



Company Information

Company Name	<i>Atrium Health (Musculoskeletal Institute)</i>	Date Submitted	<i>04/27/26</i>
Project Title	<i>Design of an accelerated aging device for orthopedic implants and biomaterials (ATRIUM_AGE)</i>	Planned Starting Semester	<i>Fall 2026</i>

Senior Design Project Description

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the table below. The Senior Design Committee will adjust as appropriate based on scope and discipline skills.

Discipline	Number	Discipline	Number
Mechanical/Biomed	4	Electrical	1
Computer	2	Systems	

Company and Project Overview:

The Atrium Health Musculoskeletal Institute (MSKI) focuses on advancing research, improving patient care, and enhancing education in musculoskeletal science and medicine. Over 200 physicians and researchers collaborate under the MSKI's umbrella, which encompasses a wide variety of disciplines including orthopedics, sports medicine and spine. We have robust clinical, translational, and basic-science research infrastructure that includes divisions of clinical research, engineering research, and biology research. This project is supported by the Orthopedic Engineering Research Laboratory within the MSKI. The OERL focuses on translational research in musculoskeletal biomechanics, biomaterials, and medical devices.

The materials implanted in the human body for orthopedic procedures degrade over time. Since these implants are intended to function for decades, understanding how material properties change with time is an essential aspect of effective implant design. Building a system (protocol and device) to artificially age implants and biomaterials will facilitate fundamental understanding of material behavior over time, unlimitedly helping to improve implant longevity and patient outcomes.



The proposed involves the development of a scientific protocol and device for artificially aging biomaterials. By simulating the in vivo aging process, researchers can evaluate how materials are expected to behave over time, in turn allowing for increased efficiency in identifying potential weaknesses in materials and allowing for the development of more robust and reliable orthopedic implants and materials.

Project Requirements:

Purpose: Develop a protocol and environmental chamber enabling reproducible, physiologically relevant conditions for artificial/accelerated aging of orthopedic implants and biomaterials with an initial focus on poly methyl methacrylate (PMMA) bone cement.

Objectives include (1) developing experimental protocols for studying aging effects on orthopedic implants and biomaterials (metals and polymers), with an initial focus on poly methyl methacrylate (PMMA) bone cement; (2) designing controlled environmental chambers to implement these protocols; and (3) building and testing a functional prototype for research use.

Preliminary project specifications:

- Protocol/algorithm linking environmental conditions with PMMA aging analogues (e.g., 24 hours at X,Y,Z conditions simulate 5 years in vivo)
- Environmental chamber enabling control of:
 - Temperature
 - Relative humidity
 - Pressure (if applicable)
 - Other variables relevant to accelerated polymeric aging
- Validation testing
- Standards relevant to this project
 - ASTM F451, ISO 5833, ASTM F1980, ISO 11607

Expected Deliverables/Results:

Core Deliverables:

- Aging protocols (baseline, physiological, accelerated) for PMMA
- Functional prototype
- User manual and operating procedures
- Calibration/testing results and documentation
- Software and related documentation for use
- Comprehensive report suitable for internal R&D



Disposition of Deliverables at the End of the Project:

Handover within a reasonable timeframe following the expo is acceptable.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

Beneficial courses/theoretical concepts:

- Material science
- Polymers/polymer chemistry
- Biomaterials
- Thermodynamics
- Orthopedic biomechanics
- Thermal/Fluid design
- Statistics
- Biomedical manufacturing
- Electronics
- Measurements and Instrumentation

Knowledge and Skills:

- Biomaterial behavior including polymers
- Coding (e.g., MATLAB, Python)
- Machining/manufacturing
- Software-hardware integration and device design (e.g., Arduino/Labview)

Some travel to Atrium Health facility (1000 Blythe Blvd, Charlotte NC 28203) may be required