



FEATURES

Meshing & Geometry

- Structured finite difference/control volume meshes for fluid and thermal solutions
- Finite element meshes for structural analysis
- Multi-Block gridding with nested, linked, partially overlapping and conforming mesh blocks
- Fractional areas/volumes (FAVOR™) for efficient & accurate geometry definition
- Mesh quality checking
- Basic Solids Modeler
- Import CAD data
- Import/export finite element meshes via Exodus-II file format
- Grid & geometry independence
- Cartesian or cylindrical coordinates

Flow Type Options

- Internal, external & free-surface flows
- 3D, 2D & 1D problems
- Transient flows
- Inviscid, viscous laminar & turbulent flows
- Hybrid shallow water/3D flows
- Non-inertial reference frame motion
- Multiple scalar species
- Two-phase flows
- Heat transfer with phase change
- Saturated & unsaturated porous media

Flow Definition Options

- General boundary conditions
 - Symmetry
 - Rigid and flexible walls
 - Continuative
 - Periodic
 - Specified pressure
 - Specified velocity
 - Outflow
 - Grid overlay
 - Hydrostatic pressure
 - Volume flow rate
 - Non-linear periodic and solitary surface waves
- Restart from previous simulation
- Continuation of a simulation
- Overlay boundary conditions
- Change mesh and modeling options
- Change model parameters

Physical Modeling Options

- Fluid structure interaction
- Thermally-induced stresses
- Plastic deformation of solids
- Granular flow
- Moisture drying
- Solid solute dissolution
- Sediment transport and scour
- Cavitation
- Phase change (liquid-vapor, liquid-solid)
- Surface tension
- Thermocapillary effects
- Wall adhesion
- Wall roughness
- Vapor & gas bubbles
- Solidification & melting
- Mass/momentum/energy sources
- Shear, density & temperature-dependent viscosity
- Thixotropic viscosity
- Visco-elastic-plastic fluids
- Elastic membranes & walls
- Evaporation residue
- Electro-mechanical effects
- Dielectric phenomena
- Electro-osmosis
- Electrostatic particles
- Joule heating
- Air entrainment
- Molecular & turbulent diffusion
- Temperature-dependent material properties
- Spray cooling

Thermal Modeling Options

- Natural convection
- Forced convection
- Conduction in fluid & solid
- Fluid-solid heat transfer
- Distributed energy sources/sinks in fluids and solids
- Radiation
- Viscous heating
- Orthographic thermal conductivity
- Thermally-induced stresses



FEATURES

Turbulence Models

- RNG model
- Two-equation k-epsilon model
- Two-equation k-omega model
- Large eddy simulation

Metal Casting Models

- Thermal stress & deformations
- Iron solidification
- Sand core blowing
- Sand core drying
- Permeable molds
- Solidification & melting
- Solidification shrinkage with interdendritic feeding
- Micro & macro porosity
- Binary alloy segregation
- Thermal die cycling
- Surface oxide defects
- Cavitation potential
- Lost-foam casting
- Semi-solid material
- Core gas generation
- Back pressure & vents
- Shot sleeves
- Air entrainment
- Temperature-dependent material properties
- Cooling channels

Numerical Modeling Options

- TruVOF Volume-of-Fluid (VOF) method for fluid interfaces
- First and second order advection
- Sharp and diffuse interface tracking
- Implicit & explicit numerical methods
- GMRES, point and line relaxation pressure solvers
- User-defined variables, subroutines & output
- Utilities for runtime interaction during execution

Fluid Modeling Options

- One incompressible fluid – confined or with free surfaces
- Two incompressible fluids – miscible or with sharp interfaces
- Compressible fluid – subsonic, transonic, supersonic
- Stratified fluid
- Acoustic phenomena
- Mass particles with variable density or diameter

Shallow Flow Models

- General topography
- Wind shear
- Ground roughness effects
- Laminar & turbulent flow
- Sediment transport and scour
- Surface tension
- Heat transfer
- Wetting & drying

Advanced Physical Models

- General Moving Object model with 6 DOF-prescribed and fully-coupled motion
- Rotating/spinning objects
- Collision model
- Tethered moving objects (springs & ropes)
- Flexing membranes and walls
- Porosity
- Finite element based elastic-plastic deformation
- Finite element based thermal stress evolution due to thermal changes in a solidifying fluid

Chemistry Models

- Stiff equation solver for chemical rate equations
- Stationary or advected species

Porous Media Models

- Saturated and unsaturated flow
- Variable porosity
- Directional porosity
- General flow losses (linear & quadratic)
- Capillary pressure
- Heat transfer in porous media
- Van Genuchten model for unsaturated flow

Discrete Particle Models

- Massless marker particles
- Mass particles of variable size/mass
- Linear & quadratic fluid-dynamic drag
- Monte-Carlo diffusion
- Particle-Fluid momentum coupling
- Coefficient of restitution or sticky particles
- Point or volumetric particle sources
- Charged particles
- Probe particles



FEATURES

Two-Phase & Two-Component Models

- Liquid/liquid & gas/liquid interfaces
- Variable density mixtures
- Compressible fluid with a dispersed incompressible component
- Drift flux
- Two-component, vapor/non-condensable gases
- Phase transformations for gas-liquid & liquid-solid
- Adiabatic bubbles
- Bubbles with phase change
- Continuum fluid with discrete particles
- Scalar transport
- Homogeneous bubbles

Coupling with Other Programs

- Geometry input from Stereolithography (STL) files – binary or ASCII
- Direct interfaces with EnSight®, FieldView® & Tecplot® visualization software
- Finite element solution import/export via Exodus-II file format
- PLOT3D output
- Neutral file output
- Extensive customization possibilities
- Solid Properties Materials Database

Data Processing Options

- State-of-the-art post-processing tool, FlowSight™
- Automatic or custom results analysis
- High-quality OpenGL-based graphics
- Color or B/W vector, contour, 3D surface & particle plots
- Moving and stationary probes
- Force & moment output
- Animation output
- PostScript, JPEG & Bitmap output
- Streamlines
- Flow tracers

User Conveniences

- Mesh generators
- Mesh quality checking
- Tabular time-dependent input using external files
- Automatic time-step control for accuracy & stability
- Automatic convergence control
- Mentor help to optimize efficiency
- Change simulation parameters while solver runs
- Launch and manage multiple simulations
- Automatic simulation termination based on user-defined criteria
- Run simulation on remote servers using remote solving

Multi-Processor Computing

- Shared memory computers
- Distributed memory clusters



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