David Littlewood

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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
- Finite element methods
- Constitutive modeling
- Peridynamics

Scientific Computing
- Algorithm development for massively parallel systems
- Heterogeneous next-generation platforms
- Optimization

EMPLOYMENT HISTORY

Principal Member of the Technical Staff, Sandia National Laboratories (Jan. 2014 - Present)

I perform research in the formulation, implementation, and application of multiscale, multiphysics modeling techniques for computational solid mechanics.

(1) Principal Investigator for the ASC-ATDM/ECP Multiscale Technology Demonstrator project. The goal of this project is to drive development of emerging technologies for the Exascale Computing Project (ECP) and the Advanced Simulation and Computing (ASC) Advanced Technology Development and Mitigation (ATDM) program. Key elements include the *Kokkos* package for performance portability across disparate hardware architectures and the *DARMA* asynchronous many-task scheduler.

(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 the 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 mesoscale 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.

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.

PEER-REVIEWED JOURNAL ARTICLES

16. Coleman Alleman, James W. Foulk, III., Alejandro Mota, Hojun Lim, and David J. Littlewood. Concurrent multiscale modeling of microstructural effects on localization behavior in finite deformation solid mechanics. *Submitted*.

15. Timothy B. Costa, Stephen D. Bond, and David J. Littlewood. Nonlocal and mixed-locality multiscale finite element methods. *Submitted*.

14. Marta D'Elia, Mauro Perego, Pavel Bochev, and David J. Littlewood. A coupling strategy for nonlocal and local diffusion models with mixed volume constraints and boundary conditions. *Computers and Mathematics with Applications*, 71(11):2218–2230, 2016. doi.

13. Pablo Seleson and David J. Littlewood. Convergence studies in meshfree peridynamic simulations. *Computers and Mathematics with Applications*, 71(11):2432–2448, 2016. doi.

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

11. John A. Mitchell, Stewart A. Silling, and David J. Littlewood. A position-aware linear solid constitutive model for peridynamics. *Journal of Mechanics of Materials and Structures*, 10(5):539–557, 2015. doi.

10. Stewart A. Silling, David J. Littlewood, and John A. Mitchell. Variable horizon in a peridynamic medium. *Journal of Mechanics of Materials and Structures*, 10(5):591–612, 2015. doi.

9. Joeseph E. Bishop, John M. Emery, Richard V. Field, Christopher R. Weinberger, and David J. Littlewood. Direct numerical simulations in solid mechanics for understanding the macroscale effects of microscale material variability. *Computer Methods in Applied Mechanics and Engineering*, 287: 262–289, 2015. doi.

8. Devin M. Pyle, Jing Lu, David J. Littlewood, and Antoinette M. Maniatty. Effect of 3D grain structure representation in polycrystal simulations. *Computational Mechanics*, 52(1):135–150, 2013. doi.

7. Jacob D. Hochhalter, David J. Littlewood, Michael G. Veilleux, Jeffrey E. Bozek, Antoinette M. Maniatty, Anthony D. Rollett, and Anthony R. Ingraffea. A geometric approach to modeling microstructurally small fatigue crack formation: III. Development of a semi-empirical model for nucleation. *Modelling and Simulation in Materials Science and Engineering*, 19(3), 2011. doi.

6. Jacob D. Hochhalter, David J. Littlewood, Robert J. Christ, Jr., Michael G. Veilleux, Jeffrey E. Bozek, Anthony R. Ingraffea, and Antoinette M. Maniatty. 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 and Simulation in Materials Science and Engineering*, 18(4), 2010. doi.

5. Jeffrey E. Bozek, Jacob D. Hochhalter, Michael G. Veilleux, M. Liu, Gerd Heber, Stephen D. Sintay, Anthony D. Rollett, David J. Littlewood, Antoinette M. Maniatty, Hasso Weiland, Robert J. Christ, Jr., Joel Payne, Greg Welsh, Gary D. Harlow, Paul A. Wawrzynek, and Anthony R. Ingraffea. A geometric approach to modeling microstructurally small fatigue crack formation: I. Probabilistic simulation of constituent particle cracking in AA 7075-T651. *Modelling and Simulation in Materials Science and Engineering*, 16(6), 2008. doi.

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

3. David J. Littlewood and Ganesh Subbarayan. Updating a CMYK printer model using a sparse data set. *Journal of Imaging Science and Technology*, 50(6):556–566, 2006. doi.

2. David J. Littlewood and Ganesh Subbarayan. Controlling the gray component with pareto-optimal color-space transformations. *Journal of Imaging Science and Technology*, 46(6):533–542, 2002.

1. David J. Littlewood, Paul A. Drakopoulos, and Ganesh Subbarayan. Pareto-optimal formulations for cost versus colorimetric accuracy trade-offs in printer color management. *ACM Transactions on Graphics*, 21(2):132–175, 2002. doi.

BOOK CHAPTERS

4. Marta D'Elia, Pavel Bochev, David J. Littlewood, and Mauro Perego. Optimization-based coupling of local and nonlocal models: Applications to peridynamics. In George Z. Voyiadjis, editor, *Handbook of Nonlocal Continuum Mechanics for Materials and Structures*. Springer. *In preparation*.

3. Pablo Seleson and David J. Littlewood. Numerical tools for effective meshfree discretizations of peridynamic models. In George Z. Voyiadjis, editor, *Handbook of Nonlocal Continuum Mechanics for Materials and Structures*. Springer. *In preparation*.

2. David J. Littlewood. Roadmap for software implementation. In Florin Bobaru, Philippe H. Geubelle, John T. Foster, and Stewart A. Silling, editors, *Handbook of Peridynamic Modeling*, chapter 5. CRC Press, 2016.

1. Yan Azdoud, Fei Han, David J. Littlewood, Gilles Lubineau, and Pablo Seleson. Coupling local and nonlocal models. In Florin Bobaru, Philippe H. Geubelle, John T. Foster, and Stewart A. Silling, editors, *Handbook of Peridynamic Modeling*, chapter 14. CRC Press, 2017.

CONFERENCE PROCEEDINGS

7. David J. Littlewood, Stewart A. Silling, and Paul N. Demmie. Identification of fragments in a meshfree peridynamic simulation. In *Proceedings of the ASME 2016 International Mechanical Engineering Congress and Exposition (IMECE)*, Phoenix, Arizona, 2016. doi.

6. David J. Littlewood, Michael Hillman, Edouard Yreux, Joseph E. Bishop, Frank Beckwith, and Jiun-Shyan Chen. Implementation and verification of RKPM in the Sierra/SolidMechanics analysis code. In *Proceedings of the ASME 2015 International Mechanical Engineering Congress and Exposition (IMECE)*, Houston, Texas, 2015. doi.

5. David J. Littlewood, Kyran D. Mish, and Kendall H. Pierson. Peridynamic simulation of damage evolution for structural health monitoring. In *Proceedings of the ASME 2012 International Mechanical Engineering Congress and Exposition (IMECE)*, Houston, Texas, 2012. doi.

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

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

2. David J. Littlewood and Antoinette M. Maniatty. Multiscale modeling of crystal plasticity in Al 7075-T651. In *8th International Conference on Computational Plasticity (COMPLAS VIII)*, Barcelona, Spain, 2005.

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

TECHNICAL REPORTS

6. Janine C. Bennett, Matthew T. Bettencourt, Robert L. Clay, Harold C. Edwards, Micheal W. Glass, David S. Hollman, Hemanth Kolla, Jonathan J. Lifflander, David J. Littlewood, Aram H. Markosyan, Stan G. Moore, Stephen L. Olivier, J. Antonio Perez, Eric T. Phipps, Francesco Rizzi, Nicole L. Slattengren, Daniel Sunderland, and Jeremiah J. Wilke. ASC ATDM level 2 milestone #6015: Asynchronous many-task software stack demonstration. Report SAND2017-9980, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, 2017.

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

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

3. 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. Strong local-nonlocal coupling for integrated fracture modeling. Report SAND2015-7998, Sandia National Laboratories, Albuquerque, NM and Livermore, CA, 2015.

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

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

PRESENTATIONS

30. David J. Littlewood, Marta D'Elia, Mauro Perego, and Pavel Bochev. Optimization-based coupling for local and nonlocal models. SIAM Conference on Computational Science and Engineering, Atlanta, Georgia, 2017.

29. David J. Littlewood, Stewart A. Silling, and Paul N. Demmie. Identification of fragments in a meshfree peridynamic simulation. ASME International Mechanical Engineering Congress and Exposition, Phoenix, Arizona, 2016.

28. David J. Littlewood, Timothy B. Costa, and Stephen D. Bond. Peridynamic multiscale finite element methods. World Congress on Computational Mechanics, Seoul, Korea, 2016.

27. David J. Littlewood, Pablo Seleson, and Stewart A. Silling. Coupling meshfree peridynamics with local finite-element models. ASME International Mechanical Engineering Congress and Exposition, Houston, Texas, 2015.

26. David J. Littlewood, Michael Hillman, Edouard Yreux, Joseph E. Bishop, Frank Beckwith, and Jiun-Shyan Chen. Implementation and verification of RKPM in the Sierra/SolidMechanics analysis code. ASME International Mechanical Engineering Congress and Exposition, Houston, Texas, 2015.

25. David J. Littlewood. Progress and challenges in computational peridynamics. USACM Workshop on Nonlocal Models in Mathematics, Computation, Science, and Engineering, Oak Ridge, Tennessee, 2015.

24. David J. Littlewood, Stewart A. Silling, Pablo Seleson, and John A. Mitchell. Coupling approaches for integrating meshfree peridynamic models with classical finite element analysis. 13th U.S. National Congress on Computational Mechanics, San Diego, California, 2015.

23. David J. Littlewood, Stewart A. Silling, and Pablo Seleson. Local-nonlocal coupling for modeling fracture. ASME International Mechanical Engineering Congress and Exposition, Montreal, Canada, 2014.

22. David J. Littlewood, Jesse D. Thomas, and Timothy R. Shelton. Estimation of the critical time step for peridynamic models. U.S. National Congress of Theoretical and Applied Mechanics, East Lansing, Michigan, 2014.

21. David J. Littlewood. Coupling peridynamics and classical finite elements. ASME International Mechanical Engineering Congress and Exposition, San Diego, California, 2013.

20. David J. Littlewood, Michael L. Parks, John A. Mitchell, and Stewart A. Silling. The peridigm framework for peridynamic simulations. 12th U.S. National Congress on Computational Mechanics, Raleigh, North Carolina, 2013.

19. David J. Littlewood, Timothy R. Shelton, and Jesse D. Thomas. Global estimation of the critical time step for peridynamic models. SIAM Conference on Mathematical Aspects of Materials Science, Philadelphia, Pennsylvania, 2013.

18. David J. Littlewood, Veena Tikare, and John Bignell. Informing macroscale constitutive laws through peridynamic modeling of grain-scale mechanisms in plutonium oxide. Workshop on Nonlocal Damage and Failure: Peridynamics and Other Nonlocal Models, San Antonio, Texas, 2013.

17. David J. Littlewood, Kyran D. Mish, and Kendall H. Pierson. Quasi-statics, modal analysis, and structural health monitoring within the peridynamic framework. ASME International Mechanical Engineering Congress and Exposition, Houston, Texas, 2012.

16. David J. Littlewood and Veena Tikare. Peridynamic modeling of void collapse in representative plutonium oxide microstructures. ASME International Mechanical Engineering Congress and Exposition, Houston, Texas, 2012.

15. David J. Littlewood, John T. Foster, and Brad L. Boyce. Peridynamic modeling of localization in ductile metals. 22nd International Workshop on Computational Mechanics of Materials, Baltimore, Maryland, 2012.

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

13. David J. Littlewood and Tracy J. Vogler. Modeling dynamic fracture with peridynamics, finite element modeling, and contact. 11th U.S. National Congress on Computational Mechanics, Minneapolis, Minnesota, 2011.

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

11. David J. Littlewood, Alex Lindblad, Arne S. Gullerud, and Nathan K. Crane. Modeling fragment size distributions in dynamic loading simulations. 10th U.S. National Congress on Computational Mechanics, 2009.

10. David J. Littlewood, Antoinette M. Maniatty, and Fujun Xu. Modeling grain structure evolution in asymmetric rolling. 2007 ASME International Mechanical Engineering Congress and Exposition, Seattle, Washington, 2007.

9. David J. Littlewood, Antoinette M. Maniatty, Fujun Xu, and Jing Lu. Multiscale modeling of finite deformation in polycrystalline materials. 9th U.S. National Congress on Computational Mechanics, San Francisco, California, 2007.

8. David J. Littlewood, Jing Lu, and Antoinette M. Maniatty. Relating properties of metals to microstructure and processing through grain-scale modeling. 3rd Annual Tech Valley Engineering Symposium, Troy, New York, 2007.

7. David J. Littlewood and Antoinette M. Maniatty. Application of crystal plasticity to fatigue damage modeling for Al 7075-T651. 7th World Congress on Computational Mechanics, Los Angeles, California, 2006.

6. David J. Littlewood and Antoinette M. Maniatty. Crystal plasticity modeling of Al 7075. Center for Automation Technologies and Systems Open House, Rensselaer Polytechnic Institute, Troy, New York, 2006.

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

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

3. David J. Littlewood and Ganesh Subbarayan. Maintaining an accurate printer calibration. Xerox Corporation, Webster, New York, 2004.

2. David J. Littlewood and Ganesh Subbarayan. Maintaining an accurate printer calibration. University of Colorado Department of Mechanical Engineering, Boulder, Colorado, 2001.

1. David J. Littlewood and Ganesh Subbarayan. Pareto-optimal formulations for printer color management. University of Colorado Department of Mechanical Engineering, Boulder, Colorado, 2001.

COURSES TAUGHT

4. John T. Foster, David J. Littlewood, and Pablo Seleson. Peridynamic theory of solid mechanics: Modeling, computation, and applications. Short Course, U.S. National Congress on Computational Mechanics, Montreal, Canada, 2017.

3. David J. Littlewood. The Peridigm peridynamics code. Short Course, University of Arizona, Tucson, Arizona, 2017.

2. David J. Littlewood. Engineering dynamics. Rensselaer Polytechnic Institute, Troy, New York, Spring Semester, 2006.

1. David J. Littlewood. Design and analysis of structures. Syracuse University, Syracuse, New York, Spring Semester, 2003.

MINISYMPOSIA ORGANIZED

2. Fei Han, Pablo Seleson, Gilles Lubineau, David J. Littlewood, and Youn Doh Ha. Nonlocal theories and multiscale methods for complex material behavior. World Congress on Computational Mechanics, Seoul, Korea, 2016.

1. David J. Littlewood, Michael L. Parks, James W. Foulk, and Alejandro Mota. Recent advances in nonlocal computational mechanics. U.S. National Congress on Computational Mechanics, Minneapolis, Minnesota, 2011.

STUDENTS MENTORED

5. J. Antonio Perez. Albuquerque Academy High School and University of New Mexico. Year-round intern, Sandia National Laboratories, Albuquerque, New Mexico, 2016-2017.

4. Marco Pasetto. Ph.D. candidate, University of California, San Diego. Summer intern, Sandia National Laboratories, Albuquerque, New Mexico, 2016.

3. Timothy B. Costa. Ph.D. candidate, Oregon State University. Year-round intern, Sandia National Laboratories, Albuquerque, New Mexico, 2015-2016.

2. Nicolas Morales. Ph.D. candidate, University of North Carolina, Chapel Hill. Summer intern, Sandia National Laboratories, Albuquerque, New Mexico, 2015.

1. Canio Hoffarth. Ph.D. candidate, Arizona State University. Summer intern, Sandia National Laboratories, Albuquerque, New Mexico, 2012.

JOURNAL REFEREE

9. Acta Materialia.

8. Computer Methods in Applied Mechanics and Engineering.

7. Geomechanics for Energy and the Environment.

6. International Journal for Numerical Methods in Engineering.
5. International Journal for Multiscale Computational Engineering.
4. International Journal of Fatigue.
3. International Journal of Plasticity.
2. International Journal of Solids and Structures.
1. Journal of Applied Mechanics.