Department of Civil Engineering and Engineering Mechanics
Columbia University

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Potential-Based Cohesive Fracture, Branching and Fragmentation

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This presentation is structured into two parts. The first part is associated to the understanding of fracture and fragmentation processes, which are of fundamental importance to address failure of material and structural systems at various engineering scales. Thus this presentation addresses an integrated multiscale computational environment for simulating spontaneous crack nucleation, initiation, propagation, branching and fragmentation of conventional and advanced materials, e.g. hybrid and functionally graded materials. The fracture criteria adopt a cohesive view of material, in which a finite material strength and work to fracture are included in the constitutive description. Especially noteworthy is the use of a novel, unified, potential-based constitutive model for mixed-mode cohesive fracture. Dynamic fracture processes are investigated using the finite element method with special interface elements and a topological data structure representation, based on topological entities (node, element, vertex, edge and facet), which is capable of accessing adjacency information in time proportional to the number of retrieved entities. The capabilities and shortcomings of the cohesive zone method are discussed from a critical point of view, and illustrated by means of examples. The use of advanced data structures, visualization, and large scale computing for simulating cohesive fracture are also discussed.

The second part of the presentation addresses my vision for mechanics both at the National Science Foundation (NSF) and in the USA.