Austin J. Baird, PhD

Biomedcial Engineering Group Leader · Distinguished Member of the Technical Staff

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About

My research looks at developing computational models of human biology that span multiple spatial scales, from cellular function to whole-body physiological responses. My goal is to positively impact quality of healthcare and patient safety through collaborative research.

Education

University of North Carolina, Chapel Hill
Chapel Hill, NC

PhD in Applied Mathematics
August 2014

- *Thesis:* Modeling Valveless Pumping Mechanisms, link
- *Advisor:* Dr. Laura Miller, *Committee:* Forest, M. Gregory, Adalsteinsson, David, White, Brian, Mucha, Peter, Kier, William M.

University of California, Santa Cruz
Santa Cruz, CA

BA in Mathematics
June 2008

- *Honors Thesis:* Modeling Native California Grassland Populations

Experience

Applied Research Associates, Inc.
Raleigh, NC

Biomedical Modeling Group Leader (Senior Engineer, Distinguished Member of the Technical Staff)
December 2018 - PRESENT

- Lead a multidisciplinary team across 4 different projects
- In charge of agile development processes, product roadmap, delivery scheduling, and direct communication with government customers
- Led and won multiple research and development funds through Defense Health Agency and Army Research Lab grants
- Principal investigator of the BioGears, BurnCare training application, and the traumatic brain injury angiogensis projects
- Organized teaming across three research hospitals and multiple small businesses
- Communicate research progress through multiple conferences and peer reviewed publications, including the BioGears 2020 conference
- Oversaw implementation of all models associated with BioGears releases 7.0-7.3

Staff Engineer 2
January 2017 - December 2018

- Expanded the BioGears physiology model by adding gastro-intestinal digestion/absorption, diuretic drug, and pain stimulus models
- Nominated and won federal innovation award in collaboration with Telemedicine & Advanced Technology Research Center (TATRC) government lab
- Updated the BioGears build library to be hosted on Github, modernized development timeline
- Won two government contracts totaling 4 million dollars in additional research and development funding
- Oversaw implementation of all models associated with BioGears releases 6.1-6.3

Staff Engineer
February 2016 - January. 2017

- Implemented a new renal system model in the BioGears engine with local autoregulation
- Contributed to updated blood/gas model and matrix circuit solver implementation
- Led validation and unit testing of C++ code base
- Oversaw Jenkins cloud build testing environment including daily reporting and system validation

Duke University
Durham, NC

Visiting Assistant Professor
August 2014 - August 2015

- Analyzed how pressure changes induced by heart failure affect the hemodynamic and reabsorption function of the kidney
- Taught two semesters of introduction to partial and ordinary differential equations, developed all course materials
- Coordinated validation and experimental data with University of Ontario research hospital clinicians
- Presented results at experimental biology, Boston MA
- Investigated blood clotting in the renal veins using the immersed boundary method

University of North Carolina, Chapel Hill *Chapel Hill, NC*

GRADUATE RESEARCH FELLOW *September 2010 - August 2014*

- Developed a fully coupled fluid-structure interaction code in C++ and Python to test the performance of valveless pumping
- Created a new computational valveless pumping mechanism using muscle cells to provide neuro-mechanical forcing in the system
- Presented and work at 12 conferences, domestic and abroad and published results
- Led wet lab organism maintenance and worked with lab-mates to collect particle image velocity data from
- Collaborated with colleagues from the Biology department to collect experimental results to validate computational models

Publications

JOURNAL ARTICLES

A multiscale computational model of angiogenesis after traumatic brain injury, investigating the role location plays in volumetric recovery

A. BAIRD, L. OELSNER, C. FISHER, M. WITTE, M. HUYNH

Mathematical Biosciences and Engineering 18.4 (2021) pp. 3227–3257. 2021

BioGears: A C++ library for whole body physiology simulations

A. BAIRD, M. McDANIEL, S. A. WHITE, N. TATUM, L. MARIN

Journal of Open Source Software 5.56 (2020) p. 2645. 2020

BurnCare tablet trainer to enhance burn injury care and treatment

A. BAIRD, M. SERIO-MELVIN, M. HACKETT, M. CLOVER, M. McDANIEL, M. ROWLAND, A. WILLIAMS, B. WILSON

BMC Emergency Medicine 20.1 (2020) pp. 1–10. BioMed Central, 2020

Open Source Pharmacokinetic/Pharmacodynamic Framework: Tutorial on the BioGears Engine

M. McDANIEL, J. CARTER, J. M. KELLER, S. A. WHITE, A. BAIRD

CPT: pharmacometrics & systems pharmacology 8.1 (2019) pp. 12–25. Wiley Online Library, 2019

A Whole-Body Mathematical Model of Sepsis Progression and Treatment Designed in the BioGears Physiology Engine

M. McDANIEL, J. KELLER, S. WHITE, A. BAIRD

Frontiers in physiology 10 (2019) p. 1321. Frontiers, 2019

Neuromechanical Pumping: Boundary Flexibility and Traveling Depolarization Waves Drive Flow Within Valveless, Tubular Hearts

A. BAIRD, L. WALDROP, L. MILLER

Japan Journal of Industrial and Applied Mathematics 32.3 (2015) pp. 829–846. Springer, 2015

A Mathematical Model and MATLAB Code for Muscle–Fluid–Structure Simulations

N. A. BATTISTA, A. J. BAIRD, L. A. MILLER

Integrative and comparative biology 55.5 (2015) pp. 901–911. Oxford University Press, 2015

Modeling Valveless Pumping Mechanisms

A. BAIRD

College of Arts and Sciences, Department of Mathematics (2014). 2014

BOOK CHAPTER

Numerical Study of Scaling Effects in Peristalsis and Dynamic Suction Pumping

A. BAIRD, T. KING, L. MILLER

Contemp. Math 628 (2014) pp. 129–148. 2014

CONFERENCE PROCEEDINGS

A Full-Body Model of Burn Pathophysiology and Treatment Using the BioGears Engine

M. McDANIEL, A. BAIRD

2019 41st Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), 2019

Electro-Dynamic Suction Pumping at Small Scales

A. BAIRD, L. MILLER

APS Division of Fluid Dynamics Meeting Abstracts, 2013

Published Datasets

BurnCare Physiology Data: Burn without Intervention

N. Tatum, A. Baird, S. White, M. Clover, M. Hackett

(Feb. 2021). Zenodo, 2021

ajbaird/TBISimulator: Alpha 1.0.1 Windows executable and data

A. Baird

(Sept. 2020). Zenodo, 2020

BioGears: A C++ library for whole body physiology simulations

A. Baird, M. McDaniel, S. A. White, N. Tatum, L. Marin

(Dec. 2020). Zenodo, 2020

Funding

Defense Health Agency   *Fredrick, MD*

Sustain: Prolonged Field Care Training Framework   *March 2018*

- *Role:* Lead Physiology Modeler and Proposal Manager
- *Amount:* $2,200,000
- *Contract(s):* W81XWH-18-C-0169

Defense Health Agency   *Orlando, FL*

BurnCare: Virtual Patient Application to Train Thermal Injury   *January 2017*

- *Role:* Principal Investigator
- *Amount:* $2,100,000
- *Contract(s):* W911NF-18-C-0037

Army Research Labs   *Raleigh, NC*

Fast Computational Simulations of Traumatic Brain Injury   *January 2017*

- *Role:* Principal Investigator
- *Amount:* $353,000
- *Contract(s):* W911NF-17-1-0572

Defense Health Agency   *Fredrick, MD*

BioGears Follow-on Research Award   *August 2016*

- *Role:* Principal Investigator
- *Amount:* $1,900,000
- *Contract(s):* W81XWH-13-2-0068, W81XWH-17-C-0172

Projects

BioGears Physiology Engine   *Raleigh, NC*

ARM, C++, Github, Java, Python, XML   *Feb 2016 - PRESENT*

- TATRC and DHA funded project to lower the barrier for whole-body physiology simulation in health care training and research
- Lumped parameter physics based cardio-pulmonary model with compartment overlays for complete systems biology modeling support
- Models include: circulation, drug pharmacokinetics-pharmacodynamics, traumatic brain injury, pnuemothorax, urine concentration, blood coagulation, pain stimulus, infection, digestion absorption, and others
- Multi-platform build support and agile process development

BurnCARE Medical Training Application   *Raleigh, NC*

Android, C++, Unreal Engine 4,   *Jan 2018 - PRESENT*

- DHA and ARL funded project to improve burn care training and patient care in the military
- Burn care application developed in Unreal Engine 4 for the Android tablet platform
- Modular concept designed to teach individual, unique burn treatment requirements
- Collaborative effort with the U.S. Army Institute of Surgical Research

Sustain: Prolonged Field Care Training Framework   *Raleigh, NC*

C++, Javascript, Python   *Jan 2018 - PRESENT*

- DHA funded project to create a computational framework for prolonged field care training in the military
- Modular framework to connect different software critical for training
- Scenario builder, Unreal Engine 4 training game, networking code, DDS virtual patient management code, and learning record database portal

Traumatic Brain Injury Angiogenesis   *Raleigh, NC*

C++, Python, Paraview, 3DSlicer   *Jan 2017 - PRESENT*

- Army Research Labs funded basic research project on angiogensis after a traumatic brain injury
- Visual studio c++ managed code base
- 3D fractal model of the vasculature with dynamical system model of the VEGF protein interaction and role in the angiogensis process

Selected Presentations (of 28)

University of Arizona Modeling and Computation Seminar   *Tucson, AZ*

"A Whole-Body Physiological Model of Sepsis and Associated Treatments, Designed in the BioGears Engine"   *March 2021*

BioGears Conference   *Raleigh, NC*

"BioGears Drug Modeling Overview"   *March 2020*

- *Conference Talks:* link

Military Health System Research Symposium   *Orlando, FL*

"BurnCare: Virtual Tablet Training to Enhance Burn Injury Care and Treatment"   *August 2019*

Society for Simulation in Health   *Raleigh, NC*

BioGears Model to Simulate Patient Responses to Sepsis   *March 2019*

American College of Surgeons Simulation Summit   *Chicago, IL*

BioGears: A Framework for Multiscale Physiology Modeling   *March 2019*

Department of Defense Working Group on Computational Modeling of Human Lethality, Injury, and Impairment from Blast-Related Threats   *Arlington, VA*

BioGears Human Physiology Engine   *February 2019*

Virtual Physiological Human Conference   *Zaragoza, Spain*

An In-Silico Whole-Body Framework to Simulate Kinetics and Dynamics of Pharmaceuticals and Associated Reversal Agents   *September 2018*

International Meeting on Simulation in Healthcare   *Los Angeles, CA*

An In-Silico Whole-Body Framework to Simulate Kinetics and Dynamics of Pharmaceuticals and Associated Reversal Agents   *January 2018*

Chemical and Biological Defense Science and Technology Conference   *Long Beach, CA*

BioGears: Simulating Whole-Body Response to Chemical Exposure   *November 2017*

Experimental Biology   *Boston, MA*

Implications of Increase Renal Venous Pressure for Renal Hemodynamic and Reabsorptive Function Studied by a Mathematical Model of the Kidney   *March 2015*

Duke Interdisciplinary Discussion Course   *Durham, NC*
Moving Fluid in Tubes   *October, 2014*

Society of Mathematical Biology   *Osaka, Japan*
Electro-Dynamic Suction Pumping at Small Scales   *August 2014*

Teaching Experience

Duke University, Math 353   *Durham, NC*
Introduction to Ordinary and Partial Differential Equations for Engineers   *Spring 2015*

Duke University, Math 353   *Durham, NC*
Introduction to Ordinary and Partial Differential Equations for Engineers   *Fall 2014*

University of North Carolina, Chapel Hill, Math 290   *Chapel Hill, NC*
Applied Mathematical Methods (Computational Lab)   *Spring 2013*
- *Course Materials:* link

University of North Carolina, Chapel Hill, Math 190   *Chapel Hill, NC*
Chaos and Population Dynamics   *Fall 2012*

Skills

Technical	Python, C++, Buildbot, Paraview, VTK, CMAKE, XML, AWS, Docker, Matlab, R
Modeling	Systems Biology, Fluid-Structure Interaction, Pharmacology (PKPD), Injury Physiology, Dynamical Systems, Protein Interaction, Angiogensis, Circulation, Lumped Parameter
Management	Agile Development, Scrum, Personnel Management, Hiring, Public Speaking, Financial Coverage, Grant Writing, Teaming, Sub-Contractor Management

Affiliations

Society for Simulation in Healthcare
Leadership group on simulation and modeling   *2016 - PRESENT*

IEEE
Engineering in Medicine and Biology   *2018 - PRESENT*

NIH
Inter-agency Modeling and Analysis Group   *2019 - PRESENT*

Recommendations

Dr. Laura Miller

Professor of Biology and Mathematics UNC, Chapel Hill, University of Arizona

- Address: Department of Biology CB 3280 Coker Hall University of North Carolina Chapel Hill, NC 27599
- Phone: 919-943-2434
- Email: fairyflies9@gmail.com
- Website: https://sites.google.com/site/swimflypump/

Dr. M. Gregory Forest

Grant Dahlstrom Distinguished Professor of Mathematics at UNC, Chapel Hill

- Address: CB 3250, UNC Chapel Hill, Chapel Hill, NC 27599-3250
- Email: forest@unc.edu
- Phone: (919) 962-9606
- Website: https://aps.unc.edu/faculty-member/forest-greg/

Dr. Arvind Santhanakrishnan

Associate Professor School of Mechanical & Aerospace Engineering, Oklahoma State University

- Address: 201 General Academic Building, Stillwater, OK 74078-5016
- Phone: (405) 744-5704
- Email: askrish@okstate.edu
- Website: www.appliedfluidslab.org

Dr. Lindsay Waldrop

Assistant Professor Schmid College of Science and Technology; Biological Sciences, Chapman University

- Email: waldrop@chapman.edu
- Website: https://www.waldroplab.com/