

# Haoyu Zhang

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## RESEARCH INTEREST

Investigating the mechanical properties of articular cartilage to advance diagnostics and treatment for cartilage-related disorders, with a focus on wear mechanisms and structural changes. Leveraging computational modeling, advanced imaging techniques, and experimental methods to enhance understanding and improve patient outcomes in musculoskeletal health.

## EDUCATION

### Columbia University

New York, NY

*Master of Science in Mechanical Engineering, concentration in **Biomechanics***

09/2022-12/2023

- **GPA:** 3.8762/4.00
- **Relevant Courses:** Data Science for Mechanical Systems, Intro Theory to Elasticity I, Introduction to Robotics, Solid Biomechanics, Mechanics of Fluid, Advanced Machine Dynamics, Sound and Hearing

### Boston University

Boston, MA

*Bachelor of Science in Mechanical Engineering*

01/2019-05/2022

- **GPA:** 3.6/4.0 | Cum Laude (05/2022), Dean's List (4 times during 2019 and 2022)
- **Relevant Courses:** Engineering Mechanics, Fluid Mechanics, Electric Circuits, Mechanics of Materials, Manufacturing Processes, Introduction to Materials Science, Energy and Thermodynamics
- **Honors:** 2020 CGS Team W Co-winning Capstone Award (11/2020)

## RESEARCH EXPERIENCE

### Investigating the Impact of Migrating Contact Area (MCA) on Inducing Wear in Human Tissue and Refining Cartilage Thickness Measurements, Musculoskeletal Biomechanics Laboratory,

Columbia University

New York, NY

*Student Research Fellow*

06/2023-08/2023

- Employing advanced software applications including 3D Slicer, Geomagic Freeform, Geomagic Wrap, Creo, and MATLAB to develop and implement an improved testing protocol, resulting in enhanced accuracy and standardized measurements.
  - Implementing the "Grow from Seeds" feature in 3D Slicer to isolate cartilage from bone and barium sulfate, creating precise segments saved in STL format.
  - Employing Geomagic Freeform to rectify imperfections and achieve a smooth surface for the cartilage model, ensuring high-quality data analysis.
  - Demonstrating proficiency in using Geomagic Wrap to extract and refine bone and cartilage surfaces, leveraging features such as "Mesh Doctor" and "Remove Spikes," and exporting them as IGES files.
  - Leveraging Creo to import IGES files and create a vertical plane for precise measurements, ensuring accurate cartilage thickness calculations.
  - Utilizing MATLAB to generate visualizations, producing surface maps that depicted variations in cartilage and bone thickness, contributing to comprehensive data analysis.
- Contributing significantly to developing robust methodologies for measuring cartilage thickness, furthering understanding of cartilage biomechanics, and facilitating improved diagnosis and treatment of cartilage-related conditions.
- Performing data collection with various methods, including photography, surface scans, sample measurements, mechanical tests, Fuji film usage, friction tests, and post-mechanical tests, ensuring comprehensive data acquisition.
- Conducting rigorous MCA vs. SCA tests on human femur cartilage to validate the wear induction capabilities of MCA tests, contributing to advancements in the field.

### Investigating Mechanical Properties and Behavior of Articular Cartilage for Understanding Osteoarthritis Progression, Musculoskeletal Biomechanics Laboratory

Columbia University

New York, NY

*Graduate Research Assistant*

10/2022-Present

- Collaborating with 3 graduate students to conduct mechanical tests on articular cartilage and provide insights into factors contributing to cartilage damage and osteoarthritis progression.
- Successfully obtaining cartilage samples through dissections of human and bovine tibiae and femora, facilitating further analysis.
- Leveraging Polarized Light Microscopy (PLM) to observe and evaluate the degree of tissue damage in articular cartilage following frictional tests, providing crucial information for assessing cartilage behavior under stress.
- Employing Fuji film and Fiji software to accurately analyze initial and final contact areas between a mechanical pendulum and cartilage, enabling precise quantification of contact mechanics and frictional properties.
- Designing and integrating a specialized tensile tester grip into the existing compression tester, enabling efficient mechanical testing.
- Developing and implementing a standardized photo rig that ensures consistent and accurate images of cartilage samples and improves the efficiency and reliability of data collection.
- Introducing a system that utilizes PET mirror sheets, resulting in enhanced profile shots for detailed cartilage analysis, contributing to more comprehensive research findings.

**Research Achievements:**

- Identified a volume error of approximately 8% to 9% compared to the actual object, improving the accuracy of volumetric assessments.
- Progressed with the assembly and stability testing of the basic 3D-printed parts for the tensile tester grip, facilitating advanced mechanical experiments and obtaining valuable results.

**Investigating the Effects of Test Solutions on Tectorial Membrane Integrity in Mouse Cochlea,**

Fowler Memorial Laboratory, Columbia University Irving Medical Center, New York, NY

*Student Laboratory Assistant*

10/2022-02/2023

- Worked with a graduate student and the project supervisor to examine the impact of various test solutions on the structural integrity of the tectorial membrane within the mouse cochlea.
- Performed precise dissections on mice using scissors, forceps, and a microscope to extract cochlear and tectorial membrane samples.
- Conducted experiments immersing the tectorial membrane in various buffers, including TES, to investigate the specific test solutions that induce damage, providing crucial insights into the membrane's susceptibility to different conditions.
- Acquired proficient microscopy skills to facilitate accurate dissections, overcoming the challenge posed by the small size of the mouse cochlea and ensuring precise sample extraction.
- Developed an understanding of the mouse ear's complex structures and demonstrated proficiency in extracting mouse cochlea and isolating the fragile tectorial membrane.

**Development of Marine-Life-Friendly Boat Propulsion System, Boston University College of Engineering, Boston, MA***Undergraduate Student Researcher*

09/2021-05/2022

- Collaborated with a team of 5 students to develop a marine-life-friendly boat propulsion system with a focus on low noise levels, marine life safety, and energy efficiency.
- Led the R&D of the 1<sup>st</sup> prototype of the propulsion system by incorporating 3D printed 4-bar linkages, 3D printed pin joints, and a silicone molded flatter flutter kick fin.
- Enhanced the initial prototype by employing HDPE for increased robustness, implementing two connected 4-bar linkage mechanisms, using an assembly of 8020 Aluminum bars as the fixture, and integrating pre-existing scuba diving fins optimized in shape and material.
- Devised a transistor-based power control circuit and a crankshaft design as a counterweight, further improving the system's efficiency and performance.
- Exhibited expertise in 3D printing, Computer-Aided Design (CAD), GibbsCAM, and materials selection, alongside knowledge in structural mechanics, fluid mechanics, and electrical circuits.

- Achieved a remarkable noise reduction of approximately 70% compared to conventional boats, highlighting the system's effectiveness and environmental benefits.

## PUBLICATION

Zhang, Haoyu. (2021). Task Optimal Scheduling Model of Machining System Based on Entity Modeling. *Journal of Physics: Conference Series. Ser. 1982* 012210.

## TEACHING EXPERIENCE

**Columbia University SEAS** **New York, NY**  
*Graduate Course Assistant, Course: MECE-4606: Digital Manufacturing* 01/2023-05/2023

- Instructed and guided a diverse class of 110 undergraduate and graduate students within the Digital Manufacturing class by coordinating communication between Professor Hod Lipson and students.
- Provided effective instruction, guidance, and support to students, ensuring their academic progress and comprehension of the course material.
- Offered timely feedback and clarification on homework assignments and projects, promoting a positive and inclusive learning environment.

## WORK EXPERIENCE

**Shenzhen Bestone Communication Co., Ltd.** **Shenzhen, China**  
*Mechanical Engineering Intern* 05/2022-08/2022

- Facilitated successful and timely project deliveries and after-sales services for 2 large communications equipment programs.
- Conducted weekly equipment inspections by remotely accessing the management interface through a laptop connected to the network, identifying and promptly resolving hardware issues.

**GRUE (Shenzhen) Technology Co., Ltd.** **Shenzhen, China**  
*R&D & Mechanical Design Intern* 05/2021-08/2021

- Independently programmed a PIC16F1718 microcontroller with various functionalities, including power on/off control, fan regulation, temperature sensing, status LED manipulation, and seamless communication with the main control chip.
- Demonstrated proficiency in programming and configuring the device, achieving strict alignment with the project manager's requirements and meeting the company's requirements.

**Chengdu Jiaoda Guangmang Technology Co., Ltd.** **Chengdu, China**  
*Mechanical Design Intern* 05/2020-08/2020

- Worked in a team of 3 to develop remote product designs by creating CAD drawings and actively contributing to collaborative design discussions.
- **Project 1: Guangzhou-Zhuhai Intercity Cuiheng Station RTU**
  - Optimized the structure of the UPS power supply monitoring cabinet and lamp assembly using SOLIDWORKS and ZWCAD software, resulting in improved product layouts, early delivery, and heightened customer satisfaction.
- **Project 2: Railway Traction Substation Auxiliary Monitoring System**
  - Enhanced the appearance and design of the inspection robot, boosting user acceptance and contributing to business growth of 5%.
- **Project 3: Yawan High-Speed Rail Switch Control Device**
  - Optimized the device using SOLIDWORKS and ZWCAD, achieving cost savings through material and process improvements.
- **Project 4: Wuhan-Guangzhou High-Speed Rail Network Switch Remote Control Transformation**
  - Demonstrated efficiency and precision in the on-site design of structural components, ensuring timely project completion.
- **Project 5: Zhuzhou Station Renovation**
  - Streamlined the design process and accelerated project delivery for the renovation project using ZWCAD software for the low-voltage substation's communication screen.

**VAPEL Power Supply Technology Co., Ltd.**

**Shenzhen, China**

*Production Testing Technician*

06/2018-12/2018

- Conducted rigorous hardware and software testing for communication devices and delivered 50+ test reports, showcasing proficiency in product functionality, performance, and safety assessments.
- Maintained an optimized testing environment and developed innovative product testing methods, contributing to streamlined production processes and ensuring 100% issue resolution.
- Exhibited exceptional record-keeping skills, analyzing process conditions during production trial runs, identifying areas for improvement, and offering valuable suggestions to enhance product processes.
- Fostered seamless coordination and communication with over 10 departments, ensuring efficient workflow and smooth collaboration to achieve production objectives.
- Maintained a vigilant approach to monitor production progress, product quality, and efficiency, promptly identifying and resolving anomalies, thus facilitating uninterrupted production operations.

**SKILLS**

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- **Language Skills:** English (fluent), Mandarin Chinese (native)
- **Computer Skills:** Python, C++, MATLAB, Arduino coding, SOLIDWORKS, word, Geomagic Wrap, 3D Slicer, GibbsCAM, Creo, MS Office Suite