

PAUL EGAN, PH.D.

USA/Ireland dual citizen

Postdoctoral Research Scientist
Swiss Federal Institute of Technology (ETH Zurich)

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EDUCATION

Carnegie Mellon University

Ph.D., Mechanical Engineering

M.S., Mechanical Engineering

Pittsburgh, Pennsylvania

May 2014

December 2010

Dissertation: "Cognitive and Agent-based Design Methodologies for Engineering Complex Biological Systems."

Concentrations: Design Theory and Methodology,
Computational Design,
Biophysical Modeling,
Complex Systems,
Cognitive Science

Advisor: Dr. Jonathan Cagan
Focus: Numerical Methods in Engineering,
Integrated Product Design,
Design for Manufacturing

Oklahoma State University

Department of Mechanical and Aerospace Engineering

Stillwater, Oklahoma

2004-2009

B.S., Aerospace Engineering

B.S., Mechanical Engineering

General Honor's Degree

May 2009

May 2009

May 2005

Additional Completed Majors:

**Applied Physics
Philosophy**

International Studies

STARTUP Campus

ETH Zurich, German (A1)

University of Canterbury

Trinity University

Cambridge University

Zurich, Switzerland

Zurich, Switzerland

Christchurch, New Zealand

Dublin, Ireland

Cambridge, England

Fall 2017

Fall 2014 - Winter 2015

Fall 2008

Summer 2007

Summers 2005, 2007

JOURNAL PUBLICATIONS

PUBLISHED

- [12] **Egan, P.**, J. Moore, A. Ehlicher, D. Weitz, C. Schunn, J. Cagan, and P. LeDuc. "Robust mechanobiological behavior emerges in heterogeneous myosin systems." *PNAS*, pp. 201713219: 1-8, 2017.
- [11] **Egan, P.**, V. Gonella, M. Engelsperger, S. Ferguson, and K. Shea. "Computationally designed lattices with tuned properties for tissue engineering using 3D printing." *PLoS One*, 12(8), pp. e0182902: 1-20, 2017.
- [10] **Egan, P.**, S. Ferguson, and K. Shea. "Design of hierarchical three-dimensional printed scaffolds considering mechanical and biological factors for bone tissue engineering." *Journal of Mechanical Design*, 139(6), pp. 061401: 1-9, 2017.
- [9] **Egan, P.**, J. Cagan, C. Schunn, F. Chiu, J. Moore, and P. LeDuc. "The D3 Methodology: Bridging science and design for bio-based product development." *Journal of Mechanical Design*, 138(8), pp. 081101: 1-13, 2016.
- [8] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. "Improving human understanding and design of complex multi-level systems with animation and parametric relationship supports." *Design Science*, e3: pp. 1-31, 2015.
- [7] **Egan, P.**, B. Sinko, S. Ketan, and P. LeDuc. "The role of mechanics in biological and bio-inspired systems." *Nature Communications*, 6, pp. 1-11, 2015.
- [6] Stankovic, T., J. Mueller, **P. Egan**, and K. Shea. "Generalized optimality criteria for optimization of additively manufactured multi-material lattice structures." *Journal of Mechanical Design*, 137(11), pp. 111705: 1-12, 2015.
- [5] **Egan, P.**, J. Moore, C. Schunn, J. Cagan, and P. LeDuc. "Emergent systems energy laws for predicting myosin ensemble processivity." *PLOS Computational Biology*, 11(4), pp. e1004177: 1-16, 2015.
- [4] **Egan, P.**, J. Cagan, C. Schunn, and P. LeDuc. "Synergistic human-agent methods for deriving effective search strategies: The case of nanoscale design." *Research in Engineering Design*, 26(2), pp. 145-169, 2015.
- [3] **Egan, P.**, J. Cagan, C. Schunn, and P. LeDuc. "Design of complex biologically based nanoscale systems using multi-agent simulations and structure-behavior-function representations." *Journal of Mechanical Design*, 135(6), pp. 061005: 1-12, 2013.
- [2] Zapf, V., V. Correa, P. Sengupta, C. Batista, M. Tsukamoto, N. Kawashima, **P. Egan**, C. Pantea, A. Migliori, J. Betts, M. Jaime, and A. Paduan-Filho. "Direct measurement of spin correlations using magnetostriction." *Physical Review B*, 77(2), pp. 020404: 1-4, 2008.
- [1] Franco, A., V. Zapf, and **P. Egan**. "Magnetic properties of nanoparticles of $\text{CoFe}_{(3-x)}\text{O}_4$ prepared by combustion reaction." *Journal of Applied Physics*, 101(9), pp. 09M506: 1-3, 2007.

IN PROCESS

- [4] **Egan, P.**, I. Bauer, K. Shea, and S. Ferguson. "Design and mechanics of 3D printed lattices for biomedical systems with hierarchical features." *in Preparation*; manuscript draft available upon request.
- [3] **Egan, P.**, X. Wang, H. Greutert, K. Shea, K. Würtz-Kozak, and S. Ferguson. "Mechanical and biological testing of polymer lattices for tissue engineering." *in Preparation*; manuscript draft available upon request.
- [2] **Egan, P.**, K. Shea, and S. Ferguson. "Simulated tissue growth in complex 3D printed geometries." *in Preparation*; manuscript draft available upon request.
- [1] **Egan, P.**, T. Ho, C. Schunn, J. Cagan, and P. LeDuc. "How training background effects software tool use and heuristics for multi-level biosystems design." *in Preparation*; manuscript draft available upon request.

BOOK CHAPTER

- [1] **Egan, P.**, and J. Cagan. "Human and computational approaches for design problem-solving." *Experimental Design Research*. Springer House Publishing, 2016. pp. 187-205.

CONFERENCE PROCEEDINGS

PEER-REVIEWED PAPERS

- [13] **Egan, P.**, V. Gonella, M. Engensperger, S. Ferguson, and K. Shea. "Design and fabrication of 3D printed tissue scaffolds informed by mechanics and fluids simulations." *ASME International Design Engineering Technical Conference*. Cleveland, OH, 2017 (10 pages).
- [12] **Egan, P.**, S. Ferguson, and K. Shea. "Design and 3D printing of hierarchical tissue engineering scaffolds based on mechanics and biology perspectives." *ASME International Conference on Design Theory and Methodology*. Charlotte, NC, 2016 (10 pages).
- [11] **Egan, P.**, J. Cagan, P. LeDuc, and C. Schunn. "The d₃ science-to-design methodology: Automated and cognitive-based processes for discovering, describing, and designing complex nanomechanical biosystems." *ASME International Conference on Design Theory and Methodology*. Boston, MA, 2015 (10 pages).
- [10] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. "Development of graphical user interfaces to improve human design proficiency for complex multi-level biosystems." ***Best Paper Award*** at *ASME Computers and Information in Engineering Conference*. Boston, MA, 2015 (10 pages).
- [9] Stankovic, T., J. Mueller, **P. Egan**, and K. Shea. "Optimization of additively manufactured multi-material lattice structures using generalized optimality criteria." ***Best Paper Award*** at *ASME Computers and Information in Engineering Conference*. Boston, MA, 2015 (10 pages).
- [8] Chen, T., **P. Egan**, F. Stoeckli, and K. Shea. "Studying the impact of incorporating an additive manufacturing based design exercise in a large, first year technical drawing and CAD course." *ASME International Conference on Design Theory and Methodology*. Boston, MA, 2015 (10 pages).
- [7] **Egan, P.**, T. Ho, C. Schunn, J. Cagan, and P. LeDuc. "The effects of training background and design tools on multi-level biosystems design." *International Conference on Engineering Design*. Milano, Italy, 2015 (9 pages).
- [6] **Egan, P.**, J. Cagan, C. Schunn and P. LeDuc. "Cognitive-based search strategies for complex bio-nanotechnology design derived through symbiotic human and agent-based approaches." *International Conference on Design Theory and Methodology*. Buffalo, NY, 2014. DETC2014-34714. (10 pages).
- [5] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. "Surprisingly stochastic: Learning and design application of emergent behavior using interactive simulations of nano-mechanical biological systems." *Annual Conference of the Cognitive Science Society*. Quebec City, CA, 2014. (6 pages).
- [4] **Egan, P.**, J. Cagan, C. Schunn, and P. LeDuc. "A modular design tool for visualizing complex multiscale systems." *International Conference on Engineering Design*. Seoul, South Korea, 2013. (9 pages).
- [3] **Egan, P.**, J. Cagan, C. Schunn, and P. LeDuc. "Utilizing emergent levels to facilitate complex systems design: demonstrated in a synthetic biology domain." *International ASME Design Automation Conference*. Portland OR, 2013. DETC2013-12072. (10 pages).
- [2] **Egan, P.**, J. Cagan, C. Schunn, and P. LeDuc. "Design of complex nano-scale systems using multi-agent simulations and structure-behavior-function representations." *ASME International Conference on Design Theory and Methodology*. Chicago, IL, 2012. pp. 793-804. (10 pages)
- [1] **Egan, P.**, P. LeDuc, J. Cagan, and C. Schunn. "A design exploration of genetically engineered myosin motors." *International ASME Design Automation Conference*. Washington DC, 2011. pp. 1017-1025 (10 pages).

ADDITIONAL CONFERENCE PROCEEDINGS

- [6] **Egan, P.**, X. Wang, H. Greutert, K. Shea, K. Würtz-Kozak, and S. Ferguson. “Mechanical and biological characterization of 3D printed polymer lattices for bone tissue engineering.” *Swiss Society for Biomedical Engineering*. Winterthur, Switzerland, 2017. (Oral presentation and poster, accepted by abstract review)
- [5] **Egan, P.**, K. Shea, and S. Ferguson. “Tissue growth simulations for 3D printed scaffolds.” *European Society of Biomechanics*. Seville, Spain, 2017. (Oral presentation, accepted by abstract review)
- [4] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. “Multiscale modeling and optimization of natural and biomimetic myosin-based systems.” *World Congress of Biomechanics*. Boston, MA, 2014. (Oral presentation, invited).
- [3] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. “Robust active material components designed with agent-based myosin-actin simulations.” *Materials Research Society Meeting and Exhibit*. Boston, MA, 2013. (Poster session, accepted by abstract review).
- [2] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. “Probing why nature may favor heterogeneous myosin systems through single molecule and systems level approaches.” *Biophysical Society Annual Meeting, Systems Biology*. Philadelphia, PA, 2013. (Poster session, accepted by abstract review).
- [1] **Egan, P.**, C. Schunn, J. Cagan, and P. LeDuc. “Investigating heterogeneous system performance of synthetic myosins computationally.” *AIChE Synthetic and Systems Biology Conference*. Pittsburgh, PA, 2012. (Oral presentation, accepted by abstract review).

INVITED TALKS

- [12] **Open Seminar**. “Computational design methods for biomechanics and 3D printing.” *Virginia Polytechnic Institute and State University*, Mechanical Engineering Department, Blacksburg, VA, 2017.
- [11] **Open Seminar**. “Computational design methods for biomechanics and 3D printing.” *Ecole polytechnique federale de Lausanne (EPFL)*, Mechanical Engineering Department, Lausanne, Switzerland, 2017.
- [10] **Internal Talk**. “Design and 3D printing of tissue scaffolds tuned for mechanics and biology.” *Swiss Federal Institute of Technology (ETH Zurich)*, for European Grants Commission and Postdoctoral Fellows, Zurich, Switzerland, 2017.
- [9] **Flash Talk**. “Design and 3D printing of tissue scaffolds with mechanics and biology perspectives.” *Life Sciences Post-doc Day*, Zurich, Switzerland, 2016.
- [8] **Open Seminar**. “Computational, human-centered, and manufacturing approaches for complex biological systems design.” *University of California Berkeley*, Mechanical Engineering Department, Berkeley, CA, 2016.
- [7] **Open Seminar**. “Cognitive and agent-based design methodologies for engineering complex biological systems.” *Northwestern University*, Mechanical Engineering Department, Evanston, IL, 2016.
- [6] **Flash Talk**. “Characterization, design, and fabrication of tissue engineering scaffolds for optimal mechanical and biological functioning.” *Life Sciences Post-doc Day*, Zurich, Switzerland, 2015.
- [5] **Outreach Talk**. “Overcoming the challenges of effective interdisciplinary communication.” *ASME IDETC conference FutureME speakers*, Boston, MA, 2015.
- [4] **Open Seminar**. “Computational, human-centered, and manufacturing approaches for complex biological systems design.” *University of Michigan*, Mechanical Engineering Department, Ann Arbor, MI, 2015.
- [3] **Open Seminar**. “Biological systems inspire non-obvious engineering design principles.” *Mechanics and Engineering of Cellular Systems Center*, Carnegie Mellon University, Pittsburgh, PA, 2013.

- [2] **Dynamic Talk.** "Designing complex systems in the human body." *ICED conference Young Member's Event*, Seoul, South Korea, 2013.
- [1] **Awards Seminar.** "State of the art in unmanned aerial vehical design at Oklahoma State University." *AIAA Conference*, Albuquerque, NM, 2009.

SELECTED RESEARCH EXPERIENCES

Postdoctoral Research Stephen Ferguson Kristina Shea	ETH Zurich Laboratory of Orthopaedic Techonlogy Engineering Design and Computing Lab	Zurich, Switzerland Fall 2014-present
Visiting Researcher Mauro Ferrari	Houston Methodist Research Institute Nanomedicine, Biomechanics, and Cancer	Houston, TX Fall 2015
Doctoral Research Jonathan Cagan Philip LeDuc	Carnegie Mellon University Integrated Design Innovation Group Biomechanics and Cellular Systems	Pittsburgh, PA Fall 2009-2014
Visiting Researcher David Weitz Allen Ehrlicher Jeffrey Moore	Harvard University and Boston University Applied Physics and Soft Matter Biophysics and Protein Mechanics Physiology and Biophysics	Boston, MA Summer 2012
Undergraduate Researcher Larry Hoberock Doren Recker	Oklahoma State University Machine Vision and Robotics Philosophy of Science and Cognition	Stillwater, OK Fall 2008 Fall 2006-Fall 2009
Research Internship Richard Welle	Aerospace Corporation Microfluidics Research and Development	El Segundo, CA Summer 2007
Research Internship Viven Zapf	Los Alamos National Laboratory National High Magnetic Field Lab	Los Alamos, NM Summer 2006

SELECTED HONORS

Favorable Submission for Branco Weiss Postdoctoral Fellowship (top 7% of 592)	2017
Best Paper: IDETC/CIE Conference for Additive Manufacturing and 3D-Printing	2015
Best Paper: IDETC/CIE Conference for Virtual Environments and Systems	2015
ETH Zurich Postdoctoral Fellowship	2015
Travel Scholarship for Bio-Inspired Design Workshop in Palo Alto California	2011
National Defense Science and Engineering Graduate Fellowship (NDSEG)	2010
Carnegie Institute of Technology Dean's Fellow	2009
1st Place AIAA International Design Build Fly Competition	2009
Barry M. Goldwater Scholarship	2008
Lew Wentz Foundation Research Scholarship	2006, 2007, 2008
Honor's Freshman Research Scholarship	2004
Oklahoma State Regent's Scholarship	2004
Valedictorian, Union High School	2004
Eagle Scout, Boy Scouts of America	2002

SERVICE

Organizer: ASME Early Career Design and Advanced Manufacturing Market Segment Leadership Team, 2015-2016.

Design Society, Organizer for Young Member's Speakers Event for ICED Conference in Milan, Italy, 2015.

Reviewer: *Journal of Mechanical Design,*
Design Studies,
3D Printing and Additive Manufacturing,
PLoS One,
ASME IDETC/CIE Conference,
Design Society ICED Conference.

FUNDING

NSF CMMI-1160840 Grant 2012
Significantly aided in writing with funded investigators (Jonathan Cagan and Philip LeDuc).
Grant title: "Computational Design of Complex Multi-scale Systems: Design of Synthetic Muscle with Shape Grammars and Agent-based Search"

TEACHING

École Polytechnique Fédérale de Lausanne (EPFL)
Lecture for Short PhD Course: "Design for 3D printed tissue scaffolds" Fall 2017

Swiss Federal Institute of Technology (ETH Zurich)
Developed and Taught Course (50%): Engineering Design Methods Fall 2015 - Spring 2016
Research Skills for Engineering Design and Computing Lab Group Fall 2014 - Spring 2015

Carnegie Mellon University
Teaching Assistant for Engineering Design: Grand Challenges Fall 2012
Teaching Assistant for Engineering Design I Spring 2011

ADVISING

ETH Zurich			
Isabella Bauer	Research Internship	2017 - 2018	(6 months)
Xiuyu Wang	Master's Thesis	2017	(6 months)
Veronica Gonella	Research Assistant	2016	(9 months)
Max Engelsperger	Master's Thesis	2016	(6 months)
Fernando Rodriguez	Bachelor's Thesis	2011	(3 months)

Carnegie Mellon University

Felix Chiu	Undergraduate/Honor's Research	2011-2014	(36 months)
Tiffany Ho	Undergraduate/Honor's Research	2012-2013	(6 months)
Patra Virasathienpornkul	Undergraduate Project	2012	(6 months)
Xiaozhou Fu	Master's Project	2010-2011	(12 months)
Chao Li	Master's Project	2010-2011	(12 months)

REFERENCES

Carnegie Mellon University

Prof. Dr. Jonathan Cagan	Design/Product Engineering	cagan@cmu.edu
Prof. Dr. Philip LeDuc	Mechanical/Bio-Engineering	pri@andrew.cmu.edu

University of Pittsburgh

Prof. Dr. Christian Schunn	Cognitive Science	schunn@pitt.edu
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University of Massachusetts, Lowell

Prof. Dr. Jeffrey Moore	Myosin Mechanobiology	Jeffrey_Moore@uml.edu
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ETH Zurich

Prof. Dr. Stephen Ferguson	3D Printing/Biomechanics	sferguson@ethz.ch
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