Curriculum Vitae

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Education

PhD Engineering Mechanics. University of Wisconsin, Madison, Dec. 1992. GPA 4.0/4.0.
Full fellowship; Advisor: Dr. Walter S. Drugan. Graduate dissertation focused on full spectral analysis of non-self-adjoint plasticity acoustic tensors, and on thermodynamic restrictions for dynamically propagating discontinuity surfaces in nonclassical elastic-plastic solids with the applications to steady-state plane-strain crack growth.

M.S. Engineering Mechanics. University of Wisconsin, Madison, May 1988. GPA 3.9/4.0

B.S. with distinction, Mechanical Engineering. University of New Mexico, Albuquerque, May 1987. 3.6/4.0.

Post-graduate professional development (abridged list)

Oct. 2016 Wolfram Technology Conference (incl. two half-day training classes)
Jan. 2014 Stress Waves, Johns Hopkins (class audit during sabbatical to help design Utah class)
Sep. 2011 WordPress Wordcamp, Salt Lake City (one day workshop)
Aug. 2011 Wolfram Alpha in the Classroom (Webinar).
Dec. 2009 Presentations with Mathematica.
Aug. 2009 University of Utah CTLE+TACC seminar: "[Professor] Preparing for the First Day [of class]."
Mar. 2008 MPM workshop, Salt Lake City.
Oct. 2007 MIT Fracture and Failure workshop.
Jul. 2007 Uncertainty Quantification in Mechanics: Theoretical and Computational Aspects (USNCCM short course; instrs: R. Ganhem, USC, and C. Soize, UMLV – France).
Jul. 2006 Statistical geomechanics (Sandia short course).
Jan. 2006 Experimental methods for materials characterization (Sandia short course).
Sep. 2003 Leadership series with Erin Brockovich.
Nov. 2002 ASME professional development: Toastmasters Better Speaking for Engineers.
Nov. 2002 Sandia Laboratories CUBIT mesh generation course.
Sep. 2002 64th UCLA Technical Management Program.
Mar. 2002 Survey of Defense Technology (Sandia short course).
Dec. 2001 Managers and the Law.
Dec. 2000 Computational Optimization (Sandia short course; instr., Omar Ghattas).
Fall   2000 Advanced Thermodynamics (instr., A. Razani) University of New Mexico.
Fall   1999 Fields and Waves (electrodynamics) University of New Mexico.
May   1999 Equations of state for hydrocode calculations (instr: Gerry Kerley), short course.
Fall   1996 Wave phenomena in non-linear materials (instr, Doug Drumheller), University of New Mexico.
Jul.   1995 The Mechanics-Materials Linkage Program. Northwestern University, week-long short course.

Professional Experience

University of Utah – Salt Lake City
Associate Professor, Department of Mechanical Engineering,   Jan. 2007-present
Adjunct Associate Professor, Department of Civil and Environmental Engineering, Apr. 2012-present

Courses taught

Statics and Introduction to Strength of Materials, ME-EN 1300: Fall'10, '12, '14 (~100 students each time)
Continuum Mechanics, ME-EN 7510/5510/6510: Spring'07,'09,'11,'15 (~15-20 students each time)
Introduction to Finite Elements, ME-EN 5540/6540: Fall 2009 (55 students)
Advanced Finite Elements, ME-EN 7540: Spring '08, '10, '12 (19, 15, 12 students respectively)

Newly developed courses

Computational Constitutive Modeling (special topics) partially based on a book Brannon is developing with Prof.
   H.L. "Buck" Schreyer of the University of New Mexico. Fall, 2011.

Student and postdoc advising

PhD students:

PhD STUDENTS GRADUATED:
Michael Homel: Fall 2015. Constitutive modeling of fluid-saturated rock subjected to hypervelocity penetration;
CSM productivity: CSM productivity: 3 conf. presentations (invited), 1 workshop presentation, 1 poster, 1 best presentation award, 5 accepted articles.
Dissertation: Elastoplastic Constitutive Modeling of Fluid-Saturated Porous Materials with New Methods for Numerical Solution and Mesoscale Validation.

Krishna C. Kamojjala: Spring 2014 Mesh dependencies in fragmentation, aleatory uncertainty in material properties, rate-dependent ductility; software for post-processing stand-alone material model drivers for verification. Novel "waiting link" concept for distributing impact damage over a structure.
CSM productivity: 3 conf. proceedings, 5 presentations (2 invited, 1 submitted), 2 journal publications
Dissertation: Systematic code verification and validation of damage in high strength armor materials.

Tony Sanders: Summer 2012, Analytical and experimental methods for rapid characterization of contact wear resistance with application to accelerated screening of materials for hip implant ceramics by testing inexpensive surrogate shapes that reproduce Hertzian contact to second order accuracy.
CSM productivity: 4 journal papers, 1 proceeding, 4 conf. presentations (1 invited), 3 conf. posters.

Dissertation: Surrogate theory for Hertzian contact pairs: application to simplify wear testing of ceramic hip prosthesis materials.

Jeff Burghardt: Summer 2011: Resolution of the Sandler-Rubin instability that exists in any conventional non-associated plasticity model, irregular flow rules and/or nonlocal physics of failure; advanced nodal integrators for the Material Point Method.
CSM productivity: 2 journal papers, 2 proceedings, 1 gov't report, 5 conf. presentations (1 invited, 1 keynote), 1 conf. poster
Dissertation: Nonlocal plasticity, instability, and well-posedness of the elastic-plastic initial-boundary value problem.

Tim Fuller: Fall 2010. Thermodynamically consistent elasticity and plasticity for shock physics;
CSM productivity: 2 journal pubs and 1 government report.
Dissertation: An investigation of the effects of deformation-induced anisotropy on isotropic classical elastic-plastic constitutive models.

PhD STUDENTS WHO HAVE PASSED QUALIFYING AND PROPOSAL EXAMS:
Brian Leavy: Systematic methods for assessing reliability and uncertainty of numerically optimized material parameter sets; software for post-processing stand-alone material model drivers for validation.
CSM productivity: 1 journal publication, 4 proceedings, 5 presentations (1 invited)

James Colovos: (2011-present) Modeling and simulation of high-rate large deformation phenomena, with current emphasis on validation of models for high-rate penetration of sandstone.
CSM productivity: 1 conf. presentation

Masters students:

<u>MASTERS STUDENTS GRADUATED:</u>
Steve Schmidt: (2013) (BS-MS): Investigation of kinematic anomalies in the Material Point Method

Conference paper in lieu of report: Instability in Some Large-Shear Problems Solved with the Material Point Method

Dave Austin: (2012-2013) (BS-ME and MS):
Thesis title: Verification and validation of a geomodel aimed at simulating wellbore completion via shaped-charge jet perforation of metal and penetration into sandstone
CSM productivity: Thesis.

Deepika Kakarla: (2009-2012) MS ME: in vitro hip implant impact damage experiments and simulations.
CSM productivity: 1 conf. proceeding, 1 conf. poster

M. Scot Swan: (2010-2011) Incorporation of non-convex strain-to-failure envelopes in computational metals plasticity models.
CSM productivity: Uintah and Kayenta software
[Thesis:](#) "Incorporation of a general strain-to-failure fracture criterion into a stress-based plasticity model"

Amanjeet Shihn: 2009 (MS-Engr) verification and validation of Uintah for well-bore penetration simulations.
CSM productivity: analysis results

Krishna C. Kamojjala: (2007) MS-Engr; now returned as PhD student: material model verification frameworks (Matlab interface to the MED constitutive model driver, Abaqus UMAT development)
CSM productivity: MED software
Ira Tibbitts: experiment design for measuring wave motion and Hertzian contact wear patterns in drop tower and subluxation loading modes in ceramic hip implants.
CSM productivity: 1 conf. proceeding, 1 conf. presentation

David Macon: (2010-2013) Thesis title: Plastic cap evolution law derived from induced transverse isotropy in dilatational triaxial compression. (Induced inelastic anisotropy from axial splitting in triaxial loading as a means of modeling shear-enhanced dilatation without concurrent unrealistic hydrostatic limit pressure evolution in prevalent isotropic geo-plasticity models.)
CSM productivity: Thesis and DOE report (of thesis)

<u>STUDENTS FUNDED PREVIOUSLY, BUT NOT ADVISED THROUGH GRADUATION:</u>
Emad Ghodrati: (2012-2016) Constitutive models for soil, sand, and clay subjected to high-rate large deformations. **CSM productivity: 1 conf. presentation**

Asghar Yarahmadi: Multiphase modeling of fully and partially saturated sand and clay subjected to blast loading from buried explosives. **CSM productivity: 3 conf. presentations; (withdrawn)**

Hamid Sarmadi (2013-2014) **CSM productivity: rate-dependence in geoplasticity in the Uintah code; (withdrawn)**

Parthasarathi Dudhiya (MS): experiment design for subluxation wear modes in ceramic hip implants. **productivity: 1 journal article**
Cindy Spangler: (2013-present) Fundamental issues in convergence and validation of quasi-plasticity models accounting for aleatory uncertainty and associated scale effects. **CSM productivity:** *N/A*

Exceptional undergraduates in research:

Katharin Jensen: (2015-present) See http://csmbrannon.net/2015/07/20/undergraduate-researcher-applies-binning-to-study-large-groups-of-statistically-variable-buckling-columns/.
Anthony Chyr: (2011-2015) Research [website](#) design, micromanipulator for mesoscale properties quantification. Recipient of prestigious summer internship in the Los Alamos National Laboratory's Dynamics Summer School (2012). Recipient of prestigious international E. Richard Booser Presidential Award (for undergraduate students) of the Society of Tribologists and Lubrication Engineers (2013).
M. Scot Swan: (2008) Incorporation of aleatory uncertainty in the Uintah MPM framework.

Supported (funded) postdocs, research associates, research professors, and visiting scholars:

Carlos Bonifasi-Lista (2012-present): Postdoc, constitutive modeling and dynamic multiphase solvers for simulating response of sand, soil, clay, and rock to buried explosives at multiple scales. Numerical methods for achieving local deformation gradient updates in the material point method consistent with motion of surrounding material.

Mataz Alcoutlabi (2009): Research Professor, verification of plasticity algorithms, statistical crack mechanics

Biswajit Banerjee (2011-2013): International Research Associate, engineering models for soil and clay in Uintah

Michael Braginski (2007): Postdoc, data analysis methods for determining the evolving tangent stiffness tensor under non-proportional and possibly incrementally nonlinear plastic flow.

Todd Harman (2008-2010): Research Professor, Automatic Mesh Refinement (AMR) in Uintah

John Schmidt (2011): Research staff, polyhedral glyph visualization and VTK output in Uintah

C. Y. Lee (2009): Visiting Scholar (S. Korea) Particle methods.

Seubpong Leelavanichkul (2008): Postdoc, improving computational efficiency and robustness of smeared damage models through multi-stage return algorithms. (2008-2011): Research Associate, design and realization of novel "waiting link" composites for protective structures. (2011-2012) Project management for ONR-MURI.

Alireza Sadeghirad (2009-2012): Postdoc, enforcement of boundary conditions in MPM through a new concept of abutting particles that can accommodate formation of thousands of new free surfaces (fractures) without having to track the surfaces explicitly. Convected Particle Domain Interpolation (CPDI) for the elimination of the extension instability, as well as for increased accuracy, in Material Point Method applied to problems with massive material distortion.

Other student support

13 graders, 8 TAs, 3 short-term graduate research assistants (UMAT in Abaqus, Literature reviews), 9 undergraduate assistants (LaTeX typesetting, website population, MPM simulations, Monte Carlo analyses, statistics in buckling), two undergraduate student-exchange summer intern (Ansys and Abaqus simulations of unstable wave propagation; buried explosive simulations using the Uintah MPM code), one high-school summer intern (assisting in hip implant testing), and a partridge in a pear tree.

Distinguished undergraduate student interns (UROP awardees): Topic1: incorporation of aleatory uncertainty in the Uintah Computational Framework. This work resulted in Sandia National Labs internship and full support of this student in subsequent graduate studies, including a practicum at the Ernst Mach Institute in Germany. Topic2: laboratory methods for direct measurement of grain cohesive strength for use in mesoscale simulations. This work fostered in this student's admittance into the prestigious Los Alamos Dynamics Summer School (2012).

Independent studies advised:
- Aleatory uncertainty in buckling systems containing thousands or millions of moving parts
- Tetrahedral meshing for MPM mesoscale modeling
- Optimization methods in topology
- On the search for a universal cumulative distribution function for brittle failure probability
- Comparative verification testing of two material point method (MPM codes).
- Survey of tensor analysis, including textbook typesetting in LaTeX.
- Plasticity modeling.
- Wave mechanics in the Material Point Method.
- Verification of surrogate contact pair design to reproduce Hertzian contact mechanics.
- Theory for induced anisotropy to reproduce dilatation in triaxial compression in a way that avoids the unrealistic hydrostatic strengthening that is predicted in some isotropic hardening theories.
- Thermomechanics of solids (applied to find new welding procedures to better reduce residual stress).

Senior design projects advised:
- Triaxial Test Machine Project: reduction of noise in stress-strain records observed during extremely low rate legs of rock testing.

Department, College, and University Service:
- Organizer and host: Distinguished seminar by KT Ramesh (2014)
- Executive committee member (2014-2015)
- ABET committee chair (2015)
- Five-year tenure review committee (2015)
- Solid Mechanics division committee (2015)
- Strategic planning committee (2014)
- Member, Design search committee (2015)
- Faculty mentor to Assit. Prof. A. Spear (2014-2015)
- Chair, Solid Mechanics Faculty Search Committee (2012); member (2010, 2013, 2014 at large on sabbatical)
- College council (2008, 2009).
- Qualifier and/or exit examiner, linear algebra (2008-2010, 2014), finite elements (2009-2010), vibrations (2010)
- Graduate committee (2008, 2009, 2010, 2011, 2012) with special project to work with CLEAR to establish a Blackboard Vista student training module on plagiarism prevention.
- PhD and Masters committee member (2007-2011) at double department average in 2010.
- Curriculum committee (2008, 2009).
- Seminar committee (2008, 2009, 2010, 2011, 2012). Personally hosted the following distinguished speakers: Iwona Jasiuk (U. Illinois), Zdeněk Bažant (Northwestern), Rod Lakes (U. Wisconsin), Dave Benson (UCSD).
- Strength of Materials Textbook selection committee consultant (2008).
- Solid Mechanics Faculty selection committee (2007, 2008, 2010).
- ABET committee (2007), co-coordinator for ABET accreditation visit (2009), ABET chair (2011, 2012).
- Employment candidate interviewer (2007, 2008, 2010), including two USTAR candidates.

External Service:

- Organizer and host: 7th Material Point Method Workshop, Salt Lake City, March10-12, 2013, Salt Lake City, UT.
- Selection committee for DOE Computational Science Graduate Fellowship (CSGF); out of ~600 applicants per year, approximately 20 are selected for this prestigious award. (2011, 2012, 2015)
- Textbook reviewer for
  - ➢ Wiley-Miriam (2011) Undergraduate-level Statics
  - ➢ CRC Press (2010) Introductory continuum mechanics
  - ➢ Cambridge University Press (2009) Advanced continuum mechanics
- Co-organizer (found speakers) for SAVIAC-DTRA workshop on Ground Shocks in Faulted Media (2010).
- Member of the Commission on Engineering Accreditation (CEA), which meets twice a year in Washington, DC, and at the annual ASME conference to evaluate and recommend changes in ABET policies, procedures, and criteria. Each commission member reviews completed accreditation reports to ensure consistency in application of the criteria. (2007-2010).
- Member of first national team of mentors for new ABET program evaluators (2010).
- ASME/ABET Mechanical Engineering accreditation evaluator (2003, 2004, 2007, 2010).
- ASME/ABET Engineering Mechanics (distinct from Mechanical Engineering) accreditation evaluator (2009).
- Initial planning for the bid to host ARMA rock mechanics symposium in Utah (2008).
- Board member, ASME Committee on Engineering Accreditation (CEA), 2008-2010 (elected unanimously).
- Conference symposium organizer: International Plasticity Conference (Hawaii, January 2008; Virgin Islands, January 2009; San Juan PR 2012), ASME McMat (Austin TX, July, 2007), 9th US National Congress on Computational Mechanics (San Francisco CA, July 2007).
- Conference technical committee: Hypervelocity Impact Symposium (Williamsburg, 2007), American Physical Society Topical Group Meeting on Shock Compression of Condensed Matter (Portland Oregon, 2003), American Physical Society Topical Group Meeting on Shock Compression of Condensed Matter (Atlanta 2001, Snowbird 1999).
- Proposal reviewer: SAVIAC-DTRA (2010) DTRA (2009), NSF (2007, 2012), Army Research Office (2007).
- Reviewer for
  - ➢ Acta Mechanica
  - ➢ ASME committee on Verification and Validation (2010)
  - ➢ Biomechanics and Modeling in Mechanobiology
  - ➢ Cambridge University Press
  - ➢ Computer Modeling in Engineering and Sciences (CMES)
  - ➢ Computers and Geotechnics
  - ➢ Government DOE and DoD reports (heavily reviewed)
  - ➢ Int. Conf. on Robotics and Automation (2010, at request of Will Provancher)
  - ➢ Int. J. Fracture (IJF)
  - ➢ Int. J. Impact Engineering (IJIE)
  - ➢ Int. J. Numer. and Anal. Meth. in Geomechanics (IJNAMG)
  - ➢ Int. J. Numerical Methods In Engineering (IJNME)
  - ➢ Int. J. Plasticity (IJP)
  - ➢ Int. J. Solids and Structures (IJSS)
  - ➢ Mathematics and Mechanics of Solids
  - ➢ MIT Crash Worthiness Consortium
  - ➢ The Journal of Applied Mechanics (JAM)
  - ➢ The Journal of Engineering Mechanics (JEM)
  - ➢ The Journal of Mechanics of Materials and Structures (JoMMS)
  - ➢ The Journal of the Mechanics and Physics of Solids (JMPS)
  - ➢ Coupled Systems Mechanics (CSM)

  Topics: Heat transfer in the Material Point Method, Explosives in centrifuges, Method of Cells applied to fiber composites, Mesh convergence in Monte Carlo simulations, boundary conditions in material point methods, assessment of convergence of Monte Carlo simulations, constitutive models for failure of fabric composites, peridynamics applied to continua, projection methods in geomechanics failure models, particle methods in dynamic large-deformation plasticity, dissipation in shock-less high-pressure high-rate loading, directional distortion of yield surfaces, third-invariant dependence of yield in metals, Hugoniot measurements for microcracking materials, micromechanical models of ferroelectric phase transitions, large deformation kinematics in production finite element codes, shear bands in granular materials, damage models for concrete, the use of particle-in-cell methods in geomechanics.

- Salt Lake Valley Science and Engineering Fair Judge (2007).
- Albuquerque Science Fair judge and safety inspector (2001-2006).

Sandia National Laboratories
Principal Technical Staff Researcher, Geomechanics (6117), Jan03 – Oct06

Developed constitutive models for shock and fracture response of rock and ceramics by using both conventional phenomenological three-invariant plasticity and microphysical statistics-based analysis of microcrack distributions and anisotropic damage, with an emphasis on predicting expected distributions in experimental scatter and incorporating this material variability within simulations. Other research includes ferroelectric to anti-ferroelectric phase transformation mechanics, entropy analysis for high-stress ramp loading of engineering materials, and fourth-order tensor stability analyses. Published in respected journals with numerous invited and keynote presentations at professional conferences on computational mechanics and materials modeling.

Sandia National Laboratories
Manager, Materials Mechanics (9123), June01 - Jan03

Oversaw daily operations and strategic planning for an organization responsible for mathematical and numerical modeling of engineering materials, including metals, polymers, honeycombs, laminates, ferroelectrics, and epoxies. All modeling efforts were implemented in large scale (production quality) finite element and/or particle code architectures. Government and commercial customer support included design and analysis to production, maintenance, and safety. Special projects included development of software tools for materials property preservation, dissemination, and deployment by generating input decks for major codes.

Sandia National Laboratories
Shock Physics Senior Technical Staff Researcher, Jan93-June02.

Developed new computer modeling capabilities in electromechanics, large-deformation continuum frame mechanics, fracture mechanics, and shock physics. Projects for statistical crack mechanics and dynamic PZT ferroelectric ceramics entailed complex, coupled physics and, therefore, considerable team coordination among experimentalists, materials scientists, design engineers and simulation code architects.

Developed a software framework, subsequently adopted by other organizations outside Sandia Laboratories, allowing physics models to be used across multiple engineering analysis codes, thus eliminating unnecessary duplication of effort previously invested in transplanting and maintaining models in different codes.

Served as a principal SNL point-of-contact (POC) with DoD organizations for consultation on high-strain-rate constitutive modeling issues. Primary POC on impact response modeling for brittle and composite armor materials with the Army Research Laboratory (ARL).

Recognized as a principal SNL resource on computational modeling of electrically active materials, such as PZT material used in shock-actuated power supplies. Fostered an international reputation in computational mechanics community for SNL work on anisotropic materials.

Other Positions held

Consultant for Idaho National Laboratory. 2012-2013. Advised student work on ductile-brittle transitions in high-rate loading of metals (Taylor and Brazilian tests)

University of New Mexico, Adjunct Professor. 1998-2003, Taught Continuum Mechanics (Introductory and Advanced levels), Elasticity, Advanced Thermodynamics (as guest lecturer for 3 weeks). Served on UNM advisory and faculty selection boards.

State of New Mexico and National Motorcycle Safety Foundation Instructor, 1996-2001. Monthly 20-hour course in safe motorcycle operation including both riding and classroom instruction. Work required a public-forum teaching style and strong interpersonal skills, especially for counseling students about their skill level.

Currently Funded Research Support

$1.09M Brannon (Utah PI)   6/1/2011-5/31/2016
         This is the University of Utah allocation out of a $7.2M consortium award also distributed to:
                 University of Colorado—Boulder
                 Louisiana State University
                 University of California—Berkeley
                 University of Texas—Dallas
Sponsor: Office of Naval Research (ONR-MURI)
SOIL BLAST MODELING AND SIMULATION:
Integrated experimental-computational multiscale immersed particle-continuum approach to modeling and simulation of multiphase soil failure mechanics under buried explosive loading. The research program will result in a validated, computationally efficient, multiscale multiphase hybrid Lagrangian particle-continuum computational approach to predicting blast wave propagation and soil ejecta motion resulting from buried explosives in natural soils, usable for simulating IED-vehicular interaction and design.

Pending Proposals

Current projects are fully funding the group for the foreseeable future.

Sponsored research completed while on the faculty at the University of Utah

$300k   Brannon (PI)   3/13/2009-9/31/2014
Sponsor: US Department of Energy – Sandia National Laboratories (DoD subcontract)
COMPUTATIONAL INELASTICY
Using irreversible induced anisotropy as a means to predict dilatation in triaxial compression without non-physical cap motion that is employed in prevailing isotropic plasticity models. Advising of Sandia intern on implementation of strain-based metals fracture criteria. Development and support of the Kayenta constitutive model.

$1M   Brannon (PI)   9/2008-12/2014
Sponsor: withheld by contractual agreement
(Application in high-rate impact and penetration of saturated geological media)

$100k   Brannon (PI)   3/28/2011-12/31/2012
Sponsor: US Department of Energy – Idaho National Laboratory
METAL FRAGMENTATION: Computational approaches for dynamically loaded low-ductility metals
Identification of sources for anomalous fracture patterns when using commonly available plasticity and damage models in un-notched Charpy impact simulations.

$400k   Brannon (PI)   7/1/2008-6/30/2011
Sponsor: NIH National Institute of Arthritis and Musculoskeletal and Skin Diseases (NIAMS)
TESTING TO RANK ORTHOPAEDIC HIP IMPLANT MATERIALS FOR THEIR RESISTANCE TO SQUEAKING, WEAR, AND RIM CRACKING
Systematic design of laboratory experiments that can be used to rapidly rank hip implant materials for their wear and performance properties by using inexpensive surrogate geometries that reproduce (to second-order) the Hertzian stresses from tapping impact and subluxation edge loading in more expensive full-scale prototypes.

$32k   Brannon (*de jure* PI), S. Leelavanichkul (*de facto* PI)   6/1/2010-5/31/2011
Sponsor: University of Utah Research Foundation
ENERGY ABSORPTION OF A BISTABLE STRUCTURE: DESIGN, VALIDATION, AND VERIFICATION
Computational and experimental seed grant to illustrate the effectiveness of bistable microstructures in protective structures such as armor and ballistic fabrics.

Notable Past Proposals

$10M   Brannon(co-PI)
Sponsor: National Nuclear Security Administration
RAPID EXASCALE ACTIONABLE COMPUTING TECHNOLOGY (REACT)
Exascale software for modeling with Verification and Validation/UQ components to provide rapid-response hierarchically predictive simulations for crisis-driven decision making, using modeling of the Spanish Fork Canyon explosion as a case study.

$7.0M   Brannon (co-PI share: 1.9M)   BAA AFOSR 2011-06
Sponsor: Air Force Office of Sponsored Research (AFOSR)
HIGH-RATE DEFORMATION AND TEMPERATURE
A Center of Excellence in High-rate Deformation Physics of Heterogeneous Materials consortium with Southwest Research Institute, University of Texas at San Antonio, and the University of Utah (Brannon and Andrej Cherkaev)

$971k   Brannon (PI)
Sponsor: US Army Research Office (BAA W911NF-07-R-0001-05)
LIGHTWEIGHT AND HIGH STRENGTH MULTISCALE PROTECTIVE STRUCTURE
Protective structures based on bistable links to distribute damage throughout a structure.

$1.2M   Brannon (consultant @ $48.5k)   7/2012-7/2015
Sponsor: Defense Advanced Research Projects Agency (DARPA)
BISTABLE PROTECTIVE STRUCTURE
Adaptive damage tolerant lightweight and high strength multiscale bistable protective structure.

$290k   Brannon (PI)   8/16/2011-8/15/2013
Sponsor: National Science Foundation (NSF)
MULTISCALE BISTABLE STRUCTURE
Controllable structural damage using multiscale bistable concept: theory, design, and simulations.

$20k   Brannon (visiting scholar)   7/1/2013-8/1/2013
Sponsor: Australian Research Council (ARC) Discovery Program.
INTERNATIONAL COLLABORATION AWARD
Award for travel and accommodations to collaborate with Australian researchers on the topic of large-deformation computational mechanics, with emphasis on penetration and flow of geological media using the Material Point Method. This nomination (in review by ARC) was submitted by D. Pedroso, Golder Geomechanics Centre, School of Civil Engineering, The University of Queensland Brisbane.

Past sponsored research completed while on the faculty at the University of Utah

$40k   Brannon (PI)   5/15/2008-8/30/2008
Sponsor: US Department of Energy – Sandia National Laboratories
NON-CLASSICAL PLASTICITY VALIDATION SANDIA LDRD
Analysis of non-monotonic loading data to assess validity of the regular flow rule and other unvalidated assumptions in plasticity theory.

$296k   Brannon (PI)   3/1/2007-3/1/2009
Sponsor: US Department of Energy – Sandia National Laboratories
NON-CLASSICAL PLASTICITY MODELING
Computational damage modeling of rock, ceramics, and metals.

Sponsored research predating academic appointment

The following funding levels are approximate since funding was not tracked in detail in the Sandia staff researcher position.

~$1.5M   Brannon (PI)   1/2004-10/2006
Sponsor: Department of Defense
CONSTITUTIVE MODELS FOR FRACTURE AND FRAGMENTATION OF CERAMIC ARMOR.
Practical constitutive modeling of impact-induced damage of armor ceramics.

~$600k   Fossum (PI), Brannon (I)   1/2003-9/2006
Sponsor: US Department of Energy – Sandia National Laboratories
CONSTITUTIVE MODELS FOR HIGH RATE DEFORMATION OF POROUS AND CRACKED ROCK
The goal of this project was to generalize conventional cap plasticity models for rock to be applicable in high-rate shock loading at laboratory and field scales.

~$400k   Montgomery/Aidun (co-PIs)   10/1997-6/2001
Sponsor: US Department of Energy – Sandia National Laboratories
MULTISCALE CONSTITUTIVE MODELS FOR FERROELECTRIC CERAMICS
The goal of this project was to develop a single constitutive model capable of spanning from micro to macro scales for deformation-induced depolarization of PZT ceramics.

~$400k   Brannon (PI)   10/1993-9/1995
Sponsor: US Department of Energy – Sandia National Laboratories
CONSTITUTIVE MODELS FOR ALUMINUM OXIDE CERAMICS
The goal of this project was to incorporate anisotropic cracking damage into a constitutive model in Eulerian simulations.

~$100k   Chhabildas (PI)   1/1993-9/1993
Sponsor: US Department of Energy – Sandia National Laboratories
EXTENSION OF THE EQUATION OF STATE FOR ZINC
The goal of this project was to analyze hypervelocity impact data for shock-induced vaporization of zinc, inferring the equation of state properties near the triple point from VISAR records of free expansion rates.

Gifts

$48k, donated by Schlumberger Corporation, has been used to support students in core graduate coursework to prepare them for research in computational solid mechanics.

Teaching Experience

2015 Spring. Continuum Mechanics, University of Utah.

2014 Fall. Introduction to Statics and Strength of Materials, University of Utah.

2014 Kayenta Geomechanics Short Course, June 2014, Sandia National Laboratories, Research Park.

2013 Spring. Continuum Mechanics, University of Utah.

2012 User's Introduction to the Theory of and Data Fitting for the Kayenta Geomechanics Material Model, October 7-12, Sandia National Laboratories, Research Park, twenty-one attendees from DoD and DOE labs, as well as academic institutions.

2012 Fall. Introduction to Statics and Strength of Materials, University of Utah.

2012 Spring. Advanced Finite Elements, University of Utah

2011 Fall. Computational Constitutive Modeling, University of Utah.

2011 Spring. Continuum Mechanics, University of Utah.

2010 Fall. Introduction to Statics and Strength of Materials, University of Utah.

2010 Spring. Advanced Finite Elements, University of Utah.

2009 Fall. Introduction to Finite Elements, University of Utah.

2009 Spring. Continuum Mechanics, University of Utah.

2008 Spring. Advanced Finite Elements, University of Utah.

2007 Spring. Continuum Mechanics, University of Utah.

2005 – 2006 Facilitator and lecturer, Twice weekly Sandia working group on computational constitutive modeling.

2004 June, Short Course "The mathematics of materials modeling," Delft University Research School Structural Engineering, Netherlands.

2003 Aug., Advanced thermodynamics (one week graduate student short course on distilling thermodynamic derivatives and generalizing thermodynamics to solids), University of New Mexico.

2003, Spring Semester, Elasticity, University of New Mexico.

199, Fall, Introduction to Continuum Mechanics, University of New Mexico.

1997 Fall, Advanced Topics in Continuum Mechanics, University of New Mexico.

1996-2001. State of New Mexico and National Motorcycle Safety Foundation Instructor. Monthly 20-hour course in safe motorcycle operation includes both riding and classroom.

1993. Continuum Thermomechanics with applications to plasticity and shock waves. Three week short course, University of New Mexico.

1993. Statistical Crack Mechanics in Eulerian Computations. Workshop on Ceramics. San Antonio, TX.

1989. Elementary Fracture Analysis Teaching Assistant, University of Wisconsin -- Madison.

1986. Finite Element Analysis Grader. University of New Mexico -- Albuquerque.

1983-1985. Algebra, Trigonometry, and Calculus (paid staff member, 20 hrs/wk) University of New Mexico Skills Center.

Professional Activities, Program Development, Honors, and Awards

- Top 15% teaching recognition (Spring 2015)
- ASME fellow, 2010.
- Technical organizing committee: MACH conference, April, 2016, Annapolis, MD
- Technical organizing committee: MACH conference, April 8-10, 2015, Annapolis, MD
- Featured researcher (5 faculty members selected), College of Engineering Annual Research Report (2012)
- NSF proposal reviewer (in the area of constitutive modeling), 2011
- Banquet speaker: International Symposium on Interaction of the Effects of Munitions with Structures, 2011 (registration and travel paid by DTRA).
- ASME ABET evaluator for first-time accreditation of the ITSEM Mechanical Engineering Program in Chihuahua Mexico, 2011.
- Highest score among all ABET program evaluators in ABET's 2010 standardized test of knowledge of accreditation policies and procedures, 2011.
- Keynote offered (but turned down because of other commitments): Plasticity '11, '14
- DOE Licensed Copyright "globe" Award, Aug. 24, 2010.
- Reviewer for Continuum Mechanics textbook by Mase, Smelser, and Mase, 2010.
- Reviewer for ASME Verification and Validation Standards document (Primer), 2010.
- Received travel award to attend DTRA Ground Shock in Faulted Media Workshop, Wash. DC, Jan. 2010.
- Invited to participate on National Academies study committee on "Opportunities in Protection Materials Science and Technology for Future Army Applications," 11/10/2009.
- Proposal reviewer for the Defense Threat Reduction Agency, Aug. 2009.
- Plenary invitee, APS topical meeting on shock compression of condensed matter, June 2009.
- University of Utah limited submission selectee for NSF Presidential award for mentoring 2007, nominated by five individuals across nation.
- Sandia employee recognition awards and nominations: Multiphysics armor simulation, continuum mechanics twice-weekly discussion group, Fragmentation Analyses of Ceramic Armor 2006, GeoModel in penetration applications 2005, documentation and testing of Sandia's GeoModel constitutive software 2005, MAVEN Neutron Generator/Power Supply Team 2001, contributions to the Sandia Technology Partnerships & Commercialization licensing program 2002.
- Testimonial support for the Univ. Utah C-SAFE (center for simulating accidental fires and explosions) Oct. 3, 2005.
- $1.5M research award from the U.S. Army ground combat systems for ceramics modeling (spanning FY2003-2006).
- Technology transfer of rock modeling software to Lawrence Livermore National Laboratory 2005.
- Featured researcher: Sloan Cornerstone newsletter for educational outreach 2005, Los Alamos National Laboratories EES Division Highlights/Accomplishments 2004, Sandia Labs Center 6100 entryway 2005.
- Sandia service: Management selection team 2004, Computer advisory group representative, process improvement panel for student internships at Sandia 2002, Organizer of annual off-site managers meeting (Monterey CA, 2002), "My Support Team" project leader 2004.
- Member: American Society of Mechanical Engineers (ASME), American Physical Society (APS), U.S. Association for Computational Mechanics (USACM), American Society for Engineering Education (ASEE).
- Founder of "gobag" student news group (about 600 people) for tutorials in mechanics.
- Employee Recognition Award for modeling contributions to Sandia's MAVEN Neutron Generator/Power Supply Team (an experiment and modeling project to characterize the electromechanical response of PZT to shock-induced phase transformation).
- Sandia National Laboratories Royalty Award recipient for contributions to the CTH hydrodynamics code.
- Reviewer for Albuquerque Public School's selection of mathematics textbooks,1997.
- Sandia volunteers (community service, "make a difference" day).
- University of New Mexico industrial representative: Faculty selection committee for tenure-track professor applications, Dean-appointed arbitrator for student-advisor conflict, doctoral committee.
- Video interviewee for the IEEE CD-ROM/video project to foster undergraduate interest in Engineering careers. IEEE Sloan Career Cornerstone Series, 1994.
- Session chair in most conferences attended since 1996.
- Poem about π (=3.14159...) published by the American Library Association and the NSF.

Books and Book Chapters

1. Brannon, R.M. (2016) Rotation, Reflection, and Frame Changes: Orthogonal tensors in the context of engineering mechanics, iOP publishers, in production pipeline.

2. Brannon, R.M. (2014) Introductory Curvilinear Coordinates and Differential Geometry for Engineers, Cambridge Univ. Press. Contract offered and in negotiation of terms.

3. Brannon, R.M. (2014) Functional and Structured Cartesian Tensor Analysis for Engineers, ~1000 pages. Minor finishing touches are needed before completion anticipated in 2014 (sabbatical).

4. Reguerio, R., R. Pak, J. McCartney, S. Sture, B. Yan, Z. Duan, J. Svoboda, W. Mun, O. Vasilyev, N. Kasimov, E. Brown-Dymkoski, C. Hansen, S. Li, B. Ren, K. Alshibli, A. Druckrey, H. Lu, H. Luo, R. Brannon, C. Bonifasi-Lista, A. Yarahmadi, E. Ghodrati, J. Colovos (2013) ONR MURI Project on Soil Blast Modeling and Simulation, In book: Dynamic Behavior of Materials Volume 1, Chapter: Chapter 42, Publisher: Springer, Vienna., Editors: B. Song, pp. 341-353. DOI: 10.1007/978-3-319-00771-7_42, http://www.springer.com/us/book/9783319007700

5. A. Yarahmadi and R.M. Brannon(2013) Dynamic Behavior of Saturated Soil under Buried Explosive Loading.   In book: Dynamic Behavior of Materials Volume 1, Chapter: Chapter 42, Publisher: Springer, Vienna., Editors: B. Song, pp. 355-362. DOI: 10.1007/978-3-319-00771-7_42, http://www.springer.com/us/book/9783319007700

6. Brannon, R. M. (2007) Elements of Phenomenological Plasticity: geometrical insight, computational algorithms, and applications in shock physics. Y. Horie Ed.. Shock Wave Science and Technology Reference Library: Solids I, Springer-New York. 2: pp. 189-274. **(BOOK CHAPTER)**

Refereed Journal Publications   (student coauthors: underlined;   postdoc coauthors: dotted line)

1. Homel, Michael A., James E. Guilkey, and R. M. Brannon (2017), Mesoscale Validation of Simplifying Assumptions for Modeling the Plastic Deformation of Fluid-Saturated Porous Material. *Journal of Dynamic Behavior of Materials*, (Accepted, December 2016).

2. Homel, Michael A., James E. Guilkey, and R. M. Brannon. (2016) Continuum effective-stress approach for high-rate plastic deformation of fluid-saturated geomaterials with application to shaped-charge jet penetration." *Acta Mechanica* 227:2, Springer Vienna, **227**, pp. 279-310. doi:10.1007/s00707-015-1407-2

3. Homel, M.A., R.M. Brannon, and J. Guilkey (2015) Controlling the Onset of Numerical Fracture in Parallelized Implementations of the Material Point Method (MPM) with Convective Particle Domain Interpolation (CPDI) Domain Scaling, *Int. J. Num. Meth. in Eng.*, 2015.

4. Kamojjala, K.C., R. Brannon, A. Sadeghirad, and J. Guilkey (2015) Verification tests in solid mechanics, Engineering with Computers, v. 2, pp. 193-213

5. Homel, M.A., Guilkey, J., Brannon, R.M. (2015) Numerical Solution for Plasticity Models using Consistency Bisection and a Transformed-Space Closest-Point Return: a nongradient solution method., *Computational Mechanics*, pp. 565-584

6. Homel, M.H. and R. M. Brannon (2015) Relaxing the Multi-Stage Nested Return Algorithm for Curved Yield Surfaces and Nonlinear Hardening Laws, Int. J. Fracture. pp. 51-57. DOI:10.1007/s10704-015-0031-4

7. Huq, F., L. Graham-Brady, and R. Brannon (2015) An Efficient Binning Scheme with Application to Statistical Crack Mechanics, Int. J. Num. Meth. Engr., vol. 105(1), pp. 33-62.

8. Pučik, T., J.A. Burghardt, and R.M. Brannon (2015) Instability and nonuniqueness induced by nonassociated plastic flow—Part 1: a case study, J. of the Mechanics of Materials and Structures.

9. Burghardt, J.A. and R.M. Brannon (2015) Instability and nonuniqueness induced by nonassociated plastic flow— Part 2: investigation of three constitutive features that eliminate or delay the Sandler-Rubin instability, J. of the Mechanics of Materials and Structures.

10. Strack, O. E. ., Leavy, R. B. . and Brannon, R. M. . (2015), Aleatory uncertainty and scale effects in computational damage models for failure and fragmentation. Int. J. Numer. Meth. Engng, 102: 468–495. doi: 10.1002/nme.4699 **invited paper**.

11. Brannon, RM and TJ Gowen. (2014) Aleatory quantile surfaces in damage mechanics. J Eur Ceram Soc., 34(11), pp. 2643-2653 http://dx.doi.org/10.1016/j.jeurceramsoc.2014.01.006. **The coauthor, Travis Gowen, was an undergraduate, who applied what he had learned in about 3D Mohr's circle and *Mathematica* to a problem of contemporary research interest.**

12. Kamojjala, K. and R.M. Brannon. (2014) Data relocalization to mitigate slow convergence caused by under-resolved stress fields in computational damage mechanics. J Eur Ceram Soc, **34**(11) pp. 2723-2730 http://dx.doi.org/10.1016/j.jeurceramsoc.2013.12.016.

13. Sanders, A. P. and R. M. Brannon (2014) A simple surrogate test method to rank the wear performance of prospective ceramic materials under hip prosthesis edge-loading conditions. Journal of Biomedical Materials Research Part B: Applied Biomaterials, 102B: 311-321. DOI: 10.1002/jbm.b.33009

14. K.C. Kamojjala, R. Brannon, A. Sadeghirad, and J. Guilkey (2013) Verification tests in solid mechanics, Engineering with Computers, 1-21. http://dx.doi.org/10.1007/s00366-013-0342-x , electronic early publication.

15. Sanders, AP, and RM Brannon (2013) A simple surrogate wear test for edge loading in ceramic hip prostheses. Journal of Biomedical Materials Research, accepted 15 July 2013, Published online 00 Month 2013 in Wiley Online Library (wileyonlinelibrary.com). http://dx.doi.org/10.1002/jbm.b.33009

16. Sanders, A.; Tibbitts, I.; Kakarla, D.; Siskey, S.; Ochoa, J.; Ong, K. & Brannon, R. (2013) Contact-Coupled Impact of Slender Rods: Analysis and Experimental Validation Experimental Mechanics, Springer US, 1-12. http://dx.doi.org/DOI 10.1007/s11340-013-9778-6

17. Sadeghirad, A., R. M. Brannon, J.E. Guilkey (2013) Second-order convected particle domain interpolation (CPDI2) with enrichment for weak discontinuities at material interfaces, Int. J. Num. Meth. Engr., vol. 95, 928-952 http://dx.doi.org/10.1002/nme.4526.

18. Burghardt, J. A., R. Brannon, and J. Guilkey (2012) A nonlocal plasticity formulation for the material point method. International Journal for Computational Methods in Engineering Science & Mechanics (CMES) **vol. 225-228** pp. 55-64. http://dx.doi.org/10.1016/j.cma.2012.03.007.

19. Sanders, A., I. Tibbitts, R. Brannon. (2012) Concomitant evolution of wear and squeaking in dual-severity, lubricated wear testing of ceramic-on-ceramic hip prostheses, Journal of Orthopaedic Research **30**(9): 1377-1383. http://dx.doi.org/10.1002/jor.22080.

20. Meyer, H. W., Jr. and R. M. Brannon (2012) A model for statistical variation of fracture properties in a continuum mechanics code. *Int. J. of Impact Engineering*, v. 42. pp. 48-58. http://www.mech.utah.edu/~brannon/pubs/7-2011MeyerBrannon_IE_1915_final_onlinePublishedVersion.pdf http://dx.doi.org/10.1016/j.ijimpeng.2010.09.007

21. Fuller, T.J. and R.M. Brannon (2012) On the effects of deformation-induced anisotropy on classical elastic-plastic materials. *Int. J. Numerical and Analytical Methods in Geomechanics* **37**(9), pp. 1079-1094. http://dx.doi.org/10.1002/nag.1139

22. Sanders, A.P., P. Dudhiya, and R.M. Brannon (2012) Thin Hard Crest on the Edge of Ceramic Acetabular Liners Accelerates Wear in Edge Loading, Brief Communication, *J. Arthroplasticy*, pp. 150-152 , doi:10.1016/j.arth.2011.08.012.

23. Sanders, A. P. and R. M. Brannon (2011) Assessment of the Applicability of Hertzian Contact Theory to Edge-Loaded Prosthetic Hip Bearings *Journal of Biomechanics*, pp. 2802-2808. http://dx.doi.org/10.1016/j.jbiomech.2011.08.007

24. Fuller, T.J. and R.M. Brannon (2011) On the thermodynamic requirement of elastic stiffness anisotropy in isotropic materials. *Int. J. Eng. Sci.* v. 79, pp. 311-321. http://www.mech.utah.edu/~brannon/pubs/7-2011FullerBrannonInducedElasticAnisotropy.pdf

25. Sanders, A. P. and R. M. Brannon (2011) Determining a Surrogate Contact Couple in a Hertzian Contact Problem, *Journal of Tribology—Transactions of the ASME*, v. 133(2), pp. [024502-]1-6
http://www.mech.utah.edu/~brannon/pubs/7-2011-SandersBrannon-IJT.pdf

26. Sadeghirad, A., R. M. Brannon, and J. Burghardt (2011) A convected particle domain interpolation technique to extend applicability of the material point method for problems involving massive deformations, *Int. J. Numer. Meth. in Engr.*, **86**(12), pp. 1435-1456. http://www.mech.utah.edu/~brannon/pubs/7-2011-SadeghiradBrannonBurghardt-NME.pdf

27. Leavy, B., R. M. Brannon, Strack, O.E. (2010) The Use of Sphere Indentation Experiments to Characterize Ceramic Damage Models. *Int. J. Applied Ceramic Technology*, v. **7**(5), pp. 606-615. (**invited article for a special issue on ceramic damage**) http://www.mech.utah.edu/~brannon/pubs/7-2009-LeavyBrannonStrack-IJACT.pdf

28. Brannon, R. M. and S. Leelavanichkul (2010) A multi-stage return algorithm for solving the classical damage component of constitutive models for rocks, ceramics, and other rock-like media. *Int. J. Fracture* v. **163**(1), pp. 133-149. (**invited article for a special issue sponsored by the International Union of Theoretical and Applied Mechanics**). http://www.mech.utah.edu/~brannon/pubs/7-2009BrannonLeelavanichkul-IJF.pdf

29. Brannon, R. M., J. M. Wells, and O.E. Strack (2007) Validating theories for brittle damage, *Metallurgical and Materials Transactions A, Physical Metallurgy and Materials Science* 38 A (12), pp. 2861-2868. http://www.mech.utah.edu/~brannon/pubs/7-2007ValidatingTheoriesForBrittleFailure11661_2007_9310_OnlinePDF.pdf

30. Wells, J. M. and R. M. Brannon (2007) Advances in X-ray Computed Tomography Diagnostics of Ballistic Impact Damage, *Metallurgical and Materials Transactions A*, Physical Metallurgy and Materials Science 38 A (12), pp. 2943-2949. http://www.mech.utah.edu/~brannon/pubs/7-2007WellsBrannonAdvancesInXrayComputedTomographyDiagnosticsOfBallisticDamage.pdf

31. Fossum, A.F. and Brannon, R.M. (2006) On a viscoplastic model for rocks with mechanism-dependent characteristic times, *Acta Geotechnica*, 1 (2), pp. 89-106. http://www.mech.utah.edu/~brannon/pubs/7-2006FossumBrannonMechanismDependentViscoplasticity.pdf

32. Crossno, P., D. Rogers, R.M. Brannon, D. Coblentz, and J.T. Fredrich (2005) Visualization of Geologic Stress Perturbations using Mohr Diagrams, *IEEE Transactions on Visualization and Computer Graphics*, V. 11, #5, pp. 508-518. http://www.mech.utah.edu/~brannon/pubs/2005CrossnoRogersBrannonEtAl_VisualizingStressPerturbationsWithMohrCircle.pdf

33. Chen, Z, W. Hu, L. Shen, and R.M. Brannon (2002) An Evaluation of the Material Point Method, *Engineering Fracture Mechanics*, v. 69 #17, pp. 1873-1890.

34. Brannon, R.M. (1998) Caveats concerning conjugate stress and strain measures for frame indifferent anisotropic elasticity. *Acta Mechanica*, v. 129 #1-2, pp. 107-116. http://csm.mech.utah.edu/content/wp-content/uploads/2011/03/GoBagCaveatConjugatStressTechNote.pdf

35. Chhabildas, L.C. and Brannon, R.M. (1998) Shock-induced vaporization of zinc: Experiment and numerical simulations. *Chemical Physics Reports* v. 17 #1-2, pp. 203-213.

36. Brannon, R.M., and L.C. Chhabildas (1995) Experimental and numerical investigation of shock-induced full vaporization of zinc, *International Journal of Impact Engineering* 17 (1-3), pp. 109-120

37. Brannon, R.M., Drugan, W.J., and Shen Y. (1995) Requirements of thermodynamics in the analysis of elastic-plastic shock waves. *J. Mech. Phys. Solids,* v. 43 #6, pp. 973-1001.

38. Brannon, R. M. and Drugan, W. J. (1993) Influence of nonclassical elastic-plastic constitutive features on shock wave existence and spectral solutions. *J. Mech. Phys. Solids*, v. 41, No 2, pp. 297-330. http://csm.mech.utah.edu/content/wp-content/uploads/2012/07/1993BrannonDrugan_InfluenceOfNonclassicalPlasticConstFeaturesOnShockWavesOCR.PDF

Papers in Rigorously Reviewed Conference Proceedings

1. Tonge, Andrew L., Brian Leavy, Jerry LaSalvia, Brian Schuster, Rebecca Brannon, and K.T. Ramesh (2015) A quantitative approach to comparing high velocity impact experiments and simulations using XCT data, 13th Hypervelocity Impact Symposium 2014, April 27-30, Boulder Colorado, Procedia Engineering, accepted.

2. Homel, M.A., R.M. Brannon, and J.E. Guilkey (2014) Simulation of shaped-charge jet penetration into drained and undrained sandstone using the material point method with new approaches for constitutive modeling, 11th World Congress on Computational Mechanics (WCCM XI), 5th European Conference on Computational Mechanics (ECCM V), 6th European Conference on Computational Fluid Dynamics (ECFD VI) E. Oñate, J. Oliver and A. Huerta (Eds)

3. Colovos, J.W., P.M. Pinsky, and R.M. Brannon (2013) Reduction of macroscale calibration experiments through constraints on anisotropic elastic stiffnesses. ARMA, American Rock Mechanics Association Conference Proceedings.

4. Bonifasi-Lista, C., R.M., Brannon, J.E. Guilkey (2013) Recent developments in Particle-Based Method for simulation of explosive blast, III International Conference on Particle-Based Methods – Fundamentals and Applications (PARTICLES 2013), September 18-20, 2013, Stuttgart, Germany. Accepted 2013-04-03.

5. Leavy, B., J. Clayton, O.E. Strack, R.M. Brannon, and E. Strassburger (2013) Edge on Impact Simulations and Experiments, 12th Hypervelocity Impact Symposium 2012, 16-20 September, 2012, Procedia Engineering 58 (2013) 445 – 452.

6. Sanders, A., Tibbitts, I., Kakarla, D., Siskey, S., Ochoa, J., Ong, K., and Brannon, R. (2011) Contact mechanics of impacting slender rods: measurement and analysis, *SEM Annual Conference*, Uncasville, CT, June 13-16, 2011. Springer NY, v.1, pp. 229-236. http://www.springerlink.com/content/n09q8v08716n6865/?MUD=MP

7. Sadeghirad, A. and R. M. Brannon, and J.E. Guilkey (2011) Enriched convected particle domain interpolation (CPDI) method for analyzing weak discontinuities. Proceedings of Particles 2011. International Center for Numerical Methods in Engineering. Barcelona, Spain, ECCOMAS Special Interest Conference, Oct. 26-28, 2011, E. Oñate and D.R.J. Owen (Eds).

8. Brannon, R. M., K.C. Kamojjala, and A. Sadeghirad (2011) Establishing credibility of particle methods through verification testing. Proceedings of Particles 2011. International Center for Numerical Methods in Engineering. Barcelona, Spain, ECCOMAS Special Interest Conference, Oct. 26-28, 2011, E. Oñate and D.R.J. Owen (Eds).

9. Brannon, R.M., A.F. Fossum, and O.E. Strack (2011) A Computational Model for Three-Dimensional Materials Containing Arbitrary Joint Sets, *Final Report and Proceedings of the GSFM 2010 Workshop: 11 - 15 January 2010*. Defense Threat Reduction Agency, DTRA-TR-10-27, April 2011. Washington, DC.

10. Kamojjala, K. C. and R.M. Brannon (2010) Verification of frame indifference for complicated numerical constitutive models. ASME Early Career Technical Conference (ECTC) Mar 31st - Apr 2nd, 2011 - Fayetteville, AR Fayetteville, AR. http://www.mech.utah.edu/~brannon/pubs/7-2010KamojjalaBrannon_ASME-ECTC.pdf

11. Burghardt, J. A., B. Leavy, J.E. Guilkey, Z. Xue, R. Brannon (2010) Application of Uintah-MPM to shaped charge jet penetration of aluminum. *9th World Congress on Computational Mechanics*, IOP Conf. Series: Materials Science and Engineering, v.10. http://www.mech.utah.edu/~brannon/pubs/7-2010BurghardtLeavyGuilkeyXueBrannon_ApplicMPMshapedCharge.pdf

12. Strack, O. E., B. Leavy, R.M. Brannon, J. Houskamp, R.P. Jensen, C. Krauthauser (2010) An update on the spatially variable Kayenta model. *Advances in Ceramic Armor V: Ceramic Engineering and Science Proceedings*, Daytona Beach, Wiley.

13. Leavy, B., O. E. Strack, R.M. Brannon, R. Jensen, J. Houskamp (2009) Simulation of Experimental Variability with Spatially Heterogeneous Models. *SEM Annual Conference, June 1-4*, Albuquerque, NM, Society for Experimental Mechanics, Inc. http://sem-proceedings.com/09s/sem.org-SEM-2009-Ann-Conf-s101p01-Simulation-Experimental-Variability-With-Spatially-Heterogeneous.pdf.

14. A. G. Neeman, Rebecca Brannon, Boris Jeremić, Allen Van Gelder, Alex Pang (2008) Decomposition and Visualization of Fourth-Order Elastic-Plastic Tensors, *Volume and Point-Based Graphics 2008*, Ed. H.-C. Hege, August 2008, pp. 121-128. **(highly competitive: 17 out of 29 accepted)** http://www.mech.utah.edu/~brannon/pubs/7-2008NeemanBrannonJeremicVanGelderPang.pdf

15. Kim, Wangdo and R.M. Brannon (2006) Factorizing Motions of Soft Tissue Surfaces into Rotation and Stretch, Ninth International Symposium on the 3D analysis of Human Movement, Valenciennes, France, June 28-30, 2006.

16. Wilson, Andrew T. and Brannon, Rebecca M. (2005) Exploring 2D Tensor Fields Using Stress Nets, in *Proceedings of IEEE Visualization 2005*, IEEE Computer Society Press, Minneapolis, MN, pp.11-18. http://csm.mech.utah.edu/content/wp-content/uploads/2011/09/2005StressNet-Vis05-screen.pdf.

17. Coblentz, D., Brannon, R.M., Fredrich, J., Rogers, D.H., Crossno, P. (2004) Visualization of Salt-Induced Stress Perturbations, *Proceedings IEEE VIS 2004*, Austin, TX, pp. 369-376. **(highly competitive: 24 out of 71 accepted)**

18. Fossum, A.F. and R.M. Brannon (2004) Unified Compaction/Dilation, Strain-Rate Sensitive, Constitutive Model for Rock Mechanics Structural Analysis Applications, *North American Rock Mechanics Symposium (ARMA/NARMS)* 04-056.

19. Crossno, P.J., D.H. Rogers, and R.M. Brannon (2003) Tensor visualization using Mohr diagrams, *Coordinated & Multiple Views in Exploratory Visualization, Special Issue of Information Visualization Journal*, V. 2, #4, Palgrave/Macmillan. [2003-2792J]

20. Brannon, R.M., Montgomery, S.T., Aidun, J.B., and Robinson, A.C. (2002) Macro- and Meso-scale Modeling of PZT Ferroelectric Ceramics. *Shock Compression of Condensed Matter - 2001*, edited by M.D. Furnish, N.N. Thadhani, and Y. Horie, American Institute of Physics, pp. 197-200.

21. Montgomery, S.T, Brannon, R.M., Robbins, J., Setchell, R.E., Zeuch, D.H. (2002) Simulation of the effects of shock stress and electrical field strength on shock-induced depoling of normally poled PZT 95/5. *Shock compression of Condensed Matter - 2001*, ed. M.D. Furnish, N.N. Thadhani, and Y. Horie, pp. 201-204.

22. Brannon, R.M., Aidun, J.B., Robinson, A.C., Montgomery, S.T. (2002) Macro- and mesoscale modeling of PZT ferroelectric ceramics. *Shock compression of Condensed Matter - 2001*, ed. M.D. Furnish, N.N. Thadhani, and Y. Horie, pp. 201-204.

23. Aidun, J.B., Brannon, R.M., Robbins, J. (2001) Grain-scale simulation of transformation and switching in PZT ceramic. Sandia National Laboratories Report Number SAND2001-0218A for The APS Shock Compression of Condensed Matter Conference, June 24-29, 2001, Atlanta, GA.

24. Meyer, H.W.Jr, T. Abeln, S. Bingert, W.J. Bruchey, R.M.Brannon, L.C. Chhabildas, J.K. Dienes, and J. Middleditch (2000) Crack behavior of ballistically impacted ceramic, *AIP Conf. Proc.* v. 505, pp. 1109-1112.

25. Brannon, R. M. (1999) A consistent kinetics porosity (CKP) model. *Proceedings of the Conference of the American Physical Society Topical Group on Shock Compression of Condensed Matter*, Snowbird, UT, American Institute of Physics, Melville, NY, 301-304.

26. H.W. Meyer, Jr., T. Abeln, S. Bingert, W.J. Bruchey, R.M. Brannon, L.C. Chhabildas, J.K. Dienes, and J. Middleditch (1999) Impact Phenomena, Hypervelocity Studies and Exotic Shock Configurations Crack Behavior of Ballistically Impacted Ceramic, in Shock Compression of Condensed Matter-1999, *Proceedings of the Conference of the American Physical Society Topical Group on Shock Compression of Condensed Matter*, Snowbird, UT, 27 June–2 July 1999, edited by M. D. Furnish, L. C. Chhabildas, and R. X. Hixson (AIP, New York, 2000), p. 1109.

27. Chhabildas, L.C., M.D. Furnish, M. David, R.M. Brannon, and W.D. Reinhart (1998) Sandia hypervelocity gun technology for validating EOS at extreme pressures and temperatures, JOWOG-37 (Joint Work Group) proceedings, February 2-5, 1998 in Los Alamos, NM.)

28. Brannon, R.M. (1997) Large deformation analysis of axisymmetric inhomogeneities including coupled elastic and plastic anisotropy, in: *Advances in Computational Engineering Science*, Ed. S. N. Atluri and G. Yagawa, pp. 1192-1201.

29. Brannon, R.M. and Chhabildas, L.C. (1995) Shock-induced vaporization of zinc. In: Shock Compression of Condensed Matter -- 1995. *Proceedings of the Conference of the American Physical Society Topical Group on Shock Compression of Condensed Matter held at Seattle*, Washington, August 13-18, 1995, Ed: S. C. Schmidt and W.C. Tao, American Institute of Physics Press, pp 201-206. http://infoserve.sandia.gov/sand_doc/2001/010218a.pdf.

Other Papers and Rigorously Reviewed Reports   (student coauthors: underlined;   postdoc coauthors: dotted line)

1. Brannon, R. M., T.J. Fuller, O.E. Strack, A.F. Fossum, J.J. Sanchez (2015) KAYENTA: Theory and User's Guide, Sandia National Laboratories [extensive revision to document thermodynamics and damage components of the model], SAND2015-0803. https://www.osti.gov/scitech/biblio/1238100-kayenta-theory-user-guide

2. Kamojjala, KC, J. Lacy, H. Chu, and R.M. Brannon (2014) Validation Study of Unnotched Charpy and Taylor-Anvil Impact Experiments Using Kayenta, Idaho National Laboratories Report INL/EXT-14-33981, December 2014, Revision 0 http://www5vip.inl.gov/technicalpublications/Documents/6372830.pdf

3. M. Homel, Sadeghirad, A., J. Colovos, and R.M. Brannon (2014) Development and implementation of Arenisca, a simplified geomodel, in Uintah. User's Guide Report (for industry client, Schlumberger).

4. Macon, D.J., R.M. Brannon, and O.E. Strack (2014) Plastic Cap Evolution Law Derived From Induced Transverse Isotropy In Dilatational Triaxial Compression, Sandia National Laboratories report # SAND2014-1217. [available at http://www.osti.gov/scitech/biblio/1124619

5.   Brannon, R.M. and the CSM research group. University of Utah Computational Solid Mechanics (CSM) annual report (2012) Schlumberger Technology Corporation, 176 pages.

6.   Brannon, R.M. and the CSM research group. University of Utah Computational Solid Mechanics (CSM) annual report (2011) Schlumberger Technology Corporation, 168 pages.

7.   Fuller, T.J., R. Brannon, O.E. Strack, and J.E. Bishop (2010) Inclusion of thermodynamic considerations in Kayenta, Sandia National Laboratories. SAND2010-4687.
http://www.mech.utah.edu/~brannon/pubs/7-2010FullerBrannonStrackBishopThermodynamicsInKayenta.pdf

8.   Brannon, R.M. and the CSM research group. University of Utah Computational Solid Mechanics (CSM) annual report (2010) Schlumberger Technology Corporation, 228 pages.

9.   Brannon, R.M. and the CSM research group. University of Utah Computational Solid Mechanics (CSM) annual report (2009) Schlumberger Technology Corporation, 102 pages.

10.   Brannon, R. M., A. F. Fossum, and O.E. Strack (2009) KAYENTA: Theory and User's Guide, Sandia National Laboratories, SAND2009-2282. http://www.mech.utah.edu/~brannon/pubs/7-2009Kayenta_Users_Guide.pdf

11.   Brannon, R. M. and S. Leelavanichkul (2009) Survey of four damage models for concrete, Sandia National Laboratories, SAND2009-5544. http://www.mech.utah.edu/~brannon/pubs/7-2009BrannonLeelavanichkulSurveyConcrete.pdf

12.   Brannon, R. M., J. A. Burghardt, David Bronowski, and Stephen Bauer (2009) Experimental Assessment of Unvalidated Assumptions in Classical Plasticity Theory, Sandia National Laboratories, SAND2009-0351.
http://www.mech.utah.edu/~brannon/pubs/7-BrannonBurghardtSAND-Report2009-0351.pdf

13.   Baer, M.R.; Bell, R.L.; Brannon, R.M.; Crawford, D.A.; Elrick, M.G.; Hertel, E.S. Jr.; Schmitt, R.G.; Silling, S.A.; Taylor, P.A. (2006) CTH User's Manuals, Sandia National Laboratories Report 2006-3576.

14.   Crossno, P., D. Rogers, R.M. Brannon, D. Coblentz, and J.T. Fredrich (2005) Using Mohr's Circles to Understand Stresses for Oil and Gas Drilling, Sandia National Laboratories Report 2005-4135P.

15.   Brannon, R.M. (2004) The influence of uncertainty in crack or slip plane orientations on cracking or localization probabilities. American Society of Civil Engineers (ASCE) Joint Specialty Conference on Probabilistic Mechanics and Structural Reliability held July 26-28, 2004 in Albuquerque, NM. (Note: this article was reviewed and accepted for publication, but ASCE has no record of any proceedings to provide page numbers; they stated that the conference organizers failed to follow through with completion of the proceedings).

16.   Lee, M.Y, Brannon, R.M., Bronowski, D.R. (2004) Uniaxial and Triaxial Compression Tests of Silicon Carbide Ceramics under Quasi-static Loading Condition, Sandia National Laboratories Report 2004-6005.

17.   Fossum, A.F. and R.M. Brannon (2004) The Sandia GeoModel: Theory and User's Guide, Sandia National Laboratories technical report SAND2004-3226.

18.   Coblentz, D., Brannon, R.M., Fredrich, J., Rogers, D.H., Crossno, P. (2003) Imaging Salt-Induced Stress Perturbations with a Tensor Visualization Algorithm Based on the Mohr Diagram: G-cubed (online rapid electronics communications journal).

19.   Chen, Z, W. Hu, L. Shen, and R.M. Brannon (2002) An Evaluation of the Material Point Method, Sandia National Laboratories report 2002-0482.

20.   Burkardt, J., M. Gunzberger, J. Peterson, and R.M. Brannon (2002) User Manual and Supporting Information for Library of Codes for Centroidal Voronoi Point Placement and Associated Zeroth, First, and Second Moment Determination, Sandia National Laboratories Report SAND2002-0099.

21.   Brannon, R.M. (2001) Prevention of negative plastic work in porous plasticity models. Accepted in The International Journal of Plasticity, http://infoserve.sandia.gov/sand_doc/2001/010208j.pdf.

22.   Brannon, R.M. (2000) The consistent kinetics porosity (CKP) model: a theory for the mechanical behavior of moderately porous solids. Sandia National Laboratories Report SAND2000-2696. http://infoserve.sandia.gov/sand_doc/2000/002696.pdf.

23.   Brannon, R.M. and M.K. Wong (1996) MIG 0.0 Model Interface Guidelines: rules to accelerate installation of numerical models into any compliant code. Sandia National Laboratories Technical Report SAND96-2000.

Publications prepared and suspended (student coauthors: <u>underlined</u>;   Univ. of Utah collaborators: dotted line)

1. Brannon, R. M. and <u>J. A. Burghardt</u> (2011) An experimental procedure for investigating incremental plastic nonlinearity without requiring multiple specimens. *Int. J. Plasticity*

2. Leelavanichkul, S., R.M. Brannon, A. Cherkaev (2011) Verification & validation of an impact protective structure with bistable links, in preparation. **Draft summarizing seed grant results.**

3. <u>K.C. Kamojjala</u>, R. Brannon, A. Sadeghirad, and J. Guilkey (2014) Code verification tests for path-dependent constitutive models in solid mechanics, Engineering with Computers, 1-21. In revision.

Invited Talks to Prestigious Colloquia or Seminar Series

1. Leavy, R. B., R.M. Brannon, and J.E. Guilkey (2016) A convected particle tetrahedral domain integration technique for the material point method, Isogeometric Analysis and Meshfree Methods, Oct. 10-12, San Diego, CA. **(KEYNOTE)**.

2. Brannon, R.M. (2016) MIG Seminar: A scale-bridging binning method that replicates perturbations from millions of microscale heterogeneities for simulations at the 'nearly continuum' scale, October 20, 2016, University of Illinois MIG Seminar, **(invited)**.

3. Brannon, R.M., O.E. Strack, and B. Leavy (2015) Aleatory uncertainty and scale effects in computational damage mechanics, CERMODEL 2015, July 2-3, 2015, Trento, Italy. **(invited)**.

4. Brannon, R.M., and <u>J. Burghardt</u> (2014) Two questions for crystal plasticity researchers: (1) Is classical non-associative plasticity intrinsically flawed because of achronicity? (2) Do elastic and plastic texture tensors have common eigenprojectors? Johns Hopkins Civil Engineering meeting of Research Group of Somnath Ghosh, Baltimore MD, March 13, 2014 **(invited, expenses paid through sabbatical visiting-faculty stipend)**.

5. Brannon, R.M. (2014) Deficiencies in overlapping support of CPDI particle basis functions without loss of partition of unity or loss of convergence, 8th Annual MPM workshop, March 9, 2014, Oregon State University, OR **(invited)**.

6. Brannon, R.M. (2014) An Introduction to the Material Point Method (MPM) with Applications to Penetration and Blast Loading, Distinguished Lecture Series, 2hour talk. June 26, 2014, Albuquerque, NM, Expenses paid **(invited)**.

7. Huq, F., R.M. Brannon, and L. Graham-Brady (2014) Initialization of Statistical Crack Properties in Continuum-Scale Domains , Continuum Models Discrete Systems -13, July 21-25, 2014, Salt Lake City, UT **(invited)**.

8. Brannon, R.M., K.C. Kamojjala, J. Burghardt, M. Homel, and T. Gowan (2014) Aleatory Uncertainty in Constitutive Models: microphysical insight converted to practical engineering mechanics software. Johns Hopkins S14 Mechanical Engineering Seminar Series (530.804), Baltimore MD, March 13, 2014
(invited, expenses paid through sabbatical visiting-faculty stipend).

9. Brannon, R.M. (2013) Some recent advances in the Material Point Method for high-rate large-deformation penetration and blast loading. MMEC Distinguished Seminar Series, Massachusetts Institute of Technology, October 1, 2013, Cambridge MA **(invited, expenses paid by host)**.

10. Brannon, R.M. (2013) An extended list of questions in macroscale constitutive modeling answerable through micromechanical analysis, HEMI Seminar, Johns Hopkins University, Aug. 13, 2013 Baltimore, MD **(invited)**.

11. Brannon, R.M. and A. Sadeghirad (2013) Deformation and Fracture of Heterogeneous Media using Boundary-Conforming Convected Particle Characteristic Functions in the Material Point Method. "Critical Assessment of the State of the Art Mechanics and Computational Methods for Predicting Fracture and Failure of Solids and Structures" in honor of Prof. Ted Belytschko's 70th birthday. April 19, 2013, Northwestern University. **(invited)**.

12. Brannon, R.M., B. Banerjee, C. Bonifasi, A. Yarahmadi, and E. Ghodrati (2013) Simulation of buried explosives using recent advances in the Material Point Method, [Advances in Computational Mechanics: A Conference Celebrating the 70th Birthday of Thomas J.R. Hughes](), February 24-27, 2013, San Diego, CA. **(KEYNOTE)**.

13. Brannon, R. and K. Kamojjala (2012) Questions in macroscale constitutive modeling that might be answered through mesoscale simulations, International Workshop on Computational Mechanics of Materials (IWCMM) XXII, Sept. 24-26, 2012, Baltimore, MD. **(KEYNOTE)**

14. Kamojjala, K. and R.M. Brannon (2012) Verification and Validation in Solid Mechanics. SIAM Conference on Uncertainty Quantification, Raleigh, NC. April 2-4, 2012. **(invited)** http://www.siam.org/meetings/uq12/index.php

15. Brannon, R.M. (2011) The sleazy side of bang-n-splat: verification and validation of blast, impact, and penetration, Banquet speaker for the 14th International Symposium on Interaction of the Effects of Munitions with Structures, Seattle, WA, Sept. 19-23, 2011. **(BANQUET SPEAKER, expenses paid by host)**.

16. Burghardt, J. and R.M. Brannon (2012) Nonuniqueness and instability of classical formulations of nonassociative plasticity: nontraditional plasticity models and the Sandler-Rubin instability. International Symposium on Plasticity and Its Current Applications 2012, Jan. 3-8, 2012, San Juan, Puerto Rico. **(KEYNOTE)**

17. Homel, M. and R.M. Brannon (2012) Semi-Empirical Effective Stress Model for Quasi-static Deformation of Fluid-Saturated Porous Materials. International Symposium on Plasticity and Its Current Applications 2012, Jan. 3-8, 2012, San Juan, Puerto Rico. **(invited)**

18. Brannon, R.M., A. Sadeghirad, and J. Guilkey (2011) Enriched Convected Particle Domain Interpolation (CPDI) Method for Analyzing Weak Discontinuities, Distinguished Seminar, Los Alamos National Laboratories, May 17, 2011. **(invited)**

19. Brannon, R.M. (2011) Verification and Validation of computational models for shaped charge jet completion of well bores in fluid saturated sandstone. 17th biannual APS Topical Conference on Shock Compression of Condensed Matter, June 26-July1, 2011, Chicago Illinois. **(invited)**

20. Sadeghirad, A., R. M. Brannon, and J. Burghardt (2010) Convected particle domain interpolation (CPDI), 6th Annual MPM workshop, Aug. 9-10, 2010, Albuquerque, NM. **(invited lead-off presentation)**.
http://www.math.unm.edu/~sulsky/MPMWorkshop/Home.html

21. Brannon, R. M. (2010) A Homogenized Rock-Joint (Fault) Formulation for Computational Material Models. DTRA workshop on Ground Shock in Faulted Media, Jan 11, 2010, Washington, DC. **(invited, expenses paid by host)**.

22. Brannon, R. M. (2009) Theoretical and computational challenges in blast loading and penetration of geological materials, American Physical Society – Shock Compression of Condensed Matter Symposium, June 29-July3, Nashville, TN **(PLENARY)**

23. Brannon, R. M. (2009) A multi-stage return algorithm for solving the classical damage component of constitutive models for rock and rock-like media. IUTAM Symposium on Dynamic Fracture and Fragmentation, Austin, TX. **(invited, attendance limited to ~20 top researchers)**.

24. Brannon, R. M. and S. Leelavanichkul (2009) Survey of three damage models for simulating dynamic nonlocal behavior via scale-sensitive uncertainty in failure properties. International Symposium on Plasticity, Jan 3-8, 2009, St. Thomas U.S. Virgin Islands. **(invited, keynote offered, but turned down by the authors to alleviate session scheduling problems)**.

25. Brannon, R. M. and S. Leelavanichkul (2008) Current studies in geologic material models: Formulation and numerical implementation. 79th Shock and Vibration Symposium. Orlando, FL. **(invited, restricted attendance, expenses paid by host)**.

26. Brannon, R.M. (2008) High-rate failure of rocks and rock-like materials. Metso Mining Corporate Seminar Series, Colorado Springs, CO **(invited, expenses paid by host)**.

27. Brannon, R.M. (2008) Verification of Computational Dynamic Plasticity Models for Deployment in Multiple Host Codes, International Symposium on Plasticity, Kailua-Kona, HA. **(KEYNOTE)**

28. Brannon, R. M. (2007) To question what is known -- a survey of tenuous assumptions in high-rate fracture and failure, Hypervelocity Impact Symposium, Williamsburg, VA. **(PLENARY)**

29. Brannon, R. M. (2007) Aleatory Uncertainty in Simulations of Failure and Fragmentation, Department of Aeronautical and Astronautical Engineering, Purdue University, **(invited, expenses paid by host)**.

30. Meyer, H. W. J. and R. M. Brannon (2007) A Model for Statistical Variation of Fracture Properties in an Eulerian Continuum Mechanics Code. ASME Applied Mechanics and Materials Conference (McMat), Austin, TX. **(invited)**.

31. Fossum, A. F. and R. M. Brannon (2007) Pore collapse vs. Cracking: Competitive Strain Rate Dependence in Salem Limestone ASME Applied Mechanics and Materials Conference (McMat) Austin, TX. **(invited)**.

32. Leavy, B., J. Houskamp, H. Miller, O.E. Strack, and R.M. Brannon (2007) Simulations and Experimental Results From Dynamically Impacted Silicon Carbide Ceramics. ASME Applied Mechanics and Materials Conference (McMat) Austin, TX. **(invited)**.

33. Fossum, A. F. and R. M. Brannon (2007) A Rate-Sensitive, Limit-State Material Model for Pressure-Sensitive Porous Materials, USNCCM (United States National Congress on Computational Mechanics), San Francisco, CA. **(invited)**

34. Brannon, R.M. and Strack, O.E. (2006) Size-Dependent Softening in Structural Ceramics, Including Correlations with Mesoscale Interferometry in Impact Experiments, International Symposium on Plasticity, July 17, 2006, Halifax, Nova Scotia. **(KEYNOTE)**

35. Brannon, R.M. and Strack, O.E. (2006) Improving predictiveness of conventional damage models by driving them with experimentally established perturbations in strength and damage properties, 17th US Army Symposium on Solid Mechanics, Sept 24-27, 2006, Ashville, NC. **(invited)**

36. Brannon, R.M. (2006) The Dramatic Influence Of Point-To-Point Variability In Strength On Damage Model Response And Mesh Sensitivity, ARO Workshop on The Role of Damage in Armor Ceramic Performance, ZAI, Arlington, VA, Feb. 14-15, 2006. **(invited)**

37. Brannon, R.M. and Strack, O.E. (2005) Overview of the Sandia BFS model for fracture and fragmentation. Cornell Seminar, Dec. 5, 2005. **(invited, expenses paid by host)**.

38. Fossum, A.F. and Brannon, R.M. (2005), Numerical Treatment of Mechanism-Dependent Characteristic Times in a Viscoplastic Model for Salem Limestone Based on Experimental Observations, 8th US National Congress on Computational Mechanics held July 25-27 in Austin, Texas, **(KEYNOTE)**.

39. Brannon, R.M., O.E. Strack, and M.G. Veilleux (2005) Incorporating micro-heterogeneity in field-scale fragmentation analyses to partially address mesh-dependency of conventional damage models. 8th US National Congress on Computational Mechanics, University of Texas at Austin, July 24-28, 2005 **(invited)**.

40. Brannon, R.M. (2005) Accepted, rejected, and debatable tenets of plasticity theory in modeling dynamic response of brittle materials, University of California, UCSD distinguished lecturer Seminar San Diego, CA, 14 Feb 2005 **(invited)**.

41. Brannon, R.M. (2005) Alternative description of MPM that avoids use of the Dirac delta, rigorously justifies gimp, guides optimal point placement, allows higher-order integration at boundaries, and reduces error for problems having a fractional number of MPM particles per element. University of Utah workshop on the Material Point Method (MPM), Salt Lake City, March 14-15, 2005 **(invited)**.

42. Brannon, R.M. (2005) Evolution from physical plasticity to mathematical plasticity, International Symposium on Plasticity, Kauai, HI, 03-09 Jan 2005 **(KEYNOTE)**.

43. Brannon, R.M. (2000) Tensile instabilities for porous plasticity models. Proceedings of the Plasticity 2000 international symposium on plasticity and its current applications, Whistler Resort Canada, July 17 – 21 **(invited)**.

44. Brannon, R.M. (2000) On the distinction between large deformation and large distortion for anisotropic materials. Proceedings of the Plasticity 2000 international symposium on plasticity and its current applications, Whistler Resort Canada, July 17 – 21 **(invited)**.

45. Brannon, R.M. and Wong, M.K. (1996) Rapid installation and maintenance of numerical models in multiple parent codes. Proceedings 14th U.S. Army Solid Mechanics Symposium, October 16-18 Myrtle Beach, SC. Ed. by Kailasam R. Iyer and Shun-chin Chou. Battelle press. 1996. ISBN: 1-574777-038-1 **(invited)**.

46. Trucano, T.G., L.C. Chhabildas, R.M. Brannon (1994) Would you bet your life on the results? (Reliability of code predictions beyond the testable regime), AIAA space programs and technologies conference and exhibit, Sept. 27-29, 1994, Huntsville, AL SAND94-0190A **(invited)**.

Other Presentations   (student coauthors: <u>underlined</u>;   postdoc coauthors: <u>dotted line</u>)

1. <u>Tonge, Andrew L.</u>, <u>Brian Leavy</u>, Jerry LaSalvia, Brian Schuster, Rebecca Brannon, and K.T. Ramesh (2014) A quantitative approach to comparing high velocity impact experiments and simulations using XCT data, 13th Hypervelocity Impact Symposium 2014, April 27-30, Boulder Colorado.

2. Lori Graham-Brady, Farah Huq, Junwei Liu, and Rebecca Brannon (2015) Efficient implementation of a strain-rate dependent constitutive relationship for ceramics, 29th International Conference and Exposition on Advanced Ceramics and Composites, Jan 25-30, 2015, Daytona Beach, FL, USA.

3. Huq, F., L. Graham-Brady, and R. Brannon (2015) Efficient Binning of Random Samples Applied to a Micromechanics Damage Model for Brittle Materials, Engineering Mechanics Institute Conference 2015, Stanford University, CA, June 16-19, 2015.

4. Huq, F., L. Graham-Brady, and R. Brannon (2015) Modeling dynamic brittle failure using efficiently binned crack families, MACH conference, April 8-10, 2015, Annapolis, MD

5. S. Schmidt, J. Guilkey, and R.M. Brannon (2014) Instability in Some Large-Shear Problems Solved with the Material Point Method, Verification and Validation Symposium, Las Vegas, Nevada, May 7-9 (accepted).

6. K.C. Kamojjala and R.M. Brannon (2014) Data relocalization to accelerate convergence for failure initiation statistics in problems with known stress concentrations, Las Vegas, Nevada, May 7-9 (accepted).

7. Ghodrati, E., H. Sarmadi, and R.M Brannon (2014) A continuum representation for soil disaggregation with subsequent recompression to model blast effects, 17th U.S. National Congress on Theoretical & Applied Mechanics, June 15-20, 2014, Michigan State University.

8. Brannon, R.M. (2013) Computational Geomechanics at the University of Utah, Schlumberger Ambassador Overview, Salt Lake City, UT, May 14, 2013. **(invited)**

9. Brannon, R.M., J. Colovos, M. Homel, A. Sadeghirad, D. Austin (2013) Schlumberger semi-annual meeting, Salt Lake City, UT.

10. Brannon, R.M. (2013) Computational Solid Mechanics at the University of Utah: Overview of current research. College of Engineering Presentation, Jan 31, 2013, University of Utah, Salt Lake City, UT. **(invited)**

11. Bonifasi-Lista, C., R.M. Brannon, and J. Wiskin (2013) New Developments in Particle-Based Method for Blast Simulation of Explosives, 7th MPM Workshop, March 14-15, Salt Lake City UT.

12. Colovos, James W., Michael A. Homel, and Rebecca M. Brannon (2013) Numerical Fracture in the Material Point Method with Convective Particle Domain Interpolation, USNCCM12, July 22-25, 2013, Raleigh, North Carolina.

13. A. Yarahmadi, R. Brannon, C. Bonifasi-Lista (2013) A thermoplastic constitutive modeling and geotechnical centrifuge simulation of partially saturated soil under buried explosive loading, ASME 2013 International Mechanical Engineering Congress & Exposition San Diego, California, November 2013.

14. R. M. Brannon and T. Gowen (2013) Strength Perturbations and Scale Effects due to Aleatory Uncertainty in Crack Orientations. CERMODEL 2013: Modeling and Simulation meet Innovation in Ceramics Technology, July 10-12, 2013, Trento-Italy.

15. Homel, M., J. Guilkey, and R.M. Brannon (2013) Numerical Fracture in the Material Point Method with Convective Particle Domain Interpolation") 7th MPM Workshop, March 14-15, Salt Lake City, UT **(best presentation award)**.

16. K. Kamojjala, J. M. Lacy, and R. M. Brannon (2013) Effects of Statistical Variability of Strength and Scale Effects on the Convergence of Unnotched Charpy and Taylor Anvil Impact Simulations, Verification and Validation Symposium, Las Vegas, Nevada, May 22-24

17. K. Kamojjala, R. M. Brannon (2013) Alternative Stress Field Regularization to Preserve Probabilities of Failure Initiation: A Case Study, CERMODEL2013 Modeling And Simulation Meet Innovation In Ceramics Technology, Trento, Italy, July 10-12.

18. A. Yarahmadi, R.M. Brannon, and C. Bonifasi-Lista (2013) Dynamic Behavior of Saturated Soil under Buried Explosive Loading.   SEM 2013 Annual Conference & Exposition on Experimental and Applied Mechanics, June 3-6, 2013, Lombard, IL. http://sem.org/APP-CONF-AC-List2-Abstract.asp?PaperNo=388.

19. Regueiro, R., R. Pak, J. McCartney, Stein Sture, B. Yan, Z. Duan, J. Svoboda, S. li, B. Ren, K. Alshibli, A. Druckrey, H. Lu, **R. Brannon**, C. Bonifasi-Lista, A. Yarahmadi, E. Ghodrati, and J. Colovos (2013) ONR MURI Project on Soil Blast Modeling and Simulation. SEM 2013 Annual Conference & Exposition on Experimental and Applied Mechanics, June 3-6, 2013, Lombard, IL.

20. Brannon, R.M., E. Ghodradi, and C. Bonifasi-Lista (2013) A comparison of DEM sand blast simulations with lower fidelity (less expensive) continuum models using MPM, 3rd. Conference on Particle-Based Methods (PARTICLES 2013), September 18-20, 2013, Stuttgart, Germany. <withdrawn >

21. Bonifasi-Lista, C., R.M., Brannon, and J.E. Guilkey (2013) Recent developments in Particle-Based Method for simulation of explosive blast, 3rd. Conference on Particle-Based Methods (PARTICLES 2013), September 18-20, 2013, Stuttgart, Germany. Accepted 2013-04-03.

22. Brannon, R.M., J. Colovos, M. Homel, A. Sadeghirad, D. Austin (2012) Schlumberger semi-annual meeting, May 16, 2012, Salt Lake City, UT.

23. Leavy, B., J. D. Clayton, T.J. Fuller, R.M. Brannon (2012) The use of mesoscale simulations to inform a macroscale ceramic model for aluminum oxynitride, International Workshop on Computational Mechanics of Materials (IWCMM) XXII, Sept. 24-26, 2012, Baltimore, MD.

24. Leavy, B., J. Clayton, O.E. Strack, R.M.Brannon, and E. Strassburger (2012) Edge on Impact Simulations and Experiments, 12th Hypervelocity Impact Symposium 2012, 16-20 September 2012, Baltimore, MD.

25. Kamojjala, K.C., M.S. Swan, and R.M. Brannon (2012) Validation of Strain-Based Failure Models Using Unnotched Charpy Tests, 2012 ASME Verification and Validation Symposium, May 2-4, Las Vegas, NV.

26. Tibbitts, I.B., A.P. Sanders, and R.M. Brannon (2012) Wear alters the dynamics of a ceramic hip wear test with edge loading, Orthopaedic Research Society Annual Meeting, San Francisco, CA, Feb. 4-7, 2012.

27. K.C. Kamojjala and R.M. Brannon (2011) Verification of computational constitutive models using the method of manufactured solutions, Workshop on Verification and Validation in Computational Science, University of Notre Dame, October 17-19, 2011.

28. Burghardt, J.A. and R.M. Brannon (2011) A method for solving the equations of nonlocal plasticity using the material point method. Sixth M.I.T. Conference on Computational Fluid and Solid Mechanics. Massachusetts Institute of Technology. June 15-17.

29. Sadeghirad, A. and R. M. Brannon, and J.E. Guilkey (2011) Enriched convected particle domain interpolation (CPDI) method for analyzing weak discontinuities. Particles 2011. International Center for Numerical Methods in Engineering. Barcelona, Spain, ECCOMAS Special Interest Conference, Oct. 26-28, 2011, E. Oñate and D.R.J. Owen (Eds).

30. Brannon, R. M., K.C. Kamojjala, and A. Sadeghirad (2011) Establishing credibility of particle methods through verification testing. Particles 2011. International Center for Numerical Methods in Engineering. Barcelona, Spain, ECCOMAS Special Interest Conference, Oct. 26-28, 2011.

31. Sanders, A. P. and R. M. Brannon (2010) Bearing Materials of Next-Generation Orthopaedic Implants, University of Utah Materials Science Seminar Series **(invited)**.

32. Brannon, R. (2010) An introduction to the Material Point Method (MPM) for high-rate large deformation of advanced engineered materials with complicated microstructures: Joint Seminar for the Metallurgy Department and Department of Materials Science at the University of Utah. **(invited)**.

33. Sadeghirad, A., R. M. Brannon, and J. Burghardt (2010) Convected particle domain interpolation (CPDI), 6th Annual MPM workshop, Albuquerque, NM. **(invited)**.

34. Sadeghirad, A., R. M. Brannon, et al. (2010) An algorithm for improving the accuracy and stability of the generalized interpolation method. 9th World Congress on Computational Mechanics, Sydney, Australia.

35. Burghardt, J. A., B. Leavy, J.E. Guilkey, Z. Xue, R. Brannon (2010) Application of Uintah-MPM to shaped charge jet penetration of aluminum. 9th World Congress on Computational Mechanics, Sydney, Australia.

36. Burghardt, J.A., Pučik, T., and R.M. Brannon (2009) A case study of instability and nonuniqueness induced by nonassociated plastic flow, United States National Congress on Computational Mechanics, Columbus, OH, July 16-19, 2009.

37. Swan, M. S. and R. M. Brannon (2009) Statistical perturbation of material properties in Uintah, The University of Utah Undergraduate Research Abstracts, pp. 61.

38. Brannon, R. M. (2008) Mathematical Challenges in Modeling High Rate Fracture and Failure, University of Utah Mathematics Department, Salt Lake City, UT **(invited)**.

39. Brannon, R. M. (2007) Triumphs and Setbacks in Engineering Simulations of Failure and Fragmentation, Utah State, Logan UT, **(invited, expenses paid by host)**.

40. Krauthauser, C., B. Leavy, T. Weerasooriya, D. Casem, O.E. Strack, and R.M.Brannon (2007) Simulations and experimental results from dynamic Brazilian tests of silicon carbide ceramic cylinders, ASME Applied Mechanics and Materials Conference (McMat), Austin, TX.

41. Strack, O.E., C. Krauthauser, R.M. Brannon, B. Leavy, J. Houskamp (2006) Dynamic Mechanism Studies of Ceramic Models As Applied to Scaled Long-Rod Penetration Interactions, 7th World Congress on Computational Mechanics, Los Angeles, California, July 16 - 22, 2006.

42. Brannon, R.M. (2006) A practical approach to modeling fragmentation, University of Utah seminar series.

43. Strack, O.E., R.M. Brannon, R.P. Jensen (2006) Spatial Variability of Material Properties to Address Mesh Dependencies of Damage Models, High Performance Computing Modernization Program (HPCMP) Users Group Conference 2006, Denver, Colorado, June 26-29 2006. **(invited)**.

44. R.M. Brannon, O.E. Strack, and M.G. Veilleux (2005) Modeling spatial variability and large deformation during failure of an armor ceramic (Silicon Carbide), PM Ground Combat Systems, Detroit MI., Aug. 2005.

45. Brannon, R.M. Strack, O.E., Fossum, A.F., and Veilleux, M.G. (2005) The Influence of Micro-Heterogeneity and Failure Progression Variability on Mesh-Dependency of Conventional Damage Models, Army Research Laboratory, Sept. 12, 2005, Aberdeen, MD. [SAND 2005-5468A] (**invited, standing room only**). Also in proceeding of: 9th ASCE Specialty Conf. on Prob Mech. and Struct. Reliability.

46. Brannon, R.M. (2005) Testimonial on potential applications of MPM to problems having either complex geometry or massive deformations. University of Utah, October 3, 2005. **(invited)**.

47. Brannon, R.M. and Strack, O.E. (2005) Modeling failure of a structural ceramic (Silicon Carbide), PM Combat Systems, Detroit, April 2005.

48. Brannon, R. M. (2003) Computational Accuracy of Plasticity Constitutive Models, SAND2003-2716P, Seventh US National Congress on Computational Mechanics (USNCCM), July 27-31, 2003, Albuquerque, NM.

49. Crossno, P.J., D.H. Rogers, and R.M. Brannon (2003) SAND2003-1527P Tensor visualization using Mohr's circles, DOE Computer Graphics Forum and VIS2003, Seattle, WA, Oct 19-24, 2003.

50. Brannon, R.M. (2003) Recent work in brittle failure modeling. TCG/1 Winter Meeting, Dec. 3, 2003, Albuquerque, NM. SAND2003-4525P. **(invited)**

51. Brannon, R.M. (2001) Statistical averaging of mesoscale mechanical and electrical properties to model the macroscale response of ferroceramic devices. Sandia National Laboratories Report Number SAND2001-0696A for PAC RIM IV Meeting of the American Ceramics Society, November 4-8, 2001, Wailea, Maui, Hawaii. **(invited)**

52. Brannon, R.M. (2001) Physical issues in the numerical analysis of porous and anisotropic plasticity. 6th US National Congress on Computational Mechanics, Aug. 1-4, Dearborn, MI.

53. Potter, B.G., Aidun, J. B., Brannon, R.M., Robbins, J., Brown, K. H. (2001) Grain-scale simulation of shock response in PZT ceramics. PAC RIM IV: International Conference on Advanced Ceramics and Glasses, November 4-8, 2001 in Wailea, Maui, HI, Sandia National Laboratories,   SAND2001-0667A. http://infoserve.sandia.gov/sand_doc/2001/010667a.pdf.

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Conference Posters

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http://prgmobileapps.com/ors2013/mobilesite/posterinfo.php?author=Anthony Sanders

67. Sanders, A. and R.M. Brannon (2012) Scaled Surrogate Hertzian Bearing Pairs for Contact and Wear Testing, Poster 2070, Orthopaedic Research Society Annual Meeting, San Francisco, CA, Feb. 4-7, 2012, Poster 2070.

68. Kakarla, D.. A.P. Sanders, S. Siskey, K. Ong, N. Ames, J.O. Ochoa, and R.M. Brannon (2012) Modeling, Testing, and Analysis of Impulse Response of Femoral Head Reduction in Ceramic Hip Prostheses, Poster No. 2076, Orthopaedic Research Society Annual Meeting, San Francisco, CA, Feb. 4-7, 2012.

69. Sanders, T. and R.M. Brannon (2010) Poster #2258 (ORS2010-1404) Hertzian Contact Theory Applied to Edge-Loaded Ceramic-on-Ceramic Hip Bearings: Analysis and Validation, 56th Annual Meeting of the Orthopaedic Research Society, March 6-9, 2010, New Orleans, LA. Poster Session 62 Implant Wear – Ceramic, poster 2258.

70. Burghardt, J.A., Pučik, T., and R.M. Brannon (2009) A case study of instability and nonuniqueness induced by nonassociated plastic flow, USNCCM Student Poster Session, Columbus, OH, July 16-19, 2009.

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http://www.mech.utah.edu/~brannon/pubs/7-09NeemanBrannonEtAlNEESposter.pdf

Web Tutorials and other informal publicly available documents

1. Brannon, R.M. (2011) How to write a referee's review of a journal manuscript
http://csm.mech.utah.edu/content/2011/08/15/tip-how-to-write-a-review-of-a-journal-manuscript/

2. Brannon, R.M. (2011) Perfect triples, "nice" unit vectors, and "nice" orthogonal matrices
    http://csm.mech.utah.edu/content/2011/08/13/perfect-triples-nice-unit-vectors-and-nice-orthogonal-matrices/

3. Brannon, R.M. (2011) Maintaining "AboutME" notes
    http://csm.mech.utah.edu/content/2011/08/09/tip-maintaining-aboutme-notes/

4. Brannon, R.M. (2011) Multi-linear regression
    http://csm.mech.utah.edu/content/2011/08/09/tutorial-multi-linear-regression/

5. Pedroso, D., K. Krabbenhoft, R.M. Brannon, and J. Andrade (2011) Computational Geomechanics International Collaboration: *Flier for the Minister Counselor of Australian Embassy in the United States*. Washington, DC.

6. Brannon, R.M. (2009) Introduction to mappings in continuum mechanics.
    http://www.mech.utah.edu/~brannon/public/VisualizeMappingWithCubicSplineExample.ppt.

7. Brannon, R.M. (2004) Curvilinear coordinates. http://www.mech.utah.edu/~brannon/public/curvilinear.pdf.

8. Brannon, R.M. (2004) Recursion tables for thermostatic derivatives. DOI: 10.13140/RG.2.1.2088.3042
    http://www.mech.utah.edu/~brannon/public/ThermoDerivativeRecursionTables.pdf

9. Brannon, R.M. (2003) Functional and Structured Tensor Analysis for Engineers (early draft).
    http://www.mech.utah.edu/~brannon/public/Tensors.pdf

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12. Brannon, R.M. (1999) Geometric justification for radial and oblique return plasticity algorithms. gobag tutorial.
    http://www.mech.utah.edu/~brannon/public/RadialReturn.pdf.

13. Brannon, R.M. (2002) Rotation. http://www.mech.utah.edu/~brannon/public/rotation.pdf.

14. Brannon, R.M. (1999) The "elas" program. gobag software for computing all elastic constants given any two independent ones. http://www.mech.utah.edu/~brannon/public/elas.f.

15. Brannon, R.M. (2000) Define your strain! http://www.mech.utah.edu/~brannon/public/strain.pdf.

16. Brannon, R.M. (1999) Fortran compared with C/C++. http://www.mech.utah.edu/~brannon/public/fortcpp.pdf.

17. Brannon, R.M. (1998) Outline of the derivation of Cauchy's Equations of Motion.
    http://www.mech.utah.edu/~brannon/public/CauchyLaws.pdf.

18. Brannon, R.M. (1999) The cnv program for text processing Fortran and other structured text files.
    http://www.mech.utah.edu/~brannon/public/cnv.f

Software (list kept current since 2013; predated items are highlights only)

2014 (with M. Homel, J. Colovos, A. Sadeghirad and J. Guilkey) Final release of Arenisca geomechanics constitutive software in Uintah
2014 (with Brian Leavy and Jim Guilkey) cpTi (convected particle tetrahedron interpolation) in Uintah
2013 (with Michael Homel, Jim Guilkey, and Shane Schumacher) Algorithm for CPDI freezing and implementation into Uintah.
2013 (with Michael Homel, Jim Guilkey, and James Colovos) Implementation of effective stress effects in Arenisca
2012 (with John Schmidt and Jim Guilkey) Implementation of "deformed glyph" visualization in Uintah.
pre2013 (with Jim Guilkey) algorithm and implementation of improved polar decomposition in Uintah
pre2013 (with Alireza Sadeghirad) theory, algorithm, and implementation of version 1 of Arenisca sandstone geomechanics software in Uintah
pre2007 (with Sandia Labs) geomechanics software for Alegra, Jas, and CTH
pre2005 (at Sandia Labs) code framework for rapid installation of material models in CTH

In-depth expertise

Algorithms	Finite-element method	LaTeX
Analysis	Fluid mechanics	Material Point Method (MPM)
Computational Physics	Fortran	Materials mechanics
Constitutive modeling	Fracture	Mathematica
Continuum mechanics	FrameMaker	Mathematical modeling
Defense	Geo-constitutive modeling	Mechanical Engineering

Military defense materials	Plasticity constitutive modeling	Scientific computing
MS Office	Program Management	Technical writing
Petroleum well bore completion	R&D	Tensor Analysis
Physics (classical)	Science	

Other skills/knowledge areas

Design of experiments (for materials characterization)
Single-crystal plasticity models
Python
X-ray computed tomography