

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
- Conforming meshes extended to arbitrary shapes
- Fractional areas/volumes (FAVOR™) for efficient & accurate geometry definition
- Mesh quality checking
- Closing gaps in geometry
- Basic Solids Modeler
- Import CAD data
- Import/export finite element meshes via ExodusII file format
- Grid & geometry independence

FLOW TYPE OPTIONS

- Internal, external & free-surface flows
- 3D, 2D & 1D simulations
- 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 boundaries with wave absorbing layers
 - Grid overlay
 - Hydrostatic pressure
 - Volume flow rate
 - Non-linear periodic and solitary surface waves
 - Rating curve and natural hydraulics
 - Wave absorbing layer
- 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 (potential, passive tracking, active tracking)
- 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
- Orthotropic thermal conductivity
- Thermally-induced stresses

TURBULENCE MODELS

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

DISCRETE PARTICLE MODELS

- Massless marker particles
- Multi-species material particles of variable size and mass
- Solid, fluid, gas particles
- Void particles tracking collapsed void regions
- Non-linear fluid-dynamic drag
- Added mass effects
- Monte-Carlo diffusion
- Particle-fluid momentum coupling
- Coefficient of restitution or sticky particles
- Point or volumetric particle sources
- Initial particle blocks
- Heat transfer with fluid
- Evaporation and condensation
- Solidification and melting
- Coulomb and dielectric forces
- Probe particles

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

ADVANCED PHYSICAL MODELS

- Moving Objects model with 6 DOF-prescribed and fully-coupled motion
- Rotating/spinning objects
- Collision model
- Tethered moving objects (springs, ropes, breaking mooring lines)
- 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
- Combusting solid components

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

TWO-PHASE & TWO-COMPONENT MODELS

- Liquid/liquid & gas/liquid interfaces
- Variable density mixtures
- Compressible fluid with a dispersed incompressible component
- Drift flux with dynamic droplet size
- 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
- Super-cooling

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™
- Batch postprocessing
- Report generation
- Automatic or custom results analysis
- High-quality OpenGL-based graphics
- Color or B/W vector, contour, 3D surface & particle plots
- Moving and stationary probes
- Visualization of non-inertial reference frame motion
- Measurement baffles
- Arbitrary sampling volumes
- Force & moment output
- Animation output
- PostScript, JPEG & Bitmap output
- Streamlines
- Flow tracers

USER CONVENIENCES

- Active simulation control (based on measurement of probes)
- 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
- Units on all variables
- Copy boundary conditions to other mesh blocks
- 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

FLOWSIGHT™

- Particle visualization
- Velocity vector fields
- Streamlines & pathlines
- Iso-surfaces
- 2D, 3D and arbitrary clips
- Non-inertial reference frame motion
- Volume render
- Probe data
- History data
- Vortex cores
- Link multiple results
- Multiple data views