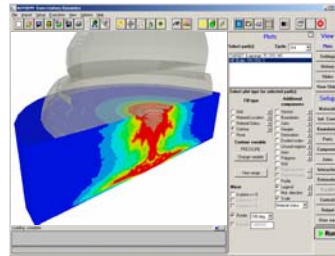
- ▶ Shared memory (SMP)
- ▶ Distributed memory (DMP)
- ▶ Mixed SMP and DMP
- ▶ Available on Windows NT/XP
- ▶ Available on Linux/Unix
- ▶ Automatic decomposition
- ▶ User defined decomposition

Supported Systems

- ▶ Windows NT/2000/XP
- ▶ Linux
- ▶ Unix

AUTODYN Overview

AUTODYN[®] is an explicit analysis tool for modeling non-linear dynamics of solids, fluids, gas and their interaction.



Interactive intuitive pre/post processor integrated with solver

AUTODYN[®] is the most versatile explicit numerical tool, providing advanced capabilities backed by first class support. Here is a small sample of the applications for which AUTODYN has been used:

- ▶ Optimization and design of armor and anti-armor systems
- ▶ Designing mine protection schemes 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
- ▶ Designing the shielding system on the International Space Station
- ▶ Safety assessment of particle accelerators
- ▶ Characterization of materials subjected to high dynamic loading

Based on continuous development since 1986 we have put together for you a user-friendly software package which includes:

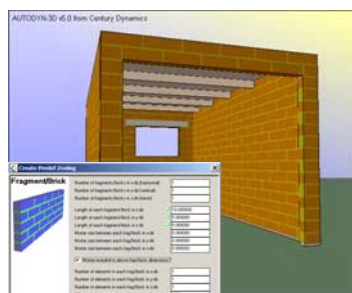
- ▶ Finite Elements for computational structural dynamics (FE)
- ▶ Finite volume solvers for fast transient Computational Fluid Dynamics (CFD)
- ▶ Meshfree/particle methods for large deformation and fragmentation (SPH)
- ▶ Multi-solver coupling enabling a wide range of multi-physics solutions
- ▶ A wide 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



Blast analysis in city centers

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

- ▶ The excellence of our support services
- ▶ Our focus on developing products which help you solve your problems
- ▶ The continuous nature of our development, management and sales teams



Wizard for ease of set-up

AUTODYN is an integrated product with the pre-processing, post-processing and analysis modules tightly integrated for maximum productivity. It can be run in serial or parallel mode on Microsoft Windows and Linux/Unix systems. Shared memory and distributed cluster are both supported.



Version 6.0 Product Features

Coupling of Solvers (cont'd)

- ▶ Joins between structural elements and SPH
- ▶ Subcycling
- ▶ Combined structured and unstructured FE meshes

Symmetries & Remapping

- ▶ 1D Cartesian and Spherical
- ▶ 2D Cartesian and Cylindrical
- ▶ 3D Cartesian
- ▶ 3D Reflective (1/8, 1/4, 1/2)
- ▶ Remapping
 - Within solvers
 - Between solvers
 - 1D to 2D to 3D
 - Dezoning

Structural Solvers

- ▶ Unstructured meshes
- ▶ Multi-block Structured meshes
- ▶ Combined Unstructured and Structured meshes
- ▶ 2D and 3D solids elements
 - Axial and planar solids
 - Hexahedral (bricks)
 - Pentahedral (wedges)
 - Tetrahedral (tets)
 - ALE (Adaptive Rezoning)
- ▶ 2D and 3D 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

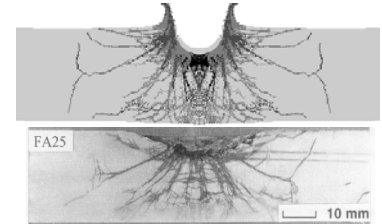
Fluid Solvers

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

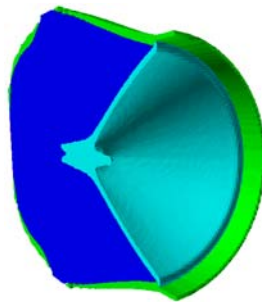
Contact

- ▶ Completely automated
- ▶ Self contact
- ▶ Node to surface
- ▶ Edge to edge
- ▶ Structural deformable to deformable contact
- ▶ Structural deformable to rigid contact
- ▶ SPH to deformable structural and rigid contact

- ▶ Designing, assessing and optimizing anti-armor devices
- ▶ Performance studies of well perforating charges
- ▶ Assessing satellite damage from space debris impacts
- ▶ Blast effects in city centers
- ▶ Safety assessment of a particle accelerator beam dump
- ▶ Fragmentation of solid bodies
- ▶ Underwater explosions effects on ships



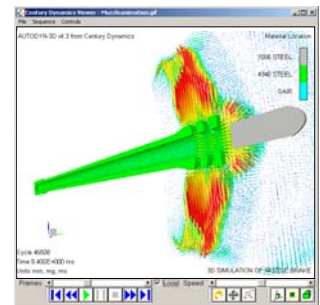
Ceramic armor impact; simulation (top) versus test (bottom – Courtesy of Cranfield University, RMCS, UK)



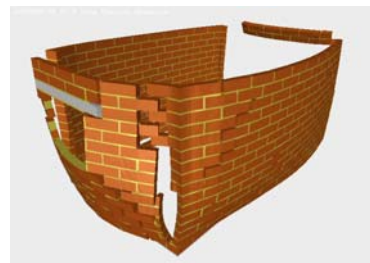
Shaped charge analysis using multi-material Euler

- ▶ Optimization of mine disposal devices
- ▶ Assessment and design of kinetic energy penetrators
- ▶ Blast propagation in underground tunnels and structures
- ▶ Sheet metal stamping
- ▶ Bird strike on aircraft
- ▶ Hydraulic ram effects in aircraft fuel tanks
- ▶ Structural response analysis of a containment vessel under hydrogen detonation

- ▶ Response and breakup of glazing under blast loading
- ▶ Sloshing of fuel in racing cars
- ▶ Explosive welding and cutting
- ▶ Powder compaction of sintered metals
- ▶ Progressive damage of composite structures to impacts loads
- ▶ Explosive forming of aerospace components
- ▶ Perforation and Behind Armor Debris analyses of various armor configurations
- ▶ Water/sand barrier assessment for mitigation of explosives fragmentation and blast
- ▶ Prediction of blunt trauma injuries
- ▶ Optimization of transparent armor on wheeled vehicles



Standalone free Viewer for interactive 2D and 3D animations



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



Fragmenting steel cylinder using stochastic material properties



Version 6.0 Product Features

Contact (cont'd)

- ▶ Eroding contact
- ▶ Friction

Detonation Models

- ▶ Automatic detonation logic
- ▶ Multiple detonation points
- ▶ 2D & 3D

Non-Linearity

- ▶ 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
- ▶ Multi-phase transitions and states
- ▶ Heat conduction

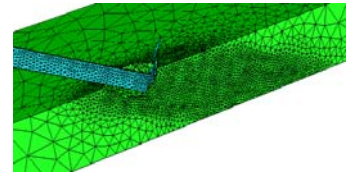
Documentation

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

Product Support

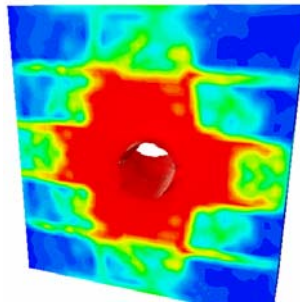
- ▶ Ongoing support, maintenance and enhancement
- ▶ Training
- ▶ User Group Meetings
- ▶ Update seminars

- ▶ Safety distance assessments for hazardous storage sites
- ▶ Damage of (reinforced) concrete structures under impact and explosive loading
- ▶ Decommissioning of offshore platforms
- ▶ Blast-structure interaction assessment of onshore petrochemical plant
- ▶ Structural damage of an offshore module to a dropped object
- ▶ Prediction of blast induced rock fragmentation
- ▶ Design of rockfall galleries
- ▶ Concrete damage caused by high frequency ground motions
- ▶ Modeling of cavitation and yawing of a supersonic projectile traveling in water
- ▶ Investigation of a pipe rupture incident at a nuclear facility
- ▶ Fracture of ceramics under intense loading
- ▶ Assessment of the disturbed flow field during rocket stage separation



Armor/anti-armor analysis

No doubt there are many more our users know about but this should give you a feel for the versatility of AUTODYN.



Penetration in a masonry structure



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Solutions through Software

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