Special Guest Lecture by:
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Friday April 14, 2006
Mason Building, Room 142-A
12:00 to 1:00 p.m.

TOPIC:
"Modeling of the Tool-rock Interaction Process"

ABSTRACT:
The mechanical interaction of a tool and a rock has been the subject of investigations for many decades. The primary motivation behind these research efforts is two-fold: on the one hand, the need to improve the efficiency of mechanical excavation of rocks; on the other hand, the possibility of deducing material properties from the action of a tool pressing against the surface of a rock. Depending on the direction of motion of the tool, the process of tool-rock interaction can be classified either as an indentation or a cutting (scratch) process.

A distinct characteristic of the tool-rock interaction process is the dual failure mechanisms, namely, failure induced by the movement of a tool involves both damage and brittle fractures. Modeling of the tool-rock interaction process has been traditionally limited to the framework of either plasticity or LEFM due to the lack of proper modeling tools. Factors governing the transition from the ductile dominant failure mode to the brittle dominant failure mode were poorly understood.

In this presentation, an analytical model is first introduced to show that initiation and propagation of a crack in the indentation process is governed by a ratio of a flaw size over an intrinsic length scale (KIc/sc)2. Numerical results based on discrete element modeling (DEM) of both the indentation and cutting processes are then discussed to demonstrate the association between this intrinsic length scale and the failure mode transition. Unlike conventional numerical methods based on continuum theories, DEM has the advantage of modeling damage and brittle fracture simultaneously. Issues about DEM modeling such as scaling laws relating micro-scale and macro-scale material properties are also addressed.