Mesh-free methods for CFD problems are implemented with the bridging scale hierarchical enrichment method as the boundary treatment. The figures on the left are the streamline plots and calculated drag coefficient for flow past a cylinder problem. The figures on the right are the vorticity of flow past a building.

Pressure-shear simulation without considering contact: evolution of the crack pattern and material pulverization upon unloading.

Automobile crash simulated by finite elements developed at Northwestern University.

Nanoscale Sensor Device
Nanotube simulations are performed simultaneously with the experiments for prediction and verifying the mechanical and electrical properties of nanotube. These figures show the bending and twisting of a SWNT.

Multiple scale analysis of shear band: comparison with experiments.

Multiresolution Reproducing Kernel Particle Method: The top right figure, which depicts the "High Scale" solution of the transonic shock, clearly indicates the shock location. In the bottom figure, a similar multiple scale decomposition is applied to the analysis of large deformation solids and the plastic deformation of a notched bar. The high scale solution clearly shows the crack tip field and the localized shear bands.

Several cutting-edge technologies have been developed in computational mechanics at Northwestern: new nonlinear finite elements for explicit programs, computational material modeling, fluid dynamics modeling, mesh-free methods, multiple-scale methods, and bridging scale methods for coupling disparate scales and different physical models.

Applications include crashworthiness, large deformation, elastic-plastic problems such as sheet-metal forming, fluid-structure interaction, multi-phase flow, micro-mechanics, crack growth and shear bands, and nano-mechanics and materials.

Mechanical Engineering at Northwestern