Brian Doran Giffin, Ph.D.

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Education

- **University of California, Davis** — Davis, CA
  Doctor of Philosophy in Computational Solid Mechanics; GPA: 4.00 — *2015 – 2018*
  - **Minor**: Applied Mathematics
  - **Advisor**: Professor Mark Rashid
  - **Dissertation**: Partitioned Polytopal Finite-Element Methods for Nonlinear Solid Mechanics
- **University of California, Davis** — Davis, CA
  Master of Science in Structural Engineering & Mechanics; GPA: 4.00 — *2013 – 2014*
  - **M.S. Project**: Applied Poromechanics for Hydraulic Fracture Simulation
- **University of California, Davis** — Davis, CA
  Bachelor of Science in Civil Engineering; GPA: 3.98 - Summa Cum Laude — *2009 – 2013*
  - **Department Citation**: Awarded by the Department of Civil & Environmental Engineering to two recipients each year, in recognition of outstanding academic achievement.

Professional Experience

- **Oklahoma State University (OSU)** — Stillwater, OK
  Assistant Professor in the College of Civil & Environmental Engineering — *2024 – Present*
- **Lawrence Livermore National Laboratory (LLNL)** — Livermore, CA
  Computational Mechanics Methods Developer — *2018 – 2023*
  - **Senior software developer of DYNA3D/ParaDyn**: a parallel, non-linear, explicit, large deformation solid and structural finite element code in Fortran, sharing the same original code base as LS-DYNA.
  - **Lead developer of BCLink**: a boundary condition remapping library in C++, for loose FSI coupling between structural and CFD analyses.
  - **Lead developer of SML**: a large deformation constitutive model library in C++, for use by both explicit and implicit thermo-mechanical HPC analysis codes.
- **McClone Construction** — Shingle Springs, CA
  Technical Lead — *2019 - 2020*
  - Software developer of FormPro: an in-house structural concrete formwork analysis tool. Assessed client needs, met regularly with stakeholders and other developers, managed code architecture considerations. Implemented core structural analysis software library in C#. Prototyped GUI and load/shear/bending/deflection graphing functionality using Mono. Developed and conducted rigorous unit testing using NUnit. Improved performance of FormPro's visualization using .NET.
- **Sandia National Laboratories** — Albuquerque, NM
  Graduate Technical Intern — *Summer 2014 & 2015*
  - Developed and implemented an agglomerated polyhedral element capability within the SIERRA Solid Mechanics simulation code.
- **Sandia National Laboratories** — Albuquerque, NM
  Undergraduate Technical Intern — *Summer 2013*
  - Worked with Dr. Joseph Bishop in Sandia's engineering sciences division to conduct verification testing of the Reproducing Kernal Particle Method (RKPM) in the SIERRA Solid Mechanics simulation code.
- **Structure Maintenance and Investigations - Caltrans** — Sacramento, CA
  Undergraduate Student Intern — *2012-2013*
  - Assisted in the field inspection of bridges located throughout the central valley of California. Reviewed as-built corrections and adjusted CAD-based structural plan documents. Performed load rating analyses on California bridges.

Research Experience

- **Research and development of novel finite element methods** — LLNL
  Various ParaDyn-related projects — *2018 – 2023*
  - Developed and a implemented a novel solid element formulation for improved bending performance, specialized for use in explicit dynamics simulations (presented at EMI).
  - Formulated a laminated solid element for use in the modeling of laminated composites (pending publication).
  - Developed an improved (naturally stable) formulation of the 10-node composite tetrahedron element for rapid analysis needs (pending publication).
  - Devised a novel elasto-plastic hourglass stabilization method for finite elements with reduced integration (presented at EMI, pending publication).

- **Research and development of novel constitutive modeling approaches** — LLNL
  Various ParaDyn-related projects — *2018 – 2023*
  - Formulated and implemented a large deformation material modeling framework accommodating multi-directional failure (publication in IJF).
  - Formulated and implemented a novel logarithmic strain-based temperature-dependent, hybrid visco-plastic/visco-elastic material model.

- **Partitioned polyhedral finite element methods for HPC applications** — LLNL
  Laboratory Directed Research & Development (LDRD) Proposal – (Not funded) — *2020*
  - Drafted and submitted an LDRD proposal to investigate novel polyhedral discretization methods for use in HPC finite element codes. The suggested approach leverages the decomposition and storage of polyhedral elements as hexahedra, upon which the element computations may be efficiently carried out using composite quadrature rules. Other notable advantages of the approach include the ability to handle contact constraints and boundary conditions on polygonal faces in a straight-forward manner, and improved GPU scalability.

- **Incremental kinematic algorithms for large deformation analyses** — UC Davis
  Graduate research — *2016 – 2018*
  - Investigated the accuracy of alternative incremental kinematic algorithms used by hypo-elastic constitutive models. Formulated an improved algorithm for efficiently evaluating matrix functions used in high-accuracy kinematic algorithms.

- **Partitioned polytopal finite-element methods for nonlinear solid mechanics** — UC Davis
  Ph.D. Dissertation — *2015 – 2018*
  - Developed a high-order arbitrary polyhedral element method for improved accuracy in the modeling of thin geometries.
  - Implemented a novel finite deformation polyhedral finite element method in a self-authored Fortran-based research code, and demonstrated notable improvements in mesh quality and solution accuracy.

- **Agglomerated polyhedral finite elements** — Sandia National Labs
  Summer research project — *2014 – 2015*
  - Developed and implemented a method for aggregating tetrahedral elements into arbitrary polyhedral elements, utilizing existing domain decomposition methods via METIS. Implemented an agglomerated polyhedral element capability within the SIERRA Solid Mechanics simulation platform. The element formulation was largely based upon the "partitioned element method" (the subject of my dissertation), and capable of handling polyhedra generated from arbitrary aggregations of tetrahedra. The method was demonstrated to provide improved accuracy in large deformation elasto-plastic impact problems.

- **Poromechanical simulation methods for hydraulic fracture** UC Davis
  M.S. Project *2014*
  - Collaborated with Lawrence Livermore National Laboratory's Computational Geosciences Group, investigating the use of continuum damage models for simulating hydraulically driven fracture. The project culminated in the implementation of a coupled poromechanics physics solver within the GEOS finite element code.

Publications

Peer-reviewed Journal Articles:

1. Giffin, B. D. and Zywicz, E. (2023). "A smeared crack modeling framework accommodating multi-directional fracture at finite strains." *International Journal of Fracture*. 239, 87-109. https://doi.org/10.1007/s10704-022-00665-9.

2. Giffin, B. D. and Zoller, M. (2023). "A layered solid finite element formulation with interlaminar enhanced displacements for the modeling of laminated composite structures." *International Journal for Numerical Methods in Engineering*. (submitted).

3. Kenawy, M. and Giffin, B. D. (2023). "Model-Based Uncertainty in Predicting Damage to Near-Fault Reinforced Concrete Structures." *18th World Congress on Earthquake Engineering*. (submitted).

Dissertation and Reports:

1. Giffin, B. D. and Guthrey, P. (2023). "BCLink User Documentation - Version 23.0." *Lawrence Livermore National Laboratory*. LLNL-SM-857271.

2. Castonguay, S., Giffin, B., Hathaway, R., Zoller, M. (2023). "Shared Material Library User Documentation - Version 23.0." *Lawrence Livermore National Laboratory*. LLNL-SM-854936.

3. Giffin, B. D. (2020). "Shell Element Material Model Verification Problems for DYNA3D: Part II." *Lawrence Livermore National Laboratory*. LLNL-TR-814964. https://doi.org/10.2172/1668518.

4. Giffin, B D. (2019). "Shell Element Material Model Verification Problems for DYNA3D." *Lawrence Livermore National Laboratory*. LLNL-TR-792469. https://doi.org/10.2172/1569660.

5. Giffin, B. D. (2019). "Verification Problems for Parameterized Load Curves in DYNA3D." *Lawrence Livermore National Laboratory*. LLNL-TR-765860. https://doi.org/10.2172/1499983.

6. Giffin, B. D. (2018). "Partitioned Polytopal Finite-Element Methods for Nonlinear Solid Mechanics." Ph.D. Dissertation. *University of California, Davis*.

7. Giffin, Brian D. (2015). "Verification Tests for Sierra/SM's Reproducing Kernal Particle Method." *Sandia National Laboratories*. SAND2017-12869. https://doi.org/10.2172/1411850.

8. Giffin, B. D. (2014). "Applied Poromechanics for Hydraulic Fracture Simulation." M.S. Project Report. *University of California, Davis*.

Conference Presentations and Posters:

1. Giffin, B. D. (2022). "Elasto-Plastic Hourglass Control for Physically Stabilized Non-Linear Finite Elements with Reduced Integration." Oral presentation, *Engineering Mechanics Institute Conference*, May 31-June 3, Baltimore, MD.

2. Giffin, B. D. (2021). "A Smeared Crack Modeling Framework Accommodating Multi-directional Fracture at Finite Strains." Oral presentation, *Engineering Mechanics Institute Conference*, May 25-28, virtual event.

3. Giffin, B. D. (2019). "A stable, efficient, locking free hexahedral element for problems in non-linear dynamics." Oral presentation, *Engineering Mechanics Institute Conference*, June 18-21, Pasadena, CA.

4. Giffin, B. D. and Rashid, M. (2017). "An Improved Partitioned Element Method for Constructing Higher-Order Shape Functions on Arbitrary Polyhedra." Oral presentation, *14th U.S. National Congress on Computational Mechanics*, July 17-20, Montreal, Canada.

5. Bishop, J. E., Giffin, B. D., and Pott, J. (2013). "Verification of a Convergent Meshless Method in Sierra Solid Mechanics." Poster presentation, *Sandia Intern Symposium*, August 6, Albuquerque, NM.

Academic and Professional Leadership

- **Earthquake Engineering Research Institute** — 12th National Conference on Earthquake Engineering
  Peer reviewer for technical conference papers — *2022*

- **National Student Steel Bridge Competition (NSSBC)** — ASCE Mid-Pacific Student Conference
  Regional Competition Judge — *2022*

- **Computational Mechanics Working Group (CMWG)** — UC Davis
  Co-founder, President — *2016 – 2018*
  - Organized a community of graduate students at UC Davis to meet and discuss research related interests in the field of computational mechanics. Invited speakers from LLNL and LBNL to come share their current projects and interests with the group.

- **National Student Steel Bridge Team at UC Davis** — UC Davis
  Project Manager — *2012 – 2013*
  - Led a team of 20 undergraduate engineering students in the design and fabrication of a 20ft steel bridge as part of the National Student Steel Bridge Competition (NSSBC). Claimed 2nd place overall at the Mid-Pacific regional competition; ranked 3rd place overall at the national competition.

- **American Society of Civil Engineers (ASCE) Student Chapter** — UC Davis
  Events and Activities Coordinator — *2012 – 2013*

Honors and Awards

- **Graduate Studies Travel Award** — 2017
  University of California, Davis - Graduate Studies

- **Academic Achievement Award** — 2013
  American Society of Civil Engineers (ASCE) Sacramento Section

- **Civil & Environmental Engineering Departmental Citation Award** — 2013
  UC Davis Department of Civil & Environmental Engineering

- **3rd Place Overall - National Student Steel Bridge Competition** — 2013
  National Student Steel Bridge Competition (NSSBC)

- **SEAOCC Student Scholarship** — 2012
  Structural Engineers Association of Central California (SEAOCC)

- **Outstanding Student Award** — 2012
  American Society of Civil Engineers (ASCE) Sacramento Section

Teaching and Mentoring Experience

- **College of Engineering Mentor Collective** — UC Davis
  Academic Mentor — *2020 – 2021*
  - Mentored first year undergraduate students at UC Davis, providing academic and career guidance during the 2020-21 academic year.

- **University of California, Davis** — Davis, CA
  Substitute Lecturer — *2017*
  - Served as a substitute lecturer for the *Mechanics of Materials* undergraduate course on behalf of Professor Bassam Younis, and Professor Sabbie Miller.

- **University of California, Davis** — Davis, CA
  Course Instructor: ENG 35 - Engineering Statics — *Fall 2015*
  - Independently organized and taught an undergraduate engineering course of 118 students. Managed a team of 5 teaching assistants and 2 graders. Prepared original course lecture notes, homework assignments, exams, and supplementary educational materials (see Teaching Innovation).

- **National Student Steel Bridge Team at UC Davis** — UC Davis
  Graduate Advisor — *2014 – 2018*
  - Provided consultation to undergraduate students regarding design and fabrication processes. Devised a suite of engineering analysis tools to help expedite the design process. Helped the team to claim 1st place overall at the national competition (2014).

- **University of California, Davis** — Davis, CA
  Teaching Assistant — *2013 – 2018*
  - Assisted lecturing, hosted laboratory sessions, held office hours, and graded assignments for the following courses: *Introduction to Civil Engineering, Mechanics of Materials, Finite Element Procedures in Applied Mechanics*

Teaching Innovation

- **Interactive Earthquake Simulator**
  https://github.com/bdgiffin/CZM — *2020*
  - Independently developed an educational, open-source, earthquake simulator. Users first "paint" a structure on a pixelated 2D canvas (a la Minecraft), and then subject their design to a dynamically simulated earthquake (using recorded motions taken from the PEER Ground Motion Database). Brittle damage and failure is modeled using cohesive zone elements, incorporating real-time simulation and rendering via OpenGL.

- **Interactive Physics Engine**
  https://github.com/bdgiffin/stf — *2020*
  - Independently developed an educational, open-source, 2D thermo-mechanical physics engine, incorporating real-time simulation and rendering via OpenGL. Users can interactively control the analysis to investigate the effects of: large deformations, heat transfer and thermal expansion, dynamic impact, frictional contact, gravitational and buoyant forces, bulk viscosity, and element erosion.

- **NSSBC Bridge Designer**
  https://github.com/bdgiffin/BridgeDesigner — *2017 – 2018*
  - Developed a MATLAB-based 3D structural analysis and optimization tool, intended for students participating in the National Student Steel Bridge Competition (NSSBC). Students can import and export designs to/from AutoCAD, run linear elastic analyses, buckling analyses, evaluate design efficiency, and improve designs using a gradient-based optimization approach to select (discrete) member section sizes.

- **Challenge Problems** — UC Davis
  ENG 35 - Engineering Statics — *Fall 2015*
  - As the course instructor for *Engineering Statics* at UC Davis, I devised "challenge problems" to accompany each homework assignment, presenting students with extra credit opportunities to further solidify their understanding of the material. These problems were posed in terms of a design problem (as one might encounter in an industry setting), and encouraged students to develop a synthetic understanding of the course material through practical application.

- **Statically Determinate Truss Analysis Tool** — UC Davis
  ENG 35 - Engineering Statics — *Fall 2015*

- As the course instructor for *Engineering Statics* at UC Davis, I independently wrote and distributed an open source Matlab-based structural analysis tool to enhance students' intuition of 2D truss structures. Students could design and analyze their own truss structures, visualize tensile and compressive forces, evaluate static determinacy. Unstable structures are analyzed dynamically, animating their deformation and collapse under loading.

- **NSSBC Design Tutorials**
  https://www.youtube.com/@briangiffin6640 *2014*
  - Recorded a series of videos demonstrating design principles in AutoCAD and SAP2000, intended for students participating in the National Student Steel Bridge Competition (NSSBC).

- **NSSBC Design Tools**
  https://github.com/bdgiffin/SBDesignTools *2014*
  - Developed a collection of VBA-based automated structural design and optimization tools utilizing the AutoCAD and SAP2000 APIs, intended for students participating in the National Student Steel Bridge Competition (NSSBC).

Licenses and Certifications

- **Engineer in Training** 2023
  California Board for Professional Engineers, Land Surveyors, and Geologists *Certificate # EIT 178316*

Knowledge, Skills, and Research Interests

- **Technical Expertise and Research Interests**: Computational solid mechanics, large deformation kinematics, finite elements and novel discretization methods, nonlinear transient dynamics, contact mechanics, numerical modeling of fracture, poromechanics, constitutive model development, structural analysis, design optimization
- **Programming Languages**: C++, C#, Fortran, Matlab, Python, VBA, .NET
- **Software Development**: High performance computing (HPC), GPGPU, Git, CVS, Agile methodologies, Unix, shell scripting, LaTeX, GNU Make, CMake, GUI, OpenGL, OpenACC, OpenMP, GitLab CI/CD, unit testing, V&V, Eclipse, Visual Studio, Mono, TotalView
- **Engineering Software**: AutoCAD, MicroStation, SAP2000, DYNA3D/ParaDyn, SIERRA Solid Mechanics, Abaqus, SolidWorks, Cubit, ParaView, Ensight, VisIt