



FIU

FLORIDA
INTERNATIONAL
UNIVERSITY

**SENIOR DESIGN
PROJECT
SHOWCASE
FALL 2018**

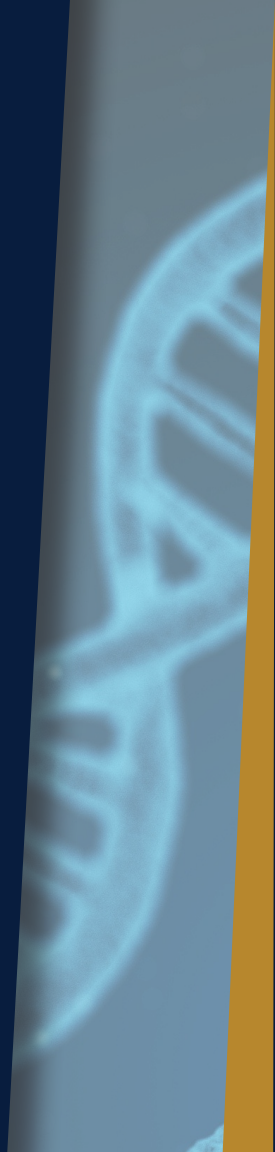
BIOMEDICAL ENGINEERING
EXPO & COMPETITION

DISCOVER DESIGN DEVELOP DELIVER

FIU

**Engineering
& Computing**

Biomedical Engineering



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 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.

Dr. Ranu Jung

SENIOR DESIGN PROJECT AGENDA

7:30am - Breakfast

8:00am - Welcome from Dr. Ranu Jung,
Chair and Professor of Biomedical Engineering

8:05am - Introduction & Orientation - Dr. Michael Christie,
Senior Instructor of Biomedical Engineering

8:15am - Team 1: Development of a Semi-Automated
Needle Insertion Device

8:40am - Team 2: Auxetic Polyurethane Foam Prosthetic Sock

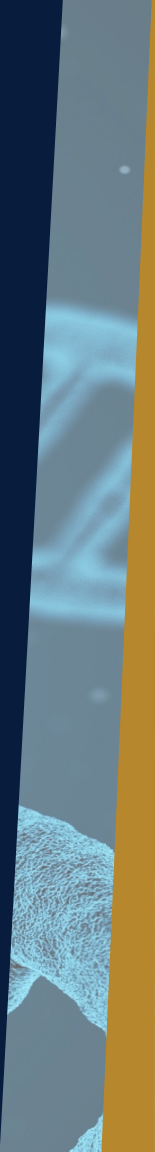
9:05am - Team 3: Weight Distribution Assessment Tool

9:30am - Team 4: Auxetic Polyurethane Foam Therapeutic Heel Boot

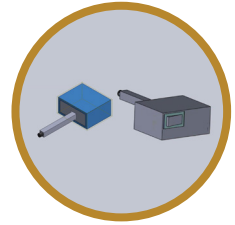
9:55am - Team 5: Guiding System for Femoral Percutaneous
Incision Utilizing Ultrasound Technology

SENIOR DESIGN PROJECT AGENDA

- 10:20am** - Team 6: Manufacturing Process for Filling and Sealing Biological Formulation
- 10:45am** - Team 7: Marker-Based Optical Tracking System for CyberKnife® Robotic Quality Assurance
- 11:10am** - Team 8: Electrotherapy for Carpal Tunnel Syndrome
- 11:35am** - Team 9: STATERA
- 12:00pm** - Lunch
- 1:00pm** - Oral Presentation Awards
- 1:30pm** - Poster Session
- 4:30pm** - Poster Awards



Development of a Semi-Automated Needle Insertion Device



Team 1

Faculty Advisor: Jessica Ramella-Roman, Ph.D.

Company Sponsor: Dr. Akm Rahman from 1Vital Health

About 4 out of 10 Americans will experience a Stroke in their life time. Neurosurgeons have a four-hour window from the moment the patient experience the first symptoms of a stroke to introduce a catheter through the femoral artery and access the stroke to perform the necessary procedure to open blocked vessels. Therefore, we have created a device that finds and perforates the femoral artery fast and efficiently to reduce the impact of stroke. The device is composed of an ultrasound that serves as an image guidance and visual feedback, a software that calculates the distance and angle needed for the needle to penetrate the artery accurately and needle insertion device that deploys a 7-cm needle into the artery. Once the needle is inserted effectively, the device is able to detach the needle so that the catheterization process can be continued.

Team 1 Nathalia Bernal, Joseph Dayao, Lemuel Fuller, Alejandro Gonzalez



Auxetic Polyurethane Foam Prosthetic Sock

Team 2

Faculty Advisor: Joshua Hutcheson, Ph.D.

Company Sponsor: Auxadyne



As of 2016, approximately 1,630,000 people in the USA have undergone transtibial amputation. It is estimated that by 2050, nearly 3.6 million lower-limb amputations will be performed. Proper stability and mobility of amputees post-surgery largely depend upon socket-limb interface. Daily volumetric fluctuations of residual limb result in skin irritation, muscle discomfort, knee pain, and back pain. Methods to mitigate volume fluctuations are, however, limited. Currently, amputees need to add/ remove socks to address the volumetric changes of the limb. The team has designed a prosthetic sock made from auxetic polyurethane foam (XPF) that addresses this issue, and consequently reduces the occurrence of revision surgeries, socket refitting, and consultation. XPF has a negative Poisson's ratio, which allows the material to expand transversely when stretched longitudinally and contract transversely when compressed longitudinally. This unique property is what confers XPF the capacity to adapt to the volumetric changes that the limb undergoes.

Team 2 *Refat Chowdhury, Quentin Diggs, Eddy Hernandez, Gricelle Perez*

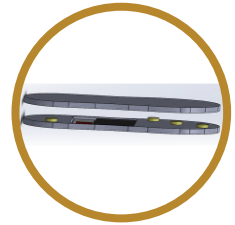


Weight Distribution Assessment Tool

Team 3

Faculty Advisor: Anthony McGoron, Ph.D.

Company Sponsor: Dr. Rossi, FIU Department of Physical Therapy



Individuals who have hip or knee replacement surgery attend physical therapy to regain mobility. After healing from surgery and completing physical therapy, pain is no longer present. Yet, habitual walking patterns still remain (McCrary et al., 2001). Altered walking patterns lead to asymmetry in load bearing, putting the individuals at risk for falls (Seo & Kim, 2013). There is a need for a biofeedback device to enhance safety of individuals at risk of falls due to asymmetrical weight bearing. Our device is a biofeedback system capable of alerting the individual when unequal weight distribution occurs between the affected and unaffected limb. Our device is a smart insole capable of sending data to a mobile device, which will provide biofeedback to alert the individual to adjust weight distribution when walking. The device will serve as a reinforcement program to assist individuals in maintaining safe gait patterns once physical therapy is completed.

Team 3 *M. Hailey Hendon, Juan Hoyos, Mauricio Viana, A. Freddy Yapó, Luvianka Zapata*



Auxetic Polyurethane Foam Therapeutic Heel Boot

Team 4

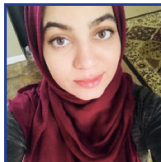
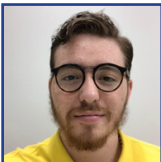
Faculty Advisor: Jacob McPherson, Ph.D.

Company Sponsor: Auxadyne

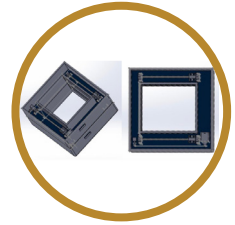


Individuals with diabetes often develop severe decubitus ulcers, a debilitating condition for which there is a lack of effective treatment options. The following process was undertaken to address the critical unmet need for viable new solutions. Decubitus ulcers, most commonly found on the heel, result from reduced oxygen perfusion to distal parts of the body. Here, we used auxetic foam procured from Auxadyne, LLC, to construct a heel boot that redistributes and reduces loads experienced by the heel. Reduced loading should increase perfusion of soft tissues in the heel, slowing the rate of ulcer progression while enabling increased mobility. Auxetic foam was selected because of its unique compressive properties: it possesses a negative Poisson's Ratio and thus, cells of the foam contract in the transverse direction in response to orthogonal, uniaxial loading. Compared to conventional foams, auxetic foam displays lesser impact deformation due to applied force. To further reduce the rate of ulcer progression, the foot will be positioned at an incline to enhance the force offloading effect.

Team 4 *Miguel Chevres, Jasmine Hatab, Simrun Rafiq, Umaima Sarwana*



Guiding System for Femoral Percutaneous Incision Utilizing Ultrasound Technology



Team 5

Faculty Advisor: Wei-Chiang-Lin, Ph.D.

Company Sponsor: Dr. Akm Rahman from 1 Vital Health

A study completed in 2009 found that 4-7% of patients undergoing venous access procedure through the femoral artery will experience complications. The United States market size of neurovascular devices is increasing with brain aneurysm being the main influencer in this matter. The solution we are proposing to this ongoing problem is to create a guiding system for Ultrasound (US). The system will be capable of determining the position of the center of the femoral artery along the groin area and is composed of a guiding track that will allow a catheterization needle or puncture unit and an US probe to be attached so that the needle is aligned and can be inserted into the artery. The device will contribute to advancements in all fields of clinical, laboratory, and research techniques with an emphasis in the North American region while still targeting a global effect (up to the sponsoring institutions' discretion).

Team 5 *Maria Aguero, Estefania Delgado, Poomrat Rasamikomen, Gomeh Saias*



Manufacturing Process for Filling and Sealing Biological Formulation



Team 6

Faculty Advisor: Michael Christie, Ph.D.

Company Sponsor: TissueTech

TissueTech utilizes the regenerative properties of human umbilical cord and amniotic membrane in innovative technologies for the treatment of patients with a range of ocular disorders. This includes over 3 million patients in the US with moderate to severe dry eye, as well as a number of other indications. The current standard of care involves the placement of plastic ring and therapeutic compound in the eye for a period of 7-14 days. This requires multiple appointments with a physician, irritates the eye and significantly restricts normal activity. An alternative treatment has been developed that involves the use of a biologically derived formulation that is placed in the eye as a fluid drop. To create this dosing system, a manual fill and seal process has been used to create small quantities of material for clinical evaluation purposes. This manual process is slow, operator intensive, and difficult to consistently deliver a quality outcome. We designed a fill-and-seal system to aid in the manufacturing process of their biological formulation. By automating the process, we demonstrate that the company can deliver a product that meets all critical process attributes, at faster cycle times and at lower cost. This solution is scalable and can be upgraded to deliver larger commercial volumes.

Team 6 *Ingrid Gandra, Zachary Harris, Jordan Pockhai, Jayson Scott*



Marker-Based Optical Tracking System for CyberKnife® Robotic Quality Assurance



Team 7

Faculty Advisor: Jorge Riera, Ph.D.

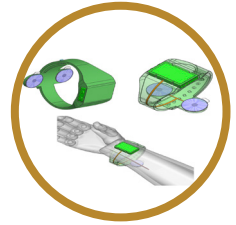
Company Sponsor: The CyberKnife Center of Miami

The CyberKnife Center of Miami utilizes a robotic radiosurgery system to destroy tumors. The CyberKnife works through a combination of imaging modalities, robotics, advanced software, and high-energy radiation to locate and treat cancer all over the body. The robotic system is held to a very high standard of precision (0.1 mm). The same high-energy radiation used to kill cancer can also damage healthy tissue. It is imperative that the system is properly calibrated and maintained. Current calibration techniques fail to detect a complete treatment path, are too timely, or too costly to work in an efficient manner. To address this, our team is working to implement a new validation method to ensure that the dynamic movement of the robotic arm is accounted for. We have developed an optical tracking system that utilizes microcontrolled cameras, near-infrared markers, and a beam simulator component that overcomes the shortcomings of current calibration modalities.

Team 7 *Chazman Childers, Alejandro Del Calvo, Gabrielle Rivera, Gabriela Rodriguez*



Electrotherapy for Carpal Tunnel Syndrome



Team 8

Faculty Advisor: Zachary Danziger, Ph.D.

Company Sponsor: Miami MedTech

Carpal tunnel syndrome is a condition that causes pain, numbness and tingling in the hand when the median nerve is compressed or squeezed. CTS affects more than eight million people each year, making it the second most common type of musculoskeletal surgery with well over 230,000 procedures performed annually. It was also concluded by the U.S Department of labor that Carpal Tunnel Syndrome is the “Chief occupational hazard” disabling people in the workforce in epidemic proportions. The goal is to deliver a non-invasive compact medical wristband that provides electrotherapy to stimulate the median nerve and temporarily relieve the pain while also being ergonomic allowing patients to use it in a work environment eliminating the necessity to use a traditional TENS device that can constrict the patient from performing numerous tasks.

Team 8 *Agustin Galecio, Hector Martinez, Samantha Menendez, Kevin Moreno, Abigail Ozual*

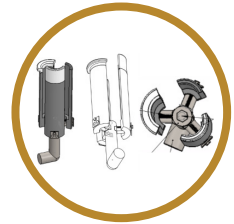


STATERA

Team 9

Faculty Advisor: Ranu Jung, Ph.D.

Company Sponsor: Garrison's Prosthetic Services



In lower limb amputees, a proper fit of the socket is essential to avoid chafing of the residual limb and provide the amputee good control over the prosthetic limb. The cast of the residual limb has a significant impact on the quality of the socket fit. A device was created that improves on the hands-on plaster casting technique for obtaining the shape of the residual limb of trans-femoral and trans-tibial amputees. The device utilizes 3 padded curved panels that enclose the limb and apply compression to the limb after the plaster cast is applied. The key contributions of this device are that it allows for residual limb shape to be obtained under weight bearing conditions. The device was designed and simulated in SolidWorks to ensure that selected materials could support a 300 pound load.

Team 9 *Niola Gonzalez, Stefan Khan, Eduardo Martinez-Tapanes, Sampson Okeke*



**THANK YOU
TO OUR SPONSORS!**

Auxadyne

CyberKnife® Center of Miami

Dr. Akm Rahman from 1Vital Health

Dr. Rossi from FIU
Department of Physical Therapy

Garrison's Prosthetic Services

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