Matthew E. Carney, PhD
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CTO (startup), DIRECTOR R&D/ENGINEERING, CHIEF ENGINEER, PRINCIPAL
Demonstrated technical leader of hardware and strategy, experienced several early-stage SF Bay startups. CEO and cofounder of Open Standard Industries, a pandemic response elastomeric respirator effort: raised nearly $1M, shipped thousands of product, ISO compliant, US Army tested. Expert level machine design and mechatronic system integration of advanced robotic technologies, built on more than 18 years of fast-paced, hands-on, product development, split between industry and academics. Proven track record of deep tech research and innovation, converting chaos into deliverables, and shipping product in fields of: bionics, humanoid robotics, actuators, biomechanics, medical devices, and renewable clean-energy systems (wind, solar, wave, tidal).

Featured in MIT News, Bloomberg, work on permanent display on the walls of MIT campus, and temporarily installed at the USAMRDC. PhD work commemorated on a 2020 US Postage Stamp representing US innovation in robotics. Named inventor on seven issued US Patents, and eleven academic publications. Invited speaker at EmTech France, TEDx, Alpbach European Peace Forum, Google Solve[x], 3DExperience, regularly speaks to audiences and classrooms, and a named contributor in two TED talks.

EDUCATION

Massachusetts Institute of Technology (MIT), Cambridge, MA, 2015 - 2019
Doctor of Philosophy (PhD) Media Arts and Sciences: Biomechatronics

Massachusetts Institute of Technology, Cambridge, MA, 2013 - 2015
Master of Science (MS) Media Arts and Sciences: Robotics & Cellular Solids

University of California Berkeley, Berkeley, CA, 2006 - 2008
Master of Science (MS) Mechanical Engineering

California Polytechnic State University, San Luis Obispo, CA, 2001 - 2004
Bachelor of Science (BS) Mechanical Engineering

EXPERIENCE (18+ years)

RAD Action Labs LLC, Portland, OR
Principal, Founder **6/2023 – Present**
Research and development institute and venture studio focused on deploying technology and products that improve lives at scale.

Massachusetts Institute of Technology, Cambridge, MA
Research Affiliate, MIT Media Lab: Biomechatronics Group **9/2020 - Present**
Support for ongoing mechatronic efforts. Mentoring graduate students through design, build and debug of novel mechatronic powered robotic prostheses and actuators.

Open Standard Industries, Inc. , Holyoke, MA **3/2020 – Present**
CEO, Co-founder
Pandemic response project: reusable elastomeric respirator. Leader driving a small team of open-source designers to rapidly bring a high-volume, ISO 13485 compliant regulated device to market in response to

the pandemic. Driving detailed design, research, manufacturing supply chain, project management, marketing, fundraising, etc.

- Developed vision and strategy for business development, supply chain, key-strategic partnerships, marketing, and fundraising critical to deploy respirators at large scale.
- Lead product design, planning, including remote rapid prototyping with fast-paced parallel iterative experimental design across a team of 50+ volunteer contributors, detailed mechanical design, tolerance analysis, process validation.
- Managed a fully remote team of 12+ regular contributors to build a new class of elastomeric half-mask air-purifying respirator.

Panthalassa, Portland, OR **8/2022 – 1/2023**
Principal Robotic Systems Engineer,
Engineering technical lead developing new robotic platforms related to renewable ocean energy.

Amazon Robotics, Boston, MA **5/2020 – 6/2022**
Senior Applied Scientist III,
Subject matter expert and engineering technical lead of team developing new mechatronic consumer products and new robotic manipulation systems.

- Demonstrated strong bias for action, and ability to chart a course through chaotic and indeterminate driving factors to bring a new mechatronic and biomechatronic system to life.
- Developed novel soft-robotics bridging hard and soft-goods using varied manufacturing processes.
- Built functional prototypes, control system design, implementation and user-study experiments.
- Supervised team work-streams including separate data, sensors, mechatronics, design, biomechanics, and user experience research.
- Communicated research findings in reports to make product platform, experimental design and roadmap recommendations.
- Inspired team to trust and expand our capabilities, with obsessive customer experience focus.

Massachusetts Institute of Technology, Cambridge, MA **9/2013 - Present**
Postdoctoral Associate, MIT Media Lab: Biomechatronics Group **1/2020 - 5/2020**
Developed novel actuators and wearable technologies, published papers and patents.

- Co-Developed novel actuator for biomechanic optimization of metabolic cost of walking with a robotic prosthetic ankle.
- Led design and manufacture of a global, 20+ person, product development team for an open-hardware N95 alternative respirator, spinning it out into a new company: Open Standard Industries, Inc.

Research Assistant (PhD Student), MIT Media Lab: Biomechatronics Group **9/2016 - 1/2020**
Designed, built, debugged, human tested, and published a novel lower-extremity powered prosthesis for bionic and neurally controlled knees and ankles, based on a series elastic actuator (SEA), for use as a lab-wide experimental platform. (https://youtu.be/-a7PJ0MHmBQ)

- Wrote Matlab script code to optimize energy efficient hardware design of mechanisms, linkages, energy storage, and energetics of novel powered prostheses.
- Detailed design of mechanisms, tolerance analysis.
- Programmed embedded system low-level safety and mid-level controllers: torque control, force control impedance control, and autonomous intrinsic reflexive state machine controllers for multi-dof robotic prosthetic legs.

- Interfaced with domestic and international manufacturing partners to build fully integrated hardware, including custom motors.
- Supervised 12 undergraduate, masters, and phd students and a postdoctoral researcher to build 6 new powered prostheses, and EMG controlled interfaces
- Specified and managed the build of a new embedded system platform for lab-wide use.

Research Assistant (Master Student), MIT Center for Bits and Atoms 9/2013 - 8/2016
Designed a vast array of reusable, interlocking structural mechanisms, and robotic assembly of reusable discrete cellular lattice structures.

- Developed numerous robots for assembly, integrating kinematics of robot and material.
- Manufactured 5000 units of injection molded discrete lattice elements.
- Designed and machined on 5-axis cnc mill multiple robotic assembler systems.
- Taught portions of MIT graduate course MAS863 - How to Make (Almost) Anything.
- Supervised and mentored two undergraduate research students (UROPs) for three years.
- Collaborated with NASA, Airbus, DHS on these projects.

Meka Robotics / Redwood Robotics, San Francisco, CA 5/2009 – 5/2010, 6/2011– 4/2013
Redwood Robotics was a spinoff from Meka Robotics, both were then acquired by Google[X] in 2013.
Lead Mechanical Design Engineer, Mechanical Design Engineer
Designed human-safe, force-controlled, humanoid robotics for artificial intelligence research and light industrial manufacturing.

- Lead mechanical design of 7 degree of freedom (DOF), force controlled humanoid arm with novel block and tackle actuation and series elastic actuators.
- Implemented Master Sketch modeling framework for rapid development and deployment.
- Researched, designed, and built anti-backlash, high-efficiency series elastic actuators.
- Managed a team of five engineers to build handfuls of new production robotic arms.
- Calculated Free body diagrams and calculations of loading conditions, gear-train, sensors, material properties.
- Finite element analysis (FEA) modeling of most structures.
- Optimized, designed, built load bearing structures made of non-conventional means.
- Machined and assembled precision components.
- 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 Dreamer humanoid robot.
- Prepared detailed engineering drawings, exploded views, BOM, and build books for manufacture of 20 DOF.

IDEO, Palo Alto, CA 4/2010 – 6/2011
Mechanical Design Engineer (Senior Designer)
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.
- Balanced engineering needs with industrial design requirements.

Makani Power, Alameda, CA **5/2008 – 5/2009**
Mechanical Engineer
Makani was 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.
- R&D 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 and re-wired a 12 pole motor for high voltage applications.
- 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.

The Polymer Technology Group, Berkeley, CA **Summers 1996-1999, 6/2004 – 9/2006**
R&D Engineer, and Summer Intern
Researched and developed manufacturing short and long-term implanted medical devices, polymers, coatings, drug delivery materials. PTG was acquired by DSM in 2009.

- Lead engineering design for two implantable medical device projects following ISO 9001:2000 methods.
- Leveraged four summers of internship experience to work in every department of the company.
- 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.

EXHIBITIONS

2021 "OSR-M1," on temporary display USAMRDC
2020 "My desk one late night," on permanent display MIT Computer Science Artificial Intelligence Lab
2020 "Robotics Innovation," US Postal Forever Stamp
2010 Cybiernetics

PRESS/MEDIA

2021 OSI Announces Partnership with U.S. Army Medical Materiel Development Activity
2021 Wake Forest Medical Center: OSI Announces User Study at Wake Forest Baptist Health
2020 MIT News: **US Postage Stamp** Innovation Series for Robotics
2020 MIT News: Open Standard Respirator
2020 Machine Design: Thanks for Sharing: Reusable Open Source Hardware Respirators
2020 IEEE Spectrum: Video Friday
2019 Bloomberg: Prognosis This MIT Engineer Built His Own Bionic Leg
2019 The Age of AI: Using AI to Build a Better Human
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

PUBLICATIONS

2022 Shu, Tony; Shallal, Chris; Chun, Ethan; Shah, Aashini; Bu, Angel; Levine, Daniel; Yeon, Song Ho; **Carney, Matthew**;Song, Hyungeun; Hsieh, Tsung-Han; Herr, Hugh M., "Modulation of Prosthetic Ankle Plantarflexion Through Direct Myoelectric Control of a Subject-Optimized Neuromuscular Model." in *IEEE Robotics and Automation Letters*, vol. 7, no. 3, pp. 7620-7627, July 2022, doi: 10.1109/LRA.2022.3183762.

2022 **Carney, Matt E.**, Cantrell, Aaron, Brown, Philip, Horsey, Jake, Jarrell, Jesse, Wang, Che-Wei, Carlberg, David, Whalen, Stephanie, "Design of a Modular Reusable Elastomeric Half-face Respirator." Manuscript in preparation.

2021 **M. E. Carney**, T. Shu, R. Stolyarov, J. -F. Duval and H. M. Herr, "Design and Preliminary Results of a Reaction Force Series Elastic Actuator for Bionic Knee and Ankle Prostheses," in *IEEE Transactions on Medical Robotics and Bionics*, vol. 3, no. 3, pp. 542-553, Aug. 2021, doi: 10.1109/TMRB.2021.3098921.

2020 E. A. Rogers, **M. E. Carney**, S. H. Yeon, T. R. Clites, D. Solav and H. M. Herr," An Ankle-Foot Prosthesis for Rock Climbing Augmentation," in *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, doi: 10.1109/TNSRE.2020.3033474.

2020 **M. E. Carney** and H. Herr, "Electric-Energetic Consequences of Springs in Lower-Extremity Powered Prostheses on Varied Terrain," *2020 8th IEEE RAS/EMBS International Conference for Biomedical Robotics and Biomechatronics (BioRob)*, 2020, pp. 989-996, doi: 10.1109/BioRob49111.2020.9224458.

2020 Stolyarov, Roman*, **Carney, Matthew***, and Herr, Hugh "Accurate Heuristic Terrain Prediction in Powered Lower-Limb Prostheses Using Onboard Sensors." *IEEE Transactions on Biomedical Engineering*. DOI:10.1109/TBME.2020.2994152 *Equally contributing authors.

2020 Stolyarov, Roman, **Carney, Matthew E.**, and Herr, Hugh M. "Automatic Incremental Learning of Terrain Transitions in a Powered Below Knee Prosthesis." Manuscript in review. DOI:10.31224/osf.io/zn3wf.

2018 Clites, Tyler R, Carty, Matthew J., Ullauri, Jessica B., **Carney**, **Matthew E.**, Mooney, Luke M., Duval, Jean-François, Srinivasan, Shriya S., and Herr, Hugh M. "Proprioception from a Neurally Controlled Lower-Extremity Prosthesis." *Science Translational Medicine* 10, no. 30 (2018). DOI: 10.1126/scitranslmed.aap8373

2016 **Carney, M.**, & Jenett, B. "Relative Robots: Scaling Automated Assembly of Discrete Cellular Lattices." *Proceedings of the ASME 2016 11th International Manufacturing Science and Engineering Conference*. *Volume 2: Materials; Biomanufacturing; Properties, Applications and Systems; Sustainable Manufacturing*. Blacksburg, Virginia, USA. June 27–July 1, 2016. V002T01A019. ASME. https://doi.org/10.1115/MSEC2016-8837

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

THESES

2019, PhD "Design and Evaluation of a Reaction-Force Series Elastic Actuator Configurable as Biomimetic Powered Ankle and Knee Prostheses." MIT

2015, MS "Discrete Cellular Lattice Assembly." MIT

2008, MS "A Multi-Axial Tribo-System: Developing a Rolling, Sliding, and Rotation Tribological Testing Machine for Assessment of Total Joint Replacements." UC Berkeley

PATENTS-ISSUED

2022 Herr, Hugh M., **Carney, Matthew E.**, Rogers, Emily, Du, Lucy, "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 11,278,235

2018 Langford, William, **Carney, Matthew**, Jenett, Benjamin, Gershenfeld, Neil, "Discrete Assemblers Utilizing Conventional Motion Systems." US Patent 10,155,313

2018 **Carney, Matthew**, Jenett, Benjamin, Gershenfeld, Neil, "Digital Material Assembly by Passive Means and Modular Isotropic Lattice Extruder Systems." US Patent 10,145,110; 10,710,698

2018 Magnusson, L., **Carney, M**., Edsinger, A., Weber, J., & Mullins, P., "Low Cost Block and Tackle Robot Transmission." US Patent 10,018,256.

2017 **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

PATENTS-APPLICATIONS

2020 **Carney, Matthew E**., Cantrell, Aaron, Brown, Philip, Horsey, Jake, Jarrell, Jesse, Wang, Che-Wei, Carlberg, David, Whalen, Stephanie, "Modular Reusable Elastomeric Half-Face Respirator." US Patent Application No. 63/057,695 (2020).

2020 Herr, Hugh M., Handford, Matthew L., Williams, Chris C., **Carney, Matthew E**. "Computer-Controlled Ankle-Foot Prosthesis with Series J-Spring Actuation" US Patent Application No. 63/117,395 (2020).

2020 Marcus, Beth, Collins, Theodore, Churchill, Phil, **Carney, Matthew E**., "Dynamically Altering an External Geometry of Body-wearable Actuatable Components" US Patent Application No. 63/064,474 (2020).

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 Devices." US Patent Application 2017/347,666

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

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

NOTABLE SPEAKING EVENTS

2021 3D Experience (Solidworks) World 2021 - Keynote (Virtual).

2020 3D Experience (Solidworks) World 2020 - Keynote.

2019 MIT Dissertation Defense.

2019 Veteran Affairs, Advanced Platform Technology / Case Western - "Personalized Bionics."

2017 EmTech France - Keynote, "Designing Robots to Transform Our Way of Life."

2017 Fablab Festival, "Prostheses: robotic design, personal fabrication."

2016	Alpbach European Forum - Techology 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."
2011-2013	LeadAmerica, "Build Cool Shit!"

LECTURES/COURSES

2021	University of Leeds, Textiles: Design and Deployment of an Elastomeric Respirator.
2018, 2019	MIT Media Lab: Mechanical Design for Electronic Components - Class Lecture MAS.S70 Audio-Electronic Products Design
2018 - 2021	MIT Media Lab: Mechanical Design and FBDs for Zero Gravity - Class Lecture MAS.S64 Zero Gravity Flight Class, Space Enabled Institute
2015	MIT, Advanced Solidworks - Class Lecture for MAS863 - How to Make Almost Anything
2013 - 2016	MIT, MAS.863: How to Make (Almost) Anything, TA
2007 - 2008	UC Berkeley, ME 103 Experimentation and Measurements
2007	UC Berkeley, ME 168 Marine Statics and Structures

AWARDS

2020	Nominated Best Paper, IEEE Bio-Robotics Conference (BioRob)
2013	Most Valuable Engineer - MIT 2.120 Introduction to Robotics, Class Project
2008	Outstanding Graduate Student Instructor
2007	Science Technology Engineering and Policy (STEP) Travel Grant
2006	Jaehne Fellowship

SOCIETIES

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

SKILLS

Machines	Machining (Mill and Lathe), MIG/TIG/Gas Welding, Surface-mount Soldering, Circuit Board Layout, Twin-Screw Extrusion of Polymers, Polymer Film Coating Machine, Polymer Synthesis, Iron Blacksmithing, Thermoforming, Rotational Molding, Injection Molding-Arburg 320C, Wind Tunnel, Omax Waterjet, Wire EDM, 3-axis & 5-axis CNC machining (Haas, Hurco).
Hardware	IBM Compatible from 8086-Pentium IV, Mac OS7.5, PIC, AVR & Arduino uController, DC & BLDC Motors, Strain Gages, Thermocouples, STM32F4xx Microcontroller, ARM-Cortex M4, Mechatronics, Biomechatronics, Biomechanics, FlexSEA.
Software	DOS, Win9x, Win2000, WinNT 4, WinXP, Windows, Linux, Ubuntu, MS Office Suite, Adobe PhotoShop, Corel 6.0, Netscape 4.7, Firefox, SolidWorks, MatLab, LabView, Abaqus, Eagle PCB Layout, Fab Modules, HSMWorks.
Programming	Matlab, Python, Javascript, HTML, DHTML, C
Languages	German (rusty conversational)

Matthew E. Carney, PhD matt@matthematic.com

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, Money for Startups, Negotiation.

INTERESTS

Machines, Making Things, Breaking Things, Robotics, Mountain Biking, Metal Work, Fermented Foods, Baking Bread, Gardening, Bicycles, Backpacking, Section-hiking (790 miles of Pacific Crest Trail, so far), Climate Resiliency.