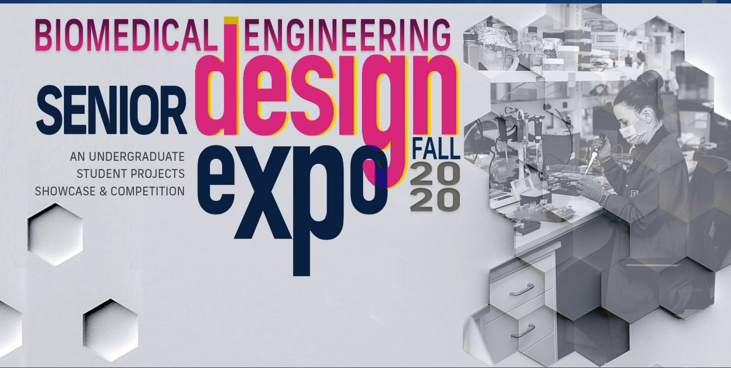
FIU Engineering & Computing

Biomedical Engineering



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

XPF Night Split

Team 1
Faculty Advisor: Anthony McGoron
Company Sponsor: Auxadyne

Over 2.5 million people are diagnosed with plantar fasciitis and Achilles tendonitis each year in the United States. The global treatment market for plantar fasciitis in 2018 was valued at $695 million and is envisaged to expand between 2019 – 2027with a 7.2% compound annual growth rate (CAGR). Achilles tendonitis has a market share of $8646.3 million with the same CAGR as plantar fasciitis forecasted for 2020 – 2025. Approximately half of all patients experience pain that is severe enough to require treatment. The pain particularly affects the first few steps of the morning after sleeping due to the foot being in plantarflexion. Night splints have traditionally been used to address this issue. When used as instructed, this is effective. However, patient adherence is low (70%) owing to complaints of discomfort. Some designs minimize discomfort at the expense of compromising effectiveness. Our novel device, which incorporates auxetic polyurethane foam (XPF), capitalizes both comfort and functionality.

It comprises of:

1. polymer foot support- supports the heel, keeping a 90º angle between the plantar fascia and intrinsic musculature.
2. XPF foam inner layer- provides comfort and cushioning from the hard polymer
3. Polycotton outer casing- reduces abrasion to skin

Team 1 *Kevin Fusco, Carina Gonzalez, Tisha Boodooram, Okeoma Arinze*

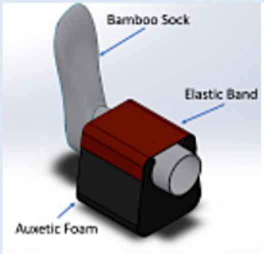
Heel Pressure Relief Sock

Team 2

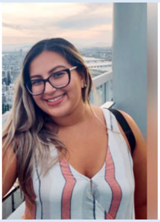
Faculty Advisor: Anuradha Godavarty

Company Sponsor: Auxadyne

Decubitus heel ulcers, or pressure ulcers, often develop due to the prolonged pressure on the heel against firm surfaces causing wounds to form and potentially leading to severe damage, affecting 34% of diabetics in the United States. Inadequate removal of pressure applied on the heel, breathability, and complexity of current modalities plague the market. To address this problem, we utilized Auxadyne LLC auxetic foam to design an ergonomic foam block that elevates the foot, thus eliminating pressure experienced on the heel, which contributes to the prevention and aid in treatment of ulcers. A sock was incorporated onto the foam for comfort while maintaining breathability and making the device easy-to-use. The 3in foam design compresses 0.15in under 45N load, proving that it can sustain the weight of the foot with minimal compression. The sock material allows adequate airflow, maintaining relative humidity within ranges of 55%-93% promoting wound healing, and requires less than 15 seconds to put on and take off with less than 5 steps making it easy to use. By choosing a simple design we were able to successfully accomplish our top priorities and subsequently created a low cost, highly manufacturable device.



Team 2 *James Guerra, Stephanie Marin, Pablo Rodriguez, Brenda Soto*

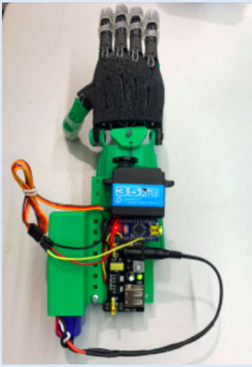



3D PEDIATRIC UPPER LIMB PROSTHETIC WITH AN ELECTRICAL SYSTEM

Team 3
Faculty Advisor: Ranu Jung
Company Sponsor: Nicole Wertheim College of Nursing & Health Sciences, FIU

Each year in the United States approximately 1,500 children are affected by congenital or traumatic upper limb differences (Quinn et al, 2019). Many companies have worked towards making devices that can help improve the act of performing bimodal tasks, but their results have led to expensive designs.

The affordable options for children of ages 6-8 years have generally been body-powered and lack the ability to grasp for extended periods of time. In our design, we expand upon previous models and introduce an electrical system to improve the grip strength, while increasing the accessibility of pediatric upper limb prosthetics by making it lightweight (under 3 lbs) and affordable (under $1,200).



Team 3 *Daniela Espinel, Anny Barona, Gerson Romero-Moreno, Rajendra Waddraji*

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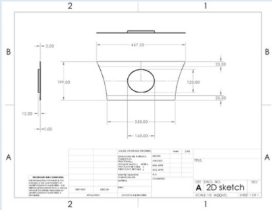
Protective Knee Brace with Auxetic Polyurethane Foam

Team 4

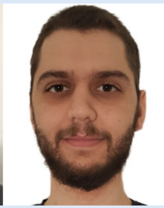
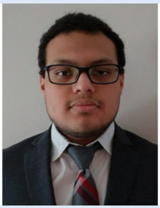
Faculty Advisor: Nikolaos Tsoukias

Company Sponsor: Auxadyne

Several athletic knee injuries arise from low and high velocity impacts, causing a variety of injuries ranging in severity. Impacts cause bone fractures and dislocations, the destruction of blood vessels, as well as torn ligaments and tendons. With 55% of sports injuries being knee injuries, preventative measures can be taken to protect the knee. The XPF can be used as padding material for the knee brace. The additional advantage of using this knee brace is the cushioning of the knee when used due to the auxetic foam properties. The unique deformation or shapechanging property of the foam allows for greater conformability without the loss of protection. This brace will provide protection to the knee when worn during sports. Use of a knee compression brace made up of auxetic polyurethane foam (XPF) to reduce muscle stiffness, improves blood supply and provides flexibility in movement relieving sensitivity to pain. The speciality of this knee brace is that it conforms to the shape of the knee without causing pressure points or restricting the range of motion unlike current knee braces.



Team 4 *Sergio Rodriguez, Amir Duraki, Juan Murillo, Taslima Tasnova*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Dynamic Resistance Orthosis (D.R.O.)

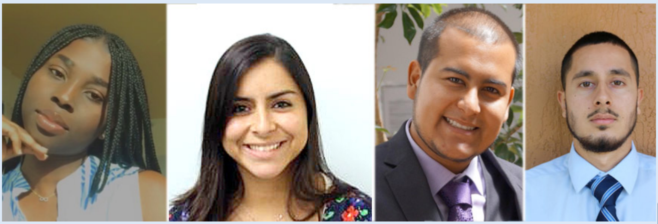
Team 5

Faculty Advisor: Michael Christie

Company Sponsor: Nicole Wertheim College of Nursing & Health Sciences, FIU

Osteoarthritis (OA) is one of the most prevalent chronic conditions in the geriatric population. As life expectancies increase along with a surge of comorbidities, such as diabetes and obesity, the incidence rates in patients over the age of 65 are rapidly increasing and projected to surge from now until 2050. In comparison to other joints, osteoarthritis of the knee has a higher incidence rate and arthroplasty is the most effective treatment. Since knee and ankle joints function as a kinematic chain through gait, knee OA results in a weakened ankle. After surgery, patients require therapy to rehabilitate the lower limb by ensuring proper alignment and restrengthening the surrounding muscles. Current modalities required to rehabilitate post-op OA patients are expensive, are limited in their range of motion, apply only passive resistance, and do not target both joints. Our device provides a solution through a dynamic resistance orthosis to target the rehabilitation of both joints simultaneously while preventing the onset of muscular atrophy. D.R.O is a cost-effective solution that can be used in the clinic or at home. In addition, the device is also applicable to patients requiring physical therapy, rehabilitation, and can be used for general physical conditioning.

Team 5 *Ife Adejugbe, Susana Restrepo, Victor Arteaga, Juan Camilo Gomez*



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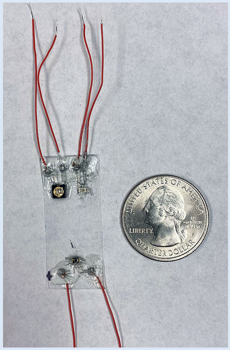
Spinal Cord Infrared Miniaturized Monitor (S.C.I.M.M.)

Team 6
Faculty Advisor: Raj Pulugurtha
Company Sponsor: Jabil

A spinal cord injury (SCI) is an injury that could results in loss of control, such as movement and/or sensation throughout the body. Popular causes of spinal cord injury include trauma (car crash, gunshot, falling, etc.) or illness (polio, spina bifida, etc.).There are about 54 cases per 1 million people affected by acute spinal cord injury (ASCI) which is about 17,700 new cases each year. In particular, the growing number of spinal cord injury circumstances requires novel solutions to monitor real-time continuous blood flow, oxygen concentration within an injured spinal cord. The project scope is to deliver a miniaturized Near-Infrared Spectroscopy (NIRS) system coupled with flexible footprint, thinner packaging to monitor and assess optimization of hemodynamic management for spinal cord injuries. Two different light-emission wavelength and a photodiode detector chiplet were successfully packaged on a clear, heat stabilized polyester film. One light-emitting diode emits near-red light and the other emits near-infrared light, which are absorbed at significantly different rates by oxygenated hemoglobin compared with deoxygenated hemoglobin. With each heartbeat, the change in blood volume causes pulsating changes in the amounts of red and infrared light absorbed. The NIRS sensor is encapsulated with a silicone dielectric gel to enhance mechanical stability. This novel approach will have a prevalent influence on the current wearable and further implantable NIRS sensor with high efficiency performance.



Team 6 *Reyly Bonilla, Thelma Del Cid, Sade Edwards, Huy Nguyen, Diego Sanchez*

JABIL

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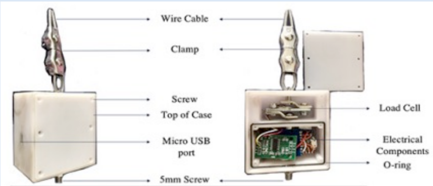
FTMS: Force-Tension Monitoring System for the Central Cable Transport Device during Distraction Osteogenesis

Team 7

Faculty Advisor: Joshua Hutcheson

Company Sponsor: M.B.I at Mount Sinai Medical Center

The cable transport device uses tension to induce distraction osteogenesis to aid in the management of tibial bone loss from severe trauma and infection. This device requires the clinician to manually tighten a cable over time to induce bone movement. However, there are no objective mechanisms to determine the cable tension applied, leading to use of a standardized extension rate that increases the risk of complications such as decreased bone integrity and nerve palsy. Additionally, every patient has many unique factors that can further influence the extension rate. The objective of this project is to design a device that integrates with the cable transport apparatus to quantitatively measure and monitor tension during transport and transmit this data to an external source. This will aid in characterization of tension in the system and the optimization and personalization of the tibial bone transport by determining important parameters associated with the procedure.



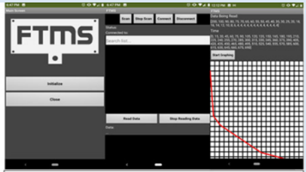


Figure 2: Figure showing User interface for FTMS measure application on android device

Team 7 Daniel Infantas, Milton Logo, Brigette Manohar, Kivash Ram, Erick Peralta

M.B.I.

Max-Biedermann-Institute for Biomechanics

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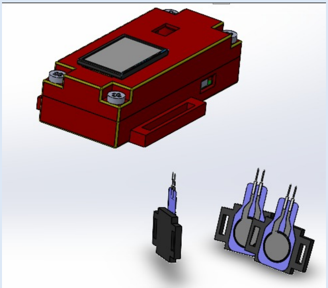
Sensory Feedback Device

Team 8

Faculty Advisor: Michael Brown

Company Sponsor: Bio Engineering Labs Corp

Hand loss is difficult for any individual because it can affect the level of autonomy they feel, thus affecting their lifestyle. The solution for upper limb loss patients were to provide them with a prosthesis. According to a survey (n=224), 98% of the participants using upper prosthetic devices stated that sensory feedback must be the main priority for modern prosthetics. Our project closes the gap in the market by designing a noninvasive sensory feedback device that will provide trans radial prosthesis users a feedback system in which they are able to perceive the gripping force on a held object. The current modalities systems in the prosthesis market are either still in the development stage, use invasive techniques, or use no active feedback methods. Our senior design project aims to provide the user with visual feedback on their gripping force. This will allow the user to utilize their prosthesis more effectively.



Team 8 *Jason Yee-Fong, Galit Moshkovitz, Alejandro Alarcon, LaTonya Roberts, Marcos Gonzalez Perez*

THANK YOU TO OUR SPONSORS!

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M.B.I at Mount Sinai Medical Center

Bio Engineering Labs Corp

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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