



Engineering  
& Computing

Department of Biomedical Engineering



# BIOMEDICAL ENGINEERING SENIOR **design** EXPO

AN UNDERGRADUATE  
STUDENT PROJECT  
SHOWCASE & COMPETITION

FALL  
2023

DISCOVER | DESIGN | DEVELOP | DELIVER



Presented through the generous support of the  
Wallace H. Coulter Foundation



**BIOMEDICAL ENGINEERING PRESENTS**

## **Senior Design Project Showcase & Competition**

**Monday, November 27, 2023**

The Biomedical Engineering Senior Design Showcase & Competition is the culminating experience for undergraduate seniors in Biomedical Engineering. Teams of senior students complete and present their capstone projects in which they design and prototype a product, device, process, or software system solution designed to address unmet biomedical needs.

# Congratulations

## Graduating Seniors!



**Jorge Riera Diaz, Ph.D.**

Associate Professor,  
Interim Chair of Biomedical Engineering

## CHAIRPERSON MESSAGE

As senior Biomedical Engineering students at Florida International University, you have come to the end of an incredible journey. Your Senior Design Projects are a reflection of your efforts and your capstone undergraduate experience.

Your work is an illustration of the many skills you have sharpened during the course of this yearlong project. You have discovered new ways of thinking, designed and developed an engineering solution for a practical problem, and collaborated with your teammates to deliver innovative solutions. It is encouraging to see your accomplishments and to have witnessed your growth as students.

As you embark on the next stage of your education and careers, keep the confidence that comes from having enhanced your knowledge, remain inquisitive and have the courage to achieve your dreams.

Best wishes for continued success,

*Jorge Riera Diaz*





# AGENDA

## FALL 2023 COMPETITION - MONDAY, NOVEMBER 27th, 2023

### **Room EC 2300**

**7:30 AM**

**Breakfast**

**8:15 - 8:30 AM**

**Introduction & Orientation - Dr. Michael Christie,  
Associate Teaching Professor**

**Welcome Remarks from Dr. Jorge Riera Diaz,  
Associate Professor of Biomedical Engineering and  
Interim Chair**

**Instructions to Judges - Dr. Christie**

**8:30 - 9:30 AM**

**Oral Presentations**

**8:30 AM - Team F1**

**8:45 AM - Team F2**

**9:00 AM - Team F3**

**9:15 AM - Team F4**

**9:30 AM - Congratulatory Messages (Video  
Compilation) & Senior Design Montage**

### **Room EC 2300**

**10:45 - 11 AM**

**Awards Ceremony with Dr. Wei-Chiang Lin, Dr.  
Riera, Dr. Christie & Professor Shahrestani**

**Certificates of Concentration - Dr. Lin -  
Associate Professor and Acting Undergraduate  
Program Director**

**Presentation of Senior Design Project Awards  
Fall 2023**

**Word of Thanks - Dr. Lin**

**Concluding Remarks – Dr. Riera**





## **TEAM PROJECTS**

**FALL 2023 ORAL COMPETITION - MONDAY, NOVEMBER 27th, 2023, ROOM EC 2300**

**Team F1: HexaFlow: Bone Marrow Aspiration Needle**

**Team F2: Dysphagia Screening Tool for Oropharyngeal Dysphagia**

**Team F3: Shoulder Brace for Transcutaneous Electrical Nerve Stimulation**

**Team F4: AmbuAir**

**Congratulatory Messages (Video Compilation) & Senior Design Montage**

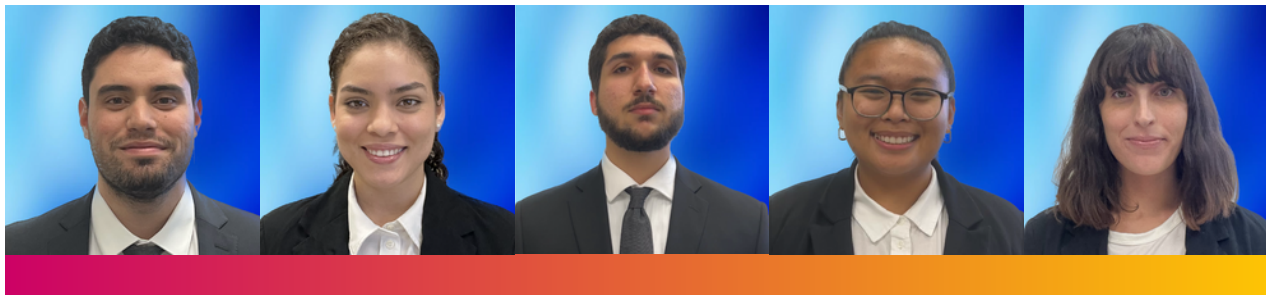
## Team F1

# HexaFlow: Bone Marrow Aspiration Needle

Faculty Mentor: Dr. Shuliang Jiao

Alumni Mentor: Ernesto Sanfiel

Project Sponsor:



**\*Samuel Eljach, Amanda Sanchez, George Gonzalez,  
Jalaica Jaramillo, Laura Angulo**



When introducing a bone marrow aspiration (BMA) needle into a patient's bone, there is a risk of cortical bone spicules being created and entering the needle cannula, potentially obstructing the needle. This obstruction can hinder the aspiration of bone marrow and result in the inadvertent inclusion of bone particles in the collected sample. The presence of these bone particles in the aspirated sample poses challenges in the density gradient separation of fluid bone marrow from peripheral blood. This issue leads to the retention of red blood cells during the isolation of mesenchymal stem cells. Currently, bone marrow concentration kits incorporate filtration devices designed to eliminate bone spicules, clotted fibrin, and other cellular debris. However, these filters come with additional costs, are prone to clogging, which can extend the procedure duration, and may diminish mesenchymal stem cell retention. Moreover, their implementation necessitates supplementary training and increases processing time, requiring the use of heparin to prevent clotting. The HexaFlow Bone Marrow Aspiration needle addresses these challenges by providing a more efficient and cost-effective solution for bone marrow aspiration and processing, all while increasing stem cell retention. The latter is specifically important for the purposes of the team's sponsoring company, SurGenTec, as they exhibit a keen interest in utilizing stem cells for bone graft applications in the context of spinal fusion, aligning with their strategic focus within this market.





## Team F2

# Dysphagia Screening Tool for Oropharyngeal Dysphagia

Faculty Mentor: Dr. Wei-Chiang Lin

Alumni Mentor: Omar Lopez

Project Sponsor:



**SigmaBiomedical**

\*Robert Rodriguez, Herman Suarez, Sophie Hawks, Andrea Lopez, Alyssa Werra

Oropharyngeal dysphagia (OD) is a swallowing disorder of the throat and/or mouth that affects over 9 million Americans, with a higher prevalence in the older population. It can affect more than 50% of those in nursing homes. The average hospital cost to treat OD is about \$7,329, with at least 70% of people who reach 65 years old needing long-term care. The consequences of OD involve compromised general health, choking, aspiraton, pneumonia, and even death. Current modalities of diagnosing OD are time-consuming and invasive, in addition to causing patient discomfort. The focus of our project is to create a portable and non-invasive OD screening tool so that patients can get the appropriate treatment they need for OD. This is achieved by detecting the hyoid bone's movement and vibrations during the process of swallowing. After detecting and recording the vibrations and movements, signal filtering is used to isolate the characteristic frequencies and patterns of the swallowing mechanism. The development of an ergonomic housing to store the accelerometer sensor allows the patient to swallow comfortably and get recordings of swallowing in a short amount of time.



## Team F3

# Shoulder Brace for Transcutaneous Electrical Nerve Stimulation

Faculty Mentor: Dr. Raj Pulugurtha

Alumni Mentor: Daniella Melendez

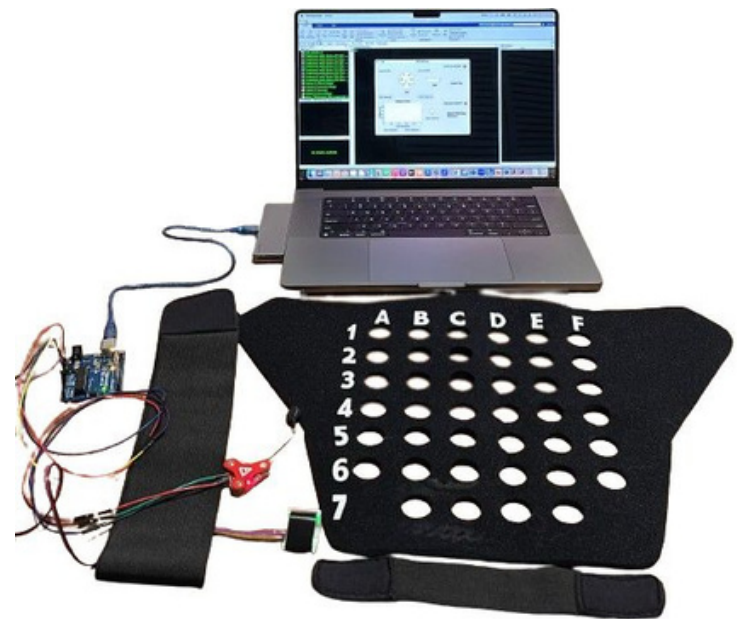
Project Sponsor:

**BetaBlue**



\*Franco Melis, Daniela Alayon, Braulio D. Jesus, Ahmed Kasem

Brachial neuritis is a type of peripheral neuropathy that manifests in the chest, shoulder, arm, and hand. Current electrical therapy for this condition is broadly designed for all parts of the body, preventing maximum pain relief for patients due to high user error with placement. Our shoulder brace offers an accessible and intuitive method for users to accurately place electrodes at the appropriate locations on their shoulder, as to specifically target affected nerves to maximize the treatment efficiency. Two sensors are included in the brace: a surface Electromyograph (sEMG) sensor and a heart rate sensor; these ensure a calibrated, and secure treatment for the patients. The sensors work with a Guided User Interface (GUI) App.





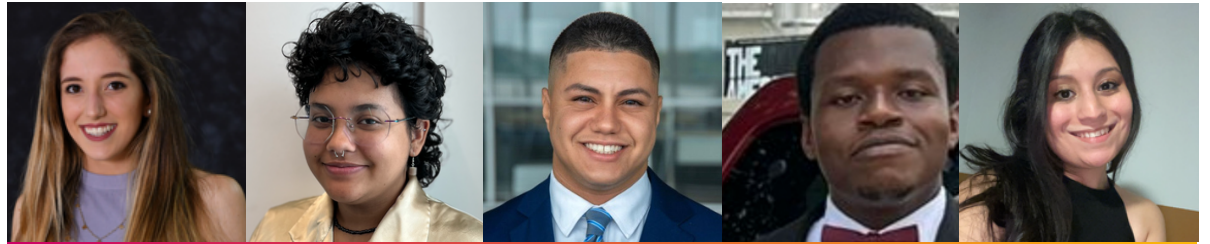
# Team F4

## AmbuAir

**Faculty Mentor:** Dr. Sharan Ramaswamy

**Alumni Mentor:** Oriana Cardenas

**Project Sponsor:** Dr. Scott Schaffer



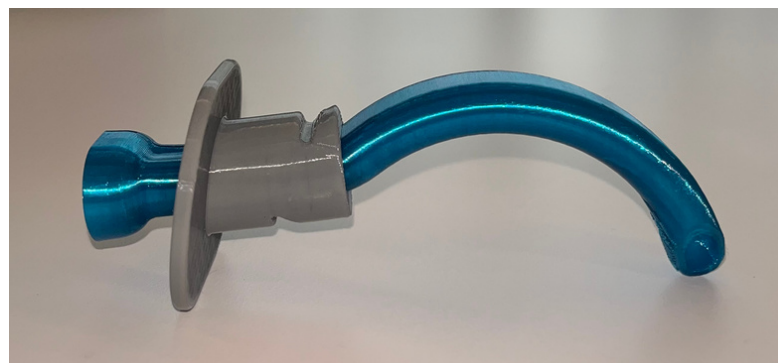
**\*Emiliana Soto-Rodriguez, Cyrus Alместica, Trevor Everglade, Samuel Metayer, Lizette Avila**

This senior design project presents the design and development of a novel oropharyngeal device tailored specifically for patients with obstructive sleep apnea (OSA) undergoing Monitored Anesthesia Care (MAC). OSA poses a significant challenge in anesthesia management due to the increased risk of airway obstruction during procedures, particularly when utilizing MAC anesthesia. For this reason, patients with OSA are obligated to undergo general anesthesia.

Our solution involves the design and fabrication of a custom oropharyngeal device that ensures a secure and unobstructed airway for patients with OSA. This has been completed by incorporating a Jaw Thrust Controller component that will advance the mandible forward (protrusion) and mechanically open the airway allowing for extra space to accommodate larger tongues. Through comprehensive research and engineering, the device addresses the unique anatomical considerations of OSA patients, offering improved safety and efficacy during MAC anesthesia procedures. The device is inserted through the patient's mouth, providing a patent airway and minimizing the risk of airway collapse.

The project encompasses a multidisciplinary approach, incorporating principles of mechanical engineering, and biomedical engineering. Prototypes of this novel oropharyngeal device were designed in SolidWorks, 3D printed with 95A TPU and subjected to verification testing, including anatomical simulations, dimensional testing, and kink testing, to assess performance, and ease of use. The results demonstrate the device's effectiveness in maintaining a clear airway while allowing for efficient administration of anesthesia.

In addition to the technical aspects, the project considers practical implementation, cost- effectiveness, and scalability, making it a feasible solution for widespread clinical use. The innovation presented in this senior design project has the potential to significantly improve the perioperative care of OSA patients, and provide a safe option for them to undergo MAC anesthesia.



# Thank you

To Our Funder

Project Sponsors

Dr. Scott Schaffer

**BetaBlue**  **SURGENTEC**<sup>®</sup> **SigmaBiomedical**

Project Judges

On behalf of the entire Biomedical Engineering staff, we'd like to thank our judges for their dedication and skill when it came to the judging of our Senior Design Expo and Competition oral and poster presentations. It is thanks to your generosity, knowledge and patience that this celebration of our students' efforts has been immensely successful.

To Our Dedicated and Distinguished Faculty



Michael Brown, M.D., Ph.D.



Michael Christie, Ph.D.



Anuradha Godavarty, Ph.D.



Joshua Hutcheson, Ph.D.



Shuliang Jiao, Ph.D.



Wei-Chiang Lin, Ph.D.



Anthony McGoron, Ph.D.



Hamid Shahrestani



Sharan Ramaswamy, Ph.D.



Jessica Ramella-Roman, Ph.D.



Jorge Riera, Ph.D.



Nikolaos Tsoukias, Ph.D.



Anamika Prasad, Ph.D.



Oleksii Shandra, Ph.D.



Raj Pulugurtha, Ph.D.





This academic event is made possible by the generous support of the Wallace H. Coulter Foundation. To learn more about the Wallace H. Coulter Foundation, please visit [whcf.org](http://whcf.org).

DREAM, DISCOVER,  
INSPIRE, INVIGORATE



**FIU** | Engineering  
& Computing  
Department of Biomedical Engineering

The Department of Biomedical Engineering at Florida International University (FIU) located in Miami is committed to preparing ambitious students who want to combine their love of problem-solving with their desire to help others through this fascinating growing field that applies cutting-edge technologies and modern engineering techniques to improve healthcare.

[bme.fiu.edu](http://bme.fiu.edu)



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