2023

Biomechanics Laboratory

Biomedical, Industrial and Human Factors Engineering

Wright State University

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www.wright.edu/bie

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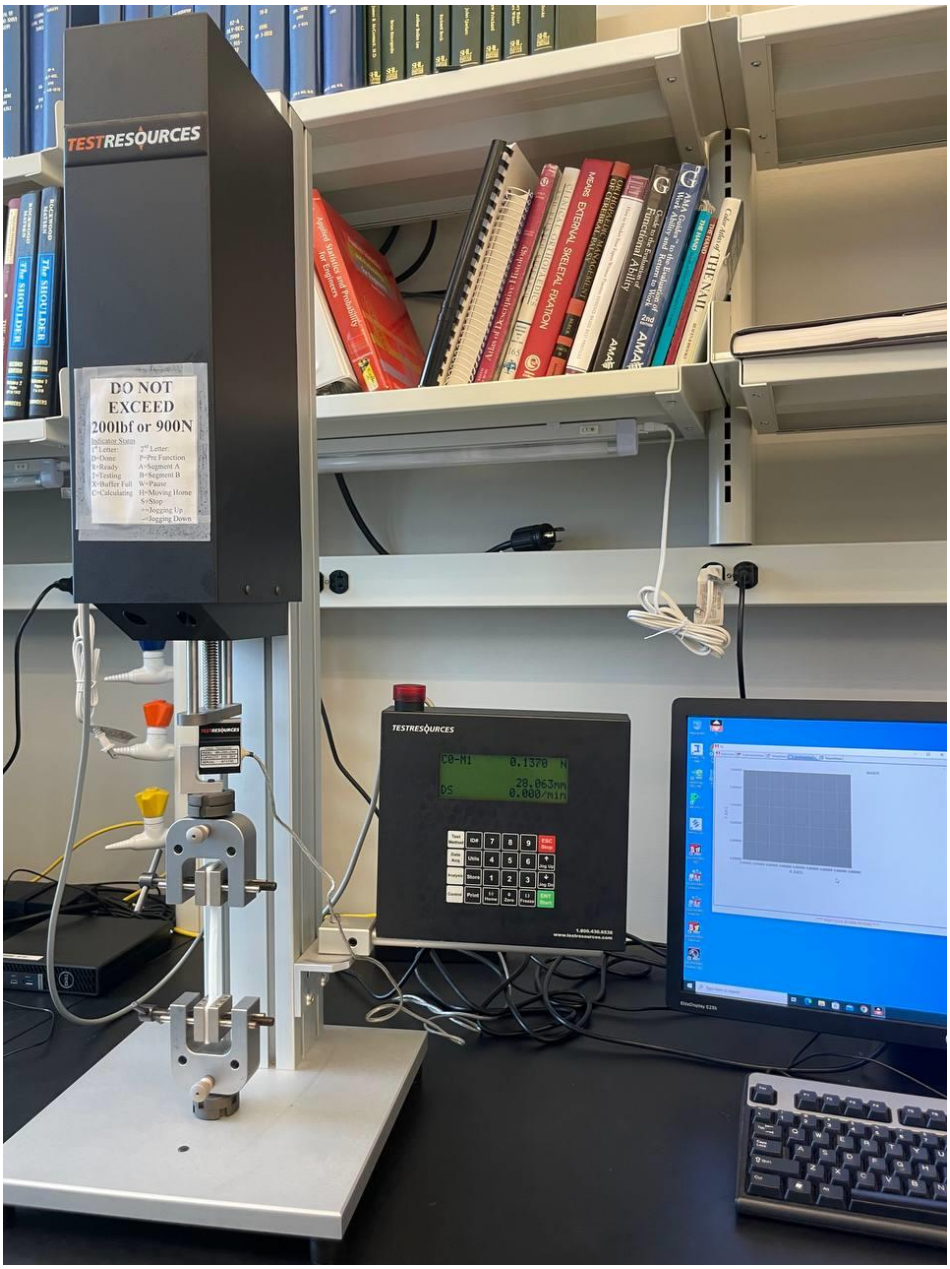
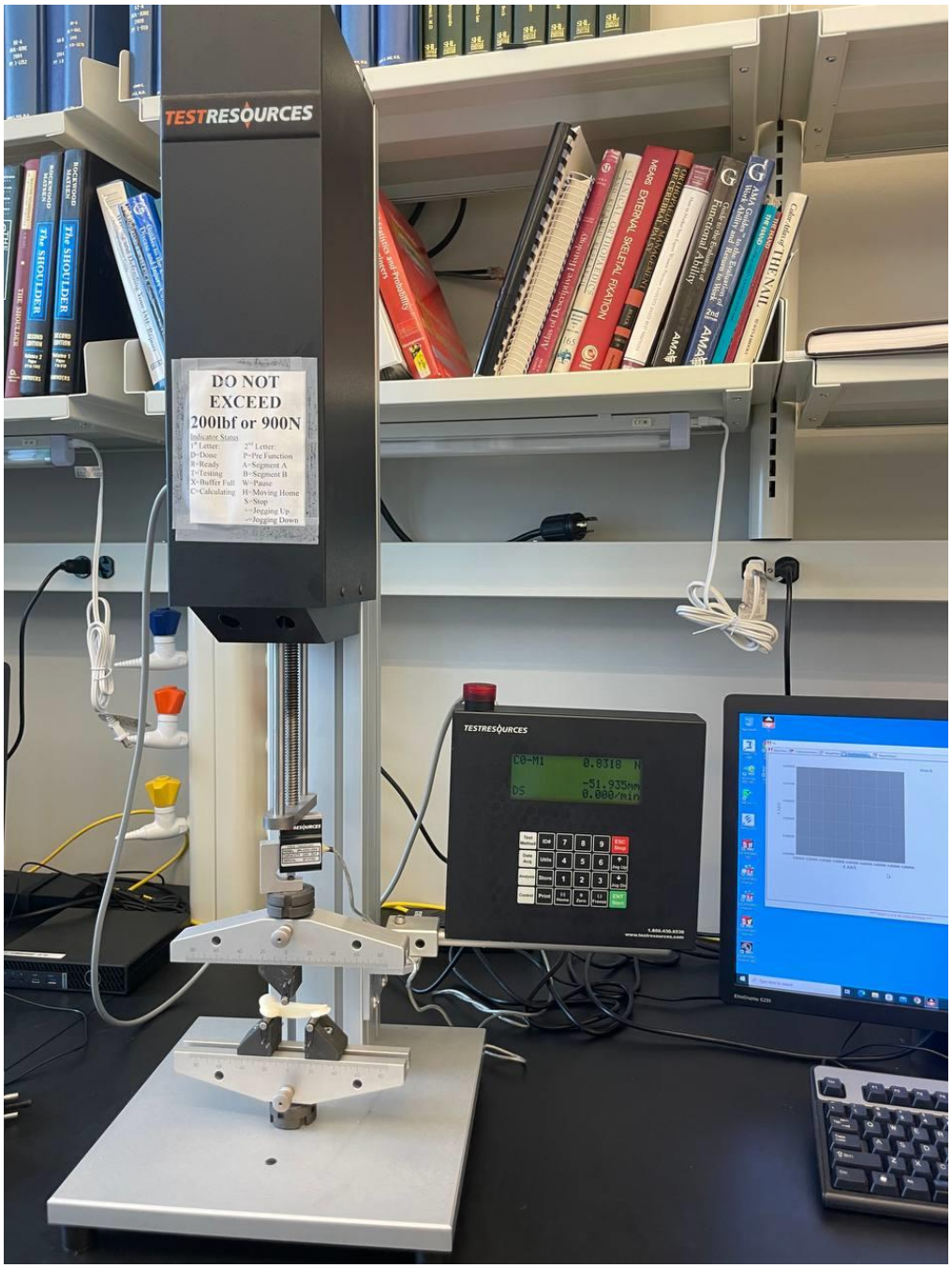
MECHANICAL TEST MACHINES

- **TestResources Q series systems**

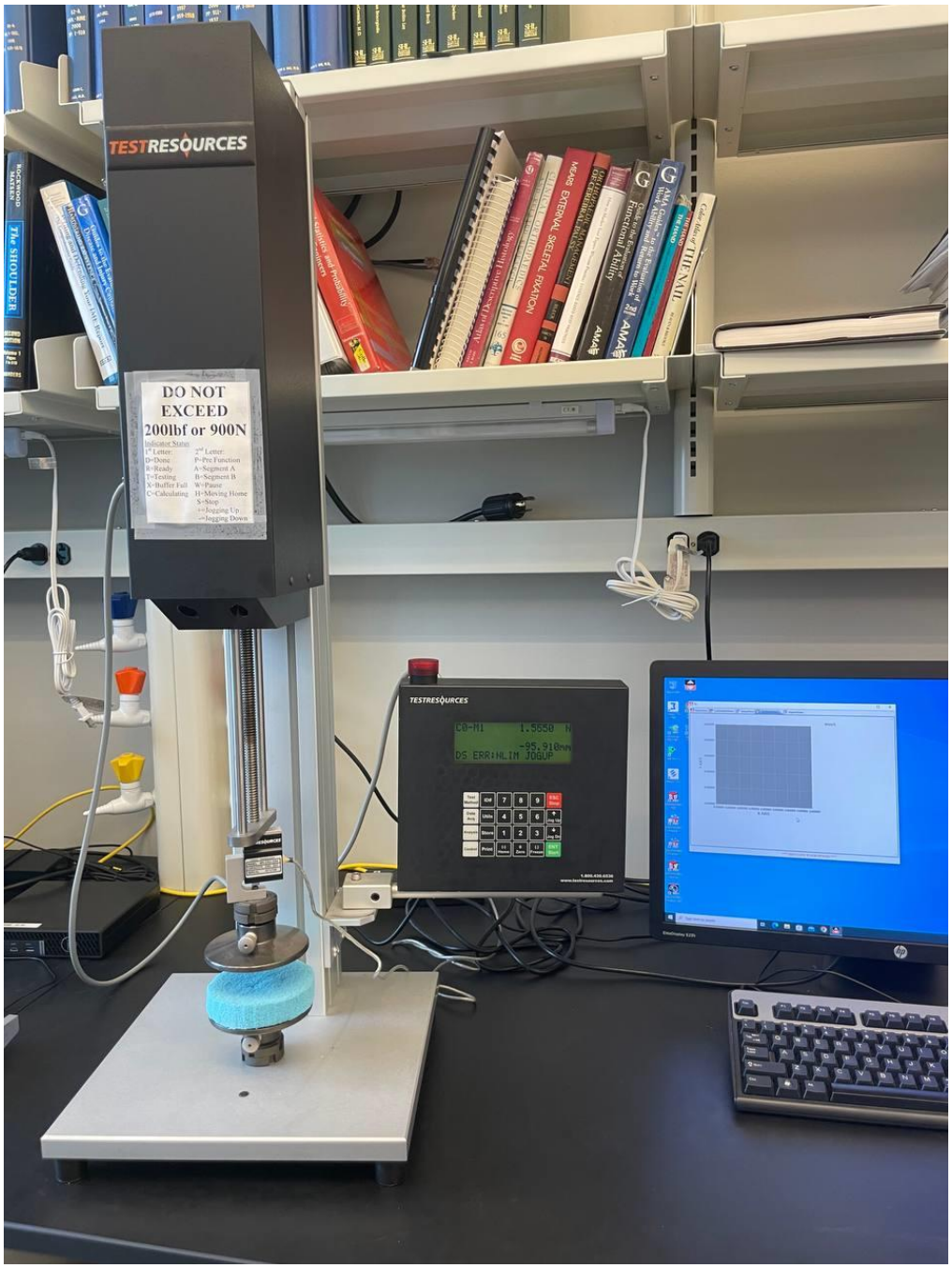
  The Biomechanics Lab has six TestResources Q series systems that are used to measure the mechanical properties of various materials such as metals, plastics, ceramics, and composites. The Q series system is designed to perform a wide range of tests including tension, compression, bending, etc. It is equipped with advanced software that enables users to control the test conditions, monitor the test data in real-time, and generate customizable reports.



Stress-strain test using the Test Resources Q series system



Three points bending test using the Test Resources Q series system



Viscoelastic Testing of Biocompatible Foam using the Test Resources Q series system

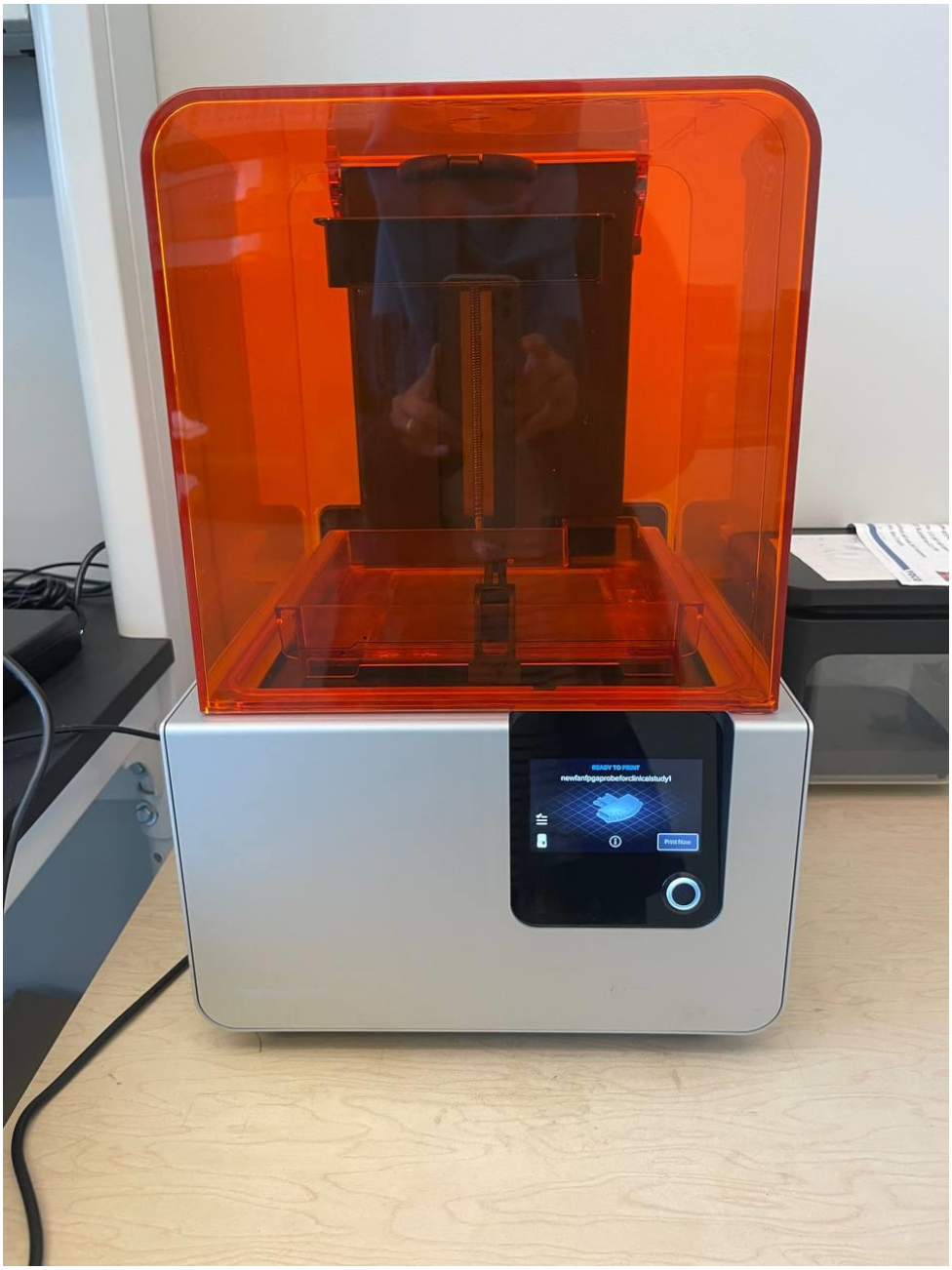
- **Bose Enduratec Bi-Axial Test System**

  One of our Biomechanics laboratory is in the basement of Miami Valley Hospital used to support orthopaedic resident and engineering students. The enduratec machine is a bi-axial system and used extensively to run projects with devices and understanding their integrity both for fixation and stability.

THREE DIMENSIONAL PRINTERS

- **Formlabs Form 2 SLA 3D Printer**

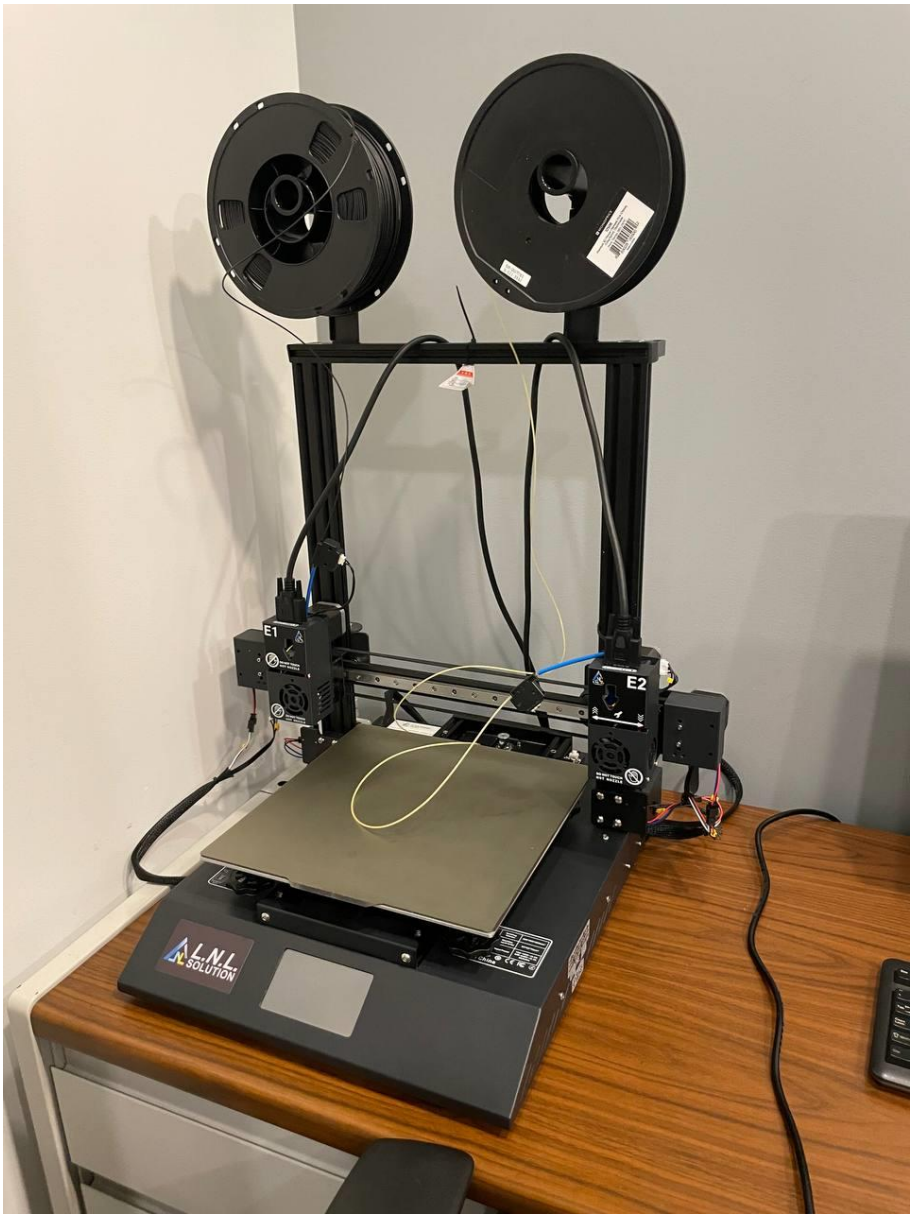
  It uses a laser to cure liquid resin layer by layer, building up a 3D object from the bottom up. The Form 2 offers a build volume of 145 × 145 × 175 mm and a layer thickness ranging from 25 to 100 microns. It supports a variety of materials, including standard resins, flexible resins, tough resins, castable resins, and more.



Formlabs Form 2 SLA 3D Printer

- **LNL3D Dual Extruder Printer - Standard Tl-D6 Large Format Dual Extruder 3D Printer**

  The TL-D6 uses Fused Filament Fabrication (FFF) technology, which involves melting a plastic filament and extruding it layer by layer to build up a 3D object. It supports a wide range of materials, including PLA, ABS, TPU, PETG, and more. The TL-D6 has a build volume of 400 x 400 x 500mm. The dual extruder system allows the printer to print with two different materials or colors at the same time. This can be useful for creating complex objects that require different materials, such as objects that need to be both rigid and flexible.



Standard Tl-D6 Large Format Dual Extruder 3D Printer

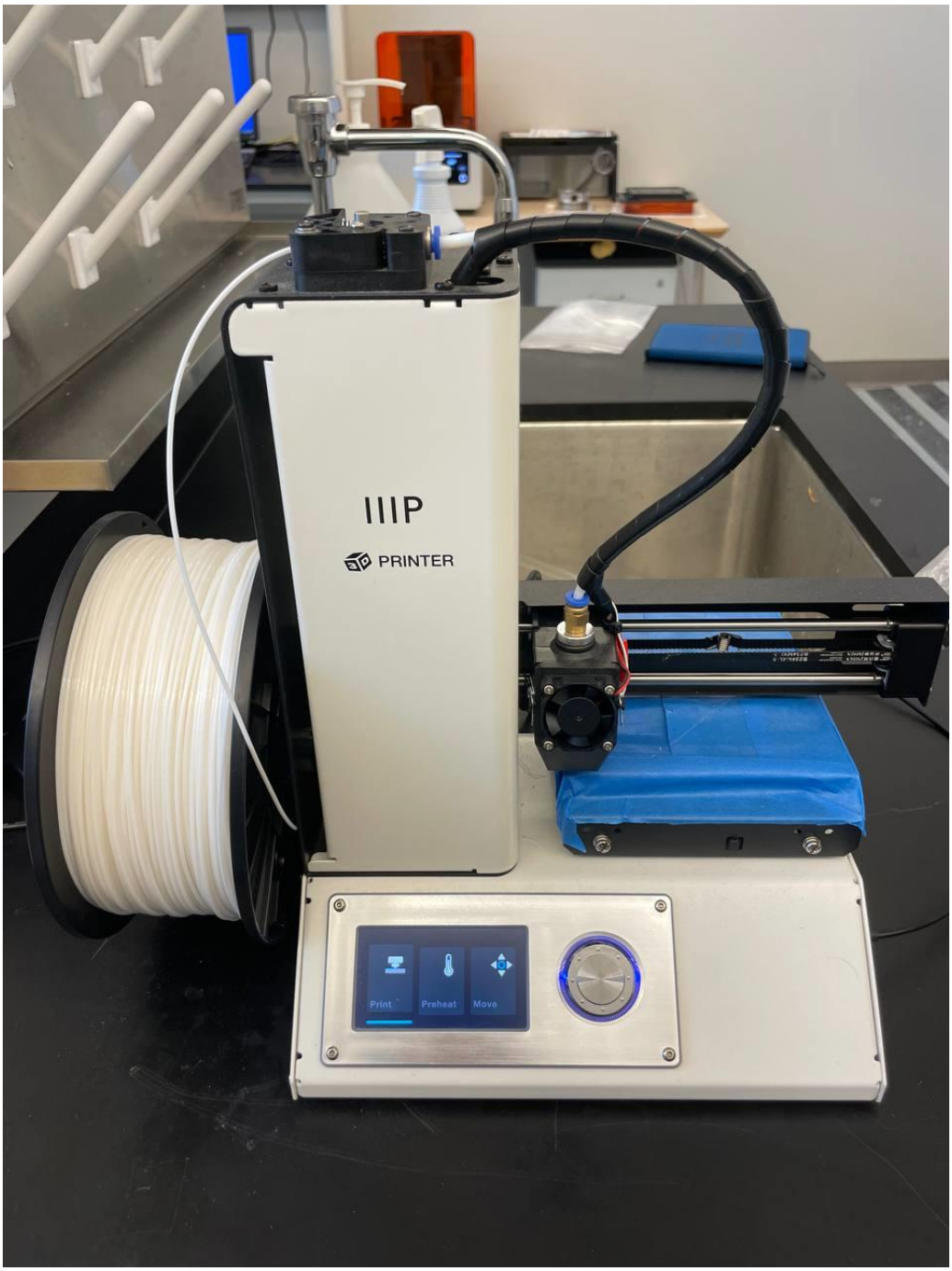
- **CraftBot Flow Grey IDEX 3D Printer**

The CraftBot Flow Grey has a build volume of 250 x 200 x 200 mm and supports a wide range of materials, including PLA, ABS, PETG, Nylon, and more. One of the key features of the CraftBot Flow Grey is its IDEX system, which allows the printer to print with two extruders independently of each other. This means that users can print two different objects simultaneously or use two different materials or colors for the same object.

CraftBot Flow Grey IDEX 3D Printer

- **Monoprice MP Select Mini Pro 3D Printer w/ Auto Leveling and Heated Removable.**

  The printer uses Fused Filament Fabrication (FFF) technology, which involves melting a plastic filament and extruding it layer by layer to build up a 3D object. It supports a wide range of materials, including PLA, ABS, PETG, and more. The MP Select Mini Pro has a build volume of 120 x 120 x 120mm.



Monoprice MP Select Mini Pro 3D Printer

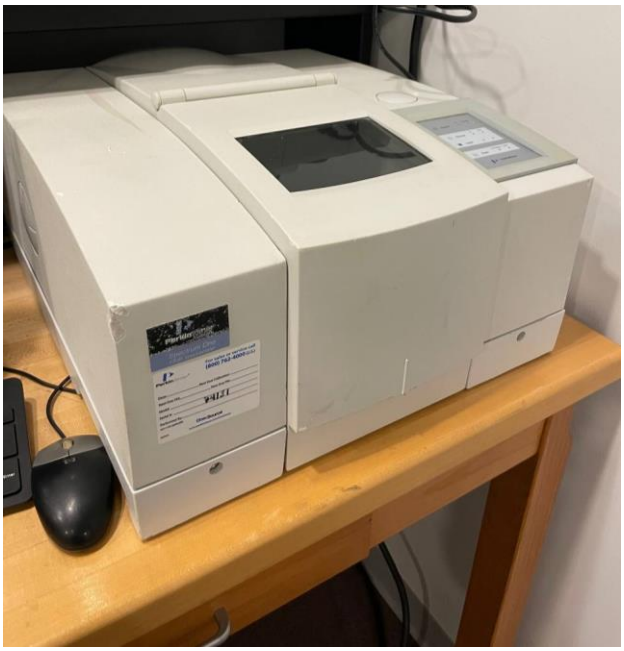
FTIR (Fourier Transform Infrared Spectroscopy)

- **PerkinElmer Spectrum One FT-IR Spectrometer**

  The spectrometer uses a highly sensitive detector to measure the infrared radiation absorbed by a sample, which can be used to identify and quantify the chemical composition of the sample.

  FTIR spectroscopy is a powerful analytical technique used in the measurement of the absorption or transmission of infrared light by a sample, providing information about its chemical composition and molecular structure and it is a powerful technique for material characterization, providing valuable information about the composition, structure, and properties of materials. Here are some of the main uses of FTIR:

  - Chemical analysis: FTIR is used for the identification and quantification of chemical compounds in various samples, including solids, liquids, and gases. It is particularly useful for the analysis of complex mixtures, such as polymers and pharmaceuticals.
  - Characterization of polymers: FTIR spectroscopy is particularly useful for the characterization of polymers. It can provide information about the polymer structure, composition, and properties, including molecular weight, degree of crystallinity, and thermal stability.
  - Analysis of coatings and films: FTIR spectroscopy can be used to analyze coatings and films on various surfaces, such as metals, ceramics, and plastics. It can provide information about the thickness, composition, and adhesion of the coatings or films.



PerkinElmer Spectrum One FT-IR Spectrometer

MICROSCOPES

- **Motic AE2000MET BF 100W - Inverted, Metallurgical Trinocular Microscope**

The microscope Brightfield (BF 10X, 20X, 50X) with 100W Illumination with Lumenera's INFINITY1 High Resolution USB2 Color Microscopy Camera.
Optical microscopes are powerful tools for characterizing materials at the microscale. Here are some ways in which optical microscopes can be used for material characterization:

- Surface analysis: Optical microscopes can be used to study the surface texture and topography of materials at the microscale. This information is useful for evaluating surface roughness, wear, corrosion, and other properties.
- Grain analysis: Optical microscopes can be used to study the grain structure of metals and alloys. This information is important for determining the mechanical properties and behavior of these materials.
- Particle analysis: Optical microscopes can be used to study the size, shape, and distribution of particles in materials.
- Defect analysis: Optical microscopes can be used to identify and analyze defects in materials such as cracks, voids, and inclusions.
- Phase analysis: Optical microscopes can be used to identify and analyze the different phases present in materials such as polymers and ceramics.

Metallurgical Trinocular Microscope

- **Olympus IX70 Inverted Fluorescence Phase Contrast Microscope**

Olympus IX70 Inverted Fluorescence Phase Contrast Microscope

REFRIGERATOR ROOM

A specialized storage area used to maintain low temperatures for the preservation of samples, reagents, and other materials that require temperature-controlled storage. The refrigerator room can typically kept at a temperature range of -80 to 8 degrees Celsius (-112 to 46.4 degrees Fahrenheit), which is the recommended temperature for storing many biological, chemical, and pharmaceutical products.

The Freezer

The Refrigerator Room

CHEMICAL FUME HOOD

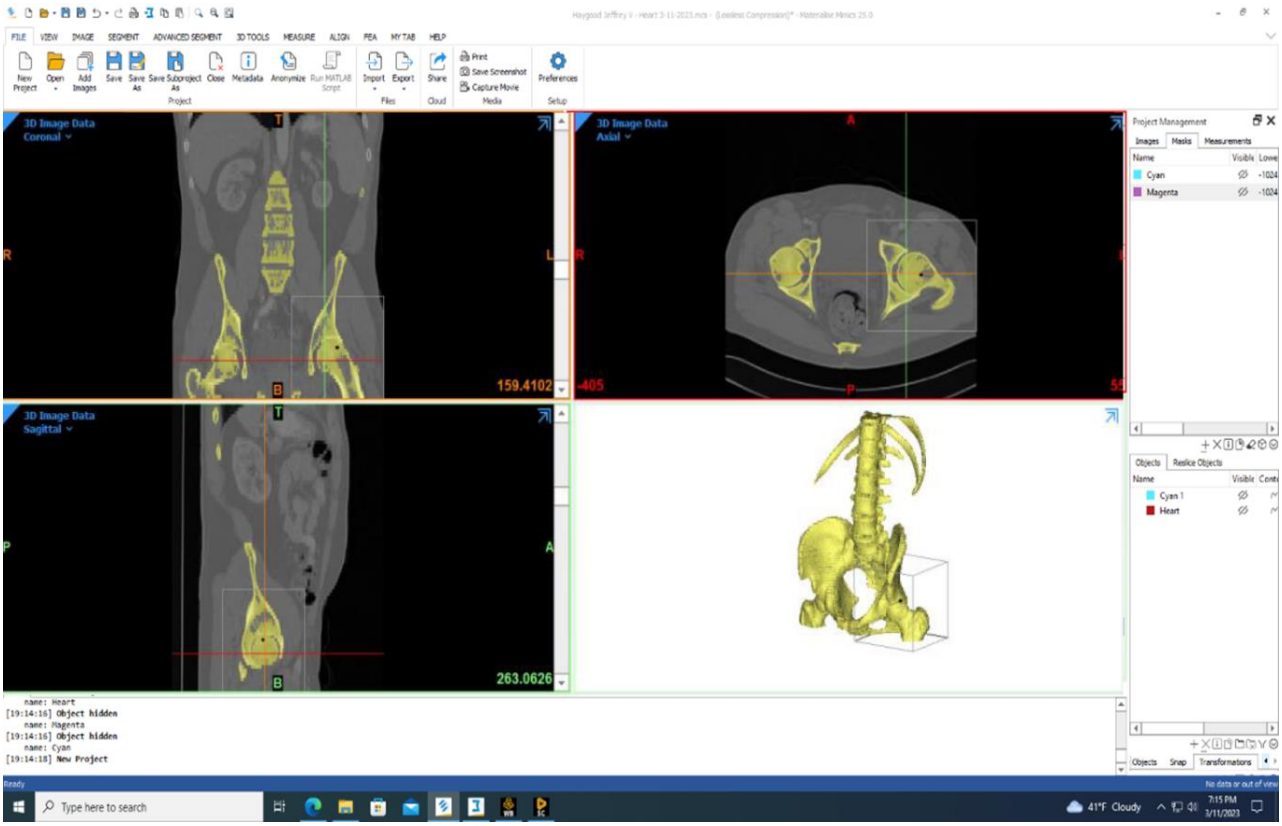
The fume hood consists of an enclosed work area with a movable window that can be raised or lowered to adjust the airflow. The fume hood is connected to a ventilation system that draws air through the work area and exhausts it outside the building or through a filtration system.

The Fume Hood

The Fume Hood

COMPUTER CAPABILITIES

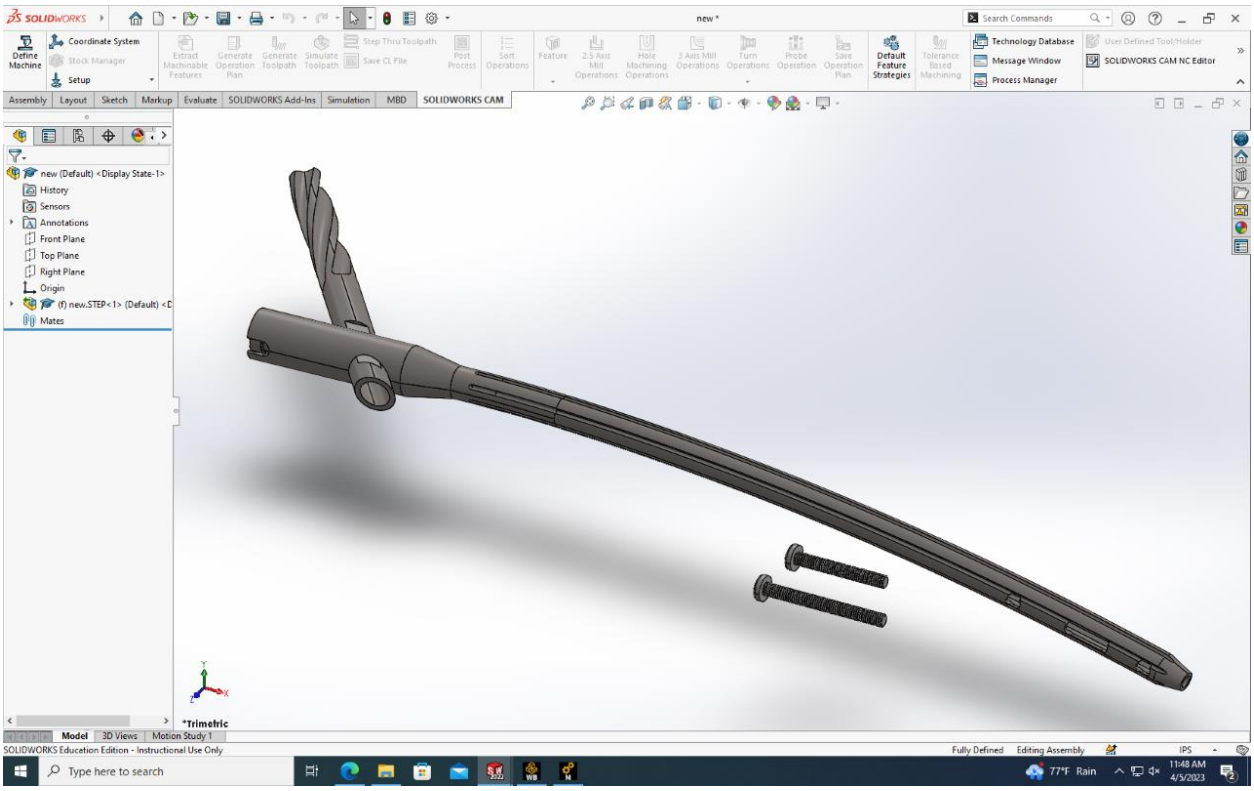
- **Mimics**
  A software tool that is used to convert medical imaging data into 3D models.



Developing a 3D model from imagining data using MIMICS

- **SolidWorks**

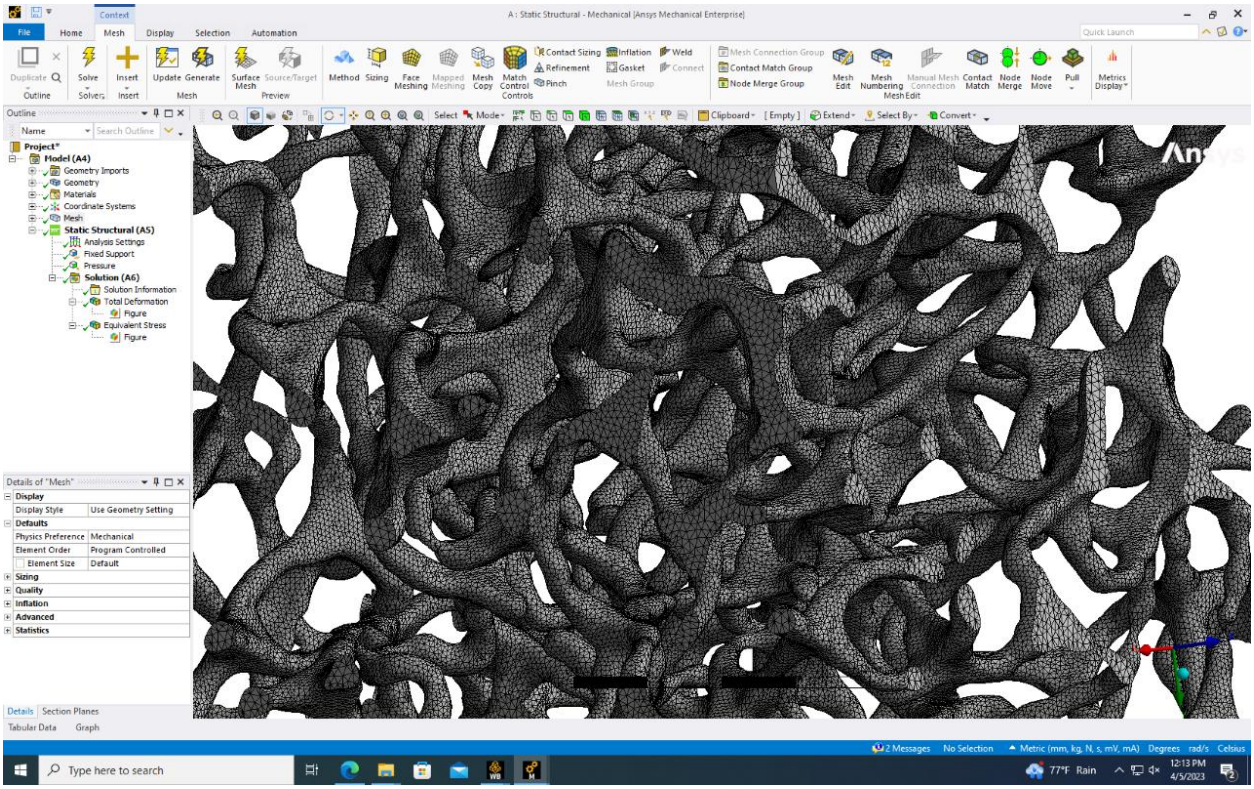
  A 3D CAD software program that is used to design and model products and mechanical components.



Designing a Femoral Cephalomedullary Nail using SolidWorks

- **Computational Simulation - ANSYS**

  A simulation software program developed by ANSYS Inc. that is used to simulate and analyze the behavior of various physical systems in engineering, physics, and other fields. It provides users with a wide range of tools and capabilities for conducting complex simulations and analysis, including structural analysis, fluid dynamics, electromagnetics, and thermal analysis. ANSYS is widely used in industries such as aerospace, automotive, energy, and electronics design, and is known for its accuracy, speed, and ability to handle large and complex simulations.

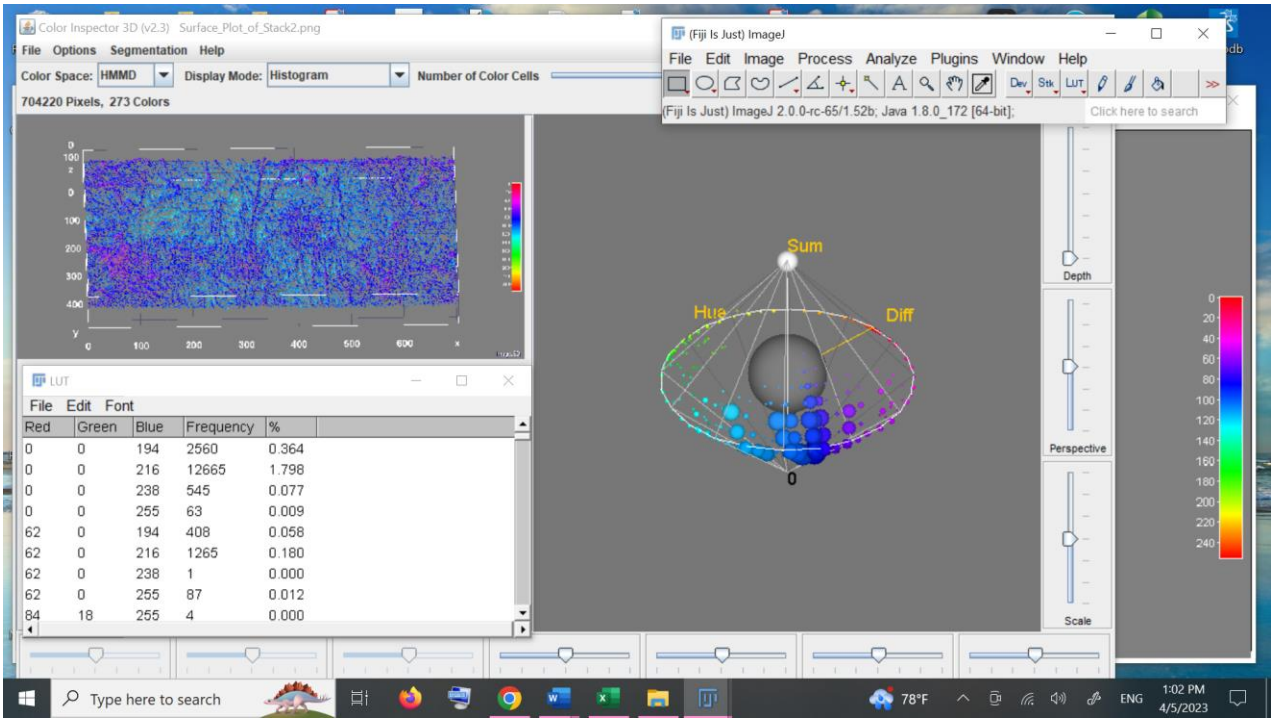


Computation simulation of trabecular bone using ANSYS

- **ImageJ**

  A powerful and versatile tool for image processing and analysis, providing important insights into the properties and behavior of biological and materials science samples. Here are some of the main uses of ImageJ:

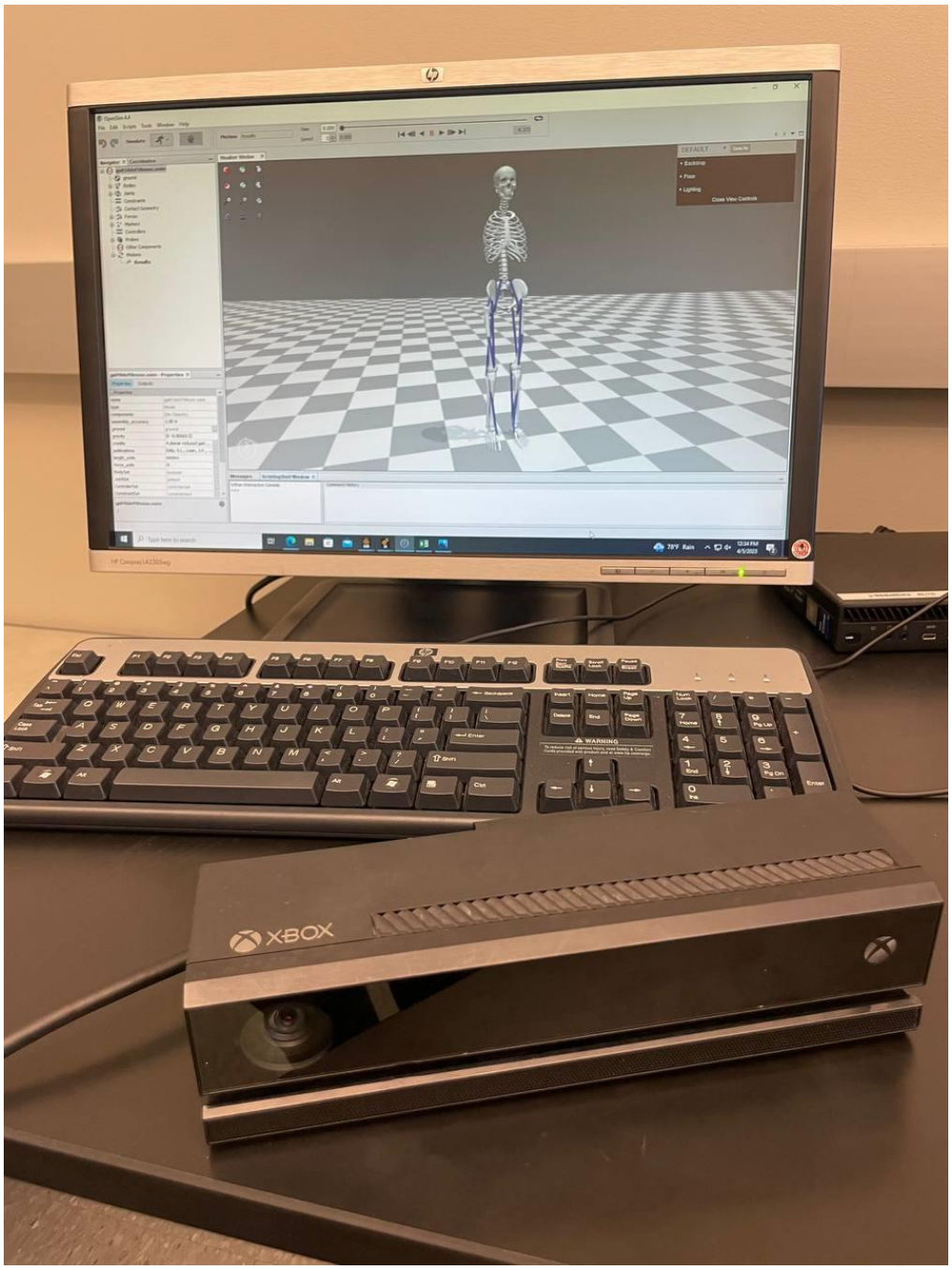
  - Quantitative analysis: ImageJ can be used to measure various properties of digital images, such as length, area, intensity, and color.
  - Image enhancement: ImageJ can be used to enhance the contrast, brightness, and color of digital images. This improves the visibility and quality of the images, making it easier to analyze and interpret them.
  - Image segmentation: ImageJ can be used to separate objects or regions of interest from complex images.
  - 3D image processing: ImageJ can be used to analyze and process 3D images. This information is useful for studying the internal structures and properties.



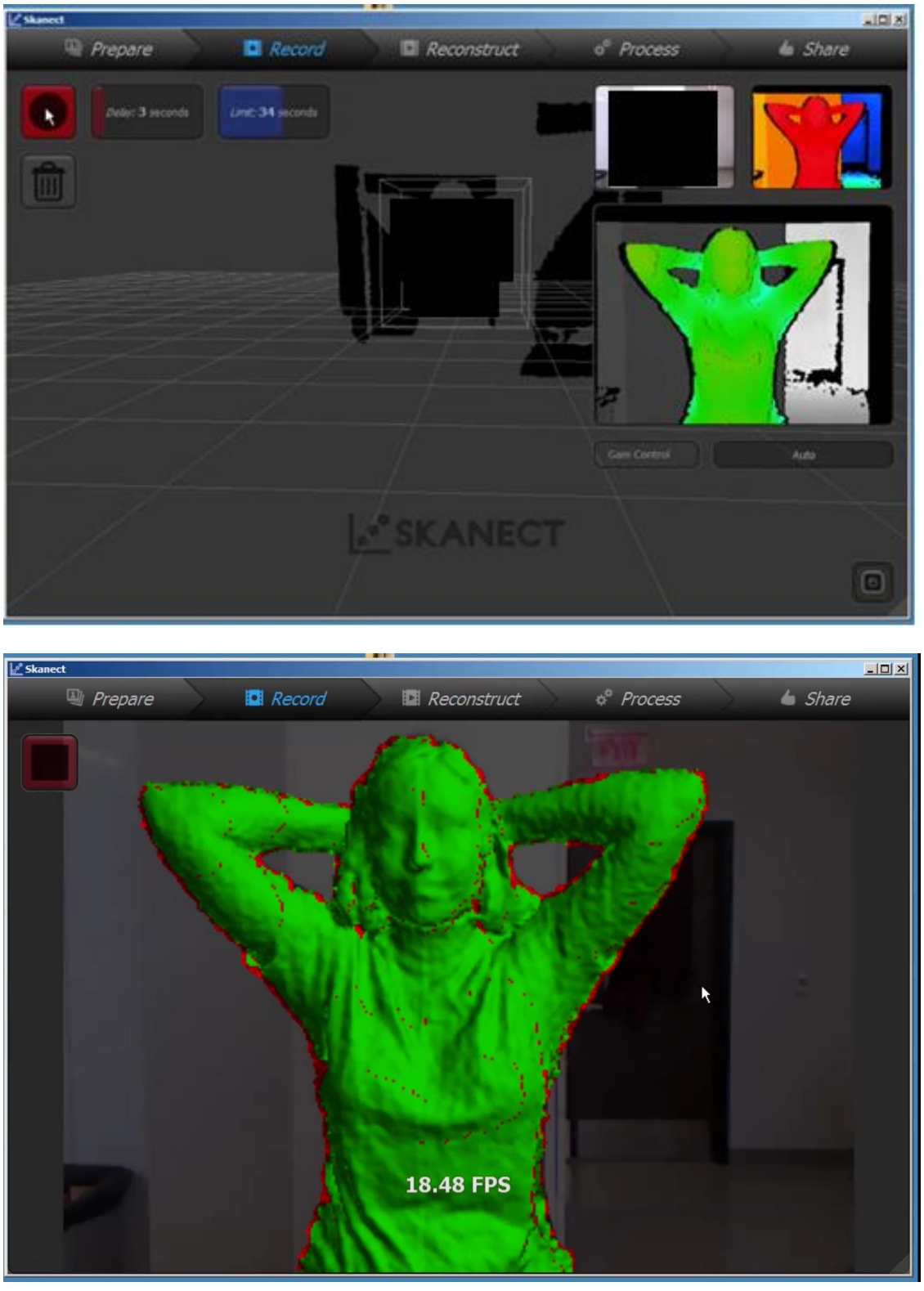
Three-dimensional color inspection using ImageJ

THREE DIMENTIONAL SCANNER

- **Full Body Scan**



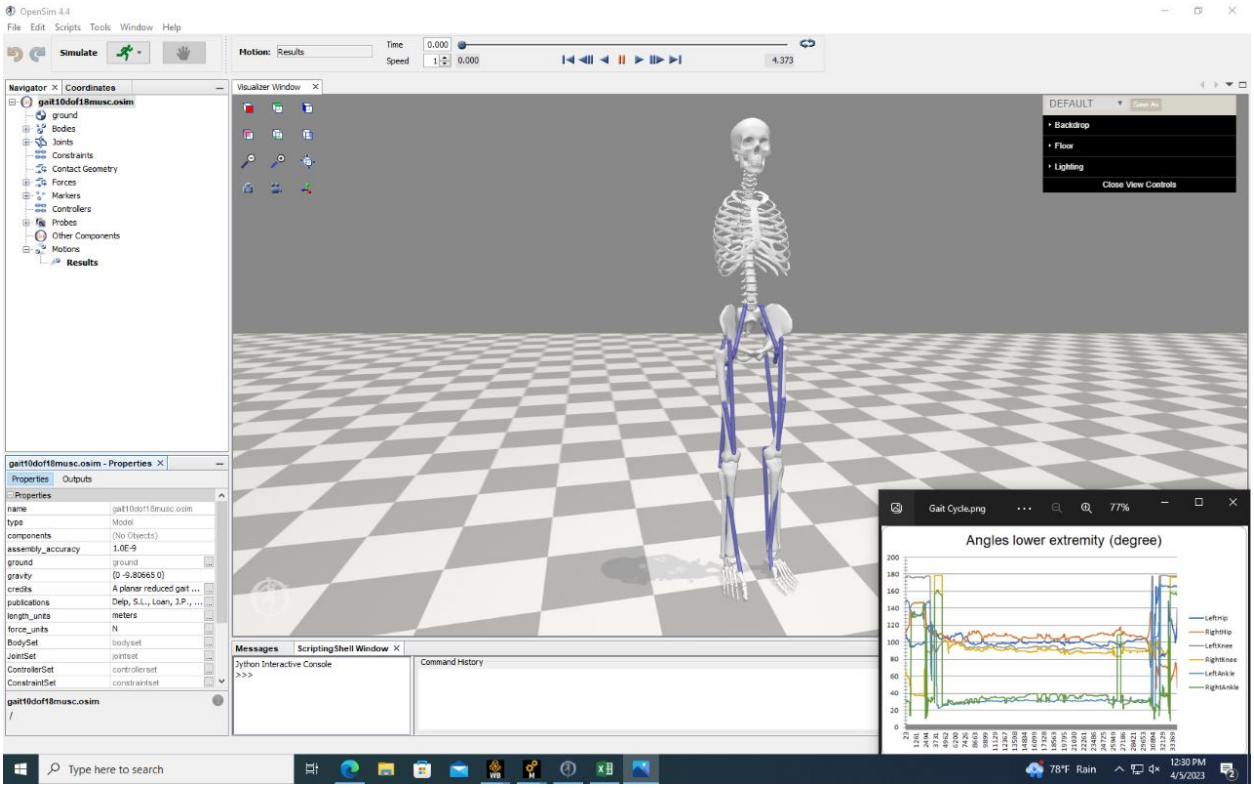
Microsoft Kinect Scanner



Three-dimensional body scan using Microsoft Kinect scanner

- **Gait cycle – OpenSim**

  It is used for modeling and simulating the musculoskeletal system and its interaction with the environment. OpenSim allows users to create dynamic models of the musculoskeletal system and simulate how muscles, bones, and joints interact during movement.



Modeling and simulating the lower extremity gait cycle using OpenSim

BIOPRINTERS

- **Brinter ONE – Multitool 3D bioprinter**

  The proposed 3D bioprinter platform utilizes a modular design to enable variable printing modalities within a unified printing framework. This approach offers the capacity to print an unlimited number of materials, thereby expanding the range of possibilities for creating complex biological structures.

- **Incubator (orbital shaking incubator)**

MICROSCOPY CORE FACILITY

- **FV1000**
  Confocal laser scanning microscope (CLSM) manufactured by Olympus

- **FV300**
  Fluorescence microscope manufactured by Olympus

- **2-photon microscope**

- **Electron Microscope**

- **Epifluorescence microscope (Spot scope)**

- **Fluorescent dissecting scope (MVX10)**

- **Sample Preparation**
-
    - **Cryostat**
    - **Vibratome**
    - **Ultramicrotome (EM)**
    - **Downdraft table (Perfusion room)**

CENTER OF NEUROIMAGING AND NEURO-EVALUATION OF COGNITIVE TECHNOLOGIES

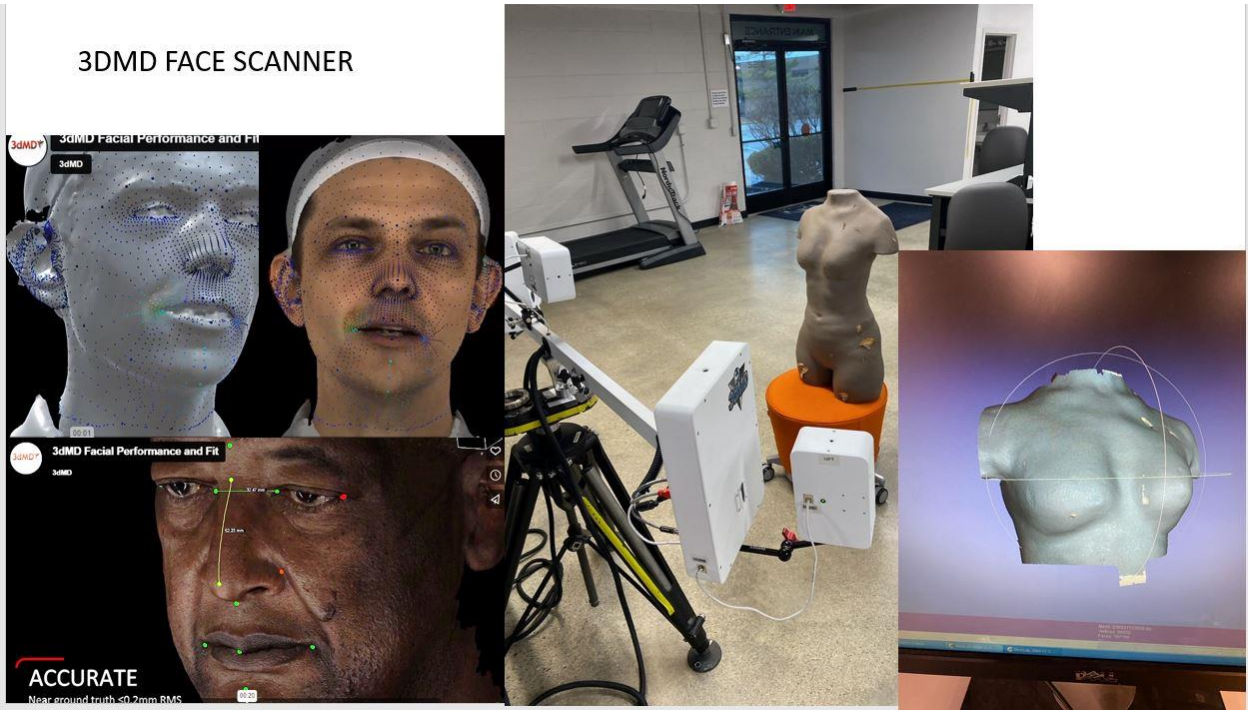
- **Philips 3-Tesla dStream Achieva magnetic resonance imaging (MRI) scanner**

  This MRI is capable of performing state-of-the-art functional and anatomical neuroimaging. The facility can support the most advanced imaging available including neurochemistry (magnetic resonance spectroscopy), blood oxygenation (functional MRI), blood perfusion (arterial spin labeling), oxygen consumption (diffuse optical imaging), structural white matter fiber tracking (diffusion tensor imaging), and chemical exchange saturation transfer (amide proton transfer-weighted). Current technology at Wright State will enable the concurrent measurements of MRI with measurements of electrical activity (electroencephalography) or optical diffusion (functional near-infrared spectroscopy).

ON LOAN, FROM THE AIR FORCE RESEARCH LABORATORY

- **3DMD Face Scanner**

  The 3DMD face scanner is a facial scanning technology that captures a 3D model of a person's face. The system uses multiple cameras to take pictures of the face from different angles, which are then processed to create a detailed 3D model.



- **Handheld 3D Scanner**

POST DOCTORAL RESEARCH FELLOW

- **Farah Hamandi, PhD**

  Farah is a Post Doc research fellow here at WSU. She is an experienced Biomedical Engineering Researcher with more than 10 years of experience in Advanced Engineering Materials with a demonstrated history of working in the higher education industry. Her areas of expertise include material property characterization and lifecycle assessment, as well as specialized knowledge in Orthopedics, Medical Devices, Computational Simulation, Molecular Dynamics, Biomechanics, and Biomaterials. These skills have enabled her to conduct advanced research in these areas and deliver high-quality results. Farah holds a Doctor of Philosophy (**PhD**) in **Biomedical Engineering** from Wright State University. Currently, she is investigating the failure analyses of medical devices, performing finite element simulations of bone and medical fixation devices, conducting mechanical testing, and characterizing materials.

Picture of Farah performing computation simulation on the trabecular bone at micro level using ANSYS program

PhD STUDENTS

- **Anmar Salih**

  Anmar Salih is a Ph.D. student in Biomedical Engineering. Anmar has a Master's degree in biomedical engineering and is an experienced clinical specialist focusing on Cardiac Rhythm Management with more than 9 years of experience in the industry. Anmar is working on designing a pacemaker lead with outer insulation and a coil to perform Finite Element Analysis and obtain the residual properties, designing a 3D model of the heart with a pacemaker attached and performing Computational Fluid Dynamics (CFD) to check how the lead will be affected, and conducting a thorough in vivo damage assessment of retrieved cardiac devices and leads. Also, he is working on a collaboration project with Medtronic to investigate silicone degradation in their 5076-pacing lead and investigating the residual properties of the insulation with respect to in-vivo years. Finally, Anmar is working on a collaborating project with the FDA to investigate the effect of electromagnetic interference of the electric vehicle on the S-ICD (Boston Scientific).

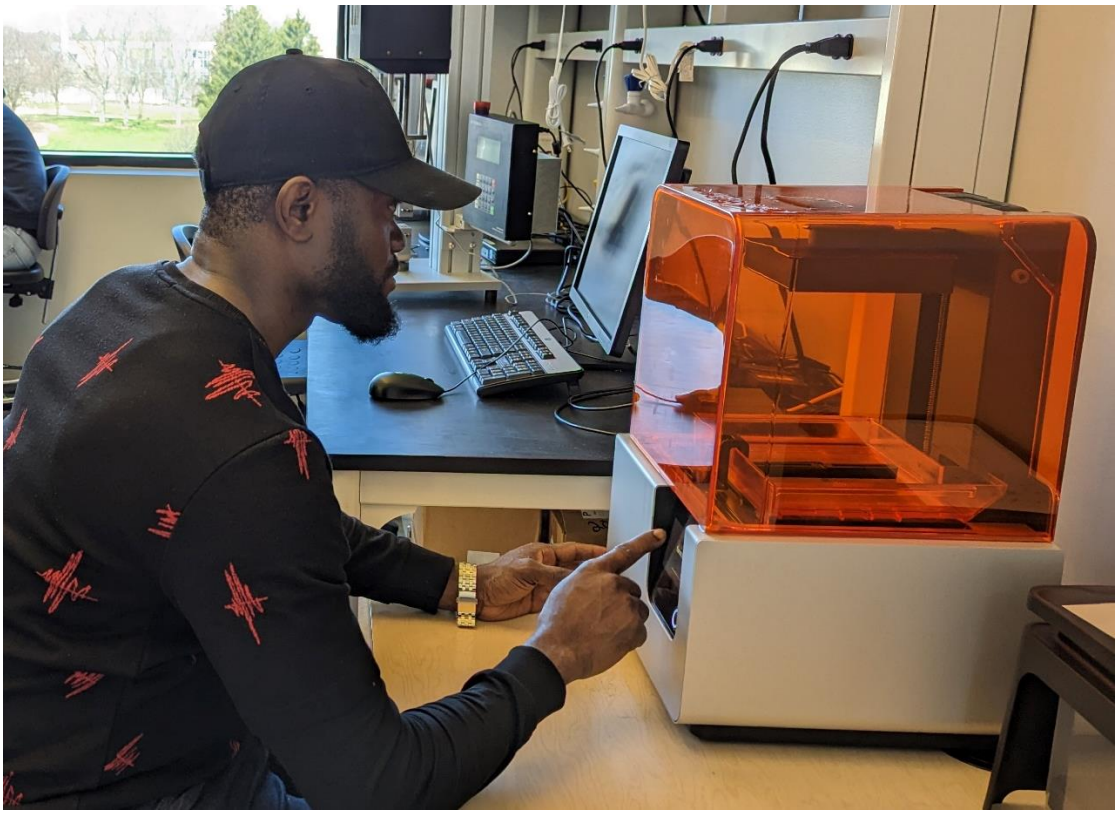
Picture of Anmar investigating the failure of pacemaker lead

- **Sheila Galbreath**

  Sheila Galbreath is a biomedical engineering doctoral student. Her current research topics are focused on biomechanical and clinical effects from traumatic brain injuries. Past research topics were evaluating the behavior of nanoparticles as a drug delivery vehicle. My future research is to focus on women's unique biomechanical behavior.

Picture of Sheila performing tensile test

- **Fidelis Obi Manghe**
  Fidelis is a Ph.D. student in Biomedical Engineering. Fidelis is working on investigating the failure of cardiac pacemaker, and gait biomechanics.

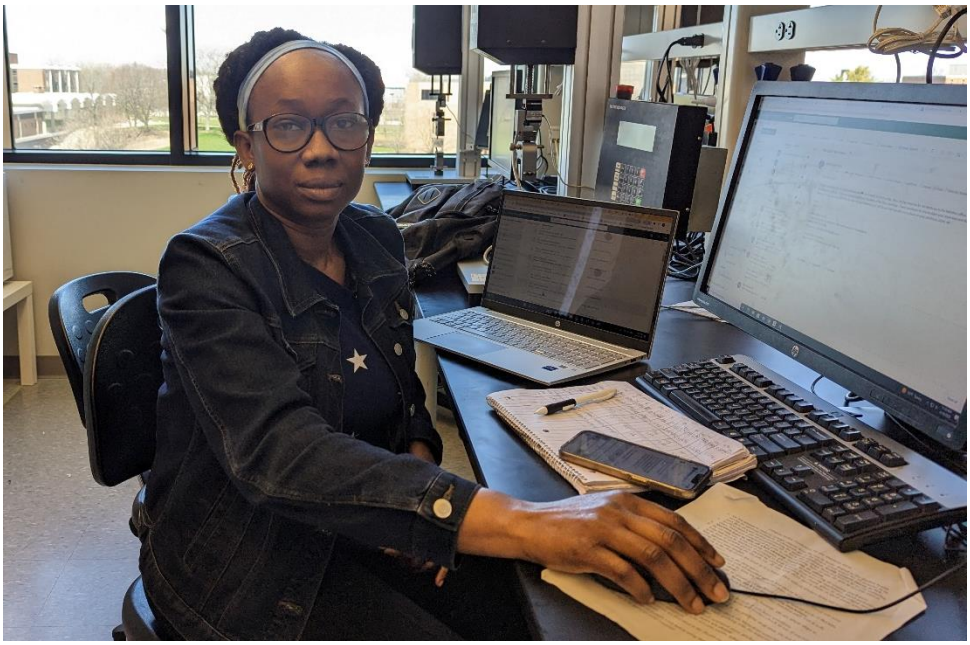


Picture of Fidelis working on the 3D printer

- **Jennifer Whitestone**
  Jennifer is a PhD student in Biomedical Engineering. Her research involves pressure ulcers, biomarker modeling, imaging and molecular dynamic simulations.

GRADUATE STUDENTS

- **Nonyelum Aniebo**
  Nonyelum is a master's student in Biomedical Engineering. Her thesis research involves the morphometric analysis of Alzheimer



Picture of Nonyelum working in the lab

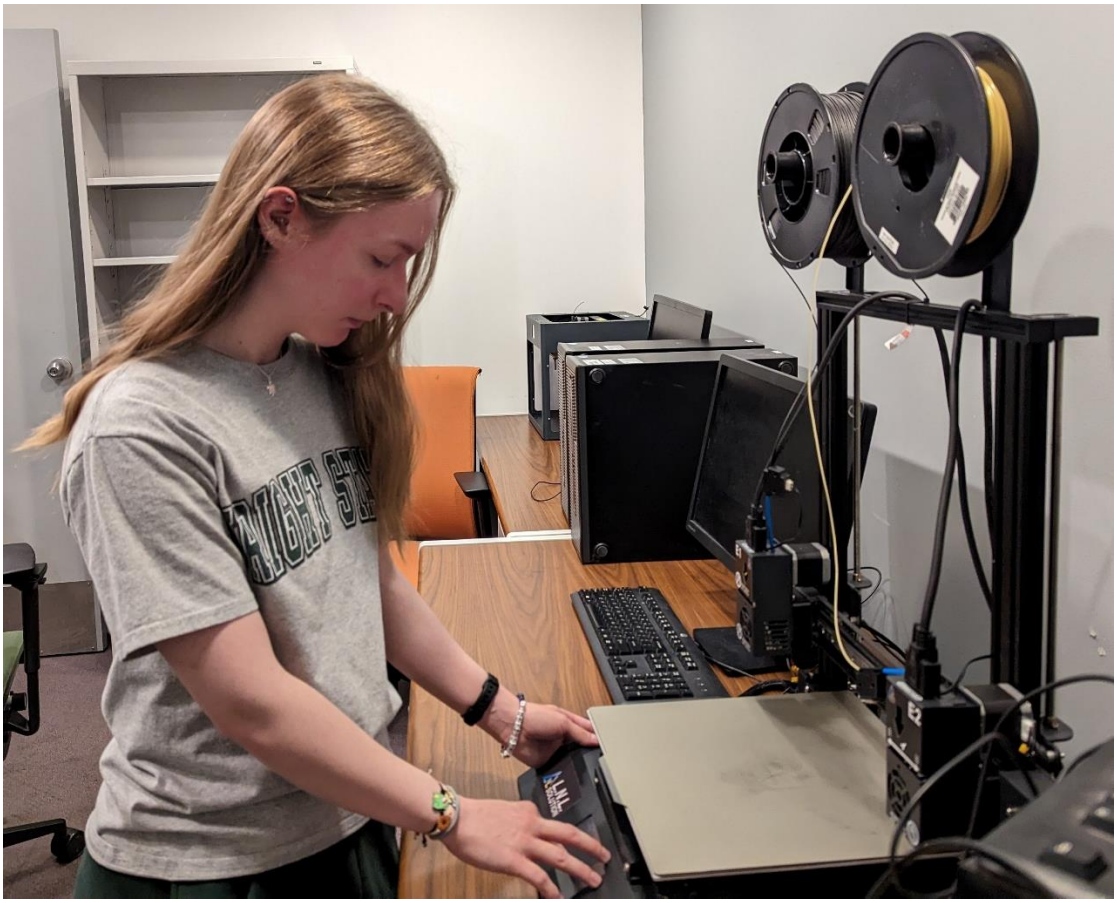
- **Lohith Suresh**
  Lohith is currently working on Gait biomechanics and failure analysis of pacemaker. He will use data mining and AI tools to investigate the pacemaker data.

Picture of Lohith investigating the gait cycle

UNDERGRADUATE STUDENTS

- **Celeste Hicks**

  Celeste is a senior biomedical engineering undergraduate student. Her primary research for the past year and a half has been into biomarkers of traumatic brain injury (TBI). Currently, TBI is mainly diagnosed based on qualitative symptoms. In her research, she focused on trying to identify and compare blood-based biomarkers of TBI that may be used clinically to provide a more specific, quantitative diagnosis of TBI and TBI severity. In the past year, she also has contributed to similar research into biomarkers of chronic traumatic encephalopathy, depression, post-traumatic stress disorder, Parkinson's Disease, Alzheimer's Disease, and osteoarthritis and collaborates with medical students from BSOM.



Picture of Celeste working on the 3D printer

- **Joshua Mallets**

  Joshua Mallets is a junior in the undergraduate BME pre-med program. He is researching biomarkers present in osteoarthritis by simulating the molecular dynamics and thermodynamic properties. The objective is to evaluate biomarker stability and relate simulated data to the progression of osteoarthritis.

Picture of Joshua performing tensile test

MEDICAL STUDENTS

- **Akshima Dhiman**

  Akshima Dhiman is a 3rd year medical student at Boonshoft School of Medicine. She graduated from the University of Virginia with a B.A. in Chemistry in May 2021. Akshima has been working on traumatic brain injury (TBI) research with Dr. Goswami since November 2021. Akshima worked on the paper "Traumatic Brain Injury Biomarkers, Simulations and Kinetics," which was published in MDPI Bioengineering in October 2022. This paper focused on studying 4 biomarkers (GFAP, Tau, UCHL1, NF-L), their role/overexpression in TBIs, and their diagnostic value. Akshima focused on investigating the biochemical changes in neuronal tissue during TBI that allow these biomarkers to traverse the blood-brain-barrier and enter systemic circulation, where the biomarkers can be detected in blood serum testing. Currently, Akshima is working on a project to understand the biomechanical changes that occur in the skull, dura, and brain prior to blood-brain-barrier dysfunction. The goal of this study is to understand the minimum amount of traumatic force required to cause a TBI in order to streamline TBI management and minimize false negative TBI diagnoses resulting from the limitations of biomarker testing and neuroimaging.

- **Ellen Model**

  Ellen Model is a 3rd year medical student at Boonshoft School of Medicine. She has a B.S. from the University of Michigan and co-authored 3 papers on the subjects of rheumatoid arthritis and systemic sclerosis. With Dr. Goswami, she is studying the role of biomarkers in the pathogenesis of Parkinson Disease.

- **Bria Williams**

  Bria is a 2nd year medical student at the Boonshoft School of Medicine. She is working with Dr. Goswami to identify and compare biomarkers associated with major depressive disorder, Alzheimer's disease and PTSD"