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# SENIOR DESIGN PROJECT SHOWCASE SPRING 2020

## BIOMEDICAL ENGINEERING EXPO & COMPETITION

*DISCOVER DESIGN DEVELOP DELIVER*

# MESSAGE FROM THE CHAIR

*Congratulations Seniors!*

*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 discoered 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.*

*Dr. Ranu Jung*

# SENIOR DESIGN PROJECTS

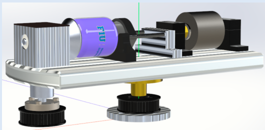
# Orbit: The Continuous Centrifuge

**Team 1**

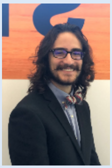
**Faculty Advisor:** Sharan Ramaswamy

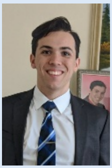
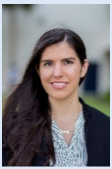
**Company Sponsor:** Biorep Technologies Inc.

There are 40 million people in the world suffering each day with type I diabetes. For this reason, scientists in research groups such as the UM Diabetes Research Institute (DRI) have been working on developing an islet cell transplant to cure type I diabetes. This treatment requires adequate isolation of islet cells, but the current devices are unable to facilitate this requirement. Biorep Technologies Inc. sponsored Team 1 to create Orbit: The Continuous Centrifuge. This device is a centrifuge that can integrate the functions of two centrifuges into one, i.e. a centrifuge that could insert and extract fluids while rotating at high velocities and yet another system that can interface with standard diabetes research equipment. With a cell centrifuge as the core, the continuous centrifuge has as the key design component: a gear system that transfers rotational force from the system to the bottle to enable tube placement for extraction and insertion. Development of the continuous centrifuge will make islet cell transplant treatment much more time efficient aside from reducing the treatment cost, thereby contributing to making islet cell isolation a reality.



***Team 1*** *Tomas Suarez Omedas, Pablo Conde, Andy Morejon, James Lopez, Cristina Sanchez Cereceda*

BIOREP® TECHNOLOGIES

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# Wearable Stress-Monitoring System

**Team 2**

**Faculty Advisor:** James Schummers

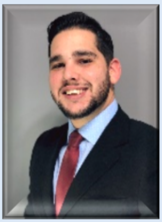
**Company Sponsor:** Bio-Mems & Microsystems

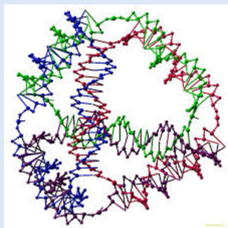
Stress affects everyone and can cause negative consequences when not properly dealt with.  As of now, there is no ideal way to measure stress. Current modalities include the measurement of heart and respiratory rate but lack accuracy.

To overcome this problem, Team 2 proposed a system which utilizes a more direct approach. By the development of a wearable sensor that uses cortisol as a specific stress biomarker and measures its concentration in human sweat.

The proposed device will be able to measure and  quantify stress as well as alert users of abnormal levels. This novel device provides a more accurate solution to those with high stress life style and patients with certain stress-related health risks.

***Team 2*** *Chavier Laffitte, David Hernandez, Fernanda Lopez, Mohammed Hasan*





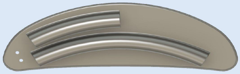
# Septal Support Splint: Intranasal Open BiValve Splint

**Team 3**

**Faculty Advisor:** Michael C. Christie

**Company Sponsor:** Naglreiter Consulting LLC.

A deviated septum is a condition in which the nasal septum is off-center, resulting in diminished air respiration. This condition, which can be caused by a congenital disorder or trauma to the nose, affects approximately 75% of the global population. Patients with a deviated septum suffer complications which adversely impact their quality of life, such as: sleep apnea, snoring, congestion, difficulty breathing, recurrent sinus infections and/or nosebleeds. A septoplasty is the current surgical solution performed to correct a deviated septum. Approximately 260,000 septoplasties are performed yearly in the United States. Intranasal splints are used postoperatively to prevent adhesions between the lateral nasal wall and the septum, as well as to support the septum during the healing process. Current modalities have proven inadequate due to airflow obstruction and patient discomfort. The intranasal splint designed and manufactured by our team includes two semi-circular lumens, which focus on providing septal support whilst avoiding airway obstruction due to coagulation of fluid; it also seeks to mimic the natural contour of the nasal passage for added comfort. We developed critical verification protocols that will confirm enhanced comfort and physiologic air and fluid flow. Our device is cost-effective and provides improved performance over the current modalities.



***Team 3*** *Jose Guzman, Carlos Caiaffa, Ingrid Mantilla, Fabien Charles*




NAGLREITER
MEDICAL DEVICE DEVELOPMENT ORGANIZATION

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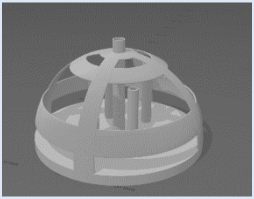
# Thermal Breast Phantom

**Team 4**

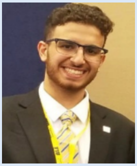
**Faculty Advisor:** Anuradha Godavarty

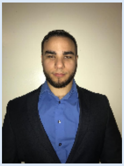
**Company Sponsor:** Jorge Millan, SigmaBiomedical

Thermal imaging could provide a noninvasive and more affordable method of detecting breast cancer. Breast tumors generate higher amounts of heat, usually 1 to 2 degrees Fahrenheit above ambient temperature, due to the creation of new vascularization. SigmaBiomedical has created a device that can potentially detect breast tumors based on surface temperature differences. The objective of this project is to design and create a breast phantom with thermal properties that can be used to test and validate the accuracy of their device through a thermal breast phantom that will simulate the heat transfer that would occur in tumorous breast tissue. This was done by filling a 3D hemispherical printed frame with 1 liter of glycerol, a material that has a similar thermal conductivity as human breast tissue. A heating element was incorporated to heat the entire model to average human breast temperature of 92-98 degrees Fahrenheit while a series of resistors imitate the heat caused by tumors by raising the temperature in localized areas by 1 to 2 degrees Fahrenheit. Through the use of Matlab, simulations were conducted that prove glycerol has similar thermal properties to that of human tissue, and SolidWorks simulation demonstrated expected temperature change rates. The ultimate goal for this project is to be able to validate Sigma Biomedcal's device as well as emerging thermal imaging technologies applied towards breast cancer detection. This model would be able to validate the accuracy of other thermal imaging breast cancer detection devices and could be used for training purposes within the medical field.



***Team 4*** *Isaac Ghobrial, Andres Rodriguez, Luis Miguel Ruiz, Diana Vance*





SigmaBiomedical

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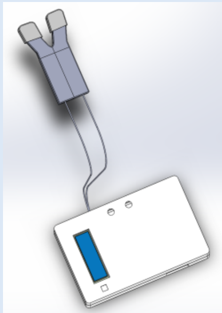
# Bite Force Recording Device

**Team 5**

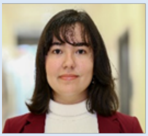
**Faculty Advisor:** Zachary Danziger

**Company Sponsor:** Inae Gadotti, FIU Department of Physical Therapy

Temporomandibular disorders (TMD) consist of both structural and functional disturbances of the masticatory system and surrounding areas, including the temporomandibular joint and teeth. Symptoms typically involve orofacial pain, limited range of motion, joint sounds, and headaches. Research is currently being performed to study how the structural disturbances impact jaw function, and bite force is a parameter used to study such orofacial conditions. Aspects of current devices such as bite plate thickness and comfort influence maximum bite force measurements, and therefore can influence results obtained in studies. The aim of this project is to deliver a bite force recording device whose bite plate will not impede jaw separation nor patient comfort by reducing plate thickness to an optimum size and decreasing material hardness. The device is composed of a bite plate, a bite plate cover, and an electronics box that displays real-time values as well as the maximum bite force obtained and has the capability of storing raw data for future analysis.



***Team 5*** *Ariadna Herrera, Mirelys Llana, Kim Ny Doan, Juan Bermudez, Alvaro Calle*





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# Wearable Bioelectronic Systems with Next- Generation Device Assembly Technologies

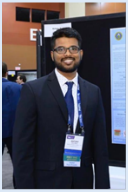
**Team 6**

**Faculty Advisor:** Pulugurtha Markondeya Raj

**Company Sponsor:** Jabil

The use of wearable health devices (WHD) has dramatically increased over the years as a means of collecting biometric parameters. Current packaging systems for WHD in the market involve the use of surface mount technology resulting in a rigid final product. Currently, the global wearable market is worth about $30 billion US dollars and is estimated to grow as much as $100 and $150 billion by 2023 and 2026, respectively. Optimization of WHD is projected to reach an all time high as companies move to advance their technologies to better fit costumer demands. There is a need for a more flexible packaging system for optimal patient experience that can be used both personally and in an ambulatory setting for hospice care. The proposed solution involves designing a manufacturing block that enhances the current modalities for these WHD through an innovative flip-chip assembly technique. This novel assembly technology will increase the conformability and reduce thickness and weight for these commercialized products.

***Team 6*** *Antony Arun, Prashant Gautam, Jessica E. Molina, John Murnin, Dennis Ramos Trinidad*





JABIL

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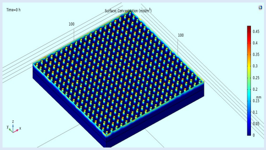
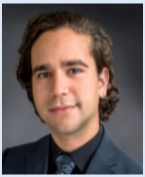
# BioPrinted Advanced Drug Delivery System (BioPADDS)

**Team 7**
**Faculty Advisor:** . Joshua Hutcheson
**Company Sponsor:** TissueTech, Inc.

Many transdermal drug delivery systems in the market are geared towards one specific drug and one specific rate. Hence, it is necessary to be able to create a component/device that allows us to control the rate of diffusion that can be used within a variety of drug substances. The objective of this project is to bioprint a component, moreover, a membrane that can be utilized within a variety of transdermal drug delivery systems. The purpose of this component is to allow the membrane to be modular to a variety at different diffusion rates and drug loads. The BioPADDS is a membrane aimed to be adjustable based on its chemically inert material and to control diffusion rate through its pore size and shape. To achieve this, before BioPADDS is manufactured with a BioBot Basic™ bioprinter previously acquired by TissueTech, Inc, thorough simulations and data analysis were done through COMSOL and Python to prove this concept. Simulations showed diffusion across time within the therapeutic window for three different drug substances of different characteristics. Data analyses were done to prove  modularity within therapeutic window. Then, the bioprinter was used to translate this concept into a physical component. Verification protocols will test whether this component can meet the tolerance specified for drug diffusion rates and drug loads capacity.



***Team 7*** *Romina Doubnia, Ernest Mares, Anibal Morales-Zambrana, Komel Patel*



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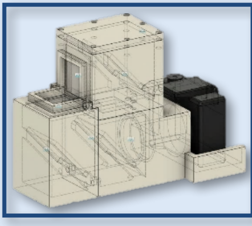
# AccuTarget

**Team 8**

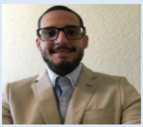
**Faculty Advisor:** . Wei-Chiang Lin

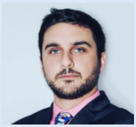
**Company Sponsor:** Xiaodong Wu, CyberKnife Center of Miami

CyberKnife is an image-guided radiation therapy device that delivers high doses of radiation to the isocenter of a cancerous tumor. In order to achieve the optimal radiation therapy effect, CyberKnife needs to deliver the radiation beam to the target with extremely high accuracy and precision. Currently, at CyberKnife Center of Miami, an Automated Quality Assurance (AQA) test device is used to verify the alignment accuracy of the beam isocenter. This device captures the anterior-posterior and the lateral x-ray beam images of a tumor phantom using disposable radiographic films, which are then digitized and analyzed using a computer software to determine the alignment accuracy. The films are costly, and the process of image acquisition is time-consuming. To address this problem, Team 8 proposed to develop an improved AQA test device (AccuTarget) that would reduce the operation cost and simultaneously improve the operation efficiency. Specifically, AccuTarget determines the isocentric targeting accuracy of the CyberKnife system using reflective mirrors, reusable x-ray intensifying screens, a beamsplitter, and a camera. The intensifying screens in AccuTarget replace the disposable films in the conventional AQA test device to reduce the operation cost; the images on the intensity screens are captured by a camera and sent to a computer via a USB interface in real time to reduce testing time. To date, Team 8 has designed and manufactured a prototype AccuTarget and is working to complete several preliminary verification studies to confirm its utility and functionality. It is expected that a working prototype AccuTarget will be delivered to the sponsor by the end of the semester.



***Team 8*** *Natalie Rivera, David Ortega, Daniela Guevara, Rodrigo Garcia Corbacho*





CYBER KNIFE CENTER OF MIAMI

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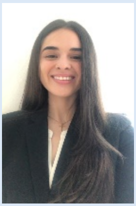
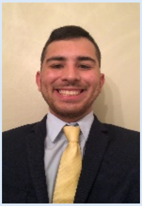
# Dobbs Boot

**Team 9**
**Faculty Advisor:** . Ranu Jung
**Company Sponsor:** Piper labs

Talipes equinovarus, commonly known as Clubfoot, is a developmental deformity in which the tendons and ligaments on the ankle and foot are shortened, causing the baby's foot to turn inward and downward. This condition is commonly treated using the Ponseti method, consisting of a 1 to 6-month casting phase, tenotomy surgery and a 3 to 5-year bracing phase with the "boots and bar". The bracing phase goes through approximately 12 boots, each of them highly priced. Currently, the leading cause of Clubfoot relapse is due to parent/patient non-compliance driven by complications from an ill-fitting boot. In addition to frequent slipping off of the boots, an ill-fitting boot can cause ulcers, sores and other skin irritations. The Dobbs Boot is an improved low profile and cost effective Ankle Foot Orthosis (AFO) made with high quality biocompatible materials proven to reduce skin irritations and to relieve areas of high plantar pressures on the foot in efforts to eliminate ulcer formation.

***Team 9*** *Victoria Ferrando, Khaleel Atkinson, Sebastian Pineda, Ivanna Corzo, Sadrac Saint Fort*





PIPER LABS

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Jorge Millan, SigmaBiomedical

Inae Gadotti, FIU Department of Physical Therapy

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TissueTech, Inc.

Xiaodong Wu, CyberKnife Center of Miami

Piper labs

# ABOUT OUR PROGRAM

*The Department of Biomedical Engineering (BME) is part of the College of Engineering and Computing at FIU and is a prime resource for biomedical engineering education, training, research, and technology development. BME is an ever-evolving field that uses and applies engineering principles to the study of biology and medicine in order to improve health care.*

*Located in Miami, Florida, Florida International University, a Top 100 public university that is designated a Carnegie Highest Research (R1) and Carnegie Community Engaged institution is committed to high-quality teaching, state-of-the-art research and creative activity, and collaborative engagement with the local and global communities. The Department of Biomedical Engineering is ranked among the Top 50 schools providing the best value to students nationally, #1 for bachelor's degrees awarded to Hispanics, and #3 in bachelor's degrees awarded to African-Americans. We are preparing a diverse community of biomedical engineers and are engaged in translation of research to health care applications through discovery, innovation, entrepreneurship, and community engagement.*

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