

# Eric J. Earley

(He/him)

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## Curriculum Vitae

### SUMMARY

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I am an Assistant Professor of Research in the Department of Orthopedics at the University of Colorado School of Medicine. I work with Dr. Jason Stoneback and the Osseointegration Research Collaborative, directing human studies and conducting outcome measure assessments related to osseointegrated prosthetic legs and arms.

My research focuses on developing and improving osseointegration technology in a way that can be impactful not only in a laboratory setting, but at home and during daily use. This requires a multidisciplinary and collaborative approach bringing together engineers, scientists, surgeons, clinicians, therapists, and patients to develop novel technologies.

### EDUCATION

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Postdoctoral Training	2020 – 2023	Chalmers University of Technology
Ph.D. Biomedical Engineering	2014 – 2020	Northwestern University
M.S. Biomedical Engineering	2012 – 2014	Northwestern University
B.S. Engineering: Mechanical Specialty	2008 – 2012	Colorado School of Mines

### RESEARCH EXPERIENCE

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#### **Assistant Professor of Research**

2023

University of Colorado ♦ Anschutz Medical Campus

Department of Orthopedics ♦ Osseointegration Research Collaborative

Collaborator: Dr. Jason Stoneback

Directing human studies and performing outcome measure assessments related to safety, use, and benefits of osseointegrated prosthetic legs and arms. Investigating critical design factors leading to increased use of prostheses. Developing and testing simple and novel solutions to improve control and sensory feedback of osseointegrated bionic limbs.

#### **Postdoctoral Research**

2020 - 2023

Chalmers University of Technology ♦ Department of Electrical Engineering

Center for Bionics and Pain Research ♦ Bionic Arms

Mentor: Prof. Max Ortiz-Catalán

Oversaw clinical trials providing and upgrading neuromusculoskeletal implants for transradial prostheses. Proposed methods of characterizing perceptions elicited via varied neurostimulation modulations. Developed signal processing algorithms to remove neurostimulation artifacts from implanted EMG sensors and mathematical models to probe electrical connectivity between implanted sensors. Investigated longitudinal behavioral and functional impacts of prosthesis use at home. Mentored three PhD students and seven Master's students during their theses.

Research has yielded at least twelve peer-reviewed publications: four first-author and six middle-author journal articles, and one first-author and one middle-author conference paper.

**Doctoral Research**

2014 – 2020

Northwestern University ♦ Shirley Ryan AbilityLab  
Center for Bionic Medicine ♦ Neural Engineering for Prosthetics and Orthotics

Thesis Title: *Sensory Substitution in the Presence of Vision: Providing Joint Speed Feedback to Improve Myoelectric Prosthesis Control and Adaptation.* [Dissertation.](#)

Advisors: Dr. Levi Hargrove, Prof. Jon Sensinger

Used sensory feedback to improve motor adaptation by providing information not accurately available via vision, as determined by psychophysical analysis.

Research yielded five peer-reviewed first-author publications: three journal articles and two conference papers.

**Master's Research**

2012 – 2014

Northwestern University ♦ Rehabilitation Institute of Chicago  
Center for Bionic Medicine ♦ Neural Engineering for Prosthetics and Orthotics

Advisor: Dr. Levi Hargrove

Improved control of partial-hand prostheses through optimization of EMG pattern-recognition parameters and dynamic window lengths while preserving wrist mobility.

Research yielded three peer-reviewed first-author publications: one journal article and two conference papers.

**Volunteer Internship**

2012

University of Colorado ♦ Anschutz Medical Campus  
BioMechatronics Development Laboratory

Advisor: Dr. Richard F. Weir

Designed thumb actuation mechanism and housing and created SolidWorks models of prototype 3-DOF prosthetic hand.

**PUBLICATIONS***Peer-Reviewed Publications*

- ♦ **E.J. Earley**, R.E. Johnson, J.W. Sensinger, L.J. Hargrove. “Wrist Speed Feedback Improves Elbow Compensation and Reaching Accuracy for Myoelectric Transradial Prosthesis Users in Hybrid Virtual Reaching Task.” *Journal of Neuroengineering and Rehabilitation*, 2023. [Links.](#)
- ♦ R. Collu, **E.J. Earley**, M. Barbaro, M. Ortiz-Catalán. “Non-rectangular neurostimulation waveforms elicit varied sensation quality and perceptive fields on the hand,” *Scientific Reports*, 2023. [Links.](#)
- ♦ **E.J. Earley**<sup>†</sup>, A. Berneving<sup>†</sup>, J. Zbinden, M. Ortiz-Catalán. “Neurostimulation Artifact Removal for Implantable Sensors Improves Signal Clarity and Decoding of Motor Volition.” *Frontiers in Human Neuroscience*, 2022. [Links.](#)

- ♦ **E.J. Earley**, J. Zbinden, M. Muñoz-Novoa, E. Mastinu, A. Smiles, M. Ortiz-Catalán. “Competitive Motivation Increased Home Use and Improved Prosthesis Self-Perception after Cybathlon 2020 for Neuromusculoskeletal Prosthesis User,” *Journal of Neuroengineering and Rehabilitation*, 2022. [Links](#).
- ♦ E. Lendaro, **E.J. Earley**, M. Ortiz-Catalán. “Statistical analysis plan for an international, double-blind, randomized controlled clinical trial on the use of phantom motor execution as a treatment for phantom limb pain,” *Trials*, 2022. [Links](#).
- ♦ B. Ahkami, E. Mastinu, **E.J. Earley**, M. Ortiz-Catalán. “Extra-neural signals from severed nerves enable intrinsic hand movements in transhumeral amputations,” *Scientific Reports*, 2022. [Links](#).
- ♦ **E.J. Earley**, R.E. Johnson, J.W. Sensinger, L.J. Hargrove. “Joint Speed Feedback Improves Myoelectric Prosthesis Adaptation after Perturbed Reaches in Non Amputees,” *Scientific Reports*, 2021. [Links](#).
- ♦ **E.J. Earley**, R.E. Johnson, L.J. Hargrove, J.W. Sensinger. “Joint Speed Discrimination and Augmentation for Prosthesis Feedback,” *Scientific Reports*, 2018. [Links](#).
- ♦ **E.J. Earley**, L.J. Hargrove, T.A. Kuiken. "Dual Window Pattern Recognition Classifier for Improved Partial-Hand Prosthesis Control," *Frontiers in Neuroscience*, 2016. [Links](#).

#### *Conference Papers and Posters*

##### Selected for Oral Presentation

- ♦ **E.J. Earley**, E. Mastinu, M. Ortiz-Catalán. “Cross-Channel Impedance Measurement for Monitoring Implanted Electrodes,” *IEEE Engineering in Medicine and Biology Society (EMBC)*, 2022. [Links](#).
- ♦ B.M. Musolf, **E.J. Earley**, M. Muñoz-Novoa, M. Ortiz-Catalán. “Analysis and Design of a Bypass Socket for Transradial Amputations,” *IEEE Engineering in Medicine and Biology Society (EMBC)*, 2021. [Links](#).
- ♦ **E.J. Earley**, L.J. Hargrove. “Modeling Expected Reaching Error and Behaviors for Motor Adaptation,” *IEEE Engineering in Medicine and Biology Society (EMBC)*, 2019. [Links](#).
- ♦ **E.J. Earley** and L.J. Hargrove. "The Effect of Wrist Position and Hand-Grasp Pattern on Virtual Prosthesis Task Performance," *IEEE RAS/EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob)*, 2016. [Links](#).

##### Selected for Poster Presentation

- ♦ **E.J. Earley**, M. Ortiz-Catalán. “Neurostimulation Perception Obeys Strength-Duration Curves and is Primarily Driven by Pulse Amplitude,” *International IEEE EMBS Conference on Neural Engineering (NER)*, 2023. Accepted. [Links](#).
- ♦ **E.J. Earley**, K.J. Kaveny, R.E. Johnson, L.J. Hargrove and J.W. Sensinger. "Joint-based velocity feedback to virtual limb dynamic perturbations," *International Conference on Rehabilitation Robotics (ICORR)*, 2017. [Links](#).
- ♦ **E.J. Earley**, A.A. Adewuyi, and L.J. Hargrove. "Optimizing Pattern Recognition-Based Control for Partial-Hand Prosthesis Application," *IEEE Engineering in Medicine and Biology Society (EMBC)*, 2014. [Links](#).

### Other Conference Proceedings

- ◆ B. Ahkami, E. Mastinu, **E. Earley**, M. Ortiz-Catalán. “Extraneural Recordings Enable the Decoding of Intrinsic Hand Movements in Transhumeral Amputations,” *World Congress of the International Society for Prosthetics and Orthotics (ISPO)*, 2021. [Links](#).
- ◆ **E.J. Earley**, R.E. Johnson, L.J. Hargrove and J.W. Sensinger. “Visual Discrimination of Biomimetic Arm Speeds,” *School and Symposium on Advanced Neurorehabilitation (SSNR)*, 2018. [Links](#).
- ◆ **E.J. Earley**, K.J. Kaveny, R.E. Johnson, L.J. Hargrove and J.W. Sensinger. “Joint-based velocity feedback improves myoelectric prosthesis performance,” *Myoelectric Controls and Upper Limb Prosthetics Symposium (MEC)*, 2017. [Links](#).
- ◆ **E. Earley**, K. Kaveny, R. Johnson, L. Hargrove, J. Sensinger. “Appropriate Sensory Feedback Improves Performance,” *World Congress of the International Society for Prosthetics and Orthotics (ISPO)*, 2017. [Links](#).

### *Publications In Preparation*

- ◆ J. Zbinden, P. Sassu, E. Mastinu, **E.J. Earley**, M. Muñoz-Novoa, R. Brånemark, M. Ortiz-Catalán. “Nerve transfer to native and free grafted muscles for the control of bionic limbs,” *Science: Translational Medicine*. Revision submitted.
- ◆ M. Ortiz-Catalán, J. Zbinden, J. Millenaar, D. D’Accolti, M. Controzzi, F. Clemente, L. Cappello, **E.J. Earley**, E. Mastinu, J. Kolankowska, M. Muñoz-Novoa, S. Jönsson, C. Cipriani, P. Sassu, R. Brånemark. “A highly integrated below-elbow bionic hand for use in daily life with neural control and feedback.” In review.
- ◆ **E.J. Earley**<sup>†</sup>, N.S. Chan<sup>†</sup>, A. Naber, E. Mastinu, M.T.N. Truong, M. Ortiz-Catalán. “Low-Cost, Wireless Bioelectric Signal Acquisition and Classification Platform.” Submitted.
- ◆ A.B. Smiles<sup>†</sup>, **E.J. Earley**<sup>†</sup>, N. Jiang, M. Ortiz-Catalán. “Sensory Feedback by Direct Neural Stimulation Improves Amputee Prediction of Object Slip.” In preparation (receiving edits from co-authors).
- ◆ E. Lendaro, C.K. Van der Sluis, L. Hermansson, E. Keesom, M.J. Muñoz-Novoa, L. Bunketorp-Käll, C. Widehammar, H. Burger, P. O’ Reilly, B.E. McGuire, **E.J. Earley**, C.S. von Waldheim, E. Diamantidis, A. Stocksélius, L. Gudmundson, W. Hill, M. Diers, L. Hargrove, K. Turner, M. Ortiz-Catalán. “Virtual reality and machine learning for the treatment of phantom limb pain: an international, double-blind, randomized controlled clinical trial on phantom motor execution.” In preparation (receiving edits from co-authors).

### GRANT FUNDING

#### *Current Research Support*

- ◆ **Vetenskapsrådet**: 2020-04817 (PI: Max Ortiz-Catalán)  
Integrerade bionisk proteser/Highly integrated bionic prostheses  
2021/01/01 – 2024/12/31                      **Role**: Post-Doctoral Investigator

#### *Completed Research Support*

- ◆ **NSF-NRI**: Small: 1317379 (PI: Levi Hargrove)  
Modeling, Quantification, and Optimization of Prosthesis-User Interface  
2014/09/01 – 2018/08/31                      **Role**: Pre-Doctoral Investigator

- ◆ **NRSA T32:** HD07418 (PI: Eric Perreault)  
Pathophysiology & Rehabilitation of Neural Dysfunction  
2016/09/01 – 2018/08/31      **Role:** Pre-Doctoral Trainee
- ◆ **NIDILRR:** 90RE5014-02-00 (PI: Levi Hargrove)  
Pattern Recognition-Based Myoelectric Control of Partial-Hand Prostheses  
2013/01/01 – 2014/08/31      **Role:** Pre-Doctoral Investigator

## PROFESSIONAL MEMBERSHIPS & SERVICE

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### *Journal Editor*

- ◆ Prosthesis, MDPI 2022 – 2023  
Co-Guest Editor, “Design, Control, and Biomechanics of Prosthetic Limbs.” [Link](#).

### *Journal Referee*

More than 65 verified peer reviews across 15 journals and 5 professional conferences.  
Details on [Web of Science](#).

### *Professional Memberships*

- ◆ Member, IEEE 2014 – present
  - ◆ Member, IEEE Engineering in Medicine and Biology Society. 2019 – present
- ◆ Member, ISPO 2022 – present

## ADVISING & MENTORING

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### *PhD Students*

- ◆ **Jan Zbinden**, Electrical Engineering 2020 – 2023  
3-Degree-of-Freedom Simultaneous and Proportional Control of Prosthetic Hands.
- ◆ **Riccardo Collu**, Engineering & Architecture 2020 – 2022  
Novel Waveform Shapes for Neurostimulation. [Links](#).
- ◆ **Bahareh Ahkami**, Electrical Engineering 2020 – 2021  
Extra-Neural Control of Intrinsic Hand Movements in Transhumeral Amputation. [Links](#).

### *MS Students*

- ◆ **Roberta Reho**, Robotics Engineering 2022-2023  
Modulating Artifact Removal Algorithms for Neurostimulation
- ◆ **Nathaly Sánchez Chan**, Biomedical Engineering 2022  
ADS\_BP v4 Open-Source Release
- ◆ **Malin Lehander**, Biomedical Engineering 2022  
Improving Tactile Discrimination with Mindful Sensory Motor Training

- ◆ **Agnes Westerlund**, Biomedical Engineering 2022  
Enhancing the Sense of Touch with Brain Modulation
- ◆ **Anton Bernevig**, Engineering Mathematics and Computational Science 2021  
Neurostimulation Artifact Removal Algorithms for iEMG Prosthesis Control. [Links](#).
- ◆ **Brett Musolf**, Biomedical Engineering 2020 – 2021  
Design of a Bypass Socket for Transradial Prosthesis Use. [Links](#).
- ◆ **Andrew Smiles**, Systems Design Engineering 2020 – 2021  
Slip Prediction and Stimulation System for Sensorized Prosthetic Hands. [Links](#).

## TEACHING

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**Chalmers University of Technology – EEM076 – Electric Circuits and Fields** 2020 – 2022  
Lecturer, Examiner

Planned and lectured for 360 undergraduate students over three years. Responsibilities included delivering 14 lectures and writing 3 examinations per year. [Course link](#).  
Student course evaluation: 4.2 / 5.0

Learning objectives: analyze linear circuits using DC and AC calculation methods, perform electromagnetic field calculations based on simple geometries, and use computer-based tools to analyze simpler electrical circuits.

Course development included refining electromagnetic field module to better integrate with the circuits modules and adapting the course for digital instruction and examination during the COVID-19 pandemic.

**Notre Dame University – PHIL 20632/STV 20233 – Robot Ethics** 2016 – 2018  
Guest Lecturer

Along with Max Shepherd, gave guest lectures titled “ProstEthics” for Dr. Don Howard’s Robot Ethics course focused on historical and current research of prosthetic limbs, and ethical considerations related to prosthetic design and transhumanism.

**Nettelhorst Elementary – Get-a-Grip Program** 2017  
Student Mentor

Through Northwestern’s Science Club, mentored 30 elementary school students in the fundamentals of engineering design, construction, and analysis, and guided them as they developed a prosthetic device made from household items.

**Northwestern University McCormick Graduate Leadership Council** 2013 – 2017  
Workshop Coordinator and Instructor

Coordinated workshops to teach introductory through advanced MATLAB and SolidWorks skills, and additional workshops on other transferable skills, for over 600 Northwestern graduate students. [Website](#).

**Northwestern University – BME 307 – Quantitative Experimentation and Design** 2015  
Teaching Assistant

Mentored biomedical engineering 50 undergraduate students as they learned to answer questions using experimental means, and to quantify their results using statistical analysis.

**LEADERSHIP**

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**Workforce for Inclusive Science** 2021 - 2023  
Organizing Committee

Facilitating meetings and seminars aimed at promoting and fostering equity and inclusion in academia. [Website](#).

**National Communicating Science Conference** 2017 – present  
Organizing Committee, Leadership Team, Advisory Committee

Treasurer and advisory committee member, responsible for developing fiscal procedures and managing \$300,000 in total donated funds for 30 flagship and local conferences attended by up to 1,500 graduate students. [Website](#).

**International Conference on Phantom Limb Pain** 2021  
Organizing Committee

Planned, oversaw, and executed social media plan before and during the event. Moderated discussion panel during final day of the conference. [Website](#).

**Chicago Communicating Science Conference** 2015 – 2017  
Treasurer, Lead Organizer

Organizer and treasurer for 2016 conference, lead organizer for 2017 conference. Tracked and budgeted \$24,000 in total donated funds, secured conference locations, invited keynote speakers, and oversaw conferences for 100 total attendees. [Website](#).

**Northwestern University Biomedical Engineering Graduate Students Group** 2013 – 2017  
Co-President, Department Representative.

Oversaw academic and social events, managed \$3,500 annual budget, represented department in Graduate Leadership & Advocacy Council, and facilitated pop talks (short research summaries using jargon-free language) for annual research day. [BMEGS Website](#). [GLAC Website](#).

**Colorado School of Mines Robotics Club** 2008 – 2011  
Treasurer, Mentor

Developed and managed \$26,000 annual budget. Mentored high school robotics team for FIRST Robotics Competition. Co-initiated project to design, build and program self-balancing wheelchair. [Website](#).

**PUBLIC OUTREACH & EDUCATION**

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**Public Talks & Demos** 2015 – present

- ♦ Sahlgrenska Universitetssjukhusets innovation- och teknikutbildning för läkare, 2022.
- ♦ Center for Bionics and Pain Research Annual Symposium, 2021-2022.
- ♦ PhD Thesis defense, 2019. [YouTube](#).

- ◆ “Wunderbar Together Science Slam,” Daley Plaza, Chicago, IL, 2019.
- ◆ “Neural Engineering: Designing Bionic Limbs Controlled by the Brain,” College of DuPage STEMinar Series, 2018. [YouTube](#).
- ◆ Chicago Science Festival, Illinois Science Council, 2016 – 2019.
- ◆ Museum of Science and Industry Robotics Week, 2016 – 2019.
- ◆ “How Do I Talk to my Robo-Limb?”, RSG Science Communicating Workshop, 2016. [YouTube](#).
- ◆ IEEE Engineer’s Week, 2016.
- ◆ “Adler After Dark”, Adler Planetarium, 2015 – 2018.
- ◆ Camp Neuro Chicago, 2015.

### **SciShow YouTube Channel**

2018 – 2020

Freelance Script Writer

Wrote video scripts for SciShow, a YouTube channel with 7-million subscribers which makes easy-to-understand science videos. Topics included osseointegrated prosthetic limbs, synthetic muscles, effects of body posture, and fetal motor development. [Links](#).

### **Sci-Inspiration YouTube Channel**

2017 – 2018

Video Creator

Scripted, recorded, directed, and animated videos exploring scientific topics through popular media including movies, television, and video games. [Links](#).

### **Other Science Videos**

2016 – 2020

- ◆ “Neuromusculoskeletal Arm Prostheses”, *CBPR*, 2020. [YouTube](#).
- ◆ “STEM Connect Careers: Eric Earley.” *Discovery Education*, 2017. [Website](#).
- ◆ “Prosthetic Limbs and Motor Adaptation”, *Ready Set Go (RSG)*, 2016. [YouTube](#).

### **Science Writing**

2017

- ◆ The Cybathlon: The Olympics of Restoring Daily Tasks, *HELIX Magazine*, 2017. [Link](#).

### **ACADEMIC & TECHNICAL SKILLS**

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- ◆ Prosthetic sensory feedback, sensory integration, psychophysics
- ◆ Pattern recognition, classification, and machine learning algorithms
- ◆ Human motor control, motor learning and adaptation
- ◆ Neuromusculoskeletal anatomy, osseointegration, implantable sensors
- ◆ Statistical analysis, hypothesis testing, power analysis, linear and nonlinear mixed effects modeling
- ◆ Prosthetic arm standardized tests: ACMC, BBT, MMDT, MT, PLT, RCRT, SHAP, TAC, VET
- ◆ MATLAB, Simulink, C, LabVIEW
- ◆ SolidWorks, FEA
- ◆ Organization, scheduling, project management, Kanban, scrum
- ◆ Adobe Illustrator, Photoshop, Premiere; Affinity Designer, Photo
- ◆ HTML5, CSS
- ◆ Native English; limited working proficiency Swedish; elementary proficiency German, French