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On behalf of the students, staff, faculty and affiliated colleagues of the School of Biological and Health Systems Engineering, one of the six schools in the Ira A. Fulton Schools of Engineering at Arizona State University and the Harrington Bioengineering Program along with our clinical and industrial partners, it is our pleasure to once again welcome you to our annual design symposium. Proudly displayed before you in this 20th annual symposium are the collective creative outcomes developed by our biomedical engineering senior capstone designers and masters applied project candidates that exemplify this culminating event. It is a testament to the wide range of expertise provided by our dedicated mentors and professional staff who, year in and year out, support the next generation of biomedical engineering scientists and designers who are expected to solve the pressing global grand challenges in health care. In addition, with an intensifying culture of innovation continuing to emerge at ASU and within the greater Arizona community, the growing entrepreneurial spirit will continue to provide unprecedented opportunities to our biomedical engineering students who will have acquired the skill sets to become the next generation of health care technology leaders in the 21st Century. Our ability to build our entrepreneurial capacity and engage in new global partnerships is better than ever. Please come join us in this exciting and rewarding journey!
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1:1 MYOSENSE: MUSCULAR MOTION ANALYSIS FOR PHYSICAL TRAINING [A12]
Hyder Hussain, Micah Rappazzo, Victoria Smith
mentors: Dr. Jeffrey LaBelle, Dr. Mark Spano - SBHSE

The goal of our project is to develop a medical device that will improve communication between patients and their physical therapists. Traditionally, a therapist must rely on their trained observational skills and the patient's self-report to know whether or not the patient is performing a therapeutic routine properly. These methods can lead to some level of ambiguity and miscommunication between both parties, which hinder the healing process. To alleviate these concerns, our final device will consist of a body suit connected with an Android-based mobile application that measures physical activity via muscular position and rotation. These devices together will provide real-time feedback to both patient and therapist during physical activity sessions. For data synthesis, processing, and transmission, an Arduino microcontroller is used along with wireless Bluetooth technology to communicate between the suit sensors and the mobile application utilized by the therapist. Our mobile application will display data to the therapist to allow for necessary corrections to be made by the patient, and store past data for review at a later time by the therapist to monitor patient treatment progression. By providing therapists with a tool to measure patient performance, fatigue, and progress, we intend to furnish real-time feedback to help make physical therapy sessions easier and more productive. This device can also potentially be used in non-therapeutic or non-rehabilitative settings, such as by personal trainers, athletic coaches, or performing arts instructors.

1:2 THE REDESIGN OF THE FLEX FOOT CHEETAH LOWER LIMB PROSTHETIC [A14]
Susan Gieske, Joshua Rood
mentor: Dr. Jeffrey LaBelle – SBHSE

The Flex Foot Cheetah, made by the company Össur, is a leading product of running prosthetics used by below the knee amputees. Currently, the product is made of a carbon fiber material, making the product costly. Because patients need specific prosthetic devices for specific daily tasks, the accumulation of multiple prosthetic devices becomes increasingly expensive.

Our goal is to create a cost effective solution to this problem by redesigning the Flex Foot Cheetah. Using bamboo fibers instead of costly carbon fibers, we hope to create a material with similar mechanical properties to carbon fiber. This will allow a cheaper alternative to the Flex Foot Cheetah prosthetic, while still allowing the user the appropriate amount of rigidity, give, and spring in order to mimic the mechanical mechanism of running – which the current carbon fiber model provides. Similarly, we hope to design the product in such a way so that it can be built and assembled in developing communities and third world countries. This will not only lower cost for the user by importing the product, but also stimulate the economies of resource-poor communities. However, this presents new challenges as we redesign the current carbon fiber model. One of the biggest challenges is the extraction of the bamboo fibers. In developed countries, this can be done by a simple chemical extraction method. However, to do this in an underdeveloped country means that we must be innovative in order to make this kind of assembly possible.

If we succeed in developing a method of fiber extraction for developed countries, the cost of the product will drop drastically for the user, while stimulating the economy in a developing area. Thus, we will not only be aiding local communities, but encouraging global cooperation in the field of prosthetics.

1:3 SAFETY APPARATUS FOR INHALED CHEMOTHERAPY [A9]
Matthew Kotin, Trevor Preschler, Sidrah Ali
mentor: Dr. Bruce Towe – SBHSE

Lung cancer is the leading cause of cancer related death worldwide. According to research from the Journal of Aerosol Medicine and Pulmonary Drug Delivery, aerosolized Gemcitabin was found to be safe and minimally toxic to human patients with non-small cell lung cancer. Since 1968 when inhalation chemotherapy was first introduced to the public several chemotherapeutic agents have been administered and proven feasible in animal and human trials. Our project for a safety apparatus for oral inhalation chemotherapy is anticipating a widespread need for devices that allows for the safe and portable administration of inhaled chemotherapeutics. In human studies performed in France, patients were asked to inhale the
medication from within hermetically sealed cabinets with air extractors comprised of both activated charcoal and HEPA filters. Our product vision is a filtered mask system that operates portably and is designed to achieve a zero exhaust function. Our mask accepts aerosol from a tube leading from an atomization device and passes through a one way valve system. When the patient inhales the one way valve prevents flow from the exhaust tube. Upon exhaling the one way valve redirects the channel to our filter and removes all of the chemotherapy agents before the exhaust exits the device. The concept, pending FDA approval of aerosolized chemotherapy agents in the United States, is to allow patients to medicate themselves comfortably from anywhere while maintaining a safe environment for everyone around them.

1:4 SOLELY FEET: VARIABLE ORTHOTIC TO PROMOTE HEALING IN PLANTAR FASCIITIS PATIENTS [B4]

Chelsie Bruning Mateosky, Stephanie Maxwell, Kevin Thomas, Alex Walsh, Connor Wiegand
mentor: Dr. Christopher Buneo – SBHSE

Solely Feet, Inc. envisions a product that treats the two million individuals suffering from plantar fasciitis every year through an affordable and customizable orthotic. Plantar Fasciitis is the micro-tearing of the plantar fascia, the connective tissue located on the bottom of the foot. This painful injury has a wide variety of treatment options available, including night splints, shoe inserts, arch supports, and custom orthotics. Despite the many methods of relieving pain, healing time for plantar fasciitis is typically several months or, in severe cases, years. There is a need to improve treatment methods for a speedier recovery. Current products concentrate on specific elements of healing such as stretching connective tissue, providing arch support, stabilizing the heel, etc., but they do not offer comprehensive treatment of plantar fasciitis. Our class I medical device is supremely customizable and multifaceted. The device is designed with all materials expected to withstand 1.5 kN to ensure quality design and durability. It will feature adjustable arch pieces (to prevent pronation and build strength) and interchangeable toe wedges varying up to 15° (to dynamically stretch the plantar fascia through toe flexion). With a $31 unit production cost and a $50 sales price, our device is comparable to current market trends, and better meets individual patient needs. These features will maximize the benefits of stretching and support twenty-four hours a day and will lead to a quicker, more affordable, and less painful recovery.

1:5 NEUROVIS [B5]

Sydney Vanda, Aashish Masih, Jenessa Lancaster, Danielle Jacobs
mentors: Dr. Mark Spano – SBHSE | Dr. Rémy Wahnoun – Barrow Neurological Institute at Phoenix Children’s Hospital

Electroencephalogram (EEG) based Brain-Computer Interface systems are an exponentially growing field of research due to their usability and affordability. NeuroVis is an innovative device that has been under development over the past year. Communication is an essential human need; paralyzed persons, who still retain high-level mental function, patients with neurodegenerative diseases, such as ALS, patients recovering from a stroke or just out of surgery, and Autistic patients will have a new outlet for expressing themselves with this device. Using the phenomena of SSVEP, steady state visually evoked potential, a patient can simply look at the icon that is desired, and a brain signal of the corresponding frequency will be evoked. The device design includes an electrode headband with 3-4 passive electrodes targeting the occipital lobe, a microcontroller equipped with code for the power spectrum using FFT, an 8-channel ADS1299 chip for pre-amplification of the EEG signal, and finally an iPad. This is a significantly less expensive method for communication than what is currently on the market, with a manufacturing cost of under $500, including the iOS application. Signals are evoked via icons on an iPad screen, and range from 15 to 30 Hz. Brain signals are picked up by electrodes and transferred to our professional class signal processing hardware. With the purchase of our application and equipment the user will be able to utilize a device that he or she may already have available. Neurovis provides a lightweight, portable, and easy-to-learn solution.
THE MCS9000: AN ADVANCED MOCK CIRCULATORY SYSTEM IMPROVING VAD PATIENT CARE [B6]

Cody Beck, Zach Jakubowski, Kenny James, Abbey Soulek, Yuzhu Wang
mentors: Dr. David Frakes – SBHSE | Lucas Schroedl – Mayo Clinic, Phoenix Campus

Over the course of the past year the Mayo Bunch has spent numerous hours poring over the design of an advanced mock circulatory system for the Mayo Clinic’s Phoenix Campus. The goal of the system developed, the MCS9000, is to improve the quality of patient care given to ventricular assistive device (VAD) recipients. Retailing at almost three-thousand dollars per device the MCS9000 is a moderately expensive, yet provides physicians an invaluable tool which allows them to replicate the vascular conditions of the patient using two pumps, four compliance chambers, several meters of 1/2” tygon tubing and compatible hardware. These components may have their specifications varied to produce a pulse between 20 and 60 beats per minute, a blood pressure of 5 to 250 mmHg, and cardiac outputs of 0.5 to 6 liters per minute. Producing the appropriate physiological conditions within the system allows physicians to apply multiple treatment options, observe their effects using strategically placed pressure and flow sensors, and optimize treatment without risking harm to the patient. Treatment options currently available for physician use on the MCS9000 include the five market share leaders in VADs in plug-and-play type setups at multiple locations. Additional treatment options may be added with easily available components. The most current version of the MCS9000 will remain with the Mayo Clinic’s Phoenix Campus to assist their perfusionists improve patient care and continue the Mayo Clinic’s mission of providing the highest quality of care to all its patients.

TRANSITIONAL CERVICAL SPINE IMPLANT [B8]

Jordan Price, Dillon Mir, Jake Snyder
mentor: Dr. Neil R. Crawford – Barrow Neurological Institute

Spinal Fusion can result in the new mass acting as a lever arm on superior and inferior vertebrae, causing degeneration of adjacent levels. The added forces which cause the degradation can be spread out over a greater area of the spine. Our group has proposed a level 3 implantable device that features intermediate transitional stiffness bands between adjacent levels of cervical vertebrae. Added support will allow for a more gentle transition of range of motion over the affected vertebrae. The device is targeted for patients needing fewer than 3 levels of spinal fusion, and is implanted via an anterior approach. Device dimensions were developed through a combination of identified customer needs and current state of the art. Analysis was performed using static and transient structural tests using Ansys 14.5 Workbench to develop theoretical models of flexion and extension motions. A physical prototype was then tested using a pure moment load machine at Barrow Neurological Institute. Motion trackers attached to the sample block allowed the angles of the vertebrae to be tracked. These were then used to develop actual models for range of motion across the fused vertebrae, transitional bands, and superior and inferior vertebrae. The actual models were then compared to the theoretical models developed from Ansys to analyze force distribution. Device success was based on smallest range of motion at the fused center, with a gradual increase over the transitional bands to the adjacent vertebrae. A net product value was calculated based upon assumptions taken from current industry markets.

BIOMUSCLE PROSTHETIC [B10]

John De La Cruz, John Ernzen, Cameron Noe
mentor: Dr. Jeffrey LaBelle – SBHSE

This project aims to use novel shape-memory alloy (SMA) actuators to create a gripping force in a trans-radial prosthetic device. Both biomechanics and prosthetic design are thriving fields, and this device seeks to adopt a novel approach in terms of design and application. More specifically, the actuators will be made of the nickel titanium alloy nitinol in the form of coils. An input signal will be fed into a microcontroller circuit which will resultantly distribute an electrical current into the device. The device will feature bundles of nitinol coils to imitate a similar actuator force found in real bundles of muscle fibers. With the applications of the electrical current these coils will contract allowing for the device to perform a gripping action. The project is currently in the prototyping stages and certain experiments are being performed upon various variables (force, current, material, etc.) to determine optimal conditions. Results so far have been promising with the sample muscle bundles being capable of lifting over 100 times their own weight with force outputs that have exceeded expectations. Goals for the end of the semester include creating a finalized prototype that demonstrates the working function of such a device.
The W.L. Gore-Sponsored Sterilization Chamber is an innovative solution to a common problem. The chamber is designed to reduce bioburden levels on various objects and materials for use in a clean room, in-line manufacturing, or in certain health care settings. The device uses small-scale, ionized hydrogen peroxide (iHP) to sterilize objects of various materials and with complex geometries. iHP is not absorbed by organic material and is therefore safe to use on all products including laboratory notebooks. This is significant because most other methods of sterilization cannot sterilize organic material due to absorption.

The final device is a sealed chamber that has a hinged door for easy access. Hydrogen peroxide is sprayed utilizing a pump directly through a plasma arc where the particles ionize and then scatter further into the air. Because the particles are all charged, they repel each other causing the iHP to cover the entire surface area in a single cell monolayer. The iHP has been tested thoroughly and been shown to be effective against spores. The device itself is extremely user-friendly; the RFID scanner allows the device to be triggered easily, and the solenoid-powered latch allows the chamber to be opened without physical contact from the user increasing the sterility of the device.

Finally, the device was extremely successful at meeting the clients' requirements. The device is portable enough that one person can move it but is sturdy enough that the user will not damage it in transport. This project was made possible through the support of our faculty mentor Dr. Jeffrey LaBelle and the mentoring associates from W.L. Gore.
2:2  A PORTABLE, LOW-COST EEG ACQUISITION SYSTEM [A20]

Denise Oswalt
mentor: Dr. Bradley Greger – SBHSE | Dr. Mark Spano – SBHSE

This design project is the development of a low-cost, hyper portable EEG to noninvasively monitor neural electrical activity. EEG recording can provide invaluable information regarding neurological state, general brain functioning, epilepsy monitoring, and even be employed for simple brain-machine interfaces. Despite its worth, EEG is often limited to clinical use due to its lengthy setup protocol, high machine cost, and computer system requirements. As a result electrical disorders of the brain are generally ignored in emergency situations and overlooked in patients with sporadic issues. This can delay proper care of patients and treatment of highly degenerative illnesses. The goal of this product is to bring the benefits of EEG monitoring to situations where it is currently inaccessible by providing clinical quality EEG in a package both portable and accessible for daily use. The resulting device delivers a more efficient platform for patient care as well as personal monitoring and medical research. Prototyping efforts have focused on developing an EEG acquisition system that fits these specifications. In its preliminary form the system has a 24-bit resolution and 2kHz sampling rate with low noise and low power requirements. Subsequent iterations of the design are scheduled to include additional channels, and wireless transmission of data via Ethernet. Additionally the device was designed with a simple, user-friendly iPad interface in mind to encourage personal and frequent use. A mobile platform such as the iPad will allow for seamless use in fast passed environments, encouraging use in ambulatory and emergency scenarios.

2:3  ECGENIE: WISHING AWAY YOUR HEART HEALTH CONCERNS [A22]

Shawn Muenz, Jared Suter, Omeed Khatami
mentor: Dr. Mark Spano Ph.D – SBHSE

The ECGenie is an affordable, portable diagnostic ECG monitor. It offers a number of advantages over its competitors including price and portability. Costing only $134.62 (including labor) per unit, the ECGenie is upwards of $100 cheaper than comparable competitors. The main feature of the ECGenie is its diagnostic capabilities. Rather than presenting the signal to a user who is likely not trained to evaluate ECG signals, the ECGenie will use cutting-edge algorithms to determine if the user should consider medical attention. The ECGenie will function by using detachable ECG leads and the "e-Health" sensor shield to capture electrical signals originating from the heart. The captured electrical signals are then passed on to the central processing unit, the arduino uno microprocessor, where the signals will be analyzed for indicators of potential cardiac events. Based on the occurrence of these indicators, which include heart rate variability and variations from the "norm" in peak amplitudes, the processor will send a message to a built in LCD screen to inform the user of their heart health. The ECGenie will be accessible to medical practitioners, as well at home users who want to be aware of their own heart health. This device will raise heart health awareness, as well as reduce the frequency of potentially fatal cardiac activity going unnoticed.

2:4  BYOSENSE: INTEGRATED PHYSIOLOGICAL SENSOR SUITE FOR REMOTE DIAGNOSTICS AND MEDICAL DATA MANAGEMENT VIA MOBILE PLATFORM [A5]

Sean Allen, Jeremy Blazer, Justin Dileone, Kris Phataraphruck
mentor: Dr. Mark Spano – SBHSE

We designed a physiological sensor suite which communicates wirelessly to a patient's phone, allowing for acquisition and wireless transmission of patient data to a medical professional. The device will be worn on the patient's chest allowing for portable and easy monitoring. Our design incorporates various sensors that measure heart rate, temperature, and activity level. A microprocessor is used for the analysis and wireless transfer via Bluetooth to an adjoining iPad application. The iPad app serves as a tool for patients to organize, monitor, and transfer data to their physician. This would fill the need for more accurate and efficient communication of medical data between patient and doctor. Testing involved using various circuit analysis techniques to compare our product to other standard methods for physiological data analysis. With the growing popularity in health/wellness devices this can easily market for a net profit of $60/unit. After selling 10 units, all manufacturing costs will be covered and profit will begin to accumulate. Future designs involve downsizing the device to something wearable on the arm and adding a photo feature to the app for patients to send photos of suspicious rashes, infections, etc. With the rise of mobile, personalized medicine, our project represents the natural step in the progression of doctor and patient communication and an improvement in effectively storing medical information.
2:5  SSTM VITALITY - PERSONAL HEALTH INFORMATICS DEVICE [A6]
Zach Scarano, Enrico Saladino, Alec Thimsen, Dave Mazur
mentor: Dr. Mark Spano – SBHSE

The SSTM Vitality is a low-profile wearable sensor array, worn on the upper left chest, capable of continuously monitoring activity, temperature, and heart rate for health and wellness purposes. A unique unobtrusive design allows for seamless integration into the user’s day-to-day life while the low-cost materials provide the user with substantial value at an affordable price. The product communicates wirelessly with an iOS device in order to display real-time metrics to the user as well as relay data to a 3rd party such as a friend, family member, or personal physician. Target users for this device are recreational athletes, healthy lifestyle enthusiasts, and at-risk individuals who require monitoring prescribed by a physician. The ability to tailor the digital metrics and functions of the device around the end-user is of critical importance and is used to increase accuracy and value to the user. Wellness-driven consumers and athletes can use the Vitality wearable for personal health management and fitness tracking. In a clinical setting, the Vitality wearable can assist physicians in monitoring the activity and general health status of their patients in order to improve safety and quality of life for those suffering from chronic disease. Through a simple but striking user interface the user is provided with valuable information, gaining insight into personal performance and general health. With the use of these metrics a training routine, diet, or health plan can be contoured to the user by a qualified individual.

2:6  THERMO-ELECTRIC BRACE DESIGNED FOR POST OPERATIONAL KNEE RECOVERY [B15]
Alexander Medawar, George Nitescu
mentors: Dr. Mark Spano – SBHSE | Dr. Jeffrey LaBelle – SBHSE

The purpose of the design is to promote proper healing for users after they have undergone knee surgery. Inspired by personal experience, this innovative product in the making would have been extremely useful for reassuring the healing process; there will always be a demand for PT devices, and the market currently is quite open with potential for further enhancement of physical therapy. Once completed, the capstone device is intended to come with a peltier-enabled heating and cooling system integrated within the material that can be cycled into a regimen. Ultimately, once completed, the team’s next step would be to develop a complimentary smartphone application for the user to easily formulate a plan that could be checked by a physical therapist, physician, etc. Due to limited time and funding, the final feature of the prototype will most likely not be available. Ideally, devices such as ours can expedite healing and improve patient compliance which will lead to greater successes in recovery.

2:7  PACE: INFANT CPR - ASSIST DEVICE [B18]
Jonah Thomas
mentor: Dr. David Frakes – SBHSE

The Pace Infant CPR Unit minimizes the response time during infant-related emergency situations that require cardiopulmonary resuscitation. By attaching crib-side, the device provides easy access to a parent or guardian during the time when most essential infant CPR emergencies occur – while the infant is sleeping. During an emergency involving an infant, every minute that cardiopulmonary resuscitation (CPR) is not performed, the chance of that infant surviving decreases by 10%. Through an interdisciplinary approach to product design, development, and innovation, our team has developed a unique CPR device that is specific for infants. Currently, there are similar products that can only be used by trained medical professionals and are designed only for adults; this device helps any person perform CPR on an infant. This innovative solution to a critical problem utilizes an iOS device and wireless microcontroller unit to walk the user through the standard infant CPR protocol, outlined by the U.S. National Library of Medicine, while also providing immediate, real-time feedback on the performance of CPR chest compressions. The Pace Infant CPR Unit has undergone fatigue testing to ensure its reliability during a full session of infant CPR. This device is planned to be introduced to the market and gain public exposure through its incorporation in CPR courses provided by hospitals for expecting parents. Additionally, sustainability of the product has been considered by allowing users to either recycle the unit as a training tool for local CPR courses, and possibly re-purposing the unit for toddlers and teens. The vision of the Pace Infant CPR Unit is that it makes its way into every home and provides peace-of-mind to all parents of infants.
ATHLETIC HELMET EQUIPPED DIAGNOSTIC DEVICE (AHED^2) [A13]

Alex King, Tiffany Juan, Hanseung Chung
mentor: Dr. Mark Spano – SBHSE

In recent news, cases of TBI in former professional football players have come to light. Causes of the disease are the results of repetitive impacts to the head over a long term. To prevent future occurrences in younger athletes, The Athletic Helmet Equipped Diagnostic Device (AHED2), a multi-sensor diagnostic device, was designed to monitor and protect those who play contact sports. The market for our product is relatively new and provides a complex basis for monitoring athletes. The device is integrated into the padding of a standard football helmet which has been modified to house a microcontroller that receives data from a connected accelerometer, pulse oximeter, and infrared thermometer. The sensors measure impact forces to the head, heart rate, respiratory rate, blood oxygen levels and core body temperature; a plethora of monitoring opportunities that is not currently being offered in existing devices. Once acquired, the data is transmitted to a connected iOS device. An application stores and displays all of the data received. The application will also serve a purpose in alerting trainers or coaches of impacts that are above a predetermined threshold, so the players may be assessed for concussion, or TBI. The goal for this device is to decrease the occurrence of chronic cases of TBI's in young athletes. The market size for this device is in the millions for athletes alone, and expands further to incorporate concerned parents that want a device that will allow the possibility of greater protection via monitoring. The device can also be adapted for placement in helmets of other contact sports to further increase the market base. At its current state, the device will sell at a price of $900, resulting in a margin profit of $500 after material and manufacturing costs.

DETECT: DETECTION OF ENVIRONMENTAL TOXINS USING ELECTROCHEMICAL TECHNIQUES [A15]

Michael March, Edward Sarafin
mentor: Dr. Jeffrey LaBelle, Dr. Mark Spano – SBHSE

DETECT is a novel low-cost, portable, user-friendly toxic gas sensor for utilization in the fire fighting and personal-health monitoring industries. This device operates using a simple screen-printed electrode modified with a sample capture mechanism comprised of a thin agarose covering. A low-cost, low profile potentiometer was developed using an Arduino platform. The Arduino was used to write the gas concentration data to an SD card for later review. Additionally, LEDs were used as alert mechanisms to signal if and when the gas concentrations reach hazardous levels or if the sensor is not operating properly. Constraints on time and resources prevent the end product of this Capstone project from being a marketable device. Rather, two physical prototypes have been built to test two vital product performance metrics. The first prototype was used to assess the sensor’s response time to a gas stimulus. Development and testing of this prototype involved several prototyping stages and the construction of a full-scale gas flow chamber. Preliminary specifications on this sensor suggest that the cost is about 1/10th the cost of the current state of the art sensor. The second prototype was used to model the electronic circuit components and assess the sensor’s overall weight as well as lower limits of detection. Using these two physical prototypes, the design team was able to determine the probable success of such a device in the market share. As a result, business models were developed to further evaluate the profitability of our device. These business models, including a Net Present Value analysis, of the device show the great potential for financial success. Upon completion of our physical prototypes and business modeling,
the design team was able to conclude that the product in development would be a very successful and lucrative endeavor. Future steps include assimilation of the two prototypes into a single comprehensive physical prototype and legal action to pursue patent protection.

3:3 SUBCUTANEOUS BIOSENSOR FOR THE ASSESSMENT OF STRESS [A16]
Shantel Shaver, John Smith
mentor: Dr. Jeffery LaBelle – SBHSE

There is currently a lack of medical devices to monitor stress related symptoms within the human body. Monitoring specific biomarker concentrations such as glucose and lactate concentrations has been demonstrated to be an accurate and rapidly responsive indicator of symptoms for complications arising from a large number of stresses including (but not limited to): Traumatic Brain Injuries (TBI), food deprivation, sleep deficiency, strenuous exercise and diabetic or pre-diabetic tendencies. Current state of the art devices for glucose monitoring are either not capable of continuous monitoring or are expensive, invasive, inaccurate and difficult to use. There are even fewer commercial devices for monitoring lactate and, at this time no commercial solutions exist for monitoring both glucose and lactate in vivo. Our goal is to combine the ease of use, accuracy, and cost of current continuous glucose monitoring devices with the ability to continuously monitor lactate for extended durations with minimal lag time. Specifically, our device should be sensitive to glucose concentrations between 50-90mg/dL and lactate concentrations between 5-10mg/dL which will provide physiologically relevant information regarding stress. Our design aims to create a sensor capable of subcutaneous deployment to minimize invasiveness while still tracking significant biomarker changes within the body. This would allow us to create a more useful stress monitoring device for both patients and health-care professionals capable of recording data over a time period meaningful for stress assessment.

3:4 µEDCC: LOW-COST MICROFLUIDIC BIOSENSOR FOR HPV DETECTION [A2]
Amy Blatt, Kulveen Dhatt, Randle Kuehner, Jonathan Yoo
mentors: Dr. Jeffrey LaBelle – SBHSE | Dr. Karen Anderson – Center for Personalized Diagnostics, Bodesign Institute

Each year 270,000 women die from cervical cancer with 85% of those deaths arising from low-and middle-income countries. Cervical cancer is more prevalent in these regions due to the inaccessibility of costly standard diagnostic tests commonly used in developed countries. Since there are no effective screening options for cervical cancer in developing countries, µDiagnostic Systems focused on designing the prototype for µEDCC, a low-cost, minimally invasive, microfluidic screening test capable of detecting the presence of HPV-16 E7 and HPV-18 E7 antibodies, the highest-risk indicators of cervical cancer. The prototype consists of HPV16/18 E7 antigens bound to carbon nanotubes (CNTs), which are immobilized along the channels of a polydimethylsiloxane (PDMS)-based microfluidic platform. Target molecules are detected based on changes in electrical potential due to binding of antibodies to antigen-CNT complexes. µDiagnostic Systems plans to mass-produce this device in targeted regions to minimize costs. Per device, the estimated initial production cost is $0.10 and the estimated initial retail cost is $0.25. Long-term, production costs will decrease while retail costs will slightly increase. µEDCC is the first device of its kind, and major advantages include portability, ease of use and access, accuracy, and a fast run-time (<1 hour). If the market expands to the U.S., µEDCC would be designated as a Class III device because of its novelty and would be subject to premarket approval. However, a de novo request may yield a Class II designation due to its moderate risk.

3:5 PRE-SYMPTOMATIC LUNG CANCER SCREENING [A21]
William Evans
mentor: Dr. Jeffery LaBelle – SBHSE

Lung cancer is responsible for the most cancer related deaths in the United States, having recently overtaken breast cancer in women. This is largely a result of failure to detect or diagnose lung cancer pre-symptomatically, at which point the cancer has often grown beyond treatment, frequently metastasizing. This failure to diagnose lung cancer early is a consequence of there not being an effective and convenient device with which to regularly screen patients. This research has looked to remedy this situation by developing an electrochemical sensor capable of detecting a protein biomarker (Neuron Specific Enolase) that is indicative of lung cancer in solution with the ultimate goal to detect in blood. This sensor will be capable of measuring the concentration of the biomarker Neuron Specific Enolase by applying a varying current and measuring the corresponding impedance. The measured impedance will utilize a previously developed mathematical algorithm so as to determine the unknown biomarker concentration. Based on the measured concentration, the physician will be able to determine whether the patient is at risk and ought to pursue more traditional diagnosis techniques and subsequent treatment options. This sensor will prove to be invaluable to physicians as it enables easy screening of patients for lung cancer, which will promote pre-symptomatic diagnosis, and consequently more personal and effective treatment plans.
3:6  TEARTOUCH GLUCOSE SENSOR [B14]
Samantha Tibbs, Jasmine Brown
mentor: Dr. Jeffrey LaBelle – SBHSE

In the United States, there are over 25.8 million people living with diabetes. Currently, these diabetics have one method of testing their glucose levels. This process involves testing using the blood directly, which is painful and inconvenient. Due to this, most diabetics do not check their glucose levels as often as they should. If a diabetic does not keep their sugar levels under control, they risk dealing with heart disease, strokes, kidney disease, or even vision and nerve problems. This device, while slightly more costly than traditional methods, will use innovative technology to create a noninvasive, pain-free way for diabetics to monitor their glucose levels throughout the day and allow diabetics to take glucose readings without having to prick their fingers. This project will focus on the piece of the device that will touch the eye and collect the tear fluid directly. The device will work by collecting a small amount of tear fluid (>1uL) when touched to the outer corner of the eye, by way of an absorbent sponge. The patient will be able to pump the tear fluid into the device from the sponge by softly squeezing the device where specified. The tear fluid will then be mixed with phosphate buffered saline solution and brought into a sensing well where the glucose levels in the tears will be detected by a sensor. This new method of glucose testing has the potential to alter the lives of millions, creating a much healthier and compliant population of diabetics.

3:7  MD^2: A DIABETIC'S ONE STOP SENSOR FOR PROVIDING IMMEDIATE, INTERMEDIATE AND LONG TERM POINT-OF-CARE ANALYSIS [B20]
Francis Eusebio
mentor: Dr. Jeffrey LaBelle – SBHSE

The Multimarker Diabetes Management Device team (MD^2) will improve upon the standard of care for diabetics, self-monitoring of blood glucose (SMBG), to self-monitoring of multiple markers (SMMM). On the user end, there should be little change in use, while the our sensor will be more sophisticated. Just as with current SMBG devices, our device will require a drop of blood and the user will have a hand held device that will analyze the sample. However, the MD^2 incorporates electrochemical impedance spectroscopy to increase sensitivity and create specificity for multiple markers on one point of care sensor. Specificity is established by immobilizing antibodies and enzymes that correlate with target analyte interactions. These interactions correlate with unique frequencies of alternating current ranging between 1 Hz and 10,000 Hz. Each marker has a unique impedance correlation curves for a specific frequency and can be selectively monitored. The markers exist in inflammatory, metabolic, and immunological pathways that are affected by diabetes, and will allow the patient and their caregiver to have more information to personalize treatment. The markers include glucose, glycated hemoglobin, 1,5-anhydroglucitol, insulin, as well as a glycated albumin index. The current level of prototyping has been developed for glycated albumin, though the final device will incorporate prototypes that have encompassed all 5 of the markers. The MD^2 will be hand held, easy to use, and fast in the electrochemical analysis so that a lay person can use it.

3:8  DETECTING BREAST CANCER BY FINDING GENE MUTATIONS USING TENTACLE PROBES [B9]
Abhinav Markus, Joseph Desamais, Wacey Teller
mentor: Dr. Michael Caplan – SBHSE

Breast cancer occurs in about 12% of women. The testing is often expensive and subject to false positives/negatives. The goal of this capstone project was to create a diagnostic assay that would be less expensive than what is currently available, simultaneously decreasing the odds of false positives/negatives. This was done by creating a diagnostic assay that uses a novel microfluidic chip to prepare biopsy samples used for testing, as well as a Tentacle Probe to target genes associated with breast cancer. It was decided that PIK3CA gene mutations would be used to detect breast cancer, specifically, the A3140G PIK3CA gene mutation. This is because PIK3CA is mutated in about 20-40% of breast cancer patients, making it an ideal gene to target. Mutations of PIK3CA are ideal not only because of how frequently it occurs in breast cancer patients, but also because drug treatment for these gene mutations are currently being developed. As of now women sometimes undergo double mastectomies based on their breast cancer results. Drug treatment for PIK3CA mutations provide an alternative option to the invasive procedures usually sought. Thus, by using the Tentacle Probe to target PIK3CA gene mutations a less expensive option for breast cancer testing is provided, also offering drug treatment options other than mastectomies, which contributes to the health and safety of patients.
[4] medical software design

4:1  PT CONNECT - MOBILE APPLICATION TO IMPROVE EFFICIENCY OF PHYSICAL THERAPY REHABILITATION PROCESS [A11]
Alexandria Davies, Salman Hasan, Keon Seif-Naraghi
mentors: Dr. Mark Spano, Dr. Christopher Buneo – SBHSE

Our objective is to digitize the rehabilitation process and improve the efficiency of patients’ at-home exercises by allowing physical therapists to become more accessible outside of the clinical environment. This application will allow physical therapists to upload instructions and video on at-home exercises. The patients can access this information, record a video of themselves performing the exercises, then send them to the physical therapist for feedback. The application will be marketed towards the physical therapists as they will buy the application and can add as many patients under them as they would like. Once the application has been completed, testing of the product will begin under one pre-designated physical therapy clinic. This will allow direct feedback from the physical therapists and patients on specific parts of the application that work well as well as other parts that do not. We also feel we can test those at the end of their therapy who used the application against those who did not use the application, to prove that our application does help patients recover faster and better than those who do not use the application.

The team, PT Connect, is positive that the results from the testing will prove that our application not only aims to help improve the communication between physical therapists and patients, but also aims to improve the original injury to prevent further re-injury.

4:2  AUDIOMETRY – IOS APP OF AUDIOMETER FOR EVALUATING HEARING LOSS [A7]
Renjie Xu, Yujie Wang, Zheng Tan
mentor: Dr. Bruce Towe, Dr. Mark Spano – SBHSE

Our project is to design a software for the iPhone/iPad to act as an audiometer so that people only need to spend several dollars to buy, and easy for perform a test at home. It will both save a lot of money and provides great convenience. The software consists of tone generator, data recorder and the record display. It can generate low to high frequency by using phone’s audio core, record and analyze the results and give out the hearing sensitivity diagram, which known as the audiogram. Users can optionally wear noise-isolated headphones to reduce environment disturbance. Product features: Wide frequencies: 125Hz, 250Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, 8000 Hz; wide amplitude: 20dB – 80dB; Tone type: continuous/pulsed. What's more, test mode selection: automatic mode and manual mode. An example test procedure is that output a tone via headphones with gradually increasing volume. When they hear the low and high frequency, they press the button in the software. By repeating, the software will record and process the data. The result view section can plot user’s audiogram while a comparison to reference hearing range plot. And since apple product is available to most people, the potential market is prospective and users can easily have access to this product. It only cost them about $20 to conduct a hearing loss evaluation at home by themselves.

4:3  QUICKFLOW [A8]
Marissa Flogel, Regina Martinez, Justo De La Cruz
mentor: Dr. Mark Spano - SBHSE

QuickFlow, a vital tool for monitoring respiratory health, is a low cost, pocket-sized, and wireless alternative to currently available meters. Home monitoring of daily peak flow measurements is important for those with chronic respiratory conditions because readings can indicate respiratory decline before symptoms are felt, alerting users to the need for preventative treatment. This early intervention results in decreased urgent care and emergency room visits. Available peak flow meters require manual logging of readings to track respiratory health or the purchase of expensive software. The current methods for daily monitoring are inconvenient, time consuming, and lead to a decrease in compliance. QuickFlow monitoring is the solution, requiring only a few simple steps to take a reading, store it and review history. QuickFlow connects wirelessly via Bluetooth to the iPhone and the free app manages the data. Results can be quickly evaluated by the user and shared with their healthcare provider at the touch of a button. QuickFlow utilizes a differential pressure sensor and a venturi tube to accurately and precisely determine peak expiratory flowrate. Our product will simplify the management of respiratory health, helping physicians and customers make better decisions.
GLIOBLASTOMA MULTIFORME TUMOR GROWTH FORECASTING SOFTWARE [B16]

Lena Snyder, Brittany Duong
mentor: Dr. David Frakes – SBHSE

Glioblastoma Multiforme (GBM) is an aggressive and deadly form of brain cancer. Unfortunately, patients are typically unaware of GBM until they have begun experiencing symptoms of the tumor, and by this time the tumor is quite sizable and difficult to treat. This difficulty in treating GBM tumor growth comes from doctors’ inability to predict where the tumor will spread next in the brain. Our Capstone Senior Design project tackles this problem by creating a computational model that accurately and precisely predicts tumor growth based on patient-specific brain geometry information acquired from magnetic resonance imaging (MRI) scans. Our medical software uses these scans to produce a 2D model of the GBM tumor growth. This information provides doctors with another tool to evaluate treatment options. Based on feedback from professionals at Barrow Neurological Institute at St. Joseph’s Hospital and Medical Center, our medical software should be fast, able to run across multiple platforms, and have a friendly user interface. The initial prototype of our Capstone Senior Design project will simulate GBM cancer in mice; once the mouse model is shown to be effective, we will move to human patient data. This novel approach to making informed treatment decisions for GBM cancer will provide essential information to doctors, helping them determine the best treatment option and improving patient outcomes.

neural engineering

NEUROLEAGUE STIMULATOR [B19]

Garrett McCann
mentor: Dr. Stephen Helms Tillery – SBHSE

Current sensory neuroprosthetics lack the resolution to restore senses to the ideal level. For example, cochlear implants are limited by the number of electrodes representing distinct frequencies that can be used without overlap. To create better devices, it is necessary to develop models for synaptic propagation in neurostimulation. Due to the interconnectedness of the brain, signals quickly propagate unpredictably. To develop better models, it is first necessary to work on a smaller scale. To this end, a neurostimulation box that that drive small amperages across large impedances of the brain will be developed. A circuit that can precisely control current with work in tandem with a microcontroller to provide the user with options ranging between 1-100 microamps. The microcontroller will be able to read input sensors and modulate it into a stimulation pulse. The device's performance will be tested with a standard breadboard setup, and it will be demonstrated that currents cannot exceed the gamut of safe currents. Statistical analysis will be useful to verify that the data does not reach outside the prescribed ranges for a given input signal. With standardized components, it can be conceivably produced for under $300. Once its internal circuitry demonstrates the desired parameters in the lab, the Neuroleague will allow for a level of precision never before seen in synaptic modeling and open a floodgate for the next generation of neuroprosthetics.
While treating mammalian cell and tissue cultures with various chemicals in vitro, it was found that certain processes such as cell growth may be improved by inducing motion of the samples. Often in scientific research, many of these samples are treated inside of an incubator in which the ambient environment is one of high humidity (RH 95%) and relatively warm temperature (32-40°C). Our proposed device is a specialized laboratory shaker designed to operate under incubator conditions for a period of at least 24 hours.

Because the device is intended to perform in an incubator, it needs to be highly resistant to negative effects of moisture, such as rust. The shaker shell needs to be composed of nonmetal materials, such as plastics or polymers. Various gels and sealants can be used to coat any exposed metallic components. In order to function uninterrupted for an extended period of time inside of an incubator, the device must be battery operated. Powering the device using a battery also allows for the shaker to be highly portable.

This device is intended for use in a research laboratory in which the use of an incubator-shaker inclusive device is not an option. Additionally, this device can be utilized in field research due to its relatively small size and portability resulting from the battery powered feature.

This capstone design project is focused on developing a nanoparticle that will be used in diagnosing acute traumatic brain injury (TBI). The leading cause of injury-related death in the United States is TBI, and each year in this country over 1.7 million people are treated for it. Little progress has been made in the diagnosis of TBI. There is not currently a diagnostic tool for acute TBI that utilizes contrast-based imaging, which is critical in identifying the location and severity of neural injury. This project focuses on using a contrast agent characterized on the surface of a nanoparticle to be used in magnetic resonance imaging, which will improve the current state of TBI diagnostics.

Micelles are the best nanoparticle for this purpose based on ease of manufacture, cost, and biocompatibility. The main objective of this project is to develop and characterize a targeted contrast agent that will recognize acute neural injury pathology (i.e. fibrin) after TBI. Single chain fragment variable antibodies (scFv) that bind specifically to fibrin have been produced and purified. DSPE-PEG micelles have been produced and the scFv has been conjugated to the surface of the micelles. A gadolinium contrast agent has also been conjugated to the micelle surface, which will be used to overcome current limitations in diagnosing TBI. I would like to thank my mentor, Dr. Sarah Stabenfeldt, the Capstone Design instructors, Dr. Vincent Pizziconi and Dr. Antonio Garcia, and the TAs for their assistance in this project.

Diabetic foot ulcers affect 1-6% of the 25.8 million patients diagnosed with diabetes back in 2012 (Rice, 2013). To treat the chronic diabetic foot ulcers, the wound must have adequate oxygen and nutrition supply. Pathogens must also be dealt with to ensure low risk from infection. A moist, but not wet, environment is crucial in properly irrigating the wound to allow nutrient flow. Dead, damaged, and infected tissue must be removed as frequently as possible (Daley, 2013). Our project
aims to solve these problems by creating a novel alginate/bovine pericardial tissue wound dressing. The alginate will allow water retention, and the bovine tissue will allow wound dressing placement stability. The alginate has been successfully modified to incorporate cell adhesion ligands, and gel imaging data was done to show visual proof. The bovine tissue also contains cell adhesion ligands, and has a specific patented method to allow a longer biodegradability time span. Physical characteristics of the dressing have been quantified via rheology to show mechanical differences between a common surgical mesh and our wound dressing. This engineered dressing will allow the wound to heal in an optimized environment while reducing the needed wound dressing changes. Our dressing will focus on infusing with the patient's own regenerative environment to promote the most natural recovery.

6:4 MEMORY SHAPE ALLOY SAFETY SYRINGE NEEDLE [B12]
Maralbek Zeinullin, Yernar Samtikov, Tuan Do
mentor: Dr. Bruce Towe – SBHSE

According to the Safeincommon website, each year 385,000 needlestick injuries and other sharps-related injuries are sustained by hospital-based healthcare personnel. This equates to an average of around 1,000 sharps injuries occur per day in hospitals and including other non-acute healthcare facilities. It is estimated that 600,000 healthcare personnel exposed to bloodborne pathogens each year in the U.S. These pathogens include Human Immunodeficiency Virus (HIV), Hepatitis B Virus (HBV), Hepatitis C Virus (HCV), and others. Comparing to the regular needle which has potential danger, tip of our shape memory needle curls backwards right after the injection, so the chance for the medical crew to get pricked is minimal. Basically, first we need to give a natural (shape to which it turns when heated) shape to the needle by heating it to the temperatures around 900-1000F. Our natural shape was chosen to be coiled or curled one. So, there is no way for the nurse or doctor to have contact with needle tip after the injection. After that we need to stretch and make it straight. Now, we have our needle ready to use. Right after the injection a small amount of heat (around 155C-175F) needs to be applied. Finally, used needle can be disposed and medical crew should not be worried about getting an unexpected poke. The target markets for the device include medical crew in the hospitals, who perform injections. The device could also be implemented in out of hospital injections if the information regarding how to use a product is provided. The manufacturing cost including material cutting, processing, sharping was taken from the Aliexpress website. The cost for the labor and tools was considered as well. Finally, our total manufacturing cost turned out to be $100.09/100 piece. This price is twice as expensive as the cost for creating regular needles. The reason why the cost of is higher because it is much harder to process a Nitinol alloy. Since it has Titanium in its composition the special tools and much labor is required. At this stage of our capstone project we have completed the prototyping step and now about to start testing our product. In conclusion, we think that our safety needle has a potential to bring millions of people, who work in a medical field into much safer work environment.

6:5 PIEZOELECTRIC NANOWIRE COATED SELF-SCRUBBING THROMBOSIS-RESISTANT CORONARY STENT [B13]
Christopher Workman, Cristian Cirjan
mentor: Dr. David Frakes – SBHSE

Coronary artery disease is the most common manifestation of heart disease and cause of heart attacks. The disease results from atherosclerotic narrowing of the coronary arteries due to plaque buildup in the artery walls. Atherosclerotic stenosis eventually closes off the vessel to blood flow and starves the heart tissue of oxygen, leading to cardiac infarction. Stenosis is currently treated via endovascular catheterization by deploying a stent to apply radial force to open up the vessel. Stents recognized as foreign bodies, however, cause platelets to bind to them and form thrombus that causes restenosis, requiring additional interventions. Stent thrombosis can be a lethal flaw in the treatment of coronary artery disease with either drug-eluting stents or bare-metal stents. We propose to solve this dilemma by redesigning the stent to resist thrombosis. The lumen of this stent will feature a coat of vertically aligned nanowire arrays, which naturally move under changing electric potential to disrupt the aggregation of platelets. Barium titanate nanowires have been shown to produce dynamic electric current in response to acceleration of the nanowires. The coronary stent will implement the inverse process, by allowing the nanowires to kinetically pulse under pulsatile voltage induced by the natural electrical activity in the heart rhythm. Kinetic energy generated at the surface of the stent material will ideally reduce the likelihood that platelets will bind to reduce the treat of stent thrombosis and further reduce the risk of heart attacks. Resistance to platelet adhesion was modeled with a Bradford protein adhesion assay.
6:6  BIODEGRADABLE SCAFFOLD COMPOSITE DESIGN FOR PELVIC ORGAN PROLAPSE SYSTEM LEVEL DESIGN [B21]

David Kawalik, Paul Lovse

mentors: Dr. Stephen Massia, Dr. Christine Pauken, Dr. Vincent Pizziconi – SBHSE

This project undertakes a systematic approach to assist in the design of building electrospun scaffolds as part of a joint project between ASU and Mayo Clinic. The overall aim is to produce a biomaterial that will be surgically implanted in patients to regenerate vaginal tissue in patients suffering from pelvic organ prolapse. The mentors for this project are Dr. Massia, Dr. Pauken, and Dr. Pizziconi with the School of Biological & Health Systems Engineering at Arizona State University and Dr. Jeff Cornella at Mayo Clinic Hospital. Electrospinning has the ability to create scaffolds with varying fiber orientations, pore sizes, porosity, and fiber diameters. These characteristics are key to altering the scaffold’s mechanical microenvironment and will drastically effect how cells will react when seeded on the device. While varying system inputs of electrospinning distance between needle and collector, voltage, solution % weight ratios, and fiber orientation, we statistically compare output scaffold characteristics. The created scaffolds are physically characterized using a micro tensile testing device and the use of SEM and computer program ImageJ to determine fiber diameter, pore size, and porosity. These output scaffold characteristics will be analyzed though a full factorial statistical analysis to determine any correlation with the input parameters. This parameterized information will allow for people to tailor scaffolds to their specific cellular needs in the future as a platform technology for tissue engineering.

6:7  PHYTOSYNTHESIZED SILVER NANOPARTICLE WOUND DRESSING [B3]

Christopher Montagne, Oscar Murillo, Nicholas Dietrich, Casey Rockwood

mentor: Dr. Antonio Garcia – SBHSE

Effective wound care requires the optimization of physiological conditions and patient compliance. A major drawback of current anti-microbial wound healing products on the market that provide a positive environment for skin repair is growing anti-microbial resistance. In an effort to prevent this rising dilemma, we are incorporating the anti-microbial properties of bamboo and silver nanoparticles to create a novel medical product. Historical evidence has shown that silver has been used as an effective antibiotic without demonstrating any significant cases of resistance. Our silver nanoparticles are phytosynthesized using bamboo leaf extract. This method is preferable over chemical, synthetic, or microorganism methods of synthesis as it is more cost effective, environmentally friendly, and can readily be scaled up for large-scale production. Competing products like Silvasorb® are being sold at around $30 for 100 mL, but our product is projected to be sold at less than a third of that price. After extraction, the Kirby-Bauer method is applied to find an effective concentration of both bamboo extract and silver nanoparticles for antibacterial elimination of gram-positive and gram-negative bacteria. SEM analysis is used to illustrate that the nanoparticles are between 20 – 100 nm to ensure biocompatibility and safety. Incorporating a cellulose-based hydrogel into the design has provided a greener method of drug delivery rather than the environmentally harmful chemicals often found in other commercial wound dressings. Using a combination of cellulose derivatives, we have designed a hydrogel capable of delivering moisture to wounds while simultaneously decreasing the bacterial burden. With the inclusion of both bamboo extract and silver’s antimicrobial synergy into the cellulose-based hydrogel, we have developed a medical product that will prevent infections due to its anti-microbial properties and ultimately promote wound healing.
KENYA SUSTAINABILITY: VACCINE STORAGE SYSTEM [A19]

Evan Norwil

mentor: Dr. Michael Caplan – SBHSE | Dr. Jan Snyder – ASU Engineering Outreach

The device is a sustainable, vaccine storage and refrigeration unit for use in Kenya. In eastern Africa, polio outbreaks in the fall of 2013 have highlighted the need for improvements to vaccine distribution to remote areas. Because vaccines require protection from light in a space cooled between 36 and 46 degrees Fahrenheit, they are only reliably supplied to hospitals in large cities. This project seeks to design a vaccine storage unit, which can be produced within Kenya’s economy for application in rural areas. Thus, some of the key product requirements involve power autonomy, and manufacturability. This design utilizes the vapor compression system commonly used for refrigeration. By circulating fluid through the cold space, compressing circulating it through the exterior, and allowing it to expand, heat can be pulled away from the vaccines in storage. To drive this process electrical power is obtained through a photovoltaic solar array. Solar power is common in Kenya on a variety of scales and does not require natural resources as fuel. Because of this, it is used in remote areas to provide electrical power.

With the design concept finalized, technical models were built in matlab and comsol to verify the capabilities of the design. Based on the models and customer needs, a power consumption of 80 watts was set for a 12 liter storage space. A major challenge identified during the modelling phase were effects of a hot environment, to mitigate this, the storage space was placed in the ground to reduce convective heat transfer.

EXTRACTION OF ANTIMICROBIAL COMPOUNDS FROM BAMBOO [A4]

Luis Laitano, John Augsburger, Israa Alsharif, Obada Aladib

mentor: Dr. Vincent Pizziconi, Dr. Brent Vernon – SBHSE

The project’s aim is to develop a process that can extract antibacterial agents from bamboo plants. Through this process, the hope is to be able to create a kit that will allow entrepreneurs in developing countries to cheaply develop their own antibacterial agents from the fast-growing and sustainable plant source, bamboo. The raw bamboo stem and leaves will be ground separated and ground into small pieces. Then, the antimicrobial agents will be extracted from the bamboo
through microwave assisted extraction. From there, the material will be characterized using UV-VIS spectroscopy, High Performance Liquid Chromatography (HPLC), and microbiological assays to identify the molecules that are present in the extract, to quantify their concentrations, and to validate the effectiveness of the antimicrobial. Initial research efforts suggest that anthraquinones, flavonoids, coumarins, and phenolic acids compounds are possibly responsible for the antibacterial activity in the plant. From this research, the decision was made to utilize 80% ethanol as the solvent for the extraction, though water and acetone are also being tested as potential solvents. The choice of extraction method was determined based on its low cost, reliability, high yield and minimal toxic waste produced. When the characterization is finished, the process of recovery will be optimized to increase yield to a reasonable level, and the equipment used will be standardized. The optimization regards details about the microwave power levels and ramping them up in stages, the use of iced water to prolong microwave exposure without evaporating the solvents, and solvent flow considerations.

7:3  **BILITRACK: A LOW COST/ NO POWER PORTABLE SPECTROMETER FOR JAUNDICE DETERMINATION IN NEONATES [B1]**

**Long Le, Qasim Rahman, Charles John, Habtom Hadish, Heewon Park**

mentor: Dr. Antonio Garcia – SBHSE

BiliTrack is a revolutionary technology that uses a mobile phone platform to detect levels of bilirubin transcutaneously. High levels of unconjugated bilirubin in blood streams can cause irreversible damage to an infant's brain. Jaundice is easily detected by observation, blood tests or a noninvasive transcutaneous bilirubinometer (NTB). The advantage of an NTB is that it can reduce blood volume losses and pain from needle-sticks, but still give an accurate indicator to physicians about the efficacy of medical treatments. In southeast Nigeria, the typical healthcare expenditure per household amounts to 150% of the total monthly income of the low social class. Many of these families earn less than $2 per day, yet expenditure on laboratory tests for neonatal jaundice can reach $73 alone. BiliTrack is a low cost device that will help physicians in developing countries overcome this shortcoming. Research has shown that smartphone technology is becoming more available universally, which will reduce costs by utilizing the inherent smartphone features such as the microprocessor, flashlight/camera and battery source to create a NTB. The team has developed a model of the device so that it can be used with an iPhone. This consists of a branched one-arm mechanism that utilizes fiber-optics to guide the light on to the patient's skin and reflect back to the camera for analysis. Customized programming will measure the reflectance and provide quantized levels of bilirubin, which will provide a premise for treatment. The base unit will have a purchase price of $45 and is feasible for use in impoverished regions.

7:4  **WORLD WORKOUT APPARATUSES AND MEDICAL ACCESSORIES [B11]**

**Bryan Rubatt**

mentor: Dr. Vincent Pizziconi – SBHSE

There is a need for workout apparatuses that will be more available and easier to adopt to affect communities where availability and adoptability can affect major health issues, such as obesity. There is also a need for a healthier style of living, a healthier nation and world, and a reduction in healthcare costs. The problem to be solved is finding a way to provide people with sustainable, affordable, and environmentally feasible workout apparatuses throughout the world, especially where there are no gyms. The use of cheaper, easier to manufacture, and more environmentally feasible resources than traditional metal will help the environment and put to use the Earth's resources for a good purpose. Research of four different materials: bamboo, PVC, HDPE, and ABS was involved in the design of greener and novel workout apparatuses that offered more exercise workout variations and allowed for improved workouts than current-on-the-market products. Also, these materials, bamboo of first choice being renewable, fast growing, and available on five different continents, will offer a cane and walker for those who are disabled and the elderly if they need a walking aid. Solidworks was utilized for design, while Solidworks SimulationXpress simulated testing and provided analysis. The results and analyses of von mises stresses indicate that all three materials were suitable for the prototypes and could withstand the required forces without yielding. True stress, bending properties, and an S-N curve provided important information needed for safety, analysis, and a warrantee.
7:5 **SICKLE CELL DIAGNOSTIC TEST KIT [B17]**

**Jamie Shawver, Daniel Moreno**

mentors: Dr. Michael Caplan – SBHSE | Dr. Jan Snyder - ASU Engineering Outreach

Over 300,000 are born each year with Sickle Cell Disease (SCD), of which over 75% are in Africa. Sickle cell disease causes blood cells to become malformed, rigid, and results in many health problems throughout life. Without early diagnosis and prophylactic treatment, the average life expectancy is less than 5 years. Utilizing industry best practices and following the guidelines laid down by the FDA, we've developed a diagnostic for SCD that has a shelf life 8x longer and 20x cheaper than its market equivalent. The diagnostic can be done with little to no training and unlike its market equivalent, doesn't require refrigeration. The test relies on the fact that in a deoxygenated environment, a single drop of blood precipitates with a very visible result. We've developed an all-inclusive test kit that can be manufactured and distributed at the rural or urban level of Africa. The test will give a positive result to most sickling genetic markers, and is intended to be followed up at a clinic or hospital for verification. Each test only costs $0.63, so for $1 we can distribute a diagnostic with enough profit to make it sustainable after this year, while still remaining a cost-effective option in Africa. Once detected, there are many simple treatment options that can be implemented to increase survival rates and quality of life, and this kit could potentially reduce the morbidity and mortality rate greatly in Kenya due to SCD. A preliminary prototype will be taken to Kenya for validation this summer.

7:6 **AMBU-LEG: TRANSFEMORAL AMBULATORY PROSTHESIS FOR DEVELOPING COUNTRIES [B2]**

**Amanda Grzybowski, Andrew Quach, Jess Tsui, Daniella Vossler**

mentor: Dr. Bruce Towe – SBHSE

Our biomedical device, the Ambu-Leg, answers the needs of underprivileged amputees by providing an affordable prosthetic leg which can improve their living conditions and provide them with greater well-being. Individuals with walking disabilities in developed countries can easily regain basic functions, such as walking, by using highly developed technologies. However a majority of individuals in third world countries have no access to such things, making daily activities very challenging. A main cause is simply the technology is not available in that area or is not affordable. The disabled population living in developing countries accounts for almost 12% of the world population and a large majority do not even have access to medical care. The Ambu-Leg is constructed mostly using locally found materials in most developing countries. By utilizing materials readily available and reducing dependence on imported materials we reduce cost and provide local job opportunities as the device can be custom built at the location. Our prosthetic is designed for above the knee amputees and includes: the foot, lower-leg, knee joint, and method of attachment. The prosthetic utilizes natural gait and translational movement for comfort and efficiency. It is designed to adapt to different terrains such as the wet environment of field work. Additionally the device will provide tactile feedback and a joint lock mechanism for greater functionality. The dexterity of our device will be able to meet the needs of a greater population of underprivileged amputees and improve their quality of life, at a cost 99% less than market.

7:7 **COST EFFECTIVE METHOD FOR TESTING BLOOD GLUCOSE IN DEVELOPING COUNTRIES [B7]**

**Jacqueline Buchak, Ammer Dbels, Kali Towner**

mentor: Dr. Michael Caplan – SBHSE | Jan Snyder – ASU Engineering Outreach

Diabetes is a growing epidemic affecting the citizens of developing countries across the world, especially in rural Kenya. The electrical requirements of current glucose testing devices and the constraint of shipping causes the cost of blood glucose testing in developing countries to be too expensive for the average citizen, prohibiting them from monitoring their diabetes. Additionally, many people affected by diabetes do not understand glucose ranges, making the quantitative results given by current glucose tests near useless. The finalized product inspired by these issues is a droplet-based colorimetric glucose testing method that utilizes glucose oxidase, catalase, and TMB to produce a visual color change that is compared to a reference sheet consisting of colors and labeled glucose levels. The results indicate whether the glucose range is high, normal, or low based on the significance of the color change. High will be indicated by a white color, normal will be indicated by a deep blue, and low will be indicated by a light blue. Results of extreme levels come with a recommendation to seek medical attention. The product allows multiple uses per test kit at approximately 30-40 cents per test, allowing the device to be significantly more affordable than the current testing methods available, at an average of $1.50- $2.00 per test.
8:1 **UNIVERSAL OBJECT IDENTIFIER CODE FOR MEDICAL DEVICES**

Benjamin Erlick
mentor: Dr. Jeffrey LaBelle – SBHSE

Universal object identifier codes are a promising alternative for identification of FDA regulated materials and equipment. Identification codes have benefits over other characterization techniques due to their small size and capability of being read subcutaneously. Circular identifier codes with a 0.8cm diameter were accurately read using an XRF handheld spectrometer. Simulated subcutaneous measurements were accurately taken 0.3cm away from the scanning instrument, through SEBS thermoplastic. Ten levels of concentration in identifier codes were distinguishable across eight different metal powders, allowing for ten million unique codes. The number of unique codes can be expanded further using additional metal powders. Therefore, these test results validate that using chemical signatures read through an XRF handheld spectrometer provides an accurate reading of a small identification code at subcutaneous depths.

8:2 **CONDUCTIVE FOAM BASED ACCELEROMETER USING ELECTROCHEMICAL ANALYSIS**

Peter Lazaravich
mentor: Dr. Jeffrey LaBelle – SBHSE

A polyurethane foam based accelerometer has been developed to address the need for a scalable, low cost, and robust sensor. The PCB based copper and gold plated sensor is tailorable to various applications by swapping parts of the sensor body. The sensor is also resistant to chemicals and static discharge. The flexible nature of the foam sensor allows for application along curved surfaces, including the inside of a helmet, around a limb, or inside the sole of a shoe. Signal detection is accomplished through the use of amperometric-it and cyclic voltammetry. The overall size, range, and scalability of the sensor lends itself well to many applications within the medical field.

8:3 **MULTI MARKER ELECTROCHEMICAL IMPEDANCE CANCER SENSOR**

Sangwoo Park
mentor: Dr. Jeffrey LaBelle – SBHSE

Immunosensor for the simultaneous analysis of tumor marker on a single electrode was developed. While electrochemical impedance was measured, unique binding frequency of the targeted biomarker and non-targeted protein were changed cyclically in order to provide multi analysis. Anti-prostate-specific antigen was immobilized on a gold electrode by covalent attachment. Using electrochemical impedance spectroscopy, the optimal binding frequency of PSA was determined to be 81.38 Hz. Then, impedance over time with cyclically changing frequency of 81.38 Hz, 833 Hz and 12250 Hz corresponding the optimal frequency for PSA, glucose and none, respectively, was measured with PSA and Glucose concentration range of 10 to 10,000 pg mL-1. This multi analysis of label-free immunosensor for PSA provides simultaneous analysis of tumor markers and increases specificity by measuring non targeted factors together.

8:4 **INVESTIGATION OF EFFECTS OF A PIPELINE STENT ON SIDEWALL ANEURYSMS USING COMPUTATIONAL FLUID DYNAMICS**

David DeJeu
mentor: Dr. David Frakes – SBHSE

Aneurysms are a weakened area of a blood vessel, often "ballooning" from the vessel wall. Cerebral aneurysms occur in approximately 1.5% to 5% of the population (American Heart Association). Rupturing of the aneurysm may lead to hemorrhagic stroke, permanent nerve damage, subarachnoid hemorrhaging, or death (National Institutes of Health). Treatment of aneurysms relies heavily on the expertise of a physician and past experience rather than quantitative data. The purpose of this research is to investigate the effects of a low-porosity stent on various sizes of sidewall aneurysms using computational fluid dynamics (CFD). Six idealized, treated models were examined at three different flow rates to determine the effects of the stent on blood flow into or out of the aneurysm (across the aneurysm neck) and blood flow within the aneurysm. The six models were characterized by neck size, aneurysm dome size, parent vessel angle of contact, and were simulated at 2 ml/s,
3 ml/s, and 4 ml/s. The CFD results were analyzed to determine the effects of each parameter on blood flow. This research, combined with the research of others in the Image Processing Applications Laboratory, will help validate the computational simulation of aneurysm treatments. As a result, physicians may be able to use these simulation methods to perform pre-surgery treatment investigations using patient data, in

8:5 CFD ANALYSIS OF IDEALIZED SIDEWALL ANEURYSM HEMODYNAMICS
James Lindsay
mentor: Dr. David Frakes – SBHSE

When an intracranial sidewall aneurysm gets large it poses a significant risk of bursting and causing subarachnoid hemorrhaging (SAH) often leading to stroke, permanent brain damage, and loss of life. Nearly half of all cases of SAH are fatal and another third suffer permanent brain damage. In order to understand how to treat aneurysms we need to first understand how the fluid dynamics of the blood is affected by the geometry of the aneurysm and parent vessel. This study focused on quantifying the effects of aneurysm geometry and flow rate of blood on key hemodynamic parameters. The parameters of interest were the root mean square velocity of blood inside the aneurysm, and the flow of blood entering or leaving the aneurysm (cross neck flow). These factors are an indication of hemodynamic forces in the aneurysm and thus affect the aneurysm growth rate and danger of bursting. The factors of interest were aneurysm dome size, aneurysm neck size, parent vessel angle of contact, and the flow rate of blood in the parent vessel. Both steady and pulsatile flows were considered, each at 2 ml/s, 3 ml/s, and 4 ml/s. Computational fluid dynamics was used to simulate flow in 8 different idealized models that were created in Solidworks. After simulating, the results were analyzed and used to quantify the effects of each factor on the two parameters of interest. By understanding how the hemodynamics of sidewall aneurysms depends on the geometry of the aneurysm, better treatment decisions can be made in a more individualized manner.

8:6 FLOW-STRUCTURE INTERACTION MEASUREMENT BY PIV AND IMAGE SEGMENTATION
Kshitij K Mehta
mentor: Dr. David Frakes – SBHSE

Fluid-Body interactions are usually difficult to model using the conventional analytical approaches. As a result of this, some advanced methods were developed. The interaction between a moving body and the surrounding fluid creates a complex set of forces which in turn depend on the coupling between them. The variations occurring in the motion of the fluid resulting from deflection of the body indicates strong coupling. To study this scenario, a complete analysis of fluid-structure interaction needs to be done which in turn requires the knowledge of forces and accelerations of solid as well as that of the moving fluid. The forces acting on the body because of motion of the surrounding fluid can be computed provided that there is enough information on flow field. The predominant technique used for computing the fluid velocity is Particle Image Velocimetry (PIV). It helps in computation of the velocity gradient which can be later employed for evaluating the forces acting on the body resulting from the moving fluid.

It is also possible to achieve the velocity measurement of fluid and solid body separately. One of the methods that can be used for this purpose is to segment the image into fluid and solid part separately prior to PIV analysis. The segmentation algorithm should be adaptable to the images including different shapes of the solid. It is important to select the appropriate segmentation techniques especially when the solids are moving. For this project, the segmentation techniques employed are Mean and Variance Thresholding, Template Matching, Enhanced Template Matching and Segmentation with Bhattacharyya Distance.

8:7 KINEMATIC DESIGN AND THREE DIMENSIONAL PRINTING OF A BIOMIMETIC HUMAN HAND FOR PROSTHETIC APPLICATIONS
Shane McCauley, EIT
mentor: Dr. Jeffery Labelle – SBHSE

An ABS plastic 3D printed modern day prosthesis was developed using the anatomy and physiology of the hand and wrist to design a biomechanically accurate representation of a human hand, ultimately to contain a Nitinol powertrain. By using the natural static and dynamic constraints of hand motion as a template; a novel CAD model was created and subsequently prototyped into ABS with a simulated, Nitinol system. The resultant design emulates 16 degrees of freedom for digit motion and the capability of 20 discrete hand states.
CHARACTERIZATION OF NOVEL THERMOPLASTIC ELASTOMERS AS ATHLETIC MOUTHGUARDS

Zoran Bundalo
mentor: Dr. Jeffrey LaBelle – SBHSE

Mouthguards have become widely used throughout the sport world. 40 million mouthguards are sold each year in the United States alone, 90% of which are stock mouthguards bought over the counter. Due to an increase in sport related injuries caused by a growth in contact sport participation, it has become evident that mouthguards are necessary to protect oral health. Injuries can occur in the teeth, the bone, the soft tissue and the joints. In order to protect these areas of the mouth, a characterization of a thermoplastic elastomer was performed in order to assess the feasibility of its use in mouthguard concept development. This characterization included compression analysis, tensile strength testing, shore hardness examination, and the potential shock absorption of the material. Using each one of these testing elements, varying volumetric percentages of thermoplastic elastomer were assessed. This resulted in a suggested and proven percentage to be used in mouthguard design. The selected percentage will provide ample protection to not just the teeth, but also the soft tissue and the temporomandibular joint, all while allowing the facial muscles to relax while participating in strenuous activity.

IMPACT SENSOR FOR MONITORING SPORTING EQUIPMENT FUNCTIONALITY

Mary Kate Siuba
mentor: Dr. Jeffrey LaBelle – SBHSE

Traumatic brain injury (TBI) contributes to a significant number of deaths and cases of permanent disability each year in the United States. An estimated 1.7 million people experience these head injuries that cause disruption in normal brain functionality which is why it is critical to understand the impacts that take place during sports-related activities. With the leading cause of death being TBI, monitoring the activity during impacts and gaining feedback associated to those collisions from the player and their equipment is crucial to aid in better understanding what forces are applied to designated areas of the head. Force or impact sensors are among the growing technology that can be used for this application. With the National Football League among other sports organizations striving for improved performance, a sensitive, durable yet flexible, and cost effective force sensing apparatus has been developed to meet the need of the new industry requirements of football helmet design and development. A thorough design of experiment was performed and provides detailed information to obtain the greatest conductive foam for insulation of the helmet. Through characterization of the feasibility and durability of the foam, we gain a better understanding of what dynamic range the foam can perform at in hopes to aid in preventing the occurrence of TBI.

MRI MEASUREMENT OF DENDRITE ABNORMALITIES IN THE MECP2-A140V MOUSE MODEL OF RETT SYNDROME

Jing Liu
mentor: Dr. Gregory Turner – Barrow Neurological Institute

Rett syndrome has been shown to cause by mutations of gene MeCP2. These mutations result in altered dendrite pathology and abnormal fine dendrite structure. In this study we used MeCP2-A140V mouse model, which has a normal lifespan and normal weight gain patterns compared to other MeCP2 mouse model. This mouse model expressed a human MeCP2 mutation linked to an X-linked mental retardation phenotype. According to histology study, there was a significant difference in the dendritic branching in both apical and basal dendrites in the somatosensory cortex between wide type and MeCP2-A140V mouse. In vivo DTI has revealed significant increase in FA in the grey matter of the sensory cortex of MeCP2-A140V mouse. To better understand how mutation genes change dendrite structure, in this project, we tried to measure differences in FA with DTI in the visual and auditory cortex of WT and MeCP2-A140V mutant mice. In our experiment, we have 7 MeCP2-A140V mice and 7 wide type (WT) mice. We took 13 directions and 7 slices in DTI. However, after processing these data, the result showed that there is no obvious difference of FA in visual and auditory cortex between WT and MeCP2-A140V mice. Our future work is to promote the existing method and analyse the data again to make sure that the conclusion is valid. We are also going to keep looking into other regions of the cortex. If we can build corresponding relationships between DTI measurement and Rett syndrome, hopefully, DTI can become a non-invasive tool to diagnose and monitor Rett syndrome progression.
8:11 DEVELOPMENT AND CHARACTERIZATION OF A PLASMONIC FIBRIN-GOLD NANOROD NANOCOMPOSITE

Adam Roussas

mentors: Dr. Sarah Stabenfeldt, Dr. Mehdi Nikkhah – SBHSE | Dr. Kaushal Rege – SEMTE

Colorectal cancer and inflammatory bowel disease affect approximately 1.5 million individuals in the U.S., and almost always requires surgical intervention. Occurring among 2.7% of patients, anastomotic leakages are among the most deleterious complications of colorectal surgery. Laser tissue welding, a technique developed by the Rege lab, is a method that has promise to supplement current anastomotic techniques employed by surgeons and significantly decrease the occurrence of leakage. The Rege lab has run successful proof of concept experiments, using plasmonic polypeptide gold nano rod (GNR) composite soldering, and is now exploring alternative materials in an effort to increase the efficacy and general clinical translatability of the technique as a whole. Due to its already ubiquitous presence in many surgical hemostatic applications, using fibrin as a type of solder is a promising option; however, there is currently limited research in literature about how incorporating metal nanorods into the fibrin clot would affect various viscomechanical, rheological, and physiological properties of fibrin polymers and no research on how well a fibrin-GNR composite would adhere to tissue. This project will focus on how to most effectively prepare a plasmonic fibrin-GNR composite, characterize the various properties of this material, and determine the practical eligibility of a fibrin composite as a tissue welding solder material.

8:12 ANALYSIS OF CARDIAC WAVEFORMS FOR DETECTION OF SLEEP APNEA

Siddharth Arunachalam

mentor: Dr. Jeffrey LaBelle – SBHSE

Sleep apnea is a respiratory disorder characterized by a cessation in airflow for ten seconds or more. Approximately $42 million is spent on diagnosis of sleep apnea every year. Polysomnography tests are presently the gold standard for diagnosis of sleep apnea which involve monitoring six different signals – EKG, from the body resulting in a very cumbersome and expensive (close to $2500/test) ordeal for the patient. Portable sleep devices such as the Watch-PAT, Sleep Strip and ApneaTrak which measure different combinations of the above six have become popular in recent years. Though such devices have been successful in diagnosis, their sensitivity and accuracy rates are still in question and some of the devices still pose discomfort to the subject while sleeping. This project aims to use Heart Rate Variability (HRV) singly for the detection of apneic episodes using an automated classification method which combines features extracted by time-domain, frequency-domain and non-linear computations using MATLAB. The project also involves comparing the accuracy of different classification algorithms such as K-nearest neighbor, Artificial Neural Networks and Support Vector Machines for classification and finding optimum parametric levels for classification using MATLAB. This could be coupled with respiratory motion signals picked up from an accelerometer (which can also be used to measure EKG) to provide accurate classification results which could ultimately be used for an initial screening for sleep apnea.

8:13 THE ADOPTION OF MINIMALLY INVASIVE APPROACHES TO PARTIAL NEPHRECTOMIES: ARE THE BENEFITS OF NEW TECHNOLOGY WORTH THE COSTS?

Shawn Anthony Haupt

mentors: Dr. David Frakes, Dr. Vincent Pizziconi – SBHSE | Dr. Erik P. Castle – Mayo Clinic

Kidney cancer represents 2% of new adult malignancies, with 65,150 cases estimated to be diagnosed in the US in 2013. Renal cell carcinoma represents 85% of kidney cancers and has the lowest survival rate of urologic cancers, with a mortality rate of 28% after five years. Partial nephrectomy (PN) has been recognized as the standard of care for small renal masses. Reports indicate that compared to radical nephrectomy (RN), PN offers comparable oncologic outcomes with lower incidences of chronic renal failure and associated cardiovascular events, with greater long-term survival. Minimally invasive approaches to PN, such as laparoscopic PN (LPN) and robot-assisted PN (RAPN) have been developed, with similar oncologic outcomes, lower blood loss, and shorter hospital length of stay (LOS). However, in a health cost-conscious environment, it is important to evaluate which therapies are most cost-effective while maintaining or improving quality of care. A review of nine cost-analysis studies indicates that LPN offers a direct cost advantage to RAPN due to lower equipment costs and to OPN due to cost savings of shorter LOS. Such savings do not consider LPN’s higher learning curve in comparison to RAPN, which has retarded LPN’s growth, while RAPN can potentially increase access to minimally invasive PN. Because PN is severely underutilized in comparison to RN, prospective randomized studies between RAPN, LPN and LRN to compare long-term
cost-effectiveness are needed. Investigations into lowering LPN and RAPN equipment costs, and lowering the LPN learning curve could be conducted to facilitate wider adoption of minimally invasive PN.

8:14 DESIGN OF A PORTABLE AND FAST ASSESSMENT TECHNIQUE FOR MEASURING UPPER EXTREMITY MOTOR FUNCTION IN POST-STROKE SUBJECTS

Shubashree Balaji
mentors: Dr. Jeffrey Kleim, Dr. Marco Santello, Dr. Chris Buneo – SBHSE

The assessment of motor impairment level in stroke patients is normally done using various assessment scales such as the Fugl meyer test for sensorimotor function and balance and the Wolf Motor Function test used exclusively for checking upper extremity functionality and several others. The time taken for these tests range from 15 minutes to an hour and the subjects are required to perform a number of tasks that are similar to everyday activities. The assessment may be based on Performance Time, Accuracy, Kinematics, Stability, Range of motion, etc. and they give a valid and reliable measure of physical mobility. The Objective of this Applied Project is to design an assessment procedure that is not as time consuming as the standard assessment scales but provides a quick measure of the impairment level that can be relatable to the Standard assessment scales. A Grip apparatus will be designed that will measure the parameters used in the motor function test. The assessment will be made based on Grip force applied to the grip apparatus, the stability of lifting motion and wrist extension. For this project, subjects with mild to moderate stroke are only considered and the assessment is limited to test upper extremity functionality. Also, this project aims at designing a portable, bedside assessment that can be used post-stroke to measure patient recovery in a Clinical environment.

8:15 3D PRINTED ELECTROCHEMICAL TACTILE PRESSURE SENSOR

Swetha Varadarajan
mentors: Dr. Jeffrey LaBelle, Dr. Mark Spano – SBHSE, Jim Blumsom – Presidium Equipment, Ltd.

The end product is a flexible tactile sensor layout, which could be applied to a range of prosthetic applications. The compressible part of the sensor is a Thermoplastic Elastomer called Ninja Flex (Chemical name: Thermoplastic Polyurethane) is 3D printed. It is highly elastic and has excellent abrasion resistance. The sensing part uses a 3 electrode system- Counter electrode, Working electrode and Reference electrode, all of which are hooked up to the electronic instrument that reads the current that results from application of pressure. This sensor functions by detecting electro active species near the electrode surface and converting it into an electrical signal which can be read by an electronic instrument (i.e.) when pressure is applied, the concentration of the electro active species at that site increases and a larger current reading results. This value of current correlates to a peak on an Amperometric I-t display. Hence that enables in determining the magnitude of pressure applied and areas of touch. These tactile pressure sensors could be made as artificial skin or mounted on the fingers of a prosthetic hand to mimic the mechanoreceptors of the fingertips. Grasping motion of a prosthetic hand could be stopped or strengthened based on the sensor’s detection of contact.

On behalf of the Biomedical Engineering Product Design and Global Health Technology Innovation Center, we would like to thank BME alumni, industry partners and mentors. We hope to continue our partnership and collaborations, as well as stay connected to our seniors to be part of what future may hold for them!
Celebrating 10 years as the Ira A. Fulton Schools of Engineering at Arizona State University, we’ve been educating engineers for Arizona and the world for nearly 60 years. With almost 9,000 students, we are building the engineers of the future and pursuing the discoveries and solutions to challenges facing society.

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