

# MARSETTE VONA, PH.D.

<http://www.ccs.neu.edu/research/gpc>  
Norwich, VT (U.S. Citizen)

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## PROFESSIONAL INTERESTS AND EXPERTISE

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I design and build software and hardware. I have particular expertise in robot design and kinematics, 3D sensing and perception, algorithms for geometry processing and graphics, CAD, and user interfaces including augmented and virtual reality. I am detail-oriented and enjoy both working as an individual contributor, as well as building project strategy, interacting with customers, and managing development.

## EXPERIENCE AND EDUCATION

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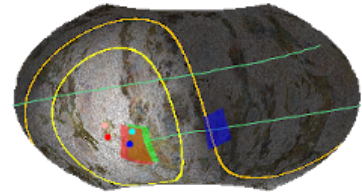
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|--------------|---|---|
| 2015–present | NASA Jet Propulsion Laboratory<br>Software Developer at JPL Ops Lab<br><i>Science Opportunity Analyzer: SPICE-based orbiter analysis and planning tool</i><br><i>Mars 2020 Imaging: cloud architecture for processing high-resolution Mars images</i><br><i>Landform: automatic large-scale Mars terrain data fusion</i><br><i>Tomo: volumetric rendering for CT scan data in virtual reality</i><br><i>ProtoSpace: collaborative augmented reality for spacecraft CAD</i><br><b>1st Place for Best Augmented Reality Experience at Unity Vision Summit, 2017</b> | Pasadena, CA                            |
| 2010–2015    | Northeastern University College of Computer and Information Science<br>Assistant Professor of Computer Science<br><i>Founder and PI of the Geometric and Physical Computing research group</i><br><b>NSF CAREER Award, 2012</b>   | Boston, MA                              |
| 2003–2009    | Massachusetts Institute of Technology<br>Ph.D. in Electrical Engineering and Computer Science<br><i>Thesis: Virtual Articulation and Kinematic Abstraction in Robotics</i>  | Cambridge, MA<br>Advisor: Daniela Rus   |
| 2001–2003    | NASA Jet Propulsion Laboratory<br>User Interface and 3D Software Developer<br><i>Science Operations Software for the Mars Exploration Rover</i><br><b>NASA Software of the Year Award Recipient, 2004</b>   | Pasadena, CA                            |
| 1999–2001    | Massachusetts Institute of Technology<br>M.S. in Electrical Engineering and Computer Science<br><i>Thesis: Metrology Techniques for Compound Rotary-Linear Motion</i>   | Cambridge, MA<br>Advisor: David Trumper |
| 1995–1999    | Dartmouth College<br>B.A. in Computer Science and Engineering<br><i>Thesis: A Two-Dimensional Crystalline Atomic Unit Modular Self-Reconfigurable Robot</i><br><b>CRA Outstanding Undergraduate Researcher, 1st place in U.S., 1999</b>   | Hanover, NH<br>Advisor: Daniela Rus     |

## PORTFOLIO

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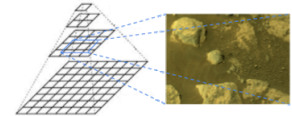
2021–present **Science Opportunity Analyzer**

- science observation planning for orbiters
- Java front-end and 2D/3D graphics developer
- SPICE-based trajectory computations
- designed/implemented 2D map projection algorithms
- rearchitected celestial timekeeping subsystem



2020–present **Mars 2020 Imaging**: processing Mars images

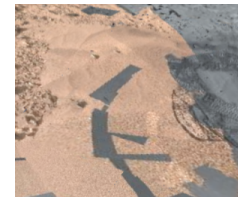
- lead developer, cognizant point of contact
- imaging algorithm design and implementation in Java
- out-of-core processing of gigapixel panoramas
- Deep Zoom Image hierarchical image streaming
- AWS Lambda, Elastic Container Service deployment



2018–present **Landform**: reconstructing Mars terrain

<https://tinyurl.com/2p8bauf6> (demo)

- project lead, lead developer
- perception algorithm design and implementation
- feature-based alignment of 3D sensor data
- fusing surface data with GIS orbiter data
- design and implement parallel and cloud-based algorithms in C#
- REST service API and interactive 3D visualization



2018–2021 **Tomo**: CT scan data visualization in virtual reality

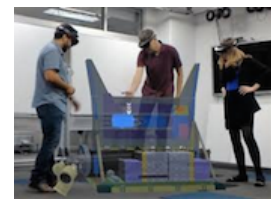
- project lead, lead developer
- real-time rendering of CT scan voxel datasets
- custom shader-based GPU real-time raycast rendering algorithm
- handheld controller spatial interactions



2015–2019 **ProtoSpace**: collaborative augmented reality for spacecraft CAD

<http://tinyurl.com/kf6b75v> (video)

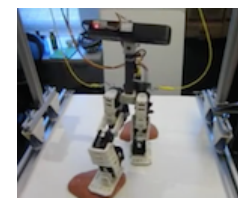
- project lead (6 person team) and developer
- Unity-based augmented reality app for HoloLens
- full-stack web app with node.js, THREE.js, Polymer
- Scrum-based Agile software process (C++, C#, JavaScript)



2012–2015 **rpbp**: Rapid-Prototyped Remote-Brain Biped with 3D Perception

<http://tinyurl.com/mo2hzjp> (images, videos)

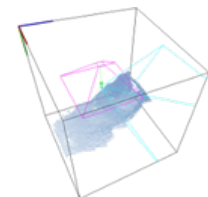
- designed and fabricated custom 12DoF mini-biped
- 3D perception with PrimeSense depth camera and IMU
- rough-terrain locomotion experiments with rxkinfu and imucam



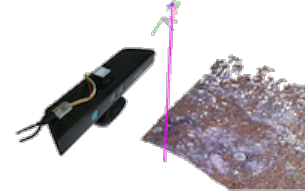
2012–2014 **rxkinfu**: Moving Volume Kinect Fusion for 3D Perception

<http://tinyurl.com/lbxk9cm> (C++ code, paper, videos)

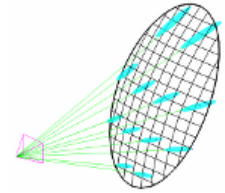
- fork of PCL KinFu with extensions for rough terrain perception
- adds volume remapping algorithms to Kinect Fusion
- CUDA-based soft-real-time GPU implementation



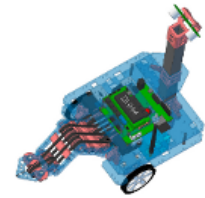
- 2013–2014 **imucam**: UM6 IMU + OpenNI depth camera for PCL  
<http://tinyurl.com/n8ossqx> (C++ code, videos)
- capture RGB-D images with IMU data
  - efficient capture at video framerates
  - IMU to camera calibration algorithm



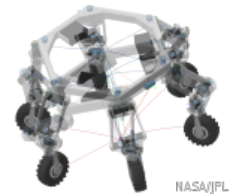
- 2011–2014 **SPL**: Surface Patch Library  
<http://tinyurl.com/mmqothj> (Matlab code, paper, videos)
- curved surface patches for 3D perception
  - algorithm to fit patches to point cloud data
  - mathematical uncertainty models



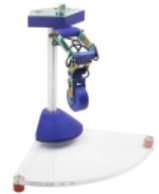
- 2011–2014 **OHMM**: The Open Hardware Mobile Manipulator  
<http://tinyurl.com/mrppenn> (hardware designs, C/Java/Scheme code, paper, videos, curriculum)
- custom designed and fabricated teaching robot kits
  - 10 kits used in my undergrad and grad robotics systems courses



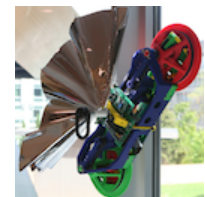
- 2007–2015 **MSim**: Mixed real/virtual articulated robot simulator  
<http://tinyurl.com/ldmc76e> (Java code, thesis, papers, videos)
- interactive arbitrary topology 3D kinematic simulator
  - supports hundreds of joints, open and closed chains
  - applied to control complex robots and to model uncertainty



- 2008–2009 **ADMIN**: NASA/JPL ATHLETE Direct Manipulation Interface  
<http://tinyurl.com/ktgkxax> (papers, videos)
- designed and fabricated custom user interface hardware
  - designed custom PCBs, wrote custom firmware
  - AVR microcontroller, USB interface



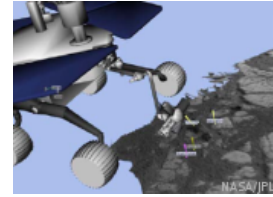
- 2006–2009 **Shady**: vertical structure climbing robot  
<http://tinyurl.com/l4yv8cz> (thesis, papers, videos)
- compliance and proprioception to climb with high reliability
  - designed and fabricated custom mechanics and PCBs
  - low-level motion control and networking firmware



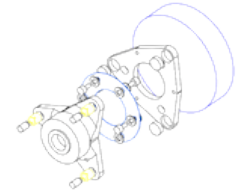
- 2006 **Visolate**: Voronoi toolpaths for PCB mechanical etch  
<http://tinyurl.com/l5vx6gg> (Java code, paper)
- novel algorithm to route PCBs
  - GPGPU techniques to accelerate computational geometry
  - open-source code adopted and maintained by the community



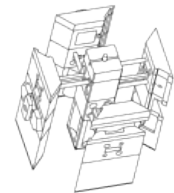
- 2001–2003 **Science Activity Planner** for MER and Maestros  
<http://tinyurl.com/kxsjxee>
- official science data visualization tool for Spirit and Opportunity
  - implemented interactive 3D visualization for Mars terrain
  - developed complex GUI software in Java



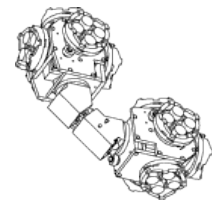
- 1999–2001 **laser metrology** for compound rotary-linear motion  
<http://tinyurl.com/lfno7jz> (thesis)
- metrology system for a high-performance micro machine tool
  - designed and machined precision optical systems
  - Matlab/Simulink integration with realtime hardware



- 1998–1999 **Crystalline Atom**: a 2D unit modular self-reconfiguring robot  
<http://tinyurl.com/lolk4w5> (thesis)
- 1DoF modular self-reconfiguring robot
  - designed and fabricated mechanics and electronics
  - custom microcontroller firmware
  - universal reconfiguration algorithm



- 1997–1999 **The Molecule**: a 3D unit modular self-reconfiguring robot  
<http://tinyurl.com/mrwzos8> (paper)
- 5DoF modular self-reconfiguring robot
  - designed and fabricated novel mechanics
  - first of my robots to use Stratasys FDM 3D printing



#### PEER-REVIEWED PUBLICATIONS

- in publication G. Paar, T. Ortner, C. Tate, R. Deen, S. Abercrombie, M. Vona, J. Proton, A. Bechtold, F. Calef, R. Barnes, C. Koeberl, K. Herkenhoff, E. Hausrath, C. Traxler, P. Caballo, A. Annex, S. Gupta, J. Bell, J. Maki. *Three-dimensional data preparation and immersive mission-spanning visualization and analysis of Mars 2020 Mastcam-Z stereo image sequences*. **Earth and Space Science**.
- March 2022 G. Pyrzak, M. Vona, R. Lopez-Roig, R. Puncel. *Mars 2020 Ground Data System Architecture*. IEEE Aerospace Conference.
- September 2019 D. Kanoulas, N. Tsagarakis and M. Vona. *Curved Patch Mapping and Tracking for Irregular Terrain Modeling: Application to Bipedal Robot Foot Placement*. **Robotics and Autonomous Systems** **119**.
- July 2019 M. Vona, D. Kanoulas. *RPBP: Rapid-Prototyped Remote-Brain BiPed with 3D Perception*. IEEE International Conference on Advanced Robotics and Mechatronics (ICARM).
- November 2018 D. Kanoulas, N. Tsagarakis, and Marsette Vona. *rxKinFu: Moving Volume KinectFusion for 3D Perception and Robotics*. IEEE-RAS International Conference on Humanoid Robots.
- November 2016 D. Kanoulas, N. Tsagarakis, and M. Vona. *Uncertainty Analysis for Curved Surface Contact Patches*. IEEE-RAS International Conference on Humanoid Robots.
- Sept. 2015 S. Castro Gomez, M. Vona, D. Kanoulas. *A Three-Toe Biped Foot with Hall-Effect Sensing*. IEEE/RSJ Int. Conf. on Intelligent Robots and Systems.

- May 2014 D. Kanoulas, M. Vona. *Bio-Inspired Rough Terrain Contact Patch Perception*. IEEE Int. Conf. on Robotics and Automation.
- May 2013 D. Kanoulas, M. Vona. *Sparse Surface Modeling with Curved Patches*. IEEE Int. Conf. on Robotics and Automation.
- Feb. 2013 M. Vona, Shekar NH. *Teaching Robotics Software with the Open Hardware Mobile Manipulator*. **IEEE Transactions on Education**.
- Sept. 2012 H. Roth, M. Vona. *Moving Volume KinectFusion*. British Machine Vision Conference.
- Jan. 2012 M. Vona. *Operating High-DoF Articulated Robots Using Virtual Links and Joints*. **Chapter 12 in Advances in Robotics and Virtual Reality (Springer)**.
- Sept. 2011 M. Vona, D. Kanoulas. *Curved Surface Contact Patches with Quantified Uncertainty*. IEEE/RSJ Int. Conf. on Intelligent Robots and Systems.
- June 2010 M. Vona. *Hierarchical Decomposition and Kinematic Abstraction with Virtual Articulations*. Advances in Robot Kinematics.
- March 2010 M. Vona. *A Graphical Operations Interface for Modular Surface Systems*. IEEE Aerospace Conference.
- March 2010 D. Rus, M. Vona, K. Quigley. *Eye-In-Hand Visual Servoing Curriculum for Young Students*. **IEEE Robotics & Automation Magazine**.
- July 2009 M. Vona, D. Mittman, J. Norris, D. Rus. *Using Virtual Articulations to Operate High-DoF Manipulation and Inspection Motions*. International Conf. on Field and Service Robotics.
- Dec. 2007 C. Detweiler, M. Vona, Y. Yoon, S. Yun, D. Rus. *Self-assembling Mobile Linkages with Passive and Active Modules*. **IEEE Robotics & Automation Magazine**.
- July 2006 M. Vona, C. Detweiler, D. Rus. *Shady: Robust Truss Climbing With Mechanical Compliances*. International Symposium on Experimental Robotics.
- May 2006 C. Detweiler, M. Vona, K. Kotay, D. Rus. *Hierarchical Control for Self-assembling Mobile Trusses with Passive and Active Links*. IEEE Int. Conf. on Robotics and Automation.
- April 2005 J. Norris, M. Powell, M. Vona, P. Backes, J. Wick. *Mars Exploration Rover Operations with the Science Activity Planner*. IEEE Int. Conf. on Robotics and Automation.
- April 2005 M. Powell, J. Norris, M. Vona, P. Backes, J. Wick. *Scientific Visualization for the Mars Exploration Rovers*. IEEE International Conference on Robotics and Automation.
- April 2005 M. Vona, D. Rus. *Voronoi toolpaths for PCB mechanical etch: Simple and intuitive algorithms with the 3D GPU*. IEEE International Conference on Robotics and Automation.
- March 2005 J. Wick, J. Callas, J. Norris, M. Powell, M. Vona. *Distributed Operations for the Mars Exploration Rover Mission with the Science Activity Planner*. IEEE Aerospace Conference.
- March 2004 P. Backes, J. Norris, M. Powell, M. Vona. *Multi-mission Activity Planning for Mars Lander and Rover Missions*. IEEE Aerospace Conference.
- March 2003 M. Vona, P. Backes, J. Norris, M. Powell. *Challenges in 3D Visualization for Mars Exploration Rover Mission Science Planning*. IEEE Aerospace Conference.
- March 2003 P. Backes, J. Norris, M. Powell, M. Vona, R. Steinke, J. Wick. *The Science Activity Planner for the Mars Exploration Rover Mission*. IEEE Aerospace Conference.
- March 2003 M. Powell, P. Backes, M. Vona, J. Norris. *Visualization of Coregistered Imagery for Remote Surface Operations*. IEEE Aerospace Conference.
- March 2002 D. Rus, Z. Butler, K. Kotay, M. Vona. *Self-reconfiguring Robots*. **Communications of the ACM 45(3)**.
- January 2001 D. Rus, M. Vona. *Crystalline Robots: Self-reconfiguration with Compressible Unit Modules*. **Autonomous Robots 10(1)**.
- Dec. 2000 K. Kotay, D. Rus, M. Vona. *Using Modular Self-reconfiguring Robots for Locomotion*. International Symposium on Experimental Robotics.

- October 2000 D. Rus, M. Vona. *A Basis for Self-reconfiguring Robots using Crystal Modules*. IEEE/RSJ International Conference on Intelligent Robots and Systems.
- July 2000 R. Fitch, D. Rus, M. Vona. *A Basis for Self-Repair Robots Using Self-Reconfiguring Crystal Modules*. International Conference on Intelligent Autonomous Systems.
- April 2000 D. Rus, M. Vona. *A Physical Implementation of the Self-reconfigurable Crystalline Robot*. IEEE International Conference on Robotics and Automation.
- May 1999 D. Rus, M. Vona. *Self-reconfiguration Planning with Compressible Unit Modules*. IEEE International Conference on Robotics and Automation.
- May 1998 K. Kotay, D. Rus, M. Vona, C. McGray. *The Self-reconfiguring Robotic Molecule*. IEEE International Conference on Robotics and Automation.
- March 1998 K. Kotay, D. Rus, M. Vona, C. McGray. *The Self-reconfiguring Robotic Molecule: Design and Control Algorithms*. Workshop on Algorithmic Foundations of Robotics.

#### OTHER PUBLICATIONS

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- Sept. 2008 D. Mittman, J. Norris, M. Powell, R. Torres, C. McQuin, M. Vona. *Lessons Learned from All-Terrain Hex-Limbed Extra-Terrestrial Explorer Robot Field Test Operations at Moses Lake Sand Dunes, Washington*. AIAA Space Conference.
- 2001 M. Liebman, M. Vona, D. Trumper. *A Rotary-Linear Hybrid Machine Tool Axis*. NSF Design, Manufacture, and Industrial Innovation Grantee Conference.

#### RESEARCH FUNDING

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- 2012–2015 PI, NSF CAREER: *Reliable Contact Under Uncertainty: Integrating 3D Perception and Compliance* (\$499,602)
- 2010–2013 Co-PI, NSF MRI-R<sup>2</sup>: *Development of a Second-Generation Applications-Driven Wireless Sensor Networking Instrument* (\$57,161 to Vona of \$499,355 with PI Guevara Noubir)
- 2009–2010 NASA/JPL Strategic University Research Partnership Grant: *Operator Interface and Control Software for the Reconfigurable Surface System Tri-ATHLETE* (\$95,000, PI Jeff Norris at JPL, Co-I Daniela Rus at MIT)
- 2006–2007 NASA/JPL Strategic University Research Partnership Grant: *Operator Interface Algorithms and Implementation for High-DoF Articulated Surface Systems* (\$40,000, PI Jeff Norris at JPL, Co-I Brian Wilcox at JPL, Co-I Daniela Rus at MIT)
- 1999–2003 NSF Graduate Research Fellowship

#### TEACHING AND OUTREACH

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- Fall 2011, Spring 2013, Spring 2014 **Taught Robotic Science and Systems (NEU CS4610/CS5335)** developed new undergrad/grad introduction to applied robotics software, with hands-on labs based on the OHMM robot; teaching effectiveness rated 4.9/5
- Fall 2013 **Taught Discrete Structures (NEU CS1800)** freshman intro to discrete math for computer science, ~80 students in section; teaching effectiveness rated 4.6/5
- Fall 2012 **Developed and Hosted Robotics Workshop** for young students at NEU in collaboration with the Johns Hopkins University Center for Talented Youth (CTY)

Marsette Vona

- Fall 2012 **Taught Fundamentals of Computer Science (NEU CS2500)** freshman intro to computer science, ~70 students in section; teaching effectiveness rated 4.3/5
- 2011 **Designed the Open Hardware Mobile Manipulator (OHMM) teaching robot** with open hardware, software, and curriculum (<http://www.ccs.neu.edu/research/gpc/ohmm/index.html>)
- 2011–2014 advisor to the Association for Computing Machinery (nuACM) student group
- Fall 2010, Spring 2012 **Taught Applied Geometric Representation and Computation (NEU CS5350)** developed new grad course in geometric algorithms; teaching effectiveness rated 4.9/5
- Spring 2010, 2011 **Taught Introduction to Computer Graphics (NEU CS4300)** redesigned course to cover both rasterization and raytracing; teaching effectiveness rated 4.7/5
- Summer 2009 **Developed Robotics Workshop Curriculum** for young students with JHU CTY and Daniela Rus at MIT
- Spring 2006 TA, developed & delivered new lab material, MIT 6.141 *Robotics: Science and Systems* with Professors Daniela Rus, John Leonard, Nick Roy, and Seth Teller
- 2004 MIT SciPro saturday morning mentor for local 7th and 8th grade students
- 2004 **Over 100k downloads of public outreach edition “Maestro” of the Mars Exploration Rover Science Activity Planner software** that I co-developed at NASA/JPL
- Fall 1998 led recitation section, Dartmouth College CS 5 *Introduction to Computer Science* with Professor Thomas H. Cormen

#### STUDENTS (ALL COMPLETED)

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- 2010–2014 Dimitrios Kanoulas (Ph.D.): *Curved Surface Patches for Rough Terrain Perception*
- 2010–2014 Daniel Blustein (Ph.D. committee member, advisor Joseph Ayers): *Synthetic nervous system control of a biomimetic robotic lobster*
- 2012–2014 Sergio Castro-Gomez (ECE M.S.): *Sensing with a 3-Toe Foot for a Mini-Biped Robot*
- 2012–2014 Benjamin Arneberg (M.S.): *Indoor Navigation and Mapping for Autonomous Vehicles*
- 2013–2014 Jason Shrand and James Steinberg (B.S.): *Micro-Quadrotor with Embedded Camera*
- 2011–2013 Henry Roth (M.S.): *GPU-accelerated 3D perception*
- 2010–2012 Anthony Westphal (Ph.D. committee member, advisor Joseph Ayers): *Controlling a lamprey-based robot with an electronic nervous system*
- 2012 Hooman Javaheri (Ph.D. committee member, advisor Guevara Noubir): *Wireless Transfer of Energy Alongside Information*
- 2011–2012 Jessica Lowell (M.S.): *BlueSANE: Integrating Functional Blueprints with Neuroevolution*
- 2010 Shyam Shankar (M.S.): *Cross Platform USB Video Class OpenCV Integration*

#### INVITED TALKS AND PRESENTATIONS

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- May 2017 Unity Vision Summit Keynote: ProtoSpace live demo
- Feb. 2014 NEU University Scholars Seminar

- Sept. 2012 Northeastern University Freshman Seminar
- May 2012 Dartmouth College Computer Science Colloquium
- Sept. 2010 Seminar at University of New Hampshire
- March 2010 Ph.D. Seminar at Northeastern University
- March 2010 Northeastern University nuACM speaker series
- March 2009 University of Texas at Austin Computer Science Colloquium
- October 2008 University of Pennsylvania ModLab Group Seminar
- Dec. 2007 University of Sydney Australian Centre for Field Robotics Seminar
- October 2007 Clinton Central High School Science Assembly
- May 2007 Swiss Federal Inst. of Technology, Lausanne, Swarm-Intelligent Systems Group Seminar
- March 2005 Sippican Philosophical Society Presentation
- Dec. 2004 Technical University of Berlin Institute of Mathematics Seminar
- July 2004 **“The coolest talk at JavaOne”—James Gosling**
- July 2004 O’Reilly Open Source Convention Featured Event
- April 2004 **IEEE International Conference on Robotics and Automation Plenary Talk**
- October 2003 MIT Computer Science and Artificial Intelligence Lab Seminar
- Sept. 2003 MIT Graduate Association of Mechanical Engineers Seminar
- Sept. 2003 MIT Laboratory for Manufacturing and Productivity Student Seminar
- June 2003 JPL Center for Space Mission Information and Software Systems Seminar
- Nov. 2002 Dartmouth College Computer Science Colloquium

#### HONORS AND AWARDS

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- 2017 **Best Augmented Reality Experience: ProtoSpace—1st place** out of 250+ entries at Unity Vision Summit
- 2012 NASA Space Act: *Tele-robotic ATHLETE Controller for Kinematics (TRACK)*
- 2011 NASA Software Award: *Operator Interface and Control Software for the Reconfigurable Surface System Tri-ATHLETE*
- 2009 NASA Space Act: *Mixed Real/Virtual Operator Interface for ATHLETE*
- 2008 NASA Space Act: *Science Activity Planner: Uplink Planning Component*
- 2007 Clinton Central School District Hall of Distinction
- 2005 NASA Space Act: *Visible Scalable Terrain (ViSta) format for MER*
- 2004 **NASA Software of the Year: Science Activity Planner/Maestro software for MER**  
**\$100k national award**, shared in 2004 with one other project
- 2004 Sun Microsystems Duke’s Choice: *Java impl. of Science Activity Planner*
- 2004 NASA Space Act: *Science Activity Planner ThreeDView & Downlink Components*
- 2004 NASA Space Act: *Science Activity Planner Downlink Component*
- 1999 **CRA Outstanding Undergraduate: research in Self-Reconfigurable Robotics**  
**national award given to one graduating man and woman per year**
- 1999 Elected to Phi Beta Kappa at Dartmouth College