



**Exponent**<sup>®</sup>  
Engineering & Scientific Consulting

## Patrick Hall, Ph.D.

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### Professional Profile

Dr Hall focuses on improving human performance through implanted devices and external mechanical intervention. He has expertise throughout the development, regulatory, and reactive phases of orthopedic implants, medical devices, exoskeletons, and other assistive devices intended for enhancing biomechanical or physiological function. This experience includes mechanical testing of devices, biomechanical testing and analysis in both human and animal models, simulation of human performance, implant design and fabrication, 3D CAD modeling, and additive manufacturing. Dr. Hall's training also includes biomechanical design, coding, machine learning, and control algorithms in the field of biomechatronics from previous research in prosthetics and surgical robotics.

Dr. Hall obtained his Ph.D. in Mechanical Engineering at the University of Tennessee, Knoxville, where he focused on development and analysis of an implanted total limb prosthesis and a passive shoulder exoskeleton. His work involved device design and prototyping, mechanical testing for failure analysis, motion capture analysis to monitor how devices affected biomechanical function, and both qualitative and quantitative analysis of muscle, bone, and skin tissues. He is proficient in both the experimental design and testing procedures required for biomechanical analysis in both human subjects and various animal models, including rabbit and rat. Additionally, he has considerable expertise in the fabrication of devices and test fixtures, using a wide variety of tools and techniques including additive manufacturing, CNC machining, wire EDM, and hand machining.

### Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, University of Tennessee, Knoxville, 2021

B.S.E., Biomedical Engineering, Baylor University, 2017

Outstanding Graduate Student for the MABE Department at UTK, April 2021

Outstanding Student for the Biomedical Engineering Department at Baylor, April 2017

Who's Who in American Colleges and Universities, 2016

### Prior Experience

Graduate Research Assistant, Upper Limb Assist Lab, University of Tennessee, Knoxville, 2017-2021

Teaching Assistant, Mechanics (ME535), System Dynamics (ME 490), Advanced Biomechanics (BME 610), and Assistive Device (BME 699), 2017-2020

Undergraduate Research Assistant, Vanderbilt Institute for Surgery and Engineering, Vanderbilt University, 2016

## Professional Affiliations

Orthopedic Research Society (ORS)

American Society of Biomechanics (ASB)

Biomedical Engineering Society (BMES)

## Publications

Hall, Patrick T., Caleb Stubbs, Alisha P. Pedersen, Caroline Billings, Stacy M. Stephenson, Cheryl B. Greenacre, David E. Anderson, and Dustin L. Crouch. "Effect of polyester-based artificial tendons on movement biomechanics: A preliminary in vivo study." *Journal of Biomechanics* 151 (2023): 111520.

Hall, Patrick, Caleb Stubbs, David E. Anderson, Cheryl Greenacre, and Dustin L. Crouch. "Rabbit hindlimb kinematics and ground contact kinetics during the stance phase of gait." *PeerJ* 10 (2022): e13611.

Crouch, Dustin L., Patrick T. Hall, Caleb Stubbs, Caroline Billings, Alisha P. Pedersen, Bryce Burton, Cheryl B. Greenacre, Stacy M. Stephenson, and David E. Anderson. "Feasibility of Implanting a Foot–Ankle Endoprosthesis within Skin in a Rabbit Model of Transtibial Amputation." *Bioengineering* 9, no. 8 (2022): 348.

Hall, Patrick. "Enhancing Biomechanical Function through Development and Testing of Assistive Devices for Shoulder Impairment and Total Limb Amputation." (2021).

Hall, Patrick T., Samantha Z. Bratcher, Caleb Stubbs, Rebecca E. Rifkin, Remi M. Grzeskowiak, Bryce J. Burton, Cheryl B. Greenacre, Stacy M. Stephenson, David E. Anderson, and Dustin L. Crouch. "Fully Implanted Prostheses for Musculoskeletal Limb Reconstruction After Amputation: An In Vivo Feasibility Study." *Annals of Biomedical Engineering* 49, no. 3 (2021): 1012-1021.

Hall, Patrick T., and Dustin L. Crouch. "Effect of continuous, mechanically passive, anti-gravity assistance on kinematics and muscle activity during dynamic shoulder elevation." *Journal of biomechanics* 103 (2020): 109685.

Nelson, A. J., Hall, P. T., Saul, K. R., & Crouch, D. L. (2020). Effect of Mechanically Passive, Wearable Shoulder Exoskeletons on Muscle Output During Dynamic Upper Extremity Movements: A Computational Simulation Study. *Journal of applied biomechanics*, 36(2), 59-67.

## Oral Presentations

Corinne Riggan, Derek Holyoak, Juan Jose Paredes, Patrick Hall, Ryan Siskey, Elizabeth Rapp van Roden, Dhara Amin, Michael Carhart, and Kathleen Rodowicz. "Mechanical Properties of Spines with Diffuse Idiopathic Skeletal Hyperostosis vs. Healthy Spines: A Pilot Cadaveric Study" American Society of Biomechanics Annual Meeting, August 2023, Seattle, WA.

Asgari, M., Hall, P. T., Moore, B. S., & Crouch, D. L. (2020, July). Wearable shoulder exoskeleton with spring-cam mechanism for customizable, nonlinear gravity compensation. In 2020 42nd Annual International Conference of the IEEE Engineering in Medicine & Biology Society (EMBC) (pp. 4926-4929). IEEE.

Patrick T. Hall, Caleb Stubbs, Rebecca E. Rifkin, Remi M. Grzeskowiak, Bryce J. Burton, Cheryl B.

Greenacre, Stacy M. Stephenson, David E. Anderson, and Dustin L. Crouch, “Musculoskeletal Limb Reconstruction through Fully Implanted Endoprostheses: An In Vivo Feasibility Study” – Orthopedic Research Society Annual Meeting – Virtual, February 12-16, 2021.

### **Poster Presentations**

Crouch DL, Anderson DE, Stephenson SM, Greenacre CB, Easton KL, Hall PT, Stubbs C, Fidelis O, Asgari M, Burton B, Rifkin RE, Grzeskowiak RM, Pedersen AP, Billings C, Bowers K. “Muscle-Driven Endoprosthetic Limbs: Rationale, Feasibility, and Challenges.” American Society of Biomechanics Annual Meeting, August 2023, Seattle, WA.

Patrick T. Hall, Caleb Stubbs, Cheryl Greenacre, David E. Anderson, and Dustin L. Crouch “Hindlimb Ankle Kinematics During Stance Phase of Hopping Gait” – American Society of Biomechanics Annual Meeting – Atlanta, GA, August 4-7, 2020

Patrick T. Hall, Gavin Warrington, David E. Anderson, Cheryl Greenacre, and Dustin L. Crouch, “Noninvasive Biomechanical Gait Analysis of a Hindlimb Tenotomy in the Rabbit Model” – Biomedical Engineering Society Annual Meeting – Philadelphia, PA, October 16-19, 2019