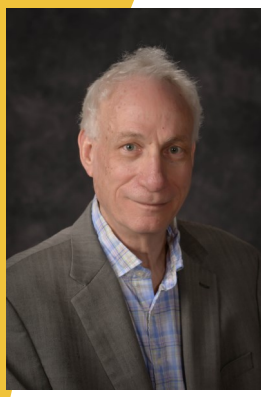
College of Engineering
Department of
Mechanical & Industrial Engineering

The Robert W. Courter Seminar Series



3:00-4:00pm, Friday, February 21st, 2020, 1263 PFT

Toughness, Roughness and the Possibility of Microstructure Design for Improved Crack Growth Resistance

by Alan Needleman*, **Texas A&M University**

Two fundamental questions in the mechanics and physics of fracture are: (i) What is the relation between observable features of a material's microstructure and its resistance to crack growth? and (ii) What is the relation between observable features of a material's microstructure and the roughness of the fracture surface? An obvious corollary question is: What is the relation, if any, between a material's crack growth resistance and the roughness of the corresponding fracture surface? In 1984, Mandelbrot and co-workers showed that fracture surfaces exhibit self-affine, fractal-like scaling properties. This observation, together with advances in image analysis, precipitated a significant body of work in the physics community on the quantitative characterization of fracture surface roughness with the aim of relating the fractal dimension to crack growth resistance. While this effort was not successful, it raised the question of what measure, if any, of fracture surface roughness can be related to crack growth resistance. I will describe work on modeling ductile fracture that reveals a measure of the statistics of fracture surface roughness that can be quantitatively related to crack growth resistance and how this quantity relates to a measurable and (hopefully) controllable microstructural feature. Simulation results for two idealized microstructures will be discussed: one microstructure involves crack growth through a distribution of second phase particles and the other involves crack growth along grain boundaries. The implications for designing material microstructures with improved crack growth resistance will be discussed.

* Alan Needleman received his B.S. from the University of Pennsylvania in 1966 and finished his Ph.D. at Harvard University in 1970. He then spent five years in Applied Mathematics at MIT before moving to Brown University where he served as Dean of the Engineering from 1988 to 1991 and became Florence Pirce Grant University Professor in 1996. He retired from Brown in 2009 and moved to the Materials Science and Engineering Department at the University of North Texas. In 2013 he was a member of the initial class of Hagler Institute Fellows at Texas A&M University and joined the Texas A&M University faculty in 2015, where he is now a University Distinguished Professor and a TEES Eminent Research Professor in the Department of Materials Science and Engineering. Professor Needleman is a Member of the US National Academy of Engineering and of the American Academy of Arts and Sciences, and is an Honorary Member of the American Society of Mechanical Engineers (ASME). He was awarded the Prager Medal by the Society of Engineering Science, and the Drucker and Timoshenko Medals by ASME. He also holds honorary doctorates from the Technical University of Denmark and Ecole Normale Superior de Cachan (France), and is an Honorary Professor of Dalian University of Technology (China).