Steven H. Collins

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Faculty Appointments

Associate Professor	**Stanford University** (September 2017—present) Department of Mechanical Engineering (without tenure)
Associate Professor	**Carnegie Mellon University** (2015—2017) Department of Mechanical Engineering Robotics Institute (by courtesy)
Assistant Professor	**Carnegie Mellon University** (2010—2015) Department of Mechanical Engineering Robotics Institute (by courtesy)

Education

Postdoctoral Fellow	**Delft University of Technology** (2008—2010) Biomechanical Engineering Supervisor: Martijn Wisse
M.S., Ph.D.	**University of Michigan** (2002—2008) Mechanical Engineering Advisor: Art Kuo
B.S.	**Cornell University** (1997—2002) Mechanical Engineering Research advisor: Andy Ruina

Journal Articles

Papers, videos and other supporting materials available at: web.stanford.edu/people/stevecollins
Numbers: 33 journal articles, 3 book chapters, 14 proceedings, 9 patents, 7,079 citations, h-index: 31, 67 podium presentations. Citation data from Google Scholar. Author and advisee names underlined.

1. Collins, S. H., Wisse, M., Ruina, A. (2001) A three-dimensional passive-dynamic walking robot with two legs and knees. *International Journal of Robotics Research*, **20**:607-615.

2. Collins, S. H., Ruina, A. L., Tedrake, R., Wisse, M. (2005) Efficient bipedal robots based on passive-dynamic walkers. *Science*, **307**:1082-1085.

3. Adamczyk, P. G., Collins, S. H., Kuo, A. D. (2006) The advantages of a rolling foot in human walking. *Journal of Experimental Biology*, **209**:3953-3963.

4. Vanderpool, M. T., Collins, S. H., Kuo, A. D. (2008) Ankle fixation need not increase the energetic cost of human walking. *Gait & Posture*, **28**:427-433.

5. Collins, S. H., Adamczyk, P. G., Ferris, D. P., Kuo, A. D. (2009) A simple method for calibrating force plates and force treadmills using an instrumented pole. *Gait & Posture*, **29**:59-64.

6. Collins, S. H., Adamczyk, P. G., Kuo, A. D. (2009) Dynamic arm swinging in human walking. *Proceedings of the Royal Society of London B.*, **276**:3679-3688.

7. van der Krogt, M. M., Bregman, D. J. J., Wisse, M., Doorenbosch, C. A. M., Harlaar, J., Collins, S. H. (2010) How crouch gait can dynamically induce stiff-knee gait. *Annals of Biomedical Engineering*, **38**:1593-1606.

8. Collins, S. H., Kuo, A. D. (2010) Recycling energy to restore impaired ankle function during human walking. *Public Library of Science ONE*, **5**:e9307.

9. Bregman, D. J., van der Krogt, M. M., de Groot, V., Harlaar, J., Wisse, M., Collins, S. H. (2011) The effect of ankle foot orthosis stiffness on the energy cost of walking: a simulation study. *Clinical Biomechanics*, **26**:955-961.

10. Morgenroth, D. C., Segal, A. D., Zelik, K. E., Czerniecki, M. J., Klute, G. K., Adamczyk, P. G., Orendurff, M. S., Hahn, M. E., Collins, S. H., Kuo, A. D. (2011) The effect of prosthetic foot push-off on mechanical loading associated with knee osteoarthritis in lower extremity amputees. *Gait & Posture*, **34**:502-507.

11. Zelik, K. E., Collins. S. H., Adamczyk, P. G., Segal, A. D., Klute, G. K., Morgenroth, D. C., Hahn, M. E., Orendurff, M. S., Czerniecki, J. M., Kuo, A. D. (2011) Systematic variation of prosthetic foot parameter affects center-of-mass mechanics and metabolic cost during walking. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, **19**:411-419.

12. Segal, A. D., Zelik, K. E., Klute, G. K., Morgenroth, D. C., Hahn, M. E., Orendurff, M. S., Adamczyk, P. G., Collins, S. H., Kuo, A. D., Czerniecki, J. M. (2012) The effects of a controlled energy storage and return prototype prosthetic foot on transtibial amputee ambulation. *Human Movement Science*, **31**:918-931.

13. Collins, S. H., Kuo, A. D. (2013) Two independent contributions to step variability during over-ground human walking. *Public Library of Science ONE*, **8**:e73597.

14. Caputo, J. M., Collins, S. H. (2014) A universal ankle–foot prosthesis emulator for human locomotion experiments. *Journal of Biomechanical Engineering*, **136**:035002.

15. Caputo, J. M., Collins, S. H. (2014) Prosthetic ankle push-off work reduces metabolic rate but not collision work in non-amputee walking. *Nature Scientific Reports*, **4**:7213.

16. Malcolm, P., Quesada, R. E., Caputo, J. M., Collins, S. H. (2015) The influence of push-off timing in a robotic ankle-foot prosthesis on the energetics and mechanics of walking. *Journal of NeuroEngineering and Rehabilitation*, **12**:21.

17. Collins, S. H., Wiggin, M. B., Sawicki, G. S. (2015) Reducing the energy cost of human walking using an unpowered exoskeleton. *Nature*, **522**:212-215.

18. Kim, M., Collins, S. H. (2015) Once-per-step control of ankle-foot prosthesis push-off work reduces effort associated with balance during human walking. *Journal of NeuroEngineering and Rehabilitation*, **12**:43.

19. Jackson, R. W., Collins, S. H. (2015) An experimental comparison of the relative benefits of work and torque assistance in ankle exoskeletons. *Journal of Applied Physiology,* **119**:541-557.

20. Quesada, R. E., Caputo, J. M., Collins, S. H. (2016) Restoring ankle push-off work with a powered prosthesis does not necessarily reduce metabolic rate for trans-tibial amputees, *Journal of Biomechanics*, **49**:3452-3459.

21. Kim, M., Collins, S. H. (2017) Once-per-step control of ankle push-off work improves balance in a three-dimensional simulation of bipedal walking. *Transactions on Robotics*, **33**:406-418.

22. Jackson, R. W., Dembia, C. L., Delp, S. L., Collins, S. H. (2017) Muscle-tendon mechanics explain unexpected effects of exoskeleton assistance on metabolic rate during walking. *Journal of Experimental Biology*, **220**:2082-2095.

23. Zhang, J., Fiers, P., Witte, K. A., Jackson, R. W., Poggensee, K. L., Atkeson, C. G., Collins, S. H. (2017) Human-in-the-loop optimization of exoskeleton assistance during walking. *Science*, **356**:1280-1284.

24. Zhang, J., Collins, S. H. (2017) The passive series stiffness that optimizes torque tracking for a lower-limb exoskeleton in human walking. *Frontiers in Neurorobotics*, **11**:68.

25. Steele, K. M., Jackson, R. W., Shuman, B., Collins, S. H. (2017) Muscle recruitment and coordination with an ankle exoskeleton. *Journal of Biomechanics*, **59**:50-58.

26. Kim, M., Collins, S. H. (2017) Step-to-step ankle inversion/eversion torque modulation can reduce effort associated with balance. *Frontiers in Neurorobotics*, **11**:62.

27. Galle, S., Malcolm, P., Collins, S. H., De Clercq, D. (2017) Reducing the metabolic cost of walking with an ankle exoskeleton: interaction between actuation timing and power. *Journal of NeuroEngineering and Rehabilitation*, **14**:35.

28. Kim, M., Chen, T., Chen, T., Collins, S. H. (2018) An ankle-foot prosthesis emulator with control of plantarflexion and inversion-eversion torque. *Transactions on Robotics*, **34:**1183-1194.

29. Diller, S. Collins, S. H., Majidi, C. (2018) The effects of electroadhesive clutch design parameters on performance characteristics. *J. Intelligent Material Systems and Structures*, **29**:3804-3828.

30. Slade, P., Troutman, R., Kochenderfer, M. J., Collins, S. H., Delp, S. L. (2019) Rapid energy expenditure estimation for assisted and inclined loaded walking. *Journal of NeuroEngineering & Rehabilitation*, **16:**67.

31. Simpson, C. S., Welker, C. G., Uhlrich, S. D., Sketch, S. M., Jackson, R. W., Delp, S. L., Collins, S. H., Selinger, J. C., Hawkes, E. W. (2019). Connecting the legs with a spring improves human running economy. *Journal of Experimental Biology*, **222**:jeb202895.

32. Chiu, V. L., Voloshina, A. S., Collins, S. H. (2019) An ankle-foot prosthesis emulator capable of modulating center of pressure. *Transactions on Biomedical Engineering*, **in press**.

33. Jackson, R. W., Collins, S. H. (2019) Heuristic-based ankle exoskeleton control for co-adaptive assistance of human locomotion. *Transactions on Neural Science and Rehabilitation Engineering*, **in press**.

In review: (available on request)

34. Kim, M., Lyness, H., Chen, T., Collins, S. H. Prosthesis inversion-eversion stiffness reduces balance-related variability during level walking. **In review**, *Journal of Biomechanical Engineering.*

35. Bryan, G. M., Franks, P. W., Klein, S. C., Peuchen, R. J., Collins, S. H. A hip-knee-ankle exoskeleton emulator for studying gait assistance. **In review**, *International Journal of Robotics Research*.

36. Witte, K. A., Fiers, P., Sheets-Singer, A., Collins, S. H. Optimizing the energy economy of human running with powered and unpowered ankle exoskeleton assistance. **In review**, *Science Robotics*.

37. Zhang, J., Collins, S. H. The iterative learning gain that optimizes real-time torque tracking for ankle exoskeletons in human walking under gait variations. **In review**, *IEEE Transactions on Industrial Informatics*.

Book Chapters

B1. Zhang, J., Cheah, C. C., Collins, S. H., Torque control in legged locomotion. In *Bio-Inspired Legged Locomotion Concepts, Control and Implementation* (eds. Sharbafi, M., and Seyfarth, A.) Butterworth-Heinemann, Chapter 5, pages: 347-395.

B2. Witte, K. A., Collins, S. H. Lower-limb exoskeleton emulators: principles of design for rapid exploration of hardware and assistive strategies. In *Wearable Robotics: Systems and Applications*, with editors P. Ferguson and J. Rosen, Elsevier. In press.

B3. Voloshina, A., Collins, S. H. A review of design and control approaches in lower-limb prosthetic devices. In *Wearable Robotics: Systems and Applications*, with editors P. Ferguson and J. Rosen, Elsevier. In press.

Peer-Reviewed Conference Proceedings

C1. Pratt, J. E., Krupp, B. T., Morse, C. J., Collins, S. H. (2004) The RoboKnee: an exoskeleton for enhancing strength and endurance during walking. In *Proc. IEEE Int. Conf. Robotics and Automation*, New Orleans, LA, pages 2430-2435. Acceptance rate: 59%.

C2. Collins, S. H., Ruina, A. (2005) A bipedal walking robot with efficient and human-like gait. In *Proc. IEEE International Conference on Robotics & Automation*, Barcelona, Spain, pages 1983-1988. Acceptance rate: 45%.

C3. Wiggin, M. B., Sawicki, G. S., Collins, S. H. (2011) An exoskeleton using controlled energy storage and release to aid ankle propulsion. In *Proc. IEEE International Conference on Rehabilitation Robotics*, Zurich, Switzerland. 5 pages. Acceptance rate: 62%.

C4. Caputo, J. M., Collins, S. H. (2013) An experimental robotic testbed for accelerated development of ankle prostheses. In *Proc. IEEE International Conference on Robotics and Automation*, Karlsruhe, Germany. pages 2630-2635. Acceptance rate oral: 18%.

C5. Zhang, J., Cheah, C. C., Collins, S. H. (2013) Stable human-robot interaction control for upper-limb rehabilitation robotics. In *Proceedings IEEE International Conference on Robotics and Automation*, Karlsruhe, Germany. pages 2201-2206. Acceptance rate oral: 18%.

C6. Song, S., LaMontagna, C., Collins, S. H., Geyer, H. (2013) The effect of foot compliance encoded in the windlass mechanism on the energetics of human walking. In *Proceedings International Conference of the IEEE Engineering in Medicine and Biology Society*, Osaka, Japan. pages 3179-3182. Acceptance rate: 40%.

C7. Kim, M., Collins, S. H. (2013) Stabilization of a three-dimensional limit cycle walking model through step-to-step ankle control. In *Proceedings IEEE International Conference on Rehabilitation Robotics*, Seattle, WA, USA. 6 pages. Acceptance rate: 62%.

C8. Collins, S. H., Jackson, R. W. (2013) Inducing Self-Selected Human Engagement in Robotic Locomotion Training. In *Proceedings IEEE International Conference on Rehabilitation Robotics*, Seattle, WA, USA. 6 pages. Acceptance rate for oral presentations: 11%.

C9. Zhang, J., Cheah, C. C., Collins, S.H. (2015) Experimental comparison of torque control methods on an ankle exoskeleton during human walking. In *Proc. IEEE International Conference on Robotics and Automation*, Seattle, WA, USA. pages 5584-5589. Acceptance rate: 41%.

C10. Witte, K. A., Zhang, J., Jackson, R. W., Collins, S.H. (2015) Design of two lightweight, high-bandwidth torque-controlled ankle exoskeletons. In *Proc. IEEE International Conference on Robotics and Automation*, Seattle, WA, USA. pages 1223-1228. Acceptance rate: 41%.

C11. Collins, S. H., Kim, M., Chen, T., Chen, T. (2015) An ankle-foot prosthesis emulator with control of plantarflexion and inversion-eversion torque. In *Proc. IEEE International Conference on Robotics and Automation*, Seattle, WA, USA. pages 1210-1216. Acceptance rate: 41%.

C12. Caputo, J. M., Adamczyk, P. G., Collins, S. H. (2015) Informing ankle-foot prosthesis prescription through haptic emulation of candidate devices. In *Proc. IEEE International Conference on Robotics and Automation*, Seattle, Washington, USA. pages 6445-6450. Acceptance rate for oral presentations: 41%.

C13. Diller, S., Majidi, C., Collins, S. H. (2016) A lightweight, low-power electroadhesive clutch and spring for exoskeleton actuation. In *Proc. IEEE International Conference on Robotics and Automation*, Stockholm, Sweden. Acceptance rate: 35%.

C14. Witte, K. A., Fatschel, A. M., Collins, S. H. (2017) Design of a lightweight, tethered, torque-controlled knee exoskeleton. In Proc. *IEEE International Conference on Rehabilitation Robotics*, London, United Kingdom. pages 1646-1653. Acceptance rate: 74%.

In review: (available on request)

C15. Krimsky, E., Collins, S. H. (2020) Optimal control of an energy-recycling actuator for mobile robotics applications. Submitted to *IEEE International Conference on Robotics and Automation*, Paris, France. In review.

C16. Tan, G. R., Raitor, M., Collins, S. H. (2020) Bump'em: an open-source, bump-emulation system for studying human balance and gait. Submitted to *IEEE International Conference on Robotics and Automation*, Paris, France. In review.

Invited Conference Proceedings

C17. Collins, S. H. (2013) What do walking humans want from mechatronics? In: *Proceedings of the IEEE International Conference on Mechatronics (ICM)*, Vicenza, Italy. pp. 24-27.

C18. Collins, S. H., Caputo, J. M., Adamczyk, P. G. (2014) Emulating prosthetic feet during the prescription process to improve outcomes and justifications. In: *Proceedings of the IEEE Workshop on Advanced Robotics and its Social Impacts (ARSO)*, Evanston, IL, USA. pages 127-128.

Patents Issued

P1. Wiggin, M. B., Sawicki, G. S., Collins, S. H. Apparatus and clutch for using controlled storage and release of mechanical energy to aid locomotion. U.S. Patent 9,492,302. Issued November 2016. Contribution: 33%.

P2. Caputo, J. M., Collins, S. H., Adamczyk, P. G., Kim, M., Chen, T., Chen, T., Chiu, V. L. Methods, apparatuses and systems for amputee gait capacity assessment. U.S. Patent 10,350,092. Issued July 2019. Contribution: 50%.

P3. Diller, S. B., Majidi, C., Collins, S. H. Electrostatic Clutch. U.S. Patent 10,355,624. Issued July 2019. Contribution: 60%.

Patent Applications

P4. Collins, S. H., Kuo, A. D., Foot prosthesis and method of use. U.S. Patent Application 20070061016. First filed August 2005.

P5. Collins, S. H., Vrinceanu, A., Mullins, C., Donelan, J. M., Apparatus for Biomechanical Energy Harvesting. U.S. Provisional Patent Application 61/175,726. Filed May 2009.

P6. Zhang, J., Collins, S. H., Torque control methods for an exoskeleton device. U.S. Patent Application 20170340506. First filed May 2015.

P7. Witte, K. A., Jackson, R. W., Collins, S. H., Exoskeleton device and control system. U.S. Patent Application 20180125738. First filed May 2015.

P8. Zhang, J., Collins, S. H., Online optimization of multivariate high level controllers in assistive robots to minimize human metabolic cost. U.S. Provisional Patent Application 62/495,690. Filed July, 2017.

P9. Witte, K. A., Collins, S. H. Exoskeleton device emulation system. U.S. Patent Application 20190015287. First filed July 2017.

Podium Presentations and Seminars

Plenary and Keynote Presentations

1. *Keynote:* What can dynamic walking teach us about robots and humans? *Dynamic Walking*, Ann Arbor Michigan, USA. May 6, 2006.

2. *Plenary:* What do walking humans want from mechatronics? *International Conference on Mechatronics*, Vicenza, Italy. March 1, 2013.

3. *Young Scientist Award Talk:* Biomechanics-centered design of robotic lower-limb prostheses and orthoses. *American Society of Biomechanics*, Omaha, Nebraska, USA. September 6, 2013.

4. *Keynote:* Reducing the energy cost of human walking using an unpowered exoskeleton. *Dynamic Walking*, Columbus, Ohio, USA. July 25, 2015.

5. *High-profile:* Designing exoskeletons that enhance performance through automatic customization. IdeasLab session: Reimagining the Human Body. *World Economic Forum*, Davos, Switzerland, January 17, 2017.

6. *Keynote:* Automatic customization of exoskeleton control during walking. *Dynamic Walking*, Mariehamn, Åland, Finland, June 6, 2017.

7. *Plenary:* Designing exoskeletons and prosthetic limbs that enhance human performance. *International Society of Posture and Gait Research World Congress*, Fort Lauderdale, Florida, USA, June 26, 2017.

8. *Keynote:* The future of active prosthesis and orthosis design. Georgia Institute of Technology Prosthetic Orthotic Research Symposium, Atlanta, Georgia, USA, April 20, 2018.

9. *Keynote:* Designing exoskeletons and prosthetic limbs that enhance human performance. *International Conference on Biomedical Robotics and Biomechatronics*, U. Twente, Enschede, The Netherlands, August 28, 2018.

10. *Invited:* Motor learning is extremely important to successful exoskeleton gait augmentation. *Congress of the International Society of Biomechanics*, Calgary, Canada, July 31, 2019.

11. *Keynote:* Human-in-the-loop optimization of exoskeleton assistance during human walking. *Annual Meeting of the European Society for Movement Analysis in Adults and Children*, Amsterdam, The Netherlands, September 26, 2019.

Other Conference Podium Presentations

12. Control of balance during walking in young and elderly adults. *American Society of Biomechanics*, Toledo Ohio, USA. September 26, 2003.

13. A bipedal walking robot with efficient and human-like gait. *International Conference on Robotics and Automation*, Barcelona, Spain. April 20, 2005.

14. Controlled energy storage and return prosthesis reduces metabolic cost of walking. *Congress of the International Society of Biomechanics*, Cleveland Ohio, USA. August 3, 2005.

15. Energetics of arm swinging. *Dynamic Walking*, Åland, Finland. June 26, 2007.

16. A comparison of controlled energy storage and return and conventional prosthetic feet: mechanics and metabolics. *Dynamic Walking*, Delft, The Netherlands. May 28, 2008.

17. When mechanics matter: utilizing passive dynamics to gain energetic benefits in human locomotion. *Society for Experimental Biology*, Glasgow, United Kingdom. July 1, 2009.

18. Exploring ankle control strategies with an experimental biomechatronic testbed. *Dynamic Walking*, Jena, Germany. July 19, 2011.

19. Toward tip-top testbeds: Biomechatronics for accelerated development of assistive devices. *Canadian Society of Biomechanics*, Vancouver, British Columbia, Canada. June 8, 2012.

20. An experimental robotic testbed for accelerated development of ankle prostheses. *International Conference on Robotics and Automation*, Karlsruhe, Germany. May 8, 2013.

21. A method for harnessing least-effort drives in robotic locomotion training. *International Conference on Rehabilitation Robotics*, Seattle, Washington, USA. June 25, 2013.

22. Emulating ankle-foot prostheses during the prescription process to improve outcomes and justifications. IEEE Workshop on Advanced Robotics and its Social Impacts, Evanston, Illinois, USA. September 12, 2014.

23. An ankle-foot prosthesis emulator with control of plantarflexion and inversion-eversion torque. *International Conference on Robotics and Automation*, Seattle, WA, USA. May 24, 2015.

24. Optimizing (artificial) ankle function during walking. *Adaptive Motion of Animals and Machines*, Massachusetts Institute of Technology, Boston, Massachusetts, USA. June 23, 2015.

25. Prosthetic limbs that reduce the energy cost of walking to below non-amputee levels are possible but hard to discover. *American Society of Biomechanics*, Columbus, Ohio, USA. August 8, 2015.

26. Designing wearable robots to enhance human locomotor performance. *Rehabilitation Robotics Workshop*, Arizona State University, Tempe, Arizona, USA. February 9, 2016.

27. Assisting human locomotion with unpowered devices. In the Human 2.0 Workshop at the *International Conference on Robotics and Automation*, Stockholm, Sweden. May 15, 2016.

28. Discovering exoskeletons that augment locomotor performance. *Nike Global Research Symposium*, Portland, Oregon, USA, October 24, 2016.

29. Human-in-the-loop optimization of exoskeleton assistance. *International Conference on Rehabilitation Robotics*, Workshop on Assessing and Optimizing Human Robot Interaction in Wearable Robotic Devices. London, United Kingdom, July 17, 2017.

30. NRI: Rapid exploration of ankle exoskeleton control strategies. *NSF National Robotics Initiative PI Meeting*, Alexandria, Virginia, USA, November 10, 2017.

31. Human-in-the-loop optimization of exoskeleton assistance. *Sensori-Motor Control of Animals and Robots*, Mathematical Biosciences Institute, Columbus, Ohio, USA, November 15, 2017.

32. Human-in-the-loop optimization of powered orthosis design. *Orthotic and Prosthetic Innovative Technologies Conference*, San Francisco, California, USA, May 11, 2018.

33. Human-in-the-loop optimization of exoskeleton assistance during walking. *World Congress of Biomechanics*, Dublin, Ireland, July 8, 2018.

34. Lightweight, low-power electroadhesive clutches for biorobotic actuation. In: Workshop on novel bioinspired actuator designs for robotics. *International Conference on Biomedical Robotics and Biomechatronics*, U. Twente, Enschede, The Netherlands, August 26, 2018.

35. Designing untethered exoskeletons that make runners faster. *Nike Global Research Symposium*, Portland, Oregon, USA, September 24, 2018.

36. Human-in-the-loop optimization of exoskeleton assistance. *Orthotic and Prosthetic Innovative Technologies Conference*, Ann Arbor, Michigan, USA, May 17, 2019.

Presentations in Academic Departments

37. Learning to help walk: Developing wearable robots for people with lower-limb disabilities. Department Seminar, Department of Mechanical Engineering, <u>The Ohio State University</u>, Columbus, Ohio, USA. November 9, 2012.

38. Universal robotic prosthesis emulators. Mechanical Engineering Colloquium, Department of Mechanical Engineering, <u>Massachusetts Institute of Technology</u>, Boston, Massachusetts, USA. November 8, 2013.

39. Tools for accelerating the development of intelligent prostheses. Center for Bionic Medicine Seminar, <u>Rehabilitation Institute of Chicago</u> and <u>Northwestern University</u>, Chicago, Illinois, USA. November 15, 2013.

40. Characterizing human locomotor response to wearable robot functionality. Bioengineering Department & National Center for Simulation in Rehabilitation Research, Stanford University, Palo Alto, California, USA. November 18, 2013.

41. Biomechanics-centered design of robotic lower-limb prostheses. Robotics Institute Seminar, Carnegie Mellon University, Pittsburgh, PA, USA. January 23, 2014.

42. Universal prosthesis emulators for rapid evaluation of human response to intervention. Department Seminar, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA. April 18, 2014.

43. How to develop wearable robots that make walking easier. Department Seminar, Department of Mechanical Engineering, Harvard University, Boston, Massachusetts, USA. October 15, 2014.

44. What I learned from my wearable robot: the unexpected physiological effects of forceful human-robot interactions. Seminar, School of Applied Physiology, Georgia Institute of Technology, Atlanta, Georgia, USA. November 12, 2014.

45. Improving the development, prescription and tuning of robotic prostheses using versatile emulator systems. Department Seminar, Department of Mechanical Engineering, University of Washington, Seattle, Washington, USA. December 2, 2014.

46. Designing robotic prostheses and exoskeletons that enhance human mobility. BioMedical Engineering Seminar, Department of Mechanical Engineering, University of British Columbia, Vancouver, British Columbia, Canada. March 12, 2015.

47. Human-in-the-loop prosthesis design using versatile robotic emulator systems. Dynamic Systems and Controls Seminar, Department of Mechanical and Aerospace Engineering, University of California, San Diego, San Diego, California, USA. April 24, 2015.

48. How to design wearable robots that augment human locomotor performance. Department of Bioengineering, University of Pittsburgh, Pittsburgh, Pennsylvania, USA. January 28, 2016.

49. Designing robotic prostheses and exoskeletons that improve human mobility. Job talk, Department of Mechanical Engineering, Stanford University, California, USA. February 18, 2016.

50. How should we develop wearable devices that improve mobility? Department of Integrative Physiology, University of Colorado Boulder, Boulder, Colorado, USA. February 22, 2016.

51. Designing exoskeletons and prostheses that enhance human performance. Stanford Robotics Seminar, Stanford University, Stanford, California, USA, February 2, 2018.

52. Designing exoskeletons and prosthetic limbs for optimal locomotor assistance. Department of BioMechanical Engineering, Technische Universiteit Delft, Delft, Nederland, 30 August, 2018.

53. Optimizing ankle exoskeleton assistance for individuals with chronic stroke. 4th Annual Stroke Symposium, Neurosciences Institute, Stanford University, Stanford, California, 5 October, 2018.

54. Designing exoskeletons using emulation and optimization. 2018 Stanford & Seoul National University Robotics Workshop. Department of Mechanical Engineering, Stanford University, Stanford, California, USA, December 7, 2018.

55. Designing exoskeletons and prosthetic limbs that enhance human performance. Grand Rounds, Division of Physical Medicine & Rehabilitation, Stanford Medicine, Palo Alto Veteran's Administration, Palo Alto, California, USA, May 8, 2019.

56. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Robotics Seminar, Department of Mechanical Engineering, University of California Berkeley, Berkeley, California, USA, September 13, 2019.

57. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Department Seminar, Mechanical Engineering, University of California Santa Barbara, Santa Barbara, California, USA, October 7, 2019.

58. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Special Seminar, School of Engineering and Applied Sciences, Harvard University, Cambridge, Massachusetts, USA, October 18, 2019.

59. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Special Robotics Seminar, Department of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts, USA, October 16, 2019.

60. A discussion of how we design lower-limb exoskeletons and prosthetic devices. Boston Action Club, Departments of Biology, Electrical & Computer Engineering, and Physics, Northeastern University, Boston, Massachusetts, USA, October 17, 2019.

61. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Maryland Robotics Center, University of Maryland, College Park, Maryland, October 25, 2019.

62. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Department Seminar, Mechanical Engineering, California Institute of Technology, Pasadena, California, USA, November 8, 2019.

63. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Department Seminar, Mechanical Engineering, University of California Los Angeles, Los Angeles, California, USA, November 15, 2019.

64. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Department Seminar, Mechanical Engineering, University of California Irvine, Irvine, California, USA, November 22, 2019.

65. Designing exoskeletons and prosthetic limbs that enhance human locomotor performance. Department Seminar, Mechanical and Aerospace Engineering, University of California San Diego, San Diego, California, USA, December 6, 2019.

Other Significant Presentations

66. How to design wearable robots that augment human locomotor performance. Nike, Portland, Oregon, USA. January 21, 2016.

67. Low-power ankle exoskeletons that improve human locomotor performance. Nike, Portland, Oregon, USA. January 21, 2016.

Grants

Principal Investigator: ($5.7M, responsible for $5.1M)

1. Development of an actively-controlled prosthetic foot. National Science Foundation, Phase I STTR. PI, 2006-2007, $100,000.

2. Controlled energy storage and release in an intelligent prosthetic foot. National Science Foundation, Phase I STTR. PI, 2003-2004, $100,000.

3. Field-based gait monitoring system for the elderly. National Institutes of Health, Phase I STTR. PI, 2006-2007, $100,000.

4. Development of prosthetic foot with controlled energy storage and release. National Institutes of Health, Phase II STTR. PI, 2007-2010, $750,000.

5. Collaborative Research: User-optimal robotic prosthesis design. National Science Foundation, CMMI, Engineering and Systems Design. PI, 2013-2016, $216,000.

6. NRI: Small: Rapid exploration of robotic ankle exoskeleton control strategies. National Science Foundation, National Robotics Initiative. PI. 2013-2018, $800,000

7. *Internal:* New measurement capabilities for bio- and neuro-mechanics experiments. Carnegie Mellon University College of Engineering Dean's Equipment Grant. PI, 2014, $32,000.

8. *Internal:* Instrumented treadmill for biomechanics experiments. Carnegie Mellon University College of Engineering Dean's Equipment Grant. PI, 2015, $183,000.

9. Development and comparison of new methods for stabilizing amputee gait. National Science Foundation, CBET, General & Age-Related Disabilities Engineering. PI, 2015-2018, $370,226.

10. Ankle exoskeletons that make recreational runners faster. Nike. PI, 2016-2017, $265,000.

11. Algorithms for co-adaptive gait assistance. Panasonic. PI, 2016-2017, $148,000.

12. Optimizing hip, knee and ankle exoskeleton assistance during walking and running at various speeds and loads. U.S. Army, NSRDEC. PI, 2017-2019, $2,225,718 (responsible for $1,600,000).

13. *Internal:* Fast, multiphase human-in-the-loop optimization of exoskeleton assistance. Stanford AI Lab, Graduate School of Business and School of Medicine: Human-Centered AI Seed Grant. PI (Co-PI: Emma Brunskill), 2018-2019, $50,000 (responsible for $25,000).

14. Untethered ankle exoskeletons that make recreational runners faster. Nike. PI, 2018-2020, $365,000.

Co-Principal Investigator: ($5.5M, responsible for $1.3M)

15. Clinic-based robotic prosthesis emulator for amputee gait assessment. National Institutes of Health, Phase I SBIR. Co-PI (PI: Peter Adamczyk), 2013-2014, $150,000 (responsible for $50,000).

16. *Internal:* OptiTrack Motion Capture System. Carnegie Mellon University College of Engineering Dean's Equipment Grant. Co-PI (PI: Koushil Sreenath), 2014, $75,000 (responsible for $37,500).

17. NRI: Balance recovery control for amputees suing powered leg prostheses. National Science Foundation, National Robotics Initiative. Co-PI (PI: Hartmut Geyer), 2015-2018, $900,000 (responsible for $450,000).

18. A prosthetic foot emulator to optimize prescription of prosthetic feet in veterans and service members with leg amputations. Department of Defense, CDMRP OPORP. Co-PI (PI: David Morgenroth), 2016-2018, $2,500,000 (responsible for $48,000).

19. Bio-Inspired ankle-knee coupling to enhance walking for individuals with transtibial amputation. National Science Foundation, CBET, Disability and Rehabilitation Engineering. Co-PI (PI: Karl Zelik), 2017-2020, $340,000 (responsible for $10,000).

20. Individualized co-robotics. National Science Foundation, CISE, National Robotics Initiative. Co-PI (PI: Chris Atkeson), 2017-2020, $1,500,000 (responsible for $750,000).

Co-Investigator: ($3.2M, responsible for $310,000)

21. MRI: Acquisition of an additive manufacturing machine for 3D metal components for research and education. National Science Foundation. Co-I (PI: Burak Ozdoganlar), 2014, $546,000 (responsible for $50,000).

22. *Internal*: Acquisition of Arcam electron beam melting additive manufacturing equipment for direct metal fabrication. College of Engineering. Co-I (PI: Gary Fedder), 2014, $1,164,000 (responsible for $110,000).

23. Additive manufacturing research infrastructure. Department of Defense, Defense University Research Instrumentation Program. Co-I (PI: Jack Beuth), 2015, $1,500,000 (responsible for $150,000).

Professional Awards

1. McManus Design Award. Mechanical Engineering, Cornell University, 2002. The graduate or undergraduate student with the most outstanding solution to a design problem.

2. Department Fellowship. Mechanical Engineering, University of Michigan, 2002-2003.

3. NASA Fellowship. National Aeronautics and Space Administration Graduate Student Researchers Program, 2004-2005.

4. Struminger Faculty Teaching Fellow. Department of Mechanical Engineering, 2012.

5. Young Scientist Award, Post-Doctoral. *American Society of Biomechanics*, 2013.

6. Professor of the Year. Awarded by Mechanical Engineering Senior Class of 2014.

7. Best Medical Robotics Paper Award, *International Conference on Robotics and Automation*, Seattle, WA, USA, May 2015. One of eight awards from among 2,275 papers submitted.

Courses Taught

Carnegie Mellon University: (averages: course 4.1; instructor 4.0)

Course #	Course Title	Units	Class	Offered	Students	Course	Instructor
24-370	Design I	12	Jun	Spring 11	99	4.3	4.2
24-674	Biomechatronics	12	Gr	Fall 11	30	3.9	3.9
24-370	Design I	12	Jun	Spring 12	109	3.8	3.7
24-674	Biomechatronics	12	Gr	Fall 12	47	4.2	4.1
24-370	Design I	12	Jun	Spring 13	118	4.4	4.3
24-674	Biomechatronics	12	Gr	Fall 13	45	4.0	4.1
24-370	Design I	12	Jun	Spring 14	123	4.0	3.9
24-674	Biomechatronics	12	Gr	Fall 14	37	4.1	4.0
24-370	Design I	12	Jun	Spring 15	123	3.8	3.7
24-674	Biomechatronics	12	Gr	Fall 15	49	4.2	4.2
24-370	Design I	12	Jun	Fall 15	110	3.8	3.8
24-674	Biomechatronics	12	Gr	Spring 17	26	3.8	4.2
24-686	Adv. Mech. Des.	12	Gr	Spring 17	28	4.4	4.2

Stanford University: (averages: learned 4.0; instruction 4.0)

Quarter	Course Number & Title	Units	Enrollment	Learned	Instruction
Winter 18	ME 112: Mech. Syst. Des.	4	177	4.0	4.0
Fall 18	ME 380: Exo. Pros. Res.	3	24	3.8	4.2
Winter 19	ME 112: Mech. Syst. Des.	4	100	4.0	4.0
Winter 19	ME 228: Fut. Mech. Eng.	1	32	4.2	4.5
Winter 19	ME 389: Biomech. Sem.	1	11	3.8	4.2

Educational Initiatives:

At Stanford University:

1. *Contributed to curriculum revitalization:* BSME 2.0, 2017—2019
   a. Participated in committee meetings, workshops and documentation
   b. Helped organize the Design and Manufacturing Core (ME 102, 103 & 104)
   c. Coordinated with Biomechanics group on effects of new curriculum

2. *Developed a new graduate elective:* ME 380, Exoskeletons and Prosthetics, 2018
    a. Introduced a new elective for seniors and graduate students
    b. Developed format around structured literature review, presentations and writing

3. *Revised a core undergraduate course:* ME 104, Mechanical Systems Design, 2019—2020
    a. Adjusted syllabus to update content and coordinate with core
    b. Adjusted format to allow effective teaching to larger cohorts (180 per year)
    c. Developed readings, lectures and labs for a flipped classroom format.

At Carnegie Mellon University:

4. *Overhaul of a core Junior-level course:* 24-370, Engineering Design I, 2011—2017
    a. Added three projects with physical prototyping
    b. Developed new lectures and exercises in a flipped classroom format
    c. Developed new Topic Readings as substitute for textbook
    d. FCEs increased by about 0.6 points, many students reported this was their favorite course

5. *Developed new core Sophomore-level course:* 24-202, Intro to CAD, 2012—2014
    a. Developed syllabus and format
    b. Recruited and trained adjunct faculty
    c. Positive FCEs (about 4.0) and students reported being better prepared with CAD

6. *Developed new graduate elective:* 24-674, Design of Biomechatronic Systems, 2011—2017
    a. Introduced new course for seniors and graduate students
    b. Developed semester-long project format, with weekly one-hour meetings with each team
    c. Excellent projects, many students continued for independent research

7. *Developed New Graduate Seminar:* 24-892, Bipedal Locomotion Seminar, 2010—2017
    a. Founded CMU Bipedal Locomotion Seminar, brought together collabroators
    b. Organize weekly speakers, manage locations, website, and mailing list
    c. Well-attended, with about 30 participants from about 7 labs at 3 Institutions

8. *Infrastructure development:* College of Engineering manufacturing facilities reorg, 2014—2017
    a. Gathered shop usage information across the College
    b. Developed new usage plans and draft floor plans for architects
    c. Participated in fundraising activities
    d. The ANSYS Design and Innovation Center will soon open

9. *High-school outreach education:* Pittsburgh SciTech High School projects, 2013—2016
    a. Mentor high school team of 4-5 underprivileged students each year
    b. Lead weekly one-hour meetings
    c. Organize separate weekly meetings with CMU Senior undergraduates
    d. All past students have gone on to STEM studies in college

10. *Developed new graduate elective:* 24-686, Advanced Mechanical Design, 2017
    a. Introduced new course for seniors and graduate students
    b. Developed format and infrastructure for five targeted build projects
    c. Well-subscribed, enrollment of about 30, positive FCEs (about 4.3).

Student Advising and Mentoring

PhD Students supervised: (17 total, 6 graduated)

1. Joshua M. Caputo, Ph.D., Department of Mechanical Engineering (CMU), Fall 2010—Spring 2015. Bertucci Fellow. Now President of HuMoTech, a robotics startup company.

2. Juanjuan Zhang, Ph.D., Department of Mechanical Engineering (CMU), Fall 2010—Summer 2016. NTU Fellow. Dual-degree with NTU, Assoc. Prof. C. C. Cheah. Now an Associate Professor at Nankai University in China.

3. Myunghee Kim, Ph.D., Department of Mechanical Engineering (CMU), Fall 2011—Fall 2015. Now an Assistant Professor at the University of Illinois at Chicago.

4. Rachel W. Jackson, Department of Mechanical Engineering (CMU), Fall 2011—Spring 2017. NSF Fellow. Now a postdoctoral scholar in Bioengineering at Stanford University.

5. Stuart B. Diller, Department of Mechanical Engineering (CMU), Fall 2013—2018. Bertucci Fellow. Co-advised with Assistant Professor Carmel Majidi. Now President of ESTAT Actuation, a robotics startup company.

6. Kirby A. Witte, Department of Mechanical Engineering (CMU), Fall 2014—2018. NSF Fellow. Now a design engineer at Intuitive Surgical.

7. Katherine L. Poggensee, Department of Mechanical Engineering, Stanford, Fall 2014—present. NSF Fellow. Luce Fellow. Co-advised with Assistant Professor Koushil Sreenath.

8. Vincent L. Chiu, Department of Mechanical Engineering, Stanford, Fall 2015—present.

9. Gwendolyn M. Bryan, Department of Mechanical Engineering, Stanford, Fall 2016—present.

10. Patrick W. Franks, Department of Mechanical Engineering, Stanford, Fall 2016—present.

11. Thu Nguyen, Department of Mechanical Engineering, Stanford, Fall 2016—present. NSF Fellow. Stanford Graduate Fellow.

12. Guan Rong Tan, Department of Mechanical Engineering, Stanford, Fall 2016—present.

13. Julia Butterfield, Department of Mechanical Engineering, Stanford, Fall 2017—present. NSF Fellow. Stanford Graduate Fellow.

14. Rachel Adenekan, Department of Mechanical Engineering, Stanford, Winter 2018—present. NSF Fellow. Stanford Graduate Fellow.

15. Erez Krimsky, Department of Mechanical Engineering, Stanford, Winter 2018—present. NSF Fellow.

16. Delaney Miller, Department of Mechanical Engineering, Stanford, Autumn 2018—present.

17. Michael Raitor, Department of Mechanical Engineering, Stanford, Autumn 2018—present. NSF Fellow.

Postdoctoral researchers supervised: (4 total, 2 completed)

1. Philippe Malcolm, Department of Mechanical Engineering, Summer 2014. Now an Assistant Professor at the University of Nebraska at Omaha.

2. Pieter Fiers, Department of Mechanical Engineering, Spring 2016—Summer 2017. Now faculty line at the University of Ghent.

3. Alexandra Voloshina, Department of Mechanical Engineering, Stanford, Spring 2017—present.

4. Seungmoon Song, Department of Mechanical Engineering, Stanford, Winter 2018—present.

Master's Project Students Supervised: (28 total)

Lowie van Zijl, Laurent Huberty, Michiel Plooij, Matthew Glisson, Kanchi Nayaka, Ben Matzke, Jaan Warnaars, Jackie Yang, Tianyao Chen, Winton Zheng, Mailing Wu, Kirby Witte, Tanuf Tembulkar, Roberto Quesada, Biju Obi, Rohan Krishnan, Tianjian Chen, Zach Batts, Russell Kirmayer, Kyle Rawding, James Gabriel, Blair Emanuel, Evan Dvorak, Tyler Del Sesto, Robert Peuchen, Kevin Wang, Stefan Klein, HoJung Choi.

Undergraduate Research Students Supervised: (33 total)

Jonathan Boerner, Sarah Kunka, Lizmarie Comenencia-Ortiz, Matthew Stanton, Jessica Lee, Pace Nalbone, Robert Wojno, Mark Erazo, Steven Pepin, Jayon Wang, Ruthika, Eli Zauner, Patrick Sumner, Elena Yasinski, Eric Volk, Mike Spinelli, Faith Quist, Alvan Mbongo, Noah Fox, Stephanie Chen, Alec Assaad, Sean Archie, Michelle Mann, Hannah Lyness, Wentao He, Timothy Barber, Gustavo Costa, Andreas Fatschel, Cecilia Morales, Henry Peck, Jack Kaplan, Cymeyna McFarland, Ricardo Reyes.

Other Students Mentored: (16 total)

Doctoral: Marjolein van der Krogt, Daan Bregman, Sjoerd Bruijn, Vrije Universiteit Amsterdam; Tomas de Boer, Erik Schuitema and Daniël Karssen, Delft University of Technology; Karl Zelik, Shawn O'Connor, Peter Adamczyk and John Rebula, University of Michigan; Bruce Wiggin, North Carolina State University. *Undergraduate and Master's:* Karin Griffoen, Delft University of Technology; Matthew Vanderpool and Andrew Chang, University of Michigan; Chaim Garfinkel and Jerry Chien, Cornell University

Other Teaching Experience

1. Guest lecturer, MAE 225, Mechanical Synthesis, Cornell University, 2001—2002

2. Teaching assistant, Physics 101. Cornell University, 1999—2001

Other Professional Appointments

1. Mechanical design engineer, Yobotics Inc., Boston, Massachusetts, 2000—2001
   Supervisor: Jerry Pratt, Ph.D.

2. President and founder, Intelligent Prosthetic Systems L.L.C., Ann Arbor, MI, 2003—2010

3. Consultant, Bionic Power Inc., Vancouver, British Columbia, Canada, 2008—2010
   Supervisor: J. Maxwell Donelan, Ph.D.

4. Board Member: Scientific Advisory Board of the NIH National Center for Simulation in Rehabilitation Research, Spring 2016—present.

5. Adviser: American Bionics Project, May 2017—present.

6. Adjunct Associate Professor, Department of Biomechanics, University of Nebraska at Omaha, Omaha Nebraska, 2017—present.

7. Adjunct Associate Professor, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh Pennsylvania, Fall 2017—present

8. Faculty Affiliate, Bio-X, Stanford University, Stanford California, 2018—present

9. Founding Faculty Member, Stanford Robotics Center, Stanford University, 2018—present

Academic Service

Conference organizing:

1. Conference aide: Dynamic Walking, Ann Arbor, MI, May 2006.
   Conference with about 60 attendees.

2. Scientific board: Dynamic Walking, June 2008—present.
   Assist with speaker recruitment, reviews, and high-level organization of an annual conference.

3. Conference aide: Dynamic Walking 2008, Delft, the Netherlands.
   Conference with about 200 attendees.

4. Co-organizer, scientific program lead: Dynamic Walking 2009, Vancouver, Canada.
   Conference with about 200 attendees.

5. Lead organizer, co-host: Dynamic Walking 2013, Pittsburgh, PA, USA.
   Conference with about 200 attendees. www.cmu.edu/dynamic-walking

6. Symposium organizer: World Congress of Biomechanics 2014, Boston, MA, USA.
   Two sessions with nine invited speakers.

7. Session organizer: American Society of Biomechanics 2015, Columbus, OH, USA.
   Moderated one interactive session with five speakers selected from submitted abstracts.

8. Workshop co-organizer: Assistive robotic devices for dynamic locomotion, Robotics Science and Systems 2016, Ann Arbor, MI, USA. Full-day workshop with 12 invited speakers.

9. Workshop co-organizer: Exoskeleton research on the edge between robotics and human physiology, International Conference on Intelligent Robots and Systems 2016, Daejeon, Korea.

10. Support Coordinator: RSS Women in Robotics Workshop, June 23 2019, Freiburg, Germany.

11. Reviewer: Rising Stars in Mechanical Engineering Workshop, October 17-18 2019, Stanford, CA, USA.

Journal editing: (47 submissions managed for 2 journals)

12. Associate Editor: *International Journal of Robotics Research*, Fall 2017—Spring 2019.

13. Editorial Board: *Science Robotics*, Spring 2019—present

Peer review of publications: (173 reviews for 38 journals and conferences)

14. Referee for:
    1. *Proceedings of the National Academy of Sciences*
    2. *Science Robotics*
    3. *Science Translational Medicine*
    4. *Nature Biomedical Engineering*
    5. *Proceedings of the Royal Society of London Interface*
    6. *Nature Scientific Reports*
    7. *Science Advances*
    8. *British Medical Journal Open*
    9. *Public Library of Science ONE*
    10. *Journal of Biomechanics*
    11. *Journal of Experimental Biology*
    12. *Journal of Biomechanical Engineering*
    13. *International Journal of Robotics Research*
    14. *Transactions on Neural Systems & Rehabilitation Engineering*
    15. *IEEE Access*
    16. *Journal of Theoretical Biology*
    17. *Gait & Posture*
    18. *Experimental Brain Research*
    19. *Journal of NeuroEngineering and Rehabilitation*
    20. *Robotics and Automation Letters*
    21. *Robotics & Autonomous Systems*
    22. *Intelligent Autonomous Systems*
    23. *Autonomous Robots*
    24. *Human Movement Science*
    25. *Humanoids*
    26. *Robotics & Automation Magazine*
    27. *Transactions on Robotics*

28. *Robotica*
29. *Journal of Medical Devices*
30. *European Journal of Applied Physiology*
31. *Journal of Rehabilitation Research and Development*
32. *Mechatronics*
33. *Annual Meeting of the American Society of Biomechanics (ASB)*
34. *International Conference on Robotics and Automation (ICRA)*
35. *International Conference on Rehabilitation Robotics (ICORR)*
36. *International Conference on Robotics and Biomimetics (ROBIO)*
37. *International Conference on Intelligent Robots and Systems (IROS)*
38. *Dynamic Systems and Control Conference (DSCC).*

Grants review: (51 proposals reviewed in 5 programs)

15. National Institutes of Health (NIH) Musculoskeletal Rehabilitation Sciences (MRS) Study Section.

16. National Science Foundation (NSF) General and Age-Related Disabilities Engineering (GARDE) Program.

17. National Science Foundation (NSF) Undisclosed Program.

18. National Science Foundation (NSF) National Robotics Initiative (NRI) Program.

19. NIH National Center for Simulation in Rehabilitation Research Pilot Program.

External faculty review:

20. Six external reviews of faculty promotion and tenure cases.

Departmental Service: Mechanical Engineering at Stanford University

21. Member: Undergraduate Curriculum Committee, Fall 2017—Summer 2019.

22. Liaison: BSME 2.0 with Design & Manufacturing Core, Biomechanics, Fall 2017—Summer 2019.

23. Proctor: Qualifying Exams. Research, Robotics and Biomechanics, 11 exams, 2017—present.

24. Coordinator: Biomechanics Group Meetings, 2018.

25. Ph.D. Thesis Reading Committee Member:
    a. Cole Simpson, Mechanical Engineering, Stanford, 2017—present.
    b. Marc Deetjen, Mechanical Engineering, Stanford, 2018—2019.
    c. Sean Sketch, Mechanical Engineering, Stanford, 2018—2019.
    d. Patrick Slade, Mechanical Engineering, Stanford, 2018—present.
    e. Chris Dembia, Mechanical Engineering, Stanford, 2019—present.

26. Ph.D. Oral Defense Committee Member:
    a. Jennifer Yong, Mechanical Engineering, Stanford, 2018.

27. Co-Chair: Faculty Search Committee, 2018—2019.

28. Member: Graduate Curriculum Committee, Fall 2019—present.

School and University Service: Stanford University

29. Ph.D. Dissertation Co-Advisor:
    a. Brian Jackson, Aeronautics & Astronautics, Stanford, 2019—present.

30. Ph.D. Thesis Reading Committee Member:
    a. Cara Welker, Bioengineering, Stanford, 2017—present.

31. Ph.D. Oral Defense Committee Member:
    a. Calvin Kuo, Bioengineering, Stanford, 2017-2018.

32. Ph.D. Committee University Chair:
    a. Jake Sganga, Bioengineering, Stanford, 2019.

33. Faculty Host, Grant Writing Academy. Two two-hour sessions, 2018—2019.

34. Housing outreach to Santa Clara County. Wrote letters and attended hearings. 2018—2019.

35. Faculty recruitment
    a. Meagan Mauter, now in CEE. Several meetings and phone calls, 2017-2019.
    b. Francis (Alvin) Pearman, now in GSE. A few meetings and phone calls, 2018-2019.
    c. Karen Liu, now in CS. A few meetings and phone calls, 2018-2019.
    d. Grace Gao, now in AA. A few phone calls, 2019.
    e. Hae Young Noh, now in CEE. A few meetings and phone calls, 2019.

Departmental Service: Mechanical Engineering and Robotics at Carnegie Mellon University

36. Proctor: Qualifying Exams. Control, Solid Mechanics, Design and Research, 2010—2017. (champion for number of exams administered, at the time, with 86 in 7 cycles)

37. Member: Mechanical Engineering Undergraduate Education Committee, Fall 2010—2017

38. Lead: Mechanical Engineering Undergraduate Teaching Fellow program, Fall 2011—2017

39. Member: Mechanical Engineering Robotics Strategic Planning Committee, 2013—2015

40. Member: Mechanical Engineering Shop Reorganization Committee, 2013—2017

41. Reviewer: CMU Robotics Minor program, 2014-2017

42. Member: Faculty search committee, 2015—2017

43. Ph.D. Committee member:
    a. Siddharth Sanan, Robotics Institute, CMU, 2010-2013.
    b. Sehyuk Yim, Mechanical Engineering, CMU, 2012.

c. Mohamed Saleh, Mechanical Engineering, CMU, 2013-2015.
d. Matthew Woodward, Mechanical Engineering, CMU, 2014-2017.
e. Alexander Schepelmann, Robotics Institute, CMU, 2014-2016.
f. Nitish Thatte, Robotics Institute, CMU, 2016—2019.

44. Judge: Bennett Conference, Carnegie Mellon University, Pittsburgh, PA, 2011, 2015.

School and University Level Service: Carnegie Mellon University

45. Member: College of Engineering Manufacturing Facilities Committee, 2014—2017

46. Judge: Meeting of the Minds, 2016

47. Judge: Sweepstakes buggy design competition, 2013—2016

Other Academic and Societal Service:

48. Ph.D. Committee member:
    a. Karl Zelik, Mechanical Engineering, University of Michigan, 2009-2012.
    b. Sjoerd Bruijn, Biomedical Kinesiology, Vrije Universiteit Amsterdam, 2010.
    c. Bruce Wiggin, Biomedical Engineering, North Carolina State University, 2012-2014.
    d. Matthew Handford, Mechanical Engineering, Ohio State University, 2016-2018.
    e. Matthew Yandell, Mechanical Engineering, Vanderbilt University, 2018-present.

49. Booth: American Association for the Advancement of Science (AAAS) Family Science Days, Washington DC, USA. February, 2005

50. Session leader: SWE High School Days, Carnegie Mellon University, Pittsburgh, PA, 2010—2013

51. Co-Organizer: Amp Up! Pittsburgh Amputee Support Group, 2011—2012

52. Judge: FIRST Robotics competition, National Robotics Engineering Center, Pittsburgh, PA, December 2011

53. Guest Lecture: How to design robotic prostheses, Ellis School for girls, Pittsburgh, PA, October 30, 2013

54. Poster at: American Orthotics and Prosthetics Association National Assembly, Las Vegas, NV, USA. Sept. 4-7 2014

55. Guest lecture: Applied Physiology 6202, Clinical Gait Analysis, Young-Hui Chang, Georgia Institute of Technology, Altanta, GA, 12 November, 2014

56. Guest lecture: Integrative Physiology 6660, Biomechanics and Energetics of Locomotion Rodger Kram, University of Colorado, Boulder, 19 November 2014

Professional memberships

1. Member, American Society of Biomechanics (ASB), 2003—present

2. Member, Institute of Electrical and Electronics Engineers (IEEE), 2012—present

3. Member, American Physiological Society (APS), 2014—present

4. Member, Robotics and Automation Society (RAS), 2015—present

Selected popular press and reviews

1. Efficient walking robot work is reviewed in: Alexander, R. M. (2005) Perspective: Walking made simple. *Science*, **308**(5718):58-59.

2. Efficient walking robot research was reported by the following popular press outlets:
   a. AP (February 2005)
   b. AFP (February 2005)
   c. BBC (February 2005)
   d. Der Spiegel (February 2005)
   e. Discover Magazine (January 2006)
   f. Discovery Channel Canada (February 2005)
   g. The Guardian (February 2005)
   h. The Independent (February 2005)
   i. Machine Design (March 2005)
   j. Nature News (February 2005)
   k. The New Scientist (February 2005)
   l. NPR's Day to Day (February 2005)
   m. New York Times (February 2005)
   n. Popular Mechanics (June 2005)
   o. Reuters (February 2005)
   p. Science News (August 2005)
   q. Science Channel (February 2005)
   r. Scientific American (February 2005)
   s. The Telegraph (February 2005)
   t. The Times (London, February 2005)
   u. The World (BBC/PRI, February 2005)
   (hundreds of additional news outlets internationally)

3. Arm swinging work is reviewed in: Gillis, G. B. (2009) Outside JEB: Getting into the swing of walking. *J. Experimental Biology*, **212**:V.

4. Arm swinging work was reported by the following popular press:
   a. AFP (August 2009)
   b. Discovery Channel Magazine (January 2010)
   c. The Guardian (August 2009)
   d. The Independent (August 2009)
   e. Radio Nacional de Columbia (August 2009)
   f. Reuters (August 2009)
   g. Scientific American (August 2009)
   h. The Telegraph (August 2009)
   i. Brille, Norwegian TV show (May, 2018)

5. Energy-recycling artificial foot work was reported by the following popular press
    a. CBC Radio's As It Happens (February 2010)
    b. New Scientist (February 2010)
    c. Popular Science (February 2010)
    d. NRC Handelsblad (February 2010)

6. Robotic emulator system work reported by the following popular press:
    a. Site Selection Magazine (September 2014)
    b. Newsmax (March 2015)
    c. ASME Hot Labs (January 2016)

7. Unpowered ankle exoskeleton work is reviewed in:
    a. Castelvecchi, D. (2015) News: Exoskeleton boots improve on evolution – Unpowered mechanical design lowers the energetic costs of walking. *Nature*, **doi**:10.1038/nature.2015.17237
    b. Nature Editorial Board (2015) Editorial: Walking 2.0 – A passive device that augments calf muscles improves on natural selection's best effort. *Nature*, 520:6, **doi**:10.1038/520006a.
    c. Conover, E. (2015) ScienceShot: Exoskeleton boot reduces cost of walking by 7%. *Science*, **doi**:10.1126/science.aab0409
    d. NIH National Institutes of Nursing Research News & Notes, April 23, 2015
    e. NSF Press Release 15-031, April 1, 2015

8. Unpowered ankle exoskeleton work reported by the following popular press:
    a. The New York Times (USA, April, 2015)
    b. The Washington Post (USA, April, 2015)
    c. NPR's Science Friday (USA, April, 2015)
    d. NBC News (USA, April, 2015)
    e. The Associated Press (USA, April, 2015)
    f. CBC's Quirks & Quarks (Canada, April, 2015)
    g. The Economist (United Kingdom, April, 2015)
    h. BBC News (United Kingdom, April, 2015)
    i. The Guardian (United Kingdom, April, 2015)
    j. The Independent (United Kingdom, April, 2015)
    k. Der Spiegel (Germany, April, 2015)
    l. Agence France-Presse (France, April, 2015)
    m. El País (Spain, April, 2015)
    n. NRC Handelsblad (The Netherlands, April, 2015)
    o. ORF1's Wissen Aktuell (Austria, April, 2015)
    p. Correio Braziliense (Brazil, April 2015)
    q. Popular Mechanics (USA, April 2015)
    r. Popular Science (USA, April 2015)
    s. Wired, Discovery News, Gizmodo, Engadget, Fusion, etc. (April 2015)
    t. Fox's Earth 2050 (September 2015)
    u. ASME (February 2016)
    v. Next Avenue (March 2016)
    (hundreds of additional news outlets internationally)

9. Human-in-the-loop optimization work is reviewed in:

  a. Malcolm, P., Galle, S., De Clercq, D. (2017) Fast exoskeleton optimization. *Science*, **356**:1230-1231.

10. Human-in-the-loop optimization work reported by the following popular press:
    a. Scientific American (USA, July 2017)
    b. Quirks & Quarks (Canada, June 2017)
    c. Deutschlandfunk (Germany, June 2017)
    d. ORF (Austria, June 2017)
    e. El Pais (Spain, June 2017)
    f. EOS Wetenschap (The Netherlands, June 2017)
    g. Wired (USA, June 2017)
    h. Motherboard (USA, June 2017)
    i. Voice of America (USA, June 2017)
    j. Deutsches Ärzteblatt International (Germany, June 2017)
    k. N+1 (Russia, June 2017)
    l. Sydney Morning Herald (Australia, July 2017)
    m. CBC News (Canada, June 2017)
    n. Science 360 (USA, June 2017)
    o. U.S. News & World Report (USA, July 2017)
    p. Phys.org (USA, June 2017)
    q. O&P Edge (USA, June 2017)
    r. Pittsburgh Post-Gazette (front page, July 10, 2017)
    (hundreds of additional news outlets internationally)