Society of Women Engineers
Aspire / Advance / Achieve

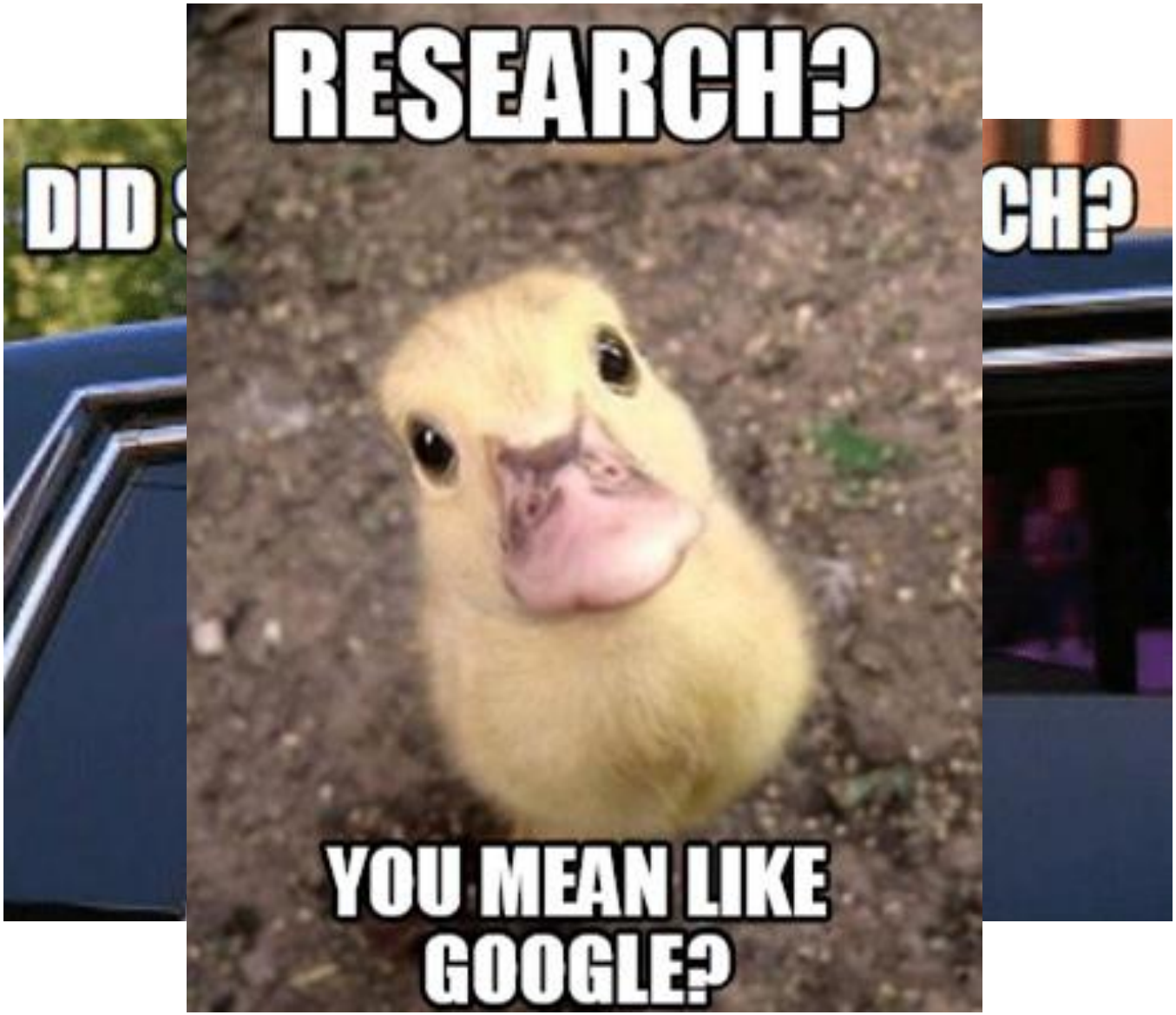
Society of Women Engineers

Spring 2020
Monday, February 17, 2020
The Wonderful World of Research

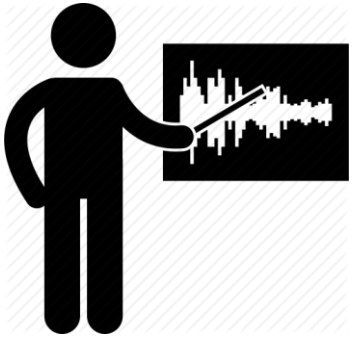
Agenda

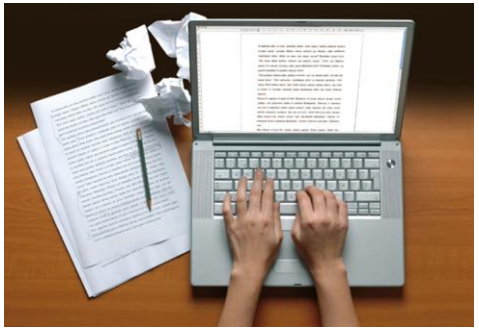
Time	Topics
6:30P - 6:45P	Sign In & Snack Time
6:45P - 7:00P	Research: What It Is & the NSF REU
7:00P - 7:15P	Special Guest: Prof. Jamie Booth, Dept of M.E.
7:15P - 7:30P	Research @ CSUN
7:30P - 7:45P	Q&A

DID SOMEONE SAY RESEARCH?

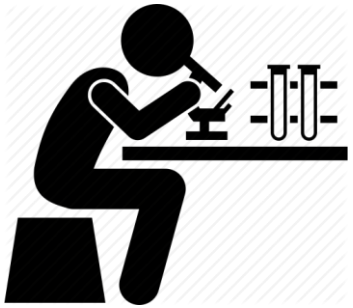

RESEARCH?
YOU MEAN LIKE GOOGLE?

Research….

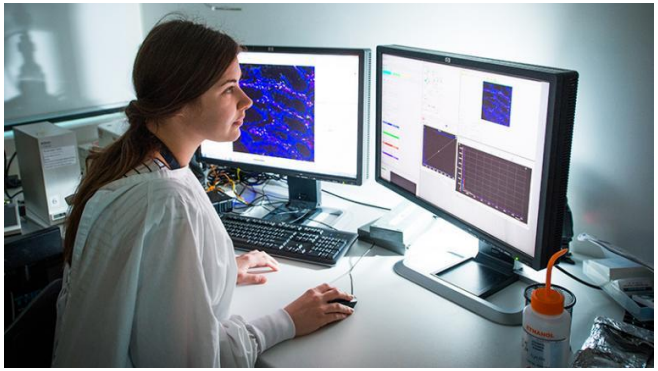




when someone asks what grad school is like
I have no friends and I never leave my house.

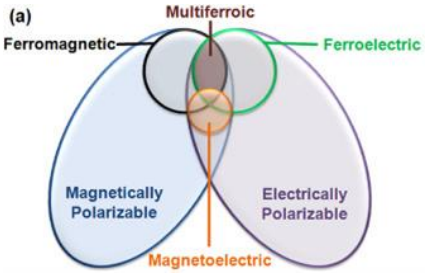


I HAVE NO
IDEA WHAT
I'M DOING
Doing Research
quickmeme.com



Inventions from University Research…

HARVARD UNIVERSITY



Nicola Spaldin

Katie Bouman

Caltech

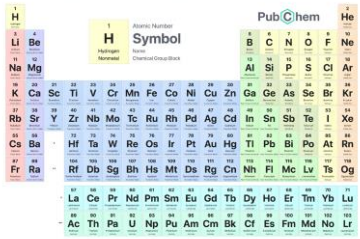
Yale

McGill UNIVERSITY

Saint Petersburg State University

Cornell University

Google



RESEARCH?

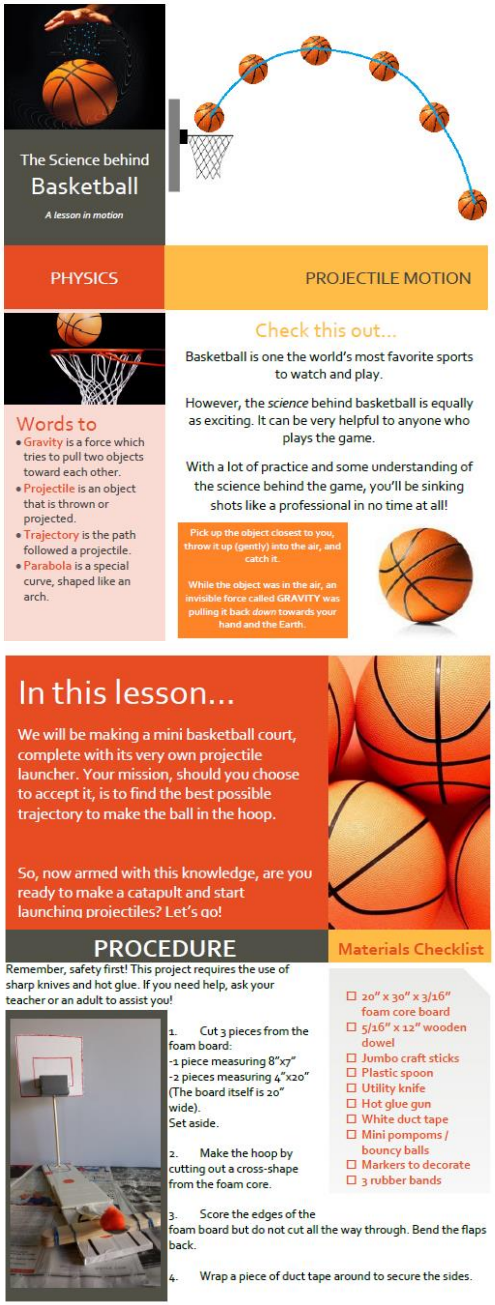
My Experiences with Research…

- AIMS^2 Summer Research
  - STEM for Elementary Students
  - Entrepreneurship in Engineering: Bon Vivant Technologies

BVT
bon vivant technologies

Attract Inspire Mentor Support Students
AIMS^2

HSI STEM Grant Program



The Science behind Basketball

A lesson in motion

PHYSICS

PROJECTILE MOTION

Check this out…

Basketball is one the world's most favorite sports to watch and play.

However, the *science* behind basketball is equally as exciting. It can be very helpful to anyone who plays the game.

With a lot of practice and some understanding of the science behind the game, you'll be sinking shots like a professional in no time at all!

Words to

- Gravity is a force which tries to pull two objects toward each other.
- Projectile is an object that is thrown or projected.
- Trajectory is the path followed a projectile.
- Parabola is a special curve, shaped like an arch.

Pick up the object closest to you, throw it up (gently) into the air, and catch it.

While the object was in the air, an invisible force called GRAVITY was pulling it back *down* towards your hand and the Earth.

In this lesson…

We will be making a mini basketball court, complete with its very own projectile launcher. Your mission, should you choose to accept it, is to find the best possible trajectory to make the ball in the hoop.

So, now armed with this knowledge, are you ready to make a catapult and start launching projectiles? Let's go!

PROCEDURE

Remember, safety first! This project requires the use of sharp knives and hot glue. If you need help, ask your teacher or an adult to assist you!

1. Cut 3 pieces from the foam board:
-1 piece measuring 8"x7"
-2 pieces measuring 4"x20"
(The board itself is 20" wide).
Set aside.

2. Make the hoop by cutting out a cross-shape from the foam core.

3. Score the edges of the foam board but do not cut all the way through. Bend the flaps back.

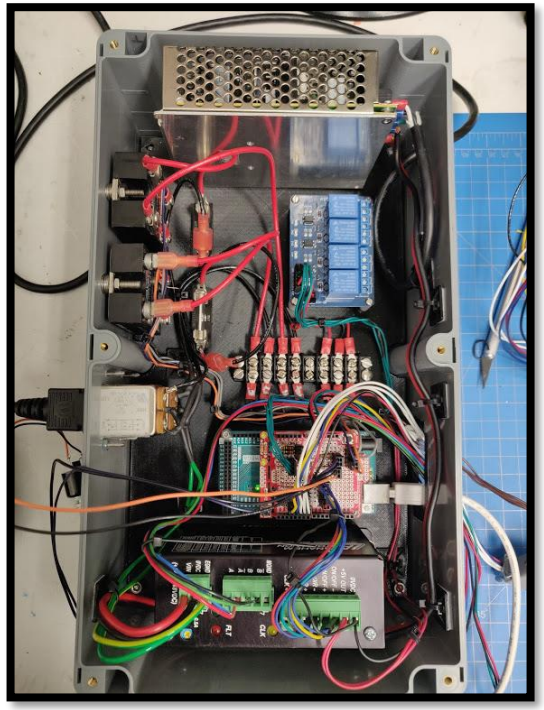
4. Wrap a piece of duct tape around to secure the sides.

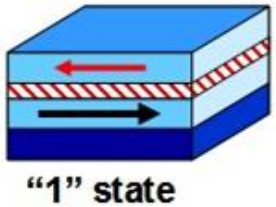
Materials Checklist

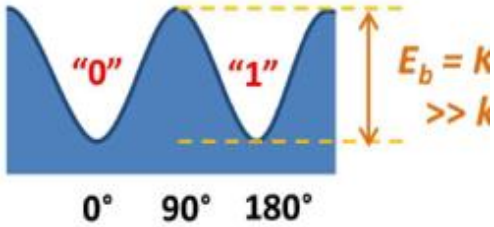
- ☐ 20" x 30" x 3/16" foam core board
- ☐ 5/16" x 12" wooden dowel
- ☐ Jumbo craft sticks
- ☐ Plastic spoon
- ☐ Utility knife
- ☐ Hot glue gun
- ☐ White duct tape
- ☐ Mini pompoms / bouncy balls
- ☐ Markers to decorate
- ☐ 3 rubber bands

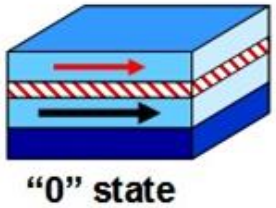
My Experiences with Research…

- HRL Laboratories
  - Industrial R&D
  - Intern for the Active Materials & Adaptive Structures group
- TANMS – NSF URP
  - Magnetic memory devices









$$VCMA = \beta \cdot \frac{E_{ext}}{\varepsilon}$$

β = VCMA coefficient
E_{ext} = external E field
ε = dielectric constant

What are we here for today?

To learn about undergraduate research opportunities

- Types of research
- Benefits of research
- NSF Research Experiences for Undergraduates
- Research opportunities at CSUN

Types of Research

Fundamental	Applied
Answer the why, what or how of fundamental principles	*Answer a question in the real world and to solve a problem*

How does this benefit you?

- Hands-on learning experiences
- Define career interests
- Expansion of knowledge
- Build a network of peers

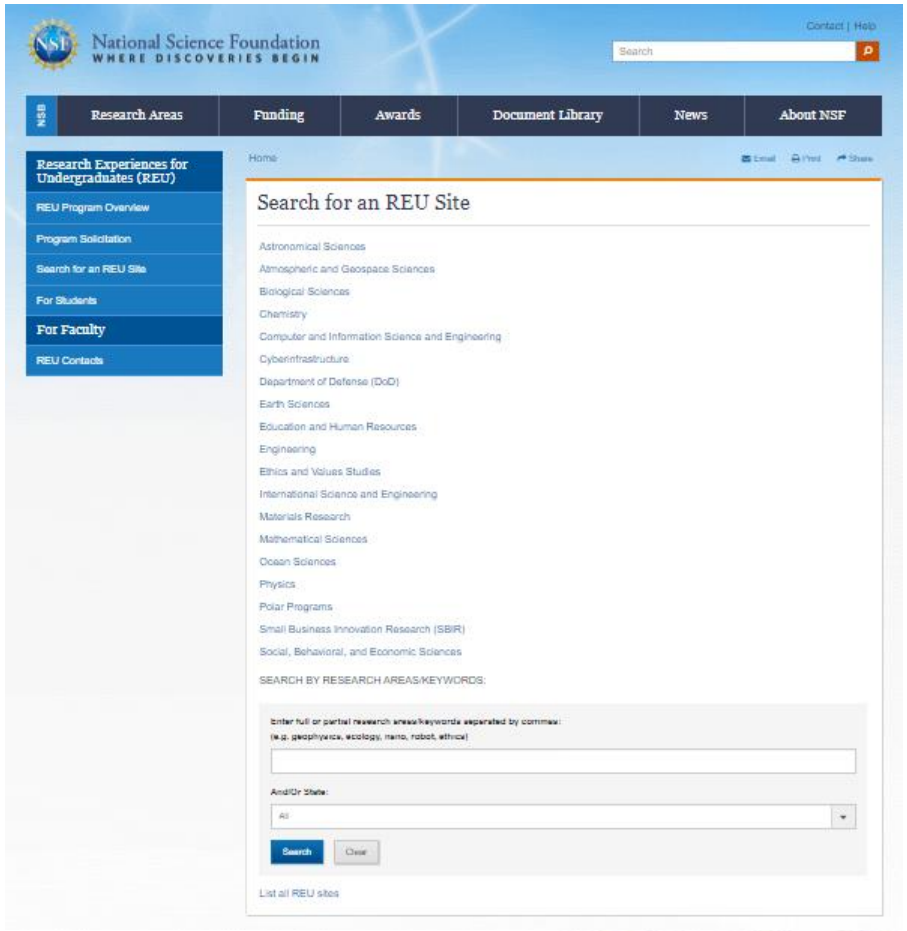
Most of all….graduate school admission!

What is REU?

Research Experiences for Undergraduates (**REU**) is a Foundation-wide program that supports active participation in science, engineering, and education research by undergraduate students.

Programs available

- Biological Sciences
- Computer and Information Science and Engineering
- Education and Human Resources
- Engineering
- Geosciences
- Mathematical and Physical Sciences
- Materials Research
- Social, Behavioral and Economic Sciences



Program Specifics

Who: Undergraduate student - U.S. citizens, U.S. nationals, or permanent residents of the United States

When: Summer or academic year

Benefits: Stipend (weekly), meals, travel assistance, and housing

Where?

Cornell University Founded A.D. 1865

Georgia Tech

Stanford

Tufts University

Texas A&M University

Illinois

Princeton University

Massachusetts Institute of Technology

How to apply?

https://www.nsf.gov/crssprgm/reu/reu_search.jsp

→ http://bit.ly/nsfREUsearch

Special Guest
Jamie Booth, PhD

swe

CSUN | CALIFORNIA STATE UNIVERSITY NORTHRIDGE

U.S.ARMY

erc European Research Council Established by the European Commission

NATIONAL SCIENCE FOUNDATION MRSEC MATERIALS RESEARCH SCIENCE & ENGINEERING CENTERS

Alexander von Humboldt Stiftung/Foundation

Designing tough multifunctional materials inspired by nature

Bioinspired Mechanics Lab
PI: Jamie A. Booth
Jamie.booth[at]csun.edu

Collaborators: Robert M. McMeeking, Kimberly L. Foster, Verena Tinnemann, René Hensel, Eduard Arzt, Mattia Bacca

Overview

- Motivation
- Research highlights
- Future work

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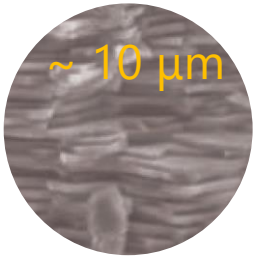
Motivation

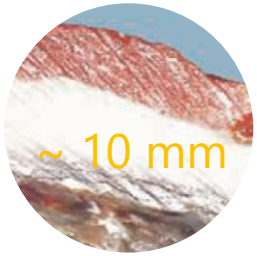
'To develop novel hierarchical materials… nature can play the role of teacher, and mechanics will lead the way.' Gao et al. (2005)

Microarchitectured materials in nature exhibit…

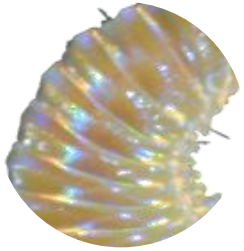
- Strength and toughness
- Multifunctionality

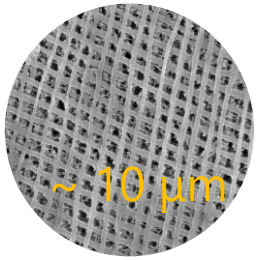
Ortiz and Boyce (2008)

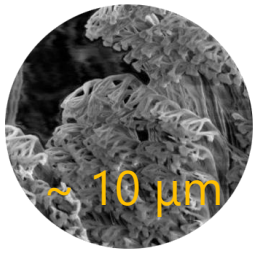


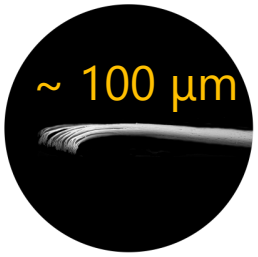


Wonderly et al. (In prep)









Kellar Autumn Photography

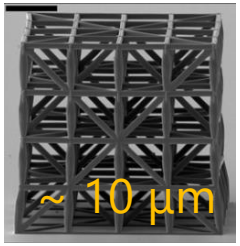
Motivation

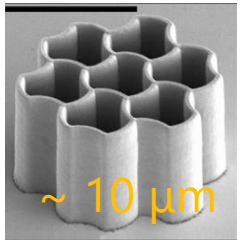
New opportunities for the creation of hierarchical microarchitectures are being afforded by advances in manufacturing capabilities…

Microfabrication

- Photolithography and replica molding
- Microcontact printing
- 3D lithography

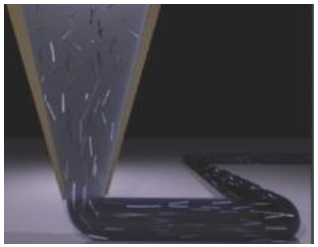
(Bauer et al. 2014)

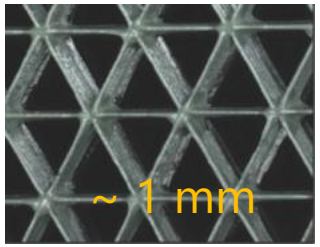




Additive manufacturing

- Multimaterial printing
- Field-assisted printing with microparticles



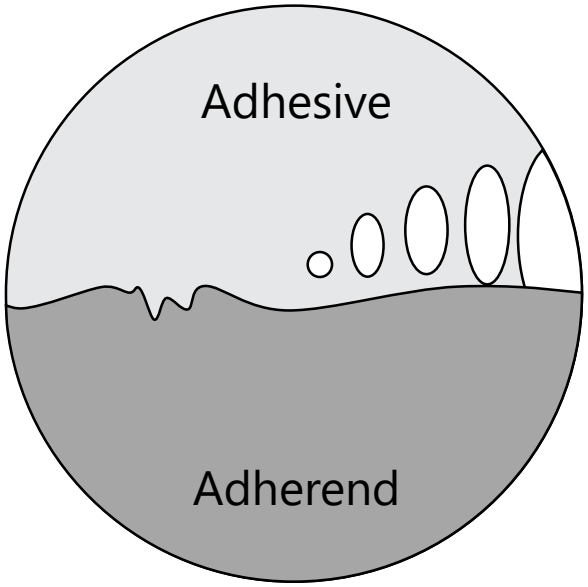


(Compton and Lewis 2014)

Overview

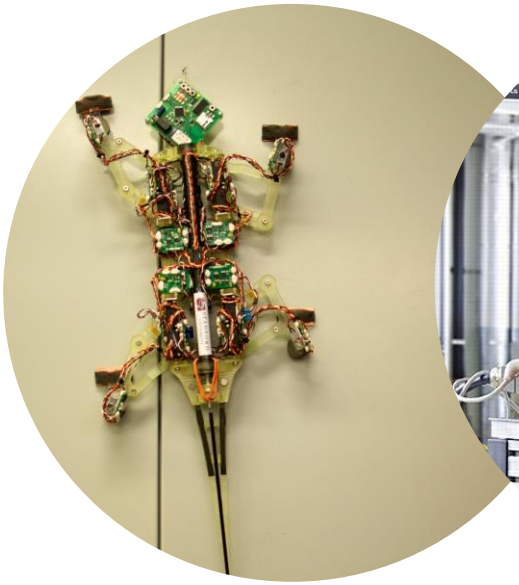
- Motivation
- Research highlights
- Future work

Conventional pressure sensitive adhesives (PSAs) use soft viscoelastic polymer layers



- Conforms to surface roughness across length scales, utilizing intermolecular forces
- Increases energy requirement for separation above intrinsic intermolecular interaction
- Prone to creep failure, self adhering, surface fouling

Reversible, reusable adhesives could enable advances in a diverse application space



(Hawkes et al. 2011)

(Hensel et al. 2018)

(Bae et al. 2013)

Multiple cooperative physical mechanisms lead to the generation of significant adhesive strength

~ 10 cm

~ 1 µm

~ 100 µm

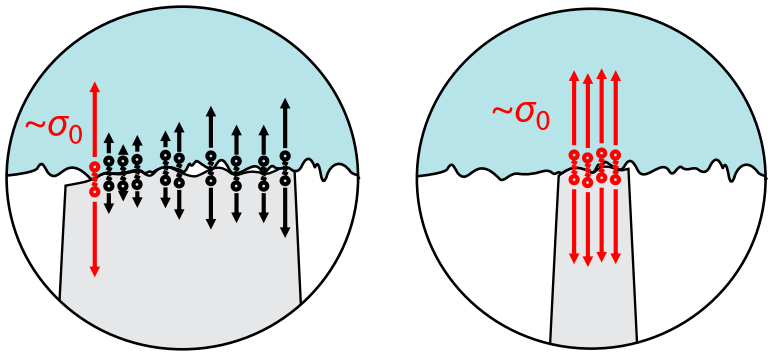
~ 10 mm

Hierarchical structure

Intrinsic modulus, E ~ 1 GPa (Peattie et al. 2007)

Effective modulus (preload), E ~ 100 kPa (Autumn et al. 2006)

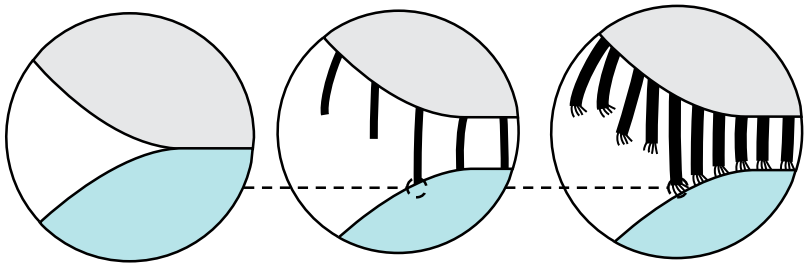
Multiple cooperative physical mechanisms lead to the generation of significant adhesive strength



Reduction in size of sub-contacts limits size of defects and reduces severity of stress concentrations

(Gao and Yao 2004)

(McMeeking et al. 2008)



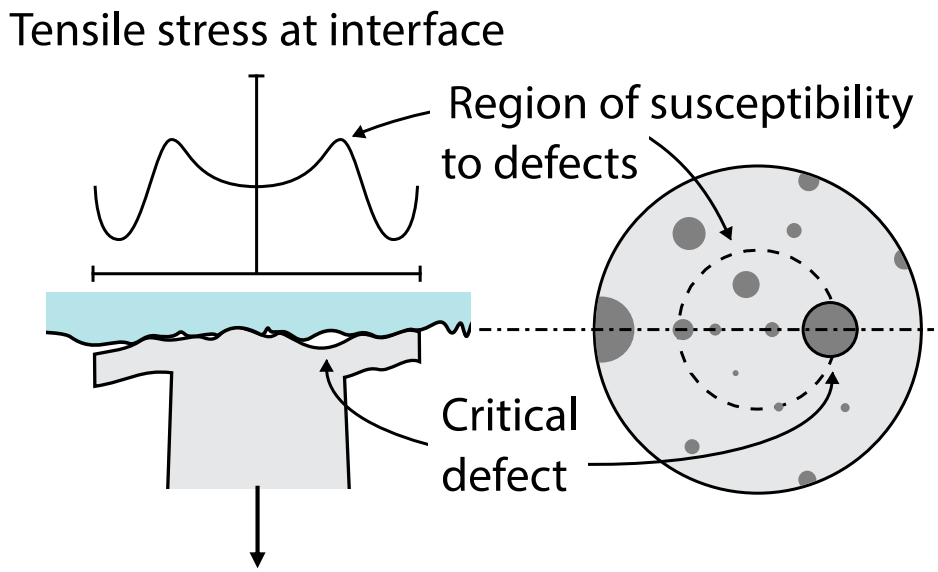
Strain energy in fibrils at detachment provides an extrinsic contribution to work of adhesion, increasing with dimensions of the contact due to hierarchy

(Jagota and Bennison 2002)

(Yao and Gao 2007)

Adhesive performance is dependent on behavior across multiple scales, from the individual fibril to the array

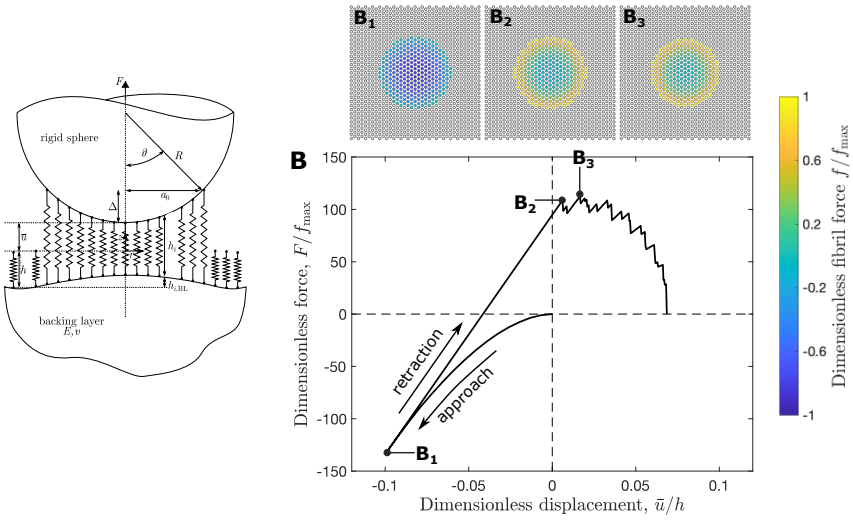
Leibniz INM



Fibril geometry, interfacial defect character (surface roughness, fabrication imperfections) control strength of an individual fibril. Currently investigating role of suction during defect growth.

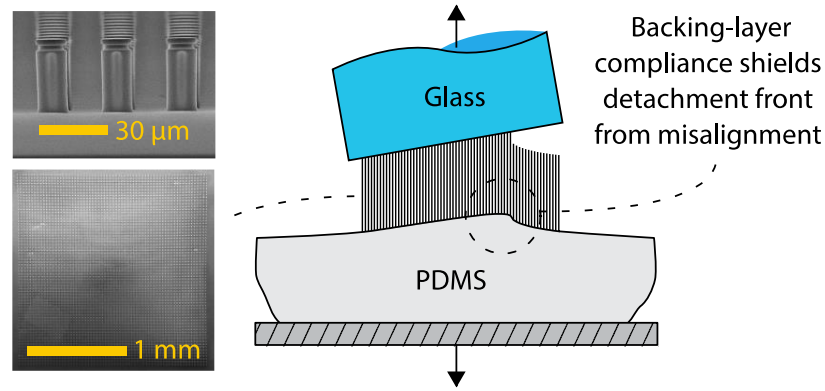
Booth et al. (In prep.)

Adhesive performance is dependent on behavior across multiple scales, from the individual fibril to the array



Discrete nature of fibrillar contact controls performance in spherical probe adhesion tests

Bettscheider, Booth et al. (In prep.)



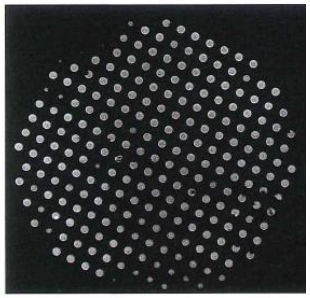
Backing layer deformation beneficial in resisting peeling of fibrillar adhesive patches

Bacca, Booth et al. *JMPS* (2016)

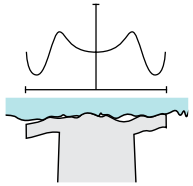
Booth et al. *Adv. Mat. Interfaces* (2018)

Variation in character of interfacial defects governs statistical properties of fibril strength

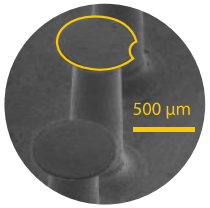
Frustrated total internal reflection – high contrast contact imaging

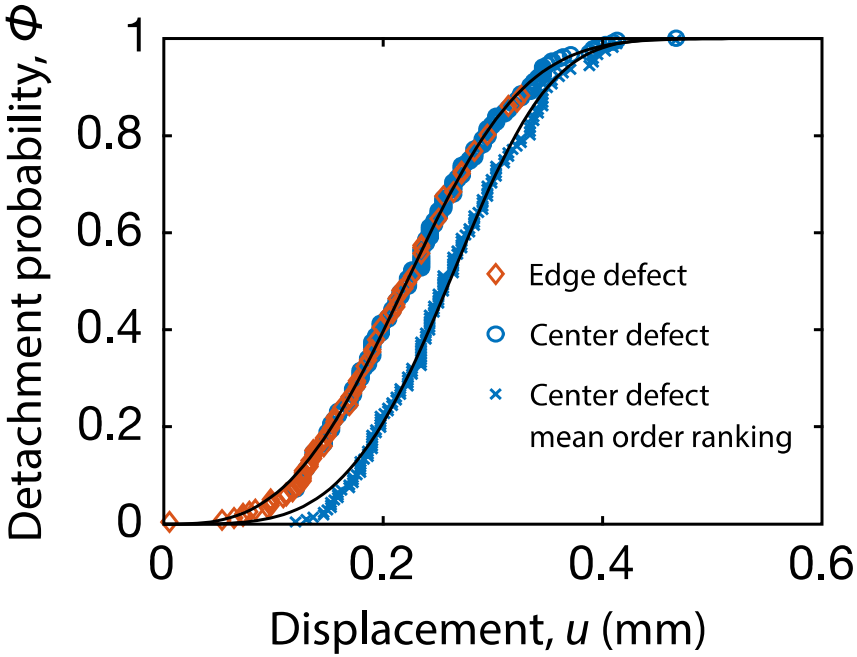


Geometry-controlled



Imperfection-controlled





Statistical properties can be decoupled and impact on performance assessed

Booth et al. *J. R. Soc. Interface* (2019)

A fibrillar adhesive in action

Source: Leibniz INM

Overview

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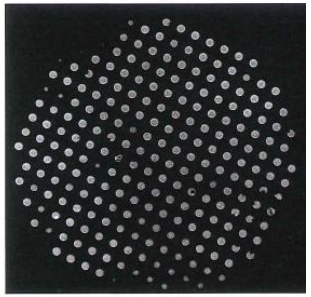
Future work

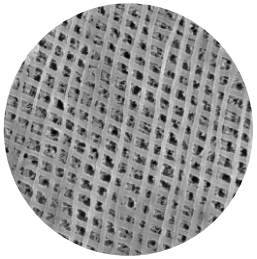


Performance of bioinspired fibrillar adhesives on rough surfaces

- Will open the door to a broader range of applications of reversible and reusable adhesives

Constitutive properties and toughening mechanisms in foams and lattice materials

- Will lead to a new generation of light-weight multifunctional bioinspired materials



Project opportunities

Undergraduate

- Design and build of experimental set-ups for specialized materials testing (machining custom components, hardware-software interfacing)
- Fabrication of materials (molding, 3D printing etc.)

Graduate

- Advanced finite element modeling approaches for architectured materials, adhesion and fracture
- Adhesion and fracture testing of bioinspired materials

Why get involved in research?

In addition to the technical skills developed, research allows you to…

- Learn skills of independent and self-motivated work
- Boost your oral and written communication skills
- Become the expert in your topic – giving you a chance to tell your professor something (or many things) they don't know!
- Evidence all of these things on your CV
- Build community in your research group
- Get a great letter of recommendation from your advisor

Research @ CSUN

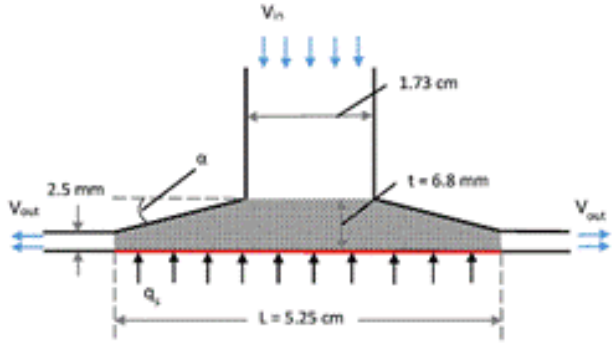
swe

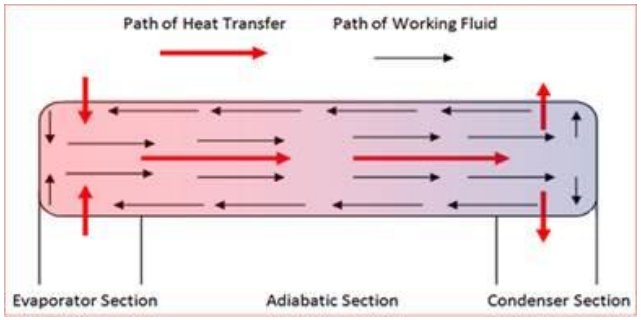
Thermofluid Research and Design Lab

Dr. Shadi Mahjoob

Research Projects

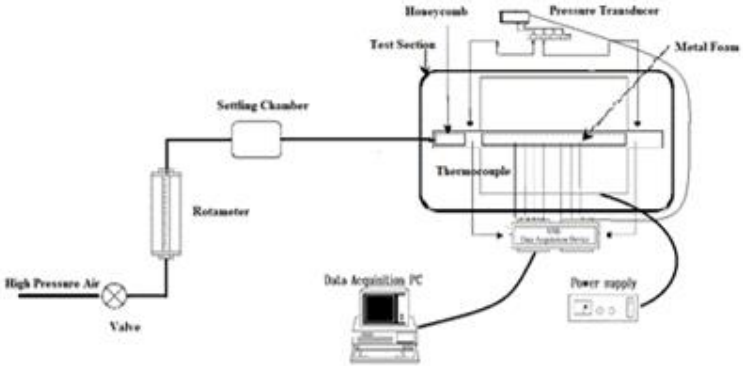
- Experimental, Numerical, and Analytical Investigation of Transport through Porous Media
- Experimental and Numerical Investigation of Multiphase flow and Phase Change
- Numerical and Analytical Investigation of Transport through Biological Media
- Turbomachinery and Gas Turbine Cooling Techniques

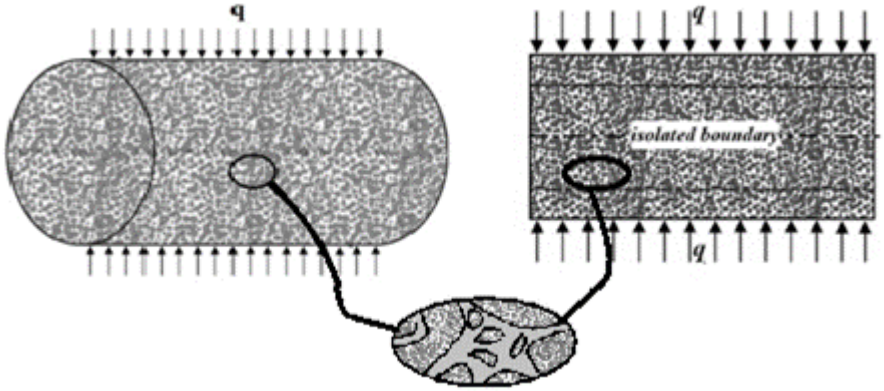




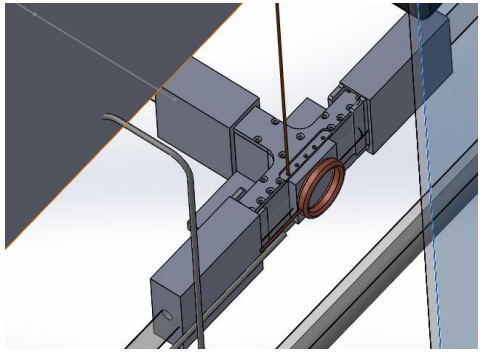
Shadi Mahjoob, PhD

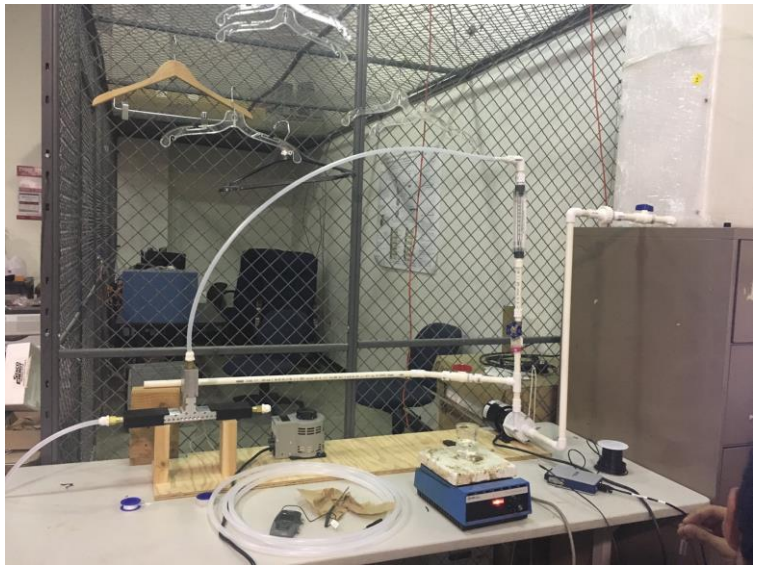
shadi.mahjoob[at]csun.edu

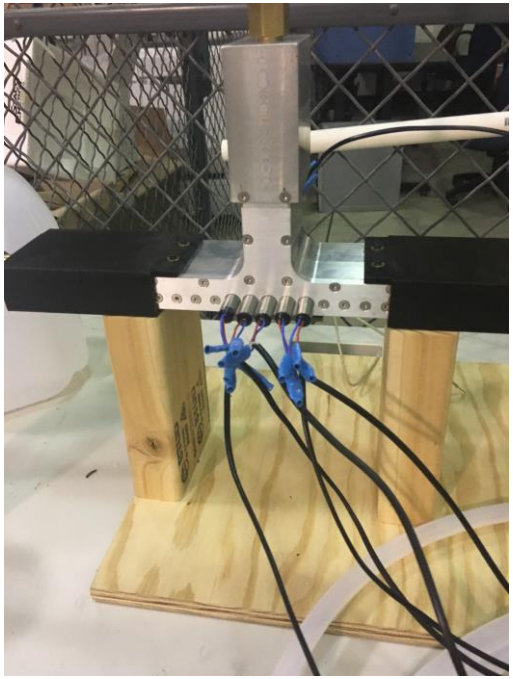




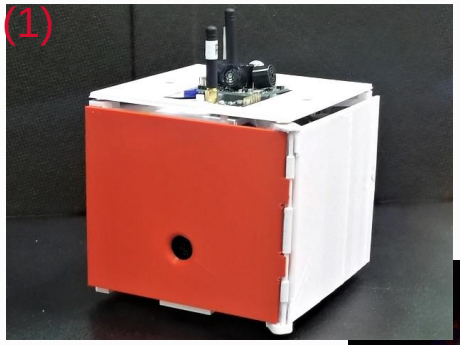
Dr.Mahjoob Heat Exchanger Design

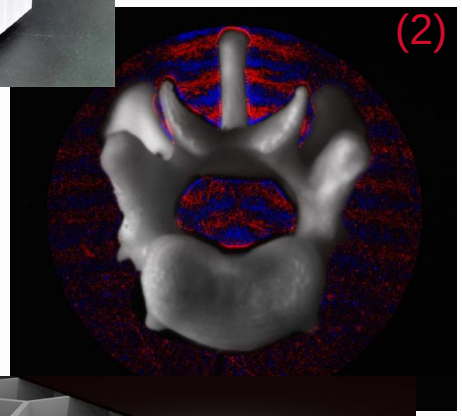


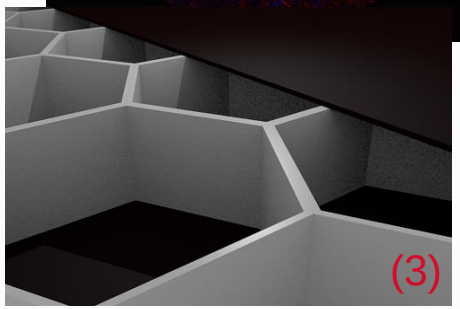




Ultrasonics and Applied Mechanics Laboratory







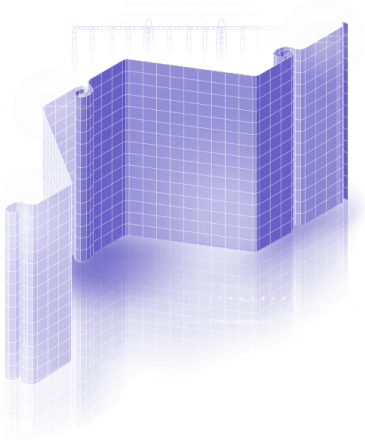
Research projects:

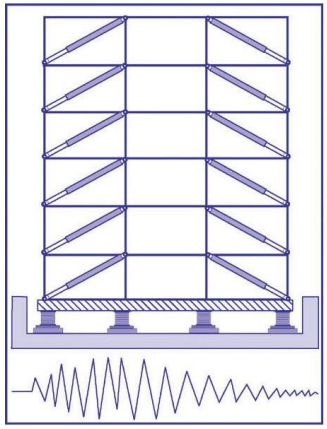
1) Autonomous aircraft inspection robot (aka *Lambot*)
2) Focused ultrasound for medical applications
3) Intelligent, sustainable composite components

Team:

- PI: Dr. Christoph Schaal, christoph.schaal[at]csun.edu
- Currently: 4 graduates (ME), 12 undergraduates (ME, CE, ECE, CS) and 3 Ph.D. (MAE, UCLA) students

www.csun.edu/~cschaal/





Tadeh Zirakian, Ph.D., P.E., LEED® Green Associate™, SAP E.&C.

tadeh.zirakian[at]csun.edu

Research Areas and Interests

- Earthquake Engineering and Structural Dynamics
- Performance-Based Design and Retrofit of Structures
- Response and Vulnerability Assessment of Structures
- Buckling Stability of Thin-Walled Structures
- Application of Innovative Materials in Civil Engineering
- Experimental Investigation and Methods
- Green & High-Performance Buildings, LEED, Sustainability
- Engineering Education

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College of Engineering and Computer Science

Computer Science

- Katya Mkrtchyan ⊕

Electrical and Computer Engineering

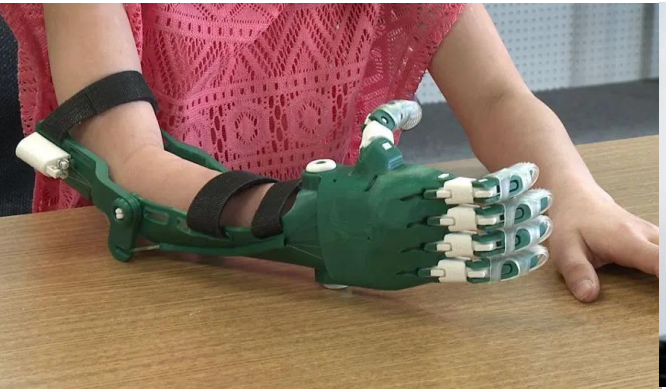
- Bruno Osorno ⊕
- John Valdovinos ⊕

Manufacturing Systems Engineering and Management

- Bingbing Li ⊕

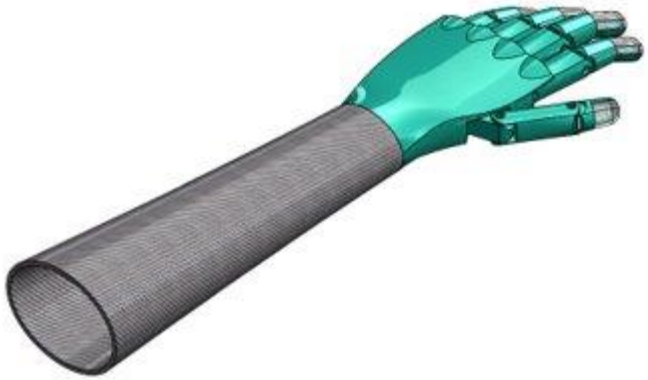
Mechanical Engineering

- Shahdi Mahjoob ⊕
- Vidya Nadikolla ⊕



Smart Prosthetics Research Club

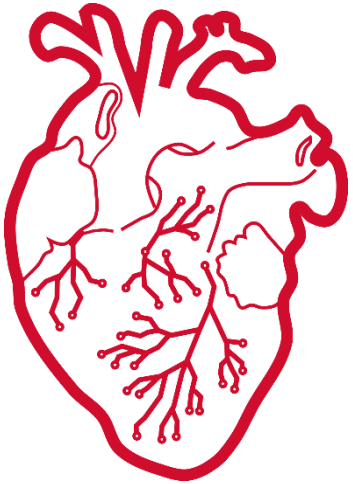
To design and produce low cost, electrical prosthetic limbs.



Activities

- 3D Printing Workshop
- Resin Printing Workshop
- Coding With Arduino Workshop
- Build-your-code
- Subteam Shadowing

For more information
Smartprosthetics[at]gmail.com



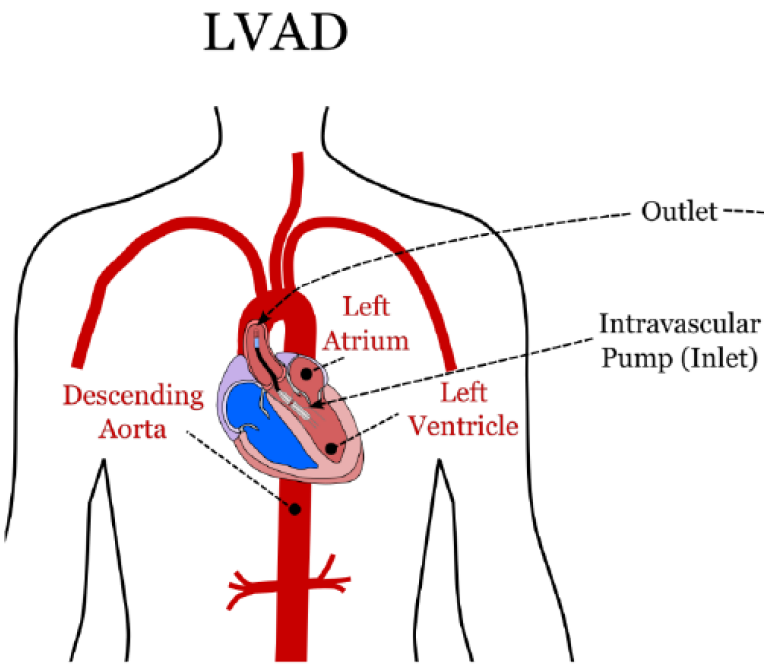
Biomedical Engineering Research Opportunities

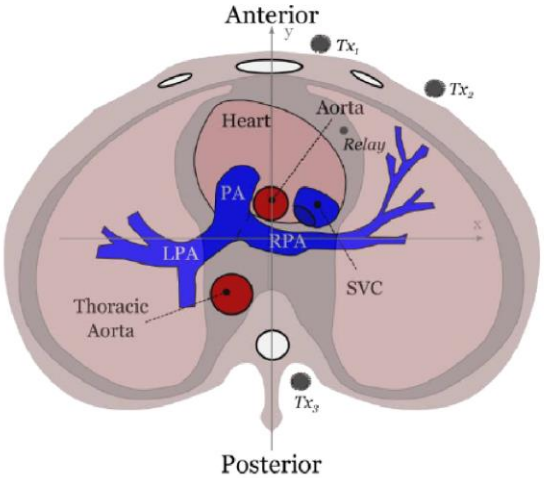
Professor John Valdovinos (ECE)
john.valdovinos[at]csun.edu

http://www.csun.edu/~jvaldovin/

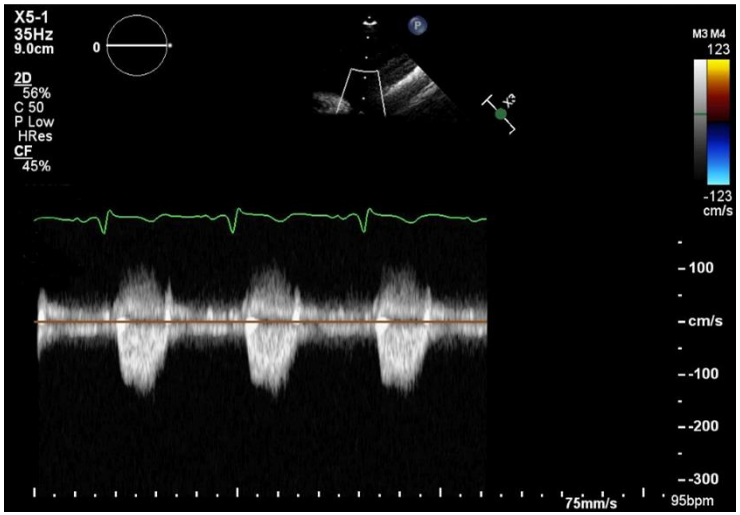
Wireless intravascular ventricular assist devices

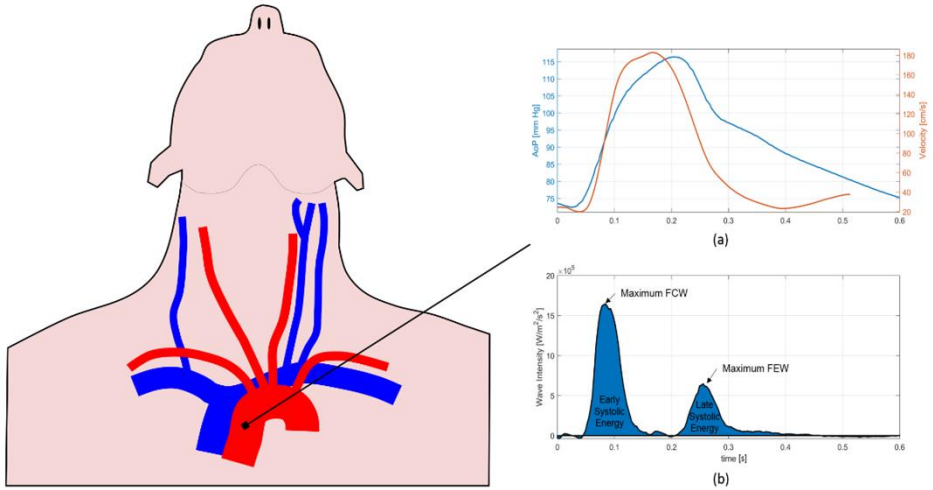
- **Objective:** Develop a system that provides electrical power to an intravascular ventricular assist device wirelessly (NIH funded)
- **Subproject 1:** Help create a 2D (planar) model of a transmitter with constructive interference in human tissue (solving wave equation)
- **Subproject 2:** Development of wireless transmitters for constructive interference in tissue
- **Requirements:** Interest in numerical modeling of Maxwell's equations, have a relatively strong MATLAB background, electronics prototyping experience a plus but not required, and enthusiastic!





Wave intensity analysis for cardiovascular disease diagnosis

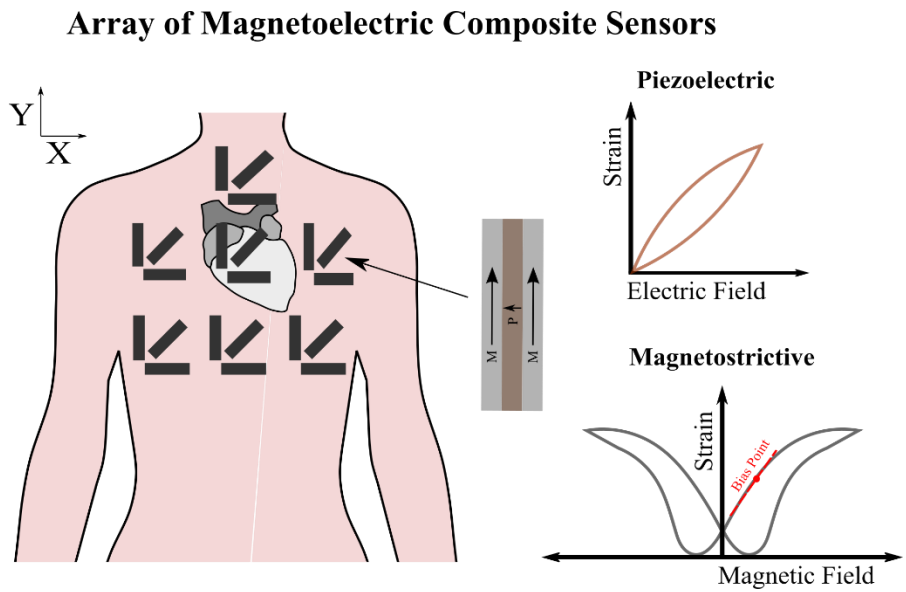


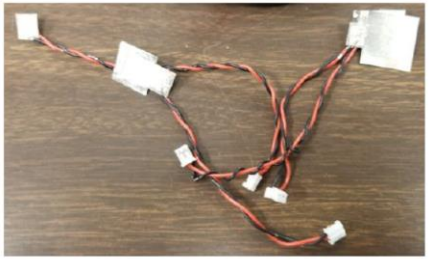


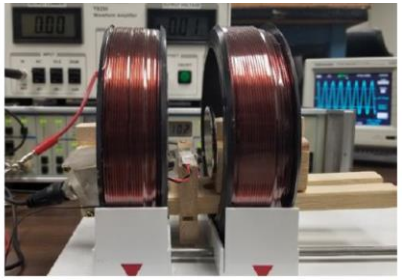
- **Objective:** Evaluate the clinical value of wave intensity analysis as a diagnostic tool for detecting heart failure in children with congenital heart disease
- **Subproject 1:** Optimize current MATLAB scripts to automatically calculate wave intensity and its components given echo Doppler images and pressure waveforms
- **Requirements:** Interest in signal analysis biomedical signals, strong background with MATLAB, interest in making MATLAB apps, interest in statistical methods in biomedical engineering, ability to collaborate with staff and MD's at UCLA Mattel Children's hospital

Biomagnetic field mapping with magnetoelectric sensors

- **Objective:** Develop magnetic sensors sensitive enough to capture weak biomagnetic signals from the heart (known as magnetocardiograms)
- **Subproject 1:** Fabricate magnetoelectric composites from piezoelectric MCF and Metglas, experimentally characterize devices, and feasibility testing as magnetic field mapping sensors
- **Requirements:** Interest in fabrication and experimental testing of magnetic field sensors and strong background in using electronic measurement equipment







Check out our lab @

http://www.csun.edu/~jvaldovin/

Valdovinos Laboratory

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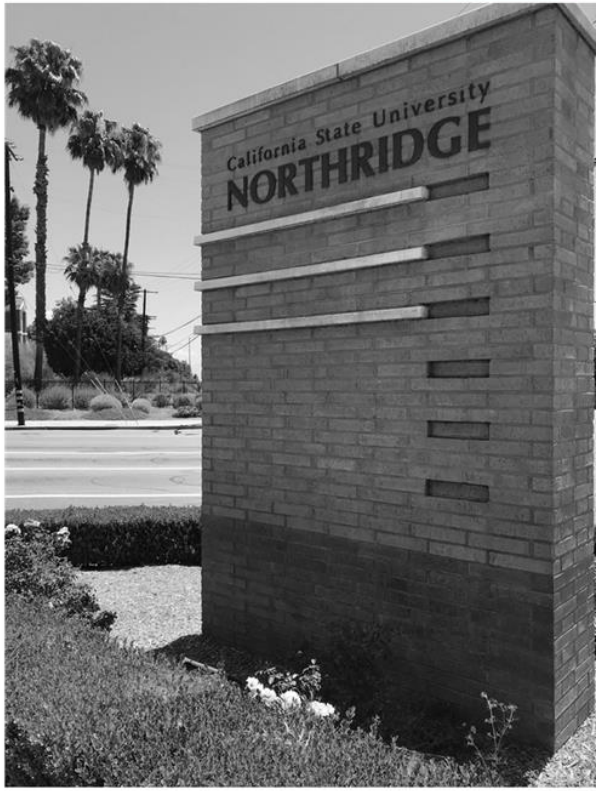

Welcome to the Biomedical Devices Laboratory! Research in the CSUN Biomedical Devices Laboratory centers on three key themes: (1) finding solutions to improve the implantability of cardiovascular medical devices used to treat heart failure, (2) using mathematical tools to understand and diagnose complex cardiovascular diseases, and (3) developing sensitive magnetic sensors to non-invasively measure biomagnetic signals. Please look through our research. Do not hesitate to contact us if you are interested in collaborating or joining the group.

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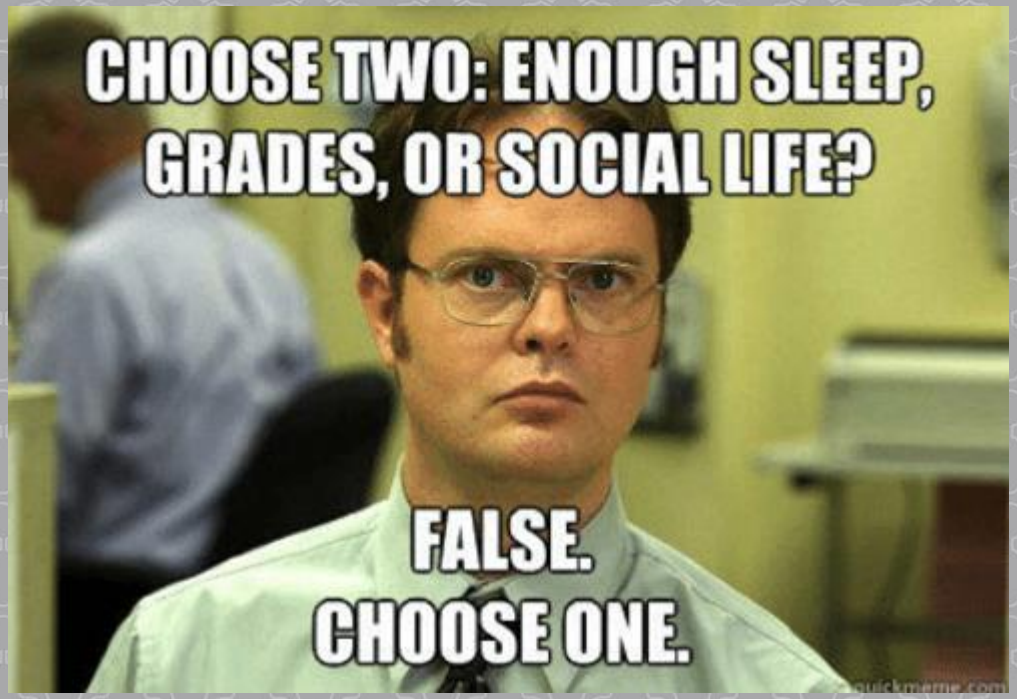
Thank you for coming!

Life as an STEM major



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