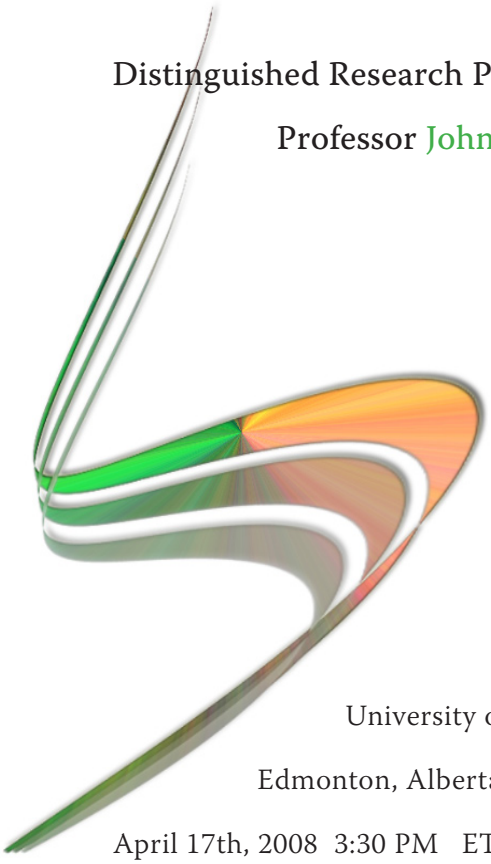

Distinguished Research Professor

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Seminar

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Edmonton, Alberta, Canada

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Designer Driven Holistic Fracture Mechanics of Welded Structures

A holistic simulation of the transient temperature distribution, microstructure evolution, stress-strain distribution during the fabrication processand possible fatigue crack growth with in-service loads is described.

This welding simulation uses the full 3D geometry of the structure being welded and typically solves hundreds of time steps in which each time stepis a coupled non-linear analysis. The software is designer driven, i.e, the software is intended to be used and is used by designers in industry.

Having completed the welding simulation of the fabrication, the behavior of the structure with its as-welded state that includes the initial state of residual stress, microstructure and distortion, the software simulates the application of in-service loads.

The stress, strain and material force distribution are computed for the in-service loads. (Material forces can be viewed as Eshelby mechanics.)A natural length scale that is a material property (see BarenBlatt for details on natural lengths in fracture) is assumed and the stress distribution is smoothed by solving a partial differential equation using this length scale as a diffusivity. This means that when the FEM mesh is significantly smaller than the natural length scale, then the FEM solution is independent of the mesh.

At crack tips the value of the material force vector is the J-integral when the mathematical assumptions required by the J-integral are satisfied. In other words, the value of the J-integral is a special case of the value of the material force at a crack tip. Unlike the J-integral the material force is always defined every where in a body.

The number of cycles for fatigue crack initiation are computed using the strain life equation. If cracks are present or initiated, then fatigue crack growth is simulated by solving the Paris-Erdogan equation for the moving crack tip. The FEM element size at a crack tip is typically of the order of 50 to 10 microns and typically cracks grow in increments of 50 to 10 microns per `time' step.

The software makes no use of handbook formulae for fracture mechanics. See www.goldaktec.com for more information on the software.