

**BRIAN A. KNARR**  
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## **EDUCATION**

University of Delaware, Newark, DE – May 2012  
Ph.D. Biomechanics and Movement Design  
GPA: 3.85 / 4.0

**PhD Dissertation** - Development of musculoskeletal models to assess muscle weakness, coordination, and response to rehabilitation in persons post-stroke

University of Delaware, Newark, DE – January 2009  
M.S. Mechanical Engineering – Biomechanics Concentration  
GPA: 3.76 / 4.0

**Master's Thesis** – Development and analysis of a finite element model of the biceps brachii muscle driven by in vivo strain and deformation data

The College of New Jersey, Ewing, NJ – May 2006  
B.S. Mechanical Engineering  
GPA: 3.75 / 4.0 - Magna Cum Laude

**Undergraduate Research** – Computational fluid dynamics modeling to determine the influence of giant vacuoles in Schlemm's Canal in the inner eye on pressure distributions that can lead to open-angle glaucoma

## **RESEARCH INTERESTS**

Develop new rehabilitation methods and techniques through the synergy of innovative hardware, software, and clinical designs.

## **PROFESSIONAL EXPERIENCE**

### **CURRENT POSITION**

**Associate Scientist**, Delaware Rehabilitation Institute, University of Delaware

**Research Assistant Professor**, Biomedical Engineering, Biomechanics and Movement Science, University of Delaware

October 2014 – Present

- Develop novel techniques to evaluate properties and control of the musculoskeletal system based on patient-specific imaging, muscle activation and motion analysis data.
- Integrate imaging techniques, biomechanics, and numerical models into clinical tools for the evaluation of patients.
- Lead an interdisciplinary senior design team on a project combining mechanical, electrical, and software design to create a clinical and research device for improving and assessing partial weight bearing compliance after injury.
- Mentor graduate and undergraduate students. This includes project conception and implementation, answering questions, troubleshooting issues, and training.

- Consult and oversee work on subject-specific database creation, implementation, and interaction for DRI researchers.

### **COMPUTER EXPERIENCE**

|                          |                           |                          |
|--------------------------|---------------------------|--------------------------|
| OpenSim                  | Visual 3D                 | LabVIEW                  |
| SQL Database Programming | MATLAB                    | Cortex                   |
| C++ Programming          | ABAQUS FE Modeling FLUENT | ANSYS Multiphysics       |
| Mathematica              | CFD Software              | Pro/ENGINEER 3D Modeling |
| FORTTRAN Programming     | IMOD Image Processing     |                          |

### **TEACHING EXPERIENCE**

2015: Course Co-Instructor and Developer: Computation Tools in Biomechanics (BMSC 667)

2014: Advisor: Interdisciplinary Senior Design: Instrumented Walking Boot Project  
(MEEG401/BMEG450/MEEG467)

2014: Instructor: Independent Study - Upper Extremity Modeling Development and Validation (BMEG866)

2012: Course Co-Instructor and Developer: Musculoskeletal Simulation (MEEG 867)

2006: Teaching Assistant: Senior Design (MEEG 401)

### **PREVIOUS POSITIONS**

#### **Technical Consulting**

2012-Present

- Development and implementation of custom software to analyze step activity in a post-stroke population
- Data processing and aggregation of motion capture data for a longitudinal clinical biomechanics study
- Development of a custom software interface for programmatic control of an instrumented split-belt treadmill

#### **Postdoctoral Researcher**, Delaware Rehabilitation Institute, University of Delaware

June 2012 – September 2014

- Development and analysis of musculoskeletal simulations of gait for individuals with orthopedic conditions.
- Consulting and instructing lab groups that wish to get involved in musculoskeletal simulation research. This includes aiding in concept generation as well as implementation.
- Mentor graduate and undergraduate students in the lab. This includes answering questions, troubleshooting issues, training new students, and acting as a liaison between the students and Dr. Higginson.
- Ensuring lab equipment is properly maintained and operating appropriately. Troubleshooting equipment/software problems during data collection and/or processing.
- Develop simulations and techniques for the analysis of wearable, upper body devices which optimally redistribute loading to minimize fatigue and injury in soldiers.
- Design and build a relational database based on the data collected under the dynamic stability project in Dr. Snyder-Mackler's lab.
- Oversee database creation and management for the Delaware Rehabilitation Institute.

#### **Research Assistant**, University of Delaware

September 2009 – May 2012

- Analyzed muscle activation and function of healthy and post-stroke gait by building musculoskeletal models
- Investigated the effects of multiple muscle group weakness on the biomechanical coordination of muscles in healthy gait using musculoskeletal modeling
- Performed muscle performance testing to evaluate volitional activation and force generating ability of muscle using electrical stimulation on the plantar flexors, dorsiflexors, and quadriceps of healthy and post-stroke individuals
- Developed a correction equation for submaximal activation the burst superimposition test for the plantar flexor muscle group
- Built and managed a Microsoft SQL relational database for an NIH funded longitudinal osteoarthritis research project
- Restructured and served as primary technical assistance and maintenance person for a motion capture lab with 8 camera system and instrumented treadmill
- Setup and maintained a local network server for data management, sharing, and redundancy
- Co-instructor for independent study course on musculoskeletal simulations

**Research Assistant**, University of Delaware

June 2007 – September 2009

- Developed a fatigue protocol for use in CPC-MRI scanning
- Designed and built an apparatus for use in CPC-MRI fatigue protocol
- Created a finite element model for the biceps brachii to use with internal strain data derived from CPC-MRI images
- Analyzed the stress fields in the biceps brachii produced from the finite element model using spatial and frequency techniques

**Department Fellow**, University of Delaware

February 2007- June 2007

- Used Linux code to generate internal strain fields from CPC-MRI images of the biceps brachii
- Analyzed biceps brachii strain fields through spatial and frequency techniques

**Teaching Assistant**, University of Delaware

September 2006 – February 2007

- Consulted senior undergraduates on senior design projects and presentations
- Managed the Senior Design Lab Equipment

**RESEARCH FUNDING**

**Funded (Current)**

**Principal Investigator:** COBRE Pilot Project Grant from NIH P30-GM103333 (PI: Thomas S. Buchanan). Acceleration-based assessment of limb loading asymmetry during daily living. Funded 07/31/2015. \$50,000 1 year, renewable.

**In Resubmission**

NIH R03. **Principal Investigator:** Changes in post-stroke propulsive gait dynamics as a result of handrail use during treadmill walking. Original Submission, February 2015. Score 37. Resubmission, November 2015.

**In Preparation**

NIH R01. **Principal Investigator:** Real-time propulsion-based gait rehabilitation with an adaptive speed treadmill for individuals post-stroke. Expected Submission, 2016.

NIH R21. **Principal Investigator:** Training and monitoring compliance of partial weight bearing gait after Achilles tendon injury. Expected Submission, 2016.

NIH R03. **Principal Investigator:** Evaluation of gait adaptation and motor learning in response to real-time biofeedback in individuals post-stroke. Expected Submission, 2016.

## PUBLICATIONS

1. HY Hsiao, **BA Knarr**, JS Higginson, RT Pohlig, SA Binder-Macleod . Mechanisms used to increase peak propulsive force following 12-weeks of gait training in individuals poststroke. *Journal of Biomechanics*, in Press. doi:10.1016/j.jbiomech.2015.12.040
2. HY Hsiao, **BA Knarr**, JS Higginson, SA Binder-Macleod. Mechanisms to increase propulsive force for individuals poststroke. *Journal of NeuroEngineering and Rehabilitation*, 2015 Apr 18;12:40. doi: 10.1186/s12984-015-0030-8. PMID: PMC4406180
3. Eitzen I, Kallerud H, Fernandes L, Nordsletten L, **Knarr BA**, Risberg MA. Gait pattern, symptoms and function in hip osteoarthritis subjects who do not undergo total hip replacement: 6-7 year follow-up. *J Orthop Sports Phys Ther*. 2015;45(7):539-549
4. **Knarr BA**, Higginson JS. Practical approach to subject-specific estimation of knee joint contact force. *Journal of Biomechanics*, 2015 Aug 20;48(11):2897-902. PMID: PMC4536092
5. **Knarr BA**, Higginson JS, Zeni JA. Changes in knee contact force with simulated change in body weight. *Computer Methods in Biomechanics and Biomedical Engineering*, 2015 Mar 11:1-4.DOI: 10.1080/10255842.2015.1018193. PMID: 25760517
6. HY Hsiao, **BA Knarr**, JS Higginson, SA Binder-Macleod. The relative contribution of ankle moment and trailing limb angle to propulsive force during gait. *Human Movement Science*, 2015 Feb;39:212-21 PMID: 25498289 PMID: PMC4272868
7. Stanhope VA, **Knarr BA**, Reisman DS, Higginson JS. Frontal plane compensatory strategies associated with self-selected walking speed in individuals post-stroke. *Clinical Biomechanics*, 2014 May;29(5):518-22. PMID: 24768223
8. **Knarr BA**, Reisman DS, Binder-Macleod SA, Higginson JS. Changes in Predicted Muscle Coordination with Subject-Specific Muscle Parameters for Individuals after Stroke. *Stroke Research and Treatment*, 2014;2014:321747. PMID: 25093141 PMID: PMC4096388
9. **Knarr BA**, Roos MA, Reisman DS. Sampling frequency impacts the measurement of walking activity after stroke. *J Rehabil Res Dev*, 2013;50(8):1107-12. PMID: 24458896
10. **Knarr BA**, Ramsay JW, Buchanan TS, Higginson JS, Binder-Macleod SA. Muscle volume as a predictor of maximum force generating ability in the plantar flexors post-stroke. *Muscle and Nerve*, 2013 Dec;48(6):971-6. PMID: 23494851
11. **Knarr BA**, Reisman DS, Binder-Macleod SA, Higginson JS. Understanding compensatory strategies for muscle weakness during gait by simulating activation deficits seen post-stroke. *Gait and Posture*, 2013 Jun;38(2):270-5. PMID: 23273489 PMID: PMC3625686
12. **Knarr BA**, Kesar TM, Reisman DS, Binder-Macleod SA, Higginson JS. Changes in activation and function of the ankle plantarflexor muscles due to gait retraining in chronic stroke survivors. *Journal of NeuroEngineering and Rehabilitation*, 2013 Jan 31;10:12. . PMID: 23369530 PMID: PMC3565909
13. **Knarr BA**, Zeni JA, Higginson JS. Comparison of Electromyography and Joint Moment as Indicators of Co-contraction. *Journal of Electromyography and Kinesiology*, 2012 Aug;22(4):607-11. PMID: 22382273 PMID: PMC3506260

14. **Knarr BA**, Higginson JS, Binder-Macleod, SA. Validation of adjustment equation for the burst superimposition technique in subjects post-stroke. *Muscle and Nerve*, 2012 Aug;46(2):267-9. PMID: 22806377 PMCID: PMC3400120
15. Sions M, Malecka C, **Knarr BA**, Jancosko A, Binder-Macleod SA. Age- and Stroke-Related Skeletal Muscle Changes: A Review for the Geriatric Clinician. *Journal of Geriatric Physical Therapy*, 2012 Jul-Sep;35(3):155-61. PMID: 22107952 PMCID: PMC3290755
16. Flynn S, **Knarr BA**, Perumal R, Kesar TM, Binder-Macleod SA. Using submaximal contractions to predict the maximum force generating ability of muscles. *Muscle and Nerve*, 2012 Jun;45(6):849-58. PMID: 22581539 PMCID: PMC3353723.

### **PUBLICATIONS IN REVIEW (or Preparation)**

17. **Knarr BA**, Roos MA, Reisman DS. Characterization of intensity of daily walking activity in individuals post-stroke, in Preparation.
18. Henderson C, Higginson JS, **Knarr BA**. Model Predicted Peak Joint Contact Force is affected by the Maximal Isometric Forces of Muscle Groups. *Computer Methods in Biomechanics and Biomedical Engineering*, in Preparation.
19. Nicholson M, Higginson JS, **Knarr BA**. Biofeedback modality: is audio or visual feedback more effective for training gait asymmetries? *Human Movement Science*, in Review.
20. Doolin M, Higginson JS, **Knarr BA**. Evaluation of multiple training paradigms when using biofeedback for learning partial weight bearing, in Preparation.

### **RESEARCH PRESENTATIONS**

#### **Invited Seminars**

1. Higginson JS, **Knarr BA**. Subject-specific Parameters and the Prediction of Knee Joint Contact Force Using Musculoskeletal Modeling. World Congress of Biomechanics, Boston, Massachusetts, July 2014.
2. Higginson JS, **Knarr BA**, Ramsay J. Measuring and Incorporating Subject-Specific Muscle Parameters in Post-Stroke Gait Simulations. OpenSim Webinar Series, Stanford University, September 17, 2013.
3. Manal K, **Knarr BA**. Gait Analysis and Knee Contact Force Modeling. Osteoarthritis Research Society International Pre-Symposium, University of Delaware, April 17, 2013.
4. **Knarr BA**. Research Applications Using Multi-Body Dynamic Musculoskeletal Models. Biomechanics and Movement Science Seminar Series, University of Delaware, April 19, 2013.

#### **National**

5. Richardson RT, **Knarr BA**, Higginson JS, Richards JG. Glenohumeral abduction and flexion moment arms: a verification study of a new musculoskeletal model of the shoulder. American Society of Biomechanics Conference, August 2015. Columbus, OH.
6. West TK, Schenk ME, Schnall DA, O'Brien ME, Groome MA, Singh A, Higginson JS, **Knarr BA**. SmartBoot: An Instrumented Clinical Walking Boot for Partial Weight Bearing Training. Summer Biomechanics, Bioengineering and Biotransport Conference, June 2015, Snowbird Resort, Utah. **(3<sup>rd</sup> Place, Undergraduate Design Competition)**.
7. Doolin M, Higginson JS, **Knarr BA**. Evaluation of multiple training paradigms when using biofeedback for learning partial weight bearing. Gait and Clinical Movement Society, March 2015, Portland, Oregon.

8. Richardson RT, **Knarr BA**, Higginson JS, Richards JG. Evaluation of glenohumeral muscle moment arms of a new musculoskeletal model of the shoulder and upper extremity. Gait & Clinical Movement Analysis Society. March 2015. Portland, OR.
9. **Knarr BA**, Awad L, Reisman DS. Training with Real-Time Visual Feedback of Propulsive Force in Post-stroke Individuals: A Case Study. Gait and Clinical Movement Society, June 2014, Newark, DE.
10. Eitzen I, Kallerud H, Fernandes L, Nordsletten L, **Knarr BA**, Risberg M. Gait, Symptoms and Function in Patients with Mild to Moderate Hip Osteoarthritis: 6-7 Year Follow-up. OARSI World Congress on Osteoarthritis. April 2014. Paris, France.
11. Brandis C, Awad LN, Hsiao H, Marion MS, Kesar TM, **Knarr BA**, Higginson JS, Binder-Macleod SA. The Effects of Fatigue on Post-Stroke Muscle Force Production and Center of Mass Acceleration: A Musculoskeletal Simulation Analysis. Computer Methods in Biomechanics and Biomedical Engineering. April 2013, Salt Lake City, Utah.
12. **Knarr BA**, Reisman DS, Binder-Macleod SA, Higginson JS. Changes in Model-Predicted Muscle Activation with Subject Specific Parameters for Individuals Post-Stroke. Computer Methods in Biomechanics and Biomedical Engineering. April 2013, Salt Lake City, Utah.
13. **Knarr BA**, Higginson JS. The Ability of a Residual Reduction Algorithm to Account for Handrail Use During Gait Analysis. American Society of Mechanical Engineering Summer Bioengineering Conference, June 2012, Fajardo, Puerto Rico.
14. **Knarr BA**, Ramsay J, Buchanan TS, Binder-Macleod SA, Higginson JS. Quantification of atrophy and activation failure in the plantar flexors post-stroke. American Society for Biomechanics Meeting, August 2011, Long Beach, CA.
15. **Knarr BA**, Kesar TM, Helm E, Reisman DS, Binder-Macleod, SA, Higginson, JS. Simulation detects changes in muscle activation in post-stroke gait after a functional electrical stimulation intervention. American Society for Biomechanics Meeting, August 2010, RI.
16. **Knarr BA**, Zeni J, Higginson JS. Comparison of Electromyography and Joint Moment as Indicators of Co-contraction. Gait and Clinical Movement Society, May 2010, Miami, FL.
17. **Knarr BA**, Higginson JS. Muscle compensation strategies with plantar flexor and dorsiflexor activation impairment. Gait and Clinical Movement Society, May 2010, Miami, FL.
18. **Knarr BA**, Novotny JE. Protective Strategies Revealed from Stress Distributions in Subject-Specific Finite Element Models of Skeletal Muscle. Orthopaedic Research Society, February 2009, Las Vegas, NV.
19. Novotny JE, **Knarr BA**, Zhou H. Maximum contractile strain in the biceps brachii is bounded by sarcomere geometry. Summer Bioengineering Conference 2008, ASME. Marco Island, FL, USA
20. Novotny JE, **Knarr BA**, Zhou H. Biceps Brachii Muscle Strains Show Simultaneous Concentric, Eccentric, and Isometric Behavior during Elbow Flexion-Extension. The Orthopaedic Research Society meeting, 2008 Transactions Vol.33, San Francisco, CA/
21. Novotny JE, **Knarr BA**, Zhou H. Observing strain distributions in skeletal muscle with CPC-MRI. Biomedical Engineering Society Annual Fall Meeting 2007, Los Angeles, CA, USA
22. Novotny JE, **Knarr BA**, Zhou H. Strains in the biceps brachii during dynamic elbow flexion show concentric, eccentric and isometric behavior simultaneously. American Society for Biomechanics Meeting, August 2007, Palo Alto, CA.

### Local

23. Justice W, **Knarr BA**. Which Partial Weight Bearing Percentage will be Easiest for Patients to Comply With? University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.
24. McCarren G, Richards J, **Knarr BA**. Reducing Torque on the Low Back of Golfers. University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.

25. Nicholson MC, Higginson JS, **Knarr BA**. Knee Contact Forces and Cost of Locomotion in Constant String Length Walking Cases. University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.
26. Collin Patterson, Higginson JS, **Knarr BA**. Development and Validation of the SmartBoot: A Biofeedback Device for Partial Weight Bearing Rehabilitation. University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.
27. Schulman M, Higginson JS, **Knarr BA**. Knee Joint Loading Cost of Locomotion with Changing Stride Length at a Normal Speed. University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.
28. Zakutney L, Higginson JS, **Knarr BA**. Knee Joint Loading Cost of Locomotion in Response to Varying Stride Lengths at a Slow Speed. University of Delaware Undergraduate Research and Service Celebratory Symposium 2015.
29. Doolin MT, Higginson JS, **Knarr BA**. Evaluation of multiple training paradigms when using biofeedback for learning partial weight bearing. University of Delaware Undergraduate Research and Service Celebratory Symposium 2014.
30. Nicholson MC, Higginson JS, **Knarr BA**. Biofeedback Modality: Is audio or visual a more effective method for training gait asymmetries? University of Delaware Undergraduate Research and Service Celebratory Symposium 2014.
31. **Knarr BA**, Roos MA, Reisman DS. The relationship between walking speed and intensity of daily walking activity in individuals post-stroke. . University of Delaware CBER Day Conference 2014.
32. Khoeilar R, **Knarr BA**, Higginson JS. Muscle Driven Forward Dynamic Simulation of Maximal Vertical Jumping in Three Dimensions. University of Delaware CBER Day Conference 2013.
33. Stanhope VA, **Knarr BA**, Higginson JS. Investigation of Factors associated with Self-Selected Walking Speed in Individuals Post-Stroke. University of Delaware CBER Day Conference 2013.
34. Richardson RT, Thomas KF, **Knarr BA**, Higginson JS. Assessment of Musculoskeletal Models of the Upper Extremity. University of Delaware CBER Day Conference 2013.
35. Seymour KM, Higginson JS, **Knarr BA**. Effect of handrail use on gait patterns in young healthy subjects. University of Delaware CBER Day Conference 2013.
36. **Knarr BA**, Higginson JS. Change in Knee Contact Force Due to Model Kinematics Processing. Center for Biomedical Engineering Research Symposium May 2013, Newark, DE.
37. **Knarr BA**, Zeni JA, Higginson JS. Change in Knee Contact Force with Experimental and Simulated Change in Body Weight. Center for Biomedical Engineering Research Symposium May 2012, Newark, DE.
38. **Knarr BA**, Kesar TM, Helm E, Reisman DS, Binder-Macleod SA, Higginson JS. Evaluation of muscle control strategy changes in post-stroke gait after a functional electrical stimulation intervention using musculoskeletal simulations. Center for Biomedical Engineering Research Symposium May 2010, Newark, DE.
39. **Knarr BA**, Higginson JS. Compensatory Strategies with modeled Muscle Activation Deficiency during Gait. Center for Biomedical Engineering Research Symposium May 2009, Newark, DE.
40. **Knarr BA**, Novotny JE, Zhou H. Finite Element Model of the Biceps Brachii muscle driven by in vivo strain and deformation data. Center for Biomedical Engineering Research Symposium May 2008, Newark, DE.
41. Novotny JE, **Knarr BA**, Zhou H. Strains in the biceps brachii during dynamic elbow flexion show concentric, eccentric and isometric behavior simultaneously. Center for Biomedical Engineering Research Symposium May 2007, Newark, DE.

## MENTORSHIP AND SERVICE

### MENTEES

1. Summer Advisor: Mary Doolin, University of Delaware. Delaware Rehabilitation Institute Summer Scholar 2014.
2. Summer Advisor: Maria Nicholson, University of Delaware. Center for Biomechanical Engineering Research Summer Undergraduate Research Fellowships 2014, 2015
3. Summer Advisor: Gillian McCarren, University of Delaware. Delaware INBRE Summer Scholars Program student from Towson University. 2015.
4. Summer Advisor: William Justice. University of Delaware. Delaware INBRE Summer Scholars Program student from Delaware State University. 2015.
5. Summer Advisor: Michaela Schulman, University of Delaware. Delaware Rehabilitation Institute Summer Scholars. 2015.
6. Summer Advisor: Lydia Zakutney, University of Delaware. 2015
7. Summer Advisor: Collin Patterson, University of Delaware. 2015
8. Senior Design Advisor: Tim West, Michael Schenk, David Schnall, Margaret O'Brien, Melissa Groome University of Delaware 2014.
9. Mentor: Victoria Stanhope, Undergraduate Research, University of Delaware 2012-13
10. Mentor: Laura van der Post, Undergraduate Research, University of Delaware 2012-13

### THESIS COMMITTEES

1. Tyler Richardson – PhD Thesis. *Evaluation of the Effect of Scapular Motion on Musculoskeletal Modeling Of the Shoulder and Upper Extremity (2016)*

### AD-HOC REVIEWER

Journal of Biomechanics  
 Journal of Applied Biomechanics  
 Electromyography and Kinesiology  
 Biomedical Engineering Society

### UNIVERSITY SERVICE

- |                     |  |
|---------------------|--|
| <b>2006-present</b> | Head Coach, University of Delaware Bowling Team  |
| <b>2009-2012</b>    | Session Designer and Instructor, Mathcounts <ul style="list-style-type: none"> <li>• Demonstrating and teaching young children on practical applications of math with a focus on biomechanics.</li> <li>• Developing experiments and modules to demonstrate biomechanical principles and technology</li> </ul> |
| <b>2013</b>         | Session Co-director. Osteoarthritis Research Society International Pre-Symposium. University of Delaware.  |
| <b>2014</b>         | Member, Search Committee, Data Manager for Delaware Rehabilitation Institute   |

### AFFILIATIONS

Professional Memberships  
 American Society of Mechanical Engineers  
 American Heart Association  
 Gait and Clinical Movement Analysis Society  
 American Society of Biomechanics

### HONORS AND MEDIA COVERAGE



## Honors

3<sup>rd</sup> Place, Undergraduate Design Competition. Primary Advisor. Summer Biomechanics, Bioengineering and Biotransport Conference, June 2015, Snowbird Resort, Utah  
Best Graduate Student Poster Award. Center for Biomedical Engineering Research Symposium. May 2007.  
USBC Academic All-American - 2003-04, 2004-05, 2005-06

## Media

Recent work has been featured on multiple media outlets:

**UDaily** 07/14/2015. *SmartBoot: Engineering students add high-tech function to low-tech orthopedic boot*, by Diane Kukich. <http://www.udel.edu/udaily/2016/jul/smartboot-071415.html>

**The O&P EDGE, OANDP.COM.** 07/23/15. *University Students Develop Orthopedic Boot With "Smart" Features.* [http://www.oandp.com/articles/NEWS\\_2015-07-23\\_06.asp](http://www.oandp.com/articles/NEWS_2015-07-23_06.asp)

**Tech Times** 07/17/2015. *University Of Delaware Students Design Boot That Helps Heal Broken Bones*, by J.E. Reich <http://www.techtimes.com/articles/69836/20150717/university-delaware-students-design-boot-helps-heal-broken-bones.htm>

**The Osgood File.** 08/04/15. *A SMARTBOOT TO HEAL INJURED FEET.* [www.theosgoodfile.com](http://www.theosgoodfile.com). Show archive: <http://www.westwood-backup.com/pg/jsp/osgood/transcript.jsp?pid=41273>

**The Philadelphia Inquirer. Philly.com.** 11/08/2015. *High-tech boot could speed healing*, by Tom Avril. [http://articles.philly.com/2015-11-09/news/68110626\\_1\\_higginson-patients-sensors](http://articles.philly.com/2015-11-09/news/68110626_1_higginson-patients-sensors)