CARLOS BARAJAS

+1 786-246-0995
carlobar@mit.edu
https://www.linkedin.com/in/carlos-barajas-08188591
https://stuff.mit.edu/people/carlobar/www/

EDUCATION

PhD| *Major: Mechanical Engineering, Minor: Machine Learning, 5.0/5.0* Aug. 2018 – May 2022
Massachusetts Institute of Technology   Cambridge, Massachusetts
Advisor: Domitilla Del Vecchio

Master of Science | *Mechanical Engineering, 5.0/5.0* Aug. 2016 – May. 2018
Massachusetts Institute of Technology   Cambridge, Massachusetts
Thesis: Understanding and stimulating cellular resource transactions for robust cell growth and genetic circuit performance

Bachelor of Science | *Major: Mechanical Engineering, Minor: Mathematics, 3.99/4.00* Aug. 2012 – May 2016
University of Michigan   Ann Arbor, MI

PROJECTS AND RESEARCH

Centralized cellular resource controller 2016-Present
Mechanical Engineering   MIT

- Designed and cloned biomolecular feedback controllers to regulate cellular resources and make gene expression and cell growth rate robust to resource fluctuations
- Created mechanistic models to guide the optimization of the controller

Intracellular spatial effects modeling 2016-Present
Mechanical Engineering   MIT

- Created a PDE based model to capture intracellular heterogeneity in genetic circutir design
- Utilized contraction theory and time scale separation to create reduced ODE models that provide the same fidelity as PDE models and are ideal for genetic circuit design

SARS-CoV-2 Detection 2020-Present
Mechanical Engineering   MIT

- Adapted an electrostatic aerosol sampler to collect SARS-CoV-2-like airborne particles
- Created a testbed to assess the feasibility of the aerosol sampler to detect relevant viral airborne concentrations within 20 minutes
- Submitted invention disclosure

Study the effects of heat and mass diffusion on bubbles oscillating in tissue-like medium 2014-2016
Computational Flow Physics Lab, Research Advisor: Prof. Johnsen   U. Michigan

- Created a PDE physics based model of cavitation in a tissue-like medium that included thermal and mass transfer effects
- Coded a CFD model to simulate the governing equations and make predictions on the dominant damaging mechanism in Histotripsy applications to aid in making this process more precise

INDUSTRY EXPERIENCE

Environmental Dynamics Lab Intern May 2016 – Aug. 2016
Boeing   St. Louis, MO

- * Tested several aircraft and weapon components on fixed-base vibration shakers to both verify dynamical requirements and design development
- * Led the creation of a simplified and cost effective method to measure free-play on aircraft control surfaces

* Designed mulitple test fixtures and hardware that possessed robust dynamic responses with minimal coupling to those of the test specimen

Turbine Design Intern
General Electric Aviation

June 2015 – Aug. 2015
Lynn, MA

* Performed engineering analysis on the two stage high pressure turbine ones of GE's future military turbo-shaft engines to validate current design through several design reviews
* Applied GD&T to create design memos that were used to manufacture parts
* Calculated turbine assembly loads analytically and with ANSYS which were used to create tooling and validate manufacturability of design

Engine Dynamics Intern
General Electric Aviation

May 2014 – Aug. 2014
Lynn, MA

* Performed dynamic analysis on one of GE's future military turbo-shaft engines to determine loads and clearances during several rotational imbalances and combat maneuvers
* Monitored real time engine testing for possible dynamic issues before delivering engine to customer
* Supported the engine program successfully through various design phases and created tools and design practices in the engine dynamics group that had the capability to save $160/use

PUBLICATIONS

1. C. Barajas, J. J. Slotine, and D. Del Vecchio, "Contraction analysis of biological models with attractive dispersal." In preperation, (2021)

2. C. Barajas, J. Gibson, L. Sandovl, and D. Del Vecchio, "A burden-free gene overexpression system." preprint, (2021), https://doi.org/10.1101/2021.02.11.430724. Currently in review in Nat. Chem. Bio.

3. C. Barajas, D. Del Vecchio, "Effects of spatial heterogeneity on bacterial genetic circuits." PLoS Comp. Bio., (2020), https://doi.org/10.1371/journal.pcbi.1008159

4. J. B. Estrada, C. Barajas, D. Henann, E. Johnsen, and C. Franck, "High strain-rate soft material characterization via inertial cavitation." J Mech Phys Solids. 112, 291-317 (2018); https://doi.org/10.1016/j.jmps.2017.12.006

5. C. Barajas and E. Johnsen, "The effects of heat and mass diffusion on freely oscillating bubbles in a viscoelastic, tissue-like medium." J. Acoust. Soc. Am. 141, 908, (2017); https://doi.org/10.1121/1.4976081

REFEREED CONFERENCE PAPERS:

1. C. Barajas, D. Del Vecchio, "Spatial Heterogeneity in Bacterial Cells." IFAC World Congress, (2020)

2. C. Barajas, D. Del Vecchio, "Genetic Circuit-Host Ribosome Transactions: Diffusion-Reaction Model." IEEE ACC, (2019),https://doi.org/10.23919/ACC.2019.8815240

3. C. Barajas and E. Johnsen, "Heat and mass transfer effects on forced radial oscillations in soft tissue." J. Acoust. Soc. Am. 137, 2253 (2015);http://dx.doi.org/10.1121/1.4920216

TEACHING AND MENTORSHIP

Teaching Assistant
2.152[J]: Nonlinear control. Students comments from course review are shown below.

Spring 2020
MIT

Undergraduate Research Opportunity Program (UROP)
Student: Cindy Lee

Summer 2021
MIT

Undergraduate Research Opportunity Program (UROP)
Student: Mihir P Khambete

Summer 2019
MIT

1E. Please comment on the effectiveness of laboratory, project-based, and/or performance-related components in engaging your interest and/or helping you learn. Please also describe any challenges or impediments you faced with this component of the subject.

The problem sets were a good learning opportunity. Typically, to complete the problem set, we were teaching ourselves material from the book, and using some items from the lectures. The professor was never available to answer questions from the problem sets; however, the TA went out of his way to make sure we understood the material and were able to communicate effectively.

1F. If this subject had teaching assistant(s), communication instructor(s), and/or lab staff, how did they help you learn?

The TA was wonderful. Not only did he make himself available for regular office hours, he also scheduled 1-on-1 time with us if we were unable to attend the OH that week. Further, he was very active on piazza post-covid, and did his best to make sure we understood all the material. For the course project, he made himself available to me to have long discussions, help me out when I was stuck, and sent me additional material. In comparison, the professor was minimally helpful with the term project, and gave most of his attention only to students who were working on quite advanced projects, showing clear preference for students who were working on projects directly relevant to his research and those which had some promise for immediate novelty.

1F. If this subject had teaching assistant(s), communication instructor(s), and/or lab staff, how did they help you learn?

The TA was really helpful. Office hours were really productive for the PSets and he was always willing to make us understand everything properly.

1F. If this subject had teaching assistant(s), communication instructor(s), and/or lab staff, how did they help you learn?

The TA's help during office hours was extremely helpful. I doubt I would have been able to complete the course without him.

1F. If this subject had teaching assistant(s), communication instructor(s), and/or lab staff, how did they help you learn?

The T.A. did an amazing job helping out. He was incredibly responsive, giving great explanations and providing helpful references when needed.

3B. If you strongly disagree or strongly agree with any of the statements above, please provide specific details. If you did not feel part of an online community, what would have helped you to feel more included?

The live class was a Q/A, so I certainly felt comfortable asking questions. Carlos was very helpful during office hours and was easily approachable.

3B. If you strongly disagree or strongly agree with any of the statements above, please provide specific details. If you did not feel part of an online community, what would have helped you to feel more included?

Carlos (the teaching assistant) was a boss. He deserves a reward.

Undergraduate Research Opportunity Program (UROP)   Summer 2019
Student: Aidan Simpson   MIT

Undergraduate Research Opportunity Program (UROP)   Summer 2018-Spring 2019
Student: Luis Sandoval   MIT

Undergraduate Research Opportunity Program (UROP)   Summer 2018-Spring 2019
Student: Amanda Putnam   MIT

Undergraduate Research Opportunity Program (UROP) Summer 2017-Summer 2018
Student: Jesse Gibson MIT

Dynamics and Vibrations Supplemental Instruction Leader Jan. 2014 – May 2016
College of Engineering U. Michigan

Mentor Jan. 2014 – May 2015
Center for Engineering Diversity and Outreach U. Michigan

Tutor Jan. 2013 – Dec. 2014
Engineering Learning Center U. Michigan

LEADERSHIP & OUTREACH

Pod Leader and Residential Advisor Summer 2021
MIT Summer Research Program MIT

Events Chair 2018-2020
Ashdown House MIT

Events chair 2016-2018
Synthetic Biology Center MIT

Events officer 2016-2018
Ashdown House MIT

External Vice-president 2015-2016
Society of Professional Hispanic Engineers U. Michigan

Academic Chair 2014-2015
Society of Professional Hispanic Engineers U. Michigan

SHPE'd Abroad Organizer and Trip Leader Spring 2015
Society of Professional Hispanic Engineers U. Michigan

SERVICE

M-STEM Academies Alumni Panelist
Panelist during undergraduate and graduate career to share best practices and mentor current students

Advise to a Scientist
Wrote an article on navigating graduate school.

Faculty search committee (student member, MechE, MIT, 2019)

Reviewer: Nat. Commun, mSystems, Cell Systems, Fobes, ASM, ACC 19'21'

HONORS AND AWARDS

National Science Foundation Graduate Research Fellowship 2016
Ford Foundation Predoctoral Fellowship 2016
Mechanical Engineering Spirit Award 2016
The Mechanical Engineering Symposium: Best Junior Research Poster 2015
Lloyd H. Donnell Scholarship 2015
Center for Engineering Diversity and Outreach: Stellar Multicultural Performance Award . . 2015
Boeing Scholarship 2015
BP Scholarship 2015
ExxonMobil Loft Fellowship 2014
ExxonMobil Future Leaders Academy 2014
Boeing Scholarship 2013
BP Scholarship 2013
Mechanical Engineering Desgin and Manufacturing I: Best Manufactured Robot 2013
William J. Branstrom Freshman Prize 2013
The University of Michigan STEM Academy 2012

SKILLS

Languages: English and Spanish
Programming: Python, MATLAB, C++, VBA, Mathematica
CAD: Catia, Solidworks, NX Siemen
Machining: Lathe, Mill, Laser cut, Water-jet
Wetlab: PCR, Gibson Asembly, Flow cytometry, Mutagenesis
Document Creation: Microsoft Office Suite, LaTex
Graphics Design: Inkscape