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Sean Michael Sketch

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Education

Stanford University, Stanford, CA — **June 2019**
Ph.D. in Mechanical Engineering — **(expected)**
Advisor: Allison M. Okamura

Stanford University, Stanford, CA — **March 2015**
M.S. in Mechanical Engineering — GPA: 4.15
Advisor: Allison M. Okamura

Princeton University, Princeton, NJ — **June 2012**
B.S.E. in Mechanical Engineering — GPA: 3.90
Certificates in Materials Science and Engineering & Robotics and Intelligent Systems

Honors

Stanford

- Best Student Presentation, 2018 IEEE Haptics Symposium (April 2018)
- Stanford Interdisciplinary Graduate Fellowship (SIGF) through the Stanford Neurosciences Institute (May 2015)
- National Science Foundation Graduate Research Fellowship Honorable Mention (April 2013, 2014)
- "Most Educational" Poster for the Stanford Science Through Art (STAr) Project (November 2013)
- Stanford School of Engineering Five-Quarter Fellowship (March 2012)

Princeton

- Highest Honors in Mechanical and Aerospace Engineering (June 2012)
- Sau-Hai Lam *58 Prize in Mechanical and Aerospace Engineering (June 2012)
- Sigma Xi (elected to membership June 2012)
- Phi Beta Kappa (elected to membership May 2012)
- Marshall Scholarship Finalist (November 2011)
- Barry M. Goldwater Scholar (April 2011)
- Tau Beta Pi (inducted November 2010)
- Shapiro Prize for Academic Excellence, recognizing outstanding academic achievement on the part of freshmen and sophomores (October 2009)
- Pyka Memorial Prize in Physics for outstanding Physics undergraduates who have shown excellence in course work and promise in independent research (July 2009)
- 10th-place, All-American at 2011 NIRCA (National Intercollegiate Running Club Association) Cross-Country Nationals (November 2011)

Publications and Presentations

1. **S. M. Sketch**, C. S. Simpson, A. J. Bastian and A. M. Okamura (2018) Measurements of Proprioception: Active, Passive, Joint Space, Task Space. IEEE Transactions on Haptics, [submitted].
2. C. S. Simpson, C. G. Welker, S. D. Uhlrich, **S. M. Sketch**, R. W. Jackson, S. L. Delp, S. H. Collins, J. C. Selinger and E. W. Hawkes (2018) Connecting the legs with a spring improves human running economy. BioRxiv, 474650.
3. **S. M. Sketch**, A. J. Bastian and A. M. Okamura (2018) Comparing Proprioceptive Acuity in the Arm between Joint Space and Task Space. In IEEE Haptics Symposium, pages 125-132.
4. **S. M. Sketch**, C. S. Simpson, F. Crevecoeur and A. M. Okamura (2017) Simulating the impact of sensorimotor deficits on reaching performance. In IEEE International Conference on Rehabilitation Robotics, pages 31-37.
5. C. S. Simpson, **S. M. Sketch**, F. Crevecoeur and A. M. Okamura (2017) Modeling sensitivity of reaching behavior to sensorimotor deficits. In 27th Annual Meeting of the Society for the Neural Control of Movement.

6. **S. M. Sketch** (presenter), C. S. Simpson (presenter), and A. M. Okamura. Understanding the neuromechanics of stroke through simulation. Presented at the Stanford Mechanical Engineering Conference (MECON), May 6, 2016, Stanford, CA.
7. **S. M. Sketch** (presenter), B. E. Dudley, J. A. Reyna, A. J. Bastian, M. R. Cutkosky, and A. M. Okamura. Towards the understanding of proprioceptive deficits for post-stroke movement rehabilitation. Presented at the Bay Area Robotics Symposium, Oct. 23, 2015, Berkeley, CA.
8. **S. M. Sketch** (presenter), B. E. Dudley, J. A. Reyna, A. J. Bastian, M. R. Cutkosky, and A. M. Okamura. Towards the understanding of proprioceptive deficits for post-stroke movement rehabilitation. Presented at the Stanford Neurosciences Institute Symposium, Oct. 1, 2015, Stanford, CA.
9. **S. M. Sketch** (presenter), D. R. Deo, J. P. Menon and A. M. Okamura. A Skin-Stretch Haptic Device for Improved Control of Brain-Computer Interfaces. Presented at the 3rd Annual ASU Rehabilitation Robotics Workshop, Feb. 13-14, 2015, Tempe, AZ.
10. **S. M. Sketch** (presenter), D. R. Deo, J. P. Menon and A. M. Okamura. Skin-Stretch Haptic Feedback for Improved Control of Brain-Computer Interfaces. Presented at the Bio-X Interdisciplinary Initiatives Symposium, Aug. 27, 2014, Stanford, CA.
11. **S. M. Sketch**, D. R. Deo, J. P. Menon and A. M. Okamura (2015) Design and Experimental Evaluation of a Skin-Stretch Haptic Device for Improved Control of Brain-Computer Interfaces. In IEEE International Conference on Robotics and Automation, pages 272-277.
12. R. C. Winck, **S. M. Sketch**, E. W. Hawkes, D. L. Christensen, H. Jiang, M. R. Cutkosky and A. M. Okamura (2014) Time-delayed teleoperation for interaction with moving objects in space. In IEEE International Conference on Robotics and Automation, pages 5952-5958.
13. N. Colonnese, **S. M. Sketch** and A. M. Okamura (2014) Closed-loop Stiffness and Damping Accuracy of Impedance-type Haptic Displays. In IEEE Haptics Symposium, pages 97-102.
14. Simnick AJ, Otvos B, **Sketch SM**, Kontos CD, Chilkoti A. Engineered cell line with titratable receptor expression for ligand-receptor binding assays. Presented at the Biomedical Engineering Society Annual Meeting, Oct. 7-10, 2009, Pittsburgh, PA.

Research Experience

***Doctoral Dissertation Research* under Allison M. Okamura, PhD**, Stanford University **Winter 2015-present**

Increasing Understanding and Assistance of Sensorimotor Control in the Upper Limb Following Stroke

- Modeled neural control of reaching with the human upper limb as a 2-degree-of-freedom feedback system with model-predictive controller, unscented Kalman filter, and biologically based parameters, including sensorimotor impairments commonly associated with post-stroke hemiparesis
- Co-authored paper accepted to 2017 IEEE International Conference on Rehabilitation Robotics and abstract accepted to 2017 Annual Meeting of the Society for the Neural Control of Movement
- Designed and programmed user-adjustable, 2-degree-of-freedom, planar robotic arm support (similar to the KINARM exoskeleton by ©BKIN Technologies) with the help of three Stanford undergraduates and one Stanford Masters student
- Evaluated proprioception in the upper limb of 42 healthy subjects and 4 stroke patients using the robotic arm support and a custom-designed mirror display
- Authored paper accepted to 2018 IEEE Haptics Symposium (winner of Best Student Presentation award)
- Submitted paper (with expedited review) to IEEE Transactions on Haptics

***Graduate Research Project* under Allison M. Okamura, PhD**, Stanford University **Spring-Fall 2014**

Design and Experimental Evaluation of a Skin-Stretch Haptic Device for Improved Control of Brain-Computer Interfaces

- Designed a desktop 2-degree-of-freedom skin-stretch haptic device controlled via non-invasive, EEG-based brain-computer interface
- Assessed the "intuitiveness" of different control paradigms for the device
- Evaluated the effectiveness of the device at BCI-based movement-intent classification in a small human-user study
- Paper accepted (with oral presentation and interactive poster session) to 2015 IEEE International Conference on Robotics and Automation

***Graduate Research Project* under Allison M. Okamura, PhD**, Stanford University **Summer-Fall 2013**

Time-Delayed Teleoperation for Interaction with Moving Objects in Space (DARPA Phoenix project)

- Designed a laboratory testbed to validate the model-mediated predictive control algorithms necessary for successful time-delayed teleoperation
- Programmed *PHANTOM Premium* and *OMNI* haptic devices for teleoperation and force feedback

- Constructed an air-bearing system to mimic the frictionless environment in space
- Implemented an overhead vision system and used the vision data to render a graphical model of the space-like environment
- Co-authored paper accepted (with long oral presentation) to 2014 IEEE International Conference on Robotics and Automation

***Graduate Research Project* under Allison M. Okamura, PhD**, Stanford University **Winter 2013**

Assessing the Quality of Haptic Virtual Environments (NSF Human-Centered Computing project)

- Developed a model of how the fidelity of virtual haptic environments changes with "haptic effects" (i.e., virtual environment parameters (e.g., virtual damping), dynamics of the haptic device, sampling rate, filtering, and time delay)
- Programmed a *PHANTOM Premium* haptic device to render spring-mass-damper environments with variable sampling rate, filter order, filter cut-off frequency, and time delay
- Generated low-noise empirical transfer function estimations (ETFEs) of spring-mass-damper environments under the influence of haptic effects using data collected from the programmed *PHANTOM Premium*
- Demonstrated the agreement of generated ETFEs with theoretical Bode plots
- Presented poster summarizing work to Stanford Mechanical Engineering faculty and students
- Co-authored paper accepted (with long oral presentation) to 2014 IEEE Haptics Symposium

***Senior Thesis* under Naomi E. Leonard, PhD**, Princeton University **2011-2012**

"Human In The Loop" – Human Decision Making in the Context of Human-Robot Teams

- Developed a framework for studying how humans make decisions when controlling robots in resource-collection tasks that feature tension between exploration (for greater resources) and exploitation (of current resources)
- Designed a single-human-single-robot two-dimensional resource-collection task in a 20,000-gallon water tank with teleoperated underwater robots (prior to this work, such tasks were only virtual)
- Created web-based user interface for the task using a combination of C++, Ruby (on Rails), JavaScript, HTML, and CSS
- Modified control system for the robots, including the addition of potential field-based boundary control
- Designed and machined new robot components for improved waterproofing
- Received approval for human-subjects testing from Princeton's Institutional Review Board
- Compiled 66-page hardbound report documenting my work
- Presented poster summarizing work to Princeton Mechanical and Aerospace Engineering faculty

***Research Assistant* under Marc A. Sommer, PhD**, Duke University **Summer 2011**

2011 Summer Fellowship Program for NSF Research Experience for Undergraduates (REU) Fellows at the Duke University Pratt School of Engineering

- Investigated neuronal circuits in the primate brain and their implications for robotics
- Learned and practiced handling and care of non-human primates (specifically, rhesus macaque), including removing from and returning to cages via pole and collar, settling into specially designed primate chairs, and cleaning head implants prior to neuron recording
- Learned and practiced single-neuron recording techniques
- Trained primates on eye-arm coordination tasks of my own design (programmed in the NIH-developed *Rex* system)
- Programmed *Nao* robots to perform basic visual recognition tasks
- Created lab guides to ease the integration of new researchers into the Sommer lab
- Completed seminars on engineering ethics and entrepreneurship
- Compiled 10-page scientific paper documenting my experimentation
- Presented PowerPoint summary of my experimentation to faculty and lab members from across the Pratt School of Engineering

***Research Assistant* under Alexander J. Smits, PhD**, Princeton University **Summer 2010**

Summer 2010 Practical Experience for Freshmen and Sophomores (sponsored by the Mechanical and Aerospace Engineering Department of Princeton University and the Boeing Corporation)

- Collaborated with undergraduate and graduate students to redesign a robotic, swimming manta ray
- Designed and machined alternative actuation system, improved waterproofing, programmed basic intelligence for the robot
- Compiled 30-page report documenting the design process, testing, and possibilities for future work

***Research Assistant* under Christopher D. Kontos, MD**, Duke University Medical Center **Summer 2009**

- Researched potential efficacy and safety of a gene-therapy treatment for vein-graft disease
- Employed Western blotting to demonstrate AAV-PTEN as an inhibitor of signaling and cellular responses that cause intimal hyperplasia in vascular smooth-muscle cells
- Designed real-time-PCR "safety assay" for the quantitative detection of viral particles in genomic DNA
- Presented PowerPoint summary of results
- Work presented at 2009 Biomedical Engineering Society Annual Meeting

Teaching Experience

***Guest Lecturer*, ME 161/261: Dynamic Systems, Vibrations and Control**, Stanford University **Spring 2018**

- Co-taught 2 1.5-hour class sessions for 30-40 students
- Explained concepts of PID control, root locus, and coupled equations of motion (including their modal decomposition via eigenvalues/vectors)

***Course Instructor*, ME 492: Teaching Assistant Training**, Stanford University **Fall 2014-Spring 2016**

- Co-led 5-6 1.5-hour class sessions per quarter (20-35 students)
- Developed a new course syllabus, including 5 "essential skills" seminars with expert guest lecturers from the university
- Compiled an exhaustive list of on-campus resources (both academic and otherwise) for teachers and their students
- Recruited and trained new course instructors

***Course Assistant*, ME 328: Medical Robotics**, Stanford University **Spring 2015**

- Held 2+ office/lab hours per week (5-15 students per hour)
- Lectured on basics of teleoperation when professor was absent (25-30 students)
- Prepared solutions for graded assignments
- Responded to student questions via Piazza, an online discussion board for the course (32 students)
- Received end-quarter feedback from students – 4.7/5.0 in overall teaching effectiveness, many comments like the following: "*[Sean] did a good job explaining concepts while guiding students to figure things out on their own.*"

***Course Assistant*, ENGR 105: Feedback Control Design**, Stanford University **Winter 2014**

- Held 2-3, heavily attended office hours per week (15-20 students)
- Prepared and presented four 1-hour review sessions, each with a PowerPoint summary of recent/upcoming topics and a related example problem on the board (10-15 students)
- Joint-lectured with another course assistant when professor was absent (40-50 students)
- Prepared solutions for and graded assignments and exams (69 students)
- Responded to student questions via Piazza, an online discussion board for the course (69 students)
- Received mid- and end-quarter feedback from students – 4.9/5.0 in overall teaching effectiveness, many comments like the following: "*[Sean's] teaching style is super effective, and the time and effort he puts into preparing the material and making it easy to understand is astounding and much appreciated.*"

***Student*, ENGR 312: Science and Engineering Course Design**, Stanford University **Winter 2016**

- Designed the beginnings of an original course titled "Neuromagic", including the course's learning goals, syllabus, and rubric for an in-class exercise
- Read book chapters and articles on recent research in science/engineering education
- Wrote a personal reflection on teaching philosophy

***Student*, ME 492: Teaching Assistant Training**, Stanford University **Winter 2014**

***Presenter*, Stanford Science Through Art (STAr) Project**, Stanford University **August 2013**

- Designed a "scientifically artistic" poster explaining the physics of cat flipping (i.e., how cats land on their feet)
- Presented poster to students at Cañada College in Redwood City, CA
- Received award for "Most Educational" poster/presentation

***Strategic Learning Consultant*, McGraw Center for Teaching & Learning**, Princeton University **2011-2012**

- Conducted one-on-one meetings with students interested in enhancing their learning (via better time management, more effective reading, etc.)
- Planned and presented an interactive problem-solving workshop for freshmen engineering students
- Created handouts, wrote blog posts, and sat on panels related to effective study skills
- Attended biweekly meetings with other consultants and directors of the McGraw Center to reflect on teaching/learning strategies and how best to meet the learning needs of the Princeton student body

Other Activities, Leadership, and Outreach

Model, Stars Management (San Francisco, CA) **2017-present**
Student Ambassador, Stanford+Connects Bay Area **May 2016**
Guest Presenter, Stanford VPGE "Quick Bytes" workshop on Spontaneous Scripting **April 2015**
Assistant to Editor-in-Chief, IEEE International Conference on Robotics and Automation **2015**
Center for Teaching and Learning Liaison, Stanford University **2014-present**
Lab Representative, Biomechanical Engineering Student Committee **2014-present**
Presenter, Bay Area Science Festival - Discovery Days at AT&T Park **November 2013**
Organizer, lab tour and demonstrations to an all-girls summer camp from Castilleja School **August 2013**

Athlete, New Balance Silicon Valley Running Team	**2013-2015**
Co-chair of San Francisco Region, Princeton Class of 2012 Alumni Council	**2012-2013**
Member, International Brotherhood of Magicians	**2006-present**
Counselor, Slovenski Camps (sleep-away camps in Raymond, ME)	**Summer 2012**
Captain, Princeton Annual Giving 2012	**2011-2012**
Tour Guide, Princeton School of Engineering and Applied Science	**2010-2012**
Co-Director, Princeton's Annual Dodgeball Tournament	**2010, 2011, 2012**
Vice President, Princeton Colosseum Club (sponsor of alcohol-free campus events)	**2009-2012**
Member, Princeton Running Club	**2008-2012**
Leader, Six-Day Outdoor Orientation Trips for Freshmen, Princeton Outdoor Action	**Sept. 2010 & 2011**
Freshman Advisor, Princeton Aquinas Institute (on-campus Catholic community)	**2010-2011**

Skills

Engineering: mechatronic system design, CAD (Solidworks), machine-shop experience
Computer: MATLAB, C++, Arduino, Qt, CHAI3D, Adobe Photoshop/Illustrator/InDesign, Keynote, Microsoft Office