Justin C. Mach

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Profile

Experienced R&D and analysis engineer with background in structural analysis, mechanics of materials, non-linear material modeling, manufacturing process simulation, and R&D project leadership and management.

Skills

- R&D project leadership/management using Technology Readiness Level (TRL) process, Six Sigma DMAIC/CPS(Lean) Black Belt trained
- Pre/Post-processing tools: Abaqus CAE, Ansys Workbench/SpaceClaim/Mechanical/Fluent, Cubit, HyperMesh, VisIt, Paraview, CAD: PTC Creo
- Solvers: Abaqus/Explicit & Standard, Ansys Mechanical/Fluent, DEFORM, WARP3D, fe-safe fatigue and Verity weld fatigue analysis
- HPC Linux environments, previous programming experience in Fortran, C, C++, MPI, OpenMP, Matlab, Python, Operating Systems: Linux, Mac, Windows
- Other: FEA, fatigue analysis, crystal-plasticity mesoscale material modeling, cohesive-zone element fracture mechanics modeling, Abaqus User Subroutines, ALE (arbitrary Lagrangian-Eulerian) and CEL (coupled Eulerian-Lagrangian) simulation, Battelle Structural Stress weld fatigue assessment method, Finite Element Alternating Method (FEAM) fracture mechanics analysis, experience with SPH (smoothed-particle hydrodynamics) and other mesh-free particle methods, CFD

Experience

Mechanical Engineering Analyst, Oak Ridge National Laboratory, TN — 2019-Present

Neutron Sciences Directorate, Spallation Neutron Source

- Led the structural analysis effort for the Proton Power Upgrade (PPU) 2 MW mercury target preliminary and final designs. Improved and developed static, dynamic, and fatigue analysis processes for the mercury target base material and welds. Documented best practices and updated the mercury target structural design criteria.
- Led a team of SNS engineers to create an FTS Target System Development Plan that will guide current and future (beyond PPU) R&D efforts for the mercury target system.

- Led a team of engineers and scientists across three directorates to create a research proposal for machine learning (ML)-enabled optimization of the mercury target dynamic analysis. Funding awarded as part of a larger proposal for a DOE ML award that focuses on applying machine learning to address user facility reliability issues.
- Performed other engineering mechanics analyses using hand calculations and custom codes for the mercury process system and service bay piping.
- Served as the Abaqus software administrator for SNS and across ORNL through active management and improvement of user communication, support documentation, and license renewal process. Performed HPC parallel performance studies to optimize CPU and license usage on the SNS cluster.

Engineering Specialist (R&D), Caterpillar Inc., Mossville, IL – 2015-2019

Senior Engineer (R&D), Caterpillar Inc., Mossville, IL – 2012-2015

Manufacturing Technology & Solutions, Innovation & Technology Development Division

- Simulation team lead and knowledge owner for welding process simulation: supervised and prioritized work for three simulation engineers.
- Performed welding process simulation and optimization to support new product introduction and continuous product improvement.
- Led R&D projects with teams of up to six engineers through Technology Readiness Level (TRL) 1-4 and technology transfer to first adopters within the company.
- Conducted high energy x-ray diffraction experiments to validate welding residual stress predictions and to measure residual stress in heat treated components.
- Performed fracture mechanics analysis using finite element alternating method (FEAM)

FEA Engineer (Eng III-IV), ATK (now Northrop Grumman), Independence, MO – 2010-2012

Small Caliber Systems, Research & Development

- Finite element modeling and simulation of small caliber ammunition manufacturing processes and performance: performed non-linear, explicit transient-dynamic analysis of metal forming, assembly, and internal/external ballistic events.
- Mentored FEA intern and co-op students.

Postdoctoral Research Associate, University of North Texas, Denton, TX – 2009

Department of Materials Science and Engineering

- Testing of a mesoscale plasticity model based on field dislocation mechanics for the analysis of gradient effects in fracture and fatigue problems.

Research Assistant, University of Illinois, Urbana-Champaign, IL – 2006-2009

Department of Mechanical Science & Engineering

- Developed a continuity requirement on the elastic rotation field for classical crystal viscoplasticity, which is founded on the theoretical basis of field dislocation mechanics. Implemented theory in a 3D, parallel, Matlab finite element code to verify the effects of the continuity condition on texture evolution and hardening.
- Completed a parametric study of delamination fracture in Al-Li alloys for NASA project concerning mechanical behavior of aluminum alloys for next generation space vehicle.
- Fit the mechanical threshold stress (MTS) constitutive model for high temperature deformation of a medium carbon steel with high harden-ability.

Engineering Intern, Caterpillar Inc., Peoria, IL – 2006

Advanced Materials Technology, Technology & Solutions Division

- Automated an abrasive wear simulation including implementation of re-meshing and state variable mapping, and performed scratch and abrasive wear tests for wear model verification.

Research and Teaching Assistant, Northwestern University, Evanston, IL – 2004-2006

Department of Mechanical Engineering

- Developed an improved mesh-free nodal integration technique to eliminate displacement field oscillations.
- Taught two discussion sections of an undergraduate statics and dynamics course.

Engineering Intern, Sandia National Laboratory, Livermore, CA – 2005

Engineering Sciences Summer Institute

- Investigated the use of nodal integration techniques in mesh-free simulation of penetration and perforation of materials

Engineering Intern, Sandia National Laboratory, Livermore, CA – 2004

Engineering Sciences Summer Institute

- Supported the W87 redeployment project through a computational performance comparison of hex and shell elements in 3D transient dynamics code PRESTO.

Engineering Intern, Lawrence Livermore National Laboratory, Livermore, CA – 2003

Computational Materials Science and Chemistry Summer Institute

- Studied void growth in aluminum using molecular dynamics to verify an interatomic potential and void growth mechanism (prismatic loop formation) by matching simulation with experimental observation.

Research Assistant, University of Illinois, Urbana-Champaign, IL – 2002-2004

Department of Mechanical Engineering

- Numerical study of the interaction of cracks and dynamic strain ageing in aluminum: a 3D cohesive element was added to an existing parallel polycrystal plasticity finite element code.

Engineering Intern, Product Design Services, Inc. (now DiMonte Group), Aurora, IL – 2002

- Modeling and design of industrial machinery using SolidWorks.

Packer Engineering, Inc., Naperville, IL – 1997-2002

- Supported the Materials, Mechanical, Chemical, and Transportation Engineering departments with engineering mechanics analyses, failure analysis testing and evaluation, and accident investigation. Assisted in the development and improvement of the summer intern program.

Education

University of Illinois, Urbana-Champaign, IL – Ph.D., Mechanical Engineering, 2009

Thesis: Continuity in Rigid Viscoplastic Flow

University of Illinois, Urbana-Champaign, IL – M.S., Mechanical Engineering, 2004

Thesis: Numerical Simulation of Dynamic Strain Ageing and Fracture in Aluminum

University of Illinois, Urbana-Champaign, IL – B.S., Mechanical Engineering, 2002
with Honors

Publications

Mach, J., C. Gales, J.S. Park, J. Okasinski, C. Budrow, A. Beaudoin, K. Swartz, M. Miller, and T. Gnaupel-Herold, "FD&E Total life T-sample residual stress analytical predictions and measured results", SAE Technical Paper, No. 2019-01-0528, 2019.

Yalamanchili, V. K., D. A. Galindo, and **J. C. Mach**, "Robust Virtual Welding Process Optimization" Procedia Computer Science 140: 342-350, 2018.

Mach, J.C., C.J. Budrow, D.C. Pagan, J.P.C. Ruff, J.-S. Park, J. Okasinski, A.J. Beaudoin, and M.P. Miller, "Validating a Model for Welding Induced Residual Stress Using High Energy X-ray Diffraction", Journal of Materials, Vol. 69, Issue 5, pp. 893-899, 2017.

Pan, L., B.P. Athreya, J.A. Forck, W. Huang, L. Zhang, T. Hong, W. Li, W. Ulrich, and **J.C. Mach**, "Welding residual stress impact on fatigue life of a welded structure", Welding in the World, Vol. 57, Issue 5, pp. 685-691, 2013.

Beaudoin, A.J., M. Obstalecki, R. Storer, W. Tayon, **J. Mach**, P. Kenesei, and U. Lienert, "Validation of a Crystal Plasticity Model Using High Energy Diffraction Microscopy", Modeling and Simulation in Materials Science and Engineering, Vol. 20, No. 2, 2012.

Mach, J. and M. Lee, "Ballistic Performance of Steels and Aluminums in FE Firing Simulations", Proceedings of the 26th International Symposium on Ballistics, Miami, FL, 2011.

Mach, J.C., A.J. Beaudoin, and A. Acharya, "Continuity in the Plastic Strain Rate and its Influence on Texture Evolution", Journal of the Mechanics and Physics of Solids, Vol. 58, pp. 105-128, 2010.

Mach, J.C., J. Kang, A.J. Beaudoin, and D.S. Wilkinson, "Heterogeneity in Plastic Deformation", Materials Science Forum, Vols. 519-521, pp. 85-92, 2006.

Presentations

Mach, J., C. Gales, J.S. Park, J. Okasinski, C. Budrow, A. Beaudoin, K. Swartz, M. Miller, and T. Gnaupel-Herold, "FD&E Total life T-sample residual stress analytical predictions and measured results", WCX SAE World Congress Experience, Detroit, MI, 2019.

Mach, J., "Characterization of residual stress for process and product validation of heavy equipment using high-energy x-ray diffraction", New Industrial and Scientific Opportunities for Structural Materials: Data, Modeling, Manufacturing, CHESS-U Workshops 2016, Ithaca, NY, 2016.

Mach, J.C., and M. Lee, "Ballistic Performance of Steels and Aluminums in FE Firing Simulations", International Infantry & Joint Services Small Arms Systems Symposium, Exhibition & Firing Demonstration, Indianapolis, IN, 2011.

Mach, J.C., A.J. Beaudoin, and A. Acharya, "Partial Continuity of the Plastic Strain Rate and its Influence on Texture Evolution", International Symposium on Plasticity, St. Thomas, U.S. Virgin Islands, 2009.

Mach, J.C., A.J. Beaudoin, and A. Acharya, "Texture Evolution & Partial Continuity of the Plastic Strain Rate", Fourth International Conference on Multiscale Materials Modeling, Tallahassee, FL, 2008 (poster presentation by A.J. Beaudoin).

Mach, J.C. and A.J. Beaudoin, "A Gradient-Based Work-Hardening Model for Metals", ASME International Mechanical Engineering Congress and Exposition, Seattle, WA, 2007.

Mach, J.C. and A.J. Beaudoin, "Heterogeneity in the Plastic Deformation of Solution Strengthened Aluminum Alloys", Materials Science & Technology Conference and Exhibition, Detroit, MI, 2007.

References

- Armand J. Beaudoin, Jr., PhD, [redacted], (thesis advisor and research collaborator)
    - Professor Emeritus, University of Illinois at Urbana-Champaign, Mechanical Science and Engineering
    - Associate Director, InSitμ, Cornell High Energy Synchrotron Source (CHESS)
- Professor Matthew P. Miller, Cornell University, Mechanical and Aerospace Engineering, [redacted], (research collaborator)
- Robert H. Dodds, Jr., PhD, NAE, [redacted] (research collaborator)

    - M.T. Geoffrey Yeh Endowed Chair Professor (Emeritus), Department of Civil & Environmental Engineering, University of Illinois at Urbana-Champaign
    - Research Professor, Department of Civil & Environmental Engineering, University of Tennessee (Knoxville)
- Dr. Badri Athreya, [redacted], [redacted], [redacted], (former team leader and colleague at Caterpillar)
- Mr. Mark Lee, Northrop Grumman Corporation, [redacted], [redacted], [redacted] (former mentor and colleague at ATK, now Northrop Grumman)