

Lawrence Smith

lawrence.Smith-1@colorado.edu | +14088873361

RESEARCH INTERESTS	Computational Design The automatic production of solutions to challenging mechanical design problems, specifically in nonlinear design spaces where human intuition struggles. Core research contributions include compact and flexible design representations, accelerated numerical models of physical phenomena, and synthesis of design, simulation, and fabrication processes.
EDUCATION	Ph.D. & M.S. Mechanical Engineering University of Colorado Boulder 2023 & 2019 B.S. Mechanical Engineering California State Polytechnic University, San Luis Obispo 2014
EXPERIENCE	Doctoral Candidate & Researcher University of Colorado, Boulder 2018–2023 Supervised by Robert MacCurdy , dissertation on computational design and fabrication of soft structures <ul style="list-style-type: none">Award winning conference proceeding and subsequent IEEE journal publication presenting open-source toolkit for seamless design, simulation, and fabrication of pneumatic soft actuatorsDesigned tunable energy-absorbing metamaterials which transmit 6x lower forces and operate over 10x wider energy bandwidth for personal safety and shipping applications (provisional pat. pending)Wrote GPU-accelerated research code for processing volumetric medical scan data (CT, MRI) into 3D print files; generated printed artifacts for multiple journal publications Independent Contractor, Engineering Design and Analysis FPrin, LLC 2018–present Client-facing expert in numerical modeling for first principles based design and analysis <ul style="list-style-type: none">Executed and communicated finite element analysis to international medical device client, resulting in retooling of 16 cavity production mold currently running at 10M units/month volume.Developed novel phase transformation model (whitepaper²) for shape memory alloys used in insulin pumps (sales >1M units/month); worked directly with Mathworks developer to implement model Mechanical Engineer Lv.1, Lv.2 Triple Ring Technologies 2014–2017 Numerical modeling, mechanical design, data collection and analysis, fixture design and validation, and client communication over 20 projects in 3 years. <ul style="list-style-type: none">Led blank-slate design and fabrication effort of novel bolus delivery mechanism for miniature wearable insulin delivery device. US Patent 11007317Implemented feedback controller to regulate optical sensor temperature to $\pm 1^{\circ}C$ in 510k approved oximetry device. International Patent WO2021142468A1Developed core competency in numerical simulation of multiphysics problems (heat transfer, fluid flow, continuum mechanics); delivered two 30 minutes technical presentations on rubber modeling and coupling global constraints to boundary integrals at the invitation of COMOSL Inc.
GRANTS & AWARDS	AB Nexus Spring 2021 Research Collaboration Grant Earned one year of funding by designing, fabricating, and mechanically characterizing multiphase composites alongside biological tissue Matching Research Grant, Sandia National Laboratories Generated numerical and empirical results of high velocity impacts on tunable metamaterials, earning one year of research funding Finalist, 3D Printed Fixture or Tool Design Stratasys and nTopology Design Competition 2021 Finalist, CU Boulder New Venture Challenge 2018 Analytical modeling and pitch delivery for electric drivetrain retrofitting system for freight industry.
COMPETENCES	Design Solidworks (expert certification), Inventor, Pro-E, Blender, Fusion360 Numerical Analysis Abaqus, COMSOL, Ansys, FEniCS, Simulink, Solidworks simulation Fabrication Additive manufacturing, laser cutting, mill, lathe, aluminum casting Data Processing & Presentation Matlab, git, MS Office Suite, \LaTeX , Inkscape

JOURNAL PUBLICATIONS	<p>[1] L. Smith and R. MacCurdy, "SoRoForge: End-to-End Soft Actuator Design." <i>IEEE Transactions on Automation Science and Engineering</i>, 2023.</p> <p>[2] N Jacobson, J Brusilovsky, M Mitchell, N Stence, R Ducey, L Smith. "The Inner Complexities of Multi-modal Medical Data: Bitmap-based 3D Printing for Surgical Planning Using Dynamic Physiology." <i>3D Printing and Additive Manufacturing</i>, 2023.</p> <p>[3] L Smith, R MacCurdy, "Mechanical Characterization and Constitutive Modeling of 3D Printable Soft Materials." <i>3D Printing and Additive Manufacturing</i>, 2023.</p> <p>[4] B Hayes, L Smith, et al. "Rapid Fabrication of Low-Cost Thermal Bubble-Driven Micro-Pumps." <i>Micromachines</i> 2022.</p> <p>[5] N Jacobson, E Carerra, L Smith, et al. "Defining Soft Tissue: Bitmap Printing of Soft Tissue for Surgical Planning." <i>3D Printing and Additive Manufacturing</i>, 2022.</p> <p>[6] T Hainsworth, L Smith, et al. "A Fabrication Free, 3D Printed, Multi-Material, Self-Sensing Soft Actuator." <i>IEEE Robotics and Automation Letters</i>, 2020.</p>
CONFERENCE PROCEEDINGS	<p>[7] L Smith, T Hainsworth, et al. "A Seamless Workflow for Design and Fabrication of Pneumatic Soft Actuators." <i>IEEE CASE Proceedings, Lyon, France</i>, 2021. Winner, Best Application Paper</p> <p>[8] L Smith, T Hainsworth, et al. "Automated Synthesis of Bending Pneumatic Soft Actuators." <i>IEEE Intl. Conference on Soft Robotics</i>, 2022.</p> <p>[9] L Smith, J Haimes, R MacCurdy, "Stretching the Boundary: Shell Finite Elements for Pneumatic Soft Actuators." <i>IEEE Intl. Conference on Soft Robotics</i>, 2022.</p>
WHITEPAPERS	<p>[10] L Smith. "A Novel Phase Transformation Model for Shape Memory Alloy Actuators" 2020.</p>
MENTORSHIP	<p>Research Advisor High-touch advisor to 15+ high school, undergraduate, and graduate engineering students. Generated three publications featuring these students as contributing authors.</p> <ul style="list-style-type: none"> • Alex Hale: Test fixture development for cyclic testing of 3D printed components • Aaditya Pore: Development of generic test fixture for pneumatic actuator characterization • Zach Jordan: Test fixture development for multiaxis testing of soft actuators • Jacob Haimes: Simulation scripting for quantitative evaluation of shell finite elements • Xavier Bell: Additive fabrication of multimaterial soft actuators • Shangwen Ma: Website design for showcasing soft robot design software • Paul Dreyer: Design for Fabrication (DFM) for pneumatic soft actuators • Graham Williams: Development of particle-based soft matter simulator • Marcus Tsuei: Development of closed loop temperature control chamber for soft material storage • Kirolos Gerges: Tensile testing of 3D-printable soft materials
INVITED TALKS	<p>Invited Speaker Western Colorado University Spring 2023 <i>Computational Design of Soft Structures</i></p> <p>Invited Speaker Sandia National Laboratories RITS3 Lecture Series 2023 <i>Tunable Energy-Absorptive Metamaterials via Additive Manufacturing</i></p> <p>Workshop Lead International Conference on Intelligent Robots and Systems (IROS) 2022 <i>Accelerated Simulations of Soft Actuator Behavior</i></p> <p>Lecturer CU Boulder Summer Intensive Session 2020. <i>Introduction to Finite Elements</i></p> <p>Guest lecturer Rural Colorado high school science class Spring 2022. Taught air quality basics to freshman students and held symposium to exhibit students' projects.</p> <p>Middle school robotics mentor FIRST VEX Challenge, Spring 2022, Spring 2020)</p> <p>Co-Founder CU Boulder 3D Printing Club, Spring 2020</p>
REFERENCES	<p>Dr. Robert Maccurdy Ph.D. advisor, CU Boulder maccurdy@colorado.edu</p> <p>Dr. Richard Regueiro Ph.D. committee, CU Boulder richard.regueiro@colorado.edu</p> <p>Dr. Vani Sundaram Colleague, CU Boulder Vani.Sundaram@colorado.edu</p> <p>Peter Holst Colleague and CEO, FPrin LLC pholst@fprin.com</p>