RITIN MATHEWS, PH.D.

+1 (516)-373-8653 | mathewsr@ornl.gov | LinkedIn | Website

790 N. Cedar Bluff Rd., Apt. 1410, Knoxville, TN 37923

A creative, hard-working, and results-oriented postdoc in mechanical engineering. Significant research experience and accomplishments into computational investigations involving high-speed machining, additive manufacturing, metal forming processes, and laser impact welding. In addition, a year of HVAC industry field experience. An all-round, collaborative, team player with excellent communication skills and a strong desire to continually learn.

Areas of research expertise and experience:

- High-speed machining
- Additive manufacturing
- Microstructure characterization
- Finite element analysis (FEA)
- Computer programming
- Project management
- Cost analysis & estimation
- Business development

EDUCATION

Ph.D., Mechanical Engineering | The University of Texas at Dallas, TX, USA
January 2020 – July 2022 CGPA: 3.81 on 4 scale
Dissertation: *Residual Stress and Distortion in Machined Wrought and Additively Manufactured Metallic Components.*
Advisor: Dr. Arif Malik.

M.S., Mechanical Engineering | The University of Texas at Dallas, TX, USA
January 2019 – May 2021 CGPA: 3.83 on 4 scale

B.Tech., Mechanical Engineering | The University of Kerala, India
June 2013 – August 2017 CGPA: 3.33 on 4 scale

High School (11th & 12th grades) | Loyola School, Trivandrum, India
June 2011 – May 2013

PROFESSIONAL EXPERIENCE

Post-doctoral Research Associate | Oak Ridge National Lab, TN, USA

November 2022 – Present

Grew well into the team to assist with research, proposal writing, funding attainment, and planning.
Submitted 2 research proposals, 1 journal paper, 1 conference paper, and conducted several talks/presentations.
Performed critical research on advanced manufacturing technology consisting of additive, subtractive, and hybrid manufacturing.
Specific projects include:

- **Modeling of additive friction stir deposition (AFSD)**
  - Development of a coupled Eulerian-Lagrangian AFSD model.
  - Predicts thermal and mechanical evolution of material during deposition.
  - Validation based on experimental data obtained in collaboration with The University of Tennessee, Knoxville.
- **Finite element (FE) assisted machine tool casting alignment**
  - Developed a framework to assist machine tool operators to rapidly align machine tool casting components.
  - The FE framework promises to cut down machine setup time from weeks to days.
  - Feasibility testing to be performed.
- **Analysis of compliant baseplate designs for additive manufacturing (AM)**
  - Development and analysis of novel baseplate designs that mitigate residual stress and distortion in AM components.
  - Experiments and FE analyses will be used to study design effectiveness.
- **Machining of aerospace components**
  - Experimental and computational analyses of subtractive manufacturing of Aluminum 7000 series, Titanium alloys, Inconel, Molybdenum etc.
  - Blue light scan measurement of distortion.
  - Finite element analysis of machining-induced distortion.
  - Tool path and material removal sequence analysis.
  - Development of distortion mitigation strategies.
- **Microstructure modeling for additive manufacturing**

- Cellular automata (CA) based microstructure modeling.
- Prediction of microstructure during directed energy deposition.
- Modification of CA model to account for heat accumulation induced melt pool size variations.
- Influence of laser scan path strategy on microstructure evolution.

- **Residual stress (RS), distortion, and crack initiation prediction during AM**
  - RS evolution during large-scale AM.
  - AM components on the scale of meters in size.
  - RS build-up and consequent crack initiation and propagation prediction.
  - Prediction of distortion during large-scale AM, and ensuing challenges during practice.
- **Continuing work consists of**:
  - Controlled machining-induced residual stress for part distortion mitigation tested via orthogonal cutting tests.
  - Study of metal powder manufacturing via advanced cutting processes.
  - Further analysis of machining-induced distortion in aerospace components via sub-scale parts.
  - Analysis of intermittent machining during AM for hybrid manufacturing.
  - Experiments, prediction, and analysis of Additive Friction Stir Deposition (AFSD) for the defense industry.
  - Study of microstructure-induced tool reaction force during hybrid manufacturing.
  - Organization of conference symposiums, publish journal papers, and assist workforce development.

Research Assistant | The University of Texas at Dallas, TX, USA
January 2020 – May 2022

Contributed to several advanced manufacturing research projects which include:

- **High-Speed Machining –** Machining of thin-walled, monolithic aluminum structures to study the effects of both inherent and machining-induced residual stresses, and microstructure influence on part distortion. Developed a program to couple Abaqus FE solver and Matlab code to iteratively reconstruct a complete residual stress field from incomplete/partial neutron diffraction (ND) and wire electric discharge machining (EDM) stress data. Studied the effect of distinct tool paths and different magnitudes of inherent residual stress fields on final residual stress and distortion. Compared coordinate measurement machine (CMM) distortion data with numerical model predictions. **Key terms**: Stress reconstruction, machining tool path study, distortion analysis.
  Tools Used – Abaqus (FEA), Matlab, GNU Image Manipulation Program.
- **CFD-FEA Coupled Simulation of Directed Energy Deposition** – Coupled a computational fluid dynamics (CFD) volume of fluid (VOF) simulation with Abaqus FEA using Matlab and Python scripts to accurately predict temporal evolution of geometry, thermal field, and residual stress in a directed energy deposition (DED) additively manufactured stainless steel 316L build. Performed experiments to build DED samples, scan 3D geometries, and facilitate residual stress measurements using neutron diffraction to validate the numerical model. **Key terms**: DED, CFD-FEA coupling, residual stress.
  Tools Used – Flow3D (CFD solver), Abaqus (FEA), Matlab, Python, GNU Image Manipulation Program.
- **Microstructure Prediction in Laser Based Additive Manufacturing –** Improved a Kinetic Monte Carlo based numerical model developed by SANDIA National Labs to dynamically predict grain morphology during selective laser sintering/melting and Directed Energy Deposition process. Obtained time-dependent thermal history using thermography data provided by National Institute of Standards and Technology (NIST). Developed Matlab codes to extract, visualize, and analyze results, which agreed well with electron backscatter diffraction (EBSD) microstructure observations reported in literature. **Key terms**: Probabilistic modeling, dynamic FEA simulation.
  Tools Used – Abaqus, C++, Matlab, Python, ParaView, ImageJ (Image processing).
- **Machining of Additively Manufactured Parts** – Numerically investigated the influence of residual stress and microstructure on final residual stress during machining of DED parts. Optical microscopy, scanning electron microscopy, and EBSD microstructure measurements were obtained and examined to calibrate the Kinetic Monte Carlo microstructure prediction model. Utilized the residual stress obtained from CFD-FEA coupled simulation to study the combined effect of initial stress and microstructure. **Key Terms**: DED, machining, hybrid manufacturing, residual stress, microstructure.
  Tools Used – Abaqus, Optical and Scanning electron microscopes, Matlab, Python, GNU Image Manipulation Program.
- **Crystal Plasticity FEA –** Applied Fortran based Abaqus user-material subroutine to simulate a laser shock peening (LSP) post-process on additively manufactured Inconel 625 considering material microstructure. Statistically replicated crystallographic orientation from experimental EBSD microstructure characterization data. Calibrated high strain-rate material constitutive behavior according to experimental data. **Key terms**: Crystal plasticity, crystallographic orientation, grain morphology, analytical field pressure loading, surface treatment.
  Tools Used – Fortran, Abaqus, Matlab, Image processing.
- **Laser Impact Welding –** Performed and co-authored the world's first laser impact welding simulation considering microstructure. Conducted analysis in a more suitable Eulerian domain as opposed to conventional Lagrangian formulation.

Investigated material jetting, plastic strains, and other weld interface characteristics. **Key terms**: Advanced collision welding, pulse laser impact welding, high strain-rate process, anisotropic material formulation, material jetting.
Tools Used – Abaqus, Matlab, Python, ParaView, GNU Image Manipulation Program.

- **Metal Rolling Mill Modeling –** Co-developed a highly efficient numerical rolling mill dynamic model that can generate results in hours compared to days/weeks using conventional finite element modeling. Modeling based on novel combination of beam stiffness and Winkler elastic foundation stiffness formulation. Co-created the first truly efficient 3D chatter model in cold rolling. **Key terms**: Newton-Raphson iteration-based model, sheet thickness control, chatter studies.
  Tools Used – Matlab.

Teaching Assistant | The University of Texas at Dallas, TX, USA
August 2021 – December 2021

Assisted the professor in organizing, managing, and grading student work as well as help and educate students on class topics.
Subject: Computational Design and Analysis.
Professor: Dr. Arif Malik.

- Graded paper based as well as digital homework of 65 students throughout a semester.
- Assisted students in learning, understanding, and applying topics taught in class.
- Organized study groups, conducted examinations, and improved student-teacher communication.
- Helped troubleshoot student's homework and project simulations.

Mechanical Draftsman and Estimator | ETNA Prestige Technology, Inc., NY, USA
September 2017 – January 2019.

Performed well above experience level to bring together engineering, manufacturing, and assembly/installation teams for smooth execution of company objectives.

- Completed over 30 large scale mechanical drawings of sheet metal ductwork, equipment, penetration sleeves, fire protection, fans, grilles, and diffusers as well as electrical boxes, control boxes, circuits, and electronic components.
- Coordinated with other trades, project managers and fabrication managers to avoid interferences/conflicts.
- Performed quick and accurate design changes improving workflow.
- Confidently estimated and negotiated the cost of projects, boosting the job win ratio by around 20%.
- Assisted the project manager considerably. Gained enough experience to lead the team multiple times in the project manager's absence.

CERTIFICATIONS

- New York State FE Exam conducted by NCEES.
- Engineer Trainee (Mechanical/HVAC) examination by NYS Dept. of Environment Conservation.
- 10 Hour OSHA Certification.
- Completed a certified course on Hyperworks FEA Software.

PUBLICATIONS

[1] Mathews, R., Malik, A., Karandikar, J., Tyler, C., Smith, S., "Iterative stress reconstruction algorithm to estimate 3D residual stress fields in manufactured components." Journal of Manufacturing Science and Engineering. (*Under review*).

[2] Mathews, R., Karandikar, J., Tyler, C., Smith, S., " Coupled Eulerian-Lagrangian Thermomechanical Model to Predict Residual Stress During Additive Friction Stir Deposition of Aluminum 6061." Manufacturing Science and Engineering Conferenec 2024. (*In Preparation*).

[3] Mathews, R., Seger, M., Marais, D., Venter, A., Malik, A., Halley, J. "Residual stress induced distortion in machined aluminum components" Journal of Manufacturing Processes. (*In Preparation*)

[4] Mathews, R., Karandikar, J., Tyler, C., Smith, S., "Residual stress-induced baseplate cracking in large-scale additive manufacturing." CIRPe conference (2023).

[5] Mathews, R., Nagaraja, K. M., Zhang, R., Sunny, S., Yu, H., Marais, D., Venter, A., Li, W., Malik, A. "Temporally continuous thermofluidic–thermomechanical modeling framework for metal additive manufacturing." International Journal of Mechanical Sciences 254 (2023): 108424. https://doi.org/10.1016/j.ijmecsci.2023.108424

[6] Mathews, R., Sunny, S., Malik, A., Halley, J. "Coupling between inherent and machining-induced residual stresses in aluminum components." International Journal of Mechanical Sciences. https://doi.org/10.1016/j.ijmecsci.2021.106865

[7] Seger, M., Mathews, R., Marais, D., Venter, A. M., Halley. J., Wang, J., Malik, A., "Effects of Aluminum plate residual stress on machined-part distortion.", Journal of Manufacturing Science and Engineering. (*Under review*).

[8] Sadeh, S., Mathews, R., Zhang, R., Sunny, S., Marais, D., Venter, A. M., Li, W., Malik, A., "Interlayer machining effects on microstructure and residual stress in directed energy deposition of stainless steel 316L.", Journal of Manufacturing Processes 94 (2023): 69-78. https://doi.org/10.1016/j.jmapro.2023.03.036.
[9] Sunny, S., Mathews, R., Gleason, G., Malik, A., and Halley, J. "Effect of metal additive manufacturing residual stress on post-process machining-induced stress and distortion." International Journal of Mechanical Sciences 202 (2021), p.106534. https://doi.org/10.1016/j.ijmecsci.2021.106534
[10] Sunny, S., Mathews, R., Yu, H., and Malik, A. "Effects of microstructure and inherent stress on residual stress induced during powder bed fusion with roller burnishing." International Journal of Mechanical Sciences 219 (2022): 107092. https://doi.org/10.1016/j.ijmecsci.2022.107092
[11] Patel, A., Malik, A., Mathews, R., "Computational method to predict 3D chatter vibration in cold rolling of flat metals." ASME journal of manufacturing science and engineering. (*Under review*) .
[12] Patel, A., Malik, A., and Mathews, R. "Efficient Three-Dimensional Model to Predict Time History of Structural Dynamics in Cold Rolling Mills." ASME Journal of Manufacturing Science and Engineering, July 2022; 144(7): 071009. https://doi.org/10.1115/1.4052703
[13] Sunny, S., Gleason. G., Mathews, R., Malik, A. "Simulation of laser impact welding for dissimilar additively manufactured foils considering influence of inhomogeneous microstructure." Materials & Design 198 (2021): 109372. https://doi.org/10.1016/j.matdes.2020.109372
[14] Sunny, S., Yu, H., Mathews, R., Malik, A. "A predictive model for in situ distortion correction in laser powder bed fusion using laser shock peen forming." The International Journal of Advanced Manufacturing Technology 112, no. 5 (2021): 1319-1337. https://doi.org/10.1007/s00170-020-06399-z
[15] Sunny, S., Yu, H., Mathews, R., Malik, A., Li, W. "Improved grain structure prediction in metal additive manufacturing using a dynamic kinetic Monte Carlo framework." Additive Manufacturing 37 (2021): 101649. https://doi.org/10.1016/j.addma.2020.101649
[16] Gleason, G., Sunny, S., Mathews, R., and Malik, A. "Numerical investigation of the transient interfacial material behavior during laser impact welding." Scripta Materialia 208 (2022): 114325. https://doi.org/10.1016/j.scriptamat.2021.114325
[17] Gleason, G., Sunny, S., Mathews, R., and Malik, A. "Numerical investigation elucidating effects of microstructure on the transient thermomechanical phenomena during laser impact welding." Journal of Manufacturing Processes 79 (2022), 115 – 125. https://doi.org/10.1016/j.jmapro.2022.04.031
[18] Patel, A., Malik, A., Zhang, F., Mathews, R. "Influence of work-roll grinding error and high-fidelity corrective grinding in cold sheet rolling." International Journal of Advanced Manufacturing Technology (2022). https://doi.org/10.1007/s00170-022-09228-7
[19] Sunny, S., Gleason, G., Bailey, K., Mathews, R., Malik, A. "Importance of microstructure modeling for additively manufactured metal post-process simulations." International Journal of Engineering Science 166 (2021): 103515. https://doi.org/10.1016/j.ijengsci.2021.103515

TECHNICAL MENTORING & COMMUNITY OUTREACH

- **CAST STEM bridge Summer Camp 2019, 2021** – Mentored and trained 7 high-school students on conventional and additive manufacturing research.
  - Introduced and taught basic engineering topics to students and trained them on finite element analyses.
  - Students developed additive manufacturing numerical simulations to investigate the residual stress developed during the process.
  - Hybrid manufacturing experiments were conducted in collaboration with other groups to improve student's practical knowledge.
  - The students performed a final presentation in front of a judging panel.

  Website: https://stem.cast-texas.org/

- Several talks and presentations on advanced manufacturing, residual stress, and distortion.

SOFTWARE PROFICIENCY

- Computer Aided Engineering (CAE) / Finite Element Analysis (FEA) – Abaqus, Ansys, Hyperworks.
- Computer Aided Design (CAD) – SolidWorks, CREO, Inventor, AutoCAD.
- Digital Image Correlation – GOM Correlate.
- Programming Languages – Matlab, Python, C++, LaTeX.
- Microsoft Office Tools.
- Audio, Video & Photo editing – Audacity, GNU Image Manipulation Program, DaVinci Resolve, Filmora.