DREXEL UNIVERSITY
School of
Biomedical Engineering,
Science and Health Systems

2017 SENIOR DESIGN SHOWCASE

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Wednesday, May 17, 2017 – 4:00 PM

George D. Behrakis Grand Hall,
3210 Chestnut St. Philadelphia, PA 19104

(Inside Creese Student Center, on Chestnut Street,
between 32nd and 33rd Streets.)

Program of Events

4:00 PM – 4:15 PM	**Showcase Event Registration**
4:15 PM – 4:25 PM	**Welcoming Remarks** *Paul W. Brandt-Rauf, Dean and Distinguished University Professor*
4:25 PM – 6:00 PM	**Poster Presentations, Judging, and Networking**
6:00 PM – 6:30 PM	**BIOMED Design and Innovation Awards Ceremony** *Wan Shih, Associate Professor*
6:30 PM – 7:00 PM	**Concluding Remarks** *Paul W. Brandt-Rauf, Dean and Distinguished University Professor*

Quad Charts

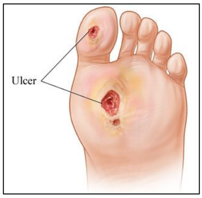
Group 1: Controlled Drug Delivery System for Chronic Wound Healing Applications

Team Members Matthew Geib, Allison Liptak, Samantha Santos, Anh Trinh, Kathryn Volk
Advisor Dr. Kara Spiller

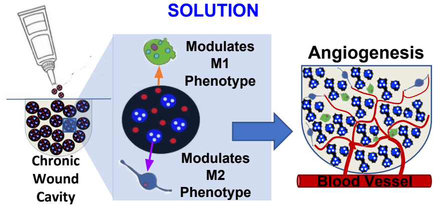
CLINICAL NEED

Chronic wounds, such as diabetic foot ulcers, **fail to heal** within 12 weeks.

No current solutions address the underlying physiological activity of chronic wounds.



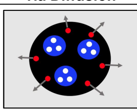
SOLUTION



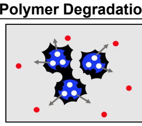
APPROACH

Sequential drug delivery system due to the different release mechanisms of drugs through biomaterials.

M1 Drug Release via Diffusion

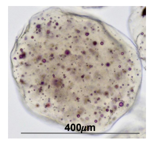


M2 Drug Release via Polymer Degradation



RESULTS

Space-filling capacity for various sized wounds



2D Image of drug delivery system via light microscopy

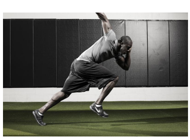
IMPACT

Novel approach to space-fill various wounds and allow for controlled release of macrophage-eliciting cytokines.

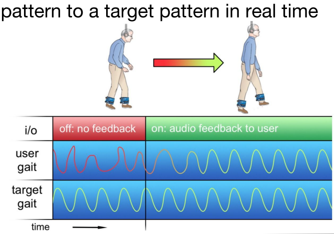
Group 2: Gait Modulation Via Rhythmic Sonification

Team Members Samantha Fox, Jaclyn Goulet, Tyler Kern, Cory Quigley, Yang Wan
Advisor Dr. Joseph J. Sarver

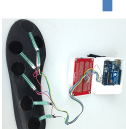
Mobile, intuitive, accessible gait modulation device for:
- Post-injury rehabilitation
- Physical therapy for neurological disorders
- Athletic training



Sonification: non-speech audio to convey data
- Map gait parameters to sound via insole sensors
- User modulates gait by matching their sonified gait pattern to a target pattern in real time



Solution



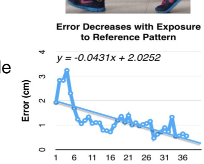
1. Insole with Force Sensors

2. Sonification Software

3. Audio Output to User

Results & Impact

- Pressure pattern modulation validated ($p = 0.01$)
- Future initiatives: dual foot design, additional sensors, larger sample size
- Device has potential to make gait therapy accessible for underserved patient populations



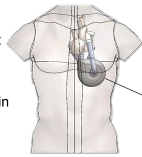
Group 3: Radial Inlet Volute Design For A Pediatric Centrifugal Cardiac Pump

Team Members Sherika Gordon, Sarah Haynes, Jennifer Patten, Khyati Prasad, Ashley Ramirez
Advisor Dr. Amy Throckmorton

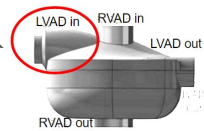
Medical Need: No total artificial hearts for clinical use
-10,000-20,000 pediatric patients would benefit
Design Need: Dragon Heart
Pediatric cardiac pump

Inlet volute: guides flow from pulmonary vein into left ventricular assist device (LVAD)

Optimize LVAD inlet volute to uniformly distribute flow around central right ventricular assist device (RVAD)



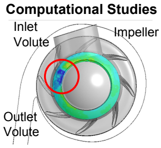
Solution: Flat profile to fit in pediatric chest
Dual shunts to redistribute flow around all sides of axial RVAD pump, peaked edges to help guide flow



Approach:

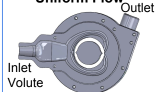
Mathematical Modeling

Computational Studies



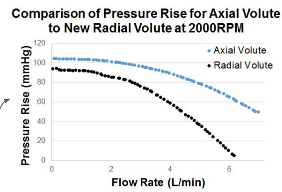
Mass flow nonuniform for elliptical volute

Optimize Design for Uniform Flow



Physical Testing

Results:

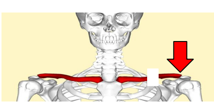


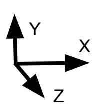
Radial volute achieves desired pressure rise for 1-2L/min at 2000 RPM for pediatric patients but leaves room for optimization

Group 4: In-Situ Malalignment Device for Midshaft Clavicular Fractures

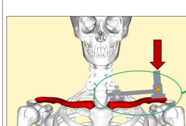
Team Members Seth Greber, Margaret Gunn, Kristin Irons, Alicia Rusnak, Cassandra Tu
Advisors Dr. Joseph Sarver, Dr. David Ebaugh, PT

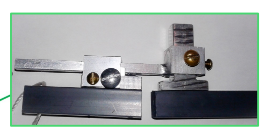
Need: A fixation device is needed to maintain 0-2 cm clavicular malalignment in the x and y directions, under a 35N load, for a cadaver study to evaluate when invasive treatment is needed.



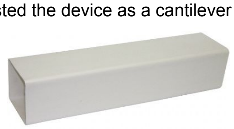


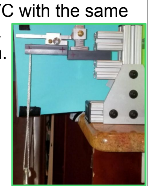
Solution: Clavicle malalignment fixation device prototype to simulate different malunions



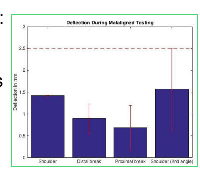


Approach: Our goal was to improve the mechanical rigidity of the crossbar and the supports of the previous device iteration. We used a square PVC with the same deflection as a clavicle and modeled & tested the device as a cantilever beam.





Results:
Device meets all requirements:
1. Adjust 0-2 cm in the x & y
2. < 2.6mm of PVC deflection
3. Under 35N device maintains malalignment
4. Device rotates < 5°



Impact:
Potential to be used in other cadaver kinematic studies.

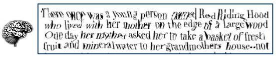
Group 5: Compact Functional Near Infrared Spectroscopy (fNIRS) System Design for Evaluation of Dyslexia in Students

Team Members Valeria Beckhoff Ferrero, Tushaar Godbole, Eshiemhomo Kadiri, Michael Iskhakov, Durand O'Meara

Advisor Dr. Meltem Izzetoglu

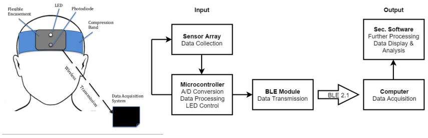
Background and Need

- **Dyslexia** → Learning disorder.
  - Difficulty reading, spelling and speaking.
- **70-80%** of people with poor reading skills are likely dyslexic.
- Currently there is no cure, only management.
- Early diagnosis is Important:
  - Provide the best educational opportunity for the individual.



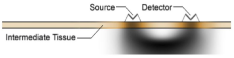
Solution

The data is captured, and transmitted wirelessly using a **low-energy Bluetooth** module.



Design Specifications

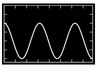
- During cognitive activities, the blood O_2 levels change;
  - These changes are quantifiable using fNIR.
- fNIR emits lights between **700-900 nm**, to a penetration Depth of **1.2cm.**
- Measures the difference in light absorbance of **deoxy- and oxy-hemoglobin.**



Results

- **Lightweight and portable** device:
  - < 50 grams
  - Transmission range of 10 meters.

- **Accurate and fast** signal:
  - ~ 1:1 linearity
  - < 1.5 seconds transience
  - < 1% drift



Impact: More children with dyslexia will be identified, and given the attention that they need to succeed academically.

Group 6: Functional Near Infrared Imaging Implant for Rat Stroke Models

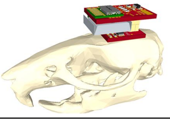
Team Members Daniel Finnegan, Andrew Joseph, Marina Louis, Trevor Montez, Michal Swoboda

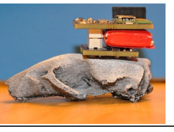
Advisors Dr. Kambiz Pourrezaei, Dr. Meltem Izzetoglu

Medical Need: Stroke affects 800,000 people per year and it is the 5th leading cause of death.

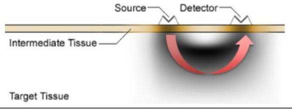
Design Need: Research is needed to develop our understanding of the pathophysiology of stroke and create effective preventative and regenerative treatment methods.
Innovative imaging methods are needed to assess animal stroke models to further the understanding.

Solution: The proposed solution is an implantable fNIR system capable of wireless transmission and untethered operation to monitor blood brain oxygenation.

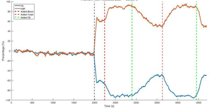




Approach: Near infrared imaging is a non-invasive method to record the metabolic activity of neural tissue. Two wavelengths of light are used to illuminate the tissue. Reflected light can be used to assess cortical tissue oxygenation based on a modified Beer-Lambert equation.



Results:



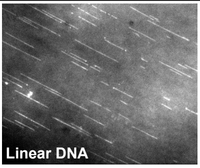
Impact:
The developed implant has the potential to image the hemodynamic response in an untethered animal enabling researchers to understand the pathophysiology of induced strokes in animals

Group 7: DNA Combing Flow Cell for Genomic Analysis

Team Members Anmol Arora, Mohan Avula, Michael Bene, Yoseph Dance, Tyler Lee
Advisors Dr. Ming Xiao, Dr. Moses Noh, Dr. Marek Swoboda

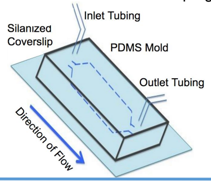
Medical Need: Linearizing (Combing) DNA is crucial in research and diagnoses of diseases.

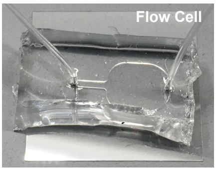
Current solutions *cost* thousands of dollars and are *low throughput*

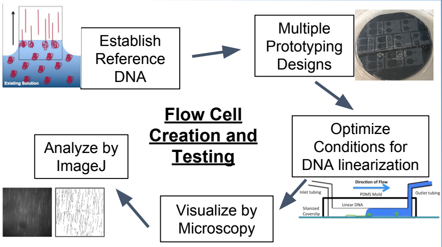


Objective: Create a device that is capable of binding and combing DNA onto a surface for use in genomic analysis

Solution: Flow cell to load DNA into inlet of open chamber and linearize DNA as solution is purged through the outlet

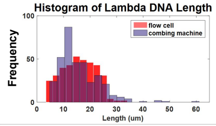


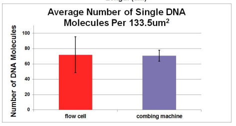




Result: The Flow Cell was able to successfully bind and linearize Lambda DNA.

Flow cell data was comparable to the existing combing machine





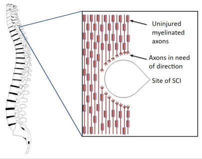
Future: Introducing enzyme in solution allows reactions to occur on flow cell's linearized DNA.

Group 8: Suture Silk Scaffold to Promote Spinal Cord Repair

Team Members Liam Barnes, Christopher Brennan, Kalgi Chokshi, Megan Donohue, Angelica Spinelli
Advisor Dr. Margaret Wheatley

Medical Need: 347,000 people with spinal cord injury in US; Currently no promising solution to repair spinal cord injury

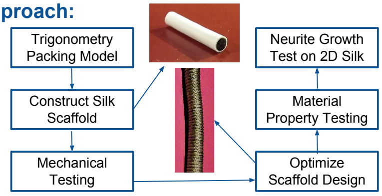
Design Need: Damaged axons in spinal cord ***require guided direction*** to restore functionality



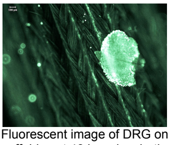
Solution: A growth permissive suture silk scaffold with channels to guide axon regeneration between sites distal and proximal to the injury

Creo model of cross section (left) and fabricated scaffold (right)

Approach:



Results:
DRGs adhered to silk scaffold but directional growth not observed



Fluorescent image of DRG on scaffold post 48 hour incubation

Future Work:
Fabricate scaffold using silk fibroin and test for DRG attachment and axon growth

Group 9: Detecting and Validating Synthetic Synapses

Team Members Yiyang Deng, Ayan Desai, Xinyi Lu, Sohil Patel
Advisor Dr. Catherine von Reyn

Need

- Achieve transient expression of engineered Synaptic Adhesion Molecule (SAM) in a Scheider-2 cell culture
- **Detect the presence of expressed connexin-36 (SAM)**
- **Validate and qualify connexin function *in vitro***

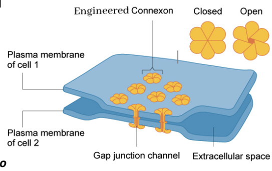
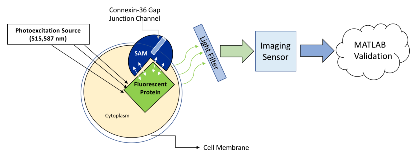


Figure.1 Connexon Gap Junction. Khan Academy, 2017

Solution

- Apply genetic engineering tools for transient SAM-Fluorophore expression



Fluorescent Proteins: YFP (515nm) and m-Cherry (587nm)

Approach

- Introduce exogenous, fluorescently tagged Connexin-36 into S-2 *Drosophila melanogaster* culture through transfection and subsequent cell culture
- Verify presence of SAM using confocal microscopy at respective excitation wavelength
- Apply open source imaging software and MATLAB algorithm to determine fluorescence location relative to cell membrane and cytoplasm

Results & Impact

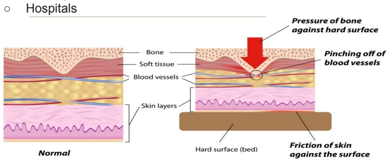
- Confocal microscopy, thus far, indicates membrane-bound fluorescence of YFP protein within Connexin-36 expressing S-2 culture – successful detection.
- Future experimentation aims to achieve results demonstrating colocalization of YFP and m-Cherry tagged Connexin-36 S-2 cells.
- Successful results will allow this assay to be used for research with other synaptic adhesion molecules, a crucial step forward in the development of *in vivo* synthetic synapses for treatment of neurodegenerative disorders.

Group 10: Probing Deep Tissue Injuries (DTIs) by Contrasting Tissue Stiffness Using Piezoelectric Fingers

Team Members Alice Alderson, Luyando Chibwe, Peter Esslinger, Arlene Genevieve Offemaria, Kevin Yeamans
Advisor Dr. Wan Y. Shih

Medical Need

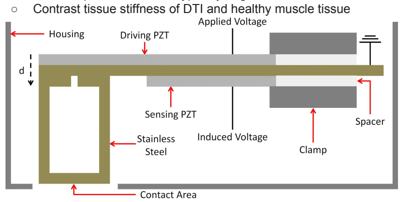
- Deep tissue injury (DTI) is a form of pressure ulcer (PU) the begins at a bony prominence and progresses outward to the epithelial skin layer
- By the time it is visually detected, severe damage ➡ surgery
- Afflicts ≅ 250,000 people annually
  - Nursing Homes
  - Hospitals



http://healthlifemedia.com/healthy/pressure-ulcers-bed-sores/

Approach

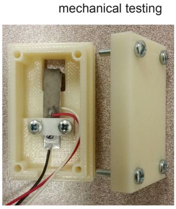
- Use Piezoelectric Finger (PEF) to measure tissue elastic modulus *in-vivo* at depths where DTIs typically originate
  - Contrast tissue stiffness of DTI and healthy muscle tissue



Schematic of PEF

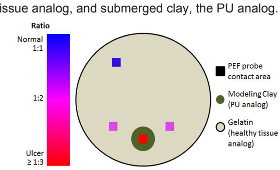
Solution

- 3D printed handheld housing assembled with PEF
  - Protects fragile PEF
  - Handheld Portable
  - Precise measurements, comparable to BOSE system mechanical testing



Results & Impact

The graph below shows elastic moduli differences between gelatin, the healthy tissue analog, and submerged clay, the PU analog.



- PEF detected elastic modulus of PU analog that was 3x greater than healthy tissue
- PEF detected increase in moduli values as it came within range of the PU analog
- Results could improve quality of life for at-risk patients and open doors to PEF being used for further diagnostic applications

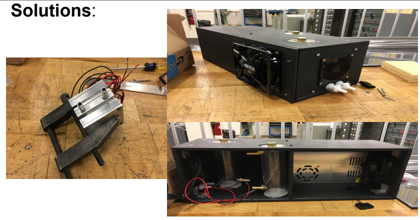
Group 11: ThermoKloth: Heating & Cooling Therapy for Myalgia

Team Members Chung Cheng, Stephen Parsons, Dennis Roy, Uyen Tran, John Yockey
Advisor Dr. Ryszard Lec

Needs:

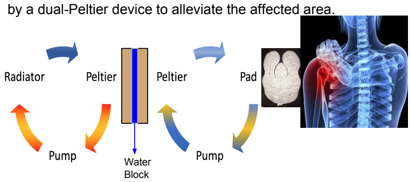
- Myalgia is a highly common symptom in multiple diseases and disorders that is initially not properly treated until the pain or damage has elevated to significantly critical levels.
- Self treated patients tend to apply the extreme ends of either high or low temperatures to the injured site instead of a controlled and effective temperature that would optimize the treatment.

Solutions:



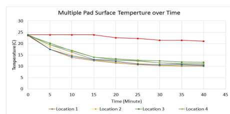
Approach:

In order to combat myalgia, ThermoKloth will utilize both cryotherapy and thermotherapy in a regulated setting powered by a dual-Peltier device to alleviate the affected area.



Results:

Current results show that optimal temperatures can be attained 40min after the system is turned on, but in order for the device to be efficient, timing needs to be reduced to roughly 5-10 minutes.



Group 12: Optimizing a Low Frequency (20 kHz), Low Pressure (55 kPa) Therapeutic Ultrasound Applicator to Treat Human Osteoporotic Long Bone Fractures

Team Members Ajo Joseph, Kevin Kunju, Mohana Nagda, Neel Patel, Sunil Shah
Advisors Dr. Peter Lewin, Dr. Kara Spiller

Need(s):

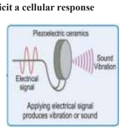
What is Osteoporosis?

- Medical condition that results in decreased bone density and is affected by hormone levels, vitamin/mineral levels, and aging.
- Consequences include altered bone structure and abnormal loading patterns and result in an increased susceptibility to fractures.
- Current patient fracture recovery time:: Approx. 4-12 weeks.
- There are an estimated 6 million fractures per year in the United States, 2 million of which are due to osteoporosis.

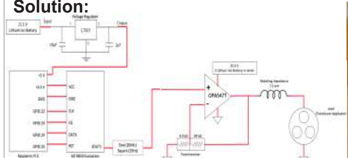
What is Ultrasound?

- Acoustic pressure wave (>20kHz) produced by a piezoelectric effect
- Can be utilized to elicit a cellular response

Osteoporotic Bone vs. Healthy Bone

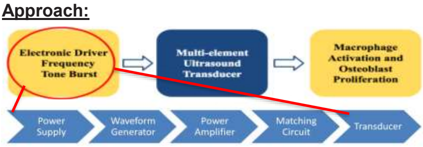


Solution:



Driver Circuit Schematic and Applicator Example

Approach:



Objective: *Develop a **non-invasive, low frequency,** ultrasound therapeutic system to treat bone fractures that result from osteoporosis by **optimizing** an electronic ultrasound transducer **driver circuit***

Results & Impact:

Maximum Power Transfer

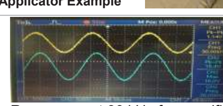
- Max Power Transfer was achieved and verified using AIM Network Analyzer 4170 by measuring reactance and resistance

Water Tank Acoustic Testing

- Verified frequency (>20 kHz) and pressure amplitude (55 kPa) outputs
- Caliper used for dimensional Verification testing

Conclusion:

- Electronic driver successfully created tone burst frequency at ~30kHz w/ 20ms repetition frequency.



Resonance at 30 kHz for specific applicator used

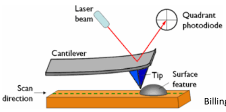
>20kHz Frequency Achieved

Group 13: Tensile Specimen Stage for In Situ Nano-mechanical and Nano-structural Testing of Biological Tissues

Team Members Jonathan Amora, Tara Jordan, Leif Malm, Kawyn Somachandra, Anthony Young
Advisor Dr. Lin Han

Background & Need

Atomic force microscopy (AFM) is a form of scanning probe microscopy that uses a sharp tip to measure surface interactions as a means of measuring various mechanical properties of biological tissues.



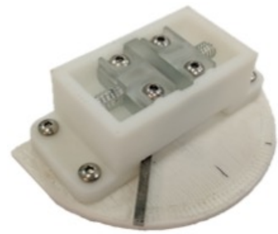
Mechanical Properties:

- Stiffness
- Strain rate dependence
- Forms of deformation

Billingsley et al, 3 April 2012, IOPScience

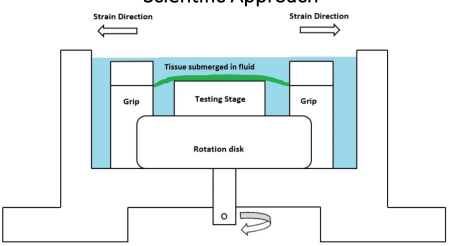
Need:
Presently, there is no way to measure the nano-scale properties of a tissue sample **under strain** in a simulated **physiological environment**.

Solution



The samples will be held in place by two grips, and the strain will be applied using an oval cam between the grips.

Scientific Approach



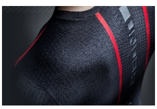
During testing, samples will be submerged in fluid and stretched across the testing stage for AFM access.

Results & Impact

Nano-scale mechanical properties can now be measured under strain in a simulated physiological environment. This solution will generate **new biomechanics research** whilst reinforcing current research.

Open Biomedical Initiative

EMS World, Synthetic Tissue



Under Armor

Numerous applications where the material is under constant strain: prosthetics, synthetic tissue grafts, fibers used in sports clothing

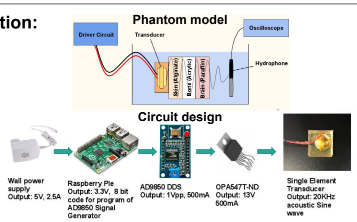
Group 14: Ultrasound Applicator for Live Animal Models

Team Members Justin Bernauer, Eric Dluhy, Randy Goldfarb, Nick Damraksa, Justin San Juan
Advisor Dr. Peter Lewin

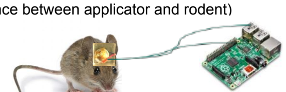
Need:
Deliver therapeutic ultrasound treatment to live rodent models (mouse or rat) **without anesthetizing** or **physically restraining** them during the therapy.

End need:
Personalized healthcare resulting from understanding mechanisms of therapeutic ultrasound

Solution:



Approach:
Optimize existing ultrasonic applicator and driving electronics to deliver low frequency (20-100 kHz), low acoustic pressure (<55 kPa) ultrasound therapy at a distance of about 3mm away from sample (to simulate distance between applicator and rodent)



Transducer applied to head of rodent

Results & Impact:
- Consistent delivery of therapy within set parameters while not inhibiting normal rodent functions and activities
- Better understanding of mechanisms of therapeutic ultrasound
- Personalization of healthcare, particularly in areas of pain attenuation, wound healing, and Alzheimer's Disease

Ultrasonic applicator, Lewin, P.A., 2013

Group 15: Design of Electrospinning Systems for the Control of Nanofiber 3D Architecture

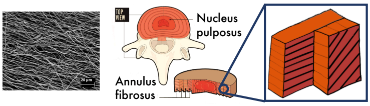
Team Members Brandon Eng, James Kirwan, Alexander Mariner, Ravi Shah, Michael Shmukler, Brendan Sweeney

Advisors Dr. Lin Han, Biao Han

Need

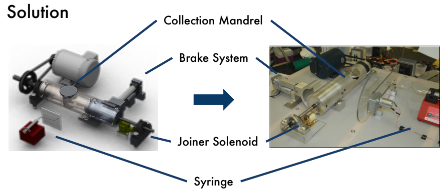
Electrospinning is a method used in tissue engineering to fabricate nanofiber matrices

Current electrospinning setups only enable **in-plane control** of fiber alignment

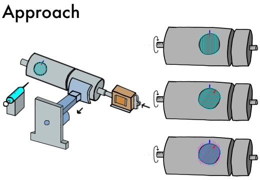


Biological tissues exhibit both in-plane *and* **through-plane** variations in fiber orientation (i.e. intervertebral disc: angle of alignment varies from layer to layer)

Solution



Approach



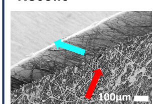
A rotating collection plate is integrated into the electrospinning setup.

An aligned nanofiber layer is collected on the plate.

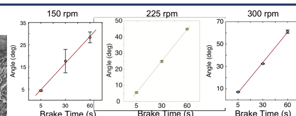
The plate is rotated and the layer is rotated with the plate.

Another aligned nanofiber layer is collected on top of the previous layer, enabling **through-plane control** of matrix architecture.

Results



Scanning electron microscope images of proof of concept show layers that are aligned at different angles.



Verification testing yielded **continuous control of collection plate angle**, seen at different speeds in the graphs above.

The device can produce scaffolds that better mimic 3D structure and mechanical properties of native biological tissues.

Group 16: Anti-Kink Custom-Curve Endotracheal Tube Stabilizer

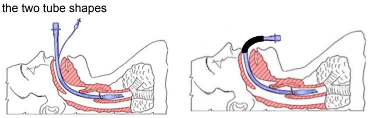
Team Members Sarah Julius, Bryan Melilli, Emily Qian, Luke Raymond, Victoria Sadowski

Advisor Dr. Kenneth Barbee

NEED

Minimize obstructions around patient during surgery

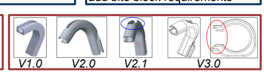
- Decreased oxygen intake leads to patient being intubated
- Endotracheal tubes (ETs) used for intubation extend straight out of the patient's mouth obstructing procedures around the face
- Special curved (RAE) tubes are a solution but have their own limitations
  - Don't fit patients with height/weight ratios outside average range
  - Curved design prevents easy cleaning of clogs
  - Constant reintubations risk damage to patient airway
- Solution needs to mimic RAE tube curvature and allow conversion between the two tube shapes



APPROACH

Requirements (R) & Constraints (C) — Set preliminary R&C to prototype — After prototyping, refine/specify R&C, add numerical values, & add bite block requirements

Prototyping — Create/revise device to suit R&C



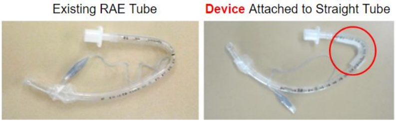
Pilot Testing — Find max reactive force to input into model for material decision — Find Average Thumb Grip Force — Find Kink Force

Final Design — Implement prototyping/pilot data in device for verification

Verification — Conduct creep, compression, snap force, air flow, & usability testing

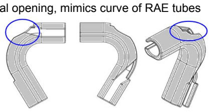
SOLUTION

Anti-kink Custom Curve Endotracheal Tube Stabilizer



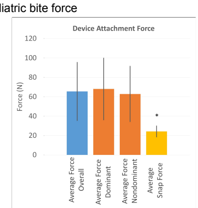
Existing RAE Tube | **Device** Attached to Straight Tube

- Hollow curved channel with half-spiral opening, mimics curve of RAE tubes
- One side of device clipped on and slid along tube into proper position using the **Tube Slot**, then other end is clipped on for stable attachment
- Portion of device that rests in patient's mouth doubles as a bite-block to protect tube



RESULTS

- Modeling found that the device must be made from a materials with a minimum elastic modulus of 2 GPa
- Compression testing showed device main channel and bite block can withstand forces associated with normal use
  - Bite Block can withstand 450 N pediatric bite force
  - Main Channel can withstand 500 N
- Creep Testing
  - Resin would deform too much in desired conditions
  - ABS deformed less than 10° max
- Air flow testing showed the device does not impact resistance through the tube



Impacts

- Less risks from multiple intubations
- Increased ease of use
- Decreased use of plastic
- Decreased cost

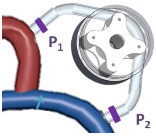
Group 17: Novel Implantable Roller Pump to Treat Heart Failure-Induced Lymphedema

Team Members Samantha Cassel, Kelsey Chung, Raymond Dulman, Kelly Fox, Maneesha Sahni
Advisor Dr. Amy Throckmorton

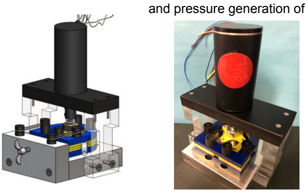
Background:
- Congestive Heart Failure (CHF) - heart no longer adequately pumps blood to organs and tissues
- Resulting excess venous 'back' pressure causes fluid build-up in lymphatic circulation
- Lymph fluid accumulates in lungs and lower extremities

Clinical Need: No current minimally invasive devices exist to treat lymphedema

Approach:
- Overcome venous back pressure using pump that returns lymphatic fluid to venous circulation
- Acrylic and aluminum roller pump prototype designed

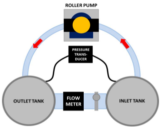


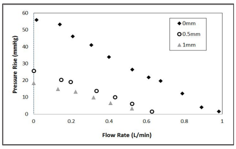
Solution:
- Implantable roller pump - size of a pacemaker
- Achieve intermittent volumetric flow rates up to 0.8 L/min and pressure generation of 30mmHg



SolidWorks design (left) and machined prototype (right)

Testing & Results:
- Varied rotational speed and occlusion gap
- 0.5mm occlusion gap ideal for desired pressure generation while still staying under 0.8 L/min



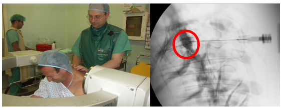


Impact: Advances development of implantable device to alleviate lymphatic congestion

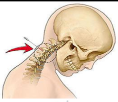
Group 18: Stabilization Device for Cervical Interlaminar Epidural Steroid Injection

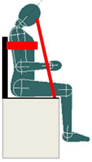
Team Members Matthew Bova, Tyler Miller, Ashley Moy, Amanda Tilles, Gregory Toci
Advisor Dr. Marek Swoboda

Need
- 47% of epidural steroid injection outcomes were associated with unintentional nerve injury.
- Hands-free device to stabilize patient's body and neck to reduce risk associated with CIESI.



Approach
- A device that restricts movement in the upper body.
- A device that is radiolucent above the patient's shoulders.
- Quickly releases patient in case of medical emergency.





Solution

Results & Impact
- Prevents significant movement of the patient during procedure.
- Universal in attachment to a variety of sized operating tables.
- Maintains structural integrity during and after use.
- Device can be implemented to reduce the risk associated with CIESI.

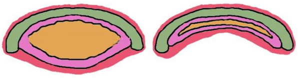
Group 19: 3D-Printed Trachea Scaffold for Tissue Engineering Applications

Team Members Kosha Kumar, Alexandria Neiman, Nicholas Wancio, David Luke Wetnight, Emrecan Yener
Advisors Dr. Wan Y. Shih, Dr. Michael Frohbergh

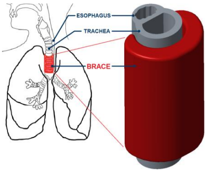
Need:

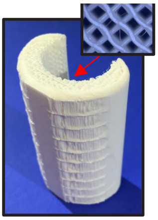
Tracheal collapse, from tracheomalacia, leads to difficulties breathing and possible suffocation. Affected trachea require ongoing mechanical support that provides an environmental framework (pores) for cartilage growth.

Cross Sectional View of Collapsed Trachea



Solution: 3D Printed Brace





Left: brace supporting the weakened trachea
Right: Prototype v5 of Brace with magnified pores

Technical Approach:

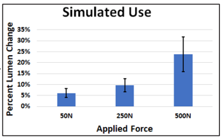
Design pore structure: Assessed via tensile, flexural testing

Test different filament sizes: Compared via pore analysis

Biomimetic Simulated Use: Degradation & compression tests

Results & Impact:

- Brace retains **97.2%** of its original **stiffness** under biological conditions.
- Retains minimum **91.6%** of **cross-sectional area** of lumen of the trachea under breathing.
- Device **will improve quality of life** for those with the medical need, will act as a permanent solution.



Group 20: Manual Muscle Testing Simulator as a Teaching Aid

Team Members Oyinkan Aderele, Caleb Gerald, Emily Du, Melissa Frendo-Rosso, Loveena Williams
Advisors Dr. Sriram Balasubramanian, Dr. Allan M. Glanzman, PT, DPT, PCS, Dr. Matthew P. Kirschen, MD

Need

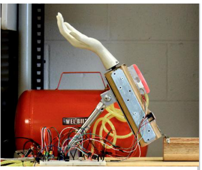
- High variability when assessing muscle strength
- Difficult to discriminate between Medical Research Council (MRC) scale values 3,4, & 5

5 Normal strength
4 Some resistance against gravity
3 No resistance against gravity
2 Movement, but not anti-gravity
1 Flicker
0 No movement

Solution

Electro-pneumatic Device

- Mimics healthy adult male arm
- Replicates arm range of motion
- Allows clinician to set MRC scale value
- Simulates arm flexion driven by pneumatic actuator
- LED lights provide clinician feedback



Approach

Design device for clinician to:

- Set MRC scale value
- Perform bicep strength test
- Record and modulate applied force

MRC	% Force [1]	Bicep Force
3	50	44.5 N
4	80	71.2 N
5	100	89.0 N

Results

Simulator Objectives	Performance
Arm Range of Motion	PASS
Arm Mass and Dimensions	PASS
Quantify Clinician Applied Force	PASS
Responsive LED Feedback System	PASS
Generate Arm Flexion Force	PASS

Impact

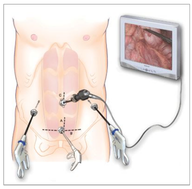
- Increase muscle strength assessment reliability
- Increase consistency of clinician training
- Portable design, easy to use, repeatable, & adaptable

Group 21: C.L.A3.S.P.- Controlled Laparoscopic Attachment for the Adjustment of Applied Surgeon Pressure

Team Members Zachary Block, Matthew Bolopue, Eric Barbalace, William Dackis, Allison Grasmeder
Advisor Dr. Sriram Balasubramanian

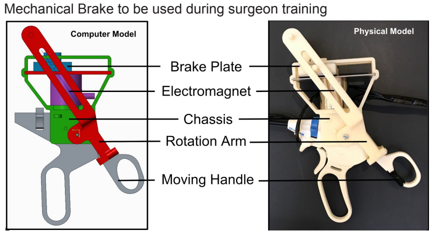
Medical Need

- Atraumatic laparoscopic graspers are used in minimally invasive surgery to safely manipulate tissue
- No existing method to modulate force applied by surgeon
- Tearing and bruising of tissue results in greater patient pain and recovery times
- **Objective**: Create a grasper attachment to prevent tissue damage in laparoscopic surgery by modulating the applied force



Solution

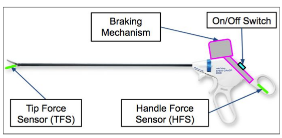
Mechanical Brake to be used during surgeon training

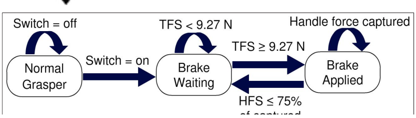


Approach

Mechanical Concept →

Circuit Logic Diagram ↓





Results

Device Feasibility Tests
○ Sensor calibration
○ Sensor synchronization
○ Force analysis
○ Magnet strength
○ Circuit response
○ Dexterity

Validation tests were performed for device efficacy and

Impact

Positive
○ Reduces risk of tissue injury
○ Improves Surgeon Training
○ Reusable
Negative
○ Device dependence
○ Additional cost

Group 22: Systems Integrated Oximetry for Multifunction Brain Monitor

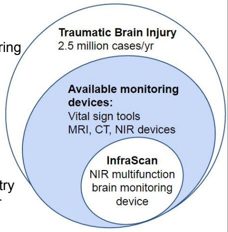
Team Members Christopher Cox, Murynia Hernandez, Anna Lu, Kaitlyn Money, Beverly Tomita
Advisors Dr. Hasan Ayaz, Dr. Meltem Izzetoglu, Dr. Banu Onaral, Dave Solt, Tony Groch

Medical Need

No point-of-care devices exist for traumatic brain injury (TBI) monitoring

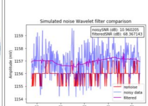
Design Need

Implement the Infrascanner oximetry module from measurement to user interface display



Solution

Wavelet Filter

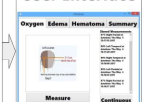


Calculate Oxygen

$$A = log_{10}\left(\frac{I_{in}}{I_{out}}\right) \approx OD_\lambda = \epsilon_\lambda \cdot c \cdot d \cdot DPF$$

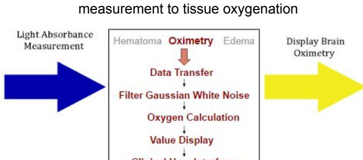
Modified Beer Lambert Law

User Interface



Approach

Design oximetry module for an existing system to link absorption measurement to tissue oxygenation



Results

Wavelet filter reduces gaussian white noise significantly
p-value: 2.47×10^{-12}

Calculated range of oxygenation spanning from 0 to 100%

Reduced user interface average walkthrough time from 3 minutes to 48.6 seconds

Impact

Improve pre-hospital TBI care options in emergency, military, and sports medicine

Enable healthcare providers and field clinicians to quickly and effectively evaluate cerebral oxygenation at point-of-care

Group 23: Melatonin Pump for Elderly and Dementia Patients

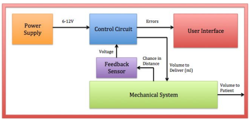
Team Members Jordan Bucher, Thomas Donnelly, Sean Jenkins, Samuel Kim, Dalton Lester
Advisor Dr. Marek Swoboda

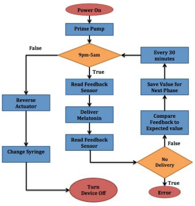
Needs:

- Lack of sleep can accelerate the symptoms of diseases that the patient has, especially in dementia.
    - Melatonin can help with lack of sleep
- Existing solutions do not have a natural release
    - High rate of patient non-compliance

Solution: Melatonin Pump:

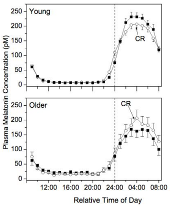
- Bedside device





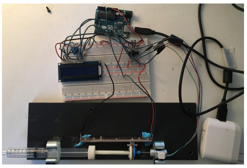
Approach:

- Release same amount of melatonin that healthy body releases
- Release melatonin with a natural rhythm
    - Want to match top graph



Results and Impacts:

- Prototype design finalized
- Release algorithm created and programed in device
- **Impact:** Efficacy of this device can be studied through a clinical trial
- **Impact:** Idea can be used on other naturally occurring chemicals

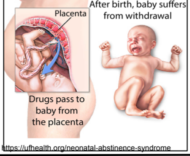


Group 24: Tremor Monitoring and Tracking for Neonatal Abstinence Syndrome

Team Members Nsilo Berry, Chris Bijumon, Priyanka Karekar, Josue Manjarrez Linares, Todd Roescher
Advisors Dr. Kambiz Pourrezaei, Dr. Barbara Amendolia, DrNP, CRNP

Objective and Motivation

Babies with Neonatal Abstinence Syndrome (NAS) need to be administered controlled doses of drug to slowly and safely wean them off the drug. Current treatment involves subjective scoring of tremors and other symptoms to plan treatment drug doses.



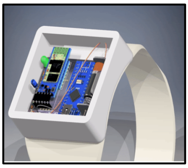
The goal of this project is to reduce subjectivity by creating a device that can detect and analyze tremors to provide standardized scores.

Solution

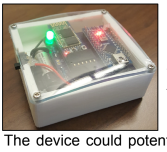
An ankle worn device by infants that will **track and quantify tremors** in order to help nurses and doctors treat infants suffering from NAS more accurately.

Approach

Device will be attached by velcro to an ankle breastfeeding band. It utilizes an accelerometer, arduino and bluetooth to detect tremors and transfer it to a computer. A Matlab GUI is used to analyze the received tremor signals and rate them based on severity (mild, moderate or severe).



Results & Impacts



Device was able to detect tremors up to 12Hz. Wireless data transfer and tremor analysis using the GUI was successful. A golden standard scale was created to rank severity. Further optimization is required to scale down the device.

The device could potentially reduce hospital costs by improving treatment accuracy. This technology can also be used for treatment of Parkinson's disease and physical therapy.

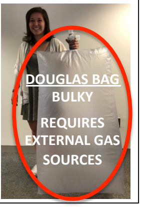
Group 25: Hypercapnia Inducement System for Assessment of Cerebral Vascular Reactivity in Traumatic Brain Injury Population

Team Members Stephen Brown, Thomas Lightfoot-Vidal, Ashley Malone, Yerram Pratusha Reddy, Joseph Sincavage
Advisor Dr. Meltem Izzetoglu

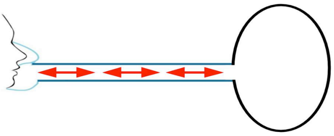
MEDICAL NEED:
Traumatic Cerebral Vascular Injury (TCVI) is a significant side-effect of Traumatic Brain Injury(TBI). Assessment of TCVI requires administration of higher than normal levels of CO_2(Hypercapnia).

OBJECTIVE:
Design a **PORTABLE AND STAND ALONE** device that induces specific increases and decreases in End Tidal CO_2

MOTIVATION:



SOLUTION: CONTROLLED RE-BREATHING



Due to patent non-disclaimer, the suggested solution is not fully described above

APPROACH: RE-BREATHING

Expired air contains ~5% CO_2, which when **re-breathed** increases CO_2 concentrations in the vasculature of the brain

Due to patent non-disclaimer, the suggested approach is not fully described above

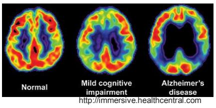
RESULTS: The proposed gas delivery system surpasses **Douglas Bag method** in setup time, $EtCO_2$ sensitivity and portability.
Due to patent non-disclaimer, the results of the solution are not fully described

IMPACT: The proposed device has the ability to provide **rapid and inexpensive diagnostic aid for assessment of Cerebrovascular Reactivity** and **early therapeutic intervention for TBI.**

Group 26: Automated Mapping of Neural Connections in the Brain

Team Members Edgar Cardenas, Melissa DuBois, Andrew Kaiser, Rea Parikh, Eaindra Tin Latt
Advisor Dr. Will Dampier

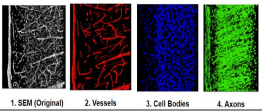
Medical Problem: Studying the brain and the neuronal connections is critical to Alzheimer's disease research.



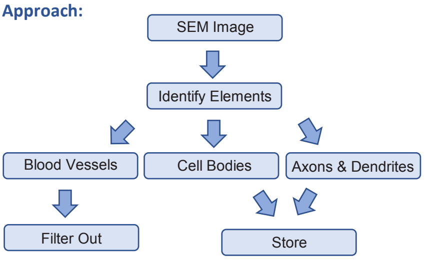
http://immersive.healthcentral.com

Design Need: One method of research is neural connectome mapping. Current manual annotation methods are extremely time consuming. This project aims to automate this process to improve the efficiency of research.

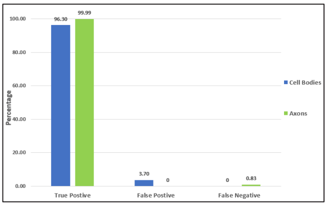
Solution: A collection of MATLAB scrips which
- Utilizes SEM image data as an input
- Analyzes the image, performing filtering and identification
- Outputs the connectome map as an image and matrix



Approach:



Results: Results show that this automated solution may be a viable alternative to current methods: >96% of cell body and axonal pixels were identified using simulated data.



Group 27: Development of a Compression Testing Protocol for Scalpel-Based Incisional Data

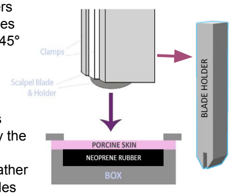
Team Members Muammar Johnson, Haiyue Lu, Mashaal Syed
Advisor Dr. Wan Shih

NEED

Development of an immersive, virtual reality surgical training simulator heavily relies on the collection and utilization of mechanical data

SOLUTION

- 3D printed blade holders capable of testing blades angled at 0°, 25°, and 45° without impinging on porcine samples
- Interfacing platform constructed to address constraints imposed by the BOSE system, while providing stability for rather compliant tissue samples



APPROACH

Limiting scope to determine the amount of force necessary for a scalpel blade to make an initial incision

Mechanical tests performed on porcine samples, as it is considered to be analogous to human skin

RESULTS

The average amount of force directly exerted upon porcine skin to create an incision was between 15 and 25 N.

Motion of the blade during incision, which pulls and scrapes the skin on a microscopic level, may have more to do with ease of making the incision rather than “static” pressure.

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