Jason K. Moore
2420 37th St
Sacramento, CA USA 95817

Professor Rida T. Farouki
Search Committee Chair
Multibody & System Dynamics – Machine Design & Robotics
Department of Mechanical and Aerospace Engineering
University of California, Davis
One Shields Avenue
Davis, CA 95616

Dear Search Committee:

I am writing to apply for both positions in the call "Two Assistant Professor Positions in the areas of 1) Multibody & System Dynamics and 2) Machine Design & Robotics" in the Mechanical and Aerospace Engineering Department at the University of California, Davis. I am currently an Assistant Professor of Teaching Mechanical and Aerospace Engineering (LPSOE) in the same department. My merit reviews and other external signs indicate I am excelling in my current position, which is focused on advancing engineering education in our department. I have been in this position for four academic years and my accomplishments over that time align with this position's heavy teaching and educational focus. I have spent 11 of my last 14 years at UC Davis and I have a deep connection to the both the academic and regional communities. It is a cherished place for me and I have vested interest in my career path here.

My primary goal at this stage in my academic career is to move into a typical professorship where I can continue to excel at teaching and education but also have the resources and support I need to focus on and further my research program in human mobility started during my graduate and postdoctoral positions. My current position has systematic hurdles that prevent me from fully realizing my research potential even if I excel at my primary educational duties. For example, many incoming graduate students want to work with me but the lack of lab space is an immediate deterrent. This unfortunately leaves me with a deep longing for the research I love. Regardless, I have been able to maintain a steady research output with a mostly undergraduate team while also excelling at my education related activities.

My prior very active research record and what I have maintained in the last four years are reflected in the 10 peer reviewed journal publications, 16 peer reviewed conference papers, 2 draft books, 12 software packages, 30+ invited and conference talks, and over $5M I have helped bring to the campus. My collective works have been cited over 550 times and I have an h-index of 12 [1], which is favorably comparable to a number of faculty already in the department. I have also demonstrated leadership in the dynamics, biomechanics, transportation safety, and computing research communities through chairing conference sessions, organizing conferences, editing journals, and acting on scientific committees. With the resources these two faculty positions could offer I will be able to launch from this already strong platform and develop as a key research contributor to the department and campus.

The UCD MAE department is at a clear turning point in its life due to the numerous retiring faculty in the past decade. These faculty defined what the world knows us for. It is certainly time to bring in many new people with new ideas but we also must steward our legacy strengths into the promising and dynamic future of the next generation of mechanical and aerospace engineering. Both advertised positions highlight this implicit desire. With this in mind, I am in a very unique position due to my strong institutional knowledge of our department and familiarity with the curriculum. I have collaborated with numerous researchers at UC Davis and have a strong regional research and engineering network tied to over a hundred projects I have been involved with over the years. I have taught eight of our undergraduate courses and taken thirteen of

[1] Google Scholar: tinyurl.com/jkm-gscholar

our courses while a graduate student. All of these courses are in the areas of multibody & system dynamics, machine design & robotics, and controls. My current course offerings are aligned precisely with the advertised positions and are a natural fit.

I also bring in new ideas and external perspective. I have spent 8 years at four other institutions. My postdoctoral training was from two of the leading biomechanicists in the world (van den Bogert and Delp) and my Fulbright year offered experience at TU Delft, one of the world's top technical universities. These experiences have provided with me with a diverse academic background and stimulus for innovation to help transform our curriculum and research activities for the next 30 years. For example, I plan to revive our lost strength in biomechanics but born anew in the form of biomechatronics to lead us into the future. Additionally, many of the retiring and retired professors that these two positions are meant to fill roles for would vouch for my likelihood of excellent stewardship of their legacy and the ability to infuse modern research and engineering themes into the future curricula.

My current research trajectory is centered around developing data-driven human-machine synergistic controllers for powered exoskeletons, powered prostheses, personal mobility vehicles (electric bicycles, scooters, wheelchairs, skateboards), and other assistive devices. These assistive vehicles and devices will play a significant role in how everyone, particularly the abled and disabled, young and old, get around both indoors and outdoors in the future. I will weave these device and vehicle technology focused efforts into the broader impact to transform our country's transportation system so that we can have a clean, multi-modal, energy efficient, accessible modes to move people from place to place indoors and outdoors. One aspect that this position could enable is an in depth exploration of the role smart self-balancing personal mobility vehicles and devices can play in enhancing the active lifestyle of elderly individuals. Also, electric bike share system companies have a growing interest in control augmented vehicles for safety and the ability to autonomously return bicycles to charging stations. This is an avenue that I plan to pursue aggressively with help from our Institute for Transportation studies new BicyclingPlus research collaborative.

I have included my research plan that centers around human mobility and how it fits here at UC Davis and a teaching statement that outlines my pedagogical practices and how I plan to contribute to new curricula if hired.

Thank you for your time and consideration.

Sincerely,

Jason K. Moore

Jason K. Moore

CONTACT INFORMATION

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Personal Website: moorepants.info
G-Scholar: tinyurl.com/jkm-gscholar
Linkedin: tinyurl.com/jkm-linkedin
Twitter: @moorepants
Google+: tinyurl.com/jkm-plus

CITIZENSHIP

United States of America

LANGUAGE

English [US] (mother tongue), Spanish [GU] (beginner), Dutch [NL] (beginner)

RESEARCH INTERESTS

Multibody dynamics, control systems, human operator control, vehicle dynamics, aircraft control, bicycle dynamics, aircraft dynamics, vehicle handling qualities, human biomechanics, gait control identification, exoskeleton control, machine design, appropriate technology, human powered machines, system identification, software engineering, wind tunnel experimentation, computational reproducibility, open science, optimal control, computer aided algebra

ACADEMIC EMPLOYMENT

Assistant Teaching Professor (LPSOE) **September 2015 to present**
Mechanical and Aerospace Engineering Department, University of California, Davis
(Chairs: C.P. van Dam [2015-2016], Stephen K. Robinson [2016-Present])

Postdoctoral Research Associate **July 2013 to August 2015**
Human Motion and Control Laboratory, Cleveland State University
(PI: Antonie J. van den Bogert)

Postdoctoral Research Programmer **January 2013 to June 2013**
Institute for Transportation Studies, University of California, Davis
(PI: Tai Stillwater)

Lecturer (Unit 18) **September 2012 to December 2012**
Mechanical and Aerospace Engineering Department, University of California, Davis
(Chair: C.P. van Dam)

Graduate Student Researcher **September 2009 to August 2012**
Sports Biomechanics Laboratory, University of California, Davis
(PIs: Mont Hubbard, Ronald Hess)

Visiting Fulbright Scholar **August 2008 to August 2009**
Bicycle Dynamics Laboratory, Delt University of Technology
(PI: A.L. Schwab)

Teaching Assistant **March 2006 to June 2007**
Mechanical and Aerospace Engineering Department, University of California, Davis
(Instructors: Jim Schaaf, Rida Farouki)

EDUCATION

University of California at Davis, Davis, California USA

Ph.D., Mechanical and Aerospace Engineering, August 2012

- Dissertation: Human Control of A Bicycle

- Dissertation Topic: Bicycle dynamics, control, and handling qualities
- Area of Study: Multibody dynamics, control systems, biomechanics, and system identification
- Advisors: Mont Hubbard, Ron A. Hess, Arend L. Schwab
- Lab: UCD Sports Biomechanics Lab, TU Delft Bicycle Dynamics Lab

M.Sc., Mechanical and Aeronautical Engineering, June 2007

- Advisor: Mont Hubbard
- Area of Study: Multibody dynamics, control systems, and machine design
- Lab: Sports Biomechanics Lab

Old Dominion University, Norfolk, Virginia USA

B.Sc., Mechanical Engineering, December 2004

- *Magna cum Laude*
- Machine Design Specialization
- Minor in Mathematics
- Minor in Philosophy and Religious Studies

Tunstall High School, Dry Fork, Virginia USA

Advanced Diploma, May 2000

- Graduated with Honors

Professional Accreditation

Passed the Fundamentals of Engineering Exam in Virginia

Grants and Awards

UC Davis Global Affairs
- Influence of Culture in Mechanical Design , PI, 2018-2019, $24k.

Center for Educational Effectiveness
- Development of an Interactive Textbook Backed by Cloud Infrastructure to Pilot Active Computational Learning in an Upper Level Mechanical Vibrations Engineering Course , PI, 2017-2018, $22k.

Nation Center of Simulation in Rehabilitation Research, Stanford University
- 2014 NCSSR Visiting Scholarship, $8k.

SAGE Publishing
- 2013 Best Paper Award, Journal of Multibody Dynamics, $400.

U.S. General Services Administration
- White House Apps for Vehicles Challenge: Phase 1, 2013, $2k.

2012 Dynamic Systems and Control Conference
- Best paper in the Single Track Vehicle Dynamics and Control Session, 2012.

National Science Foundation
- NSF Standard Grant: Human Control of Bicycle Dynamics with Experimental Validation and Implications for Bike Handling and Design, 2009-2012, $300k.

U.S. Department of State
- Fulbright Grant to the Netherlands, 2008-2009, $10k.

University of California, Davis

- Summer Graduate Student Researcher Award, 2010
- Campus Sustainability Grant (Human Powered Utility Vehicle Pilot Program), 2008
- Campus Sustainability Grant (Davis Bike Church Physical Space Renovation), 2008
- Graduate Student Association Travel Award, 2008
- Institute for Transportation Studies Travel Award, 2008
- Campus Sustainability Grant (Pedal Powered Charging Table), 2007
- Joseph Beggs Fellowship for Kinematics, 2006–2007
- MAE Department Fellowship, UC Davis, 2005–2006

Old Dominion University

- Governor's Technology Scholarship, Full Tuition, $16k, 2000–2004.

Proposals Under Review

United States Department of Education

- Expanding the LibreTexts Project into the Next-Generation Hub for Construction, Dissemination, and Usage of Open Educational Resource Textbooks, 2019-2021, CO-PI, $5M.

Rejected Proposals

National Science Foundation

- Collaborative Research: Dissemination of the LibreTexts Libraries through Expansion and Training in Digital Interfaces to Enhance Science Education across the Nation, CO-PI, 2018-2022, $5M.
- Collaborative Research: SI2-SSI: Infrastructure for Cross-Disciplinary Scientific Computation Through Optimized Symbolic Code Generation with SymPy, CO-PI, 2017-2019, $5M.

Research Experience

University of California at Davis, Davis, California USA

Faculty **September 2015 to Present**

- Led the Laboratorium of Marvelous Mechanical Motum
- Optimal bicycle design: mentored one graduate and two undergraduates students in an experimental study on bicycle handling, developed and optimization algorithm to discover optimal handling bicycle designs
- Smartphone rowing data backed coach: Worked with local startup and one undergraduate in a data science and dynamics project to predict rowing motions from smartphone data
- Design of an efficient human powered irrigation pump: mentored one graduate student and two graduate students in this research/design effort, partnered with World Bicycle Relief and Buffalo Bikes
- Identification of human standing control: mentored eight undergraduates in the design of a double pendulum balancing robot

Postdoctoral Researcher and Programmer **February 2013 to June 2013**

- Developed a cross platform smart phone/tablet application for real-time automobile driver fuel economy feedback. This application was used to conduct an experiment with 200 drivers in San Francisco on driver behavior: SmartDrive
- Won $2K in the first Phase of the White House's Apps for Vehicles Challenge with simpler version of SmartDrive for consumer use, Drive5
- Designed statistical Kalman filter based fuel economy prediction algorithms based on smart phone sensor data.

Graduate Student Researcher **September 2005 to August 2012**

- Graduate Student Researcher at the Sports Biomechanics Lab.

- Member of UC Davis's Institute for Transportation Studies.
- Co-wrote and co-managed a three year Nation Science Foundation grant.
- Developed a custom instrumented bicycle and performed control experiments to characterize the human control system in the bicycling balancing and tracking task.
- Developed numerous open source software packages.
- Mentored five graduate students during summer internships in experimental, theoretical, and computational dynamics.
- Mentored approximately ten undergraduate student interns in a lab setting.
- Mentored four undergraduates in their senior design project.
- Led multiple tours of the Sport Biomechanics Lab.
- Involved in the graduate student recruitment week.
- Designed and administered the lab website.
- Co-founded Davis Open Science.
- Co-wrote and awarded two Google Summer of Code grants (2011, 2012).
- Organized weekly lab meetings.
- Refereed an article for Vehicle System Dynamics.
- Organized and co-chaired both an invited and special session at the 2012 ASME DSCC conference.
- Featured in "Science of Balancing a Bike" by the UC Office of the President.
- Featured in "Science of Riding a Bicycle" video by KQED Quest.

Biomedical Research Engineer **August 2007 to August 2009**

- Designed and supervised the fabrication of a cell shearing device for the UCD Biomedical Passerini Lab.

Cleveland State University, Cleveland, Ohio USA

Post Doctoral Research Associate **July 2013 to August 2015**

- PI: Ton van den Bogert
- Lab: Human Motion and Control Lab
- Identified control schemes in human walking using data driven approaches.
- Developed and ran multi-subject gait experiments with a modern gait lab.
- Developed software for gait data analysis and simulation.
- Developed human walking computational models.
- Mentored several undergraduate and graduate students in research projects.
- Mentored undergraduate students in their senior design projects.
- System adminstrator for the lab web site.
- Developed a open data paper for a very large gait dataset.

Delft University of Technology, Delft, Zuid-Holland Netherlands

Fulbright Visiting Scholar and Researcher **August 2008 to August 2009**

- Ph.D. researcher at the Bicycle Dynamics Laboratory.
- Co-developed an instrumented bicycle with video logging and accompanying software.
- Used the instrumented bicycle in various experiments on and off the treadmill resulting in two conference papers.
- Participated in canceled gyro, negative trail bicycle experiments that eventually resulted a Science publication.
- Lead motion capture study on bicycle/rider kinematics resulting in two conference papers and one peer reviewed journal article.
- Developed a systematic method of measuring the physical properties of a bicycle and rider resulting in two conference papers.

- Gave a colloquium talk on the year's research.
- Researched the bicycle transportation system in the Netherlands, kept an informal blog, attended the Velo-City Brussels conference, and gave a talk on the subject at the UCD Institute of Transportation Studies.

Teaching Experience

University of California at Davis, Davis, California USA

Assistant Teaching Professor, LPSOE **September 2015 to Present**

- Taught "Introduction to Mechanical Vibrations", Fall 2016/2017, 20-40 students, upper level elective, 1 teaching assistant, redesigned entire course second time teaching it to focus on active learning and computational thinking, developed an interactive open access textbook
- Taught Multibody Dynamics, Fall 2017, 12 students, graduate course, custom software, PyDy, developed and used in the course
- Taught Mechanical Systems Design Project, Winter/Spring 2016/2017/2018, 140-160 students, 4 teaching assistants, capstone design course, mentored 70+ projects for industry clients
- Taught Mechanical and Aerospace Engineering Graduate Seminar, Spring 2017, invited 10 guest speakers for 1 hour seminars
- Taught Mechanical Design, Fall 2015/2016, required upper level course, 20-35 students
- Participated in the Engineering Education Learning Community
- Mentored 4 graduate students, 20+ undergraduates
- Member of two MSc committees

Lecturer **August 2012 to December 2012**

- Taught "Engineering Graphics in Design", 120 students, 4 Teaching Assistants
- Topics: Design, Sketching, Drawing, Drafting, Solid Modeling, CAD

Graduate Student Researcher **September 2005 to August 2012**

- Mentored five graduate students during summer internships in experimental, theoretical, and computational dynamics.
- Mentored approximately ten undergraduate student interns in a lab setting.
- Mentored four undergraduates in their senior design project.
- Led multiple tours of the Sport Biomechanics Lab.

Machine Shop Supervisor **January 2007 to June 2008**

- Supervised the College of Engineering student machine shop.
- Helped students with machining and fabrication projects.
- Taught the shop safety class.
- Fabricated various doodads and gizmos for the shop.
- Organized the shop.
- Worked on design projects for various campus research groups.

Teaching Assistant **March 2006 to June 2007**

- EME 150B, Mechanical Design (Spring 2006): Worked with student groups during the discussion period on their design projects, graded homework assignments, and held weekly office hours.
- EME 50, Manufacturing Processes (Fall 2006 and Winter 2007): Taught hands-on machining and fabrication during weekly lab sections, graded homework assignments and tests, and organized the end of quarter party.
- ENG 4, Engineering Graphics (Spring 2007): Led lab sections with lectures in sketching and 2D/3D computer aided design with modern CAD software.

Davis Open Science Co-founder **February 2010 to June 2013**

- Co-founded the graduate student group.
- Co-hosted several seminars and panels with prominent speakers in Open Science.
- Worked with various faculty and staff on open science projects.
- Led workshops on open science topics.

Action Research Team Facilitator **March 2007 to December 2007**

- Led group of students in the design and construction of a pedal powered desk laptop charging station.
- Competed in Google and Specialized's Innovate or Die Contest.
- The project was featured in many articles and news broadcasts.
- Featured in the book Human Powered Home by Tamara Dean.

Assistant Action Research Team Facilitator **March 2006 to June 2006**

- Co-led a group of students through the process of starting a mock non-profit group.

Reader **September 2006 to December 2006**

- Graded mechanical design assignments (EME 150B).

Software Carpentry, Everywhere, Planet Earth

Volunteer Instructor **January 2015 to now**

- Lead two workshops on computation for scientists and engineers.
- Developed lesson plans.
- Passed the instructor certification.

Cleveland State University, Cleveland, Ohio USA

Post Doctoral Research Associate **July 2013 to December 2014**

- Mentored graduate students.
- Mentored undergraduate students in their senior design projects.
- Led "Open Source Code Nights" workshops with the undergraduate IEEE group.
- Gave tutorials on mutlibody dynamics and control to graduate and undergraduate students.

Delft University of Technology, Delft, Zuid-Holland Netherlands

Fulbright Visiting Scholar and Researcher **August 2008 to August 2009**

- Mentored undergraduate students in their senior design projects.

Journal Publications

[1] Jason K. Moore and Mont Hubbard. "Skijumpdesign: A Ski Jump Design Tool for Specified Equivalent Fall Height". In: *The Journal of Open Source Software* 3.28 (Aug. 2018), p. 818. DOI: 10.21105/joss.00818.

[2] Jason K. Moore and Antonie van den Bogert. "Opty: Software for Trajectory Optimization and Parameter Identification Using Direct Collocation". In: *Journal of Open Source Software* 3.21 (Jan. 2018), p. 300. DOI: 10.21105/joss.00300.

[3] Aaron Meurer et al. "SymPy: Symbolic Computing in Python". In: *PeerJ Computer Science* 3.e103 (Jan. 2017). ISSN: 2376-5992. DOI: 10.7717/peerj-cs.103.

[4] Jason K. Moore, Sandra K. Hnat, and Antonie J. van den Bogert. "An Elaborate Data Set on Human Gait and the Effect of Mechanical Perturbations". In: *PeerJ* 3.e918 (Apr. 2015). ISSN: 2167-8359. DOI: 10.7717/peerj.918.

[5] Chris Dembia, Jason K. Moore, and Mont Hubbard. "An Object Oriented Implementation of the Yeadon Human Inertia Model". In: *F1000Research* 3.233 (Apr. 2015). DOI: 10.12688/f1000research.5292.2.

[6] A. L. Schwab et al. "Rider Control Identification in Bicycling Using Lateral Force Perturbation Tests". In: *Proceedings of the Institution of Mechanical Engineers, Part K: Journal of Multi-body Dynamics* 227.4 (Aug. 2013). 2013 SAGE Best Paper Award, pp. 390–406. ISSN: 1464-4193, 2041-3068. DOI: 10.1177/1464419313492317.

[7] Ronald Hess, Jason K. Moore, and Mont Hubbard. "Modeling the Manually Controlled Bicycle". In: *IEEE Transactions on Systems, Man, and Cybernetics - Part A: Systems and Humans* 42.3 (Feb. 2012), pp. 545–557. ISSN: 1083-4427, 1558-2426. DOI: 10.1109/TSMCA.2011.2164244.

[8] Jason K. Moore et al. "Rider Motion Identification during Normal Bicycling by Means of Principal Component Analysis". en. In: *Multibody System Dynamics* 25.2 (Feb. 2011), pp. 225–244. ISSN: 1384-5640, 1573-272X. DOI: 10.1007/s11044-010-9225-8.

Books & Theses

[1] Jason K. Moore and Kenneth Lyons. *Resonance: Learning Mechanical Vibration Enginering Through Computation*. Draft. Dec. 2017.

[2] Jason K. Moore. "Human Control of a Bicycle". Doctor of Philosophy. Davis, CA: University of California, Aug. 2012.

Peer Reviewed Conference Proceedings

[1] Jason K. Moore, Mont Hubbard, and Ronald A. Hess. "Optimal Bicycle Design to Maximize Handling and Safety". In: *Proceedings of the 6th Annual International Cycling Safety Conference*. Davis, CA, USA, Sept. 2017. DOI: 10.6084/m9.figshare.5405242.v1.

[2] Scott W. Kresie et al. "Experimental Validation of Bicycle Handling Prediction". In: *Proceedings of the 6th Annual International Cycling Safety Conference*. Davis, CA, USA, Sept. 2017. DOI: 10.6084/m9.figshare.5405233.v1.

[3] Jason Moore, Mont Hubbard, and Ronald A. Hess. "An Optimal Handling Bicycle". In: *Proceedings of the 2016 Bicycle and Motorcycle Dynamics Conference*. Figshare, Sept. 2016. DOI: 10.6084/m9.figshare.c.3460590.v11.

[4] Jason K. Moore and Mont Hubbard. "Methods for Elimination of Crosstalk and Inertial Effects in Bicycle and Motorcycle Steer Torque Estimation". In: *Proceedings of Bicycle and Motorcycle Dynamics: Symposium on the Dynamics and Control of Single Track Vehicles*. Narashino, Chiba, Japan, Nov. 2013.

[5] Jason K. Moore and Mont Hubbard. "Identification of Open Loop Dynamics of a Manually Controlled Bicycle-Rider System". In: *Proceedings of Bicycle and Motorcycle Dynamics: Symposium on the Dynamics and Control of Single Track Vehicles*. Narashino, Chiba, Japan, Nov. 2013.

[6] Ronald A. Hess and Jason K. Moore. "Estimating Parameters of the Structural Pilot Model Using Simulation Tracking Data". In: *AIAA Guidance, Navigation, and Control Conference*. Aug. 2013.

[7] Gilbert Gede et al. "Constrained Multibody Dynamics With Python: From Symbolic Equation Generation to Publication". In: *Volume 7B: 9th International Conference on Multibody Systems, Nonlinear Dynamics, and Control*. DETC2013-13470. Portland, Oregeon, USA, Aug. 2013. ISBN: 978-0-7918-5597-3. DOI: 10.1115/DETC2013-13470.

[8] Arend Schwab, Peter de Lange, and Jason K. Moore. "Rider Optimal Control Identification in Bicycling". In: *Proceedings of the 5th Annual Dynamic Systems and Control Conference and 11th Annual Motion and Vibration Conference*. Fort Lauderdale, Florida, USA: ASME, Oct. 2012.

[9] A. L. Schwab et al. "Rider Control Identification in Bicycling, Parameter Estimation of a Linear Model Using Lateral Force Perturbation Tests". In: *Proceedings of the IMSD2012 - The 2nd Joint International Conference on Multibody System Dynamics*. Stuttgart, Germany., May 2012.

[10] Jason K. Moore et al. "An Accurate Method of Measuring and Comparing a Bicycle's Physical Parameters". In: *Proceedings of Bicycle and Motorcycle Dynamics: Symposium on the Dynamics and Control of Single Track Vehicles*. Delft, Netherlands, Oct. 2010.

[11] Dale L. Peterson et al. "Low-Power, Modular, Wireless Dynamic Measurement of Bicycle Motion". In: *Procedia Engineering*. Vol. 2. The Engineering of Sport 8 - Engineering Emotion. July 2010, pp. 2949–2954. DOI: 10.1016/j.proeng.2010.04.093.

[12] Jason K. Moore et al. "Statistics of Bicycle Rider Motion". In: *The Engineering of Sport 8 - Engineering Emotion*. Vol. 2. The Engineering of Sport 8 - Engineering Emotion. July 2010, pp. 2937–2942. DOI: 10.1016/j.proeng.2010.04.091.

[13] Jason K. Moore et al. "A Method for Estimating Physical Properties of a Combined Bicycle and Rider". In: *Proceedings of the ASME 2009 International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, IDETC/CIE 2009*. San Diego, CA, USA: ASME, Aug. 2009. DOI: 10.1115/DETC2009-86947.

[14] J. D. G. Kooijman, A. L. Schwab, and Jason K. Moore. "Some Observations on Human Control of a Bicycle". In: *Proceedings of the ASME 2009 International Design and Engineering Technical Conferences & Computers and Information in Engineering Conference*. ASME, Aug. 2009. DOI: 10.1115/DETC2009-86959.

[15] J. K. Moore, J. D. G. Kooijman, and A. L. Schwab. "Rider Motion Identification during Normal Bicycling by Means of Principal Component Analysis". In: *Proceedings of Multibody Dynamics 2009, ECCOMAS Thematic Conference*. Ed. by K. Arczewski and M. Wojtyra J. Frączek. Warsaw, Poland, June 2009.

[16] Jason Moore and Mont Hubbard. "Parametric Study of Bicycle Stability". In: *The Engineering of Sport 7*. Ed. by Margaret Estivalet and Pierre Brisson. Vol. 2. Springer, 2008. DOI: 10.1007/978-2-287-99056-4_39.

Conference Abstracts

[1] Jason K. Moore and Antonie J. van den Bogert. "Quiet Standing Control Parameter Identification with Direct Collocation". In: *XV International Symposium on Computer Simulation in Biomechanics*. Edinburgh, UK, July 2015.

[2] Jason K. Moore, Sandra K. Hnat, and Antonie J. van den Bogert. "Identification of Human Control during Perturbed Walking". In: *Midwest American Society of Biomechanics Regional Meeting*. Akron, Ohio, USA, Mar. 2014.

[3] Mont Hubbard et al. "Human Control of Bicycle Dynamics with Experimental Validation and Implications for Bike Handling and Design". In: *Proceedings of 2011 NSF Engineering Research and Innovation Conference*. Jan. 2011.

[4] Jason K. Moore, Dale L. Peterson, and Mont Hubbard. "Influence of Rider Dynamics on the Whipple Bicycle Model". In: *Proceedings of the 11th International Symposium on Computer Simulation in Biomechanics*. Tainan, Taiwan, June 2007.

Software

[1] Jason K. Moore and Mont Hubbard. *Skijumpdesign: A Ski Jump Design Tool for Equivalent Fall Height*. Dec. 2017.

[2] Jason K. Moore and Kenneth Lyons. *Resonance: A Python Package for Mechanical Vibration Analysis*. University of California, Davis. July 2017.

[3] Jason K. Moore and Antonie J. van den Bogert. *Opty: A Library for Using Direct Collocation in the Optimization and Identification of Dynamic Systems*. Cleveland State University. May 2014.

[4] Jason K. Moore et al. *GaitAnalysisToolKit: A Python Library for Gait Analysis*. Cleveland State University, Dec. 2013.

[5] Jason K. Moore et al. *PyDy: A Multi-Body Dynamics Analysis Package Written in Python*. PyDy. Oct. 2011.

[6] Jason K. Moore, Chris Dembia, and Oliver Lee. *DynamicistToolKit: A Python Library for Dynamcis and Controls*. June 2011.

[7] Christopher Dembia et al. *Yeadon: A Python Library For Human Inertia Estimation*. June 2011.

[8] Jason K. Moore. *HumanControl: Human Control of a Bicycle*. University of California, Davis. May 2011.

[9] Jason K. Moore, Chris Dembia, and Oliver Lee. *BicycleParameters: A Python Library for Bicycle Parameter Estimation and Analysis*. Apr. 2011.

[10] Jason K. Moore, P. D. L. de Lange, and Stefen Yin. *BicycleDataProcessor: Data Storage and Processing Library for an Instrumented Bicycle*. University of California, Davis. Feb. 2011.

[11] Jason K. Moore, P. D. L. de Lange, and Yumiko Henneberry. *BicycleDAQ: Data Aquisition Application for an Instrumented Bicycle*. University of California, Davis. Oct. 2010.

[12] SymPy Development Team. *SymPy: Python Library for Symbolic Mathematics*. 2006.

Preprints

[1] Bryn Cloud et al. "Adaptive Sensor Fusion for Estimating Competitive Rowing Kinematic Metrics Using Smartphone-Based Sensing". In preparation. June 2018.

[2] Jason K Moore, Sandra K. Hnat, and Antonie J. van den Bogert. "An Elaborate Data Set on Human Gait and the Effect of Mechanical Perturbations". In: *PeerJ PrePrints* 3.e700v4 (Apr. 2015). Preprint. ISSN: 2167-9843. DOI: 10.7287/peerj.preprints.700v2.

[3] Jason K. Moore and Mont Hubbard. "Kinetic and Kinematic Measurements from an Instrumented Bicycle during Different Maneuevers on and off the Treadmill". In preparation. Aug. 2014.

[4] Jason K. Moore and Antonie J. van den Bogert. "Perturbed Standing Controller Parameter Identification: A Comparison of Methods". In preparation. Aug. 2014.

[5] Jason K. Moore, Sandra K. Hnat, and Antonie J. van den Bogert. "Identification of Human Control during Perturbed Walking". In: Zurich, Switzerland, June 2014.

[6] Jason K. Moore and Antonie J. van den Bogert. "Direct Identification of Human Gait Control". In preparation. Aug. 2013.

Academic Service

- Editor of the Journal of Open Source Education
- Editor of the Journal of Open Engineering
- UCD MAE Undergraduate Committee (January 2017-Present)
- UCD MAE Website Committee (2017-Present)
- Co-organizer of the 6th Annual International Cycling Safety Conference.
- Served on the organizing and scientific committees for the 2016 Bicycle and Motorcycle Dynamics Conference in Milwaukee, Wisconsin.
- Volunteer instructor for Software Carpentry
- Co-organizer of Cleveland's "North Coast Biomechanics and Brew" group (2014).
- Served on the scientific committee for the 2013 Bicycle and Motorcycle Dynamics Conference.
- Organized and mentored for five Google Summer of Code (Python Software Foundation/SymPy/PyDy).
- Organized and co-chaired both an invited and special session on single track vehicle dynamics at the 2012 ASME DSCC conference.

Article Reviews

- Reviewed "The effect of tyre and rider properties on the stability of a bicycle" by Bulsink, Vera, et. al, for Advances in Mechanical Engineering, 2015.
- Reviewed "Changing the bicycle seat height: Effects on rider control." for the European Journal of Sports Sciences, 2015.
- Reviewed "Gyro device for bicycle handling assessment: A reliability study" by Fonda, Borut, et. al for the Journal of Applied Biomechanics, 2015.
- Reviewed "On the influence of tyre and rider properties on the stability of a bicycle." by Vera Bulsink, et. al, for Vehicle System Dynamics, 2014.
- Reviewed "Are subject-specific musculoskeletal models robust to the uncertainties in parameter identification?" by Giordano Valente, et. al for PLoS One, 2014.
- Reviewed four papers for the Bicycle and Motorcycle Dynamics Conference 2013 proceedings, July 2013.
- Reviewed "Experimental and Numerical Analysis of Rider Motion in Weave Conditions" Doria, Alberto, et. al for Vehicle System Dynamics, 2011.

Invited Talks

JupyterCon, New York, NY

The Future of Jupyter in Education Panel **August 23, 2018**

Meijo University, Nagoya, Japan

The Trail Towards An Optimally Handling Bicycle **June 21, 2018**

UC Davis Education Graduate Group, Davis, CA

Computational Thinking in the Engineering Curriculum: A Case Study in Mechanical Vibrations **March 11, 2018**

TU Delft, Delft, Netherlands

Identification of human control during walking **June 6, 2014**

U.S. Bicycling Hall of Fame, Davis, CA

How We Ride Bikes with Luke Peterson, Mont Hubbard, and Ron Hess **October 19, 2011**

UCD Tahoe Environmental Research Center, Lake Tahoe, NV

How We Ride Bikes with Luke Peterson and Mont Hubbard **May 12, 2011**

Fulbright FAST Conference, San Francisco, CA

Bicycling in the Netherlands and Europe, policies and practices: What can America learn from them. **March 12, 2010**

UC Davis D-Lab, Davis, CA

Use of Human Power in the Developing World **January 31, 2013, January 31, 2012, January 25, 2011, January 26, 2010**

TU Delft Mechanics Colloquium, Delft, Netherlands

A First Look at Rider Biomechanics while Controlling a Bicycle **June 4, 2009**

Tutorials and Workshops

COSMOS 2018, Davis, CA, USA

Squiggly Bicycle Routes: Physics Based Design Evaluation **July 10, 2017**

Data Science Initiative, Davis, CA, USA

Computational Thinking in the Engineering Curriculum **January 10, 2017**

SCIPY 2017, Austin, Texas, USA

Automatic Code Generation With SymPy (2,015 views) **July 10, 2017**

Delta Stewardship Council Sacramento, California, USA

Software Carpentry Workshop **May 18–19, 2017**

iHub Nairobi, Kenya

Software Carpentry Workshop **June 17–18, 2016**

UCI Data Science Initiative Irvine, California, USA

Software Carpentry Workshop **February 21–22, 2015**

SCIPY 2016, Austin, Texas, USA

Simulating Robot, Vehicle, Spacecraft, and Animal Motion (3,355 views) **July 14, 2016**

SCIPY 2015, Austin, Texas, USA

Multibody Dynamics and Control with Python (3,817 views) **July 18, 2015**

SCIPY 2014, Austin, Texas, USA

Multibody Dynamics and Control with Python (3,057 views) **July 6, 2014**

PYCON 2014, Montreal, Quebec, Canada (2,608 views)

Dynamics and Control with Python **April 9, 2014**

MASB 2014, Akron, Ohio, USA

Simulation and Control of Biomechanical Systems with Python **March 9, 2014**

Talks

SacPy, Sacramento, California, USA

Resonance: An Interactive Textbook and Software Library for Learning About Mechanical Vibrations **November 9, 2017**

EME 1 Guest Lecture, Davis, California, USA

What the Bicycle Can Tell Us About Human Control **November 28, 2016**

BMD 2016, Milwaukee, Wisconsin, USA

An Optimal Handling Bicycle **September 21, 2016**

Cleveland State University Human Motion and Control Seminar, Cleveland, Ohio, USA

Reproducible Scientific Computing with Open Software and Open Data **September 17, 2014**

2014 NCSSR Visiting Scholar Kickoff, Stanford, California, USA

Indirect identification of human control during walking **July 15, 2014**

Dynamic Walking 2014, Zurich, Switzerland

Identification of human control during walking **June 10, 2014**

MASB 2014, Akron, Ohio, USA

Identification of human control during walking **November 13, 2013**

BMD 2013, Narashino, Chiba, Japan

Methods for Elimination of Crosstalk and Inertial Efects in Bicycle and Motorcycle Steer Torque Estimation **November 13, 2013**

BMD 2013, Narashino, Chiba, Japan

Identification of Open Loop Dynamics of a Manually Controlled Bicycle-Rider System **November 11, 2013**

SciPy 2013, Austin, Texas, USA

Estimating and Visualizing the Inertia of the Human Body with Python **June 27, 2013**

SciPy 2013, Austin, Texas, USA

Dynamics with SymPy Mechanics **June 27, 2013**

ASME DSCC 2012, Fort Lauderdale, Florida, USA

The Future of Bicycle and Motorcycle Dynamics **October 18, 2012**

Velo-city Global 2012, Vancouver, British Columbia, Canada

Time and Energy Penalties of Squiggly Bike Routes with Ted Buehler **June 28, 2012**

MAE Exit Seminar, Davis, CA, USA

Human Control of a Bicycle **May 15, 2012**

UCD ITS Seminar, Davis, CA

Bicycling in the Netherlands and Europe, policies and practices: What can America learn from them. with Eva Heinen **October 23, 2009**

UCD MAE Seminar, Davis, CA

A First Look at Rider Biomechanics while Controlling a Bicycle **October 29, 2009**

UCD MAE Qualifying Exam, Davis, CA

Human Control of a Bicycle **October 9, 2009**

ASME IDETC/CIE 2009, San Diego, CA

A Method for Estimating the Physical Properties of a Combinded Bicycle and Rider **August 31, 2009**

Mulitbody Dynamics 2009, Warsaw, Poland

Rider Motion Identification During Normal Bicycling By Means of Principal Component Analysis **July 1, 2009**

Fulbright Mid Year Presentation, Amsterdam, Netherlands

Jason Moore, In The Netherlands... **February 5, 2009**

ISEA 2008, Biarritz, France

Parametric Study of Bicycle Stability **June 6, 2008**

Professional Experience

Plotly, Montreal, Quebec, Canada USA

Consultant **July 2015**

- Developed a Jupyter notebook demonstrating the use of Plotly tools in control engineering.

Old Dominion University, Norfolk, Virginia USA

Langley Full Scale Tunnel Design Engineer **June 2004 to August 2005**

- Extensive design, modeling and drafting with Autodesk Inventor.
- Designed a portable floor system for a car balance.
- Designed a six degree of freedom full scale car balance.
- Wrote stress analysis reports for NASA specifications.
- Test-model design, fabrication and repair.
- Support in daily activities (test preparation, taking data, etc.).

Maglev Tram Design Engineer **May 2004 to January 2005**

- Created a reference CAD model of a full-scale magnetic levitation train car using AutoCAD Mechanical Desktop.

ODU HPV Team Project Lead **September 2003 to January 2005**

- Lead and managed a mechanical engineering senior design project.
- Designed and constructed a human powered land vehicle.
- Focused on bicycle frame, controls, stability, and drive train design
- Received 6th place out of 20 as a rookie team at the ASME Human Powered Vehicle Challenge.
- Website designer and maintainer.

ODU SAE Formula Team Design Engineer **2001 to 2002**

- Helped design and fabricate a scaled formula race car.
- Extensive design, modeling and drafting with AutoCAD Mechanical Desktop.
- Designed and fabricated the drive train and composite body.
- Website designer.

Bauer Compressors, Norfolk, Virginia USA

Mechanical Design Engineer Intern **June 2003 to December 2003**

- Extensive 3D modeling with Autodesk Inventor: modeled complex air compressor systems.
- Sheet metal design and fabrication.
- V-belt drive designs.
- Oil filtration system design.
- Designed parts and prepared drawings for fabrication.

Area Access, Norfolk, Virginia USA

Elevator Mechanic Assistant **May 2002 to August 2002**

- Installed and repaired elevators and various accessibility machines.
- Exposed to various electrical and mechanical systems.

Danville Community College, Danville, Virginia USA

CNC Mill Operator **June 2001 to August 2001**

- Learned G-code/Manual Programming.
- Learned FeatureCam 3D CAD/CAM software.
- Programmed and operated a HAAS 3-axis mill.

Mark D. Moore Construction Company, Danville, Virginia USA

Carpenter **1995 to 2001**

- Residential house construction
- Framing, finishing, painting, drywall, hardwood floors, masonry

Volunteer Service

Davis Bike Collective, Davis,CA USA

Bicycle Mechanic, Teacher and Organizer **September 2005 to June 2013**

- Volunteered bi-weekly as a teaching mechanic.
- Co-founded a consensus based non-profit.
- Co-wrote bylaws and setup the legal non-profit.
- Raised thousands of dollars in donations and grants.
- Organized conferences, parties, fundraisers, bike rides, work parties, outreach events.
- Organized two 1500+ attendee beer tasting and movie events with New Belgium Brewery.
- Web site maintenance, shift scheduling, handled distributor orders, managed email listservs.
- Lead the workshop series "Open Bike Night" for one year.

Davis Bicycles!, Davis, CA USA

Volunteer **September 2009 to June 2013**

- Administer the organization's websites [1] and [2].
- Lobby city council for bicycle amenities.
- Worked directly with city staff on various projects.

Maya Pedal, San Andres Itzapa, Guatemala

Volunteer Engineer **Summer 2007**

- Constructed pedal powered machines (i.e. blender, corn dekerneler/grinder, etc).
- Design work on a macadamia nut sheller.
- Repaired bicycles.
- Shop organization: tool boards, bike graveyard.

Whirlwind Wheelchair International, Lusaka, Zambia

Volunteer Engineer **Summer 2006**

- Worked at the Disacare Wheelchair Center.
- Worked on the design and fabrication team for a bicycle ambulance trailer.
- Fixture design and training.

Virginia Beach Public Schools, Virginia Beach, VA

Volunteer Mentor **2004**

- Assisted high schools students with an engineering design competition.

UC Davis Institute for Transportation Engineers, Davis, CA

Tour Leader **December 2006**

- Organized a group bicycle ride and museum tour.

ODU College of Engineering, Norfolk, VA

Tour Guide **February 2004**

- Led open house tours for middle school children.

Davis Bicycle Commission, Davis, CA

Bicycle Counter

- Participated in bicycle usage data collection.

FABRICATION SKILLS

Extensive machining and fabrication experience: milling, turning, welding (MIG, TIG, ARC, Torch, Brazing), wood working, sheet metal work

SOFTWARE PROFICIENCIES

Extensive drafting, solid modeling, CAD, CAM, and FEA experience. Proficient in: CADKEY, AutoCAD, AutoCAD Mechanical Desktop, Autodesk Inventor, FeatureCAM 3D, IntelliCAD, PATRAN/NASTRAN, PRO-Engineer/PRO-Mechanica, GMAX, CNC/G-code, OnShape

Programming Languages (in approximate order of proficiency): Python, MATLAB, R, BASH, C, Javascript, C++, Lua

Web development: HTML, CSS, Javascript, Pelican, Hyde, Sphinx, Flask, Amazon Web Services, Ubuntu Server, Apache, NGinx, Plone, Wordpress, Joomla, Homesite, Microsoft Front Page, Macromedia Dreamweaver

Websites that I currently administer: moorepants.info [Hyde], Sports Biomechanics Lab [Plone 3], moorepants [HTML]. 2017 ICSC [Wordpress], PyDy [Sphinx]

Websites that I developed but no longer adminster: hmc.csuohio.edu [Plone 4], N Street Cohousing [Plone 4], Davis Bike Collective [Joomla & Wordpress], BikeDavis.info [Wordpress], smartdrive.ucdavis.edu, drive5.us [Flask], clevelandwiki.org [Django], ODU HPV [HTML],

Dynamics and Simulation: SymPy Mechanics, SciPy, MATLAB/Simulink, Working Model, Autolev, Axl/CampG, Opensim, Simbody

Computational: SciPy, NumPy, Uncertainties, Pandas, Cython, IPOPT, CMA-ES, SymPy, MATLAB, MathCAD

Instrumentation: National Instruments products including LabVIEW, MatLab DAQ Toolbox, Serial Protocols

Data: HDF5, PyTables, MySQL, MariaDB, SQLite, MongoDB

Graphics: Matplotlib, R, MATLAB, GIMP, Inkscape, Paint Shop Pro, Macromedia Fireworks, Blender, GMAX

Operating Systems: Linux (Ubuntu 8.04-17.10 and other distros), Microsoft Windows (3.1-7), DOS

Utilities: FTP, Version Control (Git/Mercurial/Subversion), SSH, BASH

Reference management: BIBTEX, JabRef, Zotero, Mendeley, Endnote

Word processing: Vim, LATEX, Google Docs, LibreOffice Writer, TeXnic Center, Microsoft Word

References

Academic Research

- Dr. Antonie J. van den Bogert *Post Doctoral Supervisor* Professor, Cleveland State University, Mechanical Engineering Department, 1960 E. 24th St., SH 232 Cleveland, Ohio 44115, +01-216-687-5329, a.vandenbogert@csuohio.edu
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- Dr. Steven Velinsky *Capstone Design Co-Instructor*, Distinguished Professor, University of California, Davis, Mechanical and Aerospace Engineering Department, One Shields Avenue, Davis, CA 95616,
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- Dr. Tai Stillwater, *SmartDrive and Pedal Desk*, Postdoctoral Researcher, Institute of Transportation Studies, University of California, Davis, 2028 Academic Surge, One Shields Avenue, Davis, CA, 95616, tstillwater@ucdavis.edu
- Matthew Seitzler, P.E. *Colleague*, Professional Engineer, at Davis Energy Group, Davis, CA, matt@sre-engineering.com
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- Dr. Anthony Passerini, *Cell shearing project supervisor*, Assistant Professor, University of California, Davis, Biomedical Engineering Department, One Shields Avenue, Davis, CA 95616, +01-530-754-6715, agpasserini@ucdavis.edu
- John Dwyer, *Bauer Compressors supervisor*, Engineer Department Manager, john.dwyer@bauercomp.com

Community Organizing

- Dr. Debbie Niemeier, *ICSC 2017 Co-Organizer*, Davis, CA, dniemeier@ucdavis.edu
- Dr. Robb Davis, *Mayor of Davis, CA*, Davis, CA, rdavis@cityofdavis.org
- Dr. Sarah McCullough, *colleague at the Davis Bike Collective*, UC San Diego, smcc@ucdavis.edu

Research Statement

Introduction

My research efforts center on understanding and improving human mobility by developing biomemetic controllers for powered assistive devices and humanoid robots and on developing control augmentation for personal manually controlled vehicles. The ability humans have to ambulate and manipulate devices continues to be the envy of engineers who desire to artificially imitate their motion. Understanding and mimicking the intricacies of the mammalian neuromuscular system have the potential to allow us to improve human life through assistive machine and device design. However, contemporary robots and machines are still limited in their ability to emulate the robust capabilities of mammalian sensing and actuation.

The fundamental question that I am interested in is:

> Can dynamically human-similar machines and their controllers be designed to move as a human would move, if provided neurally-limited driving control inputs?

I am interested in identifying practical controllers for devices, robots, and vehicles which encode feedforward and feedback control such that the combined human/machine system has nearly identical motion to an able-bodied human. My current focus is on improving balance while standing and walking with lower limb prostheses and exoskeletons. To do this my research currently has three primary foci:

1. Identifying how humans balance and locomote through data intensive computational estimation, learning, and identification.
2. Applying biomemetic control algorithms and design enhancements derived from identified controllers to assistive devices such as exoskeletons, powered prostheses, small vehicles, and humanoid robots.
3. Developing next generation open and collaborative computational tools to back efforts in the first two items.

Current State of Human Locomotion Simulation & Assistive Control

Deep reinforcement learning has had growing success in creating joint torque driven closed loop controlled simulation of low-fidelity humanoid models in complex virtual environments (e.g. [45, 9]). Parallel to the reinforcement learning are efforts to generate closed and open loop controllers through optimal control methods (shooting and trajectory optimization) that focus on minimizing energy expenditure of high-fidelity neuromuscular models in more basic walking and running tasks. These methods produce simulations of much more realistic gait [2, 47, 48, 8, 39, 46, 6]. Very recently these parallel efforts have merged with signs of promise. For example, in the 2017 NIPS AI challenge contestants used deep reinforcement learning to discover realistic gait control for a muscle activated high-fidelity lower body neuromuscular model [12]. Machine learning and shooting based optimal control using the high-fidelity models are bound by the forward dynamics computation speeds, which are real-time at best. Advancements that reduce forward simulation speeds or circumvent the need to explicitly evaluate the stiff dynamics are needed to make more rapid progress. Successful simulations that incorporate modeled prostheses have just emerging (e.g. [13]) which is an exciting new path in the field.

Powered assistive devices such as powered below- and above-knee prostheses have improved drastically in the last decade and have been shown to reduce the metabolic cost of walking in amputees [3], with some now moving to commercial products (e.g. Rheo Knee). Unpowered [4] and powered [49] exoskeletons can also do the same for able bodied walkers [4]. Powered lower limb exoskeleton for paraplegics are just now being approved by the FDA for the US and European markets (e.g. Rewalk, Indego, Esko). These devices rely primary on non-neural control, offer no balance during gait, and move with a very unnatural gait. Future research will improve all three of these aspects to bring natural self-balanced walking back to the paralyzed.

In the past year, we have started to see merger of the successes in software and the successes in hardware with demonstrations such as in [40] alluding to a bright future for discovery with lower limb systems.

My Past Work in Human Motion and Control

Much of my prior research has focused on the problem of control identification in human balance where I have attempted to answer this question:

> Given the simultaneous measurements of the kinematics of human motion and optionally human/environment interface and internal system forces, what is the casual relationship from sensing to actuation in human motion?

My graduate work focused on understanding the control mechanisms humans use while balancing on a bicycle. Because the bicycle is a dynamically complex vehicle [1, 15, 34, 18] that acts as an intermediary between the human and the environment it is a powerful platform for understanding balance.

I began by applying principal component analysis to a large collection of motion capture data during steady state bicycling on a treadmill, which identified dominant motion patterns and exposed subtle leg motions used for balance at extreme cases [17], [32]. We further confirmed this behavior with video analysis of more natural bicycling behavior around a city and on a treadmill [14]. Following those initial experiments, I developed an instrumented bicycle, capable of accurately measuring the full dynamic state of the rider-vehicle system [20, 30] and collected copious amounts of data during responses to lateral perturbations in path tracking tasks. Using a manual control based theoretic controller [10] and data driven parameter estimation, I identified a set of controllers that explained the dominant rider perturbation linear response behavior [20], which was then used to characterize a general controller able to mimic human behavior for a broader set of control tasks. This was expanded further with other theoretic controller structures for bicycling [41, 43, 42] and also applied to aircraft control identification [11].

The work on bicycle control identification lead into postdoctoral work focused on developing controllers for lower extremity exoskeletons designed to assist paraplegic individuals in walking. We partnered with Parker Hannifin Corp. and targeted their Indego Exoskeleton. My goal was to provide natural gait and unassisted balance for these devices, something that is still lacking today. Utilizing an actuated treadmill coupled with full body kinematic tracking, I collected large quantities of walking data from both normal walking and longitudinally perturbed walking. I published the data as one of the first data papers in the field [29] and demonstrated the effectiveness of the treadmill belt perturbation method. I used this data with a direct gait cycle gain scheduled feedback identification technique to identify possible closed loop controllers [36, 27, 28]. This work led to the development of an indirect identification technique based on parameter estimation with direct collocation to enable simulated validation of the controllers. Direct collocation gave us the computational speed to discretely simulate hours of data. Starting with a simpler problem, I developed methods with data derived from human perturbed standing data. The techniques led to orders of magnitude of improvement in computation speed and control identification strictly from kinematic data [37, 38].

Since moving into a teaching faculty position at UC Davis I have mentored and led a number of sensing, instrumentation, and robotics projects that build on the prior research with various local companies and undergraduate students. We have developed an adaptive mouth-based control for an electric tricycle which is ALS and quadriplegic friendly with Outrider USA and Disability Reports. This past year my students developed a powered cable driven hand prostheses for partial upper body paralysis with Ekso Bionics. With SRE Engineering we developed a wireless boot for measuring ground reaction forces for horse trotting in non-laboratory settings that I would like to apply to human walking. I also mentored a group of students that developed a robot to tie a shoe, one of the more complex tasks human hands perform. Lastly, I have developed a desktop balancing robot that will be used to validate the indirect identification methods for standing balance that I mentioned above. My current projects can be viewed on my lab website: http://mechmotum.github.io.

All of my research relies heavily on open source computational data analysis and simulation tools, much of which I have developed and published. Most notably, I am a core developer of SymPy [44], a computer algebra system, and the maintainer of the classical mechanics package [7]. Our 2017 paper [16] on the 11 year old software has over 180 citations, along with thousands of users and hundreds of contributors making it one of the most popular packages in the Scientific Python ecosystem. Additionally, I have developed a suite of bicycle dynamics related software packages [21, 22, 23, 19] and dynamics/biomechanics packages [5, 24, 25, 26, 33, 31]. Recently I have published a package for general purpose trajectory optimization and parameter estimation [35] and also for ski jump design [31].

My Research Plans at UC Davis

As a professor of mechanical and aerospace engineering I will play an integral role in UC Davis's vision for growth in neuroengineering. I plan to lead a laboratory that will provide computational and experimental biomechanics expertise alongside humanoid robot and assistive device design. This will complement the existing and upcoming efforts that focus on the neural aspects of an interdisciplinary neuroengineering core. I hope to revive the MAE department's past notability in biomechanics with a modernized biomechatronics focus. I also want to help catalyze making the Sacramento region a leader in bio-robotics. The combination of UC Davis Engineering, UC Davis Med Center, CSUS Engineering, our proximity to the Bay Area, and local companies such as Intel and Siemens paired with the burgeoning local startup scene can tie in with the Chancellor's plans for Sacramento and Davis to become a new hub for technical innovation.

With more than a decade in the region, I have a wide network of partners to bring this vision to life that span the UC Davis faculty and centers, UC Davis Med Center, UC Davis Vet Med Center, local orthotics companies, and Bay Area biomechanic and robotics companies. My network also spans beyond the region to the state, national, and international collaborations. I plan to grow my collaborations with regional companies and labs (e.g. Toyota Research Institute, Motion Analysis, Ekso Bionics, Inscitech, Open Robotics, Stanford's Neuromuscular Biomechanics Lab) along with my expanded collaborators (e.g. Cleveland State's Human Motion and Control Laboratory, Cornell's Biorobotics Lab, TU Delft's Biomechanics Department, and Meijo University).

I will continue to participate in a number of academic communities that I am currently involved with. The lab will target conferences such as Dynamic Walking and Bicycle and Motorcycle Dynamics along with the American and International Societies of Biomechanics (including the ISB Technical Simulation group). On the software side, we will continue to present at SciPy, PyData, and PyCon for open source computation.

In and outside the MAE department, I am interested in growing collaborations with Zhaodan Kong for high level robot planning and machine learning, Xinfan Lin for estimation needs in human motion, and David Hawkins for human performance. I have relationships with emeritus Profs. Hess, Hubbard, Hull, Eke, Margolis, and Karnopp for vehicle dynamics, biomechanics, and control. I am a faculty affiliate at the new Data Science Initiative and plan leverage that relationship to grow our data centric computational work. My work with the Institute for Transportation Studies will grow with collaborations with Susan Handy and Dillon Fitch. I also look forward to developing more cross disciplinary research partners, many which have begun with the 90+ capstone design projects I have mentored.

The lab I am planning will be able to 1) collect motion data from humans and robots in mobility related activities both in the lab and in natural environments, 2) apply cutting edge learning, estimation, and identification methods to characterize human control, 3) build and test controllers in humanoid robots and assistive devices, and 4) contribute to and develop the next generation of open source biomechatronic related software.

My initial project plans are multifold and will build from my prior work. I will start recruiting students for 1) applying parameter identification using direct collocation to perturbed walking data to discover a gain scheduled closed loop control, 2) development of a scaled balancing robot that simulates perturbed human balancing, 3) development of an autonomous bicycle, 4) accelerating lower body neuromuscular forward dynamics simulations through implicit dynamics and optimized code generation and common sub-expression evaluation across CPU/GPU cores, and 5) development of a low-fidelity lower limb exoskeleton for controller testing.

I will use the results from these initial projects to develop grant proposals for the National Science Foundation's CMMI, IIS, CBET, and CNS divisions[1] and the NIH's rehabilitation and data focused initiatives which all have a history of and currently support similar research. Additionally, I will pursue funding with private foundations such as the Gordon and Betty Moore Foundation and the Alfred P. Sloan Foundation for open source computational and data innovation support and partner with prior mentioned companies for small commercially relevant project support.

Given the opportunity, I have the skills, network, and vision to succeed as a professor of mechanical and aerospace engineering at the University of California, Davis.

[1] Division of Civil, Mechanical and Manufacturing Innovation, Division of Information & Intelligent Systems, Division of Chemical, Bioengineering, Environmental, and Transport Systems, and Division of Computer and Network Systems, respectively.

References

[1] Karl J. Åström, Richard E. Klein, and Anders Lennartsson. Bicycle dynamics and control: Adapted bicycles for education and research. *IEEE Control Systems Magazine*, 25(4):26–47, August 2005.

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[3] S. K. Au, J. Weber, and H. Herr. Powered Ankle–Foot Prosthesis Improves Walking Metabolic Economy. *IEEE Transactions on Robotics*, 25(1):51–66, February 2009.

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[12] Łukasz Kidziński. Reinforcement learning with musculoskeletal models. http://osim-rl.stanford.edu/, 2017.

[13] Anne D. Koelewijn and Antonie J. van den Bogert. Joint contact forces can be reduced by improving joint moment symmetry in below-knee amputee gait simulations. *Gait & Posture*, 49:219–225, September 2016.

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Teaching Statement

My interest in mechanical engineering began in my childhood where I spent many hours making, tinkering, and discovering how the built environment functioned. These hands-on experiences allowed me to develop a desire to discover the connection to mathematics and physics in order to improve my projects. Once that realization occurred, the barriers I had towards learning the engineering fundamentals were lifted. I hope to bring similar kinds of experiences and motivation to the students I teach.

Teaching Philosophy

Traditional engineering pedagogy focuses heavily on lecture-based theoretical courses paired with few hands-on laboratory courses. The aspects of creativity, team work, and an infinite possibility of problem solutions are all too often absent. These aspects are needed to develop the practical side of engineering that students will require in their future careers. Often, only the students who participate in extracurricular projects, internships, or research positions make the connection from theory to practice early on in the curriculum. Thus, the traditional structure may not be the best way to maximize student understanding of engineering principles and instill the agile problem solving methods they will need in the future.

Although there are variety of motivational reasons students pursue engineering, I believe introducing the applied practices of engineering early in education will build passion and interest. Once this door is open, it is much easier to weave in the skills the students need to become stronger engineers in their future careers. I would like to see an engineering curriculum that mimics the actual practice of engineering through an iterative pattern of posing realistic problems followed by a search for the necessary fundamentals. This will culminate in the application of new knowledge to arrive at a solution to the problem. Like my childhood experiences, this model provides interesting realistic problems that allow students to discover the engineering fundamentals as opposed to presenting all of the fundamentals before the interesting problems arrive.

Engineering students are capable of creating and solving problems when they enter college. We should enrich their entire experience (especially in the first year!) with challenges from real-world problems that leave them begging for the knowledge and tools that they typically have to slog through during their first years of school. Richard Miller, President of Olin College, often draws an analogy between engineering students and violin students: "Can you imagine not playing the violin until your fourth year of study? Violinists start making sounds with their instrument the first day of lessons." Our curriculum could allow our students to draw the engineering bow across the strings the minute they step into the classroom. For these early project-based courses to be effective, however, the latest pedagogical developments must be utilized to maximize learning potential.

Practical Classroom Examples

In my courses, I try to provide students with open-ended problems that lead into larger projects instead of problems designed for rote learning and traditional exams. This approach more closely mimics the practice of engineering. I combine this with rubric based assessments that set the bar for mastery for improving student outcomes and effective assessment. I attempt to have a good mixture of group and individual work, leaning more heavily toward the former so students are prepared for the needs of industry. I also have been working to orient my classrooms towards active learning. My best example is the utilization of "computational thinking" that makes use of live coding in class. I setup a JupyterHub server that students log into via laptops, tablets, and phones during class that provides an interactive engineering computational environment. This allows access to my interactive textbook that students use as a reading guide while I provide examples paired with short computing exercises to periodically assess learning. I have developed a related workshop for other practitioners with my colleague Allen Downey from Olin College of Engineering which has been successful. Lastly, another very important method that I make use of is rapid in-class assessment; at every break, each student provides me with anonymous quick feedback: one line comments that share what they didn't understand and what was effective. This allows me to adjust my teaching after the break based on the feedback. I tie this in with collected feedback before, during, and after the course to have data to back my teaching decisions.

All of these methods are backed by evidence from education research. To keep up-to-date on topics like these, I follow the education research literature, especially the summary literature aimed at practicing

educators and attend "teach the teachers" style workshops as much as possible. I have worked closely with the Center for Educational Effectiveness and the Engineering Education Learning Community these past three years to improve student learning in my courses.

Prior Experience and Future Interests

A teacher is often at their best when they know their material well. I was fortunate to have spent most of my graduate school years in the UCD MAE department and now three years on the faculty making me intimately familiar with the undergraduate and graduate curriculum. I have taught a number of the available courses as a teaching assistant, lecturer, and professor. At the undergraduate level I have strong experience with mechanics and machine design courses along with the dynamics and controls curriculum. I have taught ENG 004, EME 050, ENG 122, EME150A, EME 150B, EME185A, and EME185B, EME 134, EME 171, MAE 223, and MAE 297. In my capacity as a teaching oriented professor I have worked on introducing evidence based practices and innovations in the classroom. Some highlights from the last three years are:

- developed a design competition and exchange program with Meijo University (Nagoya, Japan) on the cultural influences of robot and machine design
- flipped a mechanical vibrations class by utilizing "computational thinking" and project oriented learning with a custom designed interactive textbook and deployment through a JupyterHub server
- created a design studio classroom space that facilities active learning for our design courses
- created extensive rubric based assessment for written and oral communication in the capstone design course
- created a set of twenty Jupyter notebooks on multibody dynamics for in-class use and accompanying publicly available videos
- developed a transit bus bicycle rack design project which included reverse engineering, concept generation, and lightweight prototyping
- solicitation and mentoring of over 90 industry, government, and non-profit supported design projects spanning the mechanical engineering discipline

There are at least three new undergraduate courses that I would like to co-develop in the future that will help modernize our curriculum and are influenced by my research endeavors: 1) a first year problem solving with data, simulation, and engineering computation, 2) an upper level applied robotics and controls course, and 3) an upper level elective in focusing on project based prosthesis design.

At the graduate level, I am also well prepared to teach many MAE courses in dynamics, control theory, biomechanics, and vehicle dynamics many of which no longer have active instructors. I have taught Multibody Dynamics and would like to continue to do so but with an aim to modernize it with the latest developments in fundamental multibody algorithms and computational dynamics. I would also like to develop a graduate course focusing on the design, simulation, and optimization of legged biomechatronics that aligned closely with my research. Students will learn about neuromuscular modeling, mammalian gait, and get exposed to the latest tools in the field (OpenSim, Biomechancal ToolKit, ROS/Gazebo, IPOPT, etc). An experimental biomechanics oriented course would also nicely complement the computational oriented one to prepare students for applied work in the field.

My course topic strengths are not entirely based on current UCD MAE offerings. I have spent time at Delft University of Technology, Old Dominion University, Cleveland State University, Stanford University, and with the Software Carpentry non-profit where I have gleaned both new course ideas and methodologies to provide stronger connections to industry. I have experience in teaching computational methods for data science. I have given numerous workshops and tutorials to scientists and engineers on simulation, optimization, and data analysis. I have been trained by the Software Carpentry organization in pedagogical methods and teach two-day workshops around the world to introduce scientists and engineers to the best practices and methods in scientific computing. The mechanical engineer of the future will be additionally tasked with data driven engineering. The engineering curriculum will need to adapt to bring data science into many of the core courses for our students to stay competitive in the job market, which I am ready to do.

Statement of Contributions to Diversity

In terms of understanding how diversity plays an important role in the growth of our societies and the lives of the people in them, I have grown a great deal from my pre-adult years where I grew up in the still very racially segregated and homophobic small town southern United States. There I was born into a place of privilege due to my skin color, gender, and socioeconomic status. I recognize now how much those factors have played into my upward movement throughout my life and how my hard work is not the only thing that got me where I am today. My view of how the world works and what diversity means has had many positive transformational changes over the years but I would like to highlight one of the more powerful experiences I have had that has affected how I behave and make decisions when I am in a teaching role.

The mechanical engineering field unfortunately needs much improvement in attracting women and having a racially diverse student population, not to mention other diversification needs. Engineering has a long history of bias towards the status quo that educational leaders today are trying to unravel and set straight. Oddities like the dominance of women in early computer science and the rapid decline of their participation are both functions of our intentional and unintentional decisions and behavior. Many of these ingrained societal influences are beyond our control as teachers, but I will be dedicated to improving this situation with the power that I have. I have been very fortunate to be involved with several radical communities in terms of diversification over the years and believe those experiences will help improve diversity at UCD if I am hired.

I spent eight years running and volunteer teaching at a do-it-yourself bicycle repair shop which also traditionally suffers from gender and race imbalance but we challenged this head on. Using techniques I gleaned from numerous trainings on creating environments for people of all backgrounds, I was involved with implementing the latest advice from cultural studies to make the shop as inclusive as possible. I plan to extend the practices and knowledge from that experience to the teaching atmosphere at the UCD MAE department to help us create the most welcoming and inclusive engineering department in the country.

My tenure as an instructor at the bicycle shop taught me many things but the most significant takeaways were not to take diversity, inclusion, and marginalization lightly and definitely not to dismiss things that I have not experienced or do not understand. I also learned to listen to people who think about these things a lot and let their guidance influence my behavior and decisions. I now have a strong support group to turn to for advice in difficult situations. Overall, I have a better awareness and now recognize much more quickly when situations are not "right" and am willing to stand up for diverse students needs and know where the best avenues for help are.

There are also more specific examples of practices that I have picked up and utilize when teaching. I set ground rules in classroom interaction early on that helps ensure equitable time for students to speak so that traditional dominators cannot control classroom time. Training has provided better ability to recognize these patterns and facilitate classroom discussions so that they are inclusive. I have worked to ensure groupings in team projects are diverse to create stronger teams. I have also been involved with and observed developing specific times and spaces for marginalized communities, like women, LGBT, etc. This lets similar groups of learners learn on their own terms instead of those of the dominant majority. I also work to develop classroom and lab ground rules, such as codes of conduct and safe space standards, that are in place for all students to see and be aware of, whether posted on a sign in the lab or on the classroom website. I explicitly discuss these ground rules in class and even let the students collaboratively develop these agreements so they are invested in abiding by them. I have also learned how a classroom or lab atmosphere can be exclusive to many groups simply because of things like decor, lighting, politically incorrect jokes, and general attitudes and behaviors of superiors. I will be working with various groups to reduce and eliminate these factors in my courses and labs. I have fought for more equitable proposal evaluations when in that capacity. Furthermore, I work to ensure that there are anonymous feedback avenues for students and work to place students in need with the appropriate campus groups for support, letting them and the support groups help inform what I need to do to make the classroom accommodating.

Finally, I will be an ally for minority groups in the engineering college and give what support I can to help them strengthen and grow and will be a strong proponent of diversification of our selected students, staff, and faculty. My ethnicity, gender, and socioeconomic status puts me in the "typical engineer" bucket in terms of diversification but my experiences in life working with and for marginalized people, from disabled wheelchair fabricators in Zambia to disenfranchised homeless at the DIY bicycle shop, has instilled the empathy and understanding deep inside that will play an important role in changing engineering stereotypes for the next generation.