

# Matthew Carney

## Curriculum Vitae

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### Education

- 2015 – Present **Massachusetts Institute of Technology**, Cambridge, MA,  
*Doctor of Philosophy Media Arts and Sciences*, to be conferred 2019.
- 2013 – 2015 **Massachusetts Institute of Technology**, Cambridge, MA,  
*Master of Science Media Arts and Sciences*, conferred September 2015.
- 2006–2008 **University of California Berkeley**, Berkeley, CA,  
*Master of Science Mechanical Engineering*, conferred May 2008.
- 2001–2004 **California Polytechnic State University**, San Luis Obispo, CA,  
*Bachelor of Science Mechanical Engineering*, conferred December 2004.
- 2002-2003 **Fachhochschule München**, Munich, Germany,  
*Maschinenbau*, exchange student.

### Research Experience

2016–Present **Graduate Student Research Assistant**, MIT, Cambridge, MA.  
MIT Media Lab: Biomechatronics Group

- Engineered from blank-sheet-to-working-system three novel lower extremity powered prostheses.
- Designed, built, user-tested TF8, a novel series elastic actuator (SEA) for dynamic walking powered prostheses (robotic legs).
- Designed novel multi-dof, autonomous and neurally-controlled, powered prostheses for below knee (transtibial) and above knee (transfemoral amputation).
- Interfaced with domestic and international manufacturing partners to build fully integrated hardware, including custom motors.
- Implemented a mechatronic network of sensors and actuators for multi-dof bionic prosthetic legs.
- Programmed low-level torque, impedance control, and autonomous intrinsic reflexive state machine controllers for multi-dof robotic prosthetic legs.
- Mentored & Collaborated with young student engineer to build EMG controlled, two degree-of-freedom rock climbing ankle.
- Mentored a young engineer to revise the design of a two degree-of-freedom walking ankle.
- Mentored eight undergraduate research students.
- Managed a team of four young engineers to support the rapid build of: a rock climbing ankle, EMG system, and my own dynamic walking ankle (TF8 Actuator).
- Specified and managed the build of a new embedded system infrastructure for lab-wide use.

2013–2016 **Graduate Student Researcher**, MIT, Cambridge, MA.

The Center for Bits and Atoms.

- Developed numerous robotic assembly machines integrating kinematics of robot and material.
- Developed a vast array of reusable, mechanical interfaces for interlocking structural mechanisms.
- Manufactured 5000 units of injection molded discrete lattice elements.
- Designed and machined multiple robotic assembler systems.
- Researched robotic assembly of discrete cellular lattices (digital materials) for large space structures.
- Shop guru support for MAS863-How to Make (Almost) Anything.
- Mentored two undergraduate research students (UROPs) for three years.

2007–2008 **Graduate Student Researcher**, UC BERKELEY, Berkeley, CA.

The Medical Polymers Group in the Mechanical Engineering Department.

- Designed and machined a scalable multi-axis tribological testing machine for examining wear properties of artificial, implantable, load-bearing devices, i.e. hips and knees.
- Integrated data acquisition systems for real-time measurements and feedback using LabView.
- Constructed a motion control system with pneumatic and electric actuators.

2001–2002 **Plastics Lab Technician**, CALPOLY, San Luis Obispo, CA.

Plastics lab run by the Manufacturing Engineering Department where students learn about modern plastics manufacturing processes and equipment.

- Repaired Machinery including: 2 Injection Molders, Thermoformer, Blow Molder, Rotational Molder, Single Screw Extruder, Engraver, Compression Molder, Ovens.
- Fabricated acrylic components.
- Produced polyester castings.
- Managed miscellaneous Lab wiring and upkeep.
- Instructed students how to utilize manufacturing processes.

2001 **Research Assistant**, CALPOLY, San Luis Obispo, CA.

Physics Department.

- Performed Dip-Pen Nanolithography using an Atomic Force Microscope.
- Developed a temperature control system with Peltier heat pump and LabView.
- Examined effects of acetonitrile in lowering boiling points of MHA and ODT.
- Deposited Au and Ti on Si wafers in Ultra High Vacuum Vapor Deposition.

### Teaching Experience

2007–2008 **Graduate Student Instructor**, UC BERKELEY, Berkeley, CA.

TA and taught courses in the Mechanical Engineering Department.

- ME 164: Marine Statics and Structures (Spring 2007) - TA.
- ME 107A: Measurement and Experimentation (Spring 2008) - Lab Instructor.

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### Literature

- 2018 Carney, Matthew E., Herr, Hugh M. "On the Design of Moment Coupled Series Elastic Actuators." Manuscript in preparation.
- 2018 Stolyarov, Roman\*, Carney, Matthew\*, and Herr, Hugh "Automatic, Incremental Learning of Terrain Transitions in a Powered Below-Knee Prosthesis." Manuscript submitted for publication. \*Equally contributing authors.

- 2018 Clites, T. R., Carty, M. J., Ullauri, J. B., Carney, M. E., Mooney, L. M., Duval, J.-F., . . . Herr, H. M. (2018). "Proprioception from a neurally controlled lower-extremity prosthesis." *Sci. Transl. Med*, 10(30).
- 2016 Carney, Matthew, Jenett, Benjamin, "Relative Robots: Scaling Automated Assembly of Discrete Cellular Lattices." *ASME Conference Proceedings MSEC 2016*
- 2015 Carney, Matthew Eli. 2015. "Discrete Cellular Lattice Assembly." Massachusetts Institute of Technology. Masters Thesis.
- 2015 N. Gershenfeld, M. Carney, B. Jenett, S. Calisch, S. Wilson, "Macrofabrication with Digital Materials: Robotic Assembly." *Architectural Design*, (85), pp. 122-127.
- 2011 Patten, Eli W., Carney, Matthew, "A Multi-Directional Tribo-System: Testing the Wear of UHMWPE under Sliding, Rolling and Rotation." *ASME Summer Bioengineering Conference*, June 2011. SBC2011-53616
- 2008 Carney, Matthew Eli. 2008. "A Multi-Axial Tribo-System: Developing a Rolling, Sliding, and Rotation Tribological Testing Machine for Assessment of Total Joint Replacements." UC Berkeley. Masters Thesis.

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### Patents - Issued

- 2018 Magnusson, L., Carney, M., Edsinger, A., Weber, J., & Mullins, P., "Low Cost Block and Tackle Robot Transmission." *US Patent 10,018,256*.
- 2016 Carney, Matthew, Jenett, Benjamin, Gershenfeld, Neil, "Digital Material Assembly by Passive Means and Modular Isotropic Lattice Extruder Systems." *US Patent 9,809,977*
- 2013 Carney, Matthew, Edsinger, Aaron, "Embedded Encoder for an Outrunner Brushless Motor." *US Patent 9,509,195*

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### Patents - Applications

- 2018 Herr, Hugh M., Carney, Matthew E., Rogers, Emily, Yeon, Seong Ho, Stolyarov, Roman, "Neural Efferent and Afferent Control of Spring Equilibrium, Damping, and Power in Backdrivable and Non-Backdrivable Series-Elastic Actuators Comprising Variable Series Stiffness Mechanisms." *US Patent Application No. 62/749,230(2018)*.
- 2018 Herr, Hugh M., Moerman, Kevin M., Solav, Dana, Ranger, Bryan J., Steinmeyer, Rebecca, Ku, Stephanie Lai, Carney, Matthew, Dagdeviren, Canan, "Quantitative Design And Manufacturing Framework For A Biomechanical Interface Contacting A Biological Body Segment." *US Patent Application 62/629,528*
- 2017 Herr, Hugh M., Stolyarov, Roman, Mooney, Luke M., Carney, Matthew, Taylor, Cameron, "Kinetic Sensing, Signal Generation, Feature Extraction, And Pattern Recognition For Control Of Autonomous Wearable Leg Devicesitem description." *US Patent Application 2017/60710*
- 2016 Langford, William, Carney, Matthew, Jenett, Benjamin, Gershenfeld, Neil, "Discrete Assemblers Utilizing Conventional Motion Systems." *US Patent Application 2016/028806*
- 2015 Fracchia, Charles, Carney, Matthew, Jacobson, Joe, "Methods and Apparatus for Pipetting." *US Patent Application 2015/083706*
- 2014 Peek, Nadya, Langford, William, Gershenfeld, Neil, Carney, Matthew, "Discrete Motion System." *US Patent Application 2014/199,698*
- 2013 Magnusson, Lee, Carney, Matthew, Edsinger, Aaron, "Low Cost Block and Tackle Robot Transmission." *US Patent Application Number 14/061,669*.

2006 Carney, Matthew "Energy Capture in Flowing Fluids." U.S. Patent Application Number 11/509,667. 25 August 2006.

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## Industry Experience

2011–2013 **Lead Mechanical Design Engineer**, MEKA ROBOTICS/ REDWOOD ROBOTICS, San Francisco, CA.

Meka Robotics designs human-safe, force-controlled, humanoid robotics for artificial intelligence research. Redwood Robotics designs low-cost, human-safe robotics for light industrial manufacturing. Meka and Redwood were both acquired by Google[x] late 2013.

- Blank-sheet design and construction of 7 DOF, force controlled humanoid arm with novel block and tackle actuation.
- Implemented Master Sketch modeling framework for rapid development and deployment.
- Researched, designed, and built anti-backlash, high-efficiency actuators.
- Managed a team of five engineers to build handfuls of new production robotic arms.
- Free body diagrams of loading conditions.
- Finite element modeling of most structures.
- Designed and built thousands of parts and hundreds of assemblies each year.
- Optimized, designed, built load bearing structures made of non-conventional means.
- Machined and assembled precision components.

2010–2011 **Mechanical Design Engineer (Senior Designer)**, IDEO, Palo Alto, CA.

Product design consultancy implementing design thinking.

- Primary design engineer of a high volume (>10k units/month) consumer electronic product utilizing all the tricks and trades of a modern technology.
- Designed for manufacture all internal components of this device, heavy in surface modeling and tolerance analysis. Manufacture methods include: injection mold, die cut, overmold, thixotropic molding, flexible circuits.
- Specified major components such as acoustics, imaging systems, displays, touch panels, etc.
- Interfaced directly with international hardware partners, vendors, manufacturers.
- Traveled overseas to collaborate directly with hardware partners.
- Interacted and balanced engineering needs with industrial design requirements.

2009–2010 **Mechanical Design Engineer**, MEKA ROBOTICS, San Francisco, CA.

Meka Robotics designs humanoid robotics for artificial intelligence research.

- Re-designed 14 out of 37 degrees of freedom of the Mekabot M1 Manipulator for robustness and maintainability (excluding the arm actuators).
- Designed from scratch the 4 dof neck of S2R1.
- Re-designed for strength, power usage, maintainability, cost reduction, etc. the first 4 dof (J0-J3) of the 7 dof arm versions A2R1, and A2R2.
- Calculated expected and worst case loading conditions and specified appropriate motor, gear-train, load sensors, and material properties based on hand and FEA calculations.
- Prepared engineering drawings, exploded views and build books for manufacture of 20 dof.
- Machined and assembled precision components.

2008–2009 **Mechanical Engineer**, MAKANI POWER, Alameda, CA.

Makani is building autonomous flying kites to harvest energy from the wind. Makani was fully acquired by Google[x] early in 2013.

- Designed and machined all mechanical components and experiments for Energy Systems Group.
- Designed, analyzed, optimized, and fabricated high-voltage power electronics packaging: PCB layout and load bearing support structures integrated with designs from other engineering groups for use in high-performance aerodynamic maneuvers and power generation.
- Developed, calculated and optimized thermal analysis and machined the corresponding heatsink for power electronics IGBT switching modules (still flying on Wing 7).
- Designed and fabricated a six-axis load cell (multi-component balance) for in-flight force measurements using strain gauges. Also designed/fabricated a torque transducer for a DC motor dynamometer.
- Programmed automatic system identification routines for analyzing controller-to-motor transfer functions with LabView and LabJack data acquisition systems.
- Performed numerous technical experiments and analyzed results including rewiring a 12 pole motor.

2005–2006 **R&D Engineer**, THE POLYMER TECHNOLOGY GROUP, Berkeley, CA.

Research and manufacturing of short and long-term implanted medical polymers, coatings, drug delivery materials and devices. PTG was acquired by DSM in 2009.

- Lead engineer for two implantable medical device projects following ISO 9001:2000 methods.
- Trained technicians on manufacturing processes.
- Procured, installed, operated and qualified 55-ton injection molding machine, auxiliary equipment and ISO Class 7 Cleanroom.
- Designed and fabricated fixture equipment for manufacture of implantable medical devices.
- Developed experiments for manufacturing processes and analysis of material properties.
- Quoted short and long-term projects, particularly involving injection molding.

2000 **Web Programmer**, CUTTOOLS.COM, Oakland, CA.

Online distributor of manufacturing consumables, i.e. endmills, drills, abrasives, etc.. This was ahead of its time and did not survive the dotcom bust.

- Programmed Javascript for Parametric Search Algorithms and Dynamic Page Content.
- Designed and Programmed Emachinetool & Cuttools shopping cart integration.
- Executed SQL database programming for IBM DB2.
- Managed optimizing prewritten code and design of new features.
- Programmed Coldfusion for E-commerce applications.
- Optimized local and remote server operations and data transfer.
- Developed graphics design using Adobe Photoshop.

### Summer Internships

2007 **R&D Engineering Intern**, MONTEREY BAY AQUARIUM RESEARCH INSTITUTE, Moss Landing, CA.

MBARI is devoted to exploring the depths of the ocean through the development of science and engineering research and tools.

- Designed and executed experiments examining the feasibility of renewable wave energy extraction for persistent ocean-based vertical profiling instrumentation.
- Implemented hybrid electro-hydraulic regenerative torque mechanism.

- 1996–1999, **Device Manufacturing Intern**, THE POLYMER TECHNOLOGY GROUP, Berkeley, CA.  
2004 Research and manufacturing of short and long-term implanted medical polymers, coatings, drug delivery materials and devices. PTG was acquired by DSM in 2009.
- Developed testing devices and procedures for membrane desalination technology.
  - Designed and constructed an environmentally controlled cure-box.
  - Researched membrane processes and reported results in official documents.
  - Produced Design Control binder and documents for ISO 9001 certification.
  - Operated Haake Twin-Screw Extruder and Pelletizer and 24ft Kraemer web coating in ISO Class 7 cleanroom.
  - Conducted chemical synthesis of Segmented/Silicone Polyurethane.
  - Maintained 300, 500, 1000 gallon chemical reactors.
  - Assembled 1 soft-walled ISO Class 7 clean room, and 1 walk-in freezer.
- 2002 **CFD Intern**, BECHTEL NATIONAL, San Francisco, CA.  
Large project engineering firm.
- Performed Post-Process imaging of Computational Fluid Dynamics with FieldView 9.
  - Produced high-resolution computer simulations using Lightwave.
  - Developed method of integrating 3D motion-capture data with 3D Lightwave models.
  - Created two massive 5x8ft poster graphics for Technology in Engineering conference (awarded best poster in conference).
  - Learned Meshing and Pre-Processing with FLUENT CFD software.

## Volunteer

- 2009 **Volunteer Drafting Engineer**, CITY OF OAKLAND DIVISION OF BICYCLES AND PEDESTRIAN FACILITIES, Oakland, CA.  
This division is responsible for implementation of the city Master Bicycle Plan.
- Volunteered every Monday helping implement City of Oakland Master Bicycle Plan.
  - Designed official AutoCAD engineering drawings with new street striping to include the bike lanes defined in the Master Plan and following California State vehicle codes.
- 2001–2004 **Radio DJ**, KCPR 91.3FM, San Luis Obispo, CA.  
CalPoly public radio.
- Disc Jockeyed a weekly special format (heavy metal, deathmetal) radio show, called Slaytanic Carnage.
  - Co-Hosted a weekly political talk show called Political Apathy.
  - Organized and produced numerous shows and concerts with live bands.
  - Produced many public service announcements.

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## Awards

- 2013 Most Valuable Engineer - student robotics project class  
2008 Outstanding Graduate Student Instructor  
2007 Science Technology Engineering and Policy (STEP) Travel Grant  
2006 Jaehne Fellowship

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## Press/Media

- 2018 Amtrak Magazine – The National. "[The Land of What If.](#)"  
2018 Martin Trust MIT Center for Entrepreneurship: [MIT Innovators Interview](#)

- 2018 Soundsphere Magazine [Tech Spotlight: Matt Carney](#)
- 2017 Oesterreich Radio ORF Article: [Eine Maschine, die alles kann](#)
- 2017 Alpbach Forum Buzz: [An automatic future by design](#)

## Speaking Events

- 2017 EmTech France - Keynote, "[Designing Robots To Transform Our Way of Life.](#)"
- 2017 Fablab Festival, "Prostheses: robotic design, personal fabrication."
- 2016 Alpbach European Forum - Technology Symposium Keynote, "[Simplicity to Enable Complexity in Future Autonomous Production Systems.](#)"
- 2014 TEDxBeaconstreet, "[Robotic Design for Automated Manufacture.](#)"
- 2014 Google Solve<x>, "Robotic Design for Automated Manufacture."
- 2014 Solidcon, "Relative Robotics: Autonomous Digital Assembly of Reconfigurable and Arbitrarily Sized Structures."
- 2013 LeadAmerica, "Build Cool Shit!"
- 2012 LeadAmerica, "Build Cool Shit!"
- 2011 LeadAmerica, "Build Cool Shit!"

## Lectures

- 2018 Mechanical Design for Electronic Components - Class Lecture MAS.S70 - Audio-Electronic Products Design
- 2018 Mechanical Design and FBDs for Zero Gravity - Class Lecture MAS.S64 - Zero Gravity Flight Class
- 2015 Advanced Solidworks - Class Lecture for MAS863 - How to Make Almost Anything

## Societies

- 2006–2007 Secretary, Society of Naval Architects and Marine Engineers
- 1999–2000 President, Society of Engineering Students
- 2001–Present Member, American Society of Mechanical Engineers
- 2017–Present Member, IEEE

## Skills

- Machines Machining (Mill and Lathe), MIG/TIG/Gas Welding, Surface-mount Soldering, Circuit Board Layout, Twin-Screw Extrusion of Polymers, 24ft Kraemer Polymer Film Coating Machine, Polymer Synthesis, Iron Blacksmithing, Atomic Force Microscope, UHV Vapor Deposition, Thermoforming, Rotational Molding, Injection Molding-Arburg 320C, Wind Tunnel, Waterjet, Wire EDM, 3-axis & 5-axis CNC (Haas, Hurco) .
- Hardware IBM Compatible from 8086-Pentium IV, Mac OS7.5, PIC, AVR & Arduino uController, DC & BLDC Motors, Strain Gages, Thermocouples, STM32F4xx Microcontroller, Mechatronics.
- Software DOS, Win9x, Win2000, WinNT 4, WinXP, Windows, Linux, Ubuntu, MS Office Suite, Adobe PhotoShop, Corel 6.0, Netscape 4.7, Firefox, IE5, AutoCAD, IBM DB2, ColdFusion 4.01, SolidWorks, MatLab, LabView, Lightwave, FieldView 9, Fluent, Abaqus, Eagle PCB Layout, NX, Fab Modules, HSMWorks.

Programming Matlab, Python, Java, Javascript, ColdFusion, HTML, DHTML, SQL, C/C++  
Spoken German (rusty conversational)  
Languages

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## Coursework

Computer Science Data-Structures Honors, Mechanics of Solids, CAD Graphics, Machining, Welding, Electronics, Dynamics, Fluid Mechanics, Thermodynamics, Materials, Renewable Energy, Composite Materials, Wind Technology, Power Conversion, Controls, Design, Marine Hydrodynamics, Mathematics Analysis, Control and Optimization, Electro-Mechanical Actuators, Robotics, How to Make Almost Anything, Power Electronics, Nature of Mathematical Modeling, Managerial Finance.

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## Certifications

2005 Engineer-In-Training  
1999 OSHA Fork-Lift Certified

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## Interests

Machines, Making Things, Disassembling Things, Robotics, Mountain Biking, Snow Boarding, Metal Work, Brewing Beer, Fermented Foods, Baking Bread, Gardening, Bicycles.