BRIAN R. PHUNG

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EDUCATION

M.S./Ph.D. Mechanical Engineering December 2022
University of Utah Salt Lake City, Utah
Advisor: Ashley Spear
Dissertation: *Simulation of Three-Dimensional Microstructurally Sensitive Crack Growth Using a Voxel-Based Remeshing Framework*

B.S. Mechanical Engineering May 2015
University of Utah Salt Lake City, Utah

RESEARCH EXPERIENCE

University of Utah Department of Mechanical Engineering January 2023 – Present
Post-doctoral Research Associate Salt Lake City, Utah

PI: Jacob Hochhalter Materials Prognosis from Integrated Modeling & Experiment Laboratory

- Assist in the early development of the Utah Center for Aerospace Materials and Sustainment
- Perform diffraction-contrast tomography to obtain grain structures in metallic materials
- Generate yield-surface training data of polycrystalline materials using crystal plasticity fast-Fourier transform method for mapping anisotropic yield surfaces to a surrogate isotropic yield surface using interpretable machine learning

PI: Ashley Spear Multiscale Mechanics and Materials Laboratory

- Parallelize a large strain elasto-visco-plastic fast Fourier Transform code using MPI
- Extend, develop, and maintain an adaptive-remeshing framework for the simulation of impact-induced fracture in infant skulls
- Investigate fracture location predictions in sub-continuum additively manufactured metal using damage-enabled crystal-plasticity fast-Fourier transform framework

University of Utah Multiscale Mechanics and Materials Laboratory May 2015 – December 2022
Graduate Research Assistant Salt Lake City, Utah

Funded by: U.S. Air Force Office of Scientific Research and National Science Foundation
Topic: *Simulation of Three-Dimensional Microstructurally Sensitive Crack Growth*
Experience:

- Developed a parallelized voxel-based remeshing framework for the simulation of fully arbitrary three-dimensional crack growth in heterogeneous materials (i.e., polycrystals) using C++, Python, and MPI
- Investigated the validity of potential crack-growth criteria for microstructurally sensitive fatigue-crack growth in experimentally characterized underaged magnesium samples provided by the University of Michigan
- Implemented and verified crystal-plasticity constitutive models in Abaqus/Standard (UMAT/UEL), Abaqus/Explicit (VUMAT), and material-point method solver, Uintah
- Improved the computational efficiency of crack-propagation simulations by implementing a mesh refinement and coarsening scheme to incorporate mesh gradation at critical locations via direct modification of non-manifold surface meshes
- Developed a post-processing tool for the visualization of Abaqus user elements in Paraview (C++/HDF5); assisted in the development of a parallelized post-processor for the visualization of convected-particle tetrahedral domains in the material-point method (Python/MPI)

Sandia National Laboratories May – August 2019, June – August 2020
R&D Intern Livermore, CA

Experience:

- Developed a user-guided cleaning tool for microstructure images (e.g., from electron backscatter diffraction) to enable greater user control compared to conventional microscope image-cleaning algorithms; utilized image-cleaning tool and grain-growth simulations to generate a proof-of-concept 3D mesh from noisy microstructure images collected from only the front and back surfaces (SAND2019-9632PE)
- Verified a proposed homogenization scheme for mesoscale polycrystalline materials that aims to predict variables of interest that may be useful in quantifying material variability and performance without explicit material testing or intractable computational simulations (SAND2019-9632PE, SAND2020-8053PE)
- Tested and evaluated state-of-the-art non-local and phase-field ductile fracture models developed by Sandia National Laboratories

U.S. Air Force Research Laboratory (AFRL) May – August 2016, May – August 2017
Student Researcher/Contractor Wright-Patterson Air Force Base, OH

Funded by: U.S. Air Force Summer Faculty Fellowship and CRDInAL Thrust 4 Programs
Topic: *A Voxel-Based Remeshing Framework for the Simulation of Arbitrary 3D Crack Growth in Heterogeneous Materials*

Experience:

- Collaborated with AFRL researchers on the development of the voxel-based remeshing framework; performed three proof-of-concept simulations using the framework involving crack coalescence and transgranular and intergranular crack growth

PUBLICATIONS

- (Minor Revisions) **B.R. Phung**, D.A. Greeley, M. Yaghoobi, J.F. Adams, J.E. Allison, A.D. Spear. Predicting microstructurally sensitive fatigue-crack path in WE43 magnesium using high-fidelity numerical modeling and three-dimensional experimental characterization. *Fatigue & Fracture of Engineering Materials & Structures*. 2023.
- C. K. Cocke, H. Mirmohammad, M. Zecevic, **B. R. Phung**, R. A. Lebensohn, O. T. Kingstedt, A. D. Spear. Implementation and experimental validation of nonlocal damage in a large-strain elasto-viscoplastic FFT-based framework for predicting ductile fracture in 3D polycrystalline materials, *International Journal of Plasticity*. 2022. doi.org/10.1016/j.ijplas.2022.103508
- **B.R. Phung**, J. He, A.D. Spear. A Surface-Mesh Gradation Tool for The Generation of Optimized Tetrahedral Meshes for Defects in Microstructures, *Computational Materials Science*. 2021. doi.org/10.1016/j.commatsci.2021.110622
- D. Zhao, K.E. Matheson, **B.R. Phung**, S. Petruzza, M.W. Czabaj, A.D. Spear. Investigating the Effect of Grain Structure on Compressive Response of Open-Cell Metal Foam Using High-Fidelity Crystal-Plasticity Modeling, *Materials Science and Engineering: A*. 2021. doi.org/10.1016/j.msea.2021.140847
- **B.R. Phung**, A.D. Spear. A Voxel-Based Remeshing Framework for the Simulation of Arbitrary 3D Crack Growth in Heterogeneous Materials, *Engineering Fracture Mechanics*. 2019. doi.org/10.1016/j.engfracmech.2019.01.008
- A.D. Spear, M. Czabaj, P. Newell, K. DeMille, **B.R. Phung**, et al. The Third Sandia Fracture Challenge: From Theory to Practice in a Classroom Setting, *International Journal of Fracture*. 2019. doi.org/10.1007/s10704-019-00366-w
- R.B. Leavy, J.E. Guilkey, **B.R. Phung**, A.D. Spear, R.M. Brannon. A Convected-Particle Tetrahedral-Domain Integration Technique in the Material-Point Method for Mesoscale Modeling of Ceramics, *Computational Mechanics*. 2019. doi.org/10.1007/s00466-019-01670-x

PRESENTATIONS (presenter)

- E.S. Marsden, **B.R. Phung**, D.S. Watring, A.D. Spear. "Predicting fracture location in AM tensile specimens with internal porosity and surface defects using a modified Void Descriptor Function", *USNCCM17*, Albuquerque, NM, July 2023.
- J. N. Hirst, B. T. Johnsson, **B.R. Phung**, K. Clingo, B. Coats, A. D. Spear "Predicting fall parameters of impact-induced skull fractures in infants using machine learning", *USNCCM17*, Albuquerque, NM, July 2023. (Accepted)
- **B.R. Phung**, D.A. Greeley, M. Yaghoobi, J.F. Adams, J.E. Allison, A.D. Spear. "Predicting microstructurally sensitive fatigue-crack path in WE43 magnesium using high-fidelity numerical modeling and three-dimensional experimental characterization", *ICF15*, Atlanta, GA, June 2023.
- V.B. Rao, **B.R. Phung**, A.D. Spear. "Using deep learning to predict microstructurally small fatigue crack growth parameters in polycrystalline materials", *ICF15*, Atlanta, GA, June 2023.
- **B.R. Phung**, D.A. Greeley, M. Yaghoobi, J.F. Adams, J.E. Allison, A.D. Spear. "Predicting microstructurally sensitive fatigue-crack path in WE43 magnesium using high-fidelity numerical modeling and three-dimensional experimental characterization", *TMS 2023*, San Diego, CA, March 2023.
- V. B. Rao, **B.R. Phung**, A.D. Spear. "Accelerating Microstructurally Small Crack Growth Predictions in Three-dimensional Microstructures using Deep Learning", *TMS 2023*, San Diego, CA, March 2023.
- A.D. Spear, C.K. Cocke, **B.R. Phung**, L.C. Ziegler, E.S. Marsden, V.B. Rao. "Predicting Microstructure-sensitive Fracture Behavior in AM IN625 Using a Damage-enabled Elasto-viscoplastic FFT Framework", *TMS 2023*, San Diego, CA, March 2023. Invited.
- V.B. Rao, **B.R. Phung**, A.D. Spear. "Accelerating Microstructurally Small Crack Growth Predictions in Three-dimensional Microstructures using Deep Learning", *MMM10*, Baltimore, MD, October 2022.
- **B.R. Phung**, A.D. Spear. "Finite Element Based Modeling of Geometrically Explicit Cracks in 3D Microstructures", *PRISMS Center Annual Workshop*, virtual, August 2021.
- **B.R. Phung**, J. He, A.D. Spear. "A Surface-Mesh Gradation Tool for Generating Optimized Tetrahedral Meshes of Microstructures with Defects", *USNCCM16*, virtual, July 2021.
- D. Zhao, K.E. Matheson, Q. Johnson, **B.R. Phung**, S. Petruzza, M.W. Czabaj, A.D. Spear. "Investigating the Effect of Grain Structure on Compressive Response of Open-Cell Metal Foam Using High-Fidelity Crystal- Plasticity Modeling", *USNCCM16*, virtual, July 2021.
- **B.R. Phung**, J. He, A.D. Spear. "A Surface-Mesh Gradation Tool for Generating Optimized Tetrahedral Meshes of Microstructures with Defects", *3DMS 2021*, virtual, June 2021.
- D. Zhao, K.E. Matheson, **B.R. Phung**, M.W. Czabaj, A.D. Spear, "A crystal plasticity modeling framework to study the effect of grain size on mechanical response of open-cell aluminum foam", *TMS 2020*, San Diego, California, February 2020.
- **B.R. Phung**, J. Adams, J. Allison, S.F. Li, J. Lind, A.D. Spear, "Multiscale characterization and modeling of 3D crack propagation in polycrystalline materials", *Society of Engineering Sciences (SES)*, Madrid, Spain, October 2018. Invited.
- D. Zhao, J. Plumb, **B.R. Phung**, K. Matheson, J. Guilkey, A.D. Spear, "3D crystal-plastic particle-in-cell simulation of open-cell metal foam", *13th World Congress on Computational Mechanics*, New York City, New York, July 2018.
- **B.R. Phung**, A.D. Spear, "A voxel-based remeshing framework for the simulation of arbitrary 3D crack growth in heterogeneous materials", *TMS 2018*, Phoenix, Arizona, March 2018.
- **B.R. Phung**, A.D. Spear, "A voxel-based meshing framework for the simulation of arbitrary 3D crack growth in heterogeneous materials", *International Conference of Fracture 14*, Rhodes, Greece, June 2017.
- **B.R. Phung**, R.B. Leavy, R.M. Brannon, A.D. Spear, "A comparison between the finite-element method and material-point method in mesoscale crystal plasticity simulations", *Engineering Mechanics Institute*, Nashville, Tennessee, May 2016.

- S. Childs, **B.R. Phung**, J. Hochhalter, P.T. Fletcher, A.D. Spear, "Toward the Use of Machine Learning to Understand the Mechanisms of Complex Microstructurally Small Fatigue-Crack Evolution", *TMS 2016*, Nashville, Tennessee, February 2016. (Poster)

TEACHING EXPERIENCE

Teaching Assistant

- Finite Elements (ME EN 5510/6510) — Summer 2018
- Statics (ME EN 2010) — Spring 2018

ENGINEERING EXPERIENCE

Quartzdyne, Inc. — November 2013 – May 2015
R&D Engineering Intern — West Valley City, UT

- Experimentally characterized mechanical creep, hysteresis, and electronic transients in quartz-based pressure sensors
- Developed an empirical model to predict long-term mechanical creep
- Quantified the performance of potential suppliers' sensor components in terms of manufacturing failure rate due to crystallographic twinning and long-term creep
- Investigated failed sensors using optical and scanning electron microscopy
- Experimentally compared the performance of quartz-based sensors to competing technologies

NOTABLE INVOLVEMENT

NIST Additive Manufacturing Benchmark (AM Bench): Subcontinuum Mesoscale Tensile Test — 2022
- Objective: predicting subcontinuum mesoscale tensile response of as-built IN625
- 1st place in predicting tensile behavior

3rd Sandia Fracture Challenge Participant — 2017

Performed supervised paper reviews for the following journals:
- Computer-Aided Design
- Journal of Computational Physics
- Fatigue and Fracture of Engineering Materials and Structures
- JOM

Salt Lake Valley Science and Engineering Fair Judge — 2016, 2018

2015 University of Utah Formula SAE Michigan — 2014 – 2015

TECHNICAL SKILLS

Programming	C++, python, Matlab, MPI, OpenMP, Java, Object Oriented Programming, git
Simulation Tools	ABAQUS, Uintah, ANSYS, Uintah, ScIFEN, Sierra, FRANC3D, Tetgen, Gmsh, Cubit
General	Linux bash/csh, macOS, Solidworks, DREAM.3D, ParaView, VisIt, LaTeX