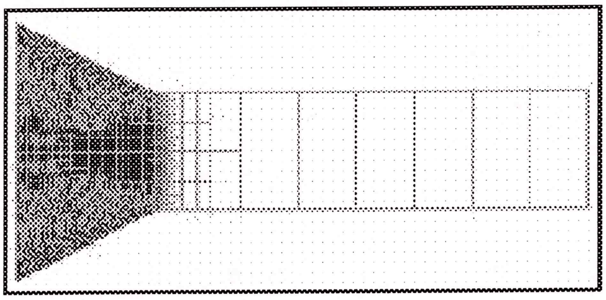
ALEGRA-An Advanced Finite Element Framework for High Energy Density Solid Dynamics Simulations



Recent Accomplishments:

ALEGRA is a multi-material, arbitrary-Lagrangian-Eulerian (ALE) simulation code for solid dynamics that combines the features of modern Eulerian shock codes with modern Lagrangian structural analysis codes. Recent development efforts have focused on:

- the implementation of electromechanical modeling capabilities for simulating fireset and neutron generator power supply performance;
- the implementation of h-adaptive mesh methodology to permit dynamic refinement of finite elements in regions where resolution must be increased to improve numerical accuracy and unrefinement in other regions where resolution can be decreased; and
- the implementation of new data structures that drastically improve data locality and usage of cache memory, as well as providing flexibility for mesh adaptivity and dynamic load balancing in a massively parallel environment.

The version of ALEGRA that incorporates electromechanical models is called EMMA (ElectroMechanical Modeling in ALEGRA). EMMA capabilities include the modeling of shock propagation due to explosive detonation, depoling of ferroelectric ceramics, application of a parallel field solver to determine the electric and magnetic fields, and coupling with an external lumped element circuit equation system.

The version of ALEGRA that utilizes h-adaptivity (referring to the subdivision of the characteristic element length, h) is called HAMMER. The objective of HAMMER is to provide efficient, high precision simulations without the computational cost of using a highly resolved mesh everywhere. This capability is critical for simulations over large spatial domains that require high precision in the presence of certain features such as shocks, burn fronts, pressure stagnation areas, and regions of large deformation.

Impact:

Computational simulation is assuming an increasingly important role in assuring the safety and reliability of the nuclear weapons stockpile. ALEGRA is being used on the massively parallel teraflop supercomputers developed for the Advanced Strategic Computing Initiative (ASCI) to conduct advanced three-dimensional (3D) simulations of systems and phenomena important to stockpile stewardship. The advanced numerical methods and physical models being implemented in ALEGRA are critical to the effective use of current and future supercomputers and the successful prediction of phenomena for these systems.

Last Updated: February 7, 1997
***Randall M. Summers** (rmsumme@sandia.gov)*