

Andrew P. Sabelhaus

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EDUCATION

PH.D. MECHANICAL ENGINEERING

Dissertation title: *Tensegrity Spines for Quadruped Robots*

Dissertation Committee: Alice M. Agogino (Chair), Andrew Packard, Claire Tomlin, Murat Arcak

University of California, Berkeley

August 2019

M.S. MECHANICAL ENGINEERING

Thesis: *Mechanism and Sensor Design for SUPERball, a Cable-Driven Tensegrity Robot*

Thesis Committee: Alice M. Agogino, Dennis Lieu

University of California, Berkeley

Dec. 2014

B.S. MECHANICAL ENGINEERING MINOR: COMPUTER SCIENCE

University of Maryland, College Park

May 2012

PROFESSIONAL EXPERIENCE

Carnegie Mellon University

Dept. of Mechanical Engineering
Soft Machines Lab (PI: Carmel Majidi)

Postdoctoral Research Associate

2019 - Present
Pittsburgh, PA

NASA Ames Research Center

Intelligent Systems Division
Intelligent Robotics Group and Robust Software Engineering

Visiting Technologist

2015 - 2019
Moffet Field, CA

University of California, Berkeley

Dept. of Mechanical Engineering
Berkeley Emergent Space Tensegrities Lab (PI: Alice Agogino)

Graduate Student Researcher

2012-2019
Berkeley, CA

GRANTS + FUNDING

5. **Intelligence Community Postdoctoral Research Fellowship.** Office of the Director of National Intelligence. Title: *Rapid Deployment of Hard-to-Control Robots with Optimality Tradeoffs*. Full funding, 2020-2022.
4. **NASA Space Technology Research Fellowship.** National Aeronautics and Space Administration. Title: *Trajectory Tracking in Nonlinear, High-Order, Underactuated Robotic Systems*. Full funding, 2015-2019.
3. **CITRIS Tech for Social Good Development Grant.** University of California Center for Information Technology Research in the Interest of Society (CITRIS). Title: *Laika, The Robot Transport for Disaster Relief*. Block grant, 2018.
2. **Markowski-Leach Foundation Scholarship Award.** Awarded to LGBTQ individuals at San Francisco Bay Area institutions who "are likely to make a substantial contribution to society." 2013-2014, re-awarded 2016-2018. Currently the only repeated awardee on record.
1. **NSF Graduate Research Fellowship.** National Science Foundation. Full funding, 2012-2015.

PEER-REVIEWED PUBLICATIONS

13. Z. Patterson, **A.P. Sabelhaus**, K. Chin, C. Majidi, "An Untethered Brittle Star Robot for Closed-Loop Underwater Locomotion." *IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, to appear, 2020.
12. **A.P. Sabelhaus**, A.H. Li, K.A. Sover, J. Madden, A. Barkan, A.K. Agogino, A.M. Agogino, "Inverse Statics Optimization for Compound Tensegrity Robots." *IEEE Robotics and Automation Letters*, 2020.
doi:10.1109/LRA.2020.2983699

11. **A.P. Sabelhaus**, H. Zhao, E. Zhu, A.K. Agogino, A.M. Agogino, "Model-Predictive Control with Inverse Statics Optimization for Tensegrity Spine Robots." *IEEE Transactions on Control System Technology*, 2020. doi:10.1109/TCST.2020.2975138
10. L.H. Chen, M.C. Daly, **A.P. Sabelhaus**, L.A. Janse van Vuuren, H.J. Garnier, M.I. Verdugo, E. Tang, C.U. Spangenberg, F. Ghahani, A.K. Agogino, A.M. Agogino, "Modular Elastic Lattice Platform for Rapid Prototyping of Tensegrity Robots." *ASME International Design Engineering Technical Conferences (IDETC) / 41st Mechanisms and Robotics Conference*, Aug 2017. doi:10.1115/DETC2017-68264
9. **A.P. Sabelhaus**, A.K. Akella, Z.A. Ahmad, V. SunSpiral, "Model-Predictive Control of a Flexible Spine Robot." *American Control Conference (ACC)*, IEEE, May 2017. doi:10.23919/ACC.2017.7963738
8. K. Zampaglione, **A.P. Sabelhaus**, L.H. Chen, A.M. Agogino, A.K. Agogino, "DNA-Structured Linear Actuators." *ASME International Design Engineering Technical Conferences (IDETC) / 40th Mechanisms and Robotics Conference*, Aug 2016. doi:10.1115/DETC2016-60291
7. **A.P. Sabelhaus**, H. Ji, P. Hylton, Y. Madaan, C. Yang, J. Friesen, V. SunSpiral, A.M. Agogino, "Mechanism Design and Simulation of the ULTRA Spine, a Tensegrity Robot." *ASME International Design Engineering Technical Conferences (IDETC) / 39th Mechanisms and Robotics Conference*, Aug 2015. doi:10.1115/DETC2015-47583
6. **A.P. Sabelhaus**, J. Bruce, K. Caluwaerts, P. Manovi, R.F. Firoozi, S. Dobi, A.M. Agogino, V. SunSpiral, "System Design and Locomotion of SUPERball, an Untethered Tensegrity Robot." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2015. doi:10.1109/ICRA.2015.7139590
5. K. Caluwaerts, J. Despraz, A. Iscen, **A.P. Sabelhaus**, J. Bruce, B. Schrauwen, V. SunSpiral, "Design and Control of Compliant Tensegrity Robots through Simulation and Hardware Validation." *Journal of the Royal Society Interface*, 2014. doi:10.1098/rsif.2014.0520
4. **A.P. Sabelhaus**, J. Bruce, K. Caluwaerts, Y. Chen, D. Lu, Y. Liu, A.K. Agogino, V. SunSpiral, A.M. Agogino, "Hardware Design and Testing of SUPERball, a Modular Tensegrity Robot." *The 6th World Conference on Structural Control and Monitoring (6WCSCM)*, July 2014.
3. J. Bruce, **A.P. Sabelhaus**, Y. Chen, D. Lu, K. Morse, S. Milam, K. Caluwaerts, A.M. Agogino, V. SunSpiral, "SUPERball: Exploring Tensegrities for Planetary Probes." *12th International Symposium on Artificial Intelligence, Robotics, and Automation in Space (i-SAIRAS)*, June 2014.
2. J. Bruce, K. Caluwaerts, A. Iscen, **A.P. Sabelhaus**, V. SunSpiral, "Design and Evolution of a Modular Tensegrity Robot Platform." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2014. doi:10.1109/ICRA.2014.6907361
1. **A.P. Sabelhaus**, D. Mirsky, L.M. Hill, S. Bergbreiter, "TinyTeRP: A Tiny Terrestrial Robotic Platform with Modular Sensing." *IEEE International Conference on Robotics and Automation (ICRA)*, May 2013. doi: 10.1109/ICRA.2013.6630933

PRE-PRINTS + PUBLICATIONS UNDER REVIEW

1. **A.P. Sabelhaus**, L.A. Janse van Vuuren, A. Joshi, E. Zhu, H.J. Garnier, K.A. Sover, J. Navarro, A.K. Agogino, V. SunSpiral, A.M. Agogino, "Design, Simulation, and Testing of a Flexible Actuated Spine for Quadruped Robots." *Preprint Only*. Available, arXiv:1804.06527

IN-PREPARATION PUBLICATIONS

2. **A.P. Sabelhaus**, E. Tang, K. Zampaglione, L.H. Chen, A.M. Agogino, "Double Helix Linear Actuators."
1. **A.P. Sabelhaus**, "Statically-Conservative Forces in Lagrangian Systems: Implications for Stability and Control."

PATENTS

2. A. Agogino, K. Zampaglione, L.-H. Chen, **A.P. Sabelhaus**, "DNA Structured Linear Actuator." *US Patent No. 10,630,208*, issued April 21, 2020.
1. L.-H. Chen, A. Agogino, M. Daly, **A.P. Sabelhaus**, A.K. Agogino, "Elastic Lattices for Design of Tensegrity Structures and Robots." *Under review, US Patent Application No. US20190382995A1*.

INVITED TALKS + PRESENTATIONS

11. A.P. Sabelhaus, "Tensegrity Spines for Quadruped Robots." *Workshop on Tensegrity Robotics, IEEE International Conference on Robotics and Automation (ICRA)*, May 2019.
10. A.P. Sabelhaus, "Tensegrity Spines for Quadruped Robots." *CMU Locomotion Seminar, Carnegie Mellon University*, Feb. 2019.
9. A.P. Sabelhaus, "Laika and Belka: Walking Robots with Flexible Spines." *Workshop on Autonomy for Future NASA Science Missions, National Aeronautics and Space Administration*, Oct. 2018.
8. A.P. Sabelhaus, "Inverse Kinematics for Tensegrity Soft Robot Control: Existence and Optimality." *Soft Robotics Modeling and Control Workshop, IEEE/RSJ International Conference on Intelligent Robots and Systems*, Oct. 2018.
7. A.P. Sabelhaus, "Laika, The Four-Legged Robot with a Flexible Spine." *NASA Space Technology Day-On-The-Hill, United States Congress / House of Representatives*, Nov. 2017.
6. A.P. Sabelhaus, "Laika, The Quadruped Robot with a Flexible Spine." *Bay Area Robotics Symposium (BARS)*, Oct. 2017.
5. A.P. Sabelhaus, "Trajectory Tracking Control of a Flexible Spine Robot." *Workshop on Structurally Adaptive Tensegrity Robotics, 13th NASA/ESA Conference on Adaptive Hardware and Systems*, July 2017.
4. A.P. Sabelhaus, "UC Berkeley Robotics for Disaster Relief." *Field Innovation Team Bootcamp 5.0*, Mar. 2017.
3. A.P. Sabelhaus, "DNA-Structured Linear Actuators." *SKTA Innopartners IP Redux*, Apr. 2016.
2. A.P. Sabelhaus, "The ULTRA Spine Project." *Bay Area Robotics Symposium (BARS)*, Oct. 2015.
1. A.P. Sabelhaus, "Robotics, Mechatronics, and Intelligent Systems." *Osher Lifelong Learning Institute*, Feb. 2014.

REVIEWER FOR JOURNALS AND CONFERENCES

Drew has served as a reviewer for the following journals and conferences:

- IEEE Robotics and Automation Letters (RA-L), 2017-2020
- IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS), 2018, 2020
- IEEE Transactions on Control System Technology (T-CST), 2018
- Journal of Open-Source Software (JOSS), 2018-2019
- IEEE Robotics and Automation Magazine (RA-M), 2018
- IEEE International Conference on Robotics and Automation (ICRA), 2017, 2019
- American Control Conference (ACC), 2017-2018.
- IEEE Conference on Control Technology and Applications (CCTA), 2017.
- International Journal of Space Structures, 2017.
- ASME International Design Engineering Technical Conference (IDETC), 2016-2017.

TEACHING + MENTORING

- **Mentorship of undergraduate students.** UC Berkeley: 18 students. Carnegie Mellon University: 1 student. Diversity: 13/19 identify as minority or under-represented, 68%.
- **Mentorship of graduate students.** UC Berkeley Master of Engineering (M.Eng) program: 15 students. Diversity: 8/15 identify as minority or under-represented, 53%.
- **Graduate Student Instructor (GSI).** University of California, Berkeley
Jan. - May, 2018 | Mech. Eng. 135/235, Design of Microprocessor-Based Mechanical Systems
 - Created course content for lab and discussion sections, delivered stand-in lectures, assisted students with projects.
 - Overall Course Evaluations: *Total Effectiveness of Instructor*: 4.7/5.0 (Undergrad.), 4.88/5.0 (Grad.)
 - Teaching evaluations were above department averages in every metric.
- **Outstanding Graduate Student Instructor (GSI) Award.** University of California, Berkeley, 2019

DIVERSITY + OUTREACH* + SERVICE

- **Faculty/Staff Advisor.** Out in Science, Technology, Engineering, and Mathematics[†] at Carnegie Mellon University, 2020 - present.
- **ASME Diversity and Inclusion Strategic Committee (DISC), Advisor.** American Society of Mechanical Engineers (ASME). Revised ASME policy P-15.11, PS16-02, and Statement on Diversity and Inclusion to include protections for transgender ASME members. June 2016 - 2018.
- **ASEE LGBTQ Virtual Community of Practice, Member.** American Society for Engineering Education. 2018 - present.
- **Graduate Student Search Committee, Member.** UC Berkeley Mechanical Engineering Faculty Searches. 2017 - 2018.
- **Graduate Peer Advisor.** UC Berkeley Mechanical Engineering - Equity, Diversity, and Inclusion Initiative. 2014 - 2015.
- **Coordinator, Chapter Leadership Programs.** Out in Science, Technology, Engineering, and Mathematics[†] Incorporated. 2012 - 2013.

**Drew has organized and volunteered with many smaller events not listed here.*

[†]Out in Science, Technology, Engineering, and Mathematics (oSTEM) is a national organization for LGBTQ science and engineering students, www.ostem.org

PROFESSIONAL DEVELOPMENT

- **Summer Institute for Preparing Future Faculty.** A professional development program to prepare students for academic careers. University of California, Berkeley. Completed / certified in June 2018.
- **Question, Persuade, Refer: Gatekeeper.** Trained for response to mental health crises in students. University of California Berkeley Health Center, March 2018.
- **Teaching of Mechanical Engineering at the University Level.** UC Berkeley Mechanical Engineering Department. Course on teaching pedagogy in engineering. Spring 2018.
- **Workshops on Teaching and Learning.** UC Berkeley GSI Teaching and Resource Center / Academic Innovation Studio. Attended workshops on teaching pedagogy, including 'How Students Learn' and 'Teaming With Diversity.' Fall 2017 - Spring 2018.
- **Teaching Conference for Graduate Student Instructors.** UC Berkeley GSI Teaching and Resource Center. Introductory pedagogy for first-time Graduate Student Instructors. Attended in Jan. 2018.