FIU | FLORIDA INTERNATIONAL UNIVERSITY

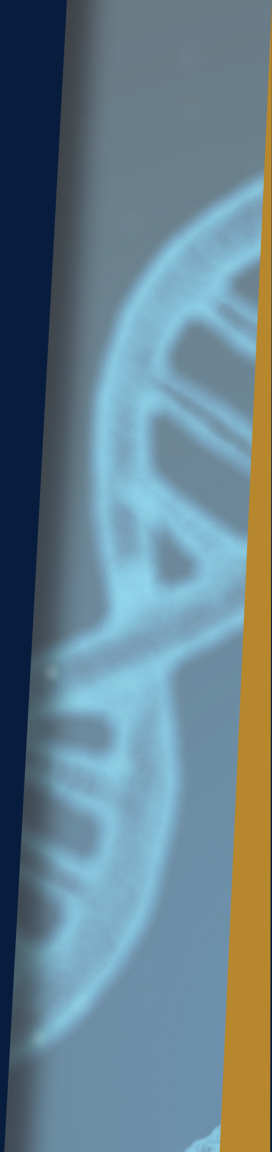
SENIOR DESIGN PROJECT SHOWCASE SPRING 2019

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 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 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

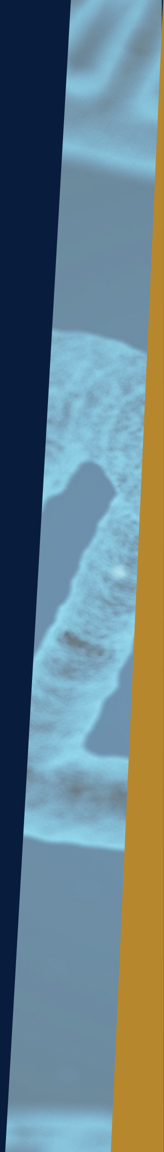
8:15am - Team 1: Port IO Acute

8:40am - Team 2: Field Therapy Accelerator

9:05am - Team 3: ProDent: a Dental Isolation Device

9:30am - Team 4: Septum for Drug Delivery Device

9:55am - Team 5: Doctor’s Cyclo Massage



SENIOR DESIGN PROJECT AGENDA

10:20am - Team 6: Prosthetic Pressure Detecting Sock

10:45am - Team 7: Dynamic Prosthetic Knee

11:10am - Team 8: Delivery of Viscous Biologics in Wearable Injectors

11:35am - Team 9: Electromyogram Signal Simulator System

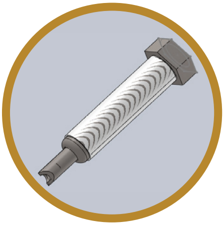
12:00pm - Team 10: System for Registering and Tracking Bone Movement

12:00pm - Team 11: Quantifying Socket Adapter Device (QSAD!)

1:00pm - Lunch

2:00pm - Awards

PortIO Acute



Team 1
Faculty Advisor: Joshua Hutcheson, Ph.D.
Company Sponsor: Richard Yazbeck, Chief Technology Officer at PAVmed Inc.

Vascular access is a fundamental component of patient care in emergency settings. During the 1930s the intraosseous (IO) space was first explored via needle placement as an alternative to treat patients with poor/no vascular access. Current IO delivery devices have direct contact with fluid requiring regular flushing and have high incidence of occlusion as well as thrombus formation. To overcome this problem, Team 1 proposed to develop a conduit to access the IO space, thereby creating an entry point for needle insertion. The PortIO Acute eliminates regular flushing and reduces the risk of occlusion and thrombus formation. We present the mathematical modeling, design, and verification of a cost-effective, off-the-shelf, telescoping device equipped to adjust into various needle lengths that optimize patient treatment. This device can remain implanted in a patient for at least 24 hours and provides easy access to introduce needs that deliver effective doses of fluid/medication to patients.

Team 1 *Melissa Alvarez, Kevin Gutt, Daniel Jimenez, Michaela Salisbury*




Field Therapy Accelerator

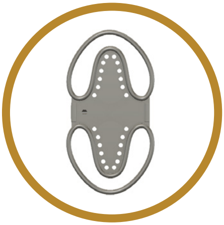
Team 2
Faculty Advisor: Raj Pulugurtha, Ph.D.
Company Sponsor: Advatech Inc.

In the U.S., chronic and slow healing wounds affect 6.5 million people; acute wounds affect 11 million people, of which 300,000 people are hospitalized yearly. An increasing number of yearly incidences can be attributed to modern epidemics such as obesity and diabetes. Despite the variety of available technologies and major companies actively researching in the area of active wound care, most current treatment modalities are invasive, costly, and timely results are unattainable. The Field Therapy Accelerator (FTA) is a prototype that uses magnetic fields to produce non-contact healing in wounded tissues. The magnetic fields from the FTA will produce an electric potential in the wounds that is intended to accelerate cell migration and in turn healing. Previous prototypes were unable to deliver the required magnetic flux. We redesigned the soft magnet to deliver the required magnetic flux of 7.8 T/s, which will produce 10 mV/cm in the wounded tissue. Benchtop testing was performed to ensure that this magnetic flux was achieved. We expect that our improvements will provide a more efficient wound healing treatment.

Team 2 *Lina Bernier, Shebin George, Valentina Melero, Claudia Pinochet*



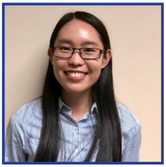

ProDent: a Dental Isolation Device



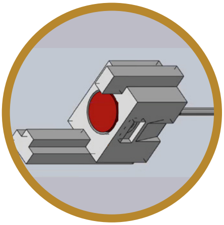
Team 3
Faculty Advisor: Anthony McGoron, Ph.D.
Company Sponsor: W.B. Engineering

Current procedures that require dental isolation involve three main components: a rubber dam, a high vacuum evacuation (HVE) system, and a tongue and cheek retractor. Current designs are not cost effective nor easy to install, and do not allow for reusability. As a result, patients spend more chair time and are subjected to sitting in an uncomfortable position for a long period of time without breaks. In addition, the material used for these dental procedures tend to block the dentist's maneuverability as they are bulky and get strongly discolored over time. This design will ensure that patients are offered a more comfortable experience while minimizing the time required to complete a procedure by promoting a more ergonomic design for the device. It will also eliminate the need for a separate apparatus to set-up the rubber dam by incorporating a frame that will serve as both the mouth retractor that holds the rubber dam and include a rubber dam, tongue and cheek retractor, and a bite block that will serve as an adaptor to the suctioning system and a light source.

Team 3 *Veronica Chen, Luis Herran, Tiffany Raymond, Ivan Santos*



Septum for Drug Delivery System



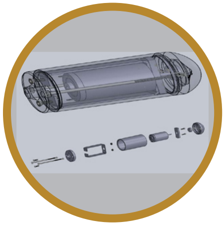
Team 4
Faculty Advisor: Jorge Riera, Ph.D.
Company Sponsor: SHL Pharma

The rise in chronic diseases such as diabetes, cancer and HIV/AIDS has created a need for wearable auto-injecting drug delivery devices capable of delivering drugs with up to 60 times the viscosity of water. Some drugs must be delivered at rates of up to 100 microliters per second, resulting in high pressures. For this project, a device has been designed in order to inject drugs with the required specifications. A septum component is required to separate the drug's fluid path from the needle that introduces a catheter into the user. Additionally, the needle needs to pass through the septum and introduced the catheter, while the drug must not be able to escape the fluid path between the septum and needle. Per ISO 11608, wearable drug delivery device components such as this septum had to be tested under extreme pressures to reduce the risk of component failure and ensure the device is safe and effect. Moreover, tests of 200 psi pressure placed on various designs for the septum and its housing components have been carried out to evaluate the performance of the septum remained unmoved under extreme pressures and the passing fluid exerted on the septum. The surface area of the septum exposed to this pressure has resulted in a 100 N force being played on the septum. This force has been counteracted by the joining method between the septum and its housing. The proposed joining methods have been friction, application of an adhesive and ultrasonic welding a piece of the housing to the top of the septum.

Team 4 *Maria Asprino, Walter Heatherly, Maria Saavedra, Michael Van Ryn*




Doctor's Cyclo Massage



Team 5
Faculty Advisor: Jacob McPherson, Ph.D.
Company Sponsor: Nikao, inc.

As of 2019, 30 million Americans are living with peripheral neuropathy. The most common cause of peripheral neuropathy is diabetes, accounting for 60% of all cases. Peripheral neuropathy interrupts signaling between the central nervous system and the rest of the body, leading to widespread complications including debilitating pain and paralysis. We have developed a second-generation therapeutic device that uses small amplitude, low frequency cycloidal vibrations to increase blood flow and lymphatic drainage in regions of the body innervated by damaged peripheral nerves. By enhancing tissue perfusion and fluid flow, vibration-based therapies have been shown to alleviate musculoskeletal pain associated with peripheral neuropathies, to reduce edema in affected tissues, and to enhance blood sugar regulation in individuals with diabetes. Our design improves upon currently available devices by regulating temperature control for comfort and by preventing water ingression when used with electrode gel. These improvements are expected to increase the lifecycle of the device without substantially increasing production costs.

Team 5 *Joaquin Brillembourg, Adrian Gutierrez, Victoria Leon, Monserrat Otarola*

Prosthetic Pressure Detecting Device

Team 6
Faculty Advisor: Zachary Danziger, Ph.D.
Company Sponsor: Orthotics and Prosthetics Center

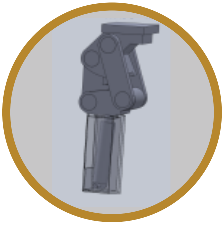
Approximately 2 million individuals in the US have prosthetics. Currently, the most common method to fit prosthetics is the clear test-socket procedure. This time-consuming process involves the patient giving subjective feedback on low/high pressure areas while the prosthesis adjusts. Thus, a device that can quantify pressure within the socket will improve the efficiency of the modification process by allowing clinicians to make more intentional adjustments. The proposed device will measure residual limb pressure and display pressure readings on a graphical user interface to facilitate adjustments. Our device is a water-resistant prosthetic sock with Velostat pressure sensors embedded within it. Velostat is a piezo-resistive material that emits a current proportional to the pressure applied. An Arduino will measure voltage and transmit the data wirelessly to a handheld device. The device will also alert patients of high/low pressures, prompting them to make adjustments to prevent adversities such as slippage and brushing.

Team 6 *Josue Gil, Maily Hernandez, Brian Redondo, Mia Virtue*




Dynamic Prosthetic Knee

Team 7
Faculty Advisor: Nikolaos Tsoukias, Ph.D.
Company Sponsor: Orthotics and Prosthetic Center



Currently, there are hydraulic and pneumatic microprocessor knees offered at a high price to transfemoral amputees. There is a need for a dynamic prosthetic knee that is provided at a low cost to transfemoral amputees that will provide varying resistance when performing activities such as biking, bending and running, while maintaining functionality of a normal knee. Our device is a polycentric knee that mimics the movement of an anatomical knee with the use of a four-bar mechanism. The polycentric knee design contains multiple axis of movement coupled with an actuator so that the walking gait is smooth, but also allows for bending resistance. The prosthetic also incorporates a shock absorbing component to add load activated resistance to the knee when performing various movements. We have developed and manufactured, using a 3D printer, a nylon, polycentric prosthetic knee that will allow transfemoral amputees to regain the ability to perform dynamic activities.

Team 7 *Emily Baragar, Francisco Dos Santos, Trevous Greene, Priscilla Lozano*




Delivery of Viscous Biologics in Wearable Injectors

Team 8
Faculty Advisor: Michael Christie, Ph.D.
Company Sponsor: SHL Pharma; Slobodan Stefanov

Biologics are developed in order to treat various diseases and simplify multiple treatments into a single dosage. Patients typically require professional assistance to receive bio therapeutic drugs via subcutaneous injection. Rather than diluting and administering the biologics through an IV, SHL Group developed a low infusion rate disposable wearable injector that saves the patient time and money. Our research focuses on the delivery subsystem from the serum cartridge to the catheter. The delivery system is capable of withstanding maximum internal pressure should the biologic clog. The sterile box of this device is constructed of polypropylene, a polymer with low surface energy that does not easily bond with adhesives. We have determined the optimal adhesive, medical grade tubing, and proper geometry that will accommodate to this microscopic scale. This novel device provides a cost effective solution, enabling patients to easily and confidently self-administer complex and highly viscous drugs at their convenience.

Team 8 *Jeffrey Cham, Luke Miller, Kristopher Odiete, Demitri Rodriguez*

Electromyogram Signal Simulator

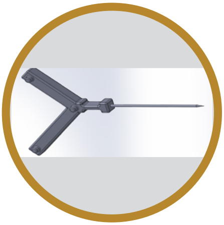
Team 9
Faculty Advisor: Jorge Riera, Ph.D.
Company Sponsor: Infinite Biomedical Technologies

Through this project we have developed an EMG signal simulator. The market size for prosthetics is increasing globally and nationally and there is a need for improving the quality by improving the efficiency and manageability/responsiveness of current prosthetic technologies. The project allows for improved quality of life for the amputees and enhancing the functionalities of the prosthetics, leading to a more natural and biomimetic solution for amputees. This simulator allows for testing of existing myoelectric prosthetic devices. The EMG signal simulator system has a tangible output of an analog voltage signal. It converts the data from digital to analog. The system is composed of a Microcontroller (Raspberry PI 3 B+), A single multi-channel DAC (16-Bit 8-Channel Digital to Analog Converter I2C), De-amplifiers (Voltage Divider), a Raspberry Pi I2C port, a touch screen display, and 8 analog voltage output ports that interface with Infinite Biomedical Technologies' myoelectric prosthetics. Through this, multiple Electromyogram (EMG) data was uploaded onto the device. This data included normal EMG data, Motion artifact, EKG artifact, and power line noise.

Team 9 *Mauricio Acosta, Ahmed Ali, Albert Jimenez, Etsubdink Weldetsadik*

System for Registering and Tracking Bone Movement



Team 10
Faculty Advisor: Anuradha Godavarty, Ph.D.
Company Sponsor: Max Biedermann Institute for Biomechanics at Mount Sinai Medical Center

The Max Biederman Lab at Mount Sinai is unable to model planar and angular bone motion, in a target bone system, based on mechanical input; thus, they are unable to simulate bone position in space during mechanical testing. To address this, we have generated a system for registering and tracking the motion of a bone undergoing mechanical testing. We have developed a reusable optical probe together with a registration software in which the probe served to locate the bone within the frame of reference of the optical markers when positioned on specific locations of the bone. This was then detected by an IR motion capture system to yield a transformation matrix that individuated the bone in space; this matrix was used to interpret marker data gathered from the camera system when the bone was tested. This allowed us to locate points on a bone surface at 6 degrees of freedom to thoroughly assess the planar and angular bone motion. The software then allowed for visualization of the position of the bone during testing. As such, our system accurately denotes the extent of movement applied to a tested bone given only the location of a point on the bone surface prior to the application of planar and angular movement and following its application.

Team 10 *Daniel Muniz, Josue Uribe, Giselle Valdes*



Quantifying Sock Adapter Device (QSAD!)

Team 11
Faculty Advisor: Michael Brown, M.D., Ph.D.
Company Sponsor: Brett Rosen and Jesse Mitrani at Hanger Inc.

There are 1,119,735 Transtibial and transfemoral amputees living in the United States of America with an expected increase of more than 600,000 amputees by 2020. The patients with lower limb amputations eventually get fitted for a prosthetic device to aid their everyday activities. Prosthetic devices consist of a socket, shaft(s), and adapter(s) that mimic joints. There are 4 screws in each adapter. The manipulation of these screws serves to adjust the angle of the components with respect to the prosthesis center line. There are currently no methods to objectively quantify these measurements (displacement or number of turns of the screw). We present the mathematical modeling, design, and verification of a device that provides the position of the adapter's screws during the alignment session. Clinicians can use QSAD to perform minuscule objective adjustments during the alignment as well as to record the position of the screws for future reference.

Team 11 *Juan Boza, Camilo Camacho, Anderson Milfort, Daniel Smith*




THANK YOU TO OUR SPONSORS!

Richard Yazbeck, Chief Technology Officer at PAVmed Inc.

Advatech Inc.

W.B. Engineering

SHL Pharma

Nikao, Inc.

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Infinite Biomedical Technologies

Max Biedermann Institute for Biomechanics at Mount Sinai Medical Center

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Be Worlds
Ahead

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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