FIU | FLORIDA INTERNATIONAL UNIVERSITY

SENIOR DESIGN PROJECT SHOWCASE SPRING 2018

BIOMEDICAL ENGINEERING
EXPO & COMPETITION

DISCOVER DESIGN DEVELOP DELIVER

FIU | Engineering & Computing

Department of 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 - Biomedical Engineering

8:15am - Team 1: Novel Dental Implant Design for
Improved Reliability and Clinical Outcomes

8:40am - Team 2: Cardiothoracic End-effector with the
Application of a Micro-wedged Adhesive Material

9:05am - Team 3: Nanovibrational Bioreactor

9:30am - Team 4: NextFlo

9:55am - Team 5: Wearable, Low Profile Muscle Oximetry
Monitor for Morbidly Obese Individuals

10:20am - Team 6: Fornix Tissue Expander

10:45am - Team 7: Residual Limb Circumference Measurement Device

11:10am - Team 8: Pediatric Tissue Engineer Heart Valve

11:35am - Team 9: Vein Preservation System

SENIOR DESIGN PROJECT AGENDA

12:00pm - Team 10: Leg Asymmetry Prosthetic Device

12:30pm - Lunch

2:00pm - Poster Session

5:00pm - Team 11: Prosthetic Socket Measurement System

5:25pm - Team 12: Development of a Low-cost High Resolution Optical Tracking System for Kinematic Evolution

5:50pm - Team 13: Standardized Vaporization Device Attachment for Inhalable Drug Dose Monitoring

6:15pm - Team 14: Adipose Tissue Disintegration Device for Extraction of Adipose Derived Stem Cells

6:40pm - Team 15: Design Optimization of a Percutaneous Intravenous Access Valve for Forearm Implantation

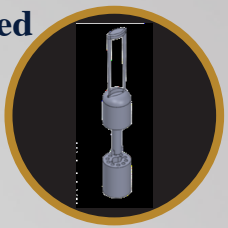
7:15pm - Awarding of Certificates of Concentration

7:20pm - Winner Announcement

7:25pm - Final Remarks

7:30pm - Program Ends

Novel Dental Implant Design for Improved Reliability and Clinical Outcomes



Team 1: Melissa Gonzalez, Yinka Ajibola, Diana Caduff, Christian Monterrey, Arnaldo Taroconte
Faculty Advisor: Dr. Michael Christie
Company Sponsor: Zimmer Biomet Dental

Current dental implants consist of three components. They include a retaining screw, an abutment, and the fixture itself. Current designs are subject to loosening of the retaining screw when the implant is overloaded, which results in bone loss and loss of osseointegration. In addition, loosening allows ingress of bacteria into the gum, thereby causing infection. This results in chronic infections, abscesses, and complete tooth loss, which will necessitate additional aggressive surgical intervention. We have developed and manufactured a prototype of a dental implant that eliminates the retaining screw, which will eliminate the problem of loosening. This design ensures that the connection between the implant and abutment remains secure to promote osseointegration between the bone and the implant. This device will greatly improve performance and reliability of dental implants, prevent postsurgical infections and bone loss, and improve the lives of patients. Our device will allow individuals to regain function in areas of their mouth where they have a tooth or teeth missing.

Team 1 *Melissa Gonzalez, Yinka Ajibola, Diana Caduff, Christian Monterrey, Arnaldo Taroconte*





Cardiothoracic End-effector with the Application of a Micro-wedged Adhesive Material

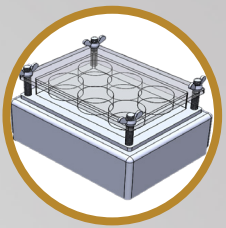
Team 2: Natasha Hirabayashi, Mario Mendoza, Edgar Solorzano, David Stewart
Faculty Advisor: Dr. Jacob McPherson
Company Sponsor: Syntheon LLC

Over 700,000 cardiothoracic procedures occur each year. Disease and aging cause the heart to become more frail overtime. The heart beats 42,048,000 times a year; perpetual use will eventually cause frailty. The decline in durability causes complications. Tools used in cardiothoracic procedures are often made of stainless steel with teeth to grip the tissue. These tools may cause physical tissue trauma, such as puncturing, tearing, or bruising. Our device will attempt to prevent intraoperative tissue damage by incorporating a micro-wedged adhesive material inspired by gecko feet. This material will enable less pressure to be applied to the tissue, while still maintaining the required shear stress characteristics. We will present on the modeling, design, and verification of a proposed end-effector for a cardiothoracic device that makes use of a micro-wedged adhesive material. This device will mitigate the risk of imposing trauma upon delicate tissue.

Team 2 *Natasha Hirabayashi, Mario Mendoza, Edgar Solorzano, David Stewart*




Nanovibrational Bioreactor



Team 3: Patrick Henry, Gulash Ayedemir, Kristoffer Dessruiseaux, Rut Farall, Alessandra Proietti
Faculty Advisor: Dr. Joshua Hutcheson
Company Sponsor: Cardiovascular Matrix Remodeling Lab

Recent developments in mechanobiology have sparked interest in the cellular responses (i.e. adhesion) due to nanoscale mechanical vibrations. This emerging field of 'nanokicking' has numerous potential applications in tissue engineering, modeling, and drug design. However, no off-the-shelf apparatus exists on the market to impart the dynamic vibration profiles necessary for such applications.

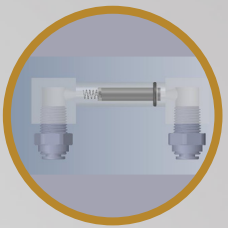
Our sponsor is interested in the potential treatment/diagnostic modalities of Calcific Aortic Valve Disease that have a biomechanical basis. Currently, treatment of CAVD is limited to surgical procedures and is contraindicated in several cases, thus failing to meet clinical demands. The developments towards a nanovibrational bioreactor device will facilitate biomechanical-based evaluation for novel therapeutics and discovery in treatment of CAVD.

Team 3 *Patrick Henry, Gulash Ayedemir, Kristoffer Dessruiseaux, Rut Farall, Alessandra Proietti*





NextFlo



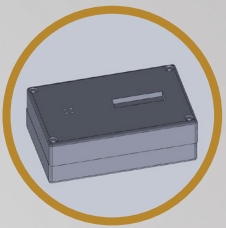
Team 4: Karla Montejo, Daniel Chaparro, Johanna Deluca, Divya Teltumbade
Faculty Advisor: Dr. Anthony McGoron
Company Sponsor: PAVmed Inc.

In the U.S., over one million hospitalized patients per day receive intravenous drug infusions. Electronic infusion pumps are used to administer critical fluids over gravity-driven sets due to their accuracy in delivering a range of flow rates. However, these electronic systems are prone to software errors subject to FDA recall. It's estimated that electronic pumps account for 30% of all medical errors. Passive infusion systems do not suffer from these errors, but are limited in accuracy because they don't account for the hydrostatic pressure differences throughout infusion. We present the mathematical modeling, design, and verification of a cost effective, off-the-shelf mechanical device capable of delivering accurate flow rates for intravenous drug infusion. This device accounts for pressure differences to maintain constant flow rate. This device will allow hospitals to revert to passive infusion for critical fluids with higher accuracy, and forgo frequent use of faulty and expensive electronic pumps.

Team 4 *Karla Montejo, Daniel Chaparro, Johanna Deluca, Divya Teltumbade*




Wearable, Low Profile Muscle Oximetry Monitor for Morbidly Obese Individuals



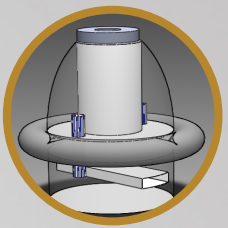
Team 5: Nicole Sevilla, Daniel Wilding, Nidhi Suthar, Jean Marc Augustin
Faculty Advisor: Dr. Anuradha Godavarty
Company Sponsor: Medical Photonics Laboratory (Dr. Jessica Ramella-Roman)

Obesity in the U.S. has increased to one-third of the population since 2014.1 Consequently, such individuals, with BMI greater than 40, are more prone to developing serious diseases such as hypertension, stroke, and heart disease. Efforts to minimize such life-threatening risks include exercise interventions, where muscle oximetry can be implemented to quantify changes in muscle oxygenation and measure exercise efficacy. However, current muscle oximetry modalities do not consider the subcutis physiology of the obese population and are known to produce inaccurate muscle tissue oxygen saturation (StO2) results. Therefore, to accurately measure the efficacy of exercise (StO2) in the obese population, we created a wearable, low profile muscle oximetry device, TinyOx. This device is intended to differ from current muscle oximetry modalities by considering the subcutis thickness of the obese population. Light emitting diodes (LED) in the Near Infrared Spectrum, a photodiode, and a wireless microprocessor are encased in a casing that allows the user to adjust the space between emitters and the detector for varying subcutis thicknesses. Also, a graphical user interface (GUI) provides for real-time data visualization, analysis and storage.

Team 5 *Nicole Sevilla, Daniel Wilding, Nidhi Suthar, Jean Marc Augustin*




Fornix Tissue Expander



Team 6: Stephany Sosa, Dayanna Romero, Xunjian Yang, George Valle
Faculty Advisor: Dr. Shuliang Jiao
Company Sponsor: Innovia, LLC

Anophthalmia is a rare congenital condition described as the absence of one or both eyeballs. The absence of the eyeball leads to the underdevelopment of its surrounding tissue, and contraction of the eyelids. Treatment of the hypoplastic tissue is require to be able to fit a prosthetic eye. Additionally, expansion of the tissue must be performed during the early stages of life for the therapy to be successful.

Patients are often treated with conformers to restore orbital structure and appearance before a prosthetic eye is placed. These current modalities require multiple replacements until a desire expansion is achieved, therefore, there is a need for a single device that can be used for the entire treatment.

The team designed a Fornix Expander, which will provide uniform growth of the eye's soft tissue and will last for the entire treatment, approximately 5 years. The device is designed to expand radially outward without an increase in its axial longitude, and to be MRI safe.

Team 6 *Stephany Sosa, Dayanna Romero, Xunjian Yang, George Valle*




Residual Limb Circumference Measurement Device

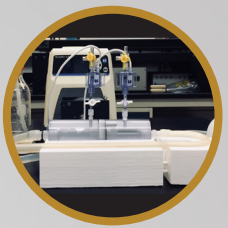
Team 7: Drew Collins, Elena Atienza, Kevin Estevez, Cristianne Fernandez
Faculty Advisor: Dr. Ranu Jung
Company Sponsor: Garrison's Prosthetics

In the United States there are approximately 2 million people with amputations and in Florida 98% of amputations are of the lower limbs. For amputees using a prosthesis, the process of refitting may be done numerous times due a change in residual limb volume. Clinicians use a measuring tape at different intervals to calculate circumference and determine if this change is significant, in which case a new socket is required. The softened tissue of the residual limb causes difficulty in standardizing the pressure applied at each measurement, producing a need for a subjective way to measure residual limb circumference. Herein, a non-contact residual limb circumference measurement device was developed to measure the circumference of lower extremity residual from transfermoral to transtibial. The number of intervals and circumference measurements wanted can be set, and the device will automatically perform measurements in under 2 minutes, and produce the information for the clinician.

Team 7 *Drew Collins, Elena Atienza, Kevin Estevez, Cristianne Fernandez*




Pediatric Tissue Engineer Heart Valve

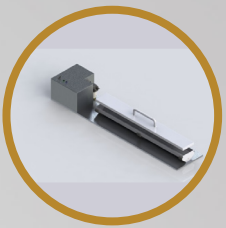


Team 8: Mehrnegar Malek, Maria Montesinos, Jean Ward, Andrea Carrasco, Aaron Armbrister
Faculty Advisor: Dr. Joshua Hutcheson
Company Sponsor: TEMIM Lab

Approximately one percent of all newborns have Congenital Heart Defects, many of them require open heart surgery including heart valve replacement. Currently available artificial valve prostheses cannot grow with the young patients & repeated replacement operation that are performed is associated with an exponentially increased morbidity and mortality to the new born. Tissue engineered heart valve offers excellent potential as a living, growing valve substitute and would be especially beneficial to the pediatric population. Current modalities of bioreactors that grow engineered tissue do not keep the geometry of the tissue in mind , additionally set parameters & protocols for the development of pediatric heart valves have yet to be established. Our object is the development of two inter-phasing components that would assist and develop the growth of a 3D geometric pediatric sized scaffold/valve in a bioreactor system as well as the optimization & systematic approach in developing pediatric heart valves with the respective components.

Team 8 *Mehrnegar Malek, Maria Montesinos, Jean Ward, Andrea Carrasco, Aaron Armbrister*

Vein Preservation System



Team 9: Morits Luik, Emily Perez, Alejandro Verdecia, Karina Sequera, Brian Pintado
Faculty Advisor: Dr. Jessica Ramella-Roman
Company Sponsor: Somahlution Inc.

Coronary Artery Bypass Graft (CABG) surgeries account for approximately 300,000 surgeries a year in the United States, of which about 40% are revascularization procedures that are due to graft failure. This high number of revascularizations has been, in part, attributed to the preservation method of the vessel between harvesting and grafting to the coronary artery. Research indicates that by providing a nominal flow that mimics the parameters found in the body, the tissue preservation is increased, thus decreasing the chances for vein graft failure and the number of revascularizations per year. This project will present a prototype of a preservation device that will provide the optimal flow conditions of solution through the vessel for the saphenous vein, in order to improve the preservation of the vessel and decrease the average number of revascularizations performed each year.

Team 9 *Mortis Luik, Emily Perez, Alejandro Verdecia, Karina Sequera, Brian Pintado*

Leg Asymmetry Prosthetic Device

Team 10: Michaela Mills, Rafael Arcila, Valentina Dargam, Christopher Estrella
Faculty Advisor: Dr. Ranu Jung
Company Sponsor: Dr. Laura McPherson and Anil Thota

Leg asymmetry prosthetic device (LAPD) is a clinical tool to objectively diagnose Anisomelia, also known as leg length discrepancy (LLD). LLD is a common occurrence in 40-70% of the population where an individual has some degree of limb length inequality either due to shortening of bone structures or altered gait biomechanics. LLD has been attributed to cause multitude of musculoskeletal dysfunctions, chronic lower back pain, osteoarthritis, postural balance and running injuries. The current diagnostic methods only address fixing the physical appearance of an LLD instead of restoring impaired gait mechanics. LAPD aims to improve the diagnosis of LLD by computing biomechanical indices from the gait/posture trials. This was accomplished by designing a prosthesis that fits most shoes and the height of the leg lift can be titrated by measuring optimal gait parameters using a sensor-based gait and balance system, which could provide better loading on muscles and bones.

Team 10 *Michaela Mills, Rafael Arcila, Valentina Dargam, Christopher Estrella*




Prosthetic Socket Measurement System

Team 11: Denise Medina, Irina Ryumina, Glenn Garcia, Mauricio Bendana, Sergio Ruiz
Faculty Advisor: Dr. Zachary Danziger
Company Sponsor: Garrison Prosthetic Services

Approximately one in every 190 Americans lives with the loss of a limb. Most amputees rely on their prosthesis to perform daily activities. As the part of the prosthesis that connects directly with the residual limb, the socket is an extension of the body. Its average lifetime is 2-3 years depending on the type of material, amount of activity, and the wearer's physiological characteristics. If a prosthetic socket cannot adhere to the precise measurements of an amputee patient's residual limb, long term damage and discomfort, such as pressure sores, and negative pressure hyperemia can occur. This prototype device automatically measures the internal depth and perimetric contours of a prosthetic socket, with the intent of aiding the correct fitting of the prosthetic socket onto a transfemoral and transtibial amputation; as well as establish a quantitative and verifiable approach to a previously established qualitative method.

Team 11 *Denise Medina, Irina Ryumina, Glenn Garcia, Maricio Bendana, Sergio Ruiz*

Development of a Low-cost High Resolution Optical Tracking System for Kinematic Evolution

Team 12: Abeer Al-Bargouthi, Michael Ardila, Alessandra Chavez, Francesca Riccio-Ackerman, Rayid Sakib
Faculty Advisor: Dr. Wei-Chiang Lin
Company Sponsor: Max Biedermann Institute of Biomechanics at Mt. Sinai Medical Center

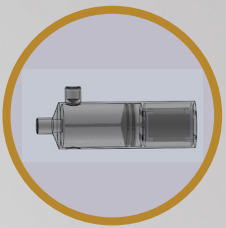
CenterAbstractKinematic evaluation is a common technique in diagnosis and therapy for neurological and orthopedic deficits in patients. Optical tracking systems allow for objective evaluation of spatiotemporal parameters of movement such as gait and joint kinematics in both clinical and laboratory settings. However, these systems are costly and often do not allow for applications in both settings. A low-cost optical tracking system with improved resolution of active photo-marking points has been developed for both laboratory and clinical use. This design provides a solution for low-resource institutions and outperforms systems that cost 10-20 times as much.

Team 12 *Abeer Al-Bargouthi, Michael Ardila, Alessandra Chavez, Francesca Riccio-Ackerman, Rayid Sakib*





Standardized Vaporization Device Attachment for Inhalable Drug Dose Monitoring

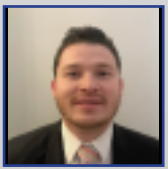


Team 13: Meraj Akhtar, Mahmoud Assad, Jose Palomino, Daniel Rivera
Faculty Advisor: Dr. Joshua Hutcheson
Company Sponsor: WB Engineering

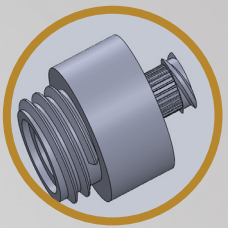
Every day 1.5 billion people suffer from intense pain, weeping cough, and other types of chronic illnesses. Many of these pathologies require fast and often long term use. Inhalable medicine is a drug delivery method that would be ideal because it has been proven to be much more efficient in terms of speed (fast reaction time to the medication administer) and the amount of dosage required for the medicine to take effect is less than that of other methods of administration. WB Engineering is prototyping a medical device that will use thermal vaporization technology to provide a standardized method of medicinal delivery which will ensure that all users get the same complete amount of medicine per dose. WB Engineering plans to create a device that will attach to vaporization pens and use differences in pressure systems, a linear actuator, and check valves to accomplish the administration of an exact dose of medicine each time.

Team 13 *Meraj Akhtar, Mahmoud Assad, Jose Palomino, Daniel Rivera*






Adipose Tissue Disintegration Device for Extraction of Adipose Derived Stem Cells



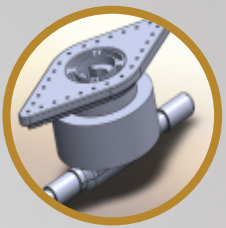
Team 14: Rebecca Kwasinski, Ramon Castellanos, Antonio Cuellar, Joselin Fuenzalida
Faculty Advisor: Dr. Michael Christie
Company Sponsor: StemCell Miami

Stem cell therapy is used to treat patients who suffer from orthopedic related issues due to the loss of cartilage or collagen in the joints or spine. Stem cell therapy is used as an alternative to invasive surgical procedures and reduces patient cost as well as rehabilitation time. Stem cells can be found in great abundance within adipose tissue and are contained within the stromal vascular fraction (SVF) of the adipose cells. Our device allows clinicians to process adipose tissue by mechanical means in order to obtain the SVF. The device is connected to syringes on both ends so that adipose can be broken down as it is passed back and forth through a mesh. The combination of mesh arrangement, turbulence, and cell collision are utilized for maximum cell lysis and extraction of adipose derived stem cells. Our device delivers an improved yield of SVF at a significantly lower cost than the current modalities on the market thereby increasing the efficiency of the procedures done at StemCell Miami.

Team 14 *Rebecca Kwasinski, Ramon Castellanos, Antonio Cuellar, Joselin Fuenzalida*




Design Optimization of a Percutaneous Intravenous Access Valve for Forearm Implantation



Team 15: Diego Gonzalez-Sempere, Juan Giraldo, Daniella Rojas, Patrick Thompson, Andrew Zicker
Faculty Advisor: Dr. Jorge Riera
Company Sponsor: DDE Lab, Inc.

Continuous intravenous access is required for treatment of chronic illnesses such as: cancer (drug delivery), chronic kidney failure (dialysis), and diabetes (glucose monitoring, insulin injections). To access the venous system, continuous puncturing of the skin and vasculature is required. This usually leads to complications such as permanent tissue damage. To eliminate the need of continuous puncturing, DDE Lab invented a magnetically sealed intravenous access valve which is implanted in the bicep to allow for selective access to the vasculature. However, like other percutaneous implants, infection is common, characterized by the buildup of biofilm resulting from proteins and moisture at the lesion site. By modifying the design of the locking mechanism, the team prevented the passage of fluids to the skin, greatly reducing the risk for biofilm infection. Also, by reducing the height, the device is now suitable for forearm implantation, which improves patient comfort and reduces cost.

Team 15 *Diego Gonzalez-Sempere, Juan Giraldo, Daniella Rojas, Patrick Thompson, Andrew Zicker*

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Max Biedermann Institute of Biomechanics at
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WB Engineering

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DDE Lab, Inc.


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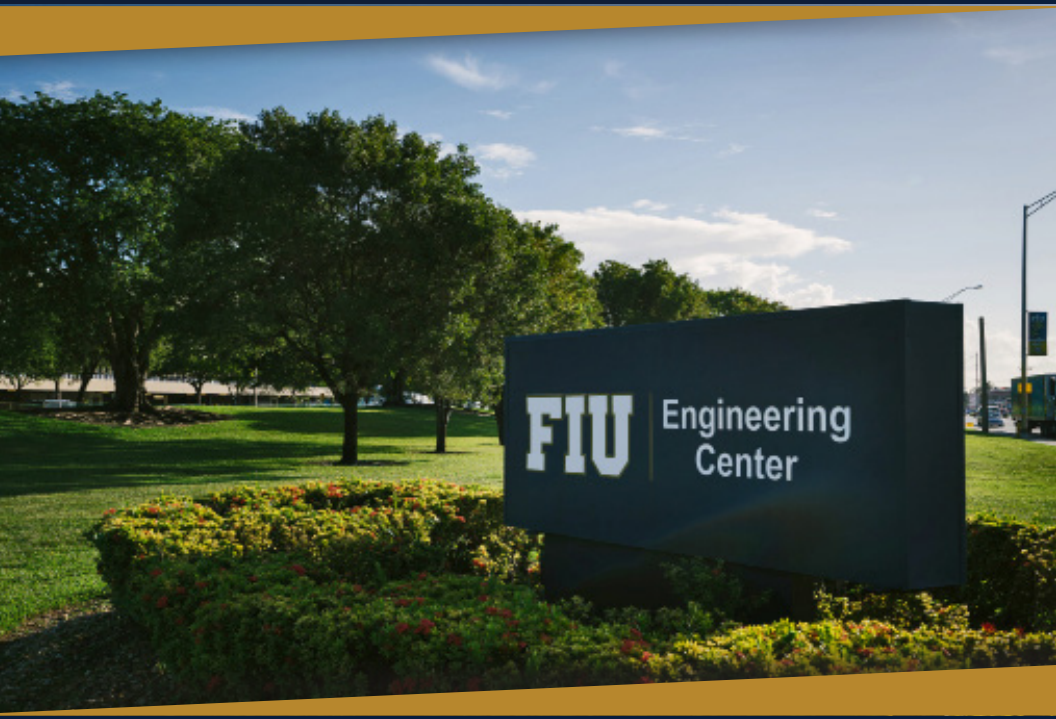
Be Worlds Ahead



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