SPEED

Shock **P**hysics **E**xplicit **E**ulerian **D**ynamics

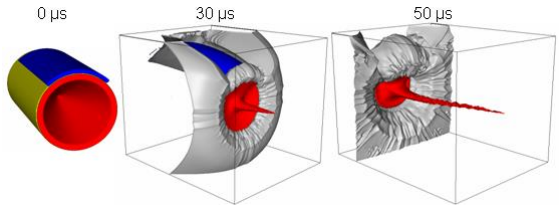
Introduction

SPEED is a hydrocode that offers a family of explicit Eulerian solvers for nonlinear transient problems of shock physics. SPEED is the commercial version of our proprietary code NUMHYD, which for several years has been successfully applied to support our customers in solving research and engineering problems.

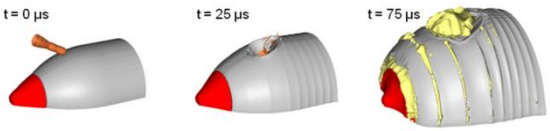
Applications

SPEED is a versatile tool for modeling nonlinear dynamics of gases, fluids, and solids. SPEED has been used in a number of applications:

- Optimization of blast-fragment warheads
- Shaped charge design
- Internal detonation and combustion
- Underwater explosions
- Explosive ordnance disposal
- Tactical ballistic missile defense
- Armor design
- Building protection measures in urban areas



Investigation of an asymmetrical shaped charge in 3D

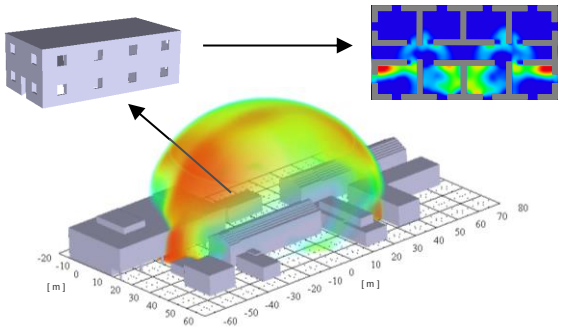


EFP impact on warhead and shock induced initiation

Compelling Performance

Compared to other production hydrocodes, SPEED offers significant advantages in performance:

- Outstanding computational speed and minimized memory requirements
- Sharp shock resolution and higher order advection schemes to limit diffusion
- Robust algorithms for multi-material cells
- Intuitive user interface for interactive model setup
- Outstanding post-processing capabilities
- Multi-Threading included



3D blast simulation in an urban scenario

Code Features

Solver Options

- Multi-material Euler, 2D Cartesian and cylindrical, 3D Cartesian
- Ideal gas Godunov solver, 3D cartesian
- Reflective or transmissive boundaries
- Embedded rigid bodies
- Adaptive mesh expansion / translation
- Mesh activity control
- 2D to 2D, 3D to 3D and 2D to 3D mapping

Material Models and Material Library

SPEED comes with a comprehensive library of complete material data sets for gases, fluids, metals, plastics, concrete, soils and many others. A variety of constitutive relations offers the possibility to accurately model the response of materials to dynamic loads. Amongst others, one can use:

Equation of State (EOS) Models

- Ideal Gas (Constant-Gamma, $c_v(T)$)
- Explosives (JWL, TD-JWL)
- Solids (Mie-Gruneisen)
- Porous Solids (p-α)
- Explosive burn and combustion
- Explosive Initiation: HVRB, Lee-Tarver

Strength Models

- Solids (Elastic-plastic with work hardening)
- Metals (Johnson-Cook, Zerilli-Armstrong, Steinberg-Guinan)
- Concrete (Holmquist-Johnson-Cook)
- Soils, granular materials (Drucker-Prager)
- Ceramics (Johnson-Holmquist 2)

Failure Models

- Plastic failure strain
- Johnson-Cook damage model
- Accumulated spall damage

Pre-Processing

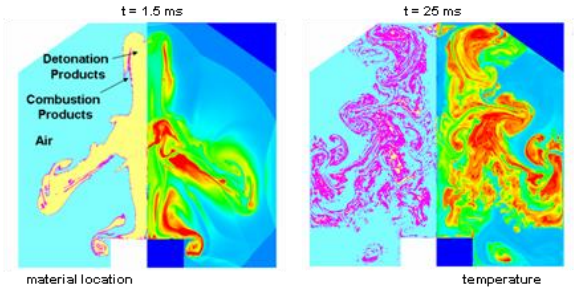
SPEED is designed to support parametric studies. Its object oriented model structure requires only a

minimum of user effort to modify and re-run a simulation.

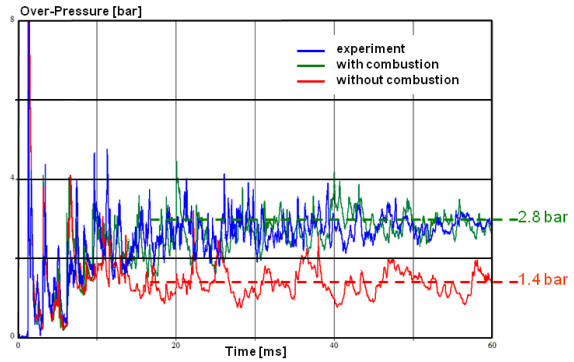
- Interactive intuitive interface
- Constructive solid geometry modeler
- Visualization during model setup
- Import of LS-Dyna geometries

Post-Processing

- Visualization of scalar, vector, and tensor data
- Arbitrary mix of rendering techniques (sliced plots, surfaces, volume rendering)
- Profile plots
- Material and gauge time histories
- Signal processing options (filter, frequency analysis, least squares, integration, derivative etc.)
- Mass / velocity distributions for shaped charge jets and behind armor debris
- Export of text and graphics to MS Office applications
- Movies (avi-files)



2D simulation of a high explosive charge fired in a detonation chamber



Measured overpressure and simulation result with and without combustion modeling

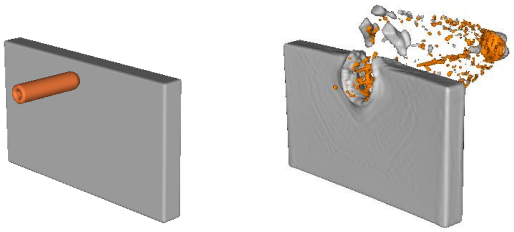
Recent Advances

An ideal gas solver has been added to handle blast propagation problems efficiently. The gas solver can be initialized by user defined regions, by remapping a multi-material state into it, or by starting with a constant volume detonation approximation.

User defined initial mesh activation and adaptive mesh expansion permit a fast and reliable simulation of blast propagation processes even in complex scenarios with very large dimensions.

A mixing controlled combustion model has been implemented into the multi-material Euler solver. The contribution of combustion to the gas pressure is essential for internal detonations.

The extensive material library with a variety of validated material models and parameter sets provides a broad basis for the simulation of all kinds of high velocity impact problems. The high robustness of SPEED ensures stable simulations and saves the user further interventions.



Near edge impact of hollow projectile and behind armor debris

Cost and Productivity Benefits

The highly efficient computation technology with its high speed, low memory requirements saves computational costs. High productivity is ensured by the superior stability that saves manpower, and by the intuitive user interface that significantly reduces the teach-in phase. Last but not least: Its attractive price makes SPEED affordable for everyone.

Licensing

SPEED is available for use on PC systems running under 64-bit Windows XP, Vista, Windows 7, Windows 8 and Windows 10. SPEED may be leased as an annual license or purchased as a paid-up license for perpetual use.

Services

- NUMERICS provides full technical support and customer service for all users.
- SPEED is continually developed to maintain and enhance its capabilities and to incorporate the suggestions of its users.
- Upon request, NUMERICS also offers support in tailoring SPEED for specific applications.

NUMERICS Software GmbH · Mozartring 3 · 85238 Petershausen · Germany
Phone +49-8137-998585 · E-Mail: info@numerics-gmbh.de · Website: www. numerics-gmbh.de