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EDUCATION

Doctor of Philosophy, Department of Mechanical Engineering

Massachusetts Institute of Technology

Cambridge, MA, Sept. 2004–Feb. 2007

Advisor: H. Harry Asada

Thesis: *Wearable Health Monitoring System: DC Power-Line Communication Network utilizing Electrically Conductive Fabric Transmission Media*

Master of Science, Mechanical Engineering

Massachusetts Institute of Technology

Cambridge, MA, Sept. 2000–Sept. 2004

Advisor: H. Harry Asada

Thesis: *DC Powerline Communication System using a Transmission Line Transformer for High Degree of Freedom Applications*

Master of Science, Electrical Engineering

Massachusetts Institute of Technology

Cambridge, MA, Sept. 2000–Sept. 2004

Advisor: H. Harry Asada

Thesis: *DC Powerline Communication System using a Transmission Line Transformer for High Degree of Freedom Applications*

Bachelor of Science, Mechanical Engineering

Massachusetts Institute of Technology
Cambridge, MA, Sept. 1996–Jun. 2000

PROFESSIONAL EXPERIENCE

Assistant Professor, Dept. of Mechanical, Biomedical, and Aerospace Engineering

University of Tennessee
Knoxville, TN, Aug. 2013–present

Postdoctoral Fellow, Division of Biokinesiology and Physical Therapy, Dept. of Computer Science

University of Southern California
Los Angeles, CA, Jul. 2009–Jul. 2013
Advisor: Carolee J. Winstein
Co-Advisor: Maja J. Matarić
Research: *Wearable Sensors for Ambient Monitoring of Individuals Post-Stroke*

Postdoctoral Fellow, Dept. of Computer Science

University of Southern California
Los Angeles, CA, Feb. 2007–Jul. 2013
Advisor: Maja J. Matarić
Research: *Socially Assistive Robotics for Post-Stroke Rehabilitation*

OTHER PROFESSIONAL EXPERIENCE

Consultant, ipCapital Group Knoxville, TN, Dec. 2014–present

Intern, Lawrence Livermore National Laboratories Livermore, CA, Jun.–Aug. 1999

Intern, Boeing Flight Systems Seattle, WA, Jun. 1998–Aug. 1998

Intern, Amoco Polymers Alpharetta, GA, Jul.–Sept. 1997

TEACHING EXPERIENCE

University Courses

ME463, Mechanical Vibrations, Free and forced response of systems with multiple degrees of freedom. Response to arbitrary excitation. Lagrange's equations. Introduction to continuous systems. Vibration absorbers and rotor balancing.

ME451, *Control Systems*, Analysis and design of feedback control systems using transient and frequency response techniques. Stability analysis in the time and frequency domain.

ME647, *Nonlinear Control*, Qualitative behavior of nonlinear systems; Lyapunov stability theory; passivity and absolute stability theory; frequency domain methods; nonlinear feedback systems; nonlinear design techniques.

ME410, *Professional Topics*, Topics relating to professional responsibility and communications, and organization. Requires a formal oral presentation by each student on an engineering topic chosen by the student and approved by the instructor.

ME449, *Mechanical Engineering Laboratory*, Designing, conducting, and reporting results of experimental exercises. Analysis of data and formation of conclusions.

ME450, *Mechanical Engineering Design I*, Design process, synthesis, and design studies.

ME460, *Mechanical Engineering Design II*, Synthesis and design of a complete mechanical engineering system. Participation in team design effort, including formal oral presentations and written design report.

Other Teaching

Guest Lecturer, *Business Entrepreneurship 557, Technology Commercialization*, Marshall School of Business, University of Southern California, Los Angeles, CA, Fall 2011

Guest Lecturer, *ENGR 499, Engineering Science and Systems*, Viterbi School of Engineering, University of Southern California, Los Angeles, CA, Fall 2007

Teaching Assistant, *2.12: Undergraduate Robotics Lab*, Mechanical Engineering Department, Massachusetts Institute of Technology, Cambridge, MA, Fall 2005

Instructor, *Introduction to Robotics*, MIT Saturday Engineering Enrichment and Discovery Program, Massachusetts Institute of Technology, Cambridge, MA, Spring 2006

GRANTS & CONTRACTS

Current

American Society of Neurorehabilitation, Clinical Research Network Task Force, “Assessment of Interlimb coordination in Adults with Hemiplegia,” PI: S. Duff, Co-PI: E. Wade. \$5,000, Nov. 2016–Nov. 2017.

University of Tennessee Office of Undergraduate Education, “Robotics for Children with Complex Hearing Impairments,” PI: E. Wade, \$2,000, Fall 2017.

NIH (NICHD) #EB022336–01 R15, “Quantifying and Reducing Motor Compensation After Stroke in Ambient Settings,” PI: E. Wade. \$349,048, July 2016–June 2019.

NSF (Smart and Connected Health) #1502242, “Contingent Cueing for the Alleviation of Symptoms of Parkinson’s Disease in Ambient Settings,” PI: E. Wade, Co-PI: J. Tan. \$551,196, Sept. 2015–Aug. 2018.

Construction Industry Research & Policy Center (UTK), “Attentional Focus and Falls: A Study of the Relationship Between Attention and Ladder Climbing Stability,” Co-PI: E. Wade, Co-PI: J. Fairbrother. \$29,720, 7/1/2014–present.

Completed

Neuroscience Network of East Tennessee (UTK), “Stroke and Neurorehabilitation,” PI: E. Wade, Co-PI: J. Tan. \$17,000, 1/2/14–6/30/14.

PUBLICATIONS

Refereed Journal Papers

- [J1] Totty, M. and **Wade, E.**, *Muscle Activation and Inertial Motion Data for Non-Invasive Classification of Activities of Daily Living*, IEEE Transactions on Biomedical Engineering (TBME), 2017, DOI: 1109/TBME.2017.2738440.
- [J2] Chen, Y. A., Chung, Y. C., Proffitt, R., **Wade, E.**, Winstein, C., *Attentional Demand of a Virtual Reality-Based Reaching Task in Non-Disabled Elders*, Journal of Motor Learning and Development (JMLD), 3(2), 2016, pp.91–109.
- [J3] Yang, H., Sawhney, R., Ji, S., **Wade, E.** *Development of Walking in Place System based on Zero Crossing Algorithm*, International Journal of Virtual Reality (IJVR), 15(2), 2015, pp.30–43.
- [J4] **Wade, E.**, Chen, C., and Winstein, C. J., *Spectral Analyses of Wrist Motion Data in Individuals Post Stroke: Developing a Performance Measure for Unsupervised Settings*, Neurorehabilitation and Neural Repair (NNR), 28(2), Feb., 2013, pp.169–178.
- [J5] **Wade, E.**, Parnandi, A. R., Mead, R., and Matarić, M. M., *Socially Assistive Robotics for Guiding Motor Task Practice*, Paladyn Journal of Behavioral Robotics (JBR), 2(4), 2011, pp.218–227.
- [J6] **Wade, E.**, and Winstein, C. J., *Virtual Reality and Robotics for Stroke Rehabilitation: Where Do We Go from Here?*, Topics in Stroke Rehabilitation (TSR), 18(6), Nov.–Dec., 2011, pp.685–700.
- [J7] **Wade, E.**, and Asada, H. H., *Conductive Fabric Garment for a Cable-Free Body Area Network: Conductivity Analysis for DC Power-Line Communication over Fabric Media*, IEEE Pervasive Computing (PC), 6(1), Jan.–Mar., 2007, pp.52–58.
- [J8] **Wade, E.**, and Asada, H. H., *Design of a Broadcasting Modem for a DC PLC Scheme*, IEEE/ASME Transactions on Mechatronics, 11(5), Oct. 2006, pp.533–540.

Book Chapters

- [B1] **Wade, E.** et al., “Assisted Ambient Living Applied to Remote Motor Rehabilitation” Handbook on Ambient Assisted Living, IOS Press, Vol. 11: Handbook of Ambient Assisted Living, 2012, 567–580.
- [B2] **Wade, E.** et al., “Power Line Communications for Wearable Applications.” Power Line Communications, John Wiley and Sons, 2010.

Refereed Conference Papers & Abstracts

- [C1] Nelson, Z. and **Wade, E.**, *Frequency Domain Analysis of Fugl-Meyer Assessment Data in Individuals Post Stroke*, to appear in proceedings, 2017 American Society for Neurorehabilitation, Baltimore, MD, Nov. 2017.
- [C2] Miller, A. and **Wade, E.**, *Sensitivity of Inertial Sensors to Motor Compensation during a Goal Directed Reaching Task*, In proceedings, 39th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Jeju Island, Korea, Jul. 2017.
- [C3] **Wade, E.**, Hall, L., and Fairbrother, J., *The Effect of Attentional Focus Training on Ladder Stability*, In proceedings, 2017 North American Society for the Psychology of Sport and Physical Activity Conference, San Diego, CA, Jun. 2017.
- [C4] McCarthy Maeder, J., Reilly, K., **Wade, E.**, and Keith, R., *Impact of Social Robots During At-Home Practice of Speech Sounds With Children With Phonological Impairment*, In proceedings, 2016 American Speech-Language-Hearing Association, Philadelphia, PA, Nov. 2016.
- [C5] Vaz, C., and **Wade, E.**, *Design of a Low-Cost Social Robot for Children With Complex Communication Needs*, Journal of Medical Devices, 2016, 10(3), DOI: 10.1115/1.4033765.
- [C6] Hemmati, S., and **Wade, E.**, *A Wavelet Transform-Based Approach for Detecting Postural Transitions in Patients Following Anterior Cruciate Ligament Reconstruction*, Journal of Medical Devices, 2016, 10(3), DOI: 10.1115/1.4033764.
- [C7] Hemmati, S. and **Wade, E.**, *Detecting postural transitions: A robust wavelet-based approach*, 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Orlando, FL, 2016.
- [C8] Chaeibakhsh, S. and **Wade, E.**, *Upper extremity post-stroke motion quality estimation with decision trees and bagging forests*, 38th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Orlando, FL, 2016.
- [C9] Hemmati, S. and **Wade, E.**, *Optimally Selected Features Detect and Predict Freezing of Gait in Parkinson's Disease*, Biomedical Engineering Society (BMES), Minneapolis, MN, 2016.
- [C10] Duff, S., Billmers, C., Brindle, S., Graver, S., Kelly, M., **Wade, E.**, *Accelerometry to Quantify Daily Upper Extremity Activity in Individuals with Hemiparesis Within 9 Months Post-Stroke*, American Physical Therapy Association Combined Sections Meeting (CSM), 2016.
- [C11] Totty, M., **Wade, E.**, *Forearm EMG Activation Classifies Activities of Daily Living*, Biomedical Engineering Society (BMES), Tampa, FL, 2015.
- [C12] **Wade, E.**, Lin, P., Hemmati, S., Sigward, S., *Predicting Daily Gait Behaviors after Anterior Cruciate Ligament Surgery: A Case Study*, 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Milan, Italy, 2015.
- [C13] Garrison, B., **Wade, E.**, *Relative Accuracy of Time and Frequency Domain Features to Quantify Upper Extremity Coordination*, 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBC), Milan, Italy, 2015.

- [C14] Chaeibakhsh, S., Fairbrother, J., **Wade, E.**, *Methodology for Prospective Evaluation of Ladder Safety Protocols using Automated Force and Inertial Sensing*, International Conference on Applied Human Factors and Ergonomics (AHFE), Las Vegas, NV, USA, 2016.
- [C15] Swift-Spong, K., Short, E., **Wade, E.**, Mataric, M., *Effects of Comparative Feedback from a Socially Assistive Robot on Self-Efficacy in Post-Stroke Rehabilitation*, 14th IEEE/RAS-EMBS International Conference on Rehabilitation Robotics (ICORR), Singapore, 2015.
- [C16] Chen, J., **Wade, E.** *Spectral Analyses as a Measure of Limb Coordination*. In proceedings, 2014 Biomedical Engineering Society (BMES), San Antonio, TX, Oct. 2014.
- [C17] Sanders-Holly, C., **Wade, E.** *Commentary on: Perceptions of equine-assisted activities and therapies by parents and children with spinal muscular atrophy*. *Pediatr. Phys. Ther.*, 26(2), Summer, 2014, pp.244.
- [C18] **Wade, E.**, Zeisler, C., Templeman, C., Chen, J. H. *Evidence of motor skill specialization in wrist motion of skilled clinicians*. In proceedings, 2013 Society for Neuroscience Conference, San Diego, CA, Nov. 2013.
- [C19] Chen, J. H., **Wade, E.**, Zeisler, C., Ghanimanti, S., Wei, J. Z., Templeman, M. D. *Wrist Accelerometer Analysis of Competent versus Expert Laparoscopic Surgeons*. In proceedings, 2013 American Association of Gynecologic Laparoscopists, Washington, DC, Nov. 2013.
- [C20] **Wade, E.**, Fan, T. W. *Kinematic Measures of Upper-Extremity Performance in the Home Setting for an Individual Post-Stroke: A Case Report*. In proceedings, 2013 IEEE EMBS Neural Engineering Conference, San Diego, CA, Nov. 2013.
- [C21] **Wade, E.**, Proffitt, R., Kim, B., Lange, B., Requejo, P., Chen, Y. A., Chung, Y. C., Winstein, C. J. *Do Older Adults Plan and Adjust Reaching Movements Similarly for Real and Virtual Targets?*. In proceedings, 2013 Gerontological Society of America Conference, New Orleans, LA, Nov. 2013.
- [C22] **Wade, E.**, Chen, S., and Winstein, C. J. *Kinematic performance of the paretic and non-paretic limbs after stroke during a goal-directed reaching task*. In proceedings, 2012 Society for Neuroscience Conference, New Orleans, LA, Oct. 2012.
- [C23] **Wade, E.**, Proffitt, P., Requejo, P., Mulroy, S., and Winstein, C. J., *Visuomotor Reaching Behavior to Virtual and Real Targets Depends on Postural Requirements in Healthy Elders*. In proceedings, 2012 American Congress of Rehabilitation Medicine Conference, Vancouver, BC, Oct. 2012.
- [C24] **Wade, E.**, Parnandi, A., and Matarić, M. J. *Using Socially Assistive Robotics to Augment Motor Task Performance in Individuals Post-Stroke*. In IEEE/RSJ International Conference on Intelligent Robots and Systems, San Francisco, California, Sept. 2011.
- [C25] **Wade, E.**, Dye, J., Mead, R., and Matarić, M. J. *Assessing the Quality and Quantity of Social Interaction in a Socially Assistive Robot-Guided Therapeutic Setting*. In 12th IEEE International Conference on Rehabilitation Robotics, Zurich, Switzerland, Jun. 2011.
- [C26] **Wade, E.**, Chen, S., and Winstein, C. J. *Determination of Nominal Task Difficulty of an Upper Extremity Motor Task Puzzle for Individuals Post-Stroke*, In proceedings, 2011 North American Society for the Psychology of Sport and Physical Activity Conference, Burlington, Vermont, Jun. 2011.

- [C27] Charalambous, C., Gerger, M., Cesar, G., **Wade, E.**, Winstein, C. J. *Systematic Investigation of Anticipatory Planning in Goal-Directed Stepping*. In proceedings, 2011 North American Society for the Psychology of Sport and Physical Activity, Burlington, Vermont, Jun. 2011.
- [C28] **Wade, E.**, Chen, S., and Winstein, C. J. *Effectiveness of Accelerometers for Evaluating Upper Limb Involvement During Gait*. In proceedings, 2nd International Conference on Ambulatory Monitoring of Physical Activity and Movement, Glasgow, Scotland, May 2011.
- [C29] Charalambous, C., Lai, Y. H., **Wade, E.**, and Winstein, C. J. *What factors are prioritized for planning actions that require goal-directed positioning?*, Proceedings of Society for Neuroscience, San Diego, California, Nov. 2010.
- [C30] Mead, R., **Wade, E.**, Johnson, P., St. Clair, A, Chen, S., and Matarić, M. J. *An Architecture for Rehabilitation Task Practice in Socially Assistive Human-Robot Interaction* In 19th IEEE International Symposium in Robot and Human Interactive Communication, Viareggio, Italy, Sept. 2010.
- [C31] **Wade, E.**, Parnandi, A., and Matarić, M. J. *Automated Administration of the Wolf Motor Function Test for Post-Stroke Assessment*. In ICST 4th International ICST Conference on Pervasive Computing Technologies for Healthcare, Munich, Germany, Mar. 2010.
- [C32] Parnandi, A., **Wade, E.**, and Matarić, M. J. *Motor Function Assessment Using Wearable Inertial Sensor*. Proceedings of the 32nd Annual International Conference of the IEEE Engineering in Medicine and Biology Society, Buenos Aires, Argentina, Aug. 2010.
- [C33] **Wade, E.** and Matarić, M. J. *Design and Testing of Lightweight Inexpensive Motion-Capture Devices with Application to Clinical Gait Analysis*. In Proceedings of the International Conference on Pervasive Computing, London, England, Aug. 2009, pp.1–7.
- [C34] Tapus, A., **Wade, E.**, and Matarić, M. J. *Using a Socially Assistive Robot in Gait Recovery and Training for Individuals with Cognitive Impairments*. In AAAI Fall Symposium AI in Eldercare: New Solutions to Old Problems, Arlington, Virginia, Nov. 2008.
- [C35] **Wade, E.**, and Asada, H. H., *DC Behavior of Conductive Fabric Networks with Application to Wearable Sensor Nodes, Wearable and Implantable Body Sensor Networks*, International Workshop on Body Sensor Networks, Boston, Massachusetts, Apr. 2006, pp.27–30.
- [C36] **Wade, E.**, and Asada, H. H., *Cable-Free Body Area Network using Conductive Fabric Sheets for Advanced Human-Robot Interaction*, Proceedings of the 27th Annual International Conference of the Engineering in Medicine and Biology Society, Shanghai, China, Sept. 2005, pp.3530–3533.
- [C37] **Wade, E.**, and Asada, H. H., *Electrostatic Analysis and Design of a Cable-Free Body Area Network of Sensor Nodes Using 2D Communication over Conductive Fabric Sheets*, In IEEE/RSJ International Conference on Intelligent Robots and Systems, Edmonton, Alberta, Aug. 2005, pp.3642–3647.
- [C38] **Wade, E.**, and Asada, H. H., *Cable-free wearable systems using conductive fabrics transmitting signals and power*, Smart Structures and Materials: Smart Sensor Technology and Measurement Systems, Proceedings SPIE Vol. 5758, San Diego, California, 2005, pp.285–295.

- [C39] **Wade, E.**, and Asada, H. H., *DC powerline communication network for a wearable health monitoring system*, International Symposium on Power Line Communications and Its Applications, Vancouver, Canada, Apr. 2005, pp.172–175.
- [C40] **Wade, E.**, and Asada, H. H., *Cable-free wearable sensor system using a DC powerline body network in a conductive fabric vest*, Proceedings of the 26th Annual International Conference of the Engineering in Medicine and Biology Society, Volume 2, San Francisco, California, Sept. 2004, pp.5376–5379.
- [C41] **Wade, E.**, and Asada, H. H., *Wearable DC powerline communication network using conductive fabrics*, IEEE International Conference on Robotics and Automation, Volume 4, New Orleans, Louisiana, Apr. 2004, pp.4085–4090.
- [C42] **Wade, E.**, and Asada, H. H., *Flexible material handling system using smart-carriers and powerline communication*, IEEE International Conference on Robotics and Automation, Volume 2, Taipei, Taiwan, Sept. 2003, pp.1711–1716.
- [C43] **Wade, E.**, and Asada, H. H., *Reduced cable smart motors communicating over the DC power bus-line for high degree of freedom systems*, In IEEE/RSJ International Conference on Intelligent Robots and Systems, Volume 2, Las Vegas, Nevada, Oct. 2003, pp.1987–1991.
- [C44] **Wade, E.**, and Asada, H. H., *One-wire smart motors communicating over the DC power bus-line with application to endless rotary joints*, IEEE International Conference on Robotics and Automation, Volume 3, Washington, D.C., May 2002, pp.2369–2374.
- [C45] Liu, C.H., **Wade, E.**, and Asada, H. H., *Reduced-cable smart motors using DC power line communication* IEEE International Conference on Robotics and Automation, Volume 4, Seoul, South Korea, 2001, pp.3831–3838.

INVITED TALKS

- [T1] *Technologies for Motor-Neurorehabilitation*, 2017 TEDxUTK Event, Knoxville, TN, Feb. 11, 2017.
- [T2] *Noninvasive Technology and Motor-Neuro Rehabilitation*, University of Tennessee Graduate School of Medicine Seminar, Knoxville, TN, Nov. 2017.
- [T3] *Novel Technologies for Closing the Loop between the Clinic and the Home*, 2013 International Conference on Collaboration Technologies and Systems, San Diego, CA, May 23, 2013.
- [T4] *Robots for Ambient Living: Cool, Practical, or Both?*, The Los Angeles/Orange County Chapter of the Association of Rehabilitation Nurses Workshop, Rancho Los Amigos National Rehabilitation Hospital, Downey, CA, Mar. 19, 2011.
- [T5] *VR and Robotics for Stroke Rehabilitation: Where Do We Go From Here?*, USC Division of Biokinesiology and Physical Therapy Seminar Series, University of Southern California, Los Angeles, CA, Oct. 28, 2010.
- [T6] *Imperceptible Wearable Sensing for Continuous Monitoring: Conductive Textiles*, 3rd IEEE-EMBS International Summer School and Symposium on Medical Devices and Biosensors, Cambridge, MA, Sept. 5–6, 2006.

- [T7] *Wearable Monitoring Applications*, Office of Engineering and Technology, Federal Communications Commission, Washington, D.C., Feb. 9, 2006.

ACADEMIC HONORS & AWARDS

Thomas Stewart McCorkle Family Endowed Faculty Award, University of Tennessee, 2017.

Training in Rehabilitation Efficacy and Effectiveness Trials (TREET) T32 Training Grant Recipient, University of Southern California, 2011.

USC Stevens Center / IDEAS Empowered Grant, University of Southern California, 2010.

NIH U01 Supplement Award, National Institute of Neurological Disorders and Stroke, NIH, 2010.

Best Paper Award Finalist, International Symposium on Robot and Human Interactive Communication, IEEE, 2010.

Best Paper Award Finalist, International Conference on Robotics and Automation, IEEE, 2003.

Leventhal Fellowship Recipient, Massachusetts Institute of Technology, 2002.

MIT Presidential Fellowship Recipient, Massachusetts Institute of Technology, 2000.

Tau Beta Pi Member, Massachusetts Institute of Technology, 1999–2000.

Pi Tau Sigma Member, Massachusetts Institute of Technology, 1998–2000.

Silent Hoist & Crane Award for Mechanical Engineers, Massachusetts Institute of Technology, 1998.

SERVICE

Reviewing: Federal Grants and Funding

National Institutes of Health (2015–present)

National Science Foundation (2016–present)

Oak Ridge Associated Universities (2014, 2015, 2016)

Canada Foundation for Innovation (2014)

Technical Program Committees

IEEE Consumer Communications and Networking Conference (2010 to present)
IEEE Pervasive Computing Technologies for Healthcare (2010 to present)
INSTICC International Conference on Health Informatics (2010 to present)
INSTICC International Conference on Informatics in Control (2009 to present)
INSTICC International Conference on Bio-inspired Systems and Signal Processing (2010 to present)
International Workshop on Intelligent Environments Supporting Healthcare and Well-being (2010 to present)

Reviewing: Journal Papers

IEEE Transactions on Robotics
IEEE Transactions on Information Technology in Biomedicine
Journal of Experimental and Theoretical Artificial Intelligence
International Journal of Advanced Robotic Systems
Neurorehabilitation and Neural Repair
Gerontology
MDPI Sensors Journal

Reviewing: Conference Papers

IEEE Engineering in Medicine and Biology
IEEE International Symposium on Robot and Human Interactive Communication
IEEE Pervasive Computing Technologies for Healthcare
IEEE International Conference on Robotics and Automation
IEEE International Conference on Biomedical Robotics and Biomechatronics

Professional Affiliations & Memberships

Institute of Electrical and Electronics Engineers
American Society of Mechanical Engineers
Society for Neuroscience
American Society of Neurorehabilitation
American Congress of Rehabilitation Medicine
North American Society for the Psychology of Sport and Physical Activity

PATENTS

Melina Agosto, Teodoro Arvio, Sean Bradshaw, Scott Hiroshige, Nicole Thomas, Eric Wade, U.S. Patent 5915869 – “Ergonomic Cleaning Apparatus with Multiple Surfaces,” Issued Jun. 29, 1999.