

Christopher McComb, Ph.D.

Postdoctoral Research Associate
Department of Mechanical Engineering
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Education

Carnegie Mellon University

Ph.D. Mechanical Engineering (2016)

Advisors: Jonathan Cagan, Kenneth Kotovsky

Dissertation: *Designing the Characteristics of Design Teams via Cognitively-Inspired Computational Modeling*

M.S. Mechanical Engineering (2014)

Advisors: Jonathan Cagan, Kenneth Kotovsky

California State University, Fresno

B.S. Mechanical Engineering (2012)

B.S. Civil Engineering (2012)

Licensure and Certifications

Future Faculty Program (estimated completion October 2016)

Workshops:

Course and Syllabus Design

Planning and Delivering Effective Lectures

Engaging Students in Active Learning

Promoting Peer Learning

Leveraging Diversity and Promoting Equity

Guiding Attention and Memory

Co-Curricular Leadership Certificate (2012)

Program pillars:

Ethical Decision-making

Community Engagement

Effective Communication

Service-learning

Diversity Awareness

Team Dynamics

Engineering-in-Training Certification (2010)

State of California, No. 139223

Research Experience

Postdoctoral Research Associate

Carnegie Mellon University (August 2016 – Present)

My research focuses primarily on extensions from my dissertation. This has involved modifying the computational models developed previously to accommodate teams that have hierarchical structure and are composed of individuals with heterogeneous skillsets. I have also

investigated extensions that apply the methodology from my dissertation to the prediction of optimized parameters for design algorithms based on problem properties.

Research Assistant

Carnegie Mellon University (August 2012 – August 2016)

My dissertation research focused on understanding and quantifying the relationship between the properties of design problems and the best team structures for solving those problems. I first created a computational model of engineering design teams, and validated this model through direct comparison to the results of a human study. Next, I leveraged the computational efficiency of the model to simulate the performance of many different teams on many different design problems. Conducting analysis on the results of these simulations resulted in a set of equations that make it possible to predict optimized team characteristics based on measurable problem properties. Finally, I validated the predictions made using these equations through a second human study. Side projects included research into computational social choice, statistical models of designer behavior, and both deterministic and stochastic optimization.

Scientific Undergraduate Laboratory Intern

National Renewable Energy Laboratory (May 2012 – August 2012)

My work at NREL focused on the efficient simulation of wave energy converters using frequency-domain analysis techniques. I developed a computational tool for modified frequency-domain analysis that readily allowed for the incorporation of nonlinear control strategies and nonlinear fluid interactions.

Undergraduate Research Assistant

California State University, Fresno (May 2011 – May 2012)

This research sought to demonstrate that common mechanical fasteners can be used to increase the strength of composite structural decks (which common in industrial and multi-family construction). Both experimental and analytical results showed an increase in strength with the addition of these embedded fasteners.

Scientific Undergraduate Laboratory Intern

National Renewable Energy Laboratory (May 2011 – August 2011)

Working within OpenFOAM (an open-source computational fluid dynamic program), I developed tools to aid in the simulation of wave energy converters. Specifically, I developed tools that made it possible to simulate power generation within a wave energy device and the effects of mooring lines.

Teaching Experience

Instructor: Integrated Product Conceptualization

Carnegie Mellon University (Fall 2016)

This undergraduate course gives students an opportunity to learn about the design of products and services within interdisciplinary teams via the integrated new product development process. I chose to feature a semester-long design project with the theme of “Innovating for Accessible Health and Fitness”. In designing the course, I have integrated reflection-based,

competition-based, and project-based assessments and activities in order to improve concept retention.

Teaching Assistant: Integrated Product Development

Carnegie Mellon University (Spring 2014)

My role as a teaching assistance for this graduate capstone course involved meeting with the instructors to refine and pre-record lectures with the goal of partially “flipping” the classroom. I edited these recordings into final lectures and made them available to students.

Teaching Assistant: Numerical Methods

Carnegie Mellon University (Fall 2013)

As a teaching assistant for this graduate course, I graded assignments, held regular office hours, and assisted students in developing their final course projects. The course topics included numerical integration, numerical differentiation, optimization, numerical solutions for ODEs, and other related concepts

Teaching Assistant: Design of Steel Structures

California State University, Fresno (Spring 2012)

As a teaching assistant for this undergraduate design course, I held weekly recitations that reviewed and emphasized critical concepts covered in lecture. The topics covered included design of tension members, columns, beams, connections, and design of members with combined loading.

Tutor: Engineering, Science, and Mathematics

California State University, Fresno (Fall 2011 – Spring 2012)

As a tutor, I provided personalized instruction to students in the Lyles College of Engineering. I tutored courses in mathematics, physics, chemistry, civil engineering, mechanical engineering and electrical engineering. I also provided general advice on study skills and test-taking strategies.

Students Advised ---

Undergraduates

- Frank Bello (co-advised with Shraddha Joshi), *Designing the Internet of Things with Varying Complexity*, August 2016 - Present
- June Williams (co-advised with Shraddha Joshi), *Investigating Human-Device Interaction in Connected Environments*, August 2016 - Present
- Guochen Shen (co-advised with Shraddha Joshi), *Internet of Things Devices: Usage in HVAC Systems and Optimization*, August 2015 – May 2016.

Publications ---

Journal Articles

1. McComb, C., Cagan, J., and Kotovsky, K., “Markov Representations of Design Activity Across Scales,” *Preparing for submission to Research In Engineering Design*.

2. McComb, C., Cagan, J., and Kotovsky, K., "Optimizing Design Teams Based on Problem Properties: Computational Team Simulations and an Applied Empirical Test," *Submitted to Journal of Mechanical Design*.
3. McComb, C., Goucher-Lamber, K., and Cagan, J., "Impossible by Design? Fairness, Strategy, and Arrow's Impossibility Theorem," *Submitted to Journal of Engineering Design*.
4. McComb, C., Johnson, N.G., Santaefemia, P.S., Gorman, B.T., and Shimada, K., "Multi-Objective Optimization and Scenario-based Robustness Analysis of the MoneyMaker Hip Pump", *Submitted to Journal of Development Engineering*.
5. Tehrani, F.M., and McComb, C., "A quantitative approach to evaluate the effectiveness of the extended situational teaching model in engineering education", *Submitted to European Journal of Engineering Education*.
6. McComb, C., Cagan, J., and Kotovsky, K., 2016, "Drawing Inspiration From Human Design Teams For Better Search And Optimization: The Heterogeneous Simulated Annealing Teams Algorithm," *Journal of Mechanical Design*, vol. 138, pp. 044501-1 – 044501-6, doi: [10.1115/1.4032810](https://doi.org/10.1115/1.4032810).
7. McComb, C., Cagan, J., and Kotovsky, K., 2015, "Lifting the Veil: Drawing Insights about Design Teams from a Cognitively-Inspired Computational Model," *Design Studies*, vol. 40, pp. 119-142, doi: [10.1016/j.destud.2015.06.005](https://doi.org/10.1016/j.destud.2015.06.005).
8. McComb, C., and Tehrani, F.M., 2015, "Enhancement of Shear Transfer in Composite Decks," *Engineering Structures*, vol. 88, pp. 251-261, doi: [10.1016/j.engstruct.2015.01.046](https://doi.org/10.1016/j.engstruct.2015.01.046).
9. McComb, C., Cagan, J., and Kotovsky, K., 2015, "Rolling with the Punches: An Examination of Team Performance in a Design Task Subject to Drastic Changes," *Design Studies*, vol. 36, pp. 99-121, doi: [10.1016/j.destud.2014.10.001](https://doi.org/10.1016/j.destud.2014.10.001).

Peer-Review Conference Proceedings

1. McComb, C., Johnson, N.G., and Gorman, B.T., 2016, "Scenario-based Robustness Analysis of Optimized I.D.E.-style Treadle Pump Designs," *ASME IDETC – Design for Manufacturing and Life Cycle Conference*, doi: [10.1115/DETC2016-60127](https://doi.org/10.1115/DETC2016-60127).
2. McComb, C., Cagan, J., and Kotovsky, K., 2016, "Linking Properties of Design Problems to Optimal Team Characteristics," *ASME IDETC – Design Theory and Methodology Conference*, doi: [10.1115/DETC2016-59333](https://doi.org/10.1115/DETC2016-59333).
3. McComb, C., Cagan, J., and Kotovsky, K., 2016, "Utilizing Markov Chains to Understand Operation Sequencing in Design Tasks," *Design Computing and Cognition '16*, doi: [10.1007/978-3-319-44989-0_22](https://doi.org/10.1007/978-3-319-44989-0_22).
4. McComb, C., Cagan, J., and Kotovsky, K., 2015, "Studying Human Design Teams through Computational Teams of Simulated Annealing Agents," *ASME IDETC – Design Theory and Methodology Conference*, doi: [10.1115/DETC2015-46545](https://doi.org/10.1115/DETC2015-46545).
5. McComb, C., Cagan, J., and Kotovsky, K., 2015, "Heterogeneous Simulated Annealing Teams: An Optimizing Search Algorithm Inspired by Engineering Design Teams," *International Conference on Engineering Design*, doi: [10.13140/RG.2.1.3400.6806/1](https://doi.org/10.13140/RG.2.1.3400.6806/1).

6. McComb, C., Goucher-Lamber, K., and Cagan, J., 2015, "Fairness and Manipulation: An Empirical Study of Arrow's Impossibility Theorem," *International Conference on Engineering Design*, doi: [10.13140/RG.2.1.2876.3920](https://doi.org/10.13140/RG.2.1.2876.3920).
7. McComb, C., Johnson, N.G., Santaefemia, P.S., and Shimada, K., 2015, "Identifying Technical and Economic Improvements to the Moneymaker Hip Pump Through Multi-Objective Optimization," *IEEE – Global Humanitarian Technology Conference*, doi: [10.1109/GHTC.2014.6970302](https://doi.org/10.1109/GHTC.2014.6970302).
8. McComb, C., Cagan, J., and Kotovsky, K., 2014, "Quantitative Comparison of High- and Low-Performing Teams in a Design Task Subject to Drastic Changes," *ASME IDETC – Design Theory and Methodology Conference*, doi: [10.1115/DETC2014-34653](https://doi.org/10.1115/DETC2014-34653).
9. Santaefemia, P.S., Johnson, N.G., McComb, C., and Shimada, K., 2014, "Improving Irrigation in Remote Areas: Multi-Objective Optimization of a Treadle Pump," *ASME IDETC – Design Automation Conference*, doi: [10.1115/DETC2014-35463](https://doi.org/10.1115/DETC2014-35463).
10. McComb, C., and Tehrani, F.M., 2014, "Research and Practice Group Methodology: A Case Study in Student Success," *ASEE Pacific-Southwest Conference*, doi: [10.13140/RG.2.1.3555.1846](https://doi.org/10.13140/RG.2.1.3555.1846).
11. McComb, C., Lawson, M., and Yu, Y.H., 2013, "Development and Verification of a Wave Energy Converter Simulation Tool," *6th Annual Global Marine Renewable Energy Conference - Marine Energy Technology Symposium*, doi: [10.13140/RG.2.1.3817.3285](https://doi.org/10.13140/RG.2.1.3817.3285).

Other

1. McComb, C., 2015, "The Cyborg Designer," International Conference on Engineering Design, Young Members Event, **invited talk**.
2. McComb, C., and Tehrani, F.M., 2012, "Enhancement of Composite Decks", *California State University Honors Conference*, **poster**.
3. McComb, C., and Lawons, M., 2012, "Numerical Moderling of Wave Energy Converters in OpenFOAM", *California State University Honors Conference*, **invited talk**.
4. Rath, L., Smith, C., Karimi, Y., McComb, C., Petruccia, M., and Ward, D., 2011, "Sustaining Service Through Student Voice", *Continuums of Service Conference*, **invited talk**.

Awards

Publication-related

- Best Paper in Computing, Design Computing and Cognition '16: "Utilizing Markov Chains to Understand Operation Sequencing in Design Tasks"
- Reviewers' Favorite, 2015 International Conference on Engineering Design: "Heterogeneous Simulated Annealing Teams: An Optimizing Search Algorithm Inspired by Engineering Design Teams"
- Reviewers' Favorite, 2015 International Conference on Engineering Design: "Fairness and Manipulation: An Empirical Study of Arrow's Impossibility Theorem"

Fellowships and Scholarships

- G. Sundback Graduate Fellowship (awarded February 2014)
- NSF Graduate Research Fellowship (awarded April 2013)
- Tau Beta Pi King Fellowship (awarded April 2012)
- Leon S Peters Engineering Scholarship (awarded August 2010, August 2011)
- California State University Presidents Scholarship (awarded August 2007)

Other

- Lyles College of Engineering Dean's Medalist (awarded April 2012)
- Eagle Scout Rank (awarded November 2004)

Affiliations and Service

Tau Beta Pi (General Engineering Honors Society)

- District Director, Pennsylvania and Delaware (May 2013 – Present)
- Chapter Advisor, Carnegie Mellon University (August 2012 – Present)

Journal Reviews

- Design Studies
- Journal of Mechanical Design
- European Journal of Engineering Education

Conference Reviews

- ASME IDETC Design Automation Conference
- ASME IDETC Design Theory and Methodology Conference
- Continuums of Service Conference

Memberships

- Pi Tau Sigma (Mechanical Engineering Honors Society)
- Chi Epsilon (Civil Engineering Honors Society)
- American Society of Mechanical Engineers
- The Design Society