Plenary Session

Prof. Stéphane Bordas
"Fracture mechanics across space and time"

Abstract:
We review in this paper two approaches to solve multi-scale fracture problems. Machine learning and model order reduction on the one hand and multi-scale methods on the other hand.
We explain as didactically as possible how material complexity has led to the need for acceleration methods and discuss advances in model selection and error estimation for such problems.
We show how model reduction/machine learning and standard multiscale methods both fails when dealing with localisation problems occurring in fracture mechanics.
We conclude by discussing the possibility of digital twins and make a parallel with medical simulation.

Short Bio:
Prof. Stéphane Bordas graduated in 2003 in Theoretical and Applied Mechanics with a Ph.D. from Northwestern University under the guidance of Professor Brian Moran. His thesis, funded by the Federal Aviation Administration, concentrated on applications of the extended finite element method (XFEM) to damage tolerance analysis of complex structures, casting design and biofilm growth processes. In addition to the unique support of Professor Moran, this work would never have been possible without Professor James Conley and Professor David Chopp as well as the instruction of Professor Ted Belytschko.
In 1999, through a joint graduate programme of the French Institute of Technology (Ecole Spéciale des Travaux Publics) and the American Northwestern University Prof. Stéphane Bordas completed a dual M.Sc. after a thesis work on Time Domain Reflectometry simulation to assess ground movements with Professor Charles H. Dowding.
On November 1st, 2013, Prof. Stéphane Bordas joined the University of Luxembourg as a Professor in Computational Mechanics, after standing as lecturer in Glasgow University Civil Engineering Department during the period 2006-2009.
Between 2003 and 2006, he was at the Laboratory of Structural and Continuum Mechanics at the Swiss Federal Institute of Technology in Lausanne, Switzerland, working under the support of Professor Thomas Zimmermann on meshfree point collocation methods and partition of unity enrichment (extended finite elements) with applications to geomechanics.

His research area is known as Computational Mechanics. Within this field, Prof. Stéphane Bordas concentrates particularly on:

- Method development (enriched/extended finite elements, meshfree methods, smooth strain finite elements) to reduce the mesh generation burden when treating complex or evolving geometries/topologies
- A posteriori error estimation, aiming at controlling the approximation error during simulations and thus focusing the computational effort where it is really required

- Isogeometric analysis with boundary elements, aiming at simplifying the link between Computer Aided Design and Numerical Analysis (idea from the paper of TJR Hughes in 2005)
- Academic research/industrial applications: bridging the gap (porting novel methods to industrial codes, real-world applications of computational mechanics and novel method development)