

J. ALEX BIRDWELL, PHD

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I am a mechanical engineer with expertise in electro-mechanical design, rehabilitation engineering, robotics, project management, curriculum and course design, and academic advising. I am fully capable of overseeing design projects from conception through realization, working across disciplines to efficiently and effectively manage multiple objectives on tight deadlines, and guiding students to creating their path during, through, and beyond their undergraduate tenure. I apply my foundational knowledge and detail-oriented work ethic towards conducting education-based and applied research, teaching avid learners, and creating innovative methods to improve educational outcomes.

EDUCATION

Northwestern University, Center for Bionic Medicine, Rehabilitation Institute of Chicago, Chicago, IL

Doctor of Philosophy (Ph.D.), Mechanical Engineering March 2012

Committee: Drs. J. Edward Colgate, Levi Hargrove, Todd Kuiken M.D. Ph.D. (chair), Wendy M. Murray, Michael A. Peshkin, Richard F. ff. Weir

Thesis: *Investigation of Extrinsic Finger and Thumb Muscles to Command Individual Digits on a Multi-Functional Artificial Hand*

Focus: Quantified extrinsic finger and thumb muscle independence. Developed and tested a novel prosthesis controller that allowed for functional grasping postures and individual digit control on a multi-functional artificial hand.

Northwestern University, Evanston, IL

Master of Science (M.S.), Mechanical Engineering December 2006

Committee: Drs. Mitra J. Hartmann (Chair) and Michael A. Peshkin

Thesis: *A Biomechanical Model for Deflected Rat Vibrissae*

Focus: Developed a model that predicted how rat whiskers deflect when contacting objects. This work aided the understanding of how rats navigate and extract object features. Developed mechanical whiskers used for tactile feature extraction on a mobile robot prototype.

Georgia Institute of Technology, Atlanta, GA

Bachelor of Science (B.S.), Mechanical Engineering May 2004

Focus: Biomechanics, Robotics, and Mechatronics

Senior Project: Designed, built, and competed a mobile robot for ASME robotics competition. Our four-wheel drive robot was able to raise/lower its chassis to navigate obstacles, collect and transport various sized objects, and ran off custom software and a machined circuit board we designed and fabricated.

PROJECT MANAGEMENT & CLASSROOM EXPERIENCES

Northwestern University, Dept. of Mechanical Engineering & The Segal Design Institute, Evanston, IL

Lecturer (formerly), Assistant Professor of Instruction, Academic Advisor

July 2012 – Present

DSGN 106 – Design Thinking and Communication (DTC)

- Collaborated across departments to manage 400+ engineering students as a core faculty member
- Created online instructional videos for teaching technical sketching techniques
- Taught students to create, scale, and proportion mechanical drawings and build prototypes
- Supervised students through the design process working with real-world clients
- Coordinated client interviews and user testing with students to get feedback on their prototype designs
- Advised students through project definition, alternative design evaluation, and final design presentation
- Co-Instructed with a communications professor to teach report writing and presentation delivery

ME 398 – Mechanical Engineering Capstone Design

- Taught and advised senior teams through the mechanical-design process across 20-week project
- Oversaw weekly progress meetings with student teams to assist and guide their project
- Coordinated course with co-instructor and teaching assistants, devised grading rubrics and assignments
- Conducted and facilitated client meetings regarding project procurement, development, and funding
- Advised on all aspects of student projects including manufacturing, design, testing, teamwork, and assessments
- Course deliverables included weekly written progress reports, team presentations, mock-ups, and alpha-level prototypes

ME 240 – Introduction to Mechanical Design and Manufacturing

- Managed three instructors, five TAs, 100 students, shop managers, weekly labs, and course logistics
- Taught students Geometric Dimensioning and Tolerancing (GD&T), engineering drawing specifications, material selection and testing procedures, and failure mode analysis
- Advised student groups through final project of designing a metal bracket that must withstand a specified load and fit within a constrained fixture using a variety of selectable sheet metals

ME 340-1 – Computer Integrated Manufacturing: Manufacturing Processes

- Managed 100 students, two TAs, five graders, lectures, weekly lab coordination, and shop logistics
- Covered an introduction to manufacturing processes including casting, machining, injection molding, forging, bulk deformation, joining, and rapid prototyping
- Re-designed lecture notes from PowerPoint slides to a combination board notes, example problems, modern video examples of manufacturing processes, and online mini-lectures
- Created weekly homework sets, exams, and rapid-prototyping laboratory

ME 220 – Thermodynamics

- Requested by department chair to teach the course to improve quality of its instruction
- Re-designed the course from ground-up including syllabus, lectures, homework, examples, and exams
- Worked with previous professor to facilitate the transition, then taught course for two quarters
- Significantly increased overall course rating, instructional quality, and learned content

ME 224 – Experimental Engineering

- Managed 40 students, two teaching assistants, and lab staff
- Taught analog/digit circuit design and analysis, filtering & amplification theory
- Re-designed weekly labs to focus on experiment design, data acquisition & analysis, and innovation
- Heavy emphasis on technical report writing through four major reports with extensive feedback

ME 399 – Independent Study Projects for Undergraduates

- Supervised one-quarter research and design projects
- Remotely Operated Vehicle (ROV) using Raspberry Pi, wife enabled RC car, and digital camera
- Darwin-OP humanoid robot interface, control, and software performance evaluation
- Three degree-of-freedom (DoF) arm to assist wheelchair users with dropped item collection
- Development of training module and project documentation for the Robotics Lacrosse Goalie project

Advising and Student Engagement

- Academic advisor for first-year and prospective engineering students
- Guide students on courses, major selection, career opportunities, & college-life adjustment
- Organized and hosted career advising seminar for mechanical engineering upper classmen
- Worked on IGNITE pilot programs specifically focused on advising first-year students (now First-Year Experience)
- Faculty fellow for Ayers College of Commerce and Industry (CCI) residence college
- Co-advisor for Robotics Club – directly advise humanoid robot group working with Darwin-OP

SIGNIFICANT DESIGN PROJECTS*Human-Centered Design Instructor – Projects with Shirley Ryan AbilityLab*

2012-Present

- Student Projects Advised
 - Devices that allow independent pants donning
 - Wheelchair adaptations that improved posture/comfort and prevented lateral leaning
 - One-handed bra clasp adapters for people with hemiplegia
 - Occupational therapy workstations to train hand prehension
 - Variable resistance trainer for wheelchair athletes and physical therapy patients
 - Adjustable alignment system for pediatric patients undergoing gait therapy training

Virtual Prosthetic Hand Control – PhD Thesis

2007 – 2012

- Developed interface for three-DoF virtual hand for real-time control from a human user
- Compared performance of two control paradigms: pattern recognition and direct-myoelectric control
- Demonstrated functional grasps were achievable under both control paradigms
- Determined viable muscles that served as control inputs to interface the human-user with the VR hand
- Managed project and conducted experiments with 30 human subject volunteers

Mechanical Whisker – MS Projects

2004 – 2006

- Developed, built, and characterized a mechanical whisker that detected 2D deflection at its base
- Modeled after rat vibrissae (whisker) follicle and initially funded by JPL Mars Rover Project
- Created 2x4 printed circuit board whisker array and attached to mobile robot for sensor fusion projects
 - Whisker array used to identify surface terrain features and combined with wheel-encoder data to determine ground velocity, wheel-slippage, and localized sensing
- Whisker attached to prosthetic hand and created slip-detectors that automatically increased grip force upon detecting object slippage

Powered Finger Exoskeleton – Mechatronics Project

Fall 2004

- Designed a single-finger one-DoF servomotor powered sleeve that assisted flexion/extension
- Flex sensors detected the onset of your fingers motion and activated the DC servomotor
- Power to the motor was scaled based on the amount of flex sensor deflection
- Machined the exoskeleton from steel tubing and the linkage from 0.25” aluminum sheet

ASME Mobile Robot Design Competition – Senior Design Project

Spring 2004

- Electro-mechanical design and fabrication of all aspects of mobile robot for ASME Design Competition
- Collaborated in a team of three for senior design and mechatronics senior elective courses
- Designed and machined our circuit board from copper sheet
- Programmed HC11 microcontroller to drive DC and stepper motors for locomotion & object traversal/collection
- Mobile robot was capable of raising/lowering chassis and collecting objects with extendable arm

Tic-Tac-Toe Robot – Final Project Robotics Senior Elective Course

Fall 2003

- Designed & Build serial 3-DoF arm with gray scale vision to play Tic-Tac-Toe against human player
- Wrote strategy algorithm in Matlab for decision making process and optimal move selection
- Created vision identification system to differentiate black circle pieces from white “X” pieces

WORK EXPERIENCE*Lightboard – Manager & Consultant, Northwestern University, Evanston, IL*

2013 – 2016

- Trained faculty, students, and clients to use the Lightboard and make their own video
- Assisted users of the Lightboard with developing their lectures, editing their videos, and uploading their content for their course or project
- Maintained and improved lights, video switching/editing equipment, macro-filming booth
- Awarded \$3000 grant to implement studio equipment upgrades and improvement
- Consulted with ~30 institutions to assist them with building their own Lightboard studio

Bioengineering Research Intern, Clemson University, Clemson, SC

Summer 2003

- Determined internal muscle forces acting about the knee using a Biodex system
- Created a model that estimates internal muscle forces acting about the knee during activity
- Expanded the on-going study of wear in total-knee-replacement implants

Mechanical Engineering Intern, Alstom Power Inc., Knoxville, TN

Summer 2001

- Standardized company-wide process flow-sheets for coal burning power plants
- Experimentally analyzed the flow-rate efficiency and limitations of a distributor nozzle
- Instigated a re-design that allowed for higher flow-rates and a more even flow-distribution

Bicycle Mechanic, West Bicycles & River Sports Outfitters, Knoxville, TN

Summer 2002/2004

- Conducted appraisals, builds, and repairs for all bicycle makes and models
- Provided exceptional customer service for bicycles, maintenance, equipment, and sale

PEER-REVIEWED PUBLICATIONS

Birdwell JA, Hargrove LJ, Weir RF, and Kuiken RA. Extrinsic Finger and Thumb Muscles Command a Virtual Hand to Allow Individual Finger and Grasp Control. *IEEE Transactions on Biomedical Engineering*. 62(1): 218-226. 2014.

Cipriani, C, Segil, JL, **Birdwell JA**, Weir RF. Dexterous Control of a Prosthetic Hand Using Fine-Wire Intramuscular Electrodes in Targeted Extrinsic Muscles. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. 22(4): 828-836. 2014.

Birdwell JA, Hargrove LJ, Kuiken TA, and Weir RF. Activation of individual extrinsic thumb muscles and compartments of extrinsic finger muscles. *Journal of Neurophysiology*. 110(6): 1385-1392. 2013.

Birdwell JA, Solomon JH, Thajchayapong M, Taylor MA, Cheely M, Towal RB, Conradt J, and Hartmann MJZ. Biomechanical models for radial distance determination by the rat vibrissal system. *Journal of Neurophysiol* 98: 2439-2455. 2007. **The model presented in this paper is now referred to, within the research community, as “The Birdwell Model.”**

CONFERENCE PROCEEDINGS AND PRESENTATIONS

Bacon HKK, **Birdwell JA**, Brown O, Tevaarwerk E, Freeman RW, Roldan W, Gentry KL, and Pokryfky AR. Academic Advising and Student Affairs Working Together to Improve First-year Experience of Engineering Students. *125th Annual Confernece of ASEE*. Salt Lake City, UT USA, June 24-27, 2018.

Freeman RW, **Birdwell JA**, Tevaarwerk E, Gentry KL, and Brown O. Engineering and Technology Literacy Introduced in Cornerstone Design Courses. *125th Annual Confernece of ASEE*. Salt Lake City, UT USA, June 24-27, 2018.

DeCosta ET, **Birdwell JA**, Gentry KL, Freeman RW, and Wolff AR. Work in Progress: Analyzing student outcomes to inform first-year advising practices and policies at Northwestern University’s McCormick School of Engineering. *124th Annual Confernece of ASEE*. Columbus, OH USA, June 25-28, 2017.

Birdwell JA and Peshkin MA. Capturing Technical Lectures on Lightboard. *122nd Annual Conference of ASEE*. Seattle, WA USA, June 14-17, 2015.

Birdwell JA, Hargrove LJ, Weir RF. Quantification of Isolated Muscle Compartment Activity in Extrinsic Finger Muscles for Potential Prosthesis Control Sites. *33RD Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, Boston, USA, 2011.

Birdwell, JA, Weir, RF (2010). “Examining activity of extrinsic finger muscle compartments to serve as inputs to directly control individual DoF of a multifunctional prosthetic hand”. *13th International Society of Prosthetics and Orthotics World Congress*. Leipzig, Germany, May 10-15, 2010.

Birdwell, JA, Weir, RF (2008). “Development of a Multifunctional Prosthesis Controller: Musculoskeletal Models to Direct Myocontrol”. *Biomedical Engineering Research Day at Northwestern University*. Evanston, IL, September 19, 2008.

Birdwell, JA, Weir, RF (2008). “Biomechanical Modeling”. *Proceedings of The 32nd Annual Great Lakes Biomedical Conference*. Racine, WI, April 18, 2008.

Birdwell, JA, Weir, RF (2007). “Hill-based musculo-skeletal hand models for controlling multi-DoF hand prostheses”. *Proceedings of the 2007 Meeting of the Society for Neuroscience*. San Diego, CA, Nov 2-7, 2007.

Birdwell, JA, Hartmann, MJ (2006). “A biomechanical model of rat vibrissae that permits radial distance detection”. *Proceedings of the 2007 Meeting of the Society for Neuroscience*. Atlanta, GA, Oct 14-18, 2006.

INVITED PRESENTATIONS

“McCormick Classroom Experience” *Northwestern Family Weekend*. Evanston, IL, October 18, 2013.

“Biomechanical Modeling”. *The 32nd Annual Great Lakes Biomedical Conference*. Racine, WI, April 18, 2008.

PROFESSIONAL DEVELOPMENT

Change Makers Program for Northwestern Faculty. Two years training in Intergroup Dialogue to increase Diversity, Inclusion, and Equity. Participated in monthly meetings hosted by the Women's Center of Northwestern University. AY 2016-2018.

Intergroup Relations Institute at University of Michigan. Conference for faculty and staff to learn about the philosophy and techniques from the Intergroup Relations program for the purpose of creating dialogue programs at home institutions. Ann Arbor, MI. June 19-22, 2017.

“Advanced Professional and Presentation Skills for Engineers.” Six-week course offered to competitively selected applicants from the McCormick School of Engineering. Spring 2011.

“The Three Laws of Communication” workshop hosted by Jean-Luc Dumont, Ph.D., author of *Trees, Maps, and Theorems: Effective Communication for Rational Minds*. March 2011.

FELLOWSHIPS AND AWARDS

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| Cole-Higgins Award for Excellence in Advising, McCormick School of Engineering | 2015-2016 |
| Associated Student Government Faculty Honor Roll | 2013-2014, 2016-2017 |
| “Advanced Professional and Presentation Skills for Engineers” – Mech. Eng. Dept. Award | 2011 |

GRANTS AWARDED

The Undergraduate Research Assistant Program - \$2250 December 2015 - June 2016

Title: Wifi Enabled Remotely Operated Vehicle (ROV)

Authors: **Birdwell JA**

Purpose: This project aims to train two students, with no prior research experience, in the foundational techniques of conducting basic research, executing a complex design process, and developing a novel electro-mechanical platform to test control theories regarding information delay and remotely operated semi-autonomous vehicle navigation.

Results: Two sophomore EECS students were hired in Jan. 2016 and have completed background research on equipment specifications, drafted project goals and timelines, and established protocols for documentation of progress, code, and results. We aim to have customized control of the vehicle by end of winter term and wifi communication by end of spring term.

The Alumnae of Northwestern University - \$3000 March 2014

Title: Lightboard Recording Studio.

Authors: **Birdwell JA** and Peshkin MA.

Amount Requested: \$6300 for equipment, renovations, and hiring an undergraduate work-study student.

Results: Managed student who designed, fabricated, and installed lighting upgrades. Producers table was renovated for ergonomics, computer upgrades, and remote recording capabilities.

The Alumnae of Northwestern University - \$2000 March 2014

Title: Mechatronic Sensors and Actuators Course

Authors: Marchuk ND and **Birdwell JA**

Amount Requested: \$6975 for course development materials, desktop data acquisition equipment, various electrical motors and sensors for laboratory kits and class demonstrations, and electrical circuit components, breadboards, wire jumper kits.

Results: Course outline developed and many online modules recorded. Currently being used by NU Robotics club and materials being considered for ME 433 – Advanced Mechatronics course.

DEPARTMENTAL & PROFESSIONAL SERVICE

Design Thinking and Communication (DTC)

AY 2016-2018

- Co-directorship transition with Bruce Ankenman (AY2017-2019)
 - Coordinate project recruitment, evaluation, and assignments with Ms. DeYandre Thaxton
 - Co-lead DTC faculty meetings, teaching assignments, shop training logistics, & syllabus
 - Collaborated on development of new Teamwork survey tool from Leadership Center
- Created and reviewed Learning Objectives (LO) with Dr. Kathleen Carmichael from Writing Program
- Created, piloted, and implemented new shop training focused on prototyping and mock-up skills
- Collaborated across disciplines to implement automated training sign-up and assessment

Mechanical Engineering ‘Education Revolution’ Committee

2013-2016

- Advised department on curriculum and advising model modifications to improve educational outcomes
- Surveyed undergraduate students to obtain feedback on current system’s strengths and weaknesses
- Presented suggestions at faculty meetings and implemented changes after faculty’s vote of approval
- Ideas have included: expanding capstone design from one to two quarters, creating a programming-intensive freshman engineering course, and hiring a CAD instructor to bolster manufacturing course

Mechanical Engineering Website

2012

- Compiled faculty webpage information including publications, course offerings, & research statements
- Coordinated with IT department to transition mechanical engineering site to new McCormick format
- Systematically updated all departmental webpage information during transition
- Assisted in curriculum outlines, descriptions, diagrams, and write-ups for undergraduate curriculum

Mechanical Engineering Graduate Student Society, Executive Committee

2004 – 2006

- Organized weekly networking events for department faculty, students, & staff
- Managed a \$4,000 annual budget with quarterly reports to the department head
- Organized departmental functions such as new student events, quarterly socials, and summer cookouts
- Maintained society website, meeting minutes, agendas, and member profiles

SKILLS, PROFICIENCIES, AND OTHER INTERESTS

Facilitator for Intergroup Dialogue – Intergroup dialogue for inclusion, diversity, & equity

Signal Processing & Analysis – Extensive experience in signal filtering and processing

Bioinstrumentation – Expert in surface and intramuscular electromyography (EMG)

Modeling – Able to develop and evaluate analytic and numerical models, including real-time simulations

Design, Prototyping, and Development – Circuit/mechanical design/fabrication, machine shop certified

Computer Aided Design (CAD) – Siemens NX software package, Printed Circuit Board (PCB) design

Human & Animal Research – Approved by Northwestern’s Institutional Animal Care and Use Committee (animal research) and Institutional Review Board (human research) during graduate work

Software – MATLAB, LabVIEW, SIMM (musculoskeletal modeling software), Microsoft Office suite, Mac & Windows

Extra-curricular Activities - Bicycle mechanic and cyclist, wheel-thrown pottery, ultimate frisbee, SCUBA certified

PROFESSIONAL AFFILIATIONS

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| American Society of Mechanical Engineers (ASME) | Since 2002 |
| Pi Tau Sigma (international mechanical engineering honors society) | Since 2003 |
| Institute of Electrical and Electronics Engineers (IEEE) | Since 2011 |
| American Society for Engineering Education (ASEE) | Since 2013 |