Track 3:
Application of Imaging Techniques to Mechanics of Materials and Structures

Organized by:

Fabrice Pierron, *Arts et Métiers ParisTech;* Michael A. Sutton, *University of South Carolina*

Welcome to Indianapolis and to this track dedicated to applications of imaging techniques to mechanics of materials and structures. It is clear that within the last 10 years, imaging techniques have spread very widely within the experimental mechanics community thanks to readily available digital cameras and other imaging techniques, such as SEM, AFM, X-ray tomography, MRI etc. The objective of this track is to share experience on how such rich experimental data can help experimentalists and modeling scientists to better understand and simulate the behavior of materials and structures. It was originally envisioned by the organizers to cover a wide range of applications and techniques to encourage cross-fertilization over disciplines and problem types. This goal has been reached, in large part due to the support provided by several Technical Divisions and dedicated session organizers. This track will run over the whole of the conference while covering a wide range of applications of imaging techniques. The following sessions will be developed for the track:

- Model Identification/Inverse Problem
- Composites
- Microscale applications
- Biological materials (2 sessions)
- Residual stresses
- Infrared imaging and thermomechanics (2 sessions)
- Digital image correlation
- Full-field volumetric measurements
- Soft materials
- Development in optical techniques
- High strain rate / dynamics

The organizers would like to thank the authors, presenters, session organizers and session chairs for their participation in this track. We are looking forward to excellent scientific interaction during these four days and hope to see you among us.

Keynote Presentations:

Dr. Michel Grédiac, *Universite Blaise Pascal-IFMA*
Identification From Full-field Measurements: A Promising Perspective in Experimental Mechanics
Monday, June 7, 10:30 AM, Session 5

Dr. Philip V. Bayly, *Washington University, St. Louis*
Measurement of Brain Biomechanics in Vivo by MR Imaging
Tuesday, June 8, 10:30 AM, Session 26

Track 3: Application of Imaging Techniques to Mechanics of Materials and Structures

Keynote Presentation:

Michel Grédiac
Universite Blaise Pascal-IFMA

Identification From Full-field Measurements: A Promising Perspective in Experimental Mechanics

Monday, June 7, 10:30 AM, Session 5

Full-field measurement techniques such as digital image correlation, moiré interferometry, speckle or grid method are now widely used in the experimental mechanics community. Such techniques provide displacement, strain or temperature maps, which are very useful to analyze phenomena that occur during mechanical tests, such as parasitic effects due to boundary conditions or strain concentrations caused by some local phenomena. This wealth of data also provides resources to validate numerical models or to propose relevant constitutive equations.

Another important and very promising issue is to identify parameters governing constitutive equations by processing these fields with suitable numerical tools. The advantage is to account for a large amount of data from one test only and to process heterogeneous strain fields in which several parameters are simultaneously involved. Solving this problem is however somewhat complicated since no direct link generally exists between measurements and unknown parameters. Suitable and robust identification strategies must therefore be developed and validated to face this challenge, which is recent in the experimental mechanics community.

The keynote lecture will first shortly describe various applications of full-field measurement techniques in experimental solid mechanics. It will then focus on identification from full-field measurements, with a special emphasis on specific difficulties raised by this problem, on recent breakthroughs which offer solutions for solving it and on related questions which still remain open.

Dr. Michel Grédiac received a M.S. degree ("diplôme d'ingénieur") in Mechanical Engineering from the "Ecole Nationale Superieure d'Arts et Metiers" in Paris and a Ph.D. degree in Mechanical Engineering from the University of Lyon in 1991. He was appointed as research professor at the "Ecole Nationale Superieure des Mines de Saint-Etienne" and promoted to full professor at the University of Clermont-Ferrand in 1997.

Dr. Grédiac is presently a member of the LaMI research group recognized by both the University of Clermont-Ferrand and the French Institute for Advanced Mechanics. His research interests are in composite materials and in the use of full-field measurement techniques in experimental solid mechanics. Dr. Grédiac is the head of the network of French research groups involved in full-field measurements and identification in solid mechanics (http://www.ifma.fr/lami/gdr2519/). He has published over 250 publications including 70 peer-reviewed papers in the area of composite materials and experimental mechanics.

Keynote Presentation:

Philip V. Bayly
Washington University, St. Louis

Measurement of Brain Biomechanics in Vivo by MR Imaging

P.V. Bayly, E.H. Clayton, Y. Feng, T.M. Abney, R. Namani,
G.M. Genin, *Washington University, St. Louis*

Tuesday, June 8, 10:30 AM, Session 26

Magnetic resonance imaging methods offer the potential for non-invasive characterization of the mechanical properties of the human brain. Existing computer models of traumatic brain injury (TBI) remain controversial because their predictions have yet to be rigorously compared to measured biomechanical data. The nonlinear, anisotropic, viscoelastic, heterogeneous character of brain tissue, and the intricate connections between the brain and skull, complicate modeling efforts. In order to make progress toward the goal of accurate modeling of TBI, experimental techniques to address these issues must be developed. In this paper we describe MR imaging techniques to characterize brain deformation, estimate brain material properties, and illuminate the boundary conditions between brain and skull.

Dr. Philip V. (Phil) Bayly is The Lilyan and E. Lisle Hughes Professor of Mechanical Engineering and Chair of the Department of Mechanical, Aerospace and Structural Engineering at Washington University in St. Louis. Dr. Bayly earned an A.B. in Engineering Science from Dartmouth College, an M.S. in Engineering from Brown University, and a Ph.D. in Mechanical Engineering from Duke University. He has worked as an engineer for Pitney Bowes in Stamford, CT and for the Shriners Hospital in Springfield, MA. Dr. Bayly has been a member of the faculty at Washington University since 1993. His research generally involves the study of nonlinear dynamic phenomena in mechanical and biological systems; a particular interest is the application of imaging technology and image processing to understanding the mechanics of cells and biological tissues. His research has been funded by industry, and by the National Science Foundation, the Whitaker Foundation, and the National Institutes of Health. At Washington University he has been awarded Engineering Professor of the Year, Engineering Advisor of the Year, and the "Big Fish" Award for graduate student mentoring. Dr. Bayly's research group currently focuses on the measurement of tissue motion in the brain by MRI tagging and MR elastography, for the purpose of illuminating the initiation and progress of traumatic brain injury.