David Littlewood

Sandia National Laboratories
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EDUCATION

Ph.D., Mechanical Engineering, University of Colorado at Boulder, December 2001

Advisor: Professor Ganesh Subbarayan

M.S., Mechanical Engineering, University of Colorado at Boulder, May 1999

B.S., Mechanical Engineering, University of Colorado at Boulder, May 1995

RESEARCH INTERESTS

Computational Solid Mechanics
- Peridynamics
- Finite element modeling
- Crystal plasticity

Scientific Computing
- Massively parallel systems
- Imaging, computer graphics, and visualization
- Optimization

EMPLOYMENT HISTORY

Principal Member of the Technical Staff, Sandia National Laboratories (Jan. 2014 - Present)
Currently pursuing research in the development, implementation, and application of multiscale, multiphysics modeling techniques for computational solid mechanics.

(1) Principal Investigator of the Laboratory Directed Research and Development (LDRD) project "Strong Local-Nonlocal Coupling for Integrated Fracture Modeling." The goal of this project is development of a mathematically consistent formulation of local-nonlocal coupling that allows for full integration of peridynamics with classical finite element analysis. An open-source, collaborative software framework provides a proving ground for candidate approaches. Deployment to the laboratory will occur through the *Sierra/SolidMechanics* production code.

(2) Serving as a lead developer for the open-source peridynamics code *Peridigm*. This work employs Sandia's *Trilinos* software suite, including the *Sacado* automatic-differentiation package for construction of the tangent matrix for implicit time integration. Current applications include quasi-static modeling of ductile material failure and simulation of material fracture under blast loading conditions.

(3) Developing a crystal plasticity constitutive model suitable for multiscale, multiphysics modeling within the *Albany/LCM* simulation code. Multiphysics modeling will capture the effect of hydrogen embrittlement. A concurrent, Schwarz-based coupling scheme will allow the linking of an explicitly-modeled grain structure at the meso scale with a continuum plasticity model at the component scale.

Senior Member of the Technical Staff, Sandia National Laboratories (Oct. 2008 - Jan. 2014)
Performed research and development in computational simulation and high-performance computing. Focused on the development of theory, algorithms, and software for the application of peridynamics to solid mechanics problems involving material damage and failure. Strengthened collaboration between Sandia's Computing Research and Engineering Science centers. Served as technical lead for collaborative effort with Professor J.-S. Chen for the implementation of RKPM in Sandia analysis codes.

Research Associate, Rensselaer Polytechnic Institute (Jun. 2006 - Oct. 2008)
Completed research in the area of computational mechanics in collaboration with Professor Antoinette Maniatty. Implemented a multiscale framework for modeling the response of polycrystalline materials. Developed models for capturing the incubation and nucleation stages of microstructurally small fatigue cracks in Al7075. Contributed to the development of research proposals that were awarded $550,000 in funding from DOD, NSF, and New York State. Mentored students and worked closely with industrial and academic partners.

Post-Doctoral Research Associate, Rensselaer Polytechnic Institute (Feb. 2004 - Jun. 2006)
Developed a crystal plasticity constitutive model and associated finite element formulation for the DARPA Structural Integrity Prognosis System project under the mentorship of Professor Antoinette Maniatty. Modeled Al7075 using three-dimensional, explicitly discretized grain structures. Implemented finite element software in C++ for use on large-scale parallel computers (e.g., linux clusters and IBM BlueGene supercomputers). Programming work was done in collaboration with the Cornell Fracture Group, led by Professor Anthony Ingraffea.

Adjunct Faculty, Rensselaer Polytechnic Institute (Jan. 2006 - May 2006)
Taught Engineering Dynamics as an adjunct professor in the Department of Mechanical, Aerospace, and Nuclear Engineering. Engineering Dynamics is a mandatory subject in the core curriculum, requiring instructors to coordinate over multiple sections. Course content included kinematics, kinetics, energy and momentum methods, and vibrations. Received an overall instructor rating of 4.6/5.0.

Adjunct Assistant Professor, Syracuse University (Jan. 2003 - May 2003)
Served as an adjunct professor in the Department of Mechanical, Aerospace, and Manufacturing Engineering. Taught Design and Analysis of Structures, a second course in solid mechanics. Course material included general principles of stress and strain, elasticity, and energy methods. Received an overall instructor rating of 4.5/5.0.

Application Developer, Glottal Enterprises, Syracuse, New York (Dec. 2002 - Jan. 2004)
Developed the SpeechTutor software package for the Glottal OroNasal product line, a speech-training system for the hearing impaired. The SpeechTutor package processes speech input and provides graphical feedback relating to the nasality and pitch aspects of speech. Responsible for all aspects of software development, including project specifications, program architecture, and programming.

Color Scientist, Quark, Inc., Denver, Colorado (May 2001 - Jul. 2002)
Solved color science problems for Quark software development while evaluating new technologies as a member of the Quark Research Lab. Prototyped advanced color functionality in QuarkXPress and the Quark CMS XTension. New technologies, including image processing and client/server applications, were implemented using C, C++, SVG, and JavaScript.

Research Assistant, University of Colorado at Boulder (Dec. 1997 - Dec. 2001)
Completed work in Professor Ganesh Subbarayan's research group in the areas of color conversion and color printer characterization. This project was done in conjunction with IBM and involved the application of artificial neural networks, interpolation schemes, and optimization techniques to the problem of conversion between color spaces.

Project Engineer, BNP Associates, Inc., Aurora, Colorado (Oct. 1995 - Jul. 1997)
Employed at an airline-industry consulting firm with both field and office duties. Office work included technical writing and drawing preparation for bid packages and specifications. Fieldwork entailed testing newly installed conveyor systems and computer equipment. Frequently interacted with clients regarding both bid packages and field installations.

PUBLICATIONS

PEER-REVIEWED JOURNAL ARTICLES

Seleson, P., and Littlewood, D.J. 2016. Convergence studies in meshfree peridynamic simulations. *Comput. Math. Appl.* 71, 2432-2448. doi

D'Elia, M., Perego, M., Bochev, P., and Littlewood, D. 2016. A coupling strategy for nonlocal and local diffusion models with mixed volume constraints and boundary conditions. *Comput. Math. Appl.* 71, 2218-2230. doi

Bishop, J.E., Emery, J.M., Battaile, C.C., Littlewood, D.J., and Baines, A.J. 2016. Direct numerical simulations in solid mechanics for quantifying the macroscale effects of microstructure and material model-form error. *JOM* 68(5), 1427-1445. doi

Mitchell, J.A., Silling, S.A., and Littlewood, D.J. 2015. A position-aware linear solid constitutive model for peridynamics. *J. Mech. Mater. Struct.* 10(5), 539-557. doi

Silling, S.A., Littlewood, D.J., and Seleson, P. 2015. Variable horizon in a peridynamic medium. *J. Mech. Mater. Struct.* 10(5), 591-612. doi

Bishop, J.E., Emery, J.M., Field, R., Weinberger, C., and Littlewood, D.J. 2015. Direct numerical simulations in solid mechanics for understanding the macroscale effects of microscale material variability. *Comput. Methods Appl. Mech. Engrg.* 287, 262-289. doi

Devin M. Pyle, Jing Lu, David J. Littlewood, and Antoinette M. Maniatty. 2012. Effect of 3D grain structure representation in polycrystal simulations. *Comput. Mech.* 52(1). doi

J.D. Hochhalter, D.J. Littlewood, M.J. Veilleux, J.E. Bozek, A.M. Maniatty, A.D. Rollett, and A.R. Ingraffea. 2011. A geometric approach to modeling microstructurally small fatigue crack formation: III. Development of a semi-empirical model for nucleation. *Modelling Simul. Mater. Sci. Eng.* 19(3). doi

J.D. Hochhalter, D.J. Littlewood, R.J. Christ Jr., M.J. Veilleux, J.E. Bozek, A.R. Ingraffea, and A.M. Maniatty. 2010. A geometric approach to modeling microstructurally small fatigue crack formation: II. Physically based modeling of microstructure-dependent slip localization and actuation of the crack nucleation mechanism in AA 7075-T651. *Modelling Simul. Mater. Sci. Eng.* 18(4). doi

J.E. Bozek, J.D. Hochhalter, M.G. Veilleux, M. Liu, G. Heber, S.D. Sintay, A.D. Rollett, D.J. Littlewood, A.M. Maniatty, H. Weiland, R.J. Christ Jr., J. Payne, G. Welsh, D.G. Harlow, P.A. Wawrzynek, and A.R. Ingraffea. 2008. A geometric approach to modeling microstructurally small fatigue crack formation: I. Probabilistic simulation of constituent particle cracking in AA 7075-T651. *Modelling Simul. Mater. Sci. Eng.* 16(6). doi

Antoinette M. Maniatty, David J. Littlewood, and Jing Lu. 2008. Polycrystal simulations investigating the effect of additional slip system availability in a 6063 aluminum alloy at elevated temperature. *J. Eng. Mater. Technol.* 130(2). doi

Littlewood, David, and Subbarayan, Ganesh. 2006. Updating a CMYK printer model using a sparse data set. *J. Imaging Sci. Tech.* 50(6), 556-566. doi

Littlewood, D.J., and Subbarayan, G. 2002. Controlling the gray component with pareto-optimal color-space transformations. *J. Imaging Sci. Tech.* 46(6), 533-542.*

Littlewood, D.J., Drakopoulos, P.A., and Subbarayan, G. 2002. Pareto-optimal formulations for cost versus colorimetric accuracy trade-offs in printer color management. *ACM Trans. Graph.* 21(2), 132-175. doi

*Received honorable mention, Charles E. Ives Award, Journal of Imaging Science and Technology.

BOOK CHAPTERS

Littlewod, D.J. 2016. Roadmap for software implementation. In Bobaru, F., Foster, J., Beubelle, P., and Silling, S., editors, *Handbook of Peridynamic Modeling*.

Azdoud, Y., Han, F., Littlewod, D., Lubineau, G., and Seleson, P. 2016. Coupling local and nonlocal models. In Bobaru, F., Foster, J., Beubelle, P., and Silling, S., editors, *Handbook of Peridynamic Modeling*.

CONFERENCE PROCEEDINGS

David Littlewood, Stewart Silling, and Paul Demmie. 2016. Identification of Fragments in a Meshfree Peridynamic Simulation. Proceedings of the ASME 2016 International Mechanical Engineering Congress and Exposition, Phoenix, Arizona.

David Littlewood, Mike Hillman, Edouard Yreux, Joseph Bishop, Frank Beckwith, Jiun-Shyan Chen. 2015. Implementation and verification of RKPM in the Sierra/SolidMechanics Analysis Code. Proceedings of the ASME 2015 International Mechanical Engineering Congress and Exposition, Houston, Texas. doi

David Littlewood, Kyran Mish, and Kendall Pierson. 2012. Peridynamic simulation of damage evolution for structural health monitoring. Proceedings of the ASME 2012 International Mechanical Engineering Congress and Exposition, Houston, Texas. doi

Littlewood, David. 2011. A nonlocal approach to modeling crack nucleation in AA 7075-T651. Proceedings of the ASME 2011 International Mechanical Engineering Congress and Exposition, Denver, Colorado. doi

Littlewood, David. 2010. Simulation of dynamic fracture using peridynamics, finite element modeling, and contact. Proceedings of the ASME 2010 International Mechanical Engineering Congress and Exposition, Vancouver, British Columbia, Canada. doi

Littlewood, D.J., and Maniatty, A.M. 2005. Multiscale modeling of crystal plasticity in Al 7075-T651. 8th International Conference on Computational Plasticity (COMPLAS VIII), Barcelona, Spain, 618-621.

Littlewood, David, and Subbarayan, Ganesh. 2004. Maintaining an accurate printer characterization. IS&T/SID's Twelfth Color Imaging Conference, Scottsdale, Arizona.

TECHNICAL REPORTS

Timothy Costa, Stephen Bond, David Littlewood, and Stan Moore. 2015. Peridynamic multiscale finite element methods. Report SAND2015-10472. Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

David J. Littlewood. 2015. Roadmap for peridynamic software implementation. Report SAND2015-9013. Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

David J. Littlewood, Stewart A. Silling, John A. Mitchell, Pablo D. Seleson, Stephen D. Bond, Michael L. Parks, Daniel Z. Turner, Damon J. Burnett, Jakob Ostien, and Max Gunzburger. 2015. Strong local-nonlocal coupling for integrated fracture modeling. Report SAND2015-7998. Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

Michael L. Parks, David J. Littlewood, John A. Mitchell, and Stewart Silling. 2012. Peridigm users' guide v1.0.0. Report SAND2012-7800. Sandia National Laboratories, Albuquerque, NM and Livermore, CA.

Michael Parks, David Littlewood, Andy Salinger, and John Mitchell. 2011. Peridigm summary report: lessons learned in development with agile components. Report SAND2011-7045. Sandia National Laboratories, Albuquerque, NM and Livermore, CA.