

**Thomas G. Sugar
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1. ACADEMIC APPOINTMENTS

2013- Present Arizona State University Mesa, AZ
Professor

2007-2013 Arizona State University Mesa, AZ
Associate Professor

Department of Engineering

Classes: Introduction to Engineering 1, Introduction to Engineering II, EGR 201, EGR 202, studio based instruction, EGR 301 Junior project course, EGR 346 Engineering Design, EGR 445 Mechanical Engineering Systems, EGR 401, EGR 402, Senior Projects, EGR 394 Robotics 1, EGR 494 Robotics 2

2005-2007 Arizona State University Mesa, AZ
Assistant Professor

Department of Engineering

Classes: Introduction to Engineering 1, Introduction to Engineering II, EGR 201, studio based instruction

1999-2005 Arizona State University Tempe, AZ
Assistant Professor

Design group in the Mechanical and Aerospace Engineering Department

Classes: Mechanism Analysis and Design, Mechanical Systems Design, Mechanical Design and Control of Robots, Introduction to Engineering, Engineering Design, Computer Aided Manufacturing and Control

1995–1999 GRASP Laboratory Philadelphia, PA
Research Fellow

Designed an integrated system for coordinating a small team of mobile robots in tasks that involve grasping large objects and transporting them in an environment with obstacles. The system included three robots with different operating systems, a wireless communication protocol, and specially designed embedded motor control boards.

1996–1997 U. of Pennsylvania Philadelphia, PA
Graduate Advisor for the Gateway Project

Supervised several teams of undergraduates in designing and building robotic and rehabilitative devices in a multi-university, collaborative design project.

ASU Research Goals:

Health Systems & Technology

Research includes: powered prosthetics, wearable robotic exoskeletons, rehabilitation robotics

Director of the Integrated Manufacturing and Engineering Laboratory, 2004 and 2005

Collaborations:

Arts, Media, and Engineering Laboratory, Topic: Spatial Navigation

Dr. M. McBeath in Psychology, Topic: Spatial Navigation

Dr. Jiping He, Bioengineering, Topic: Compliant Exoskeletons

Prof. D. Herring, Industrial Design

Dr. R. Herman, Good Samaritan Hospital

Dr. J. Koeneman, Kinetic Muscles, Inc.

Dr. V. Bonilla, Robotics Group, Inc.

Dr. Just Herder, Delft University

Dr. Jack Engsborg, Human Performance Laboratory, Washington University at St. Louis

Dr. Alain Berthoz, College de France

6. EDUCATION

University of Pennsylvania Mechanical Engineering and Applied Mechanics Ph.D., 1999

Dissertation: Design and control of cooperative mobile robotic systems.

University of Pennsylvania Mechanical Engineering and Applied Mechanics M.S.E., 1992

Thesis: Design and control of an in-parallel pneumatically actuated manipulator.

University of Pennsylvania Mechanical Engineering and Applied Mechanics B.S.E., 1991

School of Engineering and Applied Sciences

University of Pennsylvania B.S. in Economics

B.S.E., 1991

The Wharton School of Business

Concentration in Entrepreneurial Management

Management and Technology Program.

7. SCIENTIFIC AND PROFESSIONAL SOCIETIES

ASME 1997-2014

IEEE 1999-2014

RESEARCH AND SCHOLARSHIP

PUBLICATIONS

Refereed Archival Journal Papers

Publish or Perish: H Index 26, 206 Papers, 2319 Citations

J30. W. Wang, M. K. McBeath, T. G. Sugar, “Optical Angular Constancy is Maintained as a Navigational Control Strategy when Pursuing Robots Moving along Complex Pathways,” *Journal of Vision* accepted 2015.

J29. T. G. Sugar, A. Bates, M. Holgate, J. Kerestes, M. Mignolet, P. New, R. K. Ramachandran, S. Redkar, C. Wheeler, “Limit Cycles to Enhance Human Performance based on Phase Oscillators,” *ASME Journal of Mechanisms and Robotics*, 7(1), February 2015 doi: 10.1115/1.4029336.

J28. W. Wang, M. K. McBeath, T. G. Sugar, “Navigational strategy used to intercept fly balls under real-world conditions with moving visual background fields,” *Attention, Perception, and Psychophysics*, November 2014, pages 1-13.

J27. T. G. Sugar, K. W. Hollander, A. Boehler, and J. Ward, “Comparison and Analysis of a Robotic Tendon and JackSpring Actuator for Wearable Robotic Systems,” *ASME Journal of Medical Devices* 7(4) 2013.

J26. D Bernardin, H. Kadone, D. Bennequin, T. Sugar, M. Zaoui, A. Berthoz, “Gaze Anticipation during Human Locomotion”, *Experimental Brain Research*, vol 223, 2012, pp 65-78.

J25. Jeffrey Ward, Thomas Sugar, Alexander Boehler, John Standeven, Jack R. Engsborg, “Stroke Survivors’ Gait Adaptations to a Powered Ankle-Foot Orthosis, *Advanced Robotics*, vol 25, (15), November 15, 2011 pp. 1879-1901.

J24. Sangram Redkar, Tom Sugar, Anshuman Razdan, Ujwal Koneru , Bill Dillard, and Karthik Narayanan, ' Using Inertial Measurement to Sense Crash Test Dummy Kinematics', *International Journal of Modern Engineering*, vol 10(2), 2010.

J23. Joseph K. Hitt, Thomas G. Sugar, Matthew Holgate, and Ryan Bellman, “An Active Foot-Ankle Prosthesis with Biomechanical Energy Regeneration”, *ASME Journal of Medical Devices*, vol 4(1) 2010.

Number 1 downloaded paper for the journal in April and May 2010

J22. Hitt, J, Holgate, M, Bellman, R, Sugar, TG, Hollander, KW, “Robotic Transtibial Prosthesis with Biomechanical Energy Regeneration”, *Industrial Robot: An International Journal*, vol 36(5), pp. 441-447, 2009.

Outstanding Paper Award Winner at the Literati Network Awards for Excellence 2010.

J21. Ronald Van Ham, Thomas G. Sugar, Bram Vanderborght, Kevin W. Hollander, Dirk Lefeber, “Compliant Actuator Designs: Review of Actuators with Passive Adjustable Compliance / Controllable stiffness for Robotic Applications”, *IEEE Robotics and Automation Magazine*, vol 16(3), pp. 81-94, September 2009.

Top Ten downloaded paper for the Magazine

Our article is in top 10 download in February 2010

<http://ieeexplore.ieee.org/xpl/topAccessedArticles.jsp?reload=true&punumber=100>

J20. B Vanderborght, R. Van Ham, D. Lefeber, T. G. Sugar, K. W. Hollander, “Comparison of Mechanical Design and Energy Consumption of Adaptable, Passive-compliant Actuators,” *International Journal of Robotics Research*, vol 28(1), pp. 90-103, 2009.

J19. I. Dolgov, M. K. McBeath, and T. G. Sugar, “Evidence for Axis-Aligned Motion Bias: Football Axis-Trajectory Misalignment Causes Systematic Error in Projected Final Destinations of Thrown American Footballs,” *Perception*, 2009, doi:10.1068/p6114

J18. J. Ward, A. Boehler, D. Shin, K. Hollander, T. Sugar, “Control Architectures for a Powered Ankle Foot Orthosis,” *International Journal of Assistive Robotics and Mechatronics*, vol 9(2), pp. 2-13, 2008

J17. D. M. Shaffer, M. K. McBeath, S. M. Krauchunas, and T. G. Sugar, “Evidence for a Generic Interceptive Strategy,” *Perception and Psychophysics*, vol 70(1), pp. 145-157, 2008.

J16. T. Sugar, Jiping He, E.J. Koeneman, J.B. Koeneman, R. Herman, H. Huang, R. S. Schultz, D. E. Herring, J. Wanberg, J. Ward, and S. Balasubramanian, “Design and Control of RUPERT: a Device for Robotic Upper Extremity Repetitive Therapy”, *IEEE-TNSRE Special Issue on Rehabilitation Robotics*, vol 15(3), pp 336-346, September 2007.

J15. T. G. Sugar, M. K. McBeath, A. Suluh, and K. Mundhra, "Mobile Robot Interception using Human Navigational Principles: Comparison of Active versus Passive Tracking Algorithms," *Autonomous Robots*, vol 21(1), pp. 43-54, August 2006.

J14. T. G. Sugar, M. K. McBeath, and **Z. Wang**, “A Unified Fielder Theory for Interception of Moving Objects either Above or Below the Horizon,” *Psychonomic Bulletin and Review*, vol 13(5), pp 908-917, October 2006.

J13. K. W. Hollander, Robert Ilg, T. G. Sugar, and D. E. Herring, “An Efficient Robotic Tendon for Gait Assistance,” *ASME Journal of Biomechanical Engineering*, vol 128(5), pp. 788-791, October 2006.

J12. K. Hollander and T. G. Sugar, “Design of Lightweight Lead Screw Actuators for Wearable Robotic Applications,” *ASME Journal of Mechanical Design*, vol. 128(3), pp. 644-648, May 2006.

J11. K. Bharadwaj, T. G. Sugar, J. B. Koeneman, and E. J. Koeneman, “Design of a Robotic Gait Trainer using Spring Over Muscle Actuators for Ankle Stroke Rehabilitation,” Special Issue on Medical Devices, *ASME Journal of Biomechanical Engineering*, vol. 127, pp. 1009-1013, November 2005.

J10. M. K. McBeath and T. G. Sugar, "Natural Selection of Asymmetric Traits Operates at Multiple Levels," *Behavioral and Brain Sciences*, vol. 28(4), pp. 605-606, August 2005.

Professor McBeath was the lead author on this paper developing the main ideas.

J9. C. Oberle, M. K. McBeath, S. Madigan, and T. G. Sugar, "The Galileo Bias: A Naïve Conceptual Belief that Influences People's Perceptions and Performance in a Ball-Dropping Task," *Journal of Experimental Psychology: Learning, Memory, & Cognition*, vol. 31(4), pp. 643-653, 2005.

J8. T. G. Sugar and J. P. Desai, "A Framework for Kinematic and Dynamic Motion Planning for a Formation of Mobile Robots," *Journal of Intelligent Automation and Soft Computing*, vol. 10(4) pp. 307-322, 2004.

J7. D. Burns and T. G. Sugar, "Rapid Embedded Programming in the Mathworks Environment," *JCISE, Journal of Computing and Information Science in Engineering*, vol. 2(3), pp. 237-241, September 2002.

J6. T. G. Sugar and V. Kumar, "Metrics for Analysis and Optimization of Grasps and Fixtures," Special Issue on Compliance and Compliant Mechanisms, *International Journal of Robotics and Automation*, vol. 17(1), pp. 28-37, 2002.

J5. T. G. Sugar and V. Kumar, "Control of Cooperating Mobile Manipulators," *IEEE Transactions on Robotics and Automation*, vol. 18(1), pp. 94-103, 2002. Impact Factor 2.126. (Number 1 in robotics)

J4. T. G. Sugar and V. Kumar, "Design and Control of a Compliant Parallel Manipulator," *ASME Journal of Mechanical Design*, vol. 124, pp. 676-683, 2002.

J3. T. G. Sugar, "A Novel Selective Compliant Actuator," *Mechatronics*, vol. 12(9-10), pp. 1157-1171, 2002.

J2. T. G. Sugar and M. McBeath, "Robotic Modeling of Mobile Ball-Catching as a Tool for Understanding Biological Interceptive Behavior," *Behavioral and Brain Sciences*, vol. 24(6), pp. 1078-1080, 2001.

J1. G. Pfreundschuh, T. G. Sugar, and V. Kumar, "Design and control of a three degree-of-freedom, in-parallel, actuated manipulator," *Journal of Robotic Systems*, vol. 11(2), pp. 103-115, 1994.

Reviewed Trade Journals

T. G. Sugar, "Tight Mobile Robot Cooperation," in *Robotics and Machine Perception, SPIE*, vol. 11, pp. 4, 11, 2002.

Published book chapter (an edited publication):

I. Dolgov, M.K. McBeath, and T.G. Sugar, "The influence of symmetry on perception of thrown, oblong, symmetrical projectiles in 3D," in H. Heft and K.L. Marsh (Eds.), *Studies in Perception and Action VIII*, pp. 132-135, Mahwah, NJ: Erlbaum, 2005.

Hollander, K.W., and T.G. Sugar, "Powered Human Gait Assistance", *Rehabilitation Robotics*, editor Sashi Kommu, I-Tech Education and Publishing, August 2007, ISBN 978-3902613-01

Pending Articles:

In Preparation:

M. K. McBeath, and T. G. Sugar, "Perception-action navigation models and mobile robot research and design help guide each other," in preparation.

M. K. McBeath, T. G. Sugar, J. M. Thompson, and Z. Wang, "Follow the bouncing ball: Fielders keep the centroid of bouncing grounders along a Linear Optical Trajectory," in preparation.

The origins of navigational strategies to catch balls, D. Shaffer, A. Maynor, I. Golgov, and T. Sugar, in preparation.

Functional Recovery from Hemiparetic Stroke Using Real and Illusory Robot-Controlled Repetitive Motion" Flavio J.K. Da Silva, M. McBeath, T. Sugar, *Frontiers in Human Neuroscience* submitted on 13 Jul 2011.

Gait Comparison of Passive and Active Terminal Devices for Persons with Unilateral Transtibial Amputation, Jack R. Engsborg, C. Janice Hsu, Thomas Sugar, Kevin Hollander, in preparation.

PUBLICATIONS

National Conference Proceedings Refereed Papers

Published in Book

C65. T. G. Sugar and M. Holgate, "Understanding Speed and Force Ratios for Compliant Mechanisms," in *Advances in Mechanisms, Robotics and Design Education and Research, Mechanisms and Machine Science 14*, V. Kumar et al (Eds): Springer International Publishing, 2013, pp. 117-129.

C64. T. G. Sugar and V. Kumar, "Control and coordination of multiple mobile robots in manipulation and material handling tasks," in *Experimental Robotics VI*, vol. 250, *Lecture Notes in Control and Information Sciences*, P. Corke and J. Trevelyan, Eds.: Springer-Verlag, pp. 15-24, 2000, ISBN 1-85233-210-7.

C63. V. Kumar, T. G. Sugar, and G. Pfreundschuh, "A Three Degree-of-Freedom In-Parallel Actuated Manipulator," in *9th CISM-IFTOMM Symposium on the Theory and Practice of Robot Manipulators, RoManSy 9*, A. Morecki, G. Bianchi, and K. Jaworek, Eds. Udine, Italy: Springer-Verlag, pp. 217-226, 1992, ISBN 0-387-19834-2.

Conference Papers

C62. Sugar, T. G. Kerestes, J., "Developing Exoskeletons to Enhance Running Speed," WeRob 2014.

C61. Holgate, M., Sugar, T. G., "Active Compliant Parallel Mechanisms," IDETC 2014.

C60. New, P., Wheeler, C., Sugar, T. G., "Robotic Hopper Using Phase Oscillator Controller," IDETC 2014.

C59. Schroeder, K., Sugar, T. G., Flaven, T., "A Novel Force Sensitive Resistor Wheatstone Bridge for Prosthesis Control," IDETC 2014.

C58. Kerestes, J., Sugar, T. G., Holgate, M., "Adding and Subtracting Energy to Body Motion –

Phase Oscillator,” IDETC 2014.

C57. Kerestes, J., Sugar, T. G., Flaven, T., Holgate, M., “A Method to Add Energy to Running Gait – PogoSuit,” IDETC 2014.

C56. Kerestes, J., Sugar, T. G., “Enhanced Running Using a JetPack,” IDETC 2014.

C55. Sugar, T. G., Holgate, M., “Compliant Mechanisms for Robotic Ankles,” IDETC 2013.

C54. Ward, J., Sugar, T. G., Hollander, K. W., “Optimizing the Translational Potential Energy of Springs for Prosthetic Systems”, MSC 2011.

C53. Sugar, T. G., Hollander, K. W., Hitt, J. K., “Walking with Springs,” SPIE, EAPAD, 2011.

C52. Hitt, J., Merlo, J., Boehler, A., Holgate, M., and Sugar, T., “Bionic Running for Unilateral Transtibial Military Amputees,” 27th Army Science Conference, Orlando, Florida, Nov., 2010.

C51. Hitt, J., Brechue, W., Boehler, A., Ward, J., Hollander, K., Sugar, T., Audet, D., and Kanagaiki, D., “Dismounted Soldier Biomechanical Power Regeneration,” 27th Army Science Conference, Orlando, Florida, Nov., 2010.

C50. Hitt, J., and Sugar, T., “Load Carriage Effects on a Robotic Transtibial Prosthesis,” International Conference on Control, Automation and Systems, Gyeonggi-do, Korea, Oct, 2010.

C49. Jeffrey Ward, T. Sugar, J. Standeven, J. R. Engsborg, “Stroke Survivor Gait Adaption and Performance After Training on a Powered Ankle Foot Orthosis”, IEEE International Conference on Robotics and Automation (ICRA), 2010.

C48. Briner, D., Sardhara, A., Sugar, T., “A Multi-Pin End-Effector for a Robotic Colony Picker,” ASME Early Career Technical Conference, Oct 2009.

C47. S. Redkar, T. Sugar, B. Dillard, and K. Narayanan, “Inertial Sensing of Dummy Kinematics,” ASME International Design Engineering Technical Conference, CD-ROM, 2009.

C46. M. Holgate, T. G. Sugar, A. Boehler, “A Novel Control Algorithm for Wearable Robotics using Phase Plane Invariants, IEEE International Conference on Robotics and Automation (ICRA), 2009.

C45. M. Holgate, J. K. Hitt, R. D. Bellman, T. G. Sugar, K. W. Hollander, “The SPARKy (Spring Ankle with Regenerative Kinetics) Project: Choosing a DC Motor Based Actuation Method,” Biorobotics 2008.

C44. R. D. Bellman, T. G. Sugar, “SPARKy 3: Design of an Active Robotic Ankle Prosthesis with Two Actuated Degrees of Freedom Using Regenerative Kinetics,” Biorobotics 2008.

C43. M. A. Holgate, A. W. Boehler, T. G. Sugar, “Control Algorithms for Ankle Robots: A Reflection on the State-of-the-Art and Presentation of Two Novel Algorithms,” Biorobotics 2008.

C42. A. Boehler, K. W. Hollander, T. G. Sugar, D. Shin, “Design, Implementation and Test Results of a Robust Control Method for a Powered Ankle Foot Orthosis (AFO), IEEE International Conference on Robotics and Automation (ICRA), 2008.

C41. Shin, D., Wolf, P., Thomas, Sugar, and Herring, D., *It Takes Two to Tango: Designers and engineers team up to develop an innovative stroke rehabilitation device*, 2nd International Conference on Applied Human Factors and Ergonomics (AHFEI), 2008.

C40. J. Hitt, R. Bellman, M. Holgate, T. Sugar, and K. Hollander, The SPARKy (Spring Ankle with Regenerative Kinetics) Project: Design and Analysis of a Robotic Transtibial Prosthesis with Regenerative Kinetics, ASME International Design Engineering Technical Conference, CD-ROM, pp. 1-10, 2007.

- C39. K. Hollander and T. Sugar, "A Robust Control Concept for Robotic Ankle Gait Assistance," IEEE International Conference on Rehabilitation Robotics (ICORR), Holland, 2007.
- C38. J. Ward, S. Balusubramaniam, and T. Sugar, "Robotic Gait Trainer Reliability and Stroke Patient Case Study," IEEE International Conference on Rehabilitation Robotics (ICORR), Holland, 2007.
- C37. A. Mehmet Oymagil, J. Hitt, T. Sugar, and J. Fleeger, "Control of a Regenerative Braking Powered Ankle Foot Orthosis," IEEE International Conference on Rehabilitation Robotics (ICORR), Holland, 2007.
- C36. J. Hitt, A. Mehmet Oymagil, T. Sugar, K. Hollander, A. Boehler and J. Fleeger, "Dynamically Controlled Ankle-Foot Orthosis (DCO) with Regenerative Kinetics: Incrementally Attaining User Portability," IEEE International Conference on Robotics and Automation (ICRA), Roma, Italy, 2007.
- C35. D. Morrell, R. Grondin, C.Y. Kuo, C. Roberts, R. Hinks, M. Henderson, T. Sugar, and S. Danielson, "Beyond Measurement: Designing Engineering Outcomes to Foster Student Achievement," 2006 American Society for Engineering Education Annual Conference and Exposition, June 2006.
- C34. J. Ward, J. Hitt, T. Sugar, and K. Bharadwaj, "Dynamic Pace Controller for the Robotic Gait Trainer," ASME International Design Engineering Technical Conference, CD-ROM, pp. 1-6, 2006.
- ICRA is accepting only 39% of the submitted conference papers*
- C33. Z. Wang, A. Paranjape, T. Sugar, and M. K. McBeath, "Perceptual Navigation Strategy for Mobile Robots Intercepting Ground Balls," IEEE International Conference on Robotics and Automation, pp. 2713-2718, 2006.
- C32. K. Bharadwaj and T. G. Sugar, "Kinematics of a robotic gait trainer for stroke rehabilitation," IEEE International Conference on Robotics and Automation, pp. 3492-3497, 2006.
- C31. J. He, E. Koeneman, R. Schultz, D. E. Herring, J. Wanberg, H. Huang, T. Sugar, R. Herman, and J. Koeneman, "RUPERT: A Device for Robotic Upper Extremity Repetitive Therapy," 27th IEEE EMBS Annual International Conference, Shanghai, China, September 1-4, 2005.
- C30. S. Danielson, M. Henderson, C.Y. Kou, D. Morrell, R. Grondin, R. Hicks, and T. Sugar, "A Clean Slate: Designing A Mechanical Systems Concentration Within A New Engineering Program" Proceedings of IMECE2005, 2005 International Mechanical Engineering Conference and Exposition, Orlando, Florida, USA, November 5-11, 2005.
- C29. K. Bharadwaj and T. G. Sugar, "Design of a robotic gait trainer using spring over muscle actuators for ankle stroke rehabilitation," Design of Medical Devices Conference, pp. 1-10, 2005.
- C28. K. W. Hollander, R. Ilg, and T. G. Sugar, "Design of the Robotic Tendon," Design of Medical Devices, pp. 1-3, 2005.
- C27. K. W. Hollander and T. G. Sugar, "Design of Lead Screw Actuators for Wearable Robotic Applications," ASME International Design Engineering Technical Conference, CD-ROM, pp. 1-10, 2005.

- C26. K. W. Hollander, T. G. Sugar, and D. Herring, "A Robotic Jack Spring for Ankle Gait Assistance," ASME International Design Engineering Technical Conference, CD-ROM, pp. 1-10, 2005. 2nd Place Finish in the Graduate Student Design Competition
- C25. J. He, E. J. Koeneman, R. S. Schultz, D. E. Herring, H. Huang, T. Sugar, R. Herman, and J. B. Koeneman, "Design of a Robotic Upper Extremity Repetitive Therapy Device," 9th Annual Conference on Rehabilitation Robotics, ICORR, pp. 95-98, 2005.
- C24. K. W. Hollander, T. G. Sugar, and D. Herring, "Adjustable Robotic Tendon using a Jack Spring," IEEE 9th Annual Conference on Rehabilitation Robotics, ICORR, pp. 113-118, 2005.
- C23. K. Hollander and T. Sugar, "Concepts for Compliant Actuation in Wearable Robotic Systems," presented at U.S. Korea Conference, UKC, August 2004, pp. 1-7, August 2004.
- C22. K. Bharadwaj, K. Hollander, C. Mathis, and T. Sugar, "Spring over Muscle (SOM) Actuator for Rehabilitation Devices," 26th Annual International Conference of the IEEE EMBS, San Francisco, CA, pp. 2726-2729, 2004.
- C21. Z. Wang, K. Hollander, and T. G. Sugar, "A Novel Omni-directional Perturbation Platform," presented at IEEE/RSJ International Conference on Intelligent Robots and Systems, Las Vegas, pp. 3089-3093, 2003.
- C20. Z. Wang, K. Bauernfeind, and T. G. Sugar, "Omni-Directional Treadmill System," presented at 11th International Symposium on Haptic Interfaces for Virtual Environments and Teleoperator Systems, Los Angeles, pp. 367-373, 2003.
- C19. D. Nahar and T. G. Sugar, "Compliant Constant-Force Mechanism with a Variable Output for Micro/Macro Applications," IEEE International Conference on Robotics and Automation, pp. 318-323, 2003.
- C18. K. Mundhra, T. G. Sugar, and M. K. McBeath, "Perceptual Navigation Strategy: A Unified Approach to Interception of Ground balls and Fly balls", IEEE International Conference on Robotics and Automation, pp. 3461-3466, 2003.
- C17. D. Nahar, T. G. Sugar, and P. Fussell, "Novel, Compliant, Synergistic Interactions of Multiple Contacts for Grasping," presented at World Automation Congress (WAC2002), Florida, CD-ROM proceedings, pp. 1-7, 2002.
- C16. A. Suluh, K. Mundhra, T. G. Sugar, and M. McBeath, "Spatial Interception for Mobile Robots," presented at Proceedings of the 2002 IEEE International Conference on Robotics and Automation, Washington D.C., pp. 4263-4268, 2002.
- C15. K. Mundhra, A. Suluh, T. G. Sugar, and M. McBeath, "Intercepting a Falling Object: Digital Video Robot," presented at Proceedings of the 2002 IEEE International Conference on Robotics and Automation, Washington D.C., pp. 2060-2065, 2002.
- C14. D. Burns and T. G. Sugar, "Rapid Embedded Programming: A Tool for Education," presented at 2002 ASME Design Engineering Technical Conferences and Computers in Engineering Conference, Montreal, CD-ROM, pp. 1-7, 2002.
- C13. T. G. Sugar and P. Fussell, "Mouth Operated Neurosurgical Robot," presented at Proceedings of the 2001 ASME Design Engineering Technical Conferences and Computers in Engineering Conference, CD-ROM, 2001.
- C12. T. G. Sugar and M. McBeath, "Spatial Navigation Algorithms: Applications to Mobile Robotics," presented at Proceedings of VI 2001 Vision Interface Annual Conference, pp. 106-113, 2001.

- C11. A. Suluh, T. G. Sugar, and M. McBeath, "Spatial Navigation Principles: Applications to Mobile Robotics," presented at Proceedings of the 2001 International Conference on Robotics and Automation, pp. 1689-1694, 2001.
- C10. T. G. Sugar, J. P. Desai, V. Kumar, and J. Ostrowski, "Coordination of Multiple Mobile Manipulators," presented at Proceedings of the 2001 IEEE International Conference on Robotics and Automation, pp. 3022-3027, 2001.
- C9. L. Chaimowicz, T. G. Sugar, V. Kumar, and M. F. M. Campos, "An Architecture for Tightly Coupled Multi-Robot Cooperation," presented at Proceedings of the 2001 IEEE International Conference on Robotics and Automation, pp. 2992-2997, 2001.
- C8. T. G. Sugar, "A Novel Selective Compliant Actuator," presented at In the Proceedings of the 7th Mechatronics Forum, Atlanta, pp. CD-ROM, pp. 1-6, 2000.
- C7. T. G. Sugar and V. Kumar, "Metrics for Analysis and Optimization of Grasps and Fixtures," presented at Proceedings of the 2000 IEEE International Conference on Robotics and Automation, San Francisco, CA, pp. 3561-3566, 2000.
- C6. T. G. Sugar and V. Kumar, "Coordination of Multiple Mobile Platforms for Manipulation and Material Transport," presented at Video Proceedings of the 1999 IEEE International Conference on Robotics and Automation, Detroit, 1999.
- C5. T. G. Sugar and V. Kumar, "Multiple Cooperating Mobile Manipulators," presented at Proceedings of the 1999 IEEE International Conference on Robotics and Automation, Detroit, pp. 1538-1543, 1999.
- C4. T. G. Sugar and V. Kumar, "Design and control of a compliant parallel manipulator for a mobile platform," presented at Proceedings of the 1998 ASME Design Engineering Technical Conferences and Computers in Engineering Conference, Atlanta, CD-ROM, pp. 1-9, 1998.
- C3. T. G. Sugar and V. Kumar, "Decentralized control of cooperating manipulators," presented at Proceedings of the 1998 IEEE International Conference on Robotics and Automation, Belgium, pp. 2916-2921, 1998.
- C2. E. Paljug, T. G. Sugar, V. Kumar, and X. Yun, "Important Considerations in Force Control with Applications to Multi-Arm Manipulation," presented at Proceedings of the 1992 IEEE International Conference on Robotics and Automation, pp. 1270-1275, 1992.
- C1. G. Pfreundschuh, T. G. Sugar, and V. Kumar, "Design and Control of a 3DOF In-Parallel Actuated Manipulator," presented at Proceedings of the 1991 IEEE International Conference on Robotics and Automation, Sacramento, CA, pp. 1659-1664, 1991.

PUBLICATIONS

National Conference Proceedings Reviewed Papers, Abstracts, and Presentations

Abstracts in Journals and Books

- A12. Aggers, A., Sugar, T. G., Holgate, M., Engsberg, J.R. 2010, Gait Comparison of Passive and Active Terminal Devices for a Person with a Transtibial Amputation (TTA)
- A11. DaSilva, F., McBeath, M., Sugar, T. (2007). Stroke Therapy Using Wearable-Robots and Ramachandran Mirror Technique Produces Functional Improvement [Abstract]. *Journal of Vision*.

- A10. DaSilva, F., Wechsler, N. E., McBeath, M., Sugar, T., Amazeen, E., Presson, C., & Koeneman, J. (2006). Improvement in upper-extremity motor-function in hemiparetics using robot-assisted repetitive motion therapy with video games [Abstract]. *Journal of Vision*, 6(6), 76a, <http://journalofvision.org/6/6/76/>, doi:10.1167/6.6.76.
- A9. McBeath, M.K., Wang, W., Sugar, T.G., Dolgov, I. & Wang, Z. (2005). Pursuers Maintain Linear-Optical-Trajectory when Navigating to Intercept Robots Moving Along Complex Pathways. *Abstracts of the Psychonomic Society*. 10, 46. (Ms. No. 295).
- A8. McBeath, M.K., Dolgov, I., & Sugar, T.G. (2005). The axis of an American football leads observers to misjudge where it is headed. *Journal of Vision*. 5(8). 731. <http://www.journalofvision.org/5/8/731>
- A7. McBeath, M.K., Sugar, T.G., & Shaffer, D.M. (2004). Catching things that change direction: Frisbees and bouncing grounders. *Cognitive Science Association for Interdisciplinary Learning Abstracts*. 10. <http://www.ohsu.edu/csail/prog04.html>
- A6. McBeath, M.K., Sugar, T.G., & Wang, Z. (2004). Baseball fielders utilize a rule of constant cotangent change to navigate to catch ground balls. *Journal of Vision*. 4(8), 157. <http://www.journalofvision.org/4/8/157>
- A5. M. K. McBeath, T. G. Sugar, J. M. Thompson, K. Mundhra, "Catching ground balls: Optical Control Heuristics used by Humans and Robots Support a Unified Fielder Theory," *Journal of Vision*. 3(9), 543. (Ms. No. 543). <http://www.journalofvision.org/3/9/543>
- A4. M. K. McBeath, T. G. Sugar, S. E. Morgan, C. D. Oberle, K. Mundhra, and A. Suluh, "Human and Robotic Catching of Dropped Balls and Balloons: Fielders Still Try to Make the Image of the Projectile Rise," *Journal of Vision*, vol. 2(7), pp. 434, 2002.
- A3. M. K. McBeath, D. M. Shaffer, and T. G. Sugar, "Catching baseball pop flies: Individual differences in aggressiveness and handedness," *Abstracts of the Psychonomic Society*, vol. 7, pp. 103, 2002, (Ms. No. 190).
- A2. M. K. McBeath, D. M. Shaffer, S. E. Morgan, and T. G. Sugar, "Lack of Conscious Awareness of How We Navigate to Catch Baseballs," *Toward a Science of Consciousness*, vol. 84, 2002, (Ms. No. 190).
- A1. M. K. McBeath, T. G. Sugar, and D. M. Shaffer, "Comparison of active versus passive ball catching control algorithms using robotic simulations [Abstract]," *Journal of Vision*, vol. 1(3), pp. 193a, 2001, DOI 10.1167/1.3.193.

PUBLICATIONS

Other Publications

Patents

Systems and Methods for Adding or Subtracting Energy to Body Motion, T. Sugar, J. Kerestes, T. Flaven, M. Holgate, 2013 provisional application

Joint Control Systems and Methods Utilizing Muscle Activation Sensing, T. Sugar, T Flaven, G. Wolf, 2013 provisional application

P7. Thomas Sugar, Joseph Hitt, Alexander Boehler, Kevin Hollander, Jeffrey Ward, Method and Apparatus for Harvesting Energy from Ankle Motion, provisional patent submitted 5/2011,

patent will issue 2014.

P6. K. Hollander, T. G. Sugar, "Adjustable Stiffness Jack Spring Actuator," patent US US8322695, 2012.

P5. K. Hollander, T. G. Sugar, "Adjustable Stiffness Jack Spring Actuator," patent US 7,992,849, 2011.

T. G. Sugar and M. Carhart, "Spring-Over-Muscle Actuator," provisional patent submitted in April 2003, patent pending in April 2004.

P4. T. G. Sugar and D. Nahar, "Adjustable compliant mechanism," US 7,874,223, 2011

P3. K. Hollander, T. G. Sugar, "Adjustable Stiffness Leaf Spring Actuators," US 7,527,253, 2009.

P2. T. G. Sugar and K. Baurenfeind, "Omni-Directional Treadmill", US 7,399,258, 2008.

P1. T. G. Sugar and S. Yalamanchili, "Centrifuge Test Apparatus for Footwear and Apparel," US 5329807: W. L. Gore and Associates, 1994.

Thesis and Dissertation

T. G. Sugar, "Design and Control of Cooperative Mobile Robotic Systems," in *Mechanical Engineering and Applied Mechanics*: University of Pennsylvania, 1999.

T. G. Sugar, "Design and Control of an In-Parallel Pneumatically-Actuated Manipulator," in *Mechanical Engineering and Applied Mechanics*: University of Pennsylvania, 1992.

Poster Sessions:

Dynamic Walking 2011

Dynamic Walking 2009

Dynamic Walking 2008

Dynamic Walking 2007

Guest Editor

1. Vanderborght, B.; Sugar, T.; Lefeber, D., "Adaptable compliance or variable stiffness for robotic applications [From the Guest Editors]", IEEE Robotics & Automation Magazine, vol. 15, Issue: 3, pp 8-9, 2008.

Guest paper

2. Exciting Benefits of Powered Prosthetic Systems, Lt. Col. Joseph K. Hitt, PhD; Kevin Hollander, PhD; and Thomas Sugar, PhD, The O&P EDGE, October 2010

INVITED PRESENTATIONS

APT Center and FES Center at the Cleveland Veterans Affairs and Case Western University invited talk on “Designing Spring Based Robots for Enhancing Mobility”, February 2013

Leipzig, Germany, ORTHOPÄDIE + REHA-TECHNIK in May 2012

Stuttgart, Germany, Fraunhofer, Institute, Dr. med. Urs Schneider, May 2012

Rio Verde Valley Speaker Series, January 2012

Northern Arizona University invited talk with Kissa Nishikawa October 21, 2011

Invited talk on robot actuators, DARPA November 2011

Dynamic Walking 2011, one of four keynote talks

Keynote Speaker for the SPIE EAPAD conference, March 7, 2011 “Walking with Springs”

Keynote Speaker, Darmstadt, Germany: Proceedings of SIMPAR 2010 Workshops, Intl. Conf. on SIMULATION, MODELING and PROGRAMMING for AUTONOMOUS ROBOTS Darmstadt (Germany) November 15-16, 2010

SPARKy Phase 2, United States Military Academy at West Point, February 26, 2010.

“Robots: The Interactive Exhibition”, Arizona Science Center, Phoenix, Arizona, March 16, 2006.

Rehabilitation Robotics: Wearable Robotic Systems, Invited Speaker, Symposium on Robotics Technology, U.S. Korea conference, August 13, 2004.

Compliant Actuation, November 7, 2003, Northern Arizona University

Fall Prevention using an Omni-Directional Treadmill, October 2003, Arizona Parkinson Disease Meeting

Human Navigational Principles: Applications to Mobile Robotics, July 7, 2000, University of Pennsylvania

Mobile Robot Cooperation, October 1999, Psychology Department, Arizona State University

PRESENTATIONS FOR THE LISTED CONFERENCE PAPERS

“Perceptual Navigation Strategy for Mobile Robots Intercepting Ground Balls,” *presented at* IEEE International Conference on Robotics and Automation, 2006.

“Robotic gait trainer for stroke rehabilitation of the ankle joint,” *presented at* IEEE International Conference on Robotics and Automation, 2006.

“Design of a robotic gait trainer using spring over muscle actuators for ankle stroke rehabilitation,” *presented at* Design of Medical Devices Conference, 2005.

“Design of the Robotic Tendon,” *presented at* Design of Medical Devices, 2005.

“Design of Lead Screw Actuators for Wearable Robotic Applications,” *presented at* ASME International Design Engineering Technical Conference, 2005.

“A Robotic Jack Spring for Ankle Gait Assistance,” *presented at* ASME International Design Engineering Technical Conference, 2005.

"Spring over Muscle (SOM) Actuator for Rehabilitation Devices," *presented at* 26th Annual International Conference of the IEEE EMBS, San Francisco, CA, 2004.

"A Novel Omni-directional Perturbation Platform," *presented at* IEEE/RSJ International Conference on Intelligent Robots and Systems, Las Vegas, 2003

"Omni-Directional Treadmill System," *presented at* 11th International Symposium on Haptic Interfaces for Virtual Environments and Teleoperator Systems, Los Angeles, 2003

"Compliant Constant-Force Mechanism with a Variable Output for Micro/Macro Applications," IEEE International Conference on Robotics and Automation, Taipei, 2003.

“Perceptual Navigation Strategy: A Unified Approach to Interception of Ground balls and Fly balls”, IEEE International Conference on Robotics and Automation, Taipei, 2003.

"Novel, Compliant, Synergistic Interactions of Multiple Contacts for Grasping," *presented at* World Automation Congress (WAC2002), Florida, 2002.

"Spatial Interception for Mobile Robots," *presented at* Proceedings of the 2002 IEEE International Conference on Robotics and Automation, Washington D.C., 2002.

"Intercepting a Falling Object: Digital Video Robot," *presented at* Proceedings of the 2002 IEEE International Conference on Robotics and Automation, Washington D.C., 2002.

"Rapid Embedded Programming: A Tool for Education," *presented at* 2002 ASME Design Engineering Technical Conferences and Computers in Engineering Conference, Montreal, 2002.

"Mouth Operated Neurosurgical Robot," *presented at* Proceedings of the 2001 ASME Design Engineering Technical Conferences and Computers in Engineering Conference, Pittsburgh, 2001.

"Spatial Navigation Algorithms: Applications to Mobile Robotics," *presented at* Proceedings of VI 2001 Vision Interface Annual Conference, 2001.

"Spatial Navigation Principles: Applications to Mobile Robotics," *presented at* Proceedings of the 2001 International Conference on Robotics and Automation, Seoul, 2001.

"Coordination of Multiple Mobile Manipulators," *presented at* Proceedings of the 2001 IEEE International Conference on Robotics and Automation, Seoul, 2001.

"A Novel Selective Compliant Actuator," *presented at* In the Proceedings of the 7th Mechatronics Forum, Atlanta, 2000.

"Metrics for Analysis and Optimization of Grasps and Fixtures," *presented at* Proceedings of the 2000 IEEE International Conference on Robotics and Automation, San Francisco, 2000.

RESEARCH GRANTS

a. Sponsored Research – External Grants

Funded Grants

	<u>Title</u>	<u>Grant</u>	<u>Investigators</u>	<u>Amount</u>
1. DARPA	Four Minute Mile Running (4MM) Start in the Summer of 2012 for one year	\$131,264	PI: T. Sugar (100%)	\$131,264
2. DARPA	Follow on grant for 2013	\$72,812	PI: T. Sugar	\$72,812
3. DARPA	Four Minute Mile Running (4MM) Year 2 grant for 2014	\$266,004	PI: T. Sugar (50%)	\$133,002
Total		\$470,080		\$337,078

	<u>Title</u>	<u>Grant</u>	<u>Investigators</u>	<u>Amount</u>
4. Army TATRC Walter Reed Army Hospital	SPARKy, Spring Ankle with Regenerative Kinematics, Principal Investigator 1/1/2007 – 8/1/10	\$605,000	PI: T. Sugar (100%)	\$605,000
5. NIH	Robotic Spring Ankle for Gait Assistance, Principal Investigator , Score 139 8/16/05 – 4/15/10	\$359,000	PI: T. Sugar (60%) D Herring (40%)	\$215,400
6. NIH	Contract Extension: Portable and Economical Robots for Stroke Rehabilitation 9/30/06 – 9/29/09	\$1,751,401	J. He D Herring T. Sugar (20%)	\$350,280
7. Army- STTR	Neuromorphic Control of an Ankle 6/2004-12/2004	\$100,000	Prime: Advensys T. Sugar (40% of 31,515)	\$12,606
6. NSF	An Interdisciplinary Research Environment for Motion Analysis, Collaborative Research with Arts, Media, and Engineering	\$1,061,306	T. Sugar (3%)	\$31,839

	9/1/06 – 8/31/09			
8. NIH	SBIR: Air Muscle Device for Ankle Stroke Rehabilitation 5/01/04 – 4/30/06	\$200,000	Prime: Kinetic Muscles Inc. T. Sugar (10%)	\$20,000
9. NIH	Contract: Portable and Economical Robots for Stroke Rehabilitation 9/30/03 – 9/29/06	\$2,279,487	J. He D Herring T. Sugar (20%)	\$455,897
10. NSF	SGER: Compliant Actuation for Human Interaction 8/15/03 – 7/31/04	\$52,361	PI: T. Sugar, 100%	\$52,361
11. NSF	Perceptual Invariants as a General Mechanism for Human Interception 8/01/03 – 7/31/06	\$349,995	M. McBeath T. Sugar (50%)	\$174,998
12. NSF	Development of a Interactive Systems and Controls E-Book 2/15/03 – 1/31/06	\$307,910	T. Rodriguez T. Sugar (10%)	\$30,791
13. Honeywell, Inc.	Embedded Control Code using Matlab's xPC Target 1/1/02 – 12/30/02	\$20,000	PI: T. Sugar, 100%	\$20,000
14. HYI	Service Agreement: Manufacturing Composites 7/02 - Present	\$10,033	PI: T. Sugar, 100%	\$10,033
TOTAL		\$7,096,493		\$1,979,205

Grants not funded

NSF	NRI-Small: CollaRobot: Active Compliant Mechanisms for Human Robot Collaboration	\$440,435	PI: T. Sugar (100%)	
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RESEARCH GRANTS

b. Sponsored Research – Internal Grants

	<u>Title</u>		<u>Investigators</u>	<u>Amount</u>
1. ASU Faculty Grant-in-Aid	Human Interfaces for Robotic Systems 1/1/00 - 12/31/00	F-009-00	T. Sugar	\$7,000
2. ASU Research Incentive Award	Dynamic Manipulation with Heterogeneous Partners 6/1/00-5/31/01	274-00	T. Sugar	\$16,000

Jennifer Fleegeer (honors student supported by FURI 2005, and 2006)

Ryan Bellman (honors student supported by FURI 2005, and 2006)

SPRINGACTIVE, INC

c. Robotics Company

SpringActive, Inc was started to develop the patented technology returned to Drs. Sugar and Hollander. The company is developing wearable robotic systems

www.springactive.com

10 full time employees

Dr. Kevin Hollander, Dr. Jeffrey Ward, Dr. Matthew Holgate, Mr. Alex Boehler

Grants

1. Energy harvesting ankle phase 1 and phase 2 with NATICK
2. Jack Spring grant, NSF SBIR Phase 1 and Phase 2
3. Research an exoskeleton with British Aerospace Engineering, Tempe, AZ
4. Develop force feedback for helicopter seating, SAFE Engineering
5. JTAR, Joint Torque Augmentation, DARPA exploratory research grant
6. Running ankle, NIH SBIR Phase 1
7. Develop a running ankle with USMA
8. Develop a wearable exoskeleton with USMA
9. Develop a controller for the West Point Bionic Ankle

Products

Hermes ankle, Odyssey ankle, ROLLE exoskeleton

STUDENT THESES AND DISSERTATIONS ADVISED

THESIS ADVISOR

(M.S. STUDENTS) - 18

Anthony Suluh	Mechanical Engineering	Graduated Dec. 2001.
Thesis: Human Navigational Principles: Applications to Mobile Robotics		
Keshav Munhdra	Mechanical Engineering	Graduated Dec. 2002.
Thesis: Perceptual Guidance Strategies Applied to High-Speed Mobile Robots		
Dhiraj Nahar	Mechanical Engineering	Graduated Dec. 2002.
Thesis: Analysis and Synthesis of Passive Compliant Mechanisms		
Kiran Shivanna	Mechanical Engineering	Graduated Aug. 2003.
Thesis: Sensitivity Analysis of Cracks in Functionally Graded Materials		
Zheng Wang	Mechanical Engineering	Graduated Aug. 2003.
Thesis: Design of an Omni-Directional Perturbation Platform with Powered Offset Casters		
Kartik Bharadwaj	Mechanical Engineering	Graduated Dec. 2005.
Thesis: Design and Control of a Robotic Gait Trainer Using Spring over Muscle Actuators for Stroke Rehabilitation of the Ankle Joint		
Chitralekha Nahar	Mechanical Engineering	Graduated Dec. 2005.
Thesis: Evaluation and Control of an Omni-Directional Perturbation Platform for Balance Studies		
Abhay Paranjape	Mechanical Engineering	Graduated May. 2006.
Thesis: Perceptual Navigation Strategies for Mobile Robots Intercepting Ground Balls		
Sukumar Srikant	Mechanical Engineering	Graduated Aug. 2006.
Thesis: System Identification and Inertia Compensated Control of a Planar Manipulator		
Aykut Mehmet Oymagil	Mechanical Engineering	Graduated Dec. 2006.
Thesis: Control of a Regenerative Braking Powered Ankle Foot Orthosis		
Jeffrey A. Ward	Mechanical Engineering	Graduated May 2007.
Thesis: Dynamic Pace Controller for the Robotic Gait Trainer and Stroke Patient Case Study		
Don Briner	Mechanical Engineering	Graduated May 2008.
A Pick Selection Algorithm for a Machine Vision Guided Robotic Colony Picker		
Alex Boehler	Mechanical Engineering	Graduated May 2008.
Mechanics, Control and Testing of a Robotic Ankle Foot Orthosis for Stroke Rehabilitation		
Ryan Bellman	Mechanical Engineering	Graduated August 2008.
Mechanical and Conceptual Design of a Robotic Transtibial Prosthesis		
Ashish Sardhara	Mechanical Engineering	Graduated August 2009.
Design and Testing of Multi-Pin End-Effector for a Robotic Colony Picker		
Adam Fronczyk	Biomedical Engineering Co-Chair	Graduated August 2012.
Volitional Control of a Powered Prosthetic Ankle		
Chase Wheeler	Mechanical Engineering	Graduated December 2014.
Load Carrying Assistance Device: PogoSuit		
Jason Kerestes	Mechanical Engineering	Graduated December 2014.

Robotic Augmentation of Human Locomotion for High Speed Running

(Ph.D. STUDENTS) - 5

Zheng Wang	Mechanical Engineering	Graduated Dec. 2005.
Dissertation: Theory for a Mobile Robot Intercepting Projectiles Above and Below the Horizon		
Kevin Hollander	Mechanical Engineering	Graduated Dec. 2005.
Dissertation: Design and Control of Wearable Robot Actuators		
Joseph Hitt	Mechanical Engineering	Graduated May. 2008.
Dissertation: A Robotic Transtibial Prosthesis with Regenerative Kinetics		
Jeffrey Ward	Mechanical Engineering	Graduated Dec. 2009.
Dissertation: Design, Control, and Data Analysis for Rehabilitation Robotics		
2010 ASEE/NSF Corporate Research Postdoctoral Fellowship for Engineers		

Co-Advisor:

Matthew Holgate	Mechanical Engineering	Graduated Dec. 2009.
Dissertation: Control of a Robotic Transtibial Prosthesis		
2010 ASEE/NSF Corporate Research Postdoctoral Fellowship for Engineers		

(M.S.E. STUDENTS) - 2

Xiao Zhang	Mechanical Engineering	Graduated Dec. 2005.
Bekele Atnafu	Mechanical Engineering	Graduated Dec. 2005.

Current Students are Numbered

1. Philip New

(Ph.D. STUDENTS)

1. Juan de la Fuente
2. Andrew Bates
3. Nathan Cahill
4. Robert Holgate

Exchange students from Austria

Kurt Baurenfeind	Mechanical Engineering	Exchange Student.
Christian Mathis	Mechanical Engineering	Exchange Student.
Robert Ilg	Mechanical Engineering	Exchange Student.
Alexander Boehler	Mechanical Engineering	Exchange Student.
Lukas Fink	Mechanical Engineering	Exchange Student.
Sebastian Bereuter	Engineering	Exchange Student.
Philipp Pasolli	Engineering	Exchange Student.

Exchange students from France

Cathia Lize	Mechanical Engineering	Exchange Student.
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ADVISOR FOR UNDERGRADUATE RESEARCH

Daniel Burns (honor's thesis)	Mechanical Engineering	Arizona State Univ.
NSF Graduate Fellowship Award for Year 2002		

Kyle Post	Mechanical Engineering	Arizona State Univ.
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Joseph Garrison	Electrical Engineering	Arizona State Univ.
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Thomas Bowers (honor's thesis)	Mechanical Engineering	Arizona State Univ.
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Ethan Stump (honor's thesis)	Mechanical Engineering	Arizona State Univ.
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Nicholas Brindley (honor's thesis)	Mechanical Engineering	Arizona State Univ.
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NSF Honorable Mention for the Graduate Fellowship in 2003

Loren Aragon (summer student)

Heather Norris (summer student)

Marnel McElwain (summer student)

John Thompson (summer student)

Jennifer Fleegeer (supported honors student for 2004, 2005, 2006 FURI)

Ryan Bellman (supported honors student for 2004, 2005, 2006 FURI)

Ryan Manis (supported honors student for 2008)

Adam Fronczyk (2009)

Andrew Bates (2010-2011)

Nathan Cahill	Mechanical Engineering	Arizona State Univ.
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NSF Graduate Fellowship Award for Year 2014

THESIS COMMITTEE

Bernie Bettig, PhD	Mechanical Engineering	Arizona State Univ.
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Shannon Morgan, MS, PhD	Psychology	Arizona State Univ.
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Igor Paprotny, MS	Industrial Engineering	Arizona State Univ.
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Subramanian Venkateraman, MS	Mechanical Engineering	Arizona State Univ.
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Carlos Lopez, MS	Mechanical Engineering	Arizona State Univ.
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Yanyan Wu, MS	Mechanical Engineering	Arizona State Univ.
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Fernando Rangel, MS	Mechanical Engineering	Arizona State Univ.
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Adwait Vaidya, MS	Mechanical Engineering	Arizona State Univ.
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Andy Contes, MS	Mechanical Engineering	Arizona State Univ.
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Crystal Oberle, PhD	Psychology	Arizona State Univ.
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Flavio DeSilva, MS	Psychology	Arizona State Univ.
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Tao Kang, PhD	Bioengineering	Arizona State Univ.
Ravi Gupta, MS	Mechanical Engineering	Arizona State Univ.
Kwangkeun, Shen, PhD	Mechanical Engineering	Arizona State Univ.
Zhengshu Shen, PhD	Mechanical Engineering	Arizona State Univ.

CURRENT RESEARCH

1. Physical Therapy Assist Device – Medical Robots

In conjunction with the bioengineering department, Kinetic Muscles Inc, and Banner Health, a therapy assist device is being developed which will aid stroke patients in neural re-training using a wearable robotic exoskeleton. The device will assist upper arm movements for feeding and reaching. RUPERT – Robotic Upper Extremity Repetitive Training

2. Wearable Robotic Exoskeletons – Medical Robots

Compliant actuation systems are designed to safely interact with humans. These actuators, tunable leaf springs, springs-over-muscles, and jack-springs, are lightweight, energy efficient, power reducing, and safe. They will be used in areas such as stroke rehabilitation, physical rehabilitation, muscle assistance, and gait training.

3. Human Navigational Principles

Collaboration with Psychology to develop models for human navigational and pursuit strategies. Research the unconscious, low-level motor vision algorithms used by humans. A mobile robot is designed as a test-bed.

4. SPARKy – Medical Robots

A powered bionic ankle is being developed for the Military Amputee Research Program. The powered ankle stores energy in springs as the leg rolls over the ankle and releases the energy in a powerful burst for push-off. SPARKy (SPRING Ankle with Regenerative Kinetics) allows a person to walk with improved gait symmetry and normal push-off power.

5. Powered Ankle Foot Orthosis – Medical Robots

A powered ankle foot orthosis is being developed for the National Institutes of Health. The powered orthosis stores energy in springs as the leg rolls over the ankle and releases the energy in a powerful burst for push-off. The repetitive training paradigm is being used to assist stroke survivors who are paralyzed on one side.

6. Embedded Computing for Education

Motor control labs are developed which allow the user to automatically generate, real-time, embedded code for PC's. Examples include a compliant joystick and an active suspension which dynamically adjusts the equilibrium position of the suspension.

6. DEVICE DEVELOPMENT

1. Spring Over Muscle Actuator

Actuator Designed for a stroke therapy device.

2. Adjustable Constant Force mechanism

Device for gravity compensation of stroke affected limbs.

3. Sit-To-Stand Device - Leaf Spring Actuators

Device for aiding people to stand from a sitting position.

4. Stroke Therapy Devices

Upper Extremity Robot, Ankle Robot for Gait Training, RUPERT

7. RESEARCH COLLABORATIONS:

1. Kinetic Muscles Inc. – Dr. James Koeneman

Local robotics company developing devices for stroke rehabilitation

2. Good Samaritan Hospital – Dr. Richard Herman

Clinical trials of the robotic exoskeletons used in stroke rehabilitation

3. Northern Arizona University – Dr. Kissa Nishikawa

Develop models for human muscle

4. Fachhochschule Vorarlberg – Dr. Robert Merz

Robotics exchange students

5. Dr. Just Herder, Delft University – expert in storage of energy in spring systems

6. Dr. Jack Engsborg, Human Performance Laboratory, Washington University at St. Louis

7. Dr. Alain Berthoz – College de France

TEACHING AND INSTRUCTION

1. Classroom Effectiveness Courses Taught and Student Evaluations

<u>Year and Term</u>	<u>Class #</u>	<u>Title</u>	<u>No. Students</u>	<u>Evaluation Avg.</u> (Fulton School of Engineering Average, MAE Average)
1999 Fall	MAE 341	Design of Machinery	35	4.36/5.0 (4.20,4.08)
2001 Fall			37	4.01/5.0 (4.17,4.18)
2003 Spring			41	4.62/5.0 (4.10,4.24)
2000 Fall	ECE 100	Introduction to Engineering	80	3.91/5.0 (3.92,4.21)
2002 Spring	ECE 194		43	4.32/5.0 (4.15,4.11)
2000 Spring	MAE 442/591E	Mechanical Systems Design	20	4.19/5.0 (4.33,4.24)
2001 Spring	MAE 442		18	4.53/5.0 (4.22,4.19)
2002 Fall	MAE 442		20	4.47/5.0 (4.14,4.10)
2003 Fall	MAE 442		26	4.44/5.0 (4.11,3.92)
2004 Fall	MAE 442		33	4.65/5.0
2002 Spring	MAE 547	Mechanical Design and Control of Robots	9	4.79/5.0 (4.54,4.11)
2004 Spring			11	4.54/5.0 (4.45,4.06)
2005 Fall			12	4.58/5.0

2003 Fall	MAE 443	Capstone Engineering Design	46	4.24/5.0 (4.11,3.92)
2005 Spring			43	3.66/5.0
2005 Spring	IEEE 463	Computer Aided Manufacturing and Control	56	4.13/5.0
2006 Spring			56	3.98/5.0
2006 Summer	MAE Senior Proj	Sponsored a summer student		

Student Evaluations at the Department of Engineering, ASU Polytechnic Campus

<u>Year and Term</u>	<u>Class #</u>	<u>Title</u>	<u>No. Students</u>	<u>Evaluation Avg.</u>
2005 Fall	EGR 194	Engineering 1	28	
2006 Spring	EGR 194	Engineering II, Dynamics Module	26	4.32/5.0
2006 Fall	EGR 294	Engineering Project 1	25	4.41/5.0
2007 Spring	EGR 102	Intro to Engineering Design II	25	4.47/5.0
	MAE 547	Mechanical Design and Control of Robots	12	4.48/5.0
2007 Fall	EGR 301	Engineering Primary Project 1	17	4.47/5.0
	EGR 394	Failure Prevention Module	8	4.39/5.0
2008 Spring	EGR 202	Engineering Project 2	27	4.57/5.0
	EGR 231	Dynamics Module	20	3.94/5.0
	EGR 394	Engineering Design	9	4.50/5.0
2008 Fall	Sabbatical			
2009 Spring	EGR 445	Mechanical Engineering Systems	12	3.70/5.0
	EGR 202	Engineering Project 2	44	3.92/5.0
2009 Fall	EGR 346	Engineering Design	14	4.87/5.0
	EGR 401	Senior Project Medtronic Pressure Sensor Honeywell Clutch Project	13	
2010 Spring	EGR 445	Mechanical Engineering Systems	11	4.73/5.0

	EGR 402	Senior Project Medtronic Pressure Sensor Honeywell Clutch	13	4.83/5.0
2010 Fall	EGR 346	Engineering Design	22	4.44/5.0
	EGR 394	Robotics 1	9	4.35/5.0
	EGR 401	Senior Project Sandia National Labs	6	
2011 Spring	EGR 445	Mechanical Engineering Systems	22	4.60/5.0
	EGR 494	Robotics 2	8	4.17/5.0
	EGR 402	Senior Project Sandia National Labs	6	DEPT AVG 3.65
2011 Fall	EGR 346	Engineering Design	15	5.0/5.0
	EGR 394	Robotics 1	25	4.80/5.0
	EGR 401	Senior Project Sandia National Labs AFSOR Climbing	12	DEPT AVG 3.84
2012 Spring	EGR 445	Mechanical Engineering Systems	20	4.6/5.0
	EGR 494	Robotics 2	16	4.7/5.0
	EGR 402	Senior Project Sandia National Labs AFSOR Climbing	11	
	EGR 401	Senior Project Intel Heater Testbed	4	
	EGR499	Independent Study/ Robotics 3	5	5.0/5.0
	HON	Honors Student	1	
2012 Fall	EGR 346	Engineering Design	25	4.3/5.0
	EGR 401	Senior Project Sandia National Labs AFSOR Climbing	5	
2013 Spring	EGR 445	Mechanical Engineering Systems	41	4.48/5.0 AVG of scores
2013 Fall	EGR 201	Project Course	39	4.12/5.0 AVG

	EGR 520	Engineering Systems Design	15	of scores 4.91/5.0 AVG of scores
2014 Spring	EGR 445	Mechanical Engineering Systems	33	4.56/5.0 AVG of scores
	MAE 547	Mechanical Design and Control of Robots		4.36/5.0 AVG of scores
2014 Fall	EGR 201	Project Course	41	3.79/5.0 AVG of scores

Activities to enhance teaching instruction

Rookie Camp, 1999 with Susan Ledlow

2. COURSE MATERIAL DEVELOPED

EGR 102: ENGINEERING II

Developed a dynamics module for the class.

EGR 201: ENGINEERING STUDIO I

Developed a robotic based project for the class. The class is integrated with a manufacturing processes module and a materials module.

EGR 301: PRIMARY PROJECT I

Developed a thermodynamics project based on a water purification device needed for Africa. The class is integrated with a failure prevention module.

EGR 394: FAILURE PREVENTION MODULE

Developed a failure prevention module studying tension, compression, bending, torsion, buckling, creep, and hoop stress

EGR 346: ENGINEERING DESIGN

Developed a machine design course focusing on failure prevention.

EGR 445\ MAE 442 \ MAE 591E: MECHANICAL ENGINEERING SYSTEMS

1. Motor Control laboratory in Electro Mechanical Laboratory using Real Time Workshop Computers, motors, digital i/o boards, compiler, and Matlab
2. Project based course, Haptic Joystick, Active Suspension of a Vehicle, Mouth Joystick, Robotic Treadmill

3. Equipment proposal for Signal Analyzer

ECE 194

1. Paper design for a Solar Hot Water Heater for Arizona homes
2. Autonomous robot project

MAE 547: MECHANICAL DESIGN AND CONTROL OF ROBOTS

1. Design and construction of an autonomous R/C car

EGR: ROBOTICS FOCUS AREA

Developed a robotics curriculum for the Department of Engineering

EGR 394: ROBOTICS 1

Developed a robotics course focusing on kinematics and dynamics

EGR 394: ROBOTICS 2

Developed a robotics course focusing on electronic hardware and controls

3. TEACHING: SUPERVISED UNDERGRADUATE PROJECTS

MAE 490: SENIOR DESIGN PROJECTS

Medical Robotic End-effector Development, 1999

Electro-Mechanical System for Discrete Event Machine, Heather Skaar, Erik Johnson 1999

No-Hands Operation of Surgical Robot, Kyle Post, 2000

Robust Enclosure for a Computer Controlled Robot, Alfredo Rodriguez, 2000

Design and Implementation of an Open Loop Hovercraft Controller, Dan Burns, 2001

Design of a Mechanical Process for Automated Fiber Placement in a Thermoplastic, Aaron Shaw, 2001

Determine Roll Center Height Using a Kinematics and Compliant Machine, Shan G. Smith, 2002

Design and Control of a Robotic Treadmill, Andras Dombovari, Ethan Stump, Nicholas Brindley, 2003

Raytheon Missile Project, Jennifer Bayer, Amy Norris, Ryan Barnes, Joshua Green, 2003

Variable Pitch Planetary CVT, Brian Cosner, 2003

Slat Treadmill, Glen Joralmon, Kevin Wolford, 2003

Underwater Robot, Loren Aragon, Marwan, 2004

Raytheon Tail Fin Project, Jasmine Chow, Jennifer, John Herzberger, Jonathan Hoof, 2004

Serial Robot, Ron Newcomb, 2004

2nd Place, ASME Undergraduate Design Competition, 2004

Compliant knee actuator, Eric Carter, Mark Carson, 2004
Underwater Robot, Pamela Brady, Marnel McElwain, John Thompson, 2004
Scooter Protective Cover, Kurt S. Allen, Othman Mjahed, 2004

EGR 401/402: SENIOR DESIGN PROJECTS

Each Project is Sponsored by \$20,000 per year from the industrial partner

MEMS pressure sensor: Sponsor Medtronic, 2009-2010
Clutch engagement system: Sponsor Honeywell, 2009-2010
MEMS Accelerometer: Sandia National Labs, 2010-2011, 2011-2012
Intel Heater Test-bed, 2012
AFSOR Climbing Assist Device, 2011-2012, Spiderman Project

UNDERGRADUATE HONOR'S PROGRAM

Daniel Burns (honor's thesis) Mechanical Engineering	Arizona State Univ.
NSF Graduate Fellowship Award for Year 2002	
Thomas Bowers (honor's thesis) Mechanical Engineering	Arizona State Univ.
Ethan Stump (honor's thesis) Mechanical Engineering	Arizona State Univ.
Nicholas Brindley (honor's thesis) Mechanical Engineering	Arizona State Univ.
NSF Honorable Mention for the Graduate Fellowship in 2003	
Jennifer Fleegeer (supported honors student for 2004, 2005, 2006)	
Ryan Bellman (supported honors student for 2005, 2006, 2007)	Arizona State Univ.
Ryan Manis (supported honors student for 2008)	Arizona State Univ.
Andrew Bates (supported honors student for 2011-2012)	Arizona State Univ.

UNDERGRADUATE PROJECTS

Raytheon Design Competition, 2003-2004, 2004-2005, 2006-2007, 2007-2008
FIRST Robotics
Sun Devil Rover Team, 2006-2007, 2007-2008

SERVICE

PROFESSIONAL AND SCIENTIFIC SERVICE

SCIENTIFIC AND PROFESSIONAL SOCIETY MEMBERSHIPS

ASME 1997-2014

IEEE 1999-2014

PROFESSIONAL SERVICE

2014 IDETC Technical Program Chair (Premier Design Conference) (approx 1000 presentations, 1591 registrations)

2013 IDETC Mechanisms and Robotics Conference Chair

ASME Mechanism and Robotics Committee, 2004 – 2010

Organization of the International ASME Mechanism and Robotics Conference

EDITOR ACTIVITIES

Guest Editor for the International Robotics and Automation Magazine

Special Topic: Adjustable Passive Compliance

CONFERENCE ACTIVITIES

Program Committee: DETC 2009 Design Engineering Technical Conferences and Computers in Engineering Conference. **Chair of Novel Robots and Mechanisms** at the ASME DETC 2009 conference responsible for organizing and reviewing 36 conference papers.

Executive Committee: Biorob 2008

Program Committee: ICRA 2008

Program Committee: DETC 2007 Design Engineering Technical Conferences and Computers in Engineering Conference. **Chair of the Robotic Theory Symposium** at the ASME DETC 2007 conference responsible for organizing and reviewing 30 conference papers.

Program Committee: IROS 2006

Program Committee: Haptics 2006

Program Committee: DETC 2006 Design Engineering Technical Conferences and Computers in Engineering Conference. **Chair of the Robotic Theory Symposium** at the ASME DETC 2006 conference responsible for organizing and reviewing 16 conference papers.

Program Committee: IROS 2005

Review Committee: ICORR 2005

Program Committee: DETC 2005 Design Engineering Technical Conferences and Computers in Engineering Conference. **Co-chair of the Robotic Theory Symposium** at the ASME DETC

2005 conference responsible for organizing and reviewing 31 conference papers.
Evaluator for 2005 ASME Student Mechanism Competition
Session Organizer for Rehabilitation Robotics at the IEEE Conference on Medicine and Biology, 2004.
Program Committee: DETC2004 Design Engineering Technical Conferences and Computers in Engineering Conference. **Co-chair of the Robotic Systems Symposium** at the ASME DETC 2004 conference responsible for organizing and reviewing 28 conference papers.
Demonstration and Exhibit on Compliant Actuators at the IROS 2003 Conference in Las Vegas
Invited to the National Science Foundation Robotics and Computer Vision PI Workshop, 2003
Program Committee: DETC2002 Design Engineering Technical Conferences and Computers in Engineering Conference. **Co-chair of the Robotic Systems Symposium** at the ASME DETC 2002 conference responsible for organizing and reviewing 40 conference papers.
Program Committee: VI 2001 Vision Interface Annual Conference, 2001.
Session Chairman, Vision Based Control, 2002 IEEE International Conference on Robotics and Automation
Session Chairman, VI2001.
Session Chairman, Vision Based Control, 2001 IEEE International Conference on Robotics and Automation
Session Chairman, Novel Actuators, 7th Mechatronics Forum, 2000.
Evaluator for 2000 ASME Student Mechanism Competition

JOURNAL REFEREE

IEEE Transactions on Systems, Man and Cybernetics
ASME Journal of Mechanical Design
International Journal of Robotics and Automation
IEEE Transactions on Robotics and Automation
ASME JICSE Journal
Journal of Applied Bionics and Biomechanics
Psychonomic Bulletin and Review
Science
MacArthur Fellowship reviewer

PROPOSAL REVIEW

Invited to sit on the NSF Robotics Panel in May 2005
Invited to sit on the NSF Medical Assistance Panel in September 2007
NIH NICHD Review Panel, 2008, 2009, 2010, 2011, 2012, 2014
VA Rehabilitation Robotics Review Panel 2009, 2010, 2011
Review Robotics grants for the European Union, VIATORS grant 2010, 2011, 2012

UNIVERSITY SERVICE

ASU Academic Senate at the Polytechnic Campus, 2008-2009
ASU Intellectual Property and Institutional Review Committee, 2010-2014
ASU Polytechnic Dean Executive Council Committee 2010-2012
ASU Polytechnic College PTR Committee 2013-2014
SEMTE Mechanical Design Search 2014
SEMTE Robotics Search 2014
2010-2014 Honors Faculty Advisor for Engineering
College Level PTR Committee 2014-2015

DEPARTMENTAL SERVICE

2013-2014 Department Hiring Committee – Robotics, Manufacturing
2011-2012 Engineering Integration Task Force
2010-2012 ASU Polytechnic Honor's College Committee
2010-2011 Department Hiring Committee

Development of the new curriculum for the Department of Engineering at the Polytechnic Campus
Engineering 2.0 Committee
Development of a new robotics curriculum for the Department of Engineering at the Polytechnic Campus
Promotion and Tenure Committee, Department of Engineering, 2009-2011-2012
Mentor Dr. Sangram Redkar

MAE Publicity Committee
MAE Design Curriculum Committee
MAE Curriculum Review on Saturday, May 7, 2000, and May 2001
Search Committee – Manufacturing Position, Spring 2004
CEAS Award for Recognition of Contribution and Support to CEAS Student Affairs, December 2002.

STUDENT SERVICE

Started a Raytheon Design Team on the Polytechnic campus.
Advising Team for MAE department, responsible for about 80 students per year
Presentation at Engineering and Applied Sciences Day, October 22, 1999

Career Day at Brophy High School

Mentoring FIRST Robotics at three local high schools, Brophy, Xavier, and North High School, devoted 100 hours per year for January 2000, 2001, 2002, 2003, and 2004

PUBLICATIONS IN POPULAR PRESS

Wearable Rehab Robots, WDEF-TV News 12, Apr 14, 2005 8:03 AM EDT

CBS 2 Chicago WBBM-TV, Robots Help Rehabilitate Stroke Patients, May 12, 2005 3:41 pm US/Central

CBS 2 New York, Robots Help Rehabilitate Stroke Patients, May 24th, 2005

NBC, Stroke Rehabilitation, May 25th, 2005

ABC 15, Phoenix, Relying on Robots, June 13th, 2005

CBS-5 Health Watch, Green Bay, June 23rd, 2005 9:29 am

ABC News, Omaha, Robotic Device Assists Stroke Patients: This rehab may improve quality of life, May 2005

ABC World News Tonight, Medicine on the Cutting Edge, May 17th, 2005, Robot Guides Stroke Patients' Recovery: Electronic Arm Helps Patients Practice Movements, by NED POTTER

Sports Saturday, June 10th, 2006, **New York Times**, Nuts-and-Bolts Ballplayer for a Space Age Infield, by Lee Jenkins

The Issue: Robots Taking Over? Playing 2nd base: R2-D2, Editorial, June 19th, 2006 The Arizona Republic

"The Role of Robots", ASU Research Review, KAET Channel 8, October 28 and November 2, 2003.

The 6th Annual Year in Ideas: The Robot Fielder, December 10th, 2006, by Arianne Cohen, **New York Times Magazine**

Next generation of powered prosthetic devices based on lightweight energy storing springs. What's next network - Science and Technology - May 2, 2007

"Sparky;" the Ankle Prosthetic of the Future, Med Gadget - May 2, 2007

Researchers create next generation prosthetic devices - News-Medical.net - May 2, 2007

ASU researchers putting new spring into amputees' step, MSN Money, May 1, 2007

Smart Prosthesis of the future created, United Press International - May 3, 2007

Smart Prosthesis of the future created, Podiatry News, Foot News - May 3, 2007

The World's First Powered Ankle, Technology Review - By Emily Singer and Duncan Graham-Rowe - May 11, 2007

SPARKy the prosthetic ankle set to "revolutionize prosthetics", Posted May 3rd 2007 by Paul Miller

ASU, Walter Reed researchers create prosthesis of the future, ASU Insight -May 11, 2007

Innovations Report -By Chris Lambrakis - May 03, 2007

EurekAlert - May 1, 2007

Brightsurf Science News - May 2, 2007

FusePress - May 2, 2007

Medical News Today - May 3, 2007

newsrx.com - May 1, 2007

ScienceDaily - May 2, 2007

VA News Flash - VA Watchdog dot Org By Larry Scott at -May 03, 2007

First Science News - May 1, 2007

Discovery News - By Tracy Staedter - May 31, 2007

Arizona researchers putting new spring into amputees' step, The Business Journal of Phoenix - May 1, 2007

Washington Business Journal -by Ty Young May 3, 2007, Researchers take step forward in design of new prosthesis

Creating a Future Prosthesis for Today's Military Amputees, Orthotics and Prosthetics, September 1, 2007

Researchers design new prosthesis, ASU, August 6, 2007

Creating a Future Prosthesis for Today's Military Amputees, Orthotics and Prosthetics, September 1, 2007

Can the robot come out to play?, ASU, April 3, 2008

How to build a better ballplayer, ASU, July 10, 2008

Discovery Channel, 2008, “Toad research could leapfrog to new muscle model”, show was called “Toady Tendons”, December 3, 2008, 8 minutes

Robotic ankle only steps away from daily use, AZ Republic, December 21, 2009

Device reflects value of research for ASU, AZ Republic, December 21, 2009

SPARKy device helps amputees return to normal lives, ASU, December 2009

Mesa Talking with Scott Anderson, December 2009

National Geographic Magazine, Issue on The Bionic AGE, January 2010

Innovative prosthetic ankle to mobilize amputees, AZ State Press, January 22, 2010

Researchers develop new robotic prosthetic technology to aid amputees, College Times, January 21, 2010

Exciting Benefits of Powered Prosthetic Systems, Lt. Col. Joseph K. Hitt, PhD; Kevin Hollander, PhD; and Thomas Sugar, PhD, The O&P EDGE, October 2010

Dean of Invention: Introducing the Age of Bionic Limbs, October 19, 2010

Sports Illustrated, August 8, 2011, “New and Improved” by Alexander Wolff

AFSOR Climbing Assist Device, 2011-2012, Spiderman Project, **Best Buy Commercial, Co-advisor with Dr. Sangram Redkar**

ASU VIMEO video on the Jet Pack approximately 3 million views for ASU

CBS Good Morning News:

<http://www.cbsnews.com/news/militarys-darpa-lab-creates-wearable-robot-to-help-soldiers-run-faster/>

Sports Illustrated:

<http://www.si.com/edge/2014/11/20/scientist-builds-real-life-jetpack-for-runners>