Tuesday April 9th
Student Center 3rd Floor

2019

14th Annual

Undergraduate Research Spring Symposium

For more information: www.urop.gatech.edu/2019-symposium

Abstracts published in this program reflect the individual views of the authors and not necessarily that of the Office of Undergraduate Education or The Georgia Institute of Technology.

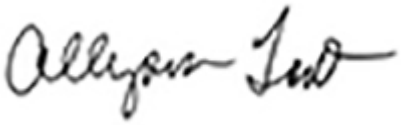
1:00 pm – 1:10 pm	**Introduction** *Student Center Ballroom*
1:15 pm – 2:15 pm	**Poster Presentations** *Student Center Ballroom*
2:20 pm – 4:30 pm	**Oral Presentations** *Student Center Ballroom and Rooms 301, 319, 320, 332 and 343*
4:30 pm – 5:30 pm	**Poster Presentations** *Student Center Ballroom*
5:30 pm – 6:00 pm	**Reception** *Student Center Ballroom*
6:00 pm – 6:30 pm	**Awards Ceremony** *Student Center Ballroom*

Georgia Tech Center for Academic Enrichment

Welcome to the Georgia Institute of Technology's 14th Annual Undergraduate Research Spring Symposium. The research conducted by our students and their faculty advisors demonstrates a commitment to not only investigate, but to resolve the issues of today while anticipating the demands of tomorrow. At Georgia Tech, we strive to develop leaders in all fields and leaders in our global society. The contributions made today and in the future will have an everlasting impact on you and on society.

I extend my thanks to the entire Georgia Tech community for making today's symposium possible. In addition to the student participants, we rely on more than one hundred faculty, staff, research scientists, postdocs, graduate students, undergraduate students, and other members of the GT community to serve as judges, moderators, registrants, organization and planning support, IT and more.

Go Jackets!



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Sara Cleland and Isabela Pavkov
Mentor: Dr. Stephen Diggle, Biological Sciences

2:30 pm **Killing of E. coli by the Vibrio Cholerae Type VI Secretion is Reduced in Response to Glucose-Mediated Spatial Assortment**
Holly Nichols
Mentor: Dr. Brian Hammer, Biological Sciences

2:40 pm **New Methodology for Sampling of Mucus-Enriched Coral Water for Vibrio Coralliilyticus Bioassay**
Simone Jarvis
Mentor: Dr. Mark Hay, Biological Sciences

Oral Presentation Sessions

Student Center, 3rd Floor

Session B: Mechanical Engineering

Student Center Room 301
Moderator: Mr. Fredrick Holloman

3:00 pm **Chemically Powered Janus Micromotors for Enzyme Rate Enhancement**
Andrew Pan
Mentor: Dr. Todd Sulchek, ME

3:10 pm **Process Modeling and In-situ Monitoring of Photopolymerization for Exposure Controlled Projection Lithography (ECPL)**
Jenny Wang
Mentor: Dr. Amit Jariwala, ME

3:20 pm **Developing a Platform to Mimic Lymphatic Vessel Injury and Induce Cell Remodeling**
Joy Brown
Mentor: Dr. J. Brandon Dixon, ME

3:40 pm **3D Carbon Nanostructures**
Biya Haile
Mentor: Dr. Jungkyu Park, ME (Kennesaw State University)

3:50 pm **The Effect of Fc Oriented Microparticles On Human Mesenchymal Stem Cell Viability In Vitro**
Jennifer Ternullo and Dale Shober
Mentor: Dr. Todd Sulchek, ME

4:00 pm **Multi Length-Scale Instrumented Indentation Study on Dual-Phase (DP) Steels**
Charles Caliendo
Mentor: Dr. Surya Kalidindi, ME

4:10 pm **Walking Parameter Estimation Through Wearable Sensor Data Fusion**
Noel Csomay-Shanklin
Mentor: Dr. Aaron Young, ME

Oral Presentation Sessions

Student Center, 3rd Floor

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Student Center Room 319
Moderator: Ms. Beatriz Rodriguez

2:20 pm **Encapsulation of Human Indoleamine 2,3-Dioxygenase in Virus-Like Particles**
Renee Julia Manalo
Mentor: Dr. M.G. Finn, Chemistry & Biochemistry

2:30 pm **Probing Heme Trafficking Factors via Organellar Contact Points Using Genetically Encoded Fluorescent Heme Sensors**
Arushi Saini
Mentor: Dr. Amit Reddi, Chemistry & Biochemistry

2:40 pm **Halogenase and Carrier Protein Specificity in Biosynthesis of Halogenated Pyrroles**
Andrew Lail
Mentor: Dr. Vinayak Agarwal, Chemistry & Biochemistry

Oral Presentation Sessions

Student Center, 3rd Floor

Session D: Biomedical Engineering

Student Center Room 319
Moderator: Ms. Beatriz Rodriguez

3:00 pm **Enhanced Self-Assembly, Length and Stability of Tobacco Mosaic Virus Nanorods**
Ranjani Sundaresan
Mentor: Dr. Yonggang Ke, BME

3:10 pm **Biological Transistors to Combat Antibiotic Resistance**
Isabel Curro
Mentor: Dr. Gabriel Kwong, BME

3:20 pm **Functional MRI Signal Complexity Analysis Using Sample Entropy**
Hisham Temmar
Mentor: Dr. Maysam Nezafati, BME

3:40 pm **hMSC Sphingolipid Profiles Modulate Exosome Production**
Frank Pittman
Mentor: Dr. Ed Botchwey, BME

3:50 pm **Precise Control of Therapeutic T Cells through Thermal Gene Switches**
Lee-Kai Sun
Mentor: Dr. Gabriel Kwong, BME

4:00 pm **The Effect of TAVR Placement Characteristics on Neosinus Hemodynamics**
Rachel Boutom
Mentor: Dr. Ajit Yoganathan, BME

4:10 pm **Study the Functional Connectivity of the Brain in Resting State Rodents Using fMRI**
Fatma Rashed and Emily Greulich
Mentor: Dr. Maysam Nezafati BME

Oral Presentation Sessions

Student Center, 3rd Floor

Session E: College of Computing

Student Center Room 320
Moderator: Ms. Kari White

2:20 pm **ZEUSSS: Zero Energy Ubiquitous Sound Sensing Surface**
Dhruva Bansal
Mentor: Dr. Gregory Abowd, Interactive Computing

2:30 pm **Interactive Bias Discovery for Machine Learning Using Automatic Subgroup Generation**
Angel Cabrera
Mentor: Dr. Polo Chau, Computational Science & Engineering

2:40 pm **Extracting Information from Gameplay Videos Using Machine Learning Techniques and Its Varieties**
Zijin Luo
Mentor: Dr. Mark Riedl, Interactive Computing

3:00 pm **Hack The Levi's Jacket**
Aayush Kumar, Caleb Rudnicki, Rhea Chatterjee, and Kenzy Michelle Wasseem Mina
Mentor: Dr. Thad Starner, Interactive Computing

3:10 pm **RF-pick: Comparing Order Picking Using a HUD with Wearable RFID Verification to Traditional Pick Methods**
Pramod Kotipalli
Mentor: Dr. Thad Starner, Interactive Computing

3:20 pm **Automated Commentary for Let's Play Videos**
Shukan Shah
Mentor: Dr. Mark Riedl, Interactive Computing

3:30 pm **Optical Sensing Using Organic Materials**
Devansh Ponda
Mentor: Dr. Gregory Abowd, Interactive Computing

Oral Presentation Sessions

Student Center, 3rd Floor

Session E: College of Computing (continued)

Student Center Room 320
Moderator: Ms.Kari White

3:50 pm **Sparse Order Picking**
Sarthak Srinivas, Georgianna Lin, Thomas Suarez, Saksham Gandhi, and Lauren Kearley
Mentor: Dr. Thad Starner, Interactive Computing

4:00 pm **Off-Center AR**
Rohan Ramakrishnan
Mentor: Dr. Thad Starner, Interactive Computing

4:10 pm **A System for Tracking All Vehicles All the Time at the Edge of the Network**
Harshil Shah
Mentor: Dr. Umakishore Ramachandran, Computer Science

4:20 pm **PopSign: Teaching American Sign Language**
Madeleine Goebel
Mentor: Dr. Thad Starner, Interactive Computing

Session F: Aerospace Engineering

Student Center Room 343
Moderator: Ms. Olga Kotlyar

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Abhijit Harathi
Mentor: Dr. Brian Gunter, AE

2:30 pm **Modeling the Performance of Urban Air Mobility in the Atlanta Metropolitan Area**
Ayush Jha and Nathan Wang
Mentor: Dr. Brian German, AE

2:40 pm **RL-10-3-3A Rocket Engine Turbopump System Level Design & Optimization Trades**
Anish Shenoy and Utkarsh Pandey
Mentor: Dr. David Wu, AE

Oral Presentation Sessions

Student Center, 3rd Floor

Session G: Civil & Environmental Engineering, Electrical & Computer Engineering and Materials Science and Engineering

Student Center Room: 343
Moderator: Ms. Olga Kotlyar

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Stefan Abi-Karam
Mentor: Dr. Lee W. Lerner, ECE

3:20 pm **Feasibility of Low-Cost Air Quality Sensors for Mobile Emissions Analysis**
Nic Alton
Mentor: Dr. Kari Watkins, CEE

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Robert Petrie
Mentor: Dr. Mark Losego, MSE

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Student Center Room: 332
Moderator: Dr. Lacy Hodges

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Siddharth Shrivastava
Mentor: Dr. Daniel Goldman, Physics

2:50 pm **Monte Carlo Simulations of Classical Spin Liquids**
Hannah Price
Mentor: Dr. Martin Mourigal, Physics

3:00 pm **Topological Analysis of Experimental Recordings of Ventricular Fibrillation**
Daniel Gurevich
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3:10 pm **Barium Ion Traps and Coulomb Crystallization**
Deniz Kurdak
Mentor: Dr. Michael Chapman, Physics

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Rebecca Keate
Mentor: Dr. Jennifer Curtis, Physics

Oral Presentation Sessions

Student Center, 3rd Floor

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Student Center Room: 332
Moderator: Dr. Lacy Hodges

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Kayla Duarte
Mentor: Dr. Britney Schmidt, Earth and Atmospheric Sciences

3:50 pm **Analysis of Crevasse Patterns and Melt Pond Evolution on Four Greenland Tidewater Glaciers**
Kathrine Udell
Mentor: Dr. Britney Schmidt, Earth and Atmospheric Sciences

4:00 pm **Enrichment and Isolation of Iron-Oxidizing Bacteria from an Ancient Earth Analogue**
Layla Ghazi
Mentor: Dr. Jennifer Glass, Earth and Atmospheric Sciences

4:10 pm **Strong Edge Colorings and Edge Cuts**
James Anderson
Mentor: Dr. Xingxing Yu, Mathematics

Oral Presentation Sessions

Student Center, 3rd Floor

Session J: Biomedical Engineering and Chemical and Biomolecular Engineering

Student Center Ballroom

Moderator: Mr. Cory Hopkins

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Bryanna Lima
Mentor: Dr. Vahid Serpooshan, BME

2:40 pm **Single RNA-Molecule Detection Using MTRIPS-FISH**
Danae Argyropoulou
Mentor: Dr. Philip Santangelo, BME

2:50 pm **Tracking and Quantifying Caenorhabditis Elegans Behaviors in Microfluidic Devices**
Seraj Grimes
Mentor: Dr. Hang Lu, CHBE

3:00 pm **Effects of Serum on Nanoparticle-Mediated Photoporation for Intracellular Drug Delivery**
Eunice Lazau
Mentor: Dr. Mark Prausnitz, ChBE

3:10 pm **Precision T Cell Immunotherapy using pMHC Liposomes for Antigen-Specific Drug Delivery**
Anna Romanov
Mentor: Dr. Gabriel Kwong, BME

COLLEGE OF COMPUTING

Oral Presentation
ZEUSSS: Zero Energy Ubiquitous Sound Sensing Surface

Dhruva Bansal
Gregory Abowd, PhD (Interactive Computing)

Physical surfaces and objects enhanced with acoustic sensing and communication capabilities provide an opportunity for an unprecedented understanding of human behavior as well as novel ways of interaction and environmental control. Combined with the advances in material science and additive manufacturing techniques, we attempt to "weave" acoustic sensing and computational capabilities into everyday objects. ZEUSSS or Zero Energy Ubiquitous Sound Sensing Surface allows physical objects and surfaces to be instrumented with a thin, self-sustainable material, giving rise to revolutionary applications such as interactive walls, localization of sound sources and people, surveillance via audio, contextualization and safer authentication services. The ZEUSSS patch is prototyped using flexible electronic components - a thin microphone built upon the principles of triboelectric nanogenerator, a flexible antenna and a transistor. The current setup consists of an RF transmitter and receiver, and ZEUSSS patch placed on any curved or flat surface. The transmitter broadcasts a carrier RF wave, which is received and amplitude-modulated by the ZEUSSS patch in the presence of slight vibrations like speech or touch. This signal is backscattered to the receiver and the audio information captured by the patch is extracted. ZEUSSS is the very first example of a completely self-powered vibrational sensing and data collection solution based on the combination of TENG an analog-backscatter communication. Such an architecture can be further expanded for passive sensing and communication of many different mechanical forces and vibrations in our environment, which promises to open doors for new applications in interactions, control and contextual sensing domain.

Oral Presentation
Interactive Bias Discovery for Machine Learning Using Automatic Subgroup Generation

Angel Cabrera
Polo Chau, PhD (Computational Science & Engineering)

As machine learning is applied to data about people, it is crucial to understand how learned models treat different demographic groups. Many factors, including what training data and class of models are used, can encode biased behavior into learned outcomes. These biases are often small when considering a single feature (e.g., sex or race) in isolation, but appear more blatantly at the intersection of multiple features. We present our ongoing work of designing automatic techniques and interactive tools to help users discover subgroups of data instances on which a model underperforms. Using a bottom-up clustering technique for subgroup generation, users can quickly find areas of a dataset in which their models are encoding bias. Our work presents some of the first user-focused, interactive methods for discovering bias in machine learning models.

Poster Presentation # 007
Improving Robustness of Model Predictive Path Integral Control to Stochastic State Disturbances

Matthieu Capuano
Byron Boots, PhD (Interactive Computing)

A common challenge with sampling based Model Predictive Control (MPC) algorithms operating in stochastic environments is ensuring stable behavior under sudden state disturbances. Model Predictive Path Integral (MPPI) control is an MPC algorithm that can optimize control of non-linear systems subject to non-differentiable cost criteria. It iteratively computes optimal control sequences by re-using the sequence optimized at the previous timestep as a warm start for the current iteration, which allows rapid convergence thus making it real time capable. This approach is successful in producing a diverse set of behaviors, the most impressive being its ability to control systems at the limits of handling. However, a strong unexpected state disturbance can make the previous control sequence an unsafe initialization for the new state and can result in undesired behavior. In this work, we address this problem by implementing a path tracker that produces control sequences that are used as the initializers for the current timestep, instead of simply re-using the sequence from the previous timestep. The path tracker iteratively computes control sequences that can guide the system to low-cost regions and feeds them into the MPPI framework as a sampling reference. This enforces the algorithm to sample behaviors normally distributed around controls that guide the state back to low-cost regions, even in cases where the state drastically changes. The additional advantage of our method is that it retains the ability to sample diverse and dynamically feasible controls, thus maintaining its ability for motion at the limits of handling. We experimentally verify this method on the AutoRally autonomous research platform, a one-fifth scale race car for aggressive driving tasks, and compare its performance against the most recently published results of MPPI for autonomous driving.

Poster Presentation # 013
MachVR: Low-Cost 3D Hand Tracking for Mobile Virtual Reality Enclosures

Victor Chen
Thad Starner, PhD (Interactive Computing)

Hand input is a key factor in the immersion and interaction that make virtual reality (VR) systems a compelling technology; however, low cost mobile VR headsets have limited input capabilities as they often lack the controllers and other peripherals that more expensive systems have. MachVR provides

a low cost technique for hand input and tracking in 3 degrees of freedom (DOF) using ultrasonic sensing. With a Google Cardboard v1, the user holds a custom controller that houses a pair of earbuds emitting ultrasonic pulses to the smartphone's two microphones. We leverage machine learning techniques to train a regression model for tracking the position of the controller in 3D space. We also compare our technique against the current standard interaction (gaze) for selection tasks and immersion.

Poster Presentation # 008
Deterministic Volume Approximation of Polytopes

Rares Cristian
Santosh Vempala, PhD (Computer Science)

Computing the volume of a polytope is an important long-studied question, with applications ranging from combinatorics to machine learning. While there are numerous randomized algorithms that efficiently approximate the volume, no deterministic algorithm is currently known to exist. This is part of a fundamental question in algorithms: when is randomness truly needed? We investigate whether the notion of chaos can be a substitute for randomness in this setting. There is a key distinction to be made here between chaos and randomness. Given the initial state of a system, we cannot predict the future state of a random process. On the other hand, a chaotic one is fully deterministic, although sensitive to initial conditions. That is, any small change in initial conditions will result in vastly different outcomes. Essentially all current methods for volume approximation rely on being able to sample uniformly from the body, with randomized algorithms doing this via random walks. Instead, we aim to create a deterministic dynamical billiard system that will uniformly cover the polytope. In particular, we consider the trajectory created by the free motion of a point particle inside the polytope with mirror-like reflections off the boundary. Additionally, we add a slight concave curvature to the facets which allows for a greater dispersion of the trajectory.

Poster Presentation # 009
Training Robotic Assistive Tasks in Simulation to be Performed in Reality

Vamsee Gangaram
Charles Kemp, PhD (Computer Science)

By training robotic controllers in accurate simulations, we can drastically improve training times by eliminating the need to physically reset an environment and can train at much higher rates than in reality. Training and testing in simulation can also save on expensive testing and degradation of the physical robot as they are usually costly machines, and we can also experiment quicker to develop the optimal robotic controller for the task by virtually altering the robot and environment rather than changing the physical build. With training the controllers in simulation currently however there are differences in sensing, actuation, and in dynamic interactions between the robot and environment compared to the physical world which can be expressed as the reality gap. This paper will focus on creating a simulated environment framework with the PyBullet physics engine to simulate various assistive tasks with robot and human interaction such as giving water to a human. Human cooperation is also simulated as humans are generally cooperative with assistive tasks. After the creation of this framework various reinforcement learning algorithms will be tested to eventually train a controller that can work in the physical environment with little to no adaptations from being trained in simulation.

Oral Presentation
PopSign: Teaching American Sign Language

Madeleine Goebel
Thad Starner, PhD (Interactive Computing)

More than 95% of deaf children in the United States are born to hearing parents (Mitchell & Karchmer 2004). With the majority of hearing parents having little to no exposure to American Sign Language (ASL) prior to the birth of their deaf child, many struggle to learn sign language while also beginning to use it to communicate with their new infant. The language deprivation experienced by deaf children as a result of their parents' inability to communicate delays their development (Kusche 1984). With the advent of smartphones and the rising popularity of movements such as BabySign, many different portable ASL lessons have been developed. It has been shown that these lessons are more effective at teaching vocabulary than classroom lessons (Lu 2008). However, these lessons struggle with a high attrition rate of students after a few weeks (Summet 2010). Recent developments in student-centered education indicate that incorporating achievement goals leads to a lower attrition rate in language classes (Oberg & Daniels 2013). To reduce the rate of attrition, I used a popular, multi-level game as a framework for the lessons and incorporated ASL phrases into the game play.

Poster Presentation # 014
Satellite Image Predictions using Machine Learning Techniques

Ziming He
Greg Turk, PhD (Interactive Computing)

Traditional snow coverage predictions are limited either by low resolution of the MODIS images sets and low frequencies of Landsat images. In this study, we employed a set of various machine learning techniques, including k nearest neighbors(KNN), random forest regressor(RF), convolutional neural networks(CNN) to model the relationship between high frequency MODIS data and high resolution Landsat data.

Poster Presentation # 010
Collaborative Execution of Deep Neural Networks on Internet of Things Devices and Its Applications

Chunjun Jia, Dongsuk Lim, Lixing Liu, Matthew Merck and Bingyao Wang
Hyesoon Kim, PhD (Computer Science)

With recent advancements in deep neural networks (DNNs), we are able to solve traditionally challenging problems. Since DNNs are compute intensive, consumers, to deploy a service, need to rely on expensive and scarce compute resources in the cloud. This approach, in addition to its dependability on high-quality network infrastructure and data centers, raises new privacy concerns. These challenges may limit DNN-based applications, so many researchers have tried optimize DNNs for local and in-edge execution. However, inadequate power and computing resources of edge devices along with small number of requests limits current optimizations applicability, such as batch processing. In our project, we propose an approach that utilizes aggregated existing computing power of Internet of Things (IoT) devices surrounding an environment by creating a collaborative network. In this approach, IoT devices cooperate to conduct single-batch inferencing in real time. While exploiting several new model-parallelism methods and their distribution characteristics, our approach enhances the collaborative network by creating a balanced and distributed processing pipeline. We have illustrated our work using many Raspberry Pis with studying DNN models such as AlexNet, VGG16, Xception, and C3D. Currently, we are experimenting with Raspberry-Pi based robot to evaluate the application of such technique in trash-recycling robots which can perform DNN-based image recognition to identify the category of trash and put it in the appropriate bin. We are also examining the power consumption of our approach and how could that be different from non-collaborative approaches.

Oral Presentation
RF-Pick: Comparing Order Picking Using a HUD with Wearable RFID Verification to Traditional Pick Methods

Pramod Kotipalli
Thad Starner, PhD (Interactive Computing)

Order picking accounts for 55% of the annual $60 billion spent on warehouse operations in the United States. Reducing human-induced errors in the order fulfillment process can save warehouses and distributors significant costs. We investigate a radio-frequency identification (RFID)-based verification method wherein wearable RFID scanners, worn on the wrists, scan passive RFID tags mounted on an item's bin as the item is picked; this method is used in conjunction with a head-up display (HUD) to guide the user to the correct item. We compare this RFID verification method to pick-to-light with button verification, pick-to-paper with barcode verification, and pick-to-paper with no verification. We find that pick-to-HUD with RFID verification enables significantly faster picking, provides the lowest error rate, and provides the lowest task workload.

Oral Presentation
Hack The Levi's Jacket

Aayush Kumar, Rhea Chatterjee, Caleb Rudnicki, and Kenzy Michelle Wasseem Mina
Thad Starner, PhD (Interactive Computing)

New user interfaces afford innovations in the user experience of computers—the interactive capacitive textile approach posed by Google's Jacquard thread is another step in this evolution. Although it commercially highlights multiple possibilities of intelligent fabric via the Levi's Jacquard Jacket collaboration, there is still a vast potential for other applications and forms of user input that altogether demand further attention. Our goal is to make Jacquard's capabilities widely accessible to the global community of developers and, in doing so, demonstrate a handful of its untapped capabilities/applications to encourage a hacker culture around it. Thus, we are building a developer friendly iOS toolkit for easily interfacing with the Jacquard technology, introducing new gestures that leverage the ability to discern variable applied pressure as a second dimension for user input, and physically exporting the Jacquard swatch to a backpack strap to showcase a versatile usage of intelligent fabric. Preliminary Findings/Progress: Currently, our toolkit exposes all four officially supported gestures (dubbed "Double Tap", "Cover", "Swipe Up", "Swipe Down") along with surfacing an extra "Scratch" gesture which, while included in the original Jacquard firmware, was not officially released in the provided Levi's Jacquard iOS application. We have also successfully demonstrated a proof-of-concept two dimensional gesture we call "Force Touch", where the user presses down on the jacket with their palm in two consecutively increasing levels of pressure, lightly and then firmly. Finally, we have posted an instructive tear-down of the Jacquard hardware and are amidst constructing our first backpack strap prototype.

Oral Presentation
Extracting Information from Gameplay Videos using Machine Learning Techniques and Its Varieties

Zijin Luo
Mark Riedl, PhD (Interactive Computing)

The ability to extract sequences of game events for high-resolution e-sport games has traditionally required access to the game's engine. This serves as a barrier to groups who don't possess this access. It is possible to apply deep learning to derive these logs from gameplay video, but it requires computational power that serves as an additional barrier. These groups would benefit from access to these logs, such as small e-sport tournament organizers who could better visualize gameplay to inform both audience and commentators. In this paper, we present a combined solution to reduce the required computational resources and time to apply a convolutional neural network (CNN) to extract events from e-sport gameplay videos. This solution consists of techniques to train CNN

faster and methods to execute predictions more quickly. This expands the types of machines capable of training and running these models, which in turn extends access to extracting game logs with this approach. We evaluate the methods in the domain of DOTA2, one of the most popular e-sports. Our results demonstrate our approach outperforms standard backpropagation baselines.

Poster Presentation # 015
Metaphors, Culture, and Computer Science

Jamal Paden
Elizabeth DiSalvo, PhD (Interactive Computing)

Computing is characterized by the notional machine that cannot be perceived directly through the senses. Learners typically use metaphors based on their experiences to construct mental models to understand these concepts. Because people live within sociocultural contexts and use metaphors based on experiences, learners may construct mental models of programming concepts that do not match the the computer's mental models. In this poster we present a study where we surveyed 250 college students in their first programming course at colleges in Ecuador and the United States to understand metaphors they use to understand concepts. We suggest that syntax and structure of programming languages constrain how learners see and understand a given problem. Findings suggest that metaphors students use to understand CS concepts are often cultured and dissimilar. There are several examples where culture may color a specific person's metaphor of a particular programming topic, and these metaphors may lead to common misconceptions.

Oral Presentation
Optical Sensing using Organic Materials

Devansh Ponda
Gregory Abowd, PhD (Interactive Computing)

We trying to create an optical sensing device that is enabled with hand gesture recognition. While this, by itself, is not very extraordinary, there are few caveats. Firstly, our device is entirely self-powered using ambient light. Secondly, there are no cameras for hand gesture detection. Instead, we use machine learning to predict gestures using input from the 4x4 photodiode array. Finally, there is no silicon used. All photodiodes are made of organic materials and are also bendable. It is a revolutionary step in the area of gesture recognition and self-powered systems. I, even as the first year with very basic CS knowledge, am handling the entire software and machine learning side by myself, with help only from mentors. I would love to share my story and the details of our project. into the game play. When tested with subjects over a two week period, it was shown that subjects using the game-version of the lesson had a lower attrition rate and a higher rate of vocabulary acquisition than subjects learning via the control-version of the lessons.

Poster Presentation # 011
Detecting Widespread Fragmentation Errors in Android Applications

Martin Prammer
Alessandro Orso, PhD (Computer Science)

Software testing and debugging has become a cumbersome problem for software developers. Due to the fragmentation of device drivers, libraries, APIs, and programs, it is infeasible for developers to test their application on all possible device configurations. Likewise, there is no guarantee that bugs are caused by the developer's app, but instead may be a result of fragment errors and incompatibilities. To help make this process more efficient, we propose a technique to leverage cloud-based testing services with existing, well proven test suites. We implemented this technique for Android apps, utilizing the Amazon Web Services Device Farm and Android Compatibility Test Suite to execute large scale device profiling. With these profiles, we are able to construct a taxonomy of API compatibility for each device. In future work, this technique can be expanded to more platforms by leveraging other existing services.

Oral Presentation
Off-Center AR

Rohan Ramakrishnan
Thad Starner, PhD (Interactive Computing)

Several studies have highlighted the usefulness of mobile augmented reality systems that project information into the tangible world to help users with various tasks. However, these systems often interfere with users' vision and present several distractions which reduces their usefulness when applied to many tasks. In this paper, we create a new 'off center' head worn display where the AR environment can be place outside the user's center of vision. We then apply this display to a coloring task and analyze the tradeoffs between completion time and errors during the experiment to determine the feasibility of such displays.

Poster Presentation # 016
American Sign Language Recognition- CopyCat Game Design

Prerna Ravi
Thad Starner, PhD (Interactive Computing)

Through our Center for Accessible Technology in Sign, we are developing a computer-based automatic sign language recognition system and using it to create the CopyCat Sign Language game that helps young deaf children of hearing parents acquire language skills. CopyCat is designed both as a platform to collect gesture data for our ASL recognition system and as a practical application which helps deaf children acquire language skills while they play the game. The system uses a video camera and wrist

mounted accelerometers as the primary sensors. In CopyCat, the user and the character of the game, Iris the cat, communicate with ASL. With the help of ASL linguists and educators, the game is designed with a limited, age-appropriate phrase set. For example, the child will sign to Iris, "you go play balloon" (glossed from ASL). If the child signs poorly, Iris looks puzzled, and the child is encouraged to attempt the phrase again. If the child signs clearly, Iris frolics and plays with a red balloon. If the child cannot remember the correct phrase to direct Iris, she can click on a button bearing the picture of the object with which she would like Iris to play. The system shows a short video with a teacher demonstrating the correct ASL phrase. The child can then mimic the teacher to communicate with Iris. Gesture-based interaction expands the possibilities for deaf educational technology by allowing children to interact with the computer in their native language.

Poster Presentation # 012
Towards the Uniform Sampling of Tournaments of a Score Sequence

Sherry Sarkar
Eric Vigoda, PhD (Computer Science)

Sampling from graphs of a given degree sequences has become a recent problem of interest. From a practical point of view, sampling random graphs of a degree sequence proves useful properties in peer to peer networks, an online protocol used often in the internet. From a more theoretical perspective, computer scientists have been interested in the generalized problem - sampling from matrices with specified row and column sums. The number of matrices with a specified row and column sum is very difficult to count; therefore, being able to uniformly sample from such graphs might shed light on a way to polynomially approximate this quantity. A subfield of this area is sampling from tournaments. Kannan, Tetali, and Vempala formulated a Markov chain to sample tournaments from a given score sequence and employed the technique of canonical paths to prove rapid mixing for ``near regular" score sequences. The Markov chain is to simply take a directed triangle and reverse it. It is an interesting combinatorial fact that the number of triangles in a tournament is a function of the score sequence, which implies that the Markov chain has a uniform stationary distribution. In a remarkably succinct path coupling argument discovered in 2000, McShine showed that one can actually sample from tournaments of any given score sequence in O(n^3) time. I will look to discover new results of sampling from tournaments. A few possible avenues include improving mixing time with new Markov chains or investigating Markov chains on unlabelled tournaments.

Oral Presentation
A System for Tracking All Vehicles All the Time At the Edge of the Network

Harshil Shah
Umakishore Ramachandran, PhD (Computer Science)

In this fast-paced age of information and connectivity, the significance of IoT devices has increased in a staggering manner to relay insightful data at the fingertips of the end-users. This need of collecting, analyzing and distributing data in a time-sensitive and geo-distributed environment gave birth to the Fog Computing infrastructure that places network services, computational resources, and data store closer to the end user. This research focuses on developing a smart-camera traffic surveillance system using the Fog architecture and replace the current Alert-based Cloud model with a more proactive, robust and geo-distributed smart surveillance that predicts and stores space-time trajectories of all vehicles on the road at the "Edge of the Network". Specifically, the traffic cameras would detect, track, and re-identify vehicles on the road and generate finite space-time trajectories by employing the methods of forward/backward propagation and inter-node communication. This network requires an efficient, real-time inter-node communication policy operating on the publish-subscribe model to asynchronously notify cameras in the network about the presence of the vehicles on the road. This service must be able to scale with the growing size of the network, must support static and dynamic cameras(emergency vehicles), and broadcast relevant vehicle information to the network for the lifetime of the vehicle in real-time. Conclusively, Fog Computing powered traffic management system solves several problems related to performance, security, workload balancing, and provides a firm foundation to a whole new field of integration of Fog and Cloud infrastructures for designing better, faster, and secure systems.

Oral Presentation
Automated Commentary for Let's Play Videos

Shukan Shah
Mark Riedl, PhD (Interactive Computing)

The rise of video streaming sites such as YouTube and Twitch has engendered a completely new medium of entertainment, popularly known as the "Let's Play." Let's Plays typically involve video streamers providing live commentary of their own gameplay to an audience of viewers. What makes this phenomenon a growing trend is not only the content of the game, but also the interesting commentary that accompanies the gameplay. The impact of Let's Plays on today's entertainment culture is evident by observing revenue numbers. In fact, studies estimate that Let's Plays and other streamed game content will generate $3.5 billion in ad revenue by the year 2021. What makes them unique is the fact that they "don't modify the games but rather how viewers experience them". We can leverage this new form of entertainment to learn an artificially intelligent

model of improvisational commentary. Since future commentary often depends on prior commentary and what is viewable on the screen, Let's Plays could serve as a training base for an AI approach that learns to generate novel, improvisational, and entertaining content for games and video. Thus, we can avoid the need for real-world machine vision or difficult annotation of real world improv. Such a model could also be incorporated to increase user engagement with AI agents by aiding in explainable AI approaches to rationalize decisions.

Oral Presentation
Sparse Order Picking

Sarthak Srinivas, Saksham Gandhi, Lauren Kearley, Georgianna Lin, and Thomas Suarez
Thad Starner, PhD (Interactive Computing)

Order picking is the process of finding and picking orders inside a warehouse. The process accounts for up to 55% of the operational costs of a warehouse. About 80% of the world still picks its orders using paper. Out of these costs, travel itself accounts for a further 55% of it. By optimizing how efficiently warehouse workers can travel inside a warehouse, such as researching the most optimal positioning of the UI interface, we can help optimize one of the largest costs faced by over 750,000 warehouses around the world that collectively ship over 1 trillion dollars worth of goods every year. Augmented Reality and Mixed Reality headsets is a new and upcoming way of finding and picking orders inside a warehouse because they enable hands free and just-in-time delivery of picking information. By using headsets like the Microsoft HoloLens, it is possible to spatially map an environment in three dimensions and get centimeter-level accuracy with inside-out tracking, enabling precise navigation within indoor environments. In particular, HoloLens weighs 579 grams (1.28 lb) and has a battery life of about 2 hours. However, HMDs like Google Glass (0.079 lb) have already proven their utility in industrial environments even though they lack most of the advanced sensor fusion and computer vision technology within HoloLens. Our goal is to evaluate how we could build an interface for HMDs like Magic Leap that helps optimize the number of steps taken by order picking workers to collect items inside an indoor environment like a warehouse.

Poster Presentation # 017
Low-Cost Real-time Virtual Reality Video Call Using User-specific Facial Model and Google Cardboard

Ruixuan Sun and Ruihan Xu
Gregory Abowd, PhD (Interactive Computing)

Virtual Reality(VR) has emerged as an interactive computer-generated experience taking place within a simulated environment. Nowadays, it is great tool not only for simulate virtual environment, but also enhances communication between people. In the research, we would like to introduce a virtual reality real-time phone calling system and evaluate its effectiveness with a detailed user study. Though the facial landmark localization algorithms and VR graphical rendering are of great importance to understanding possible ways to detect facial expressions and mimic realistic physical presence, there's little understanding of how one of them can be applied together with another to realize a real-time VR video call. Therefore, this study introduces a practical method to enhance human communications with currently available computer vision and virtual reality(VR) technologies that make 3D VR video calls between users become possible. Our methods to fill the gap and realize a VR/Mixed Reality(MR) call include two major steps: facial movement tracking and VR graphics rendering. To evaluate the performance of the system, we conducted user studies that to measure the accuracy of emotion transformation from users faces to avatar faces. We also compare our system with currently popular Lip Synchronized system that utilized audio input, instead of visual input, to generate lip movement. At the end, we would discuss how each user agree with each other through statistical methodology, and give a conclusion on the effectiveness as well as a general future implication of the VR phone system we implemented.

Poster Presentation # 018
Privacy Preserving Data Collection for Machine Learning

Victor Tolpegin
Ling Liu, PhD (Computer Science)

Organizations and companies are becoming increasingly interested in collecting user data and telemetry to improve data-driven decision making. The more data that an organization is able to collect the more insights it may draw to improve the accuracy and personalization of data-driven systems. Unfortunately, modern pervasive data collection poses many privacy risks as it often includes users' sensitive information, such as their preferences, habits, interests, and secrets. To address these concerns researchers have begun focusing on the development of privacy preserving systems which both protect users' privacy while still allowing data collecting organizations to extract meaningful insights. One technique in developing such systems is the emerging framework of local differential privacy (LDP). LDP has been implemented in consumer-facing products such as Google Chrome (to analyze browser homepages and default search engines), Apple iOS (to determine emoji frequencies, improve spelling prediction, and analyze usage of health data types), and Microsoft Windows (to collect application telemetry). However, existing LDP protocols often consider low-dimensional data types and relatively simple analytics tasks such as frequency estimation, marginal release, and heavy hitter discovery. In this research project, we investigate the use of privacy preserving techniques, including LDP, to collect high-dimensional data. In particular, we focus on the application of private data collection to supervised and unsupervised machine learning. In this work, we propose a system for privately collecting and analyzing high-dimensional data using a combination of techniques with validation through machine

learning algorithms.

Poster Presentation # 019
Making Musical Game Maps with Semantic Features

Kyle Xiao
Mark Riedl, PhD (Interactive Computing)

BeatMania is a rhythm-action game where players press buttons in response to keysound events to generate music. Rhythm-action game charts (the sequence of keysound events) have traditionally been human authored, since each song level must be creatively organized and correspond an overall pattern or theme. A deep neural network approach is proposed for rhythm-action game chart creation using a set of semantic features. That is, given an arbitrary piece of music, human users can generate BeatMania charts as well as control style and blending. This research focuses primarily on autonomous chart generation, where a combination of semantic features are incorporated into an artificial neural network, such as challenge models and audio sample classifications. The model is tested against LSTM baselines and evaluated via F1 score.

COLLEGE OF DESIGN

Poster Presentation # 005
Implementing Torque-Controlled Propulsion Mode for Robotic Wheelchair Tester to Automate Wheelchair Assessment

Salim Ben Ghorbel
Stephen Sprigle, PhD (Industrial Design)

Wheelchair 'quality' is difficult to define. Comfort and fit are subjective, whereas mechanical efficiency (yet-unmeasured) could universally compare different wheelchairs objectively. However, tests using human subjects introduce variability that affects measurement consistency. Alternatively, automated wheelchair experiments offer increased repeatability, reliability, and broader range of testable wheelchair configurations. The Anatomical Model Propulsion System (AMPS) is a robotic wheelchair operator that emulates a human wheelchair user. It is equipped with DC motors that propel the drive wheels at the hand-rims where humans grip the wheels. The AMPS can test any wheelchair model without modification to the wheelchair frame. It acquires data from current sensors and encoders on the wheels and motors to calculate the energy supplied to the chair. The proposed work will introduce closed-loop control of the motor torque using feedback signals from current sensors, replicating human-like propulsive torque profiles. A custom stationary experimentation platform will be constructed to calibrate the sensors, tune the motor controller, and assess the dependability of the control scheme. Overground AMPS trials will then test various combinations of wheelchair configurations and floor surfaces. It is hypothesized that implementing the torque-controlled 'Intermittent Propulsion' mode will more closely resemble usage by a human operator compared to the existing velocity-controlled method. The outcome of this study will quantify intermittent energy losses of wheelchair propulsion to compare between configurations and environments. These results will provide wheelchair user and clinicians more information about the tradeoffs between chair types, components, and general use-cases to find a 'better fit'.

Poster Presentation # 006
Lysande Smartphone Camera Attachment

Omari Hitson, Akhila Ballari, Meredith Caveney, and Emanuel Solis
Wang Wei, PhD (Industrial Design)

The Lysande camera attachment is an APS-C equivalent digital still camera meant to be attached to the back of the latest generations of IPhone. Our team believes that the most influencing variable of a camera's image quality is its sensor. Our research found that photographers most often opt to use their smartphone due to its convenience but, were unhappy with the overall imaging performance of the device. Traditionally digital still cameras utilize larger sensors to obtain higher overall image quality but at a compromise to the size of the overall system. As the sensor size increases, so too does the distance from the sensor plane to the lens. To challenge this compromise, we packaged the advantages of a digital still camera system with an APS-C sensor size into a small device that can be attached to your phone. This is accomplished by the utilization of multiple smaller sensors to obtain a larger sensor equivalent. As a result, photographers are no longer required to make a conscious decision whether their occasion warrants the use of a larger, bulkier system rather than their smartphone. The device is not meant to replace photographer's DSLRs but rather to supplement them on occasions which warrant quality but not larger sized systems.

COLLEGE OF ENGINEERING

Oral Presentation
DeepSpace: Spacecraft and Satellite Orientation Modeling from Moon Imagery Using Machine Learning Techniques

Stefan Abi-Karam
Lee W. Lerner, PhD (Electrical and Computing Engineering)

The goal of this project is to be able to determine a spacecraft's or satellite's orientation in space based on an image taken of a celestial object. For this project, we have chosen to focus on the Moon as the planet body of interest when determining orientation from imagery. Using various datasets and ML techniques, such as convolutional neural networks and residual neural network architectures, we can show that it is possible to build models that can predict orientation values with a reasonable degree of accuracy, providing proof of justification for this technique. These models can be integrated into a spacecraft's navigation system in order to improve the accuracy of current systems. They can also be integrated into satellites such as CubeSat opening more opportunities for lower cost research satellite platforms. We hope to expand our work in the future by implement these orientation models on reconfigurable hardware (FPGAs).

Oral Presentation
Feasibility of Low-Cost Air Quality Sensors for Mobile Emissions Analysis

Nic Alton
Kari Watkins, PhD (Civil and Enviromental Engineering)

Increasing the percentage of trips made by bicycle can have significant impacts to air quality and public health, however there is limited understanding about individual cyclist's exposure to pollutants. The objective of this research was to determine the feasibility of using a low-cost air quality sensor, the PMS 5003, to accurately measure street-level air quality as experienced by cyclists. If successful, the PM sensor would be integrated with a collection of other sensors and used in further air quality research. For this study, two PMS 5003 sensors were used to minimize the chance of miscalibration. Over the course of several days, 20 runs, and multiple physical sensor configurations, PM2.5 data from the sensors were compared to data from the research-grade GRIMM Portable Aerosol Spectrometer 1.108. The results indicated that the low-cost sensor data was not excessively different from the GRIMM, but there was some variation when the averaged PM2.5 readings from both sensors were compared at 6-second intervals. Using this interval, the mean difference in PM2.5 readings between the PMS 5003 and the GRIMM was found to be 0.745 µg/m3, with a standard deviation of 5.554 µg/m3. Additionally, the GRIMM picked up some spikes in PM2.5 readings which the PMS 5003 sensors missed or picked up to a lesser extent. However, averaging the data from both PMS 5003 sensors over 24-second intervals improved the sensor's accuracy to a level suitable for our research. The mean difference PM2.5 readings between the PMS 5003 and the GRIMM was found to be -0.576 µg/m3 with a standard deviation of 4.131 µg/m3. The findings from this study will immediately improve understanding on how to use low-cost sensors in a mobile environment. In the long-term, this study is a crucial step in gathering accurate air quality data in complex urban environments and improving cycling infrastructure.

Oral Presentation
Single RNA-Molecule Detection using MTRIPS-FISH

Danae Argyropoulou
Philip Santangelo, PhD (Biomedical Engineering)

RNA localization and interactions within a cell can give valuable insight into the cell's actions and reactions, especially during a disease state. Assays that give spatial information about the location of RNA in cells are extremely useful as controls in interaction studies and also functional understanding of cellular processes. For this purpose, Fluorescent In-Situ Hybridization (FISH) assays use fluorescently labelled strands of nucleic acids that are complementary to the RNA of interest to illuminate where the RNA is at that point in time. While much success has been achieved in visualizing single RNA molecules in live cells by the Santangelo Laboratory, FISH in fixed tissues with single-molecule specificity is more difficult to achieve. Here, we explore different methods of obtaining single-molecule specificity with previously validated MTRIPS molecules. We discovered that using pre-labelled PNAs bound to the neutravidin protein lead to highly specific detection of single-molecule RNA, while allowing for other assays, such as Proximity Ligation to occur simultaneously.

Poster Presentation # 054
Verification and Test of CubeSat Electronic Subsystems Using a Balloon Launch

Ebenezer Arunkumar, Athreya Gundamraj, Cameron Hines, Megan Kim, and Radina Yanakieva
Glenn Lightsey, PhD (Aerospace Engineering)

To prepare for the development of a series of 1U CubeSats, a team of students at the Georgia Institute of Technology developed the Sensor Telemetry Rig and Trial Operations System (STRATOS), a balloon platform to test and validate the performance of CubeSat avionics. A flight test on January 20th, 2019 saw the successful launch of a prototype structure outfitted with tracking equipment to an altitude of 16000 m. A following flight in April will launch with software, avionics, power,

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and communication subsystems designed for a 1U CubeSat. The STRATOS project objective is to familiarize undergraduates with the design, testing, and operation of spaceflight hardware in an environment that is substantially less cost-intensive and allows for rapid iteration.

Poster Presentation # 058
Simple Size Sorting of Low Boiling Point Perfluorocarbon Nanodroplet Ultrasound Contrast Agents

Joseph Awoyeye
Brooks Lindsey, PhD (Biomedical Engineering)

Over the last 2 decades, many injectable nanoparticles to aid in diagnosis and therapy in a variety of cancers have been developed. These agents have unique advantages over microscale agents due to their ability to extravasate into tumors, however the ability of a particle to remain in an extravascular space depends on the particle size, with the desired size being <200 nm. Phase change contrast agents (PCCAs) are liquid core, nanoscale contrast agents that transition from a liquid core to gas core under applied ultrasound energy and are useful for tumor imaging and therapy due to their soft composition and safe, targeted method of activation with diagnostic ultrasound. In this work, populations of PCCAs having controlled size distributions were developed, particularly smaller than those previously described in literature (300 nm to >1 μm) to 1) increase the likelihood of the agent to extravasate, and 2) increase the time the agent spends in extravascular space before re-entering the vascular space. This study reports a simple fabrication method in which nanometer sized droplets were produced and investigates their acoustic pressure vaporization thresholds. Lipid-shelled and decafluorobutane (C4F10) gas core microbubbles were generated from a lipid solution (DSPC and DSPE-PEG2000 in a 9:1 molar ratio) through mechanical agitation of lipid solution in 3 ml vials having a headspace filled with decafluorobutane and were subsequently size sorted by centrifugation. Size-sorted microbubbles were then condensed under pressure at a temperature of -10 C, causing gas-core size-sorted microbubbles to become liquid-core size-sorted nanodroplets. This procedure generated three different size populations of nanodroplets that underwent ADV to determine activation thresholds for each size population and image contrast resulting from droplet activation were quantified.

Poster Presentation # 095
Measurements of Glass Transition Temperature in Organic-Inorganic Hybrid Materials Created via Vapor Phase Infiltration (VPI)

James Bamford
Mark Losego, PhD (Materials Science and Engineering)

Glass transition temperature (Tg) is a fundamental property of a polymer that defines its upper service temperature for structural applications and is reflective of its fundamental physiochemical features. We are using a new technique, vapor phase infiltration (VPI), to alter the physiochemical structure of polymers, and this study examines the changes in Tg as a function of VPI chemistry and process conditions. In this work we examine the VPI of poly(styrene-co-2-hydroxyethyl acrylate) (PS-r-PHEA) with trimethylaluminum (TMA) and water to form aluminum oxide infiltrants that either form chemically bound pendant groups or cross-links off of the co-polymer. Specifically, our VPI precursors are designed to be unreactive towards the styrene monomer units and highly reactive towards the PHEA monomer units. Experiments were conducted on PS-r-PHEA thin films (170 nm) spun-cast onto silicon wafers and infiltrated at 100°C for 60 minutes. Polymer chemistries of pure PS, 3 wt% PHEA, and 5 wt% PHEA were investigated. Volumetric swelling of the films after VPI increased with higher PHEA weight fraction, confirming higher metal oxide loading with more PHEA units. Tg was measured using a spectroscopic ellipsometer retro-fitted with a custom-built heating unit. We find consistently increasing temperatures of the glass transition with metal oxide loading. While the 3 wt% PHEA showed a 14°C increase in glass transition (from 88°C to 102°C), the 5 wt% PHEA system showed a 20°C increase in Tg (from 87°C to 107°C). These results suggest that VPI metal oxide clusters or crosslinks are impeding chain mobility, thereby raising the polymer's Tg.

Poster Presentation # 059
Finite Element Modeling of Bicuspid Aortic Valve Dynamics

Brian Barrett
Wei Sun, PhD (Biomedical Engineering)

Bicuspid aortic valve (BAV) is a congenital heart valve malformation in which the patient has only two leaflets instead of the normal three leaflet configuration of the aortic valve. BAV is a serious malformation that can lead to aortic stenosis (AS) in which the valve is unable to fully open due to calcification forming on the leaflet. This purpose of this study is to analyze the effects of calcification on BAV dynamics to better understand how calcification affects the biomechanics of the BAV. Five patient-specific BAV models will be generated from computed tomography (CT) images. The BAV models will also include the aortic trunk and aortic sinuses. These models will be created using segmentation and finite element modeling methods. The opening and closing of the valve will then be simulated with and without the presence of calcification, and the results of the simulation will be investigated using finite element analysis. The stress, strain, and deformation of the leaflets will be compared between the calcified and non-calcified models in order to observe the effects of the calcification. A better understanding of BAV dynamics could be valuable in the treatment of AS and predicting patient outcomes.

Poster Presentation # 097
Bendable Kapton Heat Engines

Bruno Bartolek
Todd Sulchek, PhD (Mechanical Engineering)

This research project focuses on the improvements and applications of bendable heat engines. An application of bendable heat engines is their use in the cooling towers of power plants to transfer heat from steam into additional useful work, and later electricity. We designed a patternable Kapton process to form the engine walls, instead of the prior Polydimethylsiloxane elastomer process used previously within the engine. We found that Kapton is able to sustain higher working temperatures while providing more rigidity per unit thickness, thus furthering the use of these engines for applications in bendable heat engines. Kapton heat engines were constructed by thermally treating Kapton sheets with silicone glue, with cured Polydimethylsiloxane. Flow parameters were then evaluated, including amplitude of oscillation within the engine and frequency of oscillation, and were compared to a Polydimethylsiloxane engine. The amplitude of oscillation showed the Kapton heat engine to be less efficient than Polydimethylsiloxane engines for fewer than 8 W of power, and much more efficient than Polydimethylsiloxane engines for more than 8 W of power supplied. Furthermore, the Kapton engine showed to have a greater average oscillation frequency than Polydimethylsiloxane engines. Therefore, since the Kapton engine showed both greater oscillation amplitude for certain power inputs, and greater oscillation frequency overall, the Kapton engine shows great promise for pumping applications. A greater oscillation amplitude and frequency should theoretically result in greater pumping rate.

Poster Presentation # 086
Improvement of Magnet Localization for Resource-Constrained Devices Used in Tongue Tracking Speech Therapy

Arpan Bhavsar
Omer Inan, PhD (Electrical and Computer Engineering)

Speech language pathologists (SLPs) observe and guide articulators such as the lips and jaw of patients with speech disorders that can arise from a neurodegenerative disease, spinal cord injury, or brain trauma. While treating these patients, SLPs can have difficulty observing the tongue, a critical articulator, since it is hardly visible during speech. To address this problem, the GT-Bionics Lab has developed a system to track a small magnet glued to the tongue of a patient to allow for "wireless" monitoring of its location, since magnetic fields can propagate through the jaw and mouth and be read by magnetometers without intrusion. The system reads magnetic flux data from twenty-four magnetometers housed around the patient's jaw and determines the magnet's position. Current methods of predicting the magnet's location include solving the ideal magnetic dipole equation, which unfortunately requires computationally expensive numerical methods and does not account for systematic non-idealities. This research presents a deep learning approach which reduces computational power and increases accuracy when predicting the magnet's location. After pre-processing the raw sensor readings, a set of hyperparameters including learning rate, k-fold cross-validation splits, hidden layers, activation functions, and others were optimized while training a supervised neural network. This model resulted in an efficient and accurate real-time prediction of the magnet's location. With this approach, the localization process can be implemented on resource-constrained devices such as phones and tablets for portable articulator analysis due to the intrinsically low time-complexity of predicting with neural network models.

Poster Presentation # 055
NASA's Prandtl-M

David Booker-Earley, Alfredo Nunez, and Adam Shaw
Michael Mayo, PhD (Georgia Tech Research Institute)

Partnered with NASA, the goal is to test and improve an autonomous Martian glider meant to observe suitability of potential landing sites on Mars.
Problem: Humans want to go to Mars, but information (data) is still needed about potential landing sites. Satellites provide overview-pictures of Mars but are limited in resolution; rovers provide key data but are limited by speed and terrain; multirotor-drones require special conditions to work in the thinned Martian atmosphere. Solution: Deploy a low-cost autonomous aircraft that can auto-stabilize in the Martian atmosphere during descent while collecting and transmitting detailed photographs and radiation levels. As described by NASA, the Prandtl-M aircraft will be launched from a cubesat-aeroshell with a rover for expected 2020s mission(s), glide over potential landing sites for future astronaut missions, collect and transmit detailed data to either nearby rover(s) or satellite(s). Next Steps: Reduce weight to 1 pound (2.6 Earth pounds) and finalize sensor selection; Test algorithms for autonomous stabilization; Collect data during autonomous descent for 20 miles; Successfully test on Earth near 100 k-ft altitude.

Oral Presentation
The Effect of TAVR Placement Characteristics on Neosinus Hemodynamics

Rachel Boutom
Ajit Yoganathan, PhD (Biomedical Engineering)

The current standard treatment for severe aortic valve stenosis is surgical replacement of the valve. This surgery involves breaking the breastbone and stopping the heart to do an open-heart surgery. For high-risk patients who cannot withstand such an invasive surgery, the transcatheter aortic valve replacement

(TAVR) procedure is used as an alternative. Because of differences in dimensions of individual patient anatomies there is no one perfect placement position. Therefore, the goal of the surgeon is to place the TAV in the patient anatomy such that it allows for proper blood flow through the valve. This research aims develop a computational model to investigate the effects of different deployment characteristics including deployment height, rotation, and tilt angle on TAVR hemodynamics. In addition to individual characteristics, the effects of cofactors will be studied. For this research, an ideal aortic model will be used for more generalizable results.

Oral Presentation
Developing a Platform to Mimic Lymphatic Vessel Injury and Induce Cell Remodeling

Joy Brown
J. Brandon Dixon, PhD (Mechanical Engineering)

The Lymphatic system is responsible for returning fluid from the interstitium to the blood through the pumping of collecting lymphatic vessels. These vessels are composed of a layer of endothelial cells surrounded by specialized lymphatic muscle cells (LMCs). It has been shown that the health and behavior of lymphatic muscle cells are affected by loading and cyclic deformation. In-vitro stretch devices can be used to mimic these factors and further understand their impact. Using a stretch device platform that I designed in SOLIDWORKS, the goal was to stretch LMCs for 24 hour periods to mimic lymphatic vessel injury and induce cell remodeling and then to validate protein expression data previously found with experimental functional assays. Cell culture techniques were used to freeze, thaw, and culture LMCs. Once implementing my device with cells, I found that I had to make a few design modifications, such as improving the durability and depth of the wells and changing the stretch waveform to ensure cell adhesion. Upon completion of these modifications, I was able to successfully run the experiment with the device and use the Alamarblue, collagen, and f-actin assays to assess LMC health. Initial results seem to indicate that the stretched LMCs were a lot more metabolically active, more proliferative, and synthesized more collagen than the non-stretched LMCs.

Oral Presentation
Multi Length-scale Instrumented Indentation Study on Dual-Phase (DP) Steels

Charles Caliendo
Surya Kalidindi, PhD (Mechanical Engineering)

Development of new generations of dual phase (DP) steels requires rapid screening of mechanical properties at multi length-scales at various processing conditions. Altering processing conditions such as intercritical annealing temperatures, amount of cold work, and bake hardening parameters directly influence the microstructure of the final material as well as its mechanical response. The increase in intercritical annealing temperature results in the formation of higher volume fractions of martensite which act as hard constituents in the resulting microstructure. However, the martensite formed from quenching at higher temperatures gives lower carbon content with lower strength. This opposite effect requires mechanical testing investigation on the bulk response as well as individual constituents. In this research we are utilizing spherical indentation protocol as a high throughput mechanical testing method to measure mechanical properties of bulk as well as individual microstructure constituents using two different tip radii: 6350 μm and 1 μm. A total of nine different thermo-mechanical processing conditions were explored; three intercritical annealing temperatures and 3 amounts of thickness reduction in cold work. The outcome of this research provides rich information on mechanical properties from very small quantities of the material. This information will be used later by simulation in designing new generations of DP steels that aims for higher strength-to-weight ratios demanded by vehicle industries to reduce fuel consumption.

Poster Presentation # 084
Particulate Matter Sensors Mounted on a Robot for Environmental Aerosol Measurements

Abhay Cashikar
Pratim Biswas, PhD (Energy, Environmental & Chemical Engineering at Washington University in St. Louis)

Miniaturized particulate matter (PM) sensors have been studied intensively as an alternative device for air quality measurement due to their price advantage, moderate accuracy, and portable size. The accuracy of these sensors has been studied by calibration against conventional laboratory instruments. Such sensors have been connected in a network for spatiotemporal air quality measurements or used as a personal monitor for exposure estimation. Another important application is combining low-cost PM sensors with drones or other unmanned vehicles for sampling environments where the setup of a static sensor network may not be viable. In this study, a mobile robot cart with a low-cost PM sensor (AAQRL-ROBOPM ©) was developed to map spatial PM distributions over time. The robot can be moved either manually via Bluetooth inputs from an Android device, autonomously by following preprogrammed instructions, or with basic artificial intelligence (AI) and an algorithm. PM concentration readings are sent to the Android device for monitoring and storage. The mobile sensor module was tested for both indoor and outdoor environments, and effectively found the locations of the highest PM concentrations. Using such a device has advantages over a sensor network, such as lower overall cost and lesser complexity of setup. This mobile sensor module provides a more cost- and timeefficient method of finding PM hotspots. Once hotspots are located in the sampled environment, static sensors can be placed for the greatest effectiveness in measuring PM concentration over time. Furthermore, the mobile sensor module was manufactured with low-cost components, making it broadly affordable.

Oral Presentation
Walking Parameter Estimation Through Wearable Sensor Data Fusion

Noel Csomay-Shanklin
Aaron Young, PhD (Mechanical Engineering)

Currently, advanced robotic prosthetic and exoskeleton devices have individual low-level control loops for each ambulatory mode, such as level ground, ramp, and stair walking, and no intelligent way to automatically switch between them. There is a strong need for a high-level control loop which can inform robotic assistive devices about a user's intent in real time while they are walking. My research is centered on creating a large repository of biomechanics data that captures how able-bodied subjects walk in these various ambulatory modes, as well as on exploring methods of feature extraction, feature selection, and learning on collected sensor data. We have shown a high level of success in accomplishing the goal of finding correlations between intrinsic sensor measurements, such as joint angle, or gyroscope values, and important walking parameters of the subject, such as walking speed, gait phase, and ambulatory mode. Understanding these correlations will provide useful information about which subsets of sensors are needed in order to estimate attributes of the user's ambulatory modes with high accuracy. Moving forward, these concepts can be implemented on physical robotic assistive devices in order to develop a high-level strategy to switch between low-level control loops, effectively allowing these devices to be intelligent enough to recognize and adapt to changes in walking modes.

Oral Presentation
Biological Transistors to Combat Antibiotic Resistance

Isabel Curro
Gabriel Kwong, PhD (Biomedical Engineering)

Antibiotic resistant infections along with the lack of newly developed drugs have become a threat to public health. Classifying the mechanisms of antibiotic failure has led to the development of new treatment strategies for killing bacteria. Among the currently described mechanisms – which include resistance, persistence and tolerance – we propose defiance as a form of antibiotic failure specific to prodrugs. As a prototypic bacteria-activated prodrug, we construct cationic antimicrobial peptides (AMP), which are charge neutralized until activated by a bacterial protease. Despite prodrug treatment eliminating the vast majority of bacteria populations, we observe defiant phenotypes that survive exposure to identical drug concentrations and durations. Using a multi-rate kinetic feedback model, we show that bacteria spontaneously switch from susceptibility to defiance under disease-related physiological conditions (e.g., hyperthermia, downregulated protease expression). From this model, we derive a dimensionless quantity (Bacterial Advantage Heuristic, BAH) – representing the competing rates between bacterial proliferation and prodrug activation – that perfectly classifies bacteria as defiant or susceptible across a broad range of conditions. By recognizing that the switch from susceptibility to bacterial defiance under prodrug treatment behaves analogously to electronic transistors, we construct biological logic gates (e.g., AND, OR, NOT, etc.) to allow assembly of an integrated 3-bit autonomous circuit that universally kills defiant bacteria under all possible combinations of BAH values. Here, we study a form of bacterial resistance specific to prodrugs, which reveals universal treatments strategies that can be implemented with biological circuits.

Poster Presentation # 098
Characterizing the Dynamics of Macrophage Signaling and Polarization

James Forsmo
Levi Wood, PhD (Mechanical Engineering)

Macrophages are a subset of white blood cells which serve as one of the first lines of defense in the immune system. Their primary function is to combat infection by engulfing pathogens through a process known as phagocytosis. During the course of the host's response, macrophages polarize to different states, where they promote or resolve inflammation by secreting signaling molecules, i.e. cytokines. Macrophages first polarize towards a pro-inflammatory (M1) state, marked by increased inducible nitric oxide synthase (iNOS) expression. Then, to resolve inflammation, macrophages enter an M2 state, marked by Arginase-1, in which they upregulate proteins involved in tissue repair and remodeling. The relevance of macrophage polarization to a diverse range of serious health issues, such as Alzheimer's Disease, suggests that it may be an attractive target for therapy. However, the tightly-regulated and temporal nature of macrophage polarization poses challenges for developing methods to modulate their phenotype which do not interfere systemically with normal immune response. This project investigates the dynamics of macrophage polarization in response to different stimulation strategies, i.e. stimulation combination and duration. By defining the dynamics of stimuli input and activation-output, we can build a data-driven model of macrophage polarization and predict how to optimally achieve the desired set point. We have shown that M1 polarization cannot be sustained indefinitely by re-stimulation, and that these dynamics vary between 2D and 3D culture platforms. Preliminary results have also demonstrated that macrophage polarization exhibits hysteresis when stimuli are switched from M1 to M2 or vice versa.

Oral Presentation
Tracking and Quantifying Caenorhabditis Elegans Behaviors in Microfluidic Devices

Seraj Grimes
Hang Lu, PhD (Chemical and Biomolecular Engineering)

Caenorhabditis elegans has served as an ideal model organism

for investigating the impact of genetic networks on behavior and learning, and microfluidic devices have recently offered the opportunity to observe animal locomotory behavior in stable chemical environments. This project aims to utilize such behavioral data to characterize the long-term navigational and decision-making strategies employed by C. elegans. Evaluating long-term navigational strategies requires maintaining each animal's identity throughout occlusions and collisions with other animals; however, current tracking algorithms are not capable of maintaining correct animal identities. Although there have been attempts to resolve identity classification via automated algorithms, current methods suffer from switching or losing correct animal identities for situations with many freely moving animals over a timescale of several minutes. Consequently, there is a need for a method of video annotation that is both accurate and sufficiently fast to gather single animal behavioral parameters for a more thorough understanding of how genetic variation affects subtle behaviors upon learning. To address this need, I am testing and optimizing a MATLAB graphical user interface application that enables accelerated manual video annotation for worm tracking. In optimizing the GUI, I have developed a module to ensure that there is consensus in resolving collisions amongst different users of the software. I have also created a new mechanism for the GUI to select worms for tracking in an unbiased manner. Moving forward, I will develop new behavioral parameters that quantify animal movement for the purpose of capturing differences in behaviors between C. elegans genotypes.

Poster Presentation # 087
Electric Field Sensor Design for Longwave Radio Reception

Baris Gurses
Morris Cohen, PhD (Electrical and Computer Engineering)

A novel electric field sensor is presented to detect longwave radio waves (<500 kHz) with an ideal sensitivity of 6.8 nV/m(Hz)-1/2. A magnetic field version already exists, known as the AWESOME instrument, which is deployed worldwide for ionospheric remote sensing, lightning geolocation, space weather monitoring, and more. We present here the electric field companion, including design and performance characteristics of the electric field sensor as well as longwave sensor design considerations. We also describe extended applications of AWESOME enabled by combining magnetic and electric field sensors.

Poster Presentation # 099
Microsensors with Nanostructured Surfaces Fabricated by 3D Lithography

Biya Haile
Oliver Brand, PhD (Electrical and Computer Engineering)

The main goal of the project is to modify the surfaces of the (silicon-based) microsensors with 3D-printed nanoscale features to ultimately have sensing films that combine high sensitivity and short response time. Thereby, high-surface-area, nano-structured sensing films are a way to improve response times while still providing sufficient sensor sensitivity. The 3D nanoscale features are achieved using the Nanoscribe Photonic Professional GT, a commercial 3D lithography system with sub-micrometer resolution based on 2-photon polymerization. This technology is able to write arbitrary-shaped 3D patterns with a high resolution into a solvent-free photoresist (UV light-sensitive polymer). The 3D lithography system is located in the Institute for Electronics and Nanotechnology Organic Cleanroom, which is a Georgia Tech shared-use cleanroom facility. In the project, the 3D direct-write lithography system was used to write high-surface-area nano-patterns, such as nano-cylindrical pillar arrays, directly on the sensing surfaces of silicon-based hammerhead resonators. A main goal of the project is to identify the optimal process parameters such as the height and diameter of the nano-cylindrical pillars, the laser power, scan speed, hatching, and slicing pitch, as well as the photoresist developing procedure, all of which directly affect the overall integrity of the written 3D structure. Finally, one of the challenging parts of the project is to write 3D nano-patterns directly onto already fabricated micro-sensors, rather than on standard blank, un-patterned substrates, such as a silicon wafers or glass slides.

Oral Presentation
3D Carbon Nanostructures

Biya Haile
Jungkyu Park, PhD (Mechanical Engineering at Kennesaw State University)

3D carbon nanostructures that are comprised of carbon nanotubes and graphene are expected to accelerate the development of future electronics such as wearable devices and flexible electronics because of their exceptional mechanical strength and stiffness. Electrical and thermal properties of carbon nanotubes are still being examined, but the initial studies of thermal conductivity, for example, show very promising results for the material. Being able to form 3D carbon structures form carbon nanotubes is of great importance so many industries can take advantage of the promising material properties. However, the 3D carbon nanostructures that have been synthesized so far are limited to vertically or radially aligned carbon nanotubes with one or two graphene layers or randomly arranged carbon nanostructures without homogeneously repeated patterns. Therefore, the development of new types of 3D carbon nanostructures that provide structural stability and mechanical strength, and the development of mechanical and thermal characterization techniques for such materials must be an important research agenda for the next decade. In this research, a novel synthesis method that involves nanoscale 3D printing is developed to produce 3D carbon nanostructures with sp2 bonds. Nanoscale 3D printing provides a great degree of freedom for the geometries and patterns of 3D carbon nanostructures. Once a photoresist 3D structure is patterned,

non-carbon species, such as oxygen and hydrogen, are boiled off, leaving amorphous carbon nanostructures. The generated amorphous carbon nanostructures are transformed again to 3D carbon nanostructures with pure sp2 bonds by the help of Ni-assisted diffusion process. This study is to explore methodologies to fabricate 3D carbon nanostructures with repeated patterns to create a multi-layer structure. The viability of potential methods will be examined through the fabrication and testing of carbon nanostructures in controlled electronics and nanotechnology laboratory environments.

Oral Presentation
Selection of Reaction Wheels for the Tethering and Ranging Mission of the Georgia Institute of Technology (TARGIT)

Abhijit Harathi
Brian Gunter, PhD (Aerospace Engineering)

The Tethering and Ranging Mission of the Georgia Institute of Technology (TARGIT) is a CubeSat mission in development at Georgia Tech's Space System Design Laboratory. The mission's objectives are to image a tethered inflatable target with a miniaturized LiDAR camera and to autonomously track this target out to a range of 5 to 10 kilometers once it detaches from the main satellite. The Attitude Determination and Control Subsystem (ADCS) must maintain pointing accuracy on the order of tens of arcseconds to maintain tracking as the target drifts away. To achieve this level of pointing accuracy, the spacecraft was designed with a three-axis reaction wheel control system. This presentation covers a reaction wheel trade study incorporating fine pointing requirements, torque requirements, cost, power consumption, size, and other constraints. The ADCS configuration chosen to meet the TARGIT mission objectives is then described. In addition, development towards testing flight software code on hardware is described to provide insight on interfacing with different ADCS components.

Poster Presentation #076
Designing a Zika Virus Vaccine by Glycoengineering Protein Antigens

Vivek Hariharan and Shruthi Murali
Ravi Kane, PhD (Chemical and Biomolecular Engineering)

Zika outbreaks have been associated with a large increase in cases of microcephaly and Guillain-Barré syndrome. To date, there is no vaccine, antiviral drug, or other modality available to prevent or treat Zika – emphasizing the present need for a vaccine. Recent vaccine efforts have been focused on the Zika virus envelope protein (ZIKV E protein), which plays an important role in viral attachment and entry into host cells. The ZIKV E protein is composed of three spatially distinct structural domains (domain I (DI), domain II (DII), and domain III (DIII)). Previous research has shown that DIII is involved in receptor binding and elicits neutralizing antibodies. Researchers have recently characterized the epitopes for three distinct antibodies that target DIII: ZV-67, ZV-48, and ZV-2; only the epitope for ZV-67 was accessible in the context of the virion and only ZV-67 neutralized ZIKV in vivo. Thus, the goal of this study is to design an antigen that focuses the immune response on the ZV-67 epitope on DIII and effectively elicits antibodies that neutralize ZIKV. To achieve this goal, we propose to tune the glycosylation of DIII. Glycans can be used as an antigen-modifier to direct the immune response away from or to a specific region of a protein. We hypothesize that shielding non-neutralizing epitopes on ZIKV DIII by glycosylation may direct the immune response towards the ZV-67 epitope to elicit more neutralizing antibodies.

Poster Presentation # 100
Parallel Wrist Mechanism

Henry Hellstrom
Frank Hammond, PhD (Mechanical Engineering)

A three degree-of-freedom wrist mechanism was designed, prototyped, and fabricated. The mechanism has two degrees-of-freedom, pitch and yaw, in parallel and the third, roll, in series. The wrist mechanism was developed for the purpose of teleoperation and automation of dexterous micromanipulation tasks, such as suturing, microcontroller assembly, as part of a larger bimanual manipulation project. The mechanism was prototyped using foam core. A second iteration was developed, and optimization techniques were applied to maximize the range of the pitch axis. The second iteration was prototyped using additive manufacturing. A final wrist mechanism was fabricated and integrated with the larger manipulator.

Poster Presentation # 085
Domestic Wastewater use in Hydroponic Agriculture

Wiley Helm
Yongsheng Chen, PhD (Civil and Environmental Engineering)

Traditional agricultural systems are stretching the limits of sustainability. Over 50% of the America's fruit and vegetable supply is produced in California. To maintain this centralized agriculture system stake holder resources are invested into limited water supplies to combat droughts, greenhouse gas emissions through cross country produce transportation, harmful pesticides and fertilizers that can infiltrate into natural water resources. This project aims to alleviate this resource burden by synchronizing domestic wastewater treatment and hydroponic agriculture into closed loop systems, specifically in urban environments where domestic wastewater infrastructure is abundant but agricultural systems are not. Supporting objectives include 1) confirming that produce growth rates and quality don't diminish compared to commercial practices, 2) confirming that chemical contaminants don't accumulate in the produce, 3) confirming that the produce is pathogen free, 4) reducing domestic waste water treatment costs by using the

latest in energy-positive treatment technology, 5) developing a sustainable food, energy, and water loop using modelling approaches that minimize investments in domestic wastewater agricultural systems while maximizing their utility, 6) developing a veteran workforce to help operate domestic wastewater agricultural systems, and 7) guiding local policy to provide sustainable and long-lasting solutions to conserve our precious nutrient and water resources.

Poster Presentation # 077
Evaluating Transport and Intracellular Uptake of a Protein Nanocarrier in 3-D Tumor Spheroids

Hannah Howard
Julie Champion, PhD (Chemical and Biomolecular Engineering)

The delivery of therapeutics into cells could open many treatment options for various diseases such as cancer and neurological disorders, but these intracellular targets have been considered largely "undruggable" by small-molecule drugs that penetrate the cell membrane. Delivery of antibodies directly to these targets would allow for more specific interaction with intracellular proteins, but intracellular antibody delivery remains an issue. To combat this, our lab has developed the Hex carrier, which can bind up to 3 antibody Fc regions per carrier and deliver them intracellularly. Previously, I have shown that HeLa cells treated with Hex-bound fluorescently labeled rabbit Immunoglobulin G (IgGRb) show a statistically significant increase in intracellular florescence compared to treatment with soluble IgGRb. To further expand on previous studies of uptake in 2-D cell culture systems, the evaluation will be extended to a 3-D tumor spheroid model. 3-D multicellular spheroids are very common models used to evaluate nanoparticle delivery, as they better mimic actual tumor behavior. This allows for a more realistic assessment of nanoparticle transport and uptake. Confocal microscopy will be used to evaluate transport of the Hex-IgGRb complex across the extracellular matrix; additionally, the intracellular uptake of fluorescent IgGRb will be assessed by flow cytometry to confirm that intracellular delivery is maintained in a complex, 3-D system. If the delivery behavior of Hex is consistent in a 3-D tumor spheroid, it will provide further evidence for improved intracellular delivery of antibodies by the Hex carrier and motivation to test this carrier in animal tumor models.

Poster Presentation # 101
Validation of Tissue Compliance Tester for Clinical Assessment of Tissue Health

Muhammad Anmbus Iqbal
Sharon Sonenblum, PhD (Mechanical Engineering)

Prolonged durations of sitting cause compression in buttocks, back and thighs that can result in tissue damage. Especially vulnerable populations are elderly people and patients with Spinal Cord Injury (SCI) who are unable to stand or walk, cannot remove compressive load from the body tissue, and may have impaired physical sensation. There is a need to determine tissue health and identify subjects at risk of tissue damage. Typical diagnosis techniques are visual observation or palpation (i.e. directly touching the tissue). This is subjective, as observations can vary from physician to physician. Therefore, the goal of this project is to create a method of measuring tissue properties accurately and consistently. Several devices already exist that measure the force-displacement relationship of bodily tissues, but most are costly ($5000), complex, and still require experience to operate correctly. Our proposed model uses simplistic technology and inexpensive components (<$100) to appeal to a much larger market. The design comprises a hand-grip, cylindrical body, load cell, three force sensitive resistors (FSRs), and several removable plastic probes of various lengths. Longer probes require higher force to fully indent the tissue. Force and displacement data are collected and used to calculate tissue stiffness and compliance values. Initial prototypes are under evaluation using a benchtop calibration jig, materials-testing machine, and compliant gel models of bulk tissue. The device must yield a repeatable and unique stiffness value for each test substance. We postulate that the validated device will likewise be capable of differentiating between healthy and at-risk tissue.

Oral Presentation
Modeling the Performance of Urban Air Mobility in the Atlanta Metropolitan Area

Ayush Jha and Nathan Wang
Brian German, PhD (Aerospace Engineering)

With advances in battery technology, electric-powered aircraft designs have become a feasible field of research for the purpose of low-cost and time-effective transportation of people and cargo within urban sprawls. With growing research in the field of Urban Air Mobility (UAM), there is a need for a better understanding of their integration into current urban infrastructure and transportation systems. Due to the congestion of urban environments, the interaction between existing transportation systems and UAM is unavoidable and hence is necessary to be modeled. For this, a case study modelling a fleet of electric Vertical Takeoff and Landing (eVTOL) vehicles serving as an alternative transportation network is performed on the Atlanta metropolitan area. This project aims to provide a realistic agent-based model of the city driven by a fully dynamic demand and supply model built from socio-economic data as well as land-use and building information gathered from the U.S. census. In this work, we use Multi-Agent Transport Simulation (MATSim) to analyze the system-wide urban transport performance of Atlanta and evaluate the effects of eVTOL vehicle integration as an alternative transportation method on the city's network.

Poster Presentation # 060
Live Imaging of Microtubule Dynamics in Activated Platelets

Caroline Kajzer
Wilbur Lam, PhD (Biomedical Engineering)

Platelets play an integral role in the clotting cascade when a vascular injury is inflicted on the human body. The platelet cytoskeleton, specifically physical changes in the microtubule network, drive many of the major structural changes within platelets in order to allow for aggregation and clot formation. A wide variety of biochemical and biophysical cues are known to influence platelet activation and microtubule morphology. Yet, the process by which microtubules regulate platelet activation, contraction and aggregation, is still somewhat unknown. By mapping out microtubule dynamics under a variety of micro-environments containing these biochemical and biophysical cues, we ultimately intend to better understand the pathophysiology of various clotting disorders such as Wiskott-Aldrich syndrome (WAS) and Grey Platelet syndrome. In this experiment, platelets are isolated from whole blood and examined using live-confocal imaging along with 20-minute interval confocal scans to trace and define the different "stages" of microtubule morphology under a variety of agonists (fibrinogen, collagen, and thrombin) and inhibitors (ROCK I and ROCK II). Visual timelines of microtubules have been constructed to clearly demonstrate the change in microtubule morphology with respect to time and specific biophysical and biochemical environments. Finally, additional fluorescent dyes were used to identify how other platelet characteristics, for example, phosphatidylserine and integrin exposure, is directly affected by the changing microtubule morphology. These characteristics were then used to further qualify the different "stages" of microtubule dynamics. Our ultimate goal is to use these findings to potentially identify novel biomarkers for various platelet disorders.

Poster Presentation # 088
A Musical Application for the FPAA" to "Audio Classification into Musical Tones Using Mixed Signal Processing

Justin Kelley, Evelinth Cuero, and Saiharshith Kilaru
Jennifer Hasler, PhD (Electrical and Computer Engineering)

This paper presents the Field Programmable Analog Array (FPAA), a device which combines analog and digital configurable blocks into a single system-on-chip (SoC) interface. This device can be used to carry out a number of audio and signal processing applications via both analog and digital computation with energy usage up to 1000x lower than that of digital circuits. This work begins to explore a circuit design for the FPAA which converts raw audio input into sheet music. This proposed circuit design will achieve this conversion via repeated bandpass filtering into various frequency bands, max amplitude detection among those frequency bands, and VMM + WTA classification into tones based on the data collected. The resulting tones will be displayed on an Android application which interfaces with the FPAA.

Poster Presentation # 061
The Effect of Motor State on Intracortical Circuits in the Human Brain After Stroke

Maria Krakovski
Michael Borich, PhD (Biomedical Engineering)

Stroke is a leading cause of disability in the United States.1 Previous studies have associated plastic changes post-stroke to the downregulation of the motor cortex's inhibitory circuits3. Further studies tested inhibition on relaxed hand muscles and saw diminished intracortical inhibition in the affected hemisphere, whereas normal levels in the unaffected hemisphere.3The purpose of the present study was to investigate the effect of active muscle contraction on intracortical circuits in individuals with stroke, using motor evoked potentials (MEPs) to measure corticomotor excitability. In the study, eight individuals with history of a subcortical stroke and four neurologically intact individuals were recruited and tested. Participants underwent transcranial magnetic stimulation (TMS) to stimulate motor activity. Short intercortical inhibition (SICI) and intracortical facilitation (ICF) were measured using TMS to analyze the inhibitory and excitatory circuits in the brain, respectively. Muscle activity was measured with electromyography (EMG) and MEPs were assessed from the electrodes placed over participants' leg muscles. Preliminary results showed no SICI effect in either participant group. ICF levels were greater in the stroke group than the neurologically intact group in the resting condition; however, no ICF effect was present in the active condition. It was expected to see reduced SICI measurements in stroke participants, compared to neurologically-intact, as previous studies have suggested loss of inhibitory function post-stroke. A greater ICF response in the stroke group suggests an increased level of cortical excitation in motor cortex when stimulated in the absence of active muscle contraction. More data collection is intended to support the conclusions.

Poster Presentation # 089
Fourier Expansion of Periodic Orbits and Elimination Theory in Dynamical Systems

Kshitij Kulkarni
Erik Verriest, PhD (Electrical and Computer Engineering)

The subject of the research is dynamical systems theory. Periodic orbits (defined for flows as $ft(x) = ft+Tp(x)$, where Tp is the period) are central objects in systems theory because they represent trajectories that close in on themselves, thereby providing motion that recurs. The work consists of theoretical derivations in dynamical systems and modeling and simulation of various systems to predict convergence properties of approximate solutions to the problem of finding periodic orbits. Specifically, the problem statement is as follows: consider a two

dimensional state space with state variables xi and eta. Given the existence of a periodic orbit in this system, we expand the state variables into Fourier series, and consider the polynomial generated by the series under the transformation u = cos(t) and v = sin(t), with all frequencies reduced to powers of u and v. We show approximate solutions to truncated Fourier series and demonstrate the reconstruction of the state from the Fourier series for the van der Pol oscillator. A problem encountered by the researchers is that not every Fourier series arises as the result of an expansion of a dynamical system's state variables, so the general problem is not considered. Examples are shown with intersecting (cross-over) periodic orbits. Finally, Taylor approximations to the harmonic oscillator are also considered as alternatives to Fourier series.

Oral Presentation
Effects of Serum on Nanoparticle-Mediated Photoporation for Intracellular Drug Delivery

Eunice Lazau
Mark Prausnitz, PhD (Chemical and Biomolecular Engineering)

Intracellular delivery of therapeutic and diagnostic molecules is restricted by the cell membrane. Often, an endocytic route is used to transport molecules inside cells, but this can render these molecules inactive due to pH changes. Nanoparticle-mediated photoporation offers a physical route to create transient pores allowing uptake of foreign substances by cells while maintaining cell viability. Through near-infrared laser irradiation, nanoparticles absorb and dissipate energy to the surroundings, thereby vaporizing water to create steam bubbles. The media in which the cells are suspended are expected to provide necessary nutrients to keep the cells viable during and after laser exposure. However, this suspension media can also influence photoporation efficiency. In order to translate this platform drug delivery technology for in vivo use, this study focused on the effects of serum on photoporation. Experimental results revealed 75% less loss of cell viability during laser irradiation at high fluence when cells were suspended in media containing 10 (v/v)% serum, leading to a higher percentage of cells with molecular uptake. Possible properties of serum were investigated to see if they were responsible for serum's ability to preserve cell viability during laser exposure. Results suggested that viscosity and surface tension changes were not responsible for the observed viability preservation. Additionally, polymers such as Pluronic F127 (a surfactant) and PVP were also able to preserve cell viability. This indicated that viability preservation provided by serum is likely caused by physical rather than biochemical response induced by serum cell interaction.

Poster Presentation # 062
Discovering Potential Combinational Treatments of Amyotrophic Lateral Sclerosis (ALS) Using a Computational Model of G93A Mouse

Albert Lee
Cassie Mitchell, PhD (Biomedical Engineering)

Amyotrophic Lateral Sclerosis (ALS) is a fatal neurodegenerative disease characterized by motor neuron degeneration in the brainstem, spinal cord, and cortex which leads to muscle paralysis, dysphagia, respiratory distress, and ultimately death. Previous studies investigating the underlying cellular mechanisms of the disease have revealed a multitude of factors contributing the disease progression. Several highly interrelated categorical disturbances influencing ALS disease progression have been identified, ranging from axonal transport defects to proteomics. Thus, we hypothesized that ALS needs carefully timed combination treatments due to its underlying complexity. Efficient screening of potential combination of treatment requires an in-silico model of ALS pathophysiology. We utilize a new math modeling method called dynamic meta-analysis (DMA) to construct a time based dynamic model with using global optimization and unsupervised learning. In present study, we develop an in silico model of WT mice to visualize age-matched, multi-scalar homeostasis, laying a foundation for comparative pathophysiology and treatment prediction. Using the same computational methods that were used to construct WT model, the ALS mouse model will be constructed. By comparing these two models, we will be able to study the etiology of ALS and determine which physiologic parameters should be modulated and when in order to stabilize the ALS system and halt progression. Present results illustrate a mathematical instability in the ALS model. Comparisons with the homeostatic wild type model could provide promising treatment targets to re-stabilize ALS as a physiological system.

Poster Presentation # 063
Modulating Stem Cell Adhesion and Proliferation on PEG-Based Hydrogels for Scale-up of Cell Therapeutics

Matthew Levy
Johnna Temenoff, PhD (Biomedical Engineering)

Due to their ability to secrete bioactive factors, mesenchymal stem cells (MSCs) have been shown to reduce symptoms in various disease states [1]. However, methods of MSC expansion have not yet been optimized and improving cell yield and potency could decrease expensive manufacturing costs [2]. Biomaterial culture substrates offer a promising method of cell conditioning by providing sustained environmental cues to influence proliferative capacity [2]. Thus, substrates with tunable mechanical and biochemical properties can be used as culture surfaces to improve scale-up of highly-potent MSCs. We used a poly(ethylene-glycol) (PEG)-based hydrogel system with adjustable stiffnesses and adhesive ligand presentation to

improve adhesion and proliferation of MSCs on these surfaces. Modification of stiffness was achieved by varying weight percent and molecular weight of PEG, leading to substrates with moduli of 100 and 30 kPa, as measured by compression testing. Ligand presentation changes were achieved by incorporating peptide sequences, such as glycyl-arginyl-glycyl-aspartyl-serine (RGD), cyclic RGD (cRGD) and isoleucine-lysine-valine-alanine-valine (IKVAV) into the hydrogel network. MSCs cultured on various substrates were quantified after 24 hours and 4 days, measuring adhesion and proliferation, respectively. Increased adhesion was seen on 100 kPa substrates formulated with cRGD and IKVAV relative to RGD or cRGD-only gels. More differences were seen on hydrogels with different stiffnesses, with 30 kPa substrates of all formulations exhibiting lower cell proliferation versus standard tissue culture substrates. In conclusion, hydrogel surfaces with tunable stiffnesses and adhesive ligands can improve the adhesion and proliferation of MSCs. Further improvement of these qualities could lower the cost and enhance potential MSC-based therapies by improving the scale-up of potent MSCs. References: 1. Madrigal, M., Rao, K. S., & Riordan, N. H. (2014). A review of therapeutic effects of mesenchymal stem cell secretions and induction of secretory modification by different culture methods. J Transl Med, 12, 260. doi:10.1186/s12967-014-0260-8 2. R.M. Samsonraj, et al., Concise Review: Multifaceted Characterization of Human Mesenchymal Stem Cells for Use in Regenerative Medicine, Stem Cells Translational Medicine, 2017, 6, 2173-2185. 3. Abdeen, A. A., & Saha, K. (2017). Manufacturing Cell Therapies Using Engineered Biomaterials. Trends in Biotechnology, 35(10), 971-982. doi:https://doi.org/10.1016/j.tibtech.2017.06.008.

Poster Presentation # 078
Investigating the Effect of Neurotransmitter Mutations on C. elegans Whole-Brain Dynamics

Jenni Li
Hang Lu, PhD (Chemical and Biomolecular Engineering)

Neurons are connected by chemical neurotransmission to form circuits that receive signals and control behavior through neurotransmitters such as serotonin and dopamine. Since studying whole-brain dynamics is highly dependent on advanced microscopes and other recent developments, previous works only showed how a limited set of circuits are affected by abnormal neurotransmissions. The effects of abnormal neurotransmission on the whole-brain dynamics are still unexplored. In our project, we aim to study how neurotransmitter mutation affects the whole-brain dynamics in C. elegans. C. elegans is a useful organism to study for our project because it has only 302 neurons but uses almost every neurochemical found in the vertebrate brain, and it is possible to simultaneously record most neurons' activities. We have marked the specific circuit of neurons that use the neurotransmitter with a different fluorophore than the other neurons for identification purposes. The whole-brain dynamics and behavioral activities of strains with monoamine neurotransmitter mutations will be compared with that of wild-type C. elegans to identify how neurotransmitters affect whole-brain activities. Studying the effect of neurotransmitter mutations on C. elegans whole-brain dynamics is beneficial for better understanding human diseases such as Parkinson's, depression, and Schizophrenia's that are caused by an imbalance between different neurotransmitter systems.

Poster Presentation # 064
Synchronizing Visual and Near Infrared Spectroscopy for Material Classification

Siyan Li
Charlie Kemp, PhD (Biomedical Engineering)

We present a novel way of combining computer vision and spectroscopy in material recognition. Most current computer vision models suffer from heavy reliance on image context, which can fail if the material's context is not present in the training dataset. On the other hand, spectroscopy is a very localized measurement. Using pixel level material classification, we show how visual and near infrared spectral data can be combined to accurately recognize the various material labels for objects comprised of multiple materials.

Oral Presentation
A 3D Bioprinted Glioblastoma Cancer Model for In-Vitro Tumorgenesis and Drug Screening

Bryanna Lima
Vahid Serpooshan, PhD (Biomedical Engineering)

Glioblastoma (GBM) is the most aggressive and frequent form of brain cancer in adults, however scientists have yet to find a cure because current in-vitro culture systems do not accurately mimic the tumor microenvironment in the brain. These systems involve 2D monocultures, which don't allow for extracellular matrix interactions in 3D like there are in the brain. The objective of this study is to 3D bioprint a complex cancer model (CM) that can replicate an in-vivo environment for GBM, which can be used for more accurate drug development research. 3D bioprinted constructs were printed using gelatin methacrylate (gelMA) and pluronic as a sacrificial material. The pluronic was dissolved post print to create channels and a sphere in the center, mimicking vascularization and allowing space for the cancer to grow. The constructs were co-cultured by seeding with human umbilical vein endothelial cells (HUVECs) and an extracted rat glioblastoma cell line, MES1861. The models were analyzed between 2-14 days using alamarBlue cell viability reagent to determine proliferation. Preliminary findings show the models with HUVECs alone and models with a co-culture of HUVECS and MES1861 had significant cell viability, showing their functionality. Ongoing research focuses on analyzing cellular markers for tumorigenesis and cell phenotype. Future research will include creating a dynamic environment for the construct, comparing native tumors to those grown within the 3D bioprinted CM, and using human glioblastoma cell lines.

Poster Presentation # 065
3D Bioprinted Hemodynamic Flow Models of the Developing Heart to Study Congenital Heart Disease

Kevin McCoy
Vahid Serpooshan, PhD (Biomedical Engineering)

Hypoplastic Left Heart Syndrome (HLHS) is a congenital heart defect (CHD) characterized by the underdevelopment of the left side of the heart structure, including the ventricle, aorta, aortic valve, and mitral valve. Although the condition is prevalent in less than 4% of all heart related birth defects, it accounts for a disproportionate, 20-25%, of CHD related mortalities. Hemodynamics, the study of blood flow mechanics, can be used to better understand the etiology of heart development and CHDs. We hypothesize that impaired hemodynamic flow and wall shear stress correlate with the underdevelopment of the heart and the onset of HLHS. We will simulate a 3D in vitro cardiac endothelium with human umbilical vein endothelial cells (HUVECs) and subject it to ventricular flows and static (control) conditions. 3D images of fetal hearts, reconstructed from segmented immunohistochemistry analysis, will be prepared using CAD processing programs including MeshMixer and AutoDesk Fusion 360. This 3D model will be printed using clear photoresist resin (rigid and elastic) with a Form 2 Labs 3D printer, and 3D bioprinted using a 10% gelatin methacrylate (gelMA) bioink on the CELLINK BIO X printer. 3D printed constructs will be lined with HUVECs and tested under pulsatile flows. AlamarBlue assays will test cellular metabolic activity and viability, and confocal fluorescent imaging will identify relevant cellular proteins: F-actin (cytoskeleton), connexin 43 (cell-cell connections), and DAPI (nuclei). We expect an alteration in cellular proliferation and morphology of the mimicked cardiac endothelium under impaired hemodynamics unveiling a potential factor in the HLHS onset.

Poster Presentation # 066
Inter-Hemispheric Connectivity of the Mouse Somatosensory Cortex

Megan McDonnell
Garrett Stanley, PhD (Biomedical Engineering)

When the sense of touch is used, many areas are activated in the left and right hemispheres of the brain. Specifically, the transfer of information between primary and secondary somatosensory cortices (S1 and S2) across both hemispheres is essential for sensory perception. However, the precise neuronal organization linking the areas across hemispheres is unclear. Here, we mapped the neuronal projections from specific areas of S1 and S2 to the opposite hemisphere in the mouse brain. We expressed a red fluorescent protein in neurons of either S2, medial S1, or lateral S1 and then imaged their projections using a wide-field fluorescent microscope. Using histological landmarks together with an established atlas of the mouse brain, we determined the anatomical locations of the projections, and used image analysis techniques to compare the density of the S1 and S2 projections. We found that neurons from both S1 and S2 project to the opposite side of the brain mainly within their analogous area (S1-S1 and S2-S2) and that projections reach both superficial and deep layers of cortical tissue. From S1, medial neurons targeted the medial portion of S1 in the opposite hemisphere, while lateral neurons targeted the lateral portion of S1, thus retaining spatial organization across hemispheres. S2 neurons interestingly projected to two discrete locations within S2 of the opposite hemisphere. Altogether, our results revealed the anatomical organization of some neuronal circuits involved in the sense of touch, and can serve as a basis for future experiments measuring brain activity during touch.

Poster Presentation # 067
Informatics-based Literature Mining to Personalize Therapy for Chronic Myeloid Leukemia Patients

Nidhi Mehra, Anish Bikmal, Kaci Hernandez-Kluesner, Prahathishree Mohanavelu, and Mira Mutnick,
Cassie Mitchell, PhD (Biomedical Engineering)

Chronic myeloid leukemia (CML) is characterized by a consistent chromosomal abnormality known as the Philadelphia chromosome, or the BCR-ABL1 fusion oncogene. Tyrosine kinase inhibitors (TKIs) were developed in the late 1990s and have dramatically increased the life spans of CML patients. However, because toxicities and adverse events associated with different TKIs can be impacted by patients' lifestyles and health profiles, questions pertaining patient-centered approaches to CML care remain unanswered. We promote personalized predictive medicine for CML by taking a two-pronged approach. To address the broader field of CML treatments, we develop a relational database through FileMaker Pro used to curate thousands of articles in the published literature related to patient responses to treatments. We apply novel inner-lab biocuration techniques to enter data extracted from the vast volume of published literature related to CML patients' responses to different treatments into the relational database. Additionally, we are conducting a proof-of-concept meta-analysis to use aggregated data, which address whether or not gastrointestinal adverse events are more common with second generation TKIs as compared to imatinib, a first generation TKI. The analytical results using our database infrastructure initial meta-analysis will be followed with more advanced techniques and broader clinical questions to better define toxicity differences between first and second generation TKIs, which will aid in identifying predictive factors for patient responses to different TKIs. Ultimately, we intend to apply machine learning algorithms and natural language processing techniques to the relational database to develop predictive medicine models that implement patient-centered approaches to CML care.

Poster Presentation # 079
Development of a Cell-Free Vitamin B12 Biosensor

Cirstyn Michel
Mark Styczynski, PhD (Chemical and Biomolecular Engineering)

Deficiencies in vitamin B12, a micronutrient necessary to the human diet, afflict up to 15% of the world's population. Diagnosing the deficiency is both cost and time intensive, and so diagnostics are often insufficient to effectively identify those in communities most often at risk. I have been working to meet the need for better B12 diagnostics by using synthetic biology to develop a cost-effective, fast-responding, point-of-care diagnostic tool for the deficiency of vitamin B12. This tool takes the form of a cell-free biosensor composed of genetic circuits that respond to the presence of vitamin B12 by upregulating the expression of a reporter protein, LacZ proportionally to the amount of B12 in the system. The increase of the protein causes the system to change colors through its cleaving of the pigment, CPRG. As such the resulting color will be able to be compared to a standard, similar to a pH test, to arrive at an estimation of serum concentration. This protein expression takes place in a cell-free expression system which consists of the extract of a cell containing the cellular machinery necessary in protein expression. This allows for the majority of the energy of the cell to go towards transcription and translation rather than cell growth, making the system easier to control and optimize. At this point, I have proven the effectiveness of this genetic circuit in producing a dosed response to different levels of B12 in cell-free environment constituting a large step forward in the development of such a test.

Poster Presentation # 056
Simultaneous OH-PLIF and Schlieren Measurements of a Spherically Expanding Flame

Spencer Mickus
Suresh Menon, PhD (Aerospace Engineering)

A significant issue with turbulent flame speed measurements is that the results seem to depend upon the diagnostic with which it is measured, i.e. on the precise measurement location within the flame brush at which the speed is determined as well as line-of-sight averaging effects. Thus, up to to this day, experimental data sets can be compared to one another in most cases only if the same diagnostic technique is used. Previous studies have attempted to develop a constant of proportionality between MIE scattering and Schlieren turbulent flame speed results based on burning mass flux conservation arguments. Although used throughout the literature, this constant has only been proven to exist for a very limited range of experimental conditions and fuels. To improve upon the current state-of-the-art, the proposed experiments will investigate whether a meaningful relationship between OH-PLIF and Schlieren photography results. The main objectives are to investigate whether a constant of proportionality exists, what effects lead to discrepancies between results from the two diagnostics and whether the developed relationship holds over a wider range of conditions and for a different fuel. Thus the equivalence ratio and turbulence intensity are varied for the burning of natural gas-air mixtures. The experimental results will provide insight into the relationship between flame properties derived from different diagnostics and contribute to the fundamental understanding of turbulent flame evolution. Finally, it will shed light on the reliability of methods used for comparison in the past and potentially improve upon said reliability.

Poster Presentation # 080
Porous Matrimid® Support Membranes for Organic Solvent Separations

Emily Moschella
Ryan Lively. PhD (Chemical and Biomolecular Engineering)

Chemical separations processes consume about 50% of the industrial energy in the U.S., which can be reduced by augmenting widely used thermal separations such as distillation with membrane separations. Porous Matrimid® polymeric membranes were developed as supports for thin film composites (TFCs) of polymers of intrinsic microporosity (PIMs) to target organic solvent separations. PIMs have shown to form highly selective membranes and can be thinly coated on porous supports to obtain high permeances (pressure-normalized fluxes) of target solvents. The goal of this work is to develop support membranes that demonstrated excellent stability in organic solvents and sufficient porosity to allow toluene permeances of 60-200 Lm-2h-1bar-1. Polymer 'dopes' (homogeneous polymer solutions) of Matrimid® containing varying compositions of solvent and non-solvent were cast using the phase inversion technique. The resulting flat membranes were then crosslinked to prevent dissolution in harsh solvents. The desired permeance was achieved with a precise control over the dope compositions, casting conditions, and post-processing procedures. The impact of several casting parameters such as co-solvent evaporation time, ambient humidity, and post-processing procedures were studied. Generally, a decrease in permeance was observed as the drying time prior to phase inversion was increased. Average permeance at the optimized dope composition was 76.4 Lm-2h-1bar-1, with a standard deviation of 62.5 Lm-2h-1bar-1. The effect of different crosslinkers on membrane swelling and permeability was quantified, with 1,6-hexanediamine emerging as the most suitable crosslinker. Gas porosimetry was used to determine surface pore size, which was found to generally increase with permeance.

Poster Presentation # 094
Atlanta Police Response Time Analysis

Yuvaneshwar Murugesan, Alexander Bukharin, Joshua Gundugollu, and Swapnil Lad
Yao Xie, PhD (Industrial and Systems Engineering)

The poster reviews the response time of a police officer to the scene of the crime after a 911 call is placed compared to census statistics of the area of origin of the call. The time it takes for a police officer to respond to a 911 call can make the difference in whether or not a crime is prevented. However, there are a variety of factors that can influence the length and variability of police response time. We are studying how household income, education, and other population factors influence the time it takes for the Atlanta Police Department to respond to 911 calls. We began this process by visualizing different population factors with heat maps of Georgia. We used U.S. census data to see the characteristics of each block inside the city of Atlanta and used this to compare against the average response time to each of these blocks. Using linear regression and spatial regression models, we are checking to see if there are any statistically significant trends towards certain areas in the Atlanta area by the police department

Poster Presentation # 068
Subclinical Leaflet Thrombosis in Transcatheter Bioprosthetic Aortic Valves

Priya Nair
Ajit Yoganathan, PhD (Biomedical Engineering)

Transcatheter aortic valve replacement (TAVR) is a recently developed treatment for aortic valve stenosis, a heart valve disease common in the older generation due to years of calcification buildup. A TAVR procedure is less invasive than previous techniques and is an effective treatment for patients with aortic stenosis who are at intermediate or greater surgical risk and cannot undergo open heart surgery. Since the success of this procedure within this population, substantial effort has gone into expanding TAVR to lower surgical risk patients. However, recent evidence has revealed that the procedure can lead to several complications such as paravalvular leak, prosthesis-patient mismatch, and lastly, thrombosis, a condition in which normal valve leaflet motion is restricted by formation of blood clots within the prosthetic valve. Reports indicate that the rate of leaflet thrombosis in surgical bioprostheses is between 0.8% and 4.0%. Thrombosis in the valve can have severe consequences, including strokes, but little is known about what causes its formation. According to the Virchow's triad, a combination of abnormal blood flow, foreign material and blood chemistry can contribute to thrombus formation. Although each of these factors and their contribution to thrombosis have been studied individually, there is no existing unifying study that explores which of these factors is more or less dominant in causing leaflet thrombosis. This study focuses on studying the effect of the stent material, leaflet material, leaflet crimping and regions of flow stasis using a steady flow system to observe their relative effect on thrombus formation in TAVR.

Poster Presentation # 090
Marsupially-Aided Robotic Snake Exploration and Navigation of Cluttered Environments

Joao Matheus Nascimento Francolin, Gabrielle Duva, Alexander Faché, Alicia Mora Valasco, Elizabeth Prucka, and Nelson Raphael
Patricio Vela, PhD (Electrical and Computer Engineering)

In the context of disaster rescue missions, search and rescue (SAR) robots become the eyes and ears of human operators. Their most fundamental objective is competent navigation and traversal through damaged structures or unknown environments in order to capture images, assess structural integrity, and explore areas where victims may be stranded. The environments characterizing these scenarios frequently impose locomotive limitations or reachability constraints on traditionally wheeled and tracked mobile platforms. Other robotic solutions demonstrate potential to overcome these limitations; snake-like robots, in particular, are advantaged in narrow, confined spaces, desert-like terrain and arboreal environments, among others. Integrating both into a marsupial pair yields a robotic system leveraging complementary strengths of both and drawbacks of neither. A Turtlebot is employed as the marsupial carriage, towing larger scale on-board computing and power capabilities as well as a robotic snake. Exploration is approached in a divide and conquer fashion with the Turtlebot expediently exploring navegable areas and the robotic snake navigating more cluttered regions. Each will apply SLAM to map its local terrain during the course of independent frontier exploration; local maps will be periodically unified into a global map. Updated global understanding of the environment then informs a higher-level task planner's potential decision to explore different regions characterized by greater uncertainty.

Poster Presentation # 081
Diffusivity of a Drug Through Ocular Tissue

Lauren Nichols
Mark Prausnitz, PhD (Chemical and Biomolecular Engineering).

Glaucoma is a blindness-inducing eye disease affecting over 3 million Americans, most over age 40. While current treatment options include topical treatments that can decrease pressure in the eye, these treatments are often ineffective, and glaucoma remains an incurable disease. A new method for treating glaucoma has been proposed which would allow the eye to accommodate elevated pressure while protecting the optic nerve from damage. This method uses a drug to stiffen the collagen in the eye to selectively protect the optic nerve from elevated pressure. In order to maximize efficacy, the drug is delivered to the retrobulbar space and must diffuse through the Tenon's

capsule and sclera (collagenous layers of the eye.) In addition, melanin and other proteins in the sclera bind to the drug, slowing the rate of diffusion of the drug through sclera. In order to describe the amount of drug passing through ocular tissue at any point in time, the diffusion constant is needed for equations relating melanin concentration and binding, drug aggregation, and drug concentration with time. Currently, the diffusion constants for similar drugs are known, and experimental methods for determining these values are well-established; however, the diffusivities of the drug used in this glaucoma treatment through sclera and Tenon's capsule are unknown. This research will establish the diffusivities of the drug through the Tenon's capsule and sclera in both pigmented and unpigmented rat sclera in order to optimize treatment parameters and treatment prediction models for applications in glaucoma treatments.

Poster Presentation # 069
The Use of 3D Printing and Bioprinting Technologies to Manufacture Patient-Specific Cardiac Patch Devices

Joy Nish
Vahid Serpooshan, PhD (Biomedical Engineering)

Myocardial infarction (MI) is one of the leading causes of death in the US and necessitates the commitment of billions of dollars to treat and mitigate, resulting in significant stress of the healthcare system. MI arises when a blood clot obstructs flow through part of the cardiovascular system, resulting in decreased nutrient exchange in the tissues downstream of the occlusion. While functional in vivo models of MI, in a variety of animals, have proven useful to develop and test surgical treatments and novel cardiovascular drugs, they are often expensive to create and difficult to standardize, making statistical analysis of research data challenging. Here, we aim at developing a functional in vitro model of MI, using 3D printing and bioprinting technologies, to recapitulate the native cardiovascular tissue. Our proposed workflow generates a high definition heart model using the OsiriX software. The infarct area is then computationally extracted from the MRI data and 3D printed to produce a model that can be used to study the pathology ex vivo. The proposed approach allows for high-resolution reconstruction of the ischemic heart injury. Further, this method can be used to bioprint acellular and cellular cardiac patches using gelatin-methacrylate hydrogel as bioink, to rescue the heart post-MI. By combining high-resolution clinical imaging with 3D printing and bioprinting, this precision medicine approach represents a highly biomimetic patch system with significantly enhanced patient-specificity, consistency and reproducibility, that could save the lives of many patients with severe heart attack.

Poster Presentation # 057
Drone Delivery (D2)

Chima Okechukwu, David Booker-Earley, Yohannes Kasseya, and Jishnu Medisetti
Michael Mayo, PhD (Georgia Tech Research Institute)

What motivates the interest? The drone industry is changing the way most businesses operate. As the cost of the parts become cheaper, more commercial businesses (i.e., Amazon, Google Wing, UPS, Walmart, Uber, DHL) are pushing to use drones as substitutes in traditional methods of operation, mostly in the area of delivery. Our Goal: Design, build and manage an on-campus autonomous drone delivery system. Deliveries would be made from selected drop-off locations to any cleared pick-up location on campus. Target delivery time is under 10 mins. This semester, the main focus is to demonstrate proof of concept of our approach to provide the drone delivery service.

Oral Presentation
Chemically Powered Janus Micromotors For Enzyme Rate Enhancement

Andrew Pan
Todd Sulchek, PhD (Mechanical Engineering)

Enzymes have wide biological applications in biosensor technologies, bioremediation strategies, production of pharmaceuticals, or as therapeutics for disease treatment. Enzyme immobilization onto macro/micro surfaces is typically required for non-native applications. However, enzyme kinetics are negatively impeded when immobilized due to hampered mass transport and distortions of native protein configuration. We report herein a simple method of improving enzyme catalytic activity using a simple Janus micromotor. Janus particles are a special class of nano/microparticles with chemically heterogenous surface chemistry which can be exploited to create particles with spatially confined functionalities. It has been demonstrated prior that Janus particles with enzymes spatially confined to one hemisphere can function as active swimmers in the presence of a compatible substrate through a phenomenon termed self-diffusiophoresis. We hypothesized that this self-actuation could serve to improve the mass transport of the system and allow for "on-the-fly" chemistry to promote enzyme-substrate collision. An SiO2/Pt Janus particle was created and then the enzyme horseradish peroxide was conjugated to the functionalized silica hemisphere using APTES-glutaraldehyde bioconjugation strategy. We used scanning electron microscopy to demonstrate successful creation of Janus particles and hemispherical segregation. A standard ABTS colorimetric kinetic assay was conducted and demonstrated remarkably improved kinetic activity of Janus particle-HRP conjugates compared to non-Janus particle-HRP controls. Thus, Janus micromotors may prove a promising strategy of improving immobilized enzyme catalytic activity and may have potential medical or industrial application.

Poster Presentation # 070
Characterization of Primary Rat Astrocytes: A Step Towards Optic Nerve Head on a Chip

Priyasha Pareek
C. Ross Ethier, PhD (Biomedical Engineering)

The mechanism by which elevated intraocular pressure (IOP) increases risk of glaucoma remains unknown. A proposed pathway suggests astrocytes sense excessive optic nerve head (ONH) deformation due to increased IOP, triggering their transition to a reactive phenotype. Astrocytes are mechanosensitive glial support cells that maintain the matrix that surrounds retinal ganglion cells (RGCs). When reactive, they can promote axonal damage in RGCs, causing progressive vision loss in glaucoma patients. The majority of astrocyte mechanobiology research has been conducted in monolayer culture systems. 2D cultures are problematic because they induce astrocyte activation in the absence of mechanical stimulation and cannot model the main mode of biomechanical strain experienced by the ONH: compression. Limited research completed using 3D culture systems has yielded comparatively lower baseline activation in DiTNC1 cells (an immortalized, brain-derived astrocyte line), making them more physiologically relevant models. Thus, we aim to develop a high-throughput 3D culture system that can be used to elucidate astrocyte mechanotransduction pathways and contribute to the development of accurate in vitro models of glaucoma. We hypothesize ONH astrocytes (type 1a), which have not been previously studied, and are not commercially available, will be required for the successful development of this platform. Towards this end, we have isolated and characterized primary rat ONH astrocytes using immunohistochemistry, and compared the results to DiTNC1 cells. Both cell types stained positive for astrocyte markers connexin-43, glial fibrillary acidic protein (GFAP), and vimentin, and are currently being tested for aquaporin, NCAM, and s100□. Primary astrocytes differed significantly from DiTNC1 cells in size and morphology. With the hope of ultimately developing an "optic nerve head on a chip," our model system will expedite assessment of potential astrocyte-targeted therapeutics, facilitating the identification of alternative and/or complementary treatments to current IOP lowering strategies, while diminishing the need for animal subjects to study glaucoma.

Poster Presentation # 102
Automated Experimentations in Material Science: Intergration of a Nanoindentation Instrument with a Scanning Electron Microscope

Eun Chang Park
Surya Kalidindi, PhD (Mechanical Engineering)

In this research we are designing a universal sample holder that integrate two advance characterization tools, nanoindentation and scanning electron microscope (SEM), in material science field. Nanoindentation is capable of measuring mechanical property of small features inside materials while SEM is used to identify those features in terms of composition and crystal structure at sub-micron scales. Both devices run independently which makes it very difficult to perform indentation on sub-micron features observed in SEM. The result of this project enable researchers to identify interesting features on SEM images and nanoindentation tool automatically locates the same features and run the mechanical testing measurements.

Poster Presentation # 071
Comparison of Compression Modulus and Yield Strength across Different 3D Printing Processes, Materials, and Shapes

Katy Petersen
Scott Hollister, PhD (Biomedical Engineering)

Polycaprolactone (PCL) is a biodegradable polymer that can be used as a biomaterial. Few material properties are known about PCL and mixtures containing it, which is important when deciding which type of mixture or shape is best for a certain biomaterials application. The purpose of the study is to compare material properties across different bioprinting technologies and polymers to make better choices for materials used in the future creation of biomedical devices. Mechanical properties are compared across different types of additive manufacturing, polymers, and shapes. Two different types of additive manufacturing were employed in the creation of the objects tested. The first is Selective Laser Sintering (SLS). Sintering is the process of forming a cohesive, solid mass from particulate matter by heat, without melting, and for this specific printer, layers of powder are sintered together by a precise laser. This requires a specific polycaprolactone (PCL) and hydroxyapatite (HA) mixture, also referred to as a PCL/HA mixture (4%). The second is extrusion-based printing. Extrusion based printing heats up particulates to create a smooth stream of material that is then laid down, layer by layer, in the desired shape. Extruded shapes can be printed with just PCL, or the PCL/HA mixture. Two different shapes have been compared so far – cylinders and rectangular bars. Preliminary results indicate polymer is less impactful than shape in terms of stiffness/resistance to deformation. Next steps include μCT scanning of the surface and cell adhesion tests to determine viability for implantation.

Oral Presentation
Controlling Crystallization of Atomic Layer Deposited TiO2 Thin Films

Robert Petrie
Mark Losego, PhD (Materials Science and Engineering)

The growth of TiO2 by vapor phase atomic layer deposition (ALD) accomplished with Tetrakis(dimethylamido)titanium [(NMe2)4-Ti, TDMAT] as the precursor and water as the co-reactant was studied in detail. Optimized processing times of 0.7 seconds dosing and 5 seconds purging were established for TDMAT and 0.1 seconds dosing and 25 seconds purging

for water in our homemade flow-tube ALD reactor were established through the use of saturation curves to ensure that efficient and true ALD was occurring. Growth rates, refractive index, and crystallographic structure were recorded at these optimized dosing and purging times at chamber temperatures that ranged from 120 °C to 240 °C. The appearance of anatase TiO2 thin films was found to begin at 230 °C. It was discovered that upon extending the purging time of water to 85 seconds, while keeping all other conditions constant with the optimized ALD experiments, that anatase TiO2 would appear in thin films at chamber temperatures as low as 170 °C. No anatase was detected after post annealing amorphous samples at 180 °C, but anatase was detected after 3 hours of post annealing amorphous samples at 200 °C. These results show that surface diffusion of TiO2 into crystallographic anatase positions occurring between ALD cycles allows anatase films to occur at particularly low temperatures, and that bulk diffusion of amorphous TiO2 thin films into an anatase structure will occur but requires higher temperatures.

Poster Presentation # 082
AvrA Protein Nanoparticles as a Wound Healing Agent

Stephanie Pish
Julie Champion, PhD (Chemical and Biomolecular Engineering)

Chronic wounds have a long and painful healing process, primarily due to elevated inflammation, decreased cell proliferation, and lack of effective treatment methods. The therapeutic effector protein, AvrA, has been shown to decrease inflammation in inflammatory bowel disease by inhibiting the Nf-kB pathway, a key pathway in inflammation and wound healing.1 Protein nanoparticles may be useful to deliver AvrA to help alleviate inflammation and increase cell proliferation and migration at the wound site. AvrA is synthesized into protein nanoparticles with bovine serum albumin as a carrier protein by desolvation. First, AvrA is purified using glutathione sepharose affinity chromatography and the final purity of the protein is confirmed in both SDS-Page gels and Western Blots. Additionally, the size of BSA-AvrA nanoparticles is determined using dynamic light scattering and nanoparticle tracking analysis. Finally, the cellular effects of different doses of BSA-AvrA nanoparticles are studied in both HeLa cells and 3T3 fibroblasts. In these cellular studies, cell viability is observed using an MTT assay and flow cytometry. Further research will include the use of a scratch assay with the additions of inflammatory cytokines TNF-alpha and interleukin 17a to properly simulate a wound. BSA-AvrA nanoparticles may be considered a viable wound treatment option following the regulation of TNF-alpha and IL17a levels and promotion of cell migration and proliferation at the wound site.

Oral Presentation
hMSC Sphingolipid Profiles Modulate Exosome Production

Frank Pittman
Ed Botchwey, PhD (Biomedical Engineering)

Our lab has investigated how sphingolipid profiles reflect the metrics of mesenchymal stem cell immunomodulatory potency. Through this work, we have seen differences in certain sphingolipid profiles between low and high potency, measured by IDO activity, human bone marrowderived Mesenchymal Stem Cell (MSC) lots. Specifically, the longchain ceramide and long chain sphingomyelin (SM) sphingolipids show significant differences among low and high potent cells. This implies that the activity of neutral sphingomyelinase (SMase) may be differentially regulated between high and low potency hMSCs. High IDO hMSCs have more ceramide than SM, suggesting higher SMase activity. One of the possible mechanisms for this high potency could be attributed to the increased release of exosomes due to ceramideinduced membrane bending. With this in mind, we sought to study whether exogenous SM could increase the production of exosomes from MSCs and coincide with an increased IDO activity of the cells. In order to test this hypothesis we isolated exosomes from untreated hMSCs and bacterial SMasetreated hMSCs. We ran nanoparticle tracking analysis on these exosomes to determine the concentration of particles found under each condition. We found that in the SMaseenhanced condition, there was an increase in exosome production compared to the controlcondition. This shows that there could be a link between the sphingolipid profiles in MSCs, the exosome production, and ultimately, exosome potency. Data gathered through this project could be a very important link between increasing the IDO activity of hMSCs and increasing their exosome production, with potential for far reaching therapeutic implications of hMSCs. Future studies of this project include characterizing the cargo (growth factors, cytokines, miRNA, etc.)

Poster Presentation # 091
WiPower

Johnathan Radcliff
Joyelle Harris, PhD (Electrical and Computer Engineering)

My research focuses on the problems related to wireless power transfer designed for energy transmission at a distance of at least one meter. The project was created to provide data for the advancement of radio frequency power transfer. Previous research efforts that attempted to develop this technology have run into unforeseen obstacles that have hindered its commercial adoption. This research will yield more information into what can be done to assist wireless power in its future development. To begin producing data, a wireless power system first must be created. The central design element of the transmitter programmed to output a 3.6GHz sine wave,which was then

passed into an amplifier. The receiver circuit was much simpler, consisting of a bridge rectifier circuit to convert the AC signal to DC voltage. A microcontroller programs the frequency synthesizer on the transmitter and reads the voltage and current from the receiver with its integrated ADC. The research is currently still in progress, but the data that has been accumulated shows that transmission is possible but with lower power yields than initially expected. The maximum range of received power was one meter, but because the transmitted voltage and current did not meet the calculated values, the project must have reached one or more of the unknown obstacles in wireless power design. To isolate and learn more about them, the project will be revised into different models of power transfer and be tested for the benefit of future research in this topic.

Oral Presentation
Study the Functional Connectivity of the Brain in Resting State Rodents Using fMRI

Fatma Rashed and Emily Greulich
Maysam Nezafati, PhD (Biomedical Engineering)

Functional magnetic resonance imaging (fMRI) can be used to detect differences in the oxygenation of the blood resulting from the firing of neurons. In order to understand the functional connectivity of the brain, our research aims at mapping the brain based on correlations in this blood oxygen level dependent (BOLD) MRI signal in response to differing conditions using rodents. Using a protocol that our lab developed for resting state anesthetized rats, we aim to vary the conditions that the resting rat is under in order to develop a better idea of the brain's functional connectivity. Extending these results to further studies will allow for a full understanding of the alterations that occur in pathological states, for the ultimate goal of using targeted interventions to restore normal brain activity.

Poster Presentation # 103
Resolving Adhesion Data from AFM

Sharan Ravigopal
Todd Sulchek, PhD (Mechanical Engineering)

Adhesion is an important characteristic of bio-materials to study, and the adhesion data collected from the atomic force microscope can be quite large. The project involves properly finding the deflection values from the plots of adhesion measurement graphs. As the sampling rate of the AFM is about 50kHz, there is a lot of fluctuation between the data points as the time between successive measurements is too small. Therefore, in order to normalize or streamline the data, there were a number of data analysis techniques used from Gaussian distributions, kurtosis measurements to split the data into the useful parts. Also, the maximum deflection for each approach and retraction curve is hard to find qualitatively, so a quantitative perspective of the data would be most useful.

Oral Presentation
Precision T Cell Immunotherapy using pMHC Liposomes for Antigen-Specific Drug Delivery

Anna Romanov
Gabriel Kwong, PhD (Biomedical Engineering)

Classically the immune system is known to identify and target foreign threats, such as viruses and bacteria in the body, but recently immunologists have discovered that immune cells have the potential to eliminate cancer. Killer T cells recognize the receptors of hundreds of cancer cells in our bodies, but they are not always successful in fighting these mutated cells, because tumors suppress the immune response. Current treatment methods, such as chemotherapy, dampen immune activity even further, which is dangerous for patients' ability to fight even the simplest infections. T cell immunotherapy represents a new paradigm in anti-cancer therapy and shows high potential for treating patients with late-stage disease. We designed an antigen-specific drug delivery system, which allows precise delivery to a T cell subset that recognizes and responds to only the desired target. Using reverse phase hydration, we formulated liposomes and functionalized them with pMHC to deliver small molecule drugs to primary murine T cells. Once the liposomes recognize the antigen specific T cell, they bind to the receptor, activate the T cell, and internalize to deliver the drug to the cell. The activated T cells gain effector function, and they kill the target cells. With the possibility of targeting hundreds of different antigens, this method may create a safer mechanism for immunotherapy that avoids unnecessary immune response and toxicity.

Poster Presentation # 104
Stretch Mediated Mechanotransduction by Lymphatic Endothelial Cells

Josephine Rudd
J. Brandon Dixon, PhD (Mechanical Engineering)

Lymphatic endothelial cells (LECs) play a role in mechanotransduction by sensing nearby signals, including functional responses to shear stress and stretch, and relaying these signals to other cells. The lymphatic vessels' response to shear stress and stretch have been documented (Kornuta 2015, Rahbar 2014) but the molecular mechanisms leading to those responses have not been well studied. This project investigates how calcium dynamics and upregulation of proteins in the MAPK pathway in LECs respond to these mechanical forces to better understand how LECs regulate lymphatic pumping in response to pressure and flow. Ultimately, this gives insight into how disruptions in this mechanical response are responsible for the onset and progression of lymphedema. Experimental methods to investigate this aim include designing a microfluidic device to subject cultivated LECs under controlled mechanical shear stress and stretch conditions. The microfluidic device, made of PDMS polymer, has a chemically modified channel in which a confluent monolayer of LECs is grown. The LECs are stretched and flow

is applied using a programmable syringe pump, imaged using a calcium-sensitive fluorophore, and analyzed to quantify the strain distribution in the stretched LECs using image correlation and tracking software. For analyzing the potential changes in the MAPK pathway, a Luminex assay will be used after optimizing a cell lysis protocol. Through the cell culture, device development and testing, and application of shear and stress, this experiment will give more insight into the calcium dynamics and mechanotransduction pathways of LECs.

Poster Presentation #105
Anatomical Influences of Tissue Loading

Davin Seol
Sharon Sonenblum, PhD (Mechanical Engineering)

Deep tissue injuries, or pressure ulcers (PrU), are skin lesions that form primarily due to extended pressure on the sub-surface tissue. Several factors such as time, humidity, temperature, and pressure contribute to deep tissue injury development, affecting the health and well-being of patients. Generally, greater tissue deformation is correlated to higher bio-mechanical risk for PrU development. Wheelchair users are naturally at a higher risk for these injuries due to their lessened mobility and prolonged seated posture. However, there are still many unknowns about who may be at risk, and why. The aim of this study is to establish a research approach for describing the anatomical influences of tissue loading for wheelchair users on a specific foam cushion. Assessing tissue health for PrU susceptibility is difficult, as the skin can be highly sensitive to the poking and prodding of contemporary palpation techniques. Therefore, a non-invasive approach was developed to investigate the tissue properties. The buttocks of 36 participants were scanned sitting on an HR45 (standard foam) cushion using a FONAR MRI. These multi-planar scans were transformed using MATLAB for data analysis. The skeletal loading variations as a function of pelvic tilt and as a function of sacrococcygeal anatomy were investigated. By comparing these measurements, the results indicate that very few wheelchair users sit on muscle, suggesting and supporting the idea that the finite element models depicting muscle under the ischium are not consistent with the actual anatomy of wheelchair users.

Oral Presentation
RL-10-3-3A Rocket Engine Turbopump System Level Design & Optimization Trades

Anish Shenoy and Utkarsh Pandey
David Wu, PhD (Aerospace Engineering)

This study aims to follow a system level design process to recreate a turbopump based on the Aerojet Rocketdyne RL-10-3-3A rocket engine referenced from a NASA engine architecture model in order to sweep performance trade spaces. The design effort is divided into the fuel/oxidizer pumps and the turbine used to power both pumps. The designs of the current two stage centrifugal liquid hydrogen pump and single stage liquid oxygen pump were recreated using general pump design equations while imposing structural and fluid constraints. Two improvements to the pump design are explored: adjustments in blade tip velocity and shaft speed, and an alternate axial pump configuration. The turbine overall performance design was recreated through gas and flow properties given in the NASA engine architecture model. General turbine design equations were used to size the turbine stages, including the nozzles and the rotors. To identify possible areas for improvement in turbine performance, geometry sweeps of flow angles and designs of alternate turbine types are performed. Gas spouting angle of the nozzle and blade angle of the rotor are swept to gauge performance based on flow angles. Also, the design of a single-stage, two-rotor, velocity-compounded, impulse-type turbine is compared with the design of a two-stage, two-rotor, pressure-compounded, impulse-type turbine to study turbine performance parameter trades.

Oral Presentation
Precise Control of Therapeutic T Cells through Thermal Gene Switches

Lee-Kai Sun
Gabriel Kwong, PhD (Biomedical Engineering)

Adoptive transfer of therapeutic T cells has shown promising clinical outcomes in treating cancers that are unresponsive to conventional therapies. T cells engineered to express chimeric antigen receptors (CARs) are capable of recognizing antigens expressed on the surface of malignant cells; however, the permanently active nature of infused CAR T cells can induce a severe inflammatory response that can lead to multiple-organ failure and death. These severe side effects have prevented the full-scale translation of CAR T cell therapies to the clinic. To improve the safety and efficacy of these cell-based therapies, we genetically engineer human primary T cells with thermal gene switches to allow for spatiotemporal control of T cell activity through targeted heating. These thermal gene switches are constructed from the heat shock protein HSPA6 promoter and drive gene expression in response to elevated temperatures representative of mild hyperthermia. First, we characterize switch activity through a reporter gene in response to different heat treatments. Next, we demonstrate that heating does not compromise biological functions of T cells, such as cell proliferation, cytotoxicity, and viability. Finally, we engineer T cells to express anti-CD19 CARs in response to thermal cues and augment their anti-tumor response against human myeloid leukemia. This platform illustrates the potential of cellular engineering to greatly improve the precision of T cell-based immunotherapies for cancer.

Oral Presentation
Enhanced Self-Assembly, Length and Stability of Tobacco Mosaic Virus Nanorods

Ranjani Sundaresan
Yonggang Ke, PhD (Biomedical Engineering)

Tobacco Mosaic virus, the first discovered virus with a 300 nm tube structure, is the ideal template for the deposition and mineralization of 1D and 2D nanomaterials. The manufacture of one form, the Escherichia coli-derived TMV nanorod, shows promise for its ability to produce high yield of mutant TMV protein. However, the process is both slow and highly sensitive to fluctuating pH conditions, rendering the products unstable. The substitution of cysteine at the 1- and 3-sites has been shown to promote self-assembly of TMV-CP subunits into disks and nanorod. In order to further promote self-assembly stability, we rationally introduced cysteine point mutations into this recombinant TMV-CP in the vertical axis. When the subunits assembled into a disk, each site was exposed on the disk face and could form a disulfide bond with the 74-cysteine site, located on the opposite face of the disk. The 50-,51- and 52-site substitutions resulted in dramatically improved disk stacking self-assembly, producing a high yield of stabilized TMV nanorods that were several micrometers long, indicating successful formation of disulfide bonds between adjacent disks. This optimization of the E.coli-derived TMV nanorod, which till now has been unsuitable for application due to its structural instability, holds great potential for the assembly of several nanomaterials, including polymeric nanowires and platforms for functional protein arrays.

Poster Presentation # 106
Fluid Mechanics of Underwater Bubble Sniffing

Cyrus Tanade
David Hu, PhD (Mechanical Engineering)

Star-nosed moles have the unique capability of sniffing out prey underwater by rapidly expiring and re-inspiring air bubbles in a tenth of a second. The fluid dynamics behind underwater bubble sniffing is poorly understood, especially about how the animal prevents the bubble from pinching off and getting a nose-full of water upon re-inspiration. Past work demonstrated that the 'stars' of the animal – fingerlike structures pointing outwards from the nose, appears to play a role in stabilizing the bubble and preventing pinch-off. I extend this research by designing three-dimensional stars on SolidWorks with varying angular arm separation and fold angle. Increasing fold angle contributes to more bubble stability, but there is also a point at which the fold angle causes premature pinch-off. In quasi-static conditions, the results show that the maximum volume of the bubble before pinch-off is positively correlated to fold angle. Similarly, the gap width – the distance between two consecutive arms at the maximum axial length of the bubble, is also positively correlated to fold angle. Finding the optimum fold angle will provide design constraints required to ultimately develop an underwater electronic nose for chemical sensing.

Oral Presentation
Functional MRI Signal Complexity Analysis Using Sample Entropy

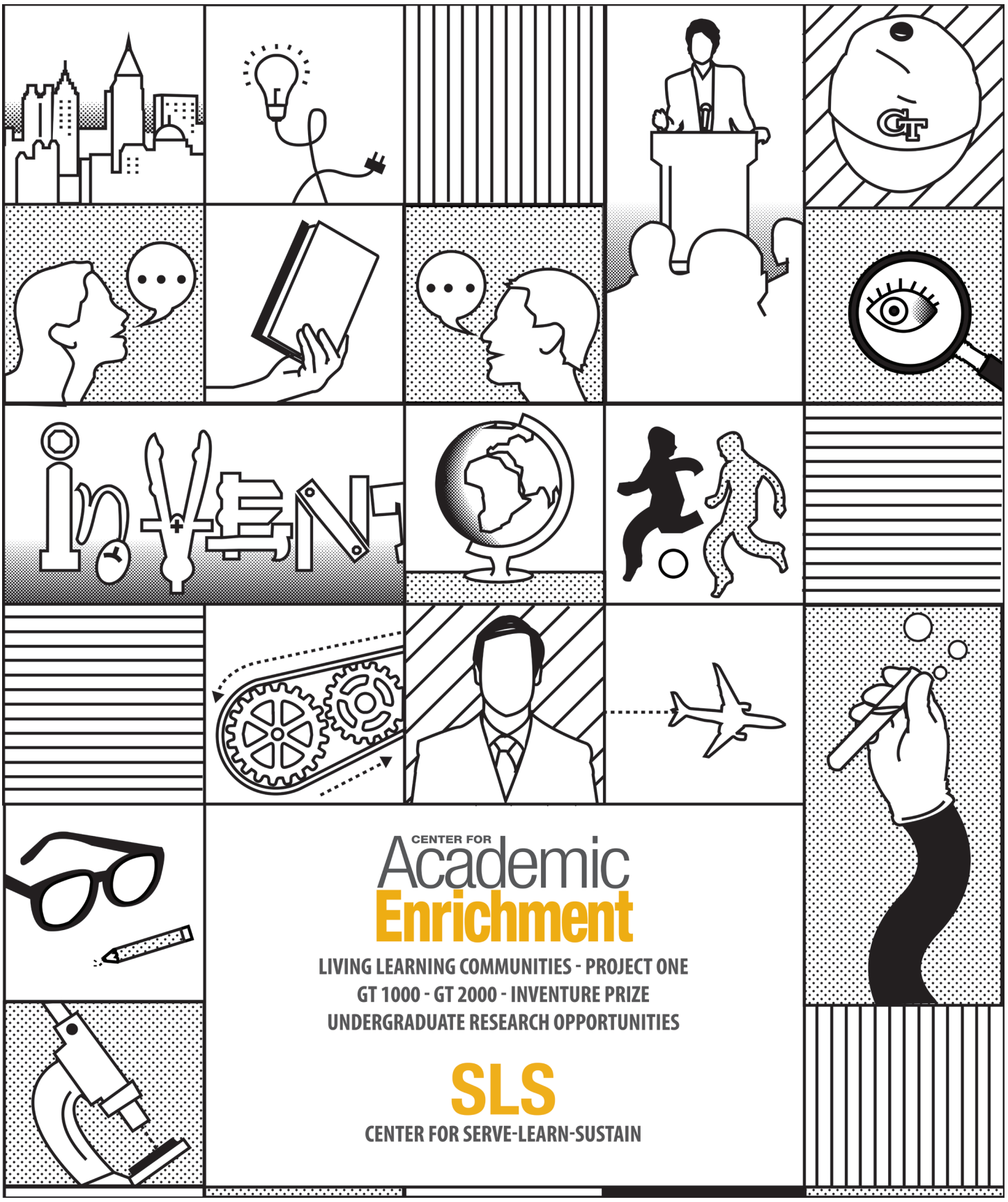
Hisham Temmar
Maysam Nezafati, PhD (Biomedical Engineering)

Functional magnetic resonance imaging (fMRI) and resting-state functional magnetic resonance imaging (rs-fMRI) are immensely powerful methods in neuroscience that use the blood oxygenation level-dependent (BOLD) signal to record and analyze neural activity in the brain. The BOLD signal arises via the hemodynamic response to neural activity, which may still preserve information about the complexity of the neural signal. This signal complexity can be quantified using Sample Entropy (SEnt), an approximation of entropy for physiological time signals that analyzes disorder in a signal. By calculating the SEnt of 200 whole-brain BOLD volumes as well as distinct brain networks, cortical regions, and subcortical regions of these brain volumes, it can be seen that different brain structures and networks exhibit distinctly different levels of entropy/complexity, and it can also be seen that entropy in the brain significantly differs between brains at rest and brains performing a task.

Oral Presentation
The Effect of Fc Oriented Microparticles On Human Mesenchymal Stem Cell Viability In Vitro

Jennifer Ternullo and Dale Shober
Todd Sulchek, PhD (Mechanical Engineering)

Human mesenchymal stem cells (hMSCs) are of great interest to the scientific and bioethical communities since they can potentially be used to treat several healthcare problems while being able to be retrieved from adult humans with consent and relatively low risk and harm. Multiple studies have shown that upon immediate interaction with blood or serum, hMSCs are damaged by the complement system, a fast-acting part of the immune system which is responsible for the targeting and lysis of foreign pathogens in addition to the recruitment of immune cells. It has also been previously shown that oriented Fc microparticles can be used to lower complement activation, while also increasing the viability of nearby bacteria. The research currently being done by us similarly attempts to use oriented microparticles to increase hMSC viability rather than bacteria viability. The independent variables being tested are human serum concentrations (20%, 50%, 100%) and Fc densities on the particle surfaces (1:1, 2:1, 1:5). The serum itself will also be tested via assay for associated complement activity and measure complement factor concentration to ensure binding to synthesized microparticles. The hMSC viability assays will be run on well plates using CCK-8 and the data will be obtained by analyzing absorbance values from a multi-mode plate reader. Expected results are that the well plate groups with a 20% serum concentration and 2:1 Fc density will yield the highest cell viability rates. This research may discover new ways to protect stem cells from immune damage during therapies.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Poster Presentation # 107
Examination of Variations in In-vitro Gene Expression of Mesenchymal Stem Cells Encapsulated in Integrin Specific Hydrogels

Hannah Theriault
Andres García, PhD (Mechanical Engineering)

Of the 8 million fractures occurring in the United States annually, an estimated 5% to 20% result in nonunion deformities requiring therapeutic intervention. Efforts to develop therapies for nonunion fractures combine biological structures (cells), biologically active molecules, and scaffolding for structure. The García Lab at Georgia Tech previously engineered a synthetic hydrogel system to promote the survival, retention, and regenerative functions of Human Mesenchymal Stem Cells (hMSCs) in an immunodeficient mouse model. Although hMSCs are well known for their ability to self-renew and their capacity for multipotent differentiation, new research suggests these therapies are beneficial due to the growth factors and cytokines they produce as part of their secretome. The hMSC secretome modulates a variety of cellular functions within the fracture environment including immune responses, inflammation, and angiogenesis. To develop an understanding of the effects of the adhesive ligand on the secretome and the fracture microenvironment requires further investigation. We engineered an integrin-specific poly(ethelyne) glycol (PEG)-hydrogel system for the delivery of hMSCs utilizing RGD and GFOGER to enable cell adhesion. Staining hMSCs with Calcein AM and TOTO-3 Iodide confirmed the ability for cells encapsulated in gels to survive in Complete Culture Media (CCM) and Bone Differentiation Media (BDM). Alkaline Phosphatase (ALP) Assays were used to confirm differentiation of hMSCs into osteoblasts by showing larger amounts of ALP per mg of protein present in the osteoblasts. We have also seen changes in hMSC osteogenesis based on adhesive ligand present in the PEG gel. These studies conducted in demonstrate that modulation of the stiffness, growth factors, and adhesive ligand utilized in the synthetic hydrogel scaffolding can direct MSC differentiation and regenerative capacity.

Poster Presentation # 092
Biomolecular Recognition via Applied Radar Theory

David Thompson
William Hunt, PhD (Electrical and Computer Engineering)

Multiple methods are used today to recognize biomolecular interactions including thermodynamic and chemical methods. These methods are well established over decades of use. However, they tend to require numerous interactions and therefore may miss interactions such as those between a single ligand and receptor cell. At a very basic level every molecule is comprised of individual atoms which each radiate a specific electromagnetic charge. Combined together and observed from a distance, these charges may provide a unique electrostatic potential signature to any given molecule and biomolecular interaction. Electrical engineering, through applied radar signaling theory, provides methods to detect specific electromagnetic patterns against a background of noise. If we can identify and characterize a unique electrostatic potential pattern for a given interaction, then utilization of radar theory through matched filters may permit recognizing individual biomolecular events, eliminating the current requirement of numerous interactions for biomolecular recognition.

Poster Presentation # 096
Chemo-Mechanical Harnessing of Lymphangiogenesis by Aluminum Oxide (Al2O3) Nanowires

Ozlem Lal Tuzman
Gleb Yushin, PhD (Materials Science and Engineering)

Of all of our body's internal systems, the lymphatic system may be one of the most crucial systems. There are hundreds of lymphatic nodes in the body and they are located in crucial places, such as heart and lung. Lymphatic vessels create the connection between tissue/organ environment and lymph nodes to help clear out body toxins, waste, and unwanted materials. The potential of the lymphatic vessels to be restored and demonstrate the controllable growth can be disrupted by, for example, a surgery. Unfortunately, after the breast cancer surgery up to 40% of women develop this condition, also, know as lymphedema, which currently does not have a clinically (FDA) approved treatment, and also worsens the quality of life yet the reasons for this disease remain largely unknown. Ultimately, the controlled growth of the lymph vessels is the key to harness the inflammation as the result of the above mentioned conditions. Yet, those few therapeutic means which currently exist in the literature did not demonstrate a great potential of controlling the lymphangiogenesis. We foresee that the controlled growth of the lymphatic smooth muscle cells can be stimulated either chemical or mechanically. Among the existing materials, nanoparticles have been often explored as nano-sized carriers to deliver treatment locally, controllably and sustainably. 1D nanoparticles (nanowires) have high strength and stiffness, which can be helpful in accommodating lymphatic cells. With this research, we will experiment with the effect of aluminum oxide nanowires (NWs) on lymphangiogenesis.

Poster Presentation # 072
Deflate Gate Study: To What Extent are Students Interactive in the Problem Solving Studio?

Disha Vaswani and Preksha Kukreja
Joe Le Doux, PhD (Biomedical Engineering)

Problem Solving Studio (PSS) is a method to develop critical thinking and problem-solving skills in students and to increase interaction among students in an introductory

analyticalengineering course. In PSS three types of participant structures can be orchestrated: dyads - two students, teams - four students at a table, and the instructor with the team. During PSS, students work in dyads and may come together to discuss problems with the team sitting opposite them on the same table. This observational case study categorizes student participation during a PSS session using the ICAP framework which suggests that students can be in one of four modes of cognitive engagement when in class: interactive, constructive, active, or passive. The greatest amount of learning occurs when students are in interactive mode. One team was video recorded as they worked in PSS during a class period. The research question was whether participant structures in PSS create opportunities for interactive learning. The video was analyzed to identify how often the students entered interactive mode, how often they transitioned in and out of interactive mode and what critical incidents prompted these transitions. Students entered interactive mode most frequently when they were developing a new idea to approach a problem and stayed in the interactive mode most frequently when they were applying their ideas to the problem. Additionally, scaffolding by the professor caused all students to enter interactive mode. This data can be used to identify new techniques that can be implemented to increase interaction within student groups.

Oral Presentation
Process Modeling and In-situ Monitoring of Photopolymerization for Exposure Controlled Projection Lithography (ECPL)

Jenny Wang
Amit Jariwala, PhD (Mechanical Engineering)

Exposure controlled projection lithography (ECPL) is an additive manufacturing process in which photopolymer resin is used to fabricate three-dimensional features. During this process, UV curing radiation, controlled by a dynamic mask, is projected through a transparent substrate onto the resin. COMSOL software has been used to model the photopolymerization reaction kinetics, predicting the cured part geometry based on certain process parameters. Additionally, an Interferometric Curing Monitoring (ICM) system has been implemented to acquire real-time information about the optical properties of the cured part. Potential sources of error with the real-time monitoring system were investigated. Additionally, refractive index and degree of conversion changes were modeled throughout the reaction. Measured and simulated results were compared to understand the ICM signal with the reaction kinetics. These comparisons were used to validate the simulation model and identify system level errors that must be reconciled to improve the accuracy and precision of the ECPL process.

Poster Presentation # 083
Electrochemical Impedance Spectroscopy Characterization of Corrosion Resistance of Polymer Coatings on Metal Surfaces

Tony Wang
Nian Liu, PhD (Chemical and Biomolecular Engineering)

Corrosion is a naturally occurring chemical process in which metals undergo degradation. This lowers their intrinsic strength, alters their appearance, and can affect porosity. In the industrial application of beverage cans, characterizing the process of corrosion due to the liquid inside can be extremely challenging. The effects of corrosion on an industrial scale can affect transportation, storage, and chemical reactivity of billions of products. Using simulated environments in custom built reactors, the proprietary polymer coatings of various aluminum alloy lids were able to be tested using a combination of Electrochemical Impedance Spectroscopy and Optical Microscopy. Impedance analysis gives a better sense of corrosion resistance because it can more accurately depict the complex nature of how a circuit resists the flow of an electrical current, while Optical Microscopy presents a high-magnification picture of the physical effects of corrosion effects on the polymer and metal system, thus the combination of these two methods gives the best holistic characterization. The polymer coated aluminum alloy lids were exposed to electrolytic solution, and the charge resistance of the lid was measured for 240 hours, with both the Bode and Nyquist Impedance being analyzed. This occurred using a reference electrode, counter electrode, and dispersed AC current. The before and after optical microscopy of the exposed area of the aluminum alloy was also compared. The results from these experiments allowed for the rankings of various proprietary polymer coatings. The experiment is planned to be continued, extending to a simulated high pressure environment using new reactor designs.

Poster Presentation # 073
Exploring Rodents as a Model for Recording Neural Population Activity During Motor Cortically-Driven Behaviors

Yaxuan Wang
Chethan Pandarinath, PhD (Biomedical Engineering)

Recent studies have revealed the vast potential in recording large populations of cortical neurons to understand how the brain drives behavior. In the monkey motor cortex, coordinated activity of neural populations is closely tied to the monkey's behavior; however, it is challenging to develop injury and disease models with primates. Thus, the development of a rodent model is key to investigating the effects of injury or disease on motor cortically-driven behaviors. Our lab aims to develop a rat paradigm for forelimb supination, as these movements are dependent upon the motor cortex. In our training system,

rodents hold or supinate a touch-sensitive knob on a visual cue. If the forelimb movement surpasses a certain time or angle threshold, a food reward is given to promote behavior. Two rats were successfully trained to hold a knob for over 300 milliseconds with a 60% hit rate, and a third to supinate a knob over 60 degrees with a 75% hit rate. To record motor cortical activity during the behavior, a 32-channel tetrode drive will be used. The drive allows adjustment of each tetrode wire's implantation depth, to accurately target the motor cortex and calibrate placement over time. Two functional drives have been built, ready to be surgically implanted into rats for data collection. We have trained rats to be comfortable with having their heads touched for the purpose of post-surgical tetrode manipulation. The next goal is to perform tetrode drive implantation and begin collecting data from neural populations in the rodent motor cortex.

Poster Presentation # 108
Sniffing Chemicals Underwater with Bubbles like the Star-Nosed Mole

John Joseph Watson and Morgan Biagioni
David Hu, PhD (Mechanical Engineering)

The star-nosed mole "sniffs" for prey underwater by rapidly blowing and then retracting bubbles back into its nostrils. It is currently unknown how scents propagate from the mole's aqueous surroundings onto the chemical receptors inside its nose. We investigate this phenomenon with a mole-inspired underwater sniffing device that uses a gas sensor coupled with a mechanical bubble "sniffer" to differentiate clean and dirty water. In our experiments, we show that the bubble interface facilitates the transfer of odors from the surrounding water to the sensor. The results of this study will be used to inform the design of an underwater sniffing device for use in harsh marine environments where other sensors tend to fail due to biofouling.

Poster Presentation # 109
Soldier Vertical Mobility System Shock-Absorbing Exoskeleton

Alex Zabaldo
Jun Ueda, PhD (Mechanical Engineering)

Exoskeleton technology has a history of development in human augmentation and structural support, but little research has been done identifying the capability of such a device to reduce severe shock to human muscular and skeletal systems. The purpose of this research project is to determine the viability of an exoskeleton to perform this function and create both simulated models as well as physically tested data showing its ability to do so. This will be done using a shock-absorbing boot device that has been modeled for simulation as well as manufactured for human jump testing, with data collection in the form of EMG, motion capture, and IMU measurements. With this information, comparisons can be drawn between the shock absorbed and control jumps for maximum muscular force exuded and maximum force to joints. There is direct interest in this information, as GTRI has partnered with the Georgia Tech School of Mechanical Engineering for a multiyear collaboration on the Soldier Vertical Mobility System, which seeks to develop a jetpack soldier system that includes a shock absorbing exoskeleton. In addition to the SVMS program, this work could have broader impacts in studies of prevention of short and long term bone and tissue damage, as this is what the exoskeleton seeks to reduce. The exoskeleton also has applications outside of its intended field; the development lessons learned by analyzing this system could be applied to devices in other areas, such as for biorobotic rehabilitation or industrial work assistance.

Poster Presentation # 074
Characterization of C2C12 Muscle Cells to Study Metabolic Disease Signaling

Yining Zheng
Shuichi Takayama, PhD (Biomedical Engineering)

The primary goal of the research is to investigate the underpinnings of glucose metabolism and signaling between tissues involved in metabolic diseases, such as Type 2 diabetes. The work on muscle tissues is used to supplement another project in characterizing 3D-cultured adipose tissues, with the hope of integrating the two into a new microfluidic device concept for studying muscle-fat/liver-fat tissue crosstalk. The initial stages of culturing the C2C12 (mouse muscle) cells on the 2D and the 3D stage revealed that the 3D spheroids were not as metabolically active as the 2D. This was observed by a lack of media color change in the 3D wells, while the 2D did change as a result of a greater accumulation of pH-lowering waste products. After changing the media from 10% FBS to 2% HS, the 2D C2C12 started to form myotubes, while the 3D spheroids lost their original compactness. In later experiments, the C2C12 were seeded onto a 2D plate and allowed to differentiate for only 5 days to avoid delamination. The glucose uptake assays conducted to characterize the insulin uptake of the C2C12 revealed that the measured glucose consumption was not affected by insulin, leading us to look elsewhere. Current understanding on the signaling between tissues involved in metabolic diseases is still lacking, and it was just recently discovered that adipocyte-induced IL-6 expression could play a role in the suppression of myogenesis. Moving forward, we intend to focus on the signals that cause C2C12 to suppress differentiation by co-culturing them with adipocytes.

Poster Presentation # 093
A Novel Design of Aluminum Nitride – based Nonreciprocal Acoustic Device Featuring Acoustoelectric Effect

Yue Zheng
Azadeh Ansari, PhD (Electrical and Computer Engineering)

Today's heavily occupied radio frequency spectrum, from base

band to 30GHz, requires researchers to exploit the unutilized frequency band such as Tera-hertz (THz) band, or alternatively, to devise a radio which can be used to simultaneously transmit and receive the signal at the same frequency band. The former approach, however, will eventually call for a redesign of current electronics component, since active device no longer exhibits power gain when operated beyond maximum oscillation frequency, which is normally less than 30 GHz. Therefore, there has been growing interest in the alternative approach, wherein the device, namely acoustic non-reciprocal device, is compatible with most modern communication systems. Simultaneous transmission and reception at the same frequency band requires a violation of Lorentz reciprocity, which can be achieved by either breaking time-invariance or introducing non-linear parameters to the system. Active non-reciprocal devices like transistor feature poor noise performance and unstable power-handling ability. These obstacles force researchers to explore passive non-reciprocal device like RF circulator to break the time-invariance property. Previous work involved utilizing the gauge magnetic field and a circulating air flow or liquid flow in an RF circulator to break the time-reversal symmetry, but this type of method requires high power supply to driver the circulation. A recent work on lithium niobate silicon acoustoelectric MESFET unleashed a new era of gate-controlled semiconductor-based RF devices, but traditional MESFET structure cannot resolve the issue of high shot noise in piezoelectric material, especially AlN. Here, we present an implementation of high-performance AlN-based surface-acoustic wave (SAW) circulator featuring HEMT structure at 3GHz – 30GHz.

Poster Presentation # 075
Improving Neurophysiological Implantation in Mice – High Resolution 3D-Printed Headplates with Multiple Electrodes

Katherine Zhu
Nigel Pedersen, PhD (Biomedical Engineering)

Mouse models are uniquely beneficial to understanding neural networks given a wide array of transgenic mice and resulting cell-selective techniques. Experimental error arises from non-concurrent and variable implantation, resulting in difficulties comparing mice and less controlled small group recordings. Implanting numerous electrodes in mice is also technically difficult and can result in long surgeries. We have developed a novel method for the rapid and reproducible implantation of easily reconfigured ECog, EMG and depth electrodes in mice. By extracting the cartesian coordinates of an average scan of 40 C57bl/6J mouse skulls, a conformal headplate was created using the script-based computer aided-design software, OpenSCAD, complete with housing for the friction-fit assembly of connectors and wires, as well as a Microdrive for hippocampal electrode placement. The headplate was then printed using a high-resolution resin 3D printer and then assembled for surgical implantation. Implantation of a headplate on a mouse was reduced to 40 minutes without practice, enabling a whole cohort of eight mice to be prepared in one day. Good quality recordings were obtained after surgical recovery. Depth electrode placement was found to be accurate post-mortem. While similar methods exist for the mouse, these are not based on 3D resin printing, nor easily reconfigurable by adjustments to source-code, nor micro-drivable macroelectrodes. These 3D printed headplates offers a rapid, consistent, and cost-effective way to implant larger numbers of mice in a highly reproducible way, reducing surgical time and mitigating experimental error.

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Poster Presentation # 050
Functional Neuroimaging of Task Representation on Motor Learning Performance

Juliana Alfonso and Yeseul Heo
Eric Schumacher, PhD (Psychology)

Despite extensive literature regarding response cost in dual-task processing, the predominant procedures do not isolate task-processing from stimulus processing. The purpose of this study is to investigate the neural correlates of motor learning and dual-task processing using a procedure in which stimulus processing is held constant. Participants learn to make bimanual or unimanual hand responses to indicate the individual or associated pairs of stimuli in two types of tasks. In the independent task (two-set task), participants make a response with the left hand that corresponds to the left image and a response with the right hand based on the right image shown on the screen simultaneously. In the relational task (one-set task), the individuals respond with button-presses to the pair of images shown. Subjects performed an equal number of trials per condition and neural activation was recorded using fMRI. Preliminary behavioral results showed that there was a greater response-cost for bimanual responses in the independent condition, but a greater response-cost for unimanual responses in the relational condition. Imaging analysis suggests greater neural activation in the superior parietal lobe during the relational task, and greater neural activation in the inferior frontal sulcus (IFS) during the independent task. These preliminary results seem to support the behavioral findings of Schumacher et al. (2018) and implicate, at the level of neural activation, a dissociation in the location of task-processing between the independent and relational tasks.

Poster Presentation # 020
Crosstalk Between Motor Neurons, Vasculature, and Muscle Fibers Modulate Innervation of Skeletal Muscle Following CLI

Berna Aliya
Young Jang, PhD (Biological Sciences)

Critical limb ischemia (CLI) is the most severe form of peripheral artery disease (PAD) and is characterized by a loss of blood flow to the affected extremities. While current treatments for the relief of PAD symptoms include angiogenic therapies that promote collateral vascularization, the success of these regenerative approaches is limited. Because skeletal muscles exhibit remarkable regenerative capacity, they may be a promising therapeutic target for regenerative therapies. Skeletal muscle fibers require a fully functional neurovascular system supported by blood supplying oxygen and nutrients to motor neurons and myofibers. Therefore, disrupted vasculature caused by ischemia disrupts innervation due to the close proximity of blood vessels to motor axons. Thus, we explored the effects of CLI on muscle and the various components of its muscle microenvironment, specifically on the crosstalk between the neuromuscular junction (NMJ), muscle fibers, and vascularization. A murine hindlimb ischemia surgical model was applied to the left leg and a sham surgery applied to the right as a contralateral control for time points up to 56 days. Immunofluorescence staining using synapsin1 and bungarotoxin were used for the presynaptic axon terminal and the postsynaptic endplate, respectively. Our results revealed muscle fiber denervation up to 56 days after injury compared to control, assessed by the low percentage of overlap of presynaptic motor neuron and postsynaptic myofiber of the NMJ, suggesting potential deficits in muscle contractile function. Regeneration of the NMJ is apparent 14 days following injury, indicated by a higher percentage overlap. However, complete innervation is not achieved by day 56. Future studies will focus on analyzing the neurotrophic factors involved in the regeneration of the NMJ. Furthermore, we will perform ischemic preconditioning before the ischemic injury in order to determine whether transient ischemia can preserve innervation at the NMJ, thereby acting as a preventative method to the more severe CLI.

Poster Presentation # 051
The Impact of Varying Emotional States on Visual Working Memory Capacity

Claire Allison and Erek Humm
Eric Schumacher, PhD (Psychology)

Emotional states can affect our daily life through their influences on cognitive processes. One cognitive process that may be affected by emotional state is visual working memory (VWM). Visual WM is the active maintenance of visual information needed for task completion. Emotions may affect VWM because as we allocate neurocognitive resources for dealing with emotional content, those resources may be less available for VWM. One task often used for investigating VWM is the change detection task. In this task, the subject is presented with two sets of stimuli and must report whether the second set of stimuli has changed from the first. The number of objects used as stimuli in the change detection paradigm correlates to the amount of objects stored in VWM. Contralateral delay activity (CDA) is also sensitive to VWM. CDA is an event-related potential that is sensitive to the number of task-relevant items stored in WM. We investigated the effects that a pleasant, unpleasant, and neutral emotional state had on VWM representations. We hypothesized that VWM capacity and CDA amplitude would be lower during the unpleasant and pleasant emotional states than during neutral states; that is, an emotional state can reduce task-relevant items the participants can store in WM. Participants performed a change detection task that was preceded by the presentation of pleasant, unpleasant, or neutral task-irrelevant pictures in a blocked fashion. These results aid in uncovering the emotional-cognitive processing that underlies maladaptive

WM representations and the role of such processing in the development of mental illness

Oral Presentation
Strong Edge Colorings and Edge Cuts

James Anderson
Xingxing Yu, PhD (Mathematics)

Erdos and Nesetril conjectured in 1985 that every graph with maximum degree d can be strong edge colored using at most 5/4 d^2 colors. The conjecture is still open for d=4. We show the minimum counter example to the conjecture for d=4 does not contain an edge cut of size 1 or 2. In addition, we show whenever neither of the components of the cut is a single vertex, the minimum counter example does not contain a cut of size 3 or 4. We also discuss similar techniques for higher values of d.

Poster Presentation # 021
Neurobehavioral Patterns during Action Observation and Execution of Complex Goal Directed Movements

Neel Atawala
Lewis Wheaton, PhD (Biological Sciences)

The production and mastery of complex action begins with action understanding, a process which arises from the observation of others. The mechanisms through which humans engage in action understanding are unclear, and several conceptual theories, such as the direct matching hypothesis and teleological stance theory, attempt to explain the underlying mechanisms. Brain areas in the frontoparietal network have been associated with action understanding due to the presence of mirror neurons. The visual streams, a network that interconnects occipital, parietal, and temporal areas, encode object shape, size, orientation, and use as well as eye movements during the online control of movement. Tool-use utilizes the visual streams and the frontoparietal networks in order to encode the visual features of the task and the control of grasp. Prior to the execution of movement such as in tool use, one must engage in motor planning, a three stage process that consists of: 1) task recognition 2) coordination of required motor sequences, and 3) performance of the task. Second order motor planning requires both knowledge and planning of immediate task demands (first order motor planning) along with the planning of the subsequent steps during reach and grasp. The purpose of this study is to analyze the neurobehavioral encoding of context and grasp intent during action observation and execution of a second order motor task using electroencephalography and eye tracking. The results may help us uncover the neurobehavioral mechanisms in action understanding that we can leverage and target for more effective neurorehabilitative therapies.

Poster Presentation # 052
Using Intercranial Neural Recordings to Compare Successful Memory to Those who Fail to Remember

Tal Ben-yishai
Thackery Brown, PhD (Psychology)

The medial temporal lobe plays a significant role in the ability to recognize previously experienced stimuli. Due to technological insufficiencies it is difficult to measure the behavior of individual neurons. Faraut et al, gives us the opportunity to look at individual neural data with a published data set of intracranial neural recordings of subjects performing a recognition memory task. The dataset includes 1,576 single neurons form the human hippocampus from 42 patients, in 65 sessions, undergoing intracranial monitoring for localization of epileptic seizures. During this, subjects completed a recognition memory task where they were asked to distinguish previously seen images from new ones. MATLAB is used to retrieve neural data. These data allow us to ask what the firing patters each individual neuron tell us, and why some individuals better remember than others. We compare behavior of a neurons when one has a good memory versus one who fails to remember. If we can understand the reason for these memory errors this can give an idea of how to improve outcomes for patients with memory related diseases such as dementia and Alzheimer's. Future plans: Looking at the spiking relative to the mean level of activity we can find correlation between memory performance. We hypothesize that individuals who fail to remember will have spiking data that are similar to previous stimuli, causing this error in memory. This can give an insight on memory enhancement in individuals suffering from memory failure.

Poster Presentation # 047
Sonification of Protein Molecular Dynamics

Sarah Anne Bowling and Tyler Kostun
J.C. Gumbart, PhD (Physics)

Visual Molecular Dynamics is a modeling and visualization program that is commonly used in biological and physical sciences. The folding of proteins in aqueous environments is one of many things that can be simulated in VMD. We have run simulations of a simple beta-hairpin protein with a radical tyrosine folding in conditions similar to those in the natural world. Radius of gyration, hydrogen bonding, and end-to-end displacement were tracked and recorded in these simulations. We then turned this information into sounds by mapping each parameter to a different timbre synthesizer and altering the pitch and rhythm according to the dynamic changes. This process is called sonification. The goal of this is to not only improve intermediate science education, but also to provide a multidisciplinary approach for biophysicists to analyze protein information.

Oral Presentation
Effect of Intraspecific Diversity in Pseudomonas Aeruginosa Populations on Antibiotic Susceptibility

Sara Cleland and Isabela Pavkov
Stephen Diggle, PhD (Biological Sciences)

Pseudomonas aeruginosa (P. aeruginosa) contributes to lethal infections related to cystic fibrosis (CF), chronic wounds, and hospital infections. P. aeruginosa is extremely resistant to antibiotics due to its ability to adapt and diversify within its environment. Variation between isolates in the same population is relevant because clinical testing of bacterial antibiotic resistance only accounts for a few isolates, ignoring the intraspecific diversity of P. aeruginosa within a population. In this sense, the antibiotics prescribed would not effectively treat the infection because the antibiotic resistance of a few colonies does not accurately represent the entire population. The purpose of this study is to analyze the diversity in antibiotic susceptibility of P. aeruginosa isolates within one population as well as between populations. We assessed the susceptibility levels of 100 isolates of P. aeruginosa from two CF patients to six commonly used antibiotics (ceftazidime, meropenem, piperacillin-tazobactam, amikacin, tobramycin, and ciprofloxacin). We used disk diffusion assay following the CSLI guidelines. We expected to observe variable levels of susceptibility to tested antibiotics within one population and between the two patient samples. As expected, we found variation in antibiotic susceptibility between the two CF patients. More notably, we observe variation in susceptibility of isolates from the same population to individual antibiotics. Specifically, Patient A isolates vary in susceptibility to tobramycin and Patient B isolates vary in susceptibility to tobramycin as well as ceftazidime. We plan to further test the intraspecific patient diversity against those two antibiotics using Minimum Inhibitory Concentrations (MICs). By understanding the variation in antibiotic susceptibility within one P. aeruginosa population, more effective treatments for CF lung infections can be developed.

Poster Presentation # 044
Polynomials over Hyperfields

Steven Creech
Matthew Baker, PhD (Mathematics)

In this presentation, I define hyperfields and give both Krasner's construction of quotient hyperfields and Massarouros's non-quotient construction of hyperfields. I define polynomials and roots over hyperfields and give a construction of a hyperfield extension for irreducible polynomials over quotient hyperfields. I discuss current research and open problems in hyperfields.

Poster Presentation # 031
Designing Monomers for Degradable Ring-Opening Metathesis Polymerization

Alex Crolais
Will Gutekunst, PhD (Chemistry and Biochemistry)

Ring opening metathesis polymerization (ROMP) is a chain-growth polymerization of strained cyclic olefin-containing monomers that has shown great versatility in the field of polymer chemistry. Although it allows polymerization of monomers containing a multitude of functional groups, very few examples of degradable polymers have been reported to date. In this report, we demonstrate a novel synthetic pathway to synthesize an acetal-containing degradable monomer that is compatible with ROMP and gives well-defined polymers with control over molecular weight and dispersity. Polymers made from this monomer were characterized by gel permeation chromatography (GPC) and degradation studies were performed. Acetals undergo hydrolysis in mildly acid conditions and even in biologically relevant pH ranges, so this new monomer has potential future applications in drug delivery systems. The monomer also has the capacity to have its functional groups modified for facile introduction of drug cargo or stimuli responsive groups.

Oral Presentation
The Role of Ground-Ice in the Formation of Ceres' Diverse Geomorphology

Kayla Duarte
Britney Schmidt, PhD (Earth and Atmospheric Sciences)

Ceres is the largest body in the Main Asteroid Belt and was one of two subjects of NASA's Dawn Mission. It was confirmed through gamma ray and neutron spectroscopy from Dawn that Ceres contains water-ice both on the surface (Combe et al., 2016; 2019) and subsurface (Prettyman et al., 2017). It has been proposed that the presence of a diverse set of geologic features on Ceres are influenced by the presence of ground-ice on Ceres during their formation (Schmidt et al., 2017; Sizemore et al., 2017; Duarte et al., 2018). Notable features include small domes (tholi), landslides (Schmidt et al., 2017; Duarte et al., 2018), fractures, and ridges. Features such as landslides are seen globally on Ceres, while features like small domes and fracture systems are predominantly found with Occator crater, one of Ceres' largest and most distinctive craters. Here we discuss two main findings in the role ground-ice may play in the formation of these features. First, recent findings suggest a continuum of landslides characteristics on Ceres, mostly latitudinally and situationally dependent, supporting the hypothesis that ground-ice exists globally on Ceres (Duarte et al., 2018). Second, new results from Dawn's second extended mission (XM2) suggest potential pingo candidates may exist as small mounds on the floor of Occator crater. Through mapping, classification, and quantitative measurements, we are able to discuss how these findings further

our understanding of the key role ground-ice plays in forming geologic features on Ceres.

Poster Presentation # 022
Role of Ribosome-Associated Chaperone Hsp70-Ssb in Prion-Based Stress Memory

Quincy Faber
Yury Chernoff, PhD (Biological Sciences)

Prions are self-perpetuating protein isoforms, that are usually based on ordered fibrous protein aggregates (amyloids), cause disease in humans and control non-Mendelian heritable traits in yeast. Formation and loss of yeast prions are modulated by environmental and physiological conditions, including heat stress. [LSB+], a metastable prion generated by the cytoskeleton-associated protein Lsb2 and influencing aggregation of other proteins, in induced by heat stress and persists in a fraction of yeast cells for a number of cell generations after stress, thus generating a cellular memory of stress (Chernova et al. 2017 Cell Rep. 18: 751). Chaperone proteins control protein folding, play an important role in adaptation during stress conditions, and are involved in prion formation and propagation. Ssb is member of the Hsp70 chaperone family and is normally associated with translating ribosomes. Previous studies in our lab indicated that Hsp70-Ssb has an anti-prion effect. We show that the formation and mitotic stability of the [LSB+] prion are greatly increased in the absence of Ssb. This links the ribosome-associated chaperone machinery to the cellular memory of stress.

Poster Presentation # 032
Effect of Route of Vaccine Administration on Glycan Antigenicity

Rachel Fitzgerald
M.G. Finn, PhD (Chemistry and Biochemistry)

This project attempted to determine the most effective method of administration for glycoconjugate vaccines. The glycoconjugate vaccines this research focuses on are composed of a virus-like particle (VLP) modified to display a glycan antigen. Glycoconjugate vaccines have shown promising results in creating long-lasting IgG antibodies, but due to high variability among vaccine types, the best route of administration is currently unknown. Bacteriophage PP7 was used as a model virus-like particle, and tetrasaccharide 14, a sugar found in S. pneumoniae, was used as a model antigen. The vaccine was created by transforming E. coli bacteria with a plasmid to create a VLP, acylating the VLP, and then using the Copper (I)-Catalyzed Alkyne Azide Cycloaddition to add the tetrasaccharide 14 glycan. The VLPs were purified and analytical tests confirmed VLP purity and structure. To quantify the advantages of each route, vaccines and two booster doses were administered to groups of five mice either subcutaneously, intradermally, intramuscularly, or intraperitoneally. Antibody production was analyzed over 12 weeks to discover the best route of injection.

Oral Presentation
Enrichment and Isolation of Iron-Oxidizing Bacteria from an Ancient Earth Analogue

Layla Ghazi
Jennifer Glass, PhD (Earth and Atmospheric Sciences)

On the surface of modern Earth, oxygen is the most widespread electron acceptor for respiration. However, in deeper anoxic environments, many microbes can use other electron acceptors to respire anaerobically. The goal of this study was to test whether anaerobic microbial growth could occur with Fe2+ as the electron donor. Enrichment cultures were inoculated with anoxic, Fe2+-rich sediments from Lake Matano, Indonesia, an ancient ocean analogue. Sediments were incubated with Fe2+ sulfide as the electron donor in a nitrogen:carbon dioxide (90/10%) atmosphere. Soluble manganese(III) or oxidized nitrogen were provided as electron acceptors. Control cultures were tested for aerobic Fe2+ oxidation . With Mn(III) as the electron acceptor, cultures showed some evidence of growth near the middle of the gradient tube. However, orange Fe(III) oxides were absent, suggesting that anaerobic Fe2+ oxidation had not occurred. A white precipitate indicated that the microbes were reducing Mn(III) to Mn(II), which precipitated as a white manganese carbonate mineral, which was not present in the uninoculated controls. Fe(III) oxides were also absent in tubes containing oxidized nitrogen. With oxygen as the electron donor, an layer of orange Fe(III) oxide minerals formed near the water-air interface, indicative of growth of microaerophilic Fe2+ oxidizing bacteria ; this layer did not form in uninoculated controls. Our preliminary results suggest that anaerobic Lake Matano enrichments are capable of Fe2+ oxidation using oxygen but not alternative electron acceptors.

Poster Presentation # 033
Confirmation of Computationally-Predicted Kinase Binding by Callophycoic Acids G and H

Madison Greene
Julia Kubanek, PhD (Chemistry and Biochemistry)

Kinases are proteins that play an integral role in multiple processes within a cell. Deregulation or upregulation of a kinase can have profound effects on a cell, possibly leading to growth of tumors. Discovery of new compounds that could target multiple kinases would prove to be extremely beneficial for treatment of cancers. In order to determine possible leads for drug discovery, compounds discovered by the Kubanek lab were computationally screened against libraries of proteins using a program designed by Jeff Skolnick's group called FINDSITE. This program predicted that the compound bromophycolide A, originally isolated from the species Callophycus serratus, and bromophycoic acids A and E, isolated from a closely related species, bind to multiple kinases. Published studies on these compounds identified inhibition of the following cancer cell lines: AU565, H3396, HCC1143, HCC70,

HCT116, KPL4, LNCaP-FGC, LS174T, MCF-7, MDA-MB- 468, SW403, T47D, ZR-75-1, PA-1, BT-549, DU4475, MDA-MD-468, NCI-H446, PC-3, SHP-77, MDA-MB-231, A2780/DDP-S, and Du145. The purpose of this work is to re-isolate bromophycoic acids A and E and confirm the predicted binding results of these compounds and previously isolated bromophycolide A through the use of a kinase inhibition assay. Results will provide insight to possible mechanisms of action by which these compounds inhibit cancer cell growth.

Poster Presentation # 023
Improved System for Measuring Bower-Building Behavior of Lake Malawi Cichlids

Karen Gu
Patrick McGrath, PhD (Biological Sciences)

Understanding how genetic diversity gives rise to behavioral diversity can reveal the link between genetics and the environment. However, traditional model organisms are ill-suited as research models for studying social behavioral diversity due to decades of inbreeding, genetic drift, and artificial selection. Lake Malawi cichlids are a nontraditional species that are uniquely suited for studying complex behavior because they demonstrate extreme behavioral differences combined with low genetic diversity. The sand-dwelling cichlids have evolved the behavior of building spawning nests (bowers). Bowers are used as mating displays and sites for fertilization and provide a measurable behavior from the depth and size of the bowers. This project aimed to design an improved automated recording system for measuring the bower-building behavior of cichlids. This project focused on evaluating the Kinect v2, sr300, and d415 depth sensors for the new recording system, and a new single board computer, the ODROID-XU4, as an alternative to the current Raspberry Pi 3. Trials were conducted on an empty model tank over six-hour periods. From preliminary analysis, the d415 depth sensor displayed the highest resolution and most suitable minimum depth distance and customizable settings making it the best choice for building an improved recording system. It was also determined that the ODROID-XU4 lacked the necessary processing power to operate with these sensors. To achieve the necessary processing requirements, it was recommended that a mini PC be used for the improved recording system. Future work will include optimizing the d415 parameters and setting up the mini PC system.

Oral Presentation
Topological Analysis of Experimental Recordings of Ventricular Fibrillation

Daniel Gurevich
Flavio Fenton, PhD (Physics)

Cardiac arrhythmias such as atrial and ventricular fibrillation are a leading cause of mortality worldwide, but their causes and effective treatments remain elusive. Fibrillation is characterized by multiple interacting spiral waves of electrical activity, and analysis of fibrillation has traditionally been simplified by focusing on point-like "phase singularities" lying at their centers. We have developed and implemented a novel level-set based approach that can reliably detect and track the temporally and spatially resolved positions of wavefronts, wavebacks, and phase singularities from noisy and/or sparse recordings of fibrillation. Our topological definitions incorporate spatially global information, resulting in an extremely robust and high-precision mapping algorithm. This method was illustrated by analyzing simulated fibrillation data with added noise and optical mapping data during ventricular fibrillation in adult pig hearts.

Poster Presentation # 034
Heme Homeostasis in Mycobacterium Tuberculosis Infection

Owen Hale
Amit Reddi, PhD (Chemistry and Biochemistry)

Mycobacterium tuberculosis causes more deaths than any other pathogen and it is estimated that 1.7 billion people are infected worldwide. M. tuberculosis is able to infect humans because it can adapt its metabolism to respond to host defenses. Heme is an essential molecule required by M. tuberculosis for virulence and can be synthesized within the bacterium or acquired from the host. In order to determine if heme is involved in the metabolic changes of M. tuberculosis during infection, we treated Mycobacterium smegmatis, a commonly used non-pathogenic M. tuberculosis model, with molecules and chemical conditions that M. tuberculosis would encounter during infection. We employed a genetically encoded heme sensor and a protoporphyrin IX fluorescence assay to measure exchange labile heme and total heme, respectively. We show that exchange labile heme is responsive to spent macrophage media and pH, and that total heme is responsive to spent macrophage media, pH, and intercellular heme.

Poster Presentation # 045
Counting Acyclic Orientations with a Unique Sink Vertex

Daniel Hathcock
Prasad Tetali, PhD (Mathematics)

Many bijections are known relating acyclic orientations to other structures and properties on graphs. In particular, it is known that the number of acyclic orientations of a graph G with a unique fixed sink vertex is equal to the number of spanning trees with no broken circuit (with respect to some edge ordering). These are both also equal to the Tutte polynomial $T(1, 0)$, as well as the coefficient (up to sign) of the linear term of the chromatic polynomial. It has also been shown that, for general graphs, counting this quantity is #P-complete. However, there has not been much work on counting this quantity for specific families of graphs. We study this quantity for grid graphs and n-cubes. It is

easy to find that for 2xn grids, the number of acyclic orientations with unique sink is 3^(n-1), but counting for mxn or even 3xn grids is more difficult. We use standard combinatorial techniques to find a solution for the 3xn case, and attempt to employ other techniques to find or bound the quantity for more general families of graphs.

Poster Presentation # 048
Effect of Flow Regime on Snowflake Yeast Body Plan

Jacob Holt
Peter Yunker, PhD (Physics)

Snowflake yeast, evolved in the lab from common baker's yeast, have become a favored model organism for the study of the evolution of multicellularity. In response to settling speed selection, baker's yeast quickly develop mutations that result in a multicellular body plan, increased density, and improved hydrodynamics. While it is evident that the multicellular body plan provides the greatness initial fitness benefit under the artificial force of settling speed selection, it is not clear how much of a contribution to increased fitness improved hydrodynamics provides. If varying the flow regime present in the settling speed selection media has an impact on the type of snowflake yeast body plan seen, this would show that selection for hydrodynamics that best suit the selection environment plays a strong role in how snowflake yeast evolve. This is important because snowflake yeast are currently being used to study how the structural challenges posed to nascent multicellular organisms were overcome during the transition from uni- to multicellularity. Whether or not a novel adaptation is mostly the result of selective pressure from the constraints of a multicellular body plan (increased size) or the result of selective pressure for hydrodynamics that are beneficial under the experimental flow regime should be known as we continue to use this organism to make inferences on the past evolution of other multicellular lineages.

Oral Presentation
New Methodology for Sampling of Mucus-Enriched Coral Water for Vibrio Coralliilyticus Bioassay

Simone Jarvis
Mark Hay, PhD (Biological Sciences)

Consistently warming ocean temperatures are decreasing coral reef health. A major contributor to this trend is warming ocean temperatures. As ocean temperature increases, corals become more susceptible to diseases that lead to bleaching and tissue mortality. Vibrio coralliilyticus is one such coral pathogen especially known to cause bleaching. Previous methods quantified V. coralliilyticus metabolism and antipathogen activity of several coral species through fragmentation and agitation in seawater. This methodology was effective but included a few drawbacks, including the destruction of the sample which prevented sampling over multiple time points. This study intends to improve upon the current methodology for sampling surface mucus-enriched coral water.

Poster Presentation # 035
Cytochrome b562 as a Heme Chelator in Saccharomyces Cerevisae

Bryan Jenkin
Amit Reddi, PhD (Chemistry and Biochemistry)

Heme is an essential, but toxic cofactor required for virtually all aerobic life. As a consequence, cells are challenged to safely traffic heme to hemoproteins that reside in every subcellular compartment. However, the mechanisms underlying heme transport and trafficking are largely unknown. Moreover, it is unclear how various subcellular compartments communicate their requirement for heme to the mitochondria, where heme is synthesized. In order to determine how different subcellular compartments sense and respond to heme deficiency, I have been developing a heme chelator to induce local heme deficiencies. Once this is achieved, we can employ transcriptome and proteome profiling to determine pathways that enable various organelles to adapt to heme deficiency. Altogether, we seek to better understand how cells appropriate and distribute heme to diverse compartments that require this essential nutrient.

Poster Presentation # 036
Synthesis and Study of Influence of Nucleic Acid Intercalators on Proto-Nucleobase/Nucleotide Assemblies

Aditya Kakkar
Nicholas Hud, PhD (Chemistry and Biochemistry)

Prebiotic chemists have long hypothesized that RNA was the original informational polymer of life (RNA world hypothesis), and that RNA first assembled by the spontaneous, non-enzymatic couplings of pre-existing molecular building blocks. But, it has been observed that the nucleobases of extant RNA do not assemble in water as free bases or as mononucleotides, which presents a significant challenge to the RNA world hypothesis.1 We are investigating two potential solutions to this problem: 1) that certain prebiotic molecules facilitated nucleic acid polymerization by acting as nanometer-scale surfaces that stabilized base pair formation through non-covalent interactions (the 'molecular midwife' hypothesis),2-3 and 2) that RNA has evolved from an ancestral polymer that contained nucleobases that had an intrinsic ability to base pair at the monomer level (the hypothesis that RNA is the product of evolution).4 It has also been demonstrated that four plausibly prebiotic heterocycles that are similar in structure to the extant nucleobases of RNA, 2,4,6-triaminopyrimidine, cyanuric acid, melamine and barbituric acid, base pair in aqueous solution at the monomer level to form linear supramolecular assemblies,5-7

results that lend support to the hypothesis that the earliest nucleic acids contained different bases. Currently, we are investigating the potential for known nucleic acids intercalators, as model midwife molecules, to promote the supramolecular polymerization of model proto-nucleotides. It is found that the assemblies made from proto-nucleotides R5-MMP and G6-BMP form "short polymers" of length >100 nm. We are investigating that, the addition of intercalators such as purine in to these short assemblies will facilitate their supramolecular polymerization by acting as nanometer-scale surfaces following the 'molecular midwife' hypothesis. The synthesis and purification of melamine and barbituric acid mononucleotides and the intercalator mediated supramolecular polymerization of these nucleotides as analyzed by circular dichroism, 1H NMR, UV light and AFM will be discussed in the presentation.

Oral Presentation
Hyaluronan Physically Mediates Cell Adhesion Strength

Rebecca Keate
Jennifer Curtis, PhD (Physics)

Cell adhesion is the fundamental process underlying all basic life processes. While features that enhance cell adhesion strength, such as focal adhesions (FAs), have been widely studied, influences that decrease cell adhesion strength have yet to be explored. Hyaluronan (HA) is hypothesized to physically repulse cells from surfaces due to its high molecular weight and negative charge. Increased and specific production of HA has been recorded during events such as cell migration, cell proliferation, and tumor metastasis, which indicate HA may play a critical role in increasing cell motility. The primary objective of this work is to quantify the influence of HA polymers on cell adhesion strength. Using a hydrodynamic spinning disk assay, average cell adhesion strength will be quantified for various cell types, including rat chondrocytes and prostate cancer cells, with and without HA, which is removed with the enzyme hyaluronidase. A more comprehensive understanding of the factors influencing cell adhesion dynamics may elucidate targets for new therapeutic approaches for diseases such as cancer. The results of these experiments demonstrate that following HA removal, cell adhesion strength increases, and FA area does not significantly increase. This study indicates that HA does play a significant role in influencing cell adhesion strength in physiological and pathological systems.

Poster Presentation # 049
Evaluating and comparing the Numerical Relativity (NR) Waveforms from the World's Leading NR groups

Grace Kim
Deirdre Shoemaker, PhD (Physics)

During the last two semesters, I have been dedicated to checking the accuracy and consistency of the higher modes of spherical harmonics computed by Numerical Relativity simulations performed by different groups, and their associated physics. The increased loudness of future gravitational wave detections from binary black holes could allow us to observe the dominant spherical harmonic mode of its emission and its higher harmonics during the merger. While multiple studies have checked the accuracy of waveform models for the dominant spherical harmonic mode, there is no such study assessing the accuracy of higher modes. We have found that not all existing NR simulations are adequate for studying higher modes, which resulted in only certain simulations making the final list.

Poster Presentation # 037
Development of Conformational Antibodies to the N-terminal Coiled-Coils of Glaucoma-Associated Myocilin

Yemo Ku
Racquel Lieberman, PhD (Chemistry and Biochemistry)

Mutations to myocilin constitute a leading genetic cause of primary open-angle glaucoma (POAG), affecting more than 40 million people worldwide. Despite nearly 20 years of research into the role of myocilin in the eye, the function of myocilin remains unknown. Myocilin antibodies are widely used to track myocilin in tissue samples and to validate primary cell lines used in glaucoma research. However, current commercial myocilin antibodies used by the community cannot distinguish between folded (functional) and misfolded (dysfunctional) conformations of myocilin and therefore limit insight into the localization and protein-protein interactions associated with either state. To develop conformational myocilin antibodies, well-characterized N-terminal structural regions from both mouse and human myocilin were used to immunize mice, and antibody sequences were selected in-vitro for recombinant expression and characterization. We identified two new conformationally-specific antibodies which target the leucine-zipper portion of N-terminal myocilin, can immunoprecipitate myocilin from primary cell culture, and are cross-reactive towards human and mouse myocilin. The availability of these new antibodies offers unique opportunities to track human and murine myocilin in unprecedented detail, as well as to identify elusive binding partners and post-translational modifications.

Oral Presentation
Barium Ion Traps and Coulomb Crystallization

Deniz Kurdak
Michael Chapman, PhD (Physics)

Ion traps are structures that use dynamical electromagnetic fields that allow for the confinement of objects of different sizes ranging from macroscopic particles like cornstarch to single charged ions like barium. Applications of these traps have ranged from atomic spectroscopy experiments to quantum control of complex systems. One of the recent promising advances has

been its use in quantum simulations and quantum computation. We utilize an ultra-high vacuum chamber at 10^-12 torrs, alongside a high-power pulsed laser to create barium ions as well as two lasers to laser cool the ionic barium to confine these ions. We demonstrate a linear Paul ion trap consisting of a RF quadrupole electric field capable of producing fluorescing barium ions in an ordered pattern, called a coulomb crystal. This crystal could be seen through a lens with the naked eye. We are additionally attempting to incorporate the synthetic radioisotope of barium, that has a nuclear spin of I=1/2, thus possessing a hyperfine structure capable of supporting a qubit state. We aim to demonstrate high fidelity qubits though this radioisotope that can be used in quantum information and computation experiments.

Oral Presentation
Halogenase and Carrier Protein Specificity in Biosynthesis of Halogenated Pyrroles

Andrew Lail
Vinayak Agarwal, PhD (Chemistry and Biochemistry)

A variety of organisms produce natural product secondary metabolites for purposes including chemical defense from predation, antimicrobial toxins, and group signaling. These diverse functions lead to interesting chemical motifs and biological activities, some of which can be exploited for drug discovery pipelines. Many of these compounds are biosynthesized in an assembly-line format, so they contain common motifs that are incorporated into larger structures. One such motif is the halogenated pyrrole ring. The halogenated pyrrole takes an important role in pyoluteorin, an antifungal, and tetrabromopyrrole, a coral settlement cue. When an organism makes the halogenated pyrrole, the halogenase acts on the substrate while it is tethered to the carrier protein, suggesting the possibility for enzymatic specificity between halogenase and carrier protein pairs. Using purified enzymes from four distinct pathways, enzyme assays were performed to determine the specificity between halogenases and their native carrier proteins. The halogenases and carrier proteins were combinatorially tested to see which cross-species pairs could successfully form halogenated products, with the reaction products analyzed by mass spectrometry. Initial results show that some non-native carrier protein and halogenase pairs can form halogenated pyrrole products. Further research into this topic could yield novel chemistry and further our understanding of protein-protein interactions in this type of enzyme.

Poster Presentation # 038
Anti-Tuberculosis Leads from the Marine Sponge Haliclona sp. and Petrosia sp.

Yifan Liang
Julia Kubanek, PhD (Chemistry and Biochemistry)

Tuberculosis is an infectious disease caused by Mycobacterium tuberculosis and primarily affects the pulmonary system. The World Health Organization (WHO) estimated that about 10 million people developed tuberculosis in 2017, leading to 1.6 million deaths. Multidrug-resistant tuberculosis (MDR-TB) is quickly posing a serious health issue, with only 52% of patients being treated successfully and over half of patients showing resistance towards second-line medicines. To this end, discovery of new drugs with novel targets and mechanisms of action is of utmost importance. Most antibiotics in use today have been inspired from natural products of terrestrial origins. Marine sources are relatively unexplored and can pave the way for novel bioactive chemical structures. In our continued efforts to discover novel bioactive compounds from marine macroorganisms, the organic extract of marine sponges Haliclona sp. and Petrosia sp. showed promising anti-tuberculosis activity against M37Rv (virulent strain of Mycobacterium tuberculosis) with MIC90 of 1.5 and 3.0 µg/ml respectively. Further investigation has led to the isolation of two novel macrocyclic alkaloids from Haliclona sp. The high concentration of these alkaloids in the bioactive extract, along with literature precedents on analogous macrocyclic alkaloids being active against Mycobacterium tuberculosis, suggests that the bioactivity observed in our initial screening is imparted by these novel alkaloids. Ongoing efforts are focused on determining the structure using 1D and 2D NMR spectroscopy in conjunction with x-ray crystallography to elucidate the planar structure and relative stereochemistry. Additionally, the absolute stereochemistry will be determined using spectroscopic and computational methods. Future studies aim to establish structure-activity relationship and mechanism of action.

Poster Presentation # 024
Planar Covariation of Leg Elevation Angles During Locomotion in Cats

Timothy Liu and Bryce Matlock
Boris Prilutsky, PhD (Biological Sciences)

During locomotion the three-dimensional trajectories of elevation angles of the three leg segments (foot, shank, and thigh) lie closely to a plane. This planar covariation of the elevation angles may reflect constraints imposed by the nervous system on the control variables reducing their dimensions from three to two. In this study, we looked at the possible role of the cerebral cortex, the brainstem with the spinal cord, and motion-dependent sensory feedback and asked if one of these factors played a more significant role than the other in restricting the effective degrees of freedom leading to a higher level of planarity in cats. This was tested by tracking the locomotion of both intact (i) and decerebrated cats on a treadmill. Locomotion in the decerebrated cats was induced through stimulation to either the brainstem (ii) or the spinal cord (iii). We found that all three walking conditions exhibited planar covariation of elevation angles. There was no significant difference in planarity between the two decerebrate walking conditions and the intact condition. Since the circuitry in the spinal cord and brainstem lead to planar covariation, this means that the neural constraints

on the elevation angles must originate in neural networks of the brainstem and/or spinal cord but not in the cerebral cortex. Since there was a statistical difference in planarity between conditions (ii) and (iii), the motion-dependent feedback also plays a role in planarity. The results of this study will help design better therapeutic methods for recovery of locomotion after spinal cord injury.

Poster Presentation # 025
3-D X-ray Analysis of Birds' Unipedal Posture

Madison Luker
Young-Hui Chang, PhD (Biological Sciences)

Birds make up one of the most diverse and abundant vertebrate taxonomic groups, yet many avian species exhibit the common behavior of standing on one leg. In a recent study investigating this one-legged stance in flamingos, it was demonstrated that no muscular activation was necessary in the standing leg once this unipedal posture was adopted. This intriguing finding suggests that a passively-engaged gravitational stay apparatus functions to stabilize the standing leg; however, this mechanism was not directly illustrated. In this study, we aim to determine the anatomical structures that compose this biomechanical stabilizing mechanism and how it is engaged once the bird is positioned in the one-legged stance. Biplanar fluoroscopy and bone geometry from segmented CT will be utilized to obtain three-dimensional kinematic analysis of this mechanism. We will further investigate whether this mechanism is present in different avian taxonomic groups that exhibit one-legged behavior. This aim will provide insight into whether this mechanism is specific to flamingos or is a conserved physiological trait across avian morphology. Through investigating birds' unipedal posture, we intend to provide a greater perspective on the anatomical complexity behind organisms' behaviors which enable them to succeed evolutionarily.

Oral Presentation
Encapsulation of Human Indoleamine 2,3-Dioxygenase in Virus-Like Particles

Renee Julia Manalo
M.G. Finn, PhD (Chemistry and Biochemistry)

Human indoleamine 2,3-dioxygenase (IDO) is a heme-containing enzyme that participates in the catabolism of L-tryptophan to kynurenine. Kynurenine and its metabolites have been found to regulate T cell survival and proliferation. IDO plays a vital role in establishing immune tolerance, and tumor cells overexpress and secrete IDO as a means of evading detection by the immune system. The objective of this project is to encapsulate IDO within virus-like particles (VLPs) as a foundation for inducing antigen-specific immune tolerance to remedy autoimmunity and graft rejection. VLPs derived from PP7 bacteriophage are optimal carriers for IDO as they are stable structures that can be modified chemically or genetically to display specific antigens on their surface, or to target specific cell types, as opposed to administering enzymes indiscriminately. Using standard molecular cloning techniques, plasmid constructs were designed to express free and packaged IDO in E. coli. Packaging of IDO was confirmed via microfluidic PAGE (polyacrylamide gel electrophoresis). A colorimetric assay is used to assess IDO activity in vitro; it has been determined that the enzyme retains functionality when packaged. Current efforts are focusing on comparing the kinetic behavior of encapsulated IDO to that of free IDO, optimizing enzyme packaging, and screening the robustness of packaged enzyme after chemical modification. Future work will test the ability of VLP-encapsulated IDO to induce immune tolerance.

Poster Presentation # 039
Development of Machine-Learning Enabled Handwritten Chemical Structure Recognition Software

Grant Marshall
Michael Evans, PhD (Chemistry and Biochemistry)

The purpose of this project is to develop a program capable of translating an image of a hand drawn molecule into computer readable format such as SMILES. By combining tried-and-true computer-vision algorithms with emerging advances in machine learning, we hope to improve upon the most recent attempt to solve this problem by Bradley Emi. Currently, corner detection and agglomerative clustering have been effective at identifying and isolating areas of interest within the image. A modified version of the Hough transform is being employed to accurately determine connections between the areas of interest. In order to classify the areas of interest, we plan to implement a neural network classifier trained on a combination of handwritten characters and molecule fragments. To determine bond types between atoms, we plan to follow the success of Bradley Emi and implement a supervised learning classifier (linear support vector machine) trained with features from several cross sections of each bond. Successful completion of this project will result in a useful tool for both chemistry education and research scientists. Combined with a platform such as Gradescope, educators can use it to speed up the grading process for organic chemistry coursework, and researchers may use it to quickly search references for information on a molecule or intermediate.

Poster Presentation # 040
Degradable Polymers from Thionolactone Radical Ring-Opening Copolymerization

Owen McAteer
Will Gutekunst, PhD (Chemistry and Biochemistry)

Synthetic polymers play a crucial role in our everyday life. Many types of useful polymeric materials contain the common structural feature of an all carbon backbone. This structural feature makes these polymers non-biodegradable

which introduces environmental and sustainability concerns. My undergraduate research has focused on developing a new approach for the synthesis of acrylate and acrylamide copolymers with thioester-containing backbones. These thioester-containing polymers readily degrade under hydrolytic conditions as well as cysteine-mediated degradation. This was done by employing radical ring-opening polymerization, an underutilized technique, of a novel thionolactone monomer. Different from traditional radical ring-opening monomers, a thiocarbonyl radical acceptor allowed for complete ring-opening and compatibility with a variety of acrylate polymers. Furthermore, this novel thionolactone is compatible with reversible addition-fragmentation chain transfer (RAFT) polymerization, allowing for the synthesis of well-defined molecular weight polymers with reinitiating capabilities. Since publication in JACS, different routes for the future of thionolactone polymerization are being explored. My independent research project has mainly focused on the development of a second generation thionolactone with a more versatile synthetic pathway. We have observed significant differences in reactivity behavior with different vinyl monomers, such as acrylamides. The thionolactone polymerizes rapidly with acrylamide monomers, allowing for the implementation of localized degradable units in di-block copolymers. One of the main challenges of our research is poor thionolactone polymerization compatibility with styrene and methacrylate monomers. This highly modular thionolactone design will allow us to better understand vinyl monomer compatibility and reactivity behavior of thionolactones. J. Am. Chem. Soc. 2019, 141, 1446−1451

Poster Presentation # 041
Development of Four Subsystems for the ICEFIN Payload, a Novel Portable Cell Counter

Julianna McNeice
Amanda Stockton, PhD (Chemistry and Biochemistry)

A functional, independent cell counter is in development for deep sea applications and examination of the microbial population of the Ross Ice Shelf in Antarctica. The fabrication of this counter comprises five main subsystems: fluid pumping, cell labeling, sample filtration, sheath flow microfluidics, and cell detection. Herein the development of pumping systems for sheath flow, DNA staining optimization, and detection of fluorescing cells by way of an optical stack are addressed. A sheath flow of approximately 10 µm was generated in a PDMS prototype chip by a pumping system consisting of a sheath fluid syringe pump and sample dispensing piezoelectric pump. The region of saturation for Hoechst dye was found to be 12-48 µg/mL, while the region of saturation for DAPI stain was found to be 20-40 µg/mL. The full optical stack laser induced fluorescence system has been compressed into a lens tube to provide effective cell counts in a portable format. The development of these subsystems and their use in the final payload will compose an efficient LIF analytical instrument with applications in barren environments.

Poster Presentation # 053
The Role of Basal Forebrain Degeneration and Cortisol as Biomarkers Mediating Alzheimer's Disease Pathology: A Machine Learning Approach

Anudeep Nakirikanti
Thackery Brown, PhD (Psychology)

The pervasiveness of dementia in today's society is unprecedented in terms of the scope of the aging population afflicted with Alzheimer's Disease (AD). As a growing proportion of today's population encroaches on the age at which AD becomes prevalent, it is critical that health practitioners take steps to prevent the development and progress of this disease. Early diagnosis may constitute one of the best ways to combat AD, enabling preclinical interventions that encourage healthy neural aging. Such preclinical interventions focus primarily on mitigating identified risk factors of AD. Interestingly, two risk factors attributed to AD are cortisol, a hormone that is released by the body during times of stress, and basal forebrain degeneration. Critically, elevated cortisol levels and decreased basal forebrain volume are associated with neural pathology and an increased risk of AD. Here, we used machine learning (ML) and data from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database to classify (diagnose) individuals with AD based on evidence from multiple predictors. Importantly, this enabled us to test the prediction that cortisol and basal forebrain degeneration mediates the characterization of AD pathology. Supporting this prediction, we found that providing the ML algorithm with these metrics alone and alongside physiological AD biomarkers led to above chance diagnostic classification of AD and cognitively normal individuals. As a result, preclinical interventions targeting elevated stress and basal forebrain degeneration may play an invaluable role in preventing the development of AD in the general population.

Oral Presentation
Killing of E. coli by the Vibrio cholerae Type VI Secretion is Reduced in Response to Glucose-Mediated Spatial Assortment

Holly Nichols
Brian Hammer, PhD (Biological Sciences)

Vibrio cholerae is causative agent of the acute diarrheal disease cholera. In addition to its planktonic life cycle, V. cholerae interacts with other bacteria in dense polymicrobial microbiomes in environmental settings and the host gut. Like many Gram-negative bacteria, V. cholerae is equipped with a type VI secretion system (T6SS), a harpoon-like molecular weapon that delivers toxic effector proteins into neighboring target cells, typically causing cell death. The antibacterial properties of the T6SS have been implicated in the success of V. cholerae in host colonization

and in environmental reservoirs. Mechanisms by which target cells may evade or resist T6 killing are virtually unexplored. In a standard 3-hour co-culture assay on solid LB medium, cell counts of E. coli and many other targets are reduced by 4-5 orders of magnitude when co-cultured with T6+, but not T6- V. cholerae. We observed that on LB medium with glucose, cell counts of E. coli are nearly identical when co-cultured with T6+ and T6- V. cholerae. This unexpected survival of E. coli was not observed with any other targets or sugars tested. We demonstrate that E. coli does not simply outgrow V. cholerae on glucose, nor does it repress the T6SS. Preliminary data from visualizing V. cholerae and E. coli co-culture biofilms with confocal fluorescence microscopy suggest that E. coli may minimize T6-mediated killing as a result of changes in spatial structure of the community in a strictly glucose-dependent manner. These studies may provide insights useful for engineering of microbiomes.

Poster Presentation # 026
The Genetic Basis of Contralateral Axon Projection in Descending Decussating Neurons

Jameson Orvis
Alberto Stolfi, PhD (Biological Sciences)

The invertebrate sea squirt Ciona robusta is a very convenient model organism for studying neurological development. At the larval stage, there are only 177 neurons in the entire organism, however the nervous system is highly homologous to much larger vertebrate nervous systems. Out of these 177 neurons, only two at a larval stage cross the midline of the organism, connecting the left and right halves. No other neurons cross the midline. Finding out how the ddNs accomplish this midline crossing while no other neuron does is the goal of my research. To that end, a list of about 15 genes exclusively expressed in ddNs and not other neurons was generated using single cell RNA sequencing. Two of the most promising candidates in this list are Fibronectin-related (FNrel), an extracellular matrix protein, and Netrin1, an axon guidance growth factor. Overexpressing FNrel and Netrin1 in neurons which do not usually cross the midline does seem to induce neuron decussation, if not at least significantly alter their axon path. It has proven difficult to consistently assay potentially crossing neurons, and as such more work is needed to concretely conclude FNrel and Netrin1 are responsible for axon decussation. Work is also currently underway (and may be finished by the time of the symposium) to knock out Netrin1 and FNrel using CRISPR-Cas9, which would provide another avenue for determining the role of FNrel and Netrin1 in differentiating ddNs.

Poster Presentation # 027
Using Proales similis (Rotifera) for toxicity assessment in marine waters

Nancy Park
Terry Snell, PhD (Biological Sciences)

While extensive data in the literature uses rotifer toxicity assays to survey the effects of a variety of toxicants, most of this data focuses on Brachionid species. This study sought to develop toxicity tests with a novel species of rotifer, Proales similis, to expand options for aquatic toxicity testing. Certain species may be more representative of certain environments and sensitivity to different classes of toxicants is species-specific. P. similis is a compelling organism for developing new methods of toxicity screening in marine habitats because of its different physiology and small size. Furthermore, its ability to produce stable diapausing cysts that hatch within 24 hours of hydration make it convenient and cost-effective, since there is no need for maintaining live cultures. This is the first study directly assessing suitability of P. similis as a test animal for researchers studying marine pollution. It also introduces new methodologies for developing a new toxicity test based on inhibition of hatching rates of diapausing embryos of P. similis following heavy metal exposure. P. similis was exposed to various concentrations of cadmium, copper, and mercury and then effects on survival, hatching, reproduction, and ingestion were quantified. We found that mortality and cyst hatching endpoints were overall more resistant to heavy metal toxicity than reproduction or ingestion. Expanding test options, both in species used and methodologies, will help researchers understand the far-reaching effects of water system contamination and elucidate how pollutants can differentially affect a variety of species in an ecosystem. Overall, we confirmed that P. similis is a suitable tool for convenient and quick ecotoxicology assessments, and established cyst inhibition as a novel, reliable endpoint for observing effects of toxicity on rotifer populations.

Poster Presentation # 028
Immunohistochemical Identification of New Molecules Underlying Functioning of Muscle Spindles

Emily Pfahl
Dario Carrasco, PhD (Biological Sciences)

Muscle spindles are highly specialized receptors that encode information about static and dynamic features of muscle force and length that contribute to one's sense of body and limb position (proprioception), and movement (kinaesthesia). Although substantial advances have been made recently, the complete collection of molecules underlying transduction and encoding of mechanical stimulation by muscle spindles remains incomplete. In particular, the complete repertoire of ionic conductances involved in the normal firing occurring during changes in muscle dynamics still are unidentified. The present project was undertaken to identify new molecules previously not

known to be present in muscle spindles but known to be crucial for the normal functioning and modulation of repetitive firing in other neuronal cells.

Oral Presentation
Monte Carlo Simulations of Classical Spin Liquids

Hannah Price
Martin Mourigal, PhD (Physics)

Spin Liquids are a class of materials, whose spins are not ordered even at zero temperature. These materials have unique properties, with applications in high-temperature superconductivity, electronics, and quantum computing. Using the Monte Carlo simulation method, we simulate the ground state spin configurations of materials at low temperatures and classify these materials based on their spin. We classify the phases of the pyrochlore lattice, based on coupling energies, and identify regions of probable spin liquids. The program requires only basic unit cell and coupling energy information to run, thus, it is advantageous in simulating a broad spectrum of materials and lattice structures.

Poster Presentation # 042
Neural Networks as Chemical Descriptors to Facilitate Next-Generation Battery Development

Daniel Profili
Jesse McDaniel, PhD (Chemistry and Biochemistry)

The objective of this project was to develop new machine learning-based approaches for computationally screening solid-state electrolyte materials for next-generation sodium-ion batteries (SIBs). Specifically, we designed artificial neural networks that can predict a variety of descriptors governing the reactivity, ionic conductivity, and other critical parameters of solid-state electrolytes. High-throughput computational screening is essential for accelerating the experimental design of new battery technologies. Ab initio molecular dynamics simulations have been utilized to predict chemical properties of solid-state battery technologies, but these approaches are slow, computationally expensive, and limited in scope. Recent improvements in machine learning, particularly neural networks, present an exciting new direction for computational materials characterization. Trained on quantum-chemical data, a neural network could estimate the pertinent material properties more quickly and with less computational cost than molecular dynamics simulations alone. Another major advantage of neural networks is the potential for easy extensibility to a wide variety of systems, going beyond the spatial and temporal limitations of traditional simulations.

Poster Presentation # 029
Phenotypic Diversity of Staphylococcus aureus Isolates in the Cystic Fibrosis Lung

Angelica Rodriguez
Marvin Whiteley, PhD (Biological Sciences)

Cystic fibrosis (CF) is a progressive genetic disorder caused by a mutation in the cystic fibrosis transmembrane conductance regulator (CFTR) gene, which results in abnormally thick mucus that obstructs airways and glands. Mucus (sputum) buildup in the lungs allows opportunistic bacteria to persist long-term as chronic infections despite appropriate host immune responses and antibiotic therapies. Staphylococcus aureus is one of the most common bacteria isolated from CF lung infections, and the increased prevalence of antibiotic-resistant clinical isolates has become a crucial concern. Current clinical protocols analyze one to three S. aureus isolates to characterize overall genetic diversity in CF patients' lungs. However, an assessment of overall S. aureus diversity during CF lung infection with a wide range of isolates within the same patient and across multiple patients has not been performed. To address this gap, the phenotypic characteristics of fifty S. aureus isolates from multiple CF patients were assessed. To evaluate these isolates' ability to produce secreted virulence factors such as proteases and hemolysins, the casein hydrolysis zones and hemolysis zones of these isolates were quantified. Antibiotic susceptibilities were also compared, and most of these isolates exhibit resistance to several of six antibiotic classes commonly used in CF treatments. Preliminary results indicate phenotypic heterogeneity across and within CF patients. Further, we found a large range in the generation times of these isolates during growth in rich laboratory medium, which could indicate more global changes in the physiology of these isolates. Future experiments include the genetic characterization of these isolates.

Oral Presentation
Probing Heme Trafficking Factors via Organellar Contact Points Using Genetically Encoded Fluorescent Heme Sensors

Arushi Saini
Amit Reddi, PhD (Chemistry and Biochemistry)

Heme is an important protein cofactor and signaling molecule that plays diverse roles in biological systems. The hydrophobicity and cytotoxicity of heme necessitates that it is transported and trafficked in a regulated manner. However, the molecules and mechanisms responsible for mediating heme trafficking remain poorly understood. Until recently, the tools to study heme in vivo did not exist, but the emergence of genetically encoded fluorescent sensors has enabled comprehensive real time analysis of heme in model organisms such as Saccharomyces cerevisiae. This study showcases a new a protocol that allows investigation of heme trafficking from its site of synthesis in the matrix side of the mitochondrial inner membrane to the outer matrix, cytosol, and nucleus over time. The method allows for

the simultaneous examination of heme re-saturation in three cellular compartments after chemically depleting it. The study revealed that mitochondrial contact points play central roles in regulating heme availability and illuminates novel approaches to heme trafficking. These methods have the potential to be adapted to more inclusive compartmental analyses and a better understanding of heme trafficking can empower innovative approaches to study neurodegenerative disorders associated with perturbations in heme cellular dynamics.

Oral Presentation
A Robophysical Analysis and Gait Development for the NASA Resource Prospector Rover

Siddharth Shrivastava
Daniel Goldman, PhD (Physics)

Planetary rovers can become entrapped in soft substrates. The LCROSS lunar mission in 2009 indicated that regolith was less consolidated at the lunar poles than the equator. This led NASA JSC to develop RP-15, a 300 kg rover capable of lifting and sweeping each wheel to develop a crawling behavior. To discover techniques to improve performance, we created a scaled (2.1 kg) robophysical rover, conducting systematic experiments in our autonomous tilting, aerating, and motion capture gantry apparatus. A combination of stepping and wheel rolling produced higher drawbar-pull than wheel rotation alone in any situation (~4x increase on a 0 poppy incline). We validated our findings through experiments on RP-15 at JSC (~2x on a 0 sand incline). On steeper slopes (up to 27 , near max angle of stability), a novel gait generated forward progress via terrain remodeling via controlled avalanches. Rolling front wheels led to substrate mound formation posterior to the rover with stepping/paddling hind wheels generating forward progress; the wheel-only and walking-only gaits led to backward progress. Single paddling/ rolling wheel force measurements showed a 2x increase in normal force per gait cycle over pure rolling.

Poster Presentation #043
Submesoscale Mixing in the Northern Gulf of Mexico

Alexandra Sitar
Annalisa Bracco, PhD (Earth and Atmospheric Sciences)

The northern Gulf of Mexico, specifically the portion influenced by the Mississippi River plume (characterized by the presence of large lateral density gradients at the ocean surface) is of climatic, ecological, and economic relevance. Oceanic mesoscale structures, less than 100 km in diameter, have been extensively studied for their dynamics and impact on marine ecosystems, but submesoscale motions, between 100 m and 10 km, are not as well characterized. Submesoscale features involve much larger vertical fluxes than those associated with mesoscale motions, impacting nutrient distributions in the euphotic zone. The Regional Ocean Modeling System and a Lagrangian advection module were used to analyze the vertical and horizontal motion of 3D Lagrangian tracer injections. The virtual trajectories were analyzed with the objective of evaluating mechanisms governing lateral and vertical mixing within and across the mixed layer. Model resolution of 1km and 5km were compared to in-situ and remotely sensed data for locations outside mesoscale structures or in their center for summer and winter seasons from 2011-2016. Sensitivity runs established relationships between freshwater fluxes, surface submesoscale dynamics, horizontal and vertical mixing, and mixed layer depth. Results show that nutrient distribution across the mixed layer is affected by vertical mixing from submesoscale motions. There is seasonality to submesoscale circulations, which is especially critical for the vertical dispersion that drives nutrient supply during the winter. Moreover, the model resolution impacts the vertical tracer dispersion. This study will improve understanding of interactions that have direct biogeochemical impacts in coastal areas, thus facilitating preparation for harmful algal blooms or tracking efforts in the event of another large oil spill.

Poster Presentation # 030
Context-Dependent Allele-Specific Expression in Malawi Cichlid Crosses

Joseph Stockert
Todd Streelman, PhD (Biological Sciences)

During the early stages of adaptive radiation, species diverge through local adaptation to spatially distinct microhabitats. Such ecotype differentiation is poorly understood in the Lake Malawi cichlid lineage because otherwise closely related groups contain both rock-dwelling and sand-dwelling species. In order to clarify the evolutionary mechanisms of the rock/sand divergence, we analyze neural RNAseq data from experimental F1 hybrids performing courtship behaviors over rock or sand in social contexts. We use an allele-specific expression approach to identify gene-environment interactions and cis-regulatory elements that are involved with local adaptation in cichlids.

Oral Presentation
Analysis of Crevasse Patterns and Melt Pond Evolution on Four Greenland Tidewater Glaciers

Kathrine Udell
Britney Schmidt, PhD (Earth and Atmospheric Sciences)

As tidewater glaciers flow through valleys, they accumulate fractures and surface melt that provide qualitative information on how glacier thickness, climate forcing, and stress conspire within the ice over time. Rapid changes in the pattern can be indicative of a transition in the movement of the glacier. Fracture patterns can also provide quantitative information that allows for the calculation of the stress field and dynamics the ice experiences. In this study we examine crevasse patterns of four large glaciers

in Greenland; Helheim, Kangerdlugssuaq, Rink and Jakobshavn. Using satellite imagery, we collected images for the years 2001-2016 for each glacier and manually traced the fractures in QGIS. We recorded terminus position and melt pond area for each year. Using a Matlab code we developed, we obtained the fracture density per 0.5 square kilometers for each year we traced. Analyzing this data provides insight into the transition of ice from solid mass to highly fractured/collapse state. Preliminary results include a higher density of fractures closer to the terminus, large terminus retreats observed during the same years on Helheim and Kangerdlugssuaq, and melt pond shrinkage close to large calving events. In particular, the drainage of the same group of melt ponds on Kangerdlugssuaq during the large calving events of 2004 and 2008. Overall, gaining a better understanding of glacial dynamics and ice fracturing has implications for understanding the effects of climate change on glaciers and for our understanding of ice fracturing processes on other planetary bodies such as Europa.

Poster Presentation # 046
Stable Tame Isomorphisms of Legendrian Knots

Hunter Vallejos
Caitlin Leverson, PhD (Mathematics)

Legendrian knot theory is the study of embeddings of the circle in a 3-dimensional space with the added geometric constraint that the knot must everywhere lie tangent to a given plane field. One of the central aims of the area is to construct Legendrian knot invariants, which are computable methods of distinguishing knots. We investigate the Chekanov-Eliashberg differential graded algebra, a significant Legendrian knot invariant, testing if it can distinguish a class of ribbon knots from the standard Legendrian unknot. Moreover, we introduce "polynomial" contact homology by developing a computational tool in Haskell to compare it with linearized contact homology on the differential graded algebra under different gradings.

IVAN ALLEN COLLEGE OF LIBERAL ARTS

Poster Presentation # 002
Venezuelan Science Fiction

Samantha Hudock
Lisa Yaszek, PhD (Literature, Media, & Communication)

The purpose of this study is to look at the current situation in Venezuela and the resulting science fiction stories that have been produced over the past twenty years and to compare the trends they have followed to those that have been seen in other countries that have gone through socialist revolutions, like the USSR. For this study, I communicated with several authors in Venezuela who have been sending more stories and information and gathered several short stories and novels that were written over ten years ago. I also researched current scholarship on socialist science fiction and the relationship it has to utopian and dystopian stories. During the last twenty years, the stories in Venezuela have followed the general publics view of the revolution. At first, the stories were utopian, reflecting the positivity people had towards the socialist revolution. As Chavez, and eventually Maduro, began to become a dictator, the stories started to pick up more of a dystopian vibe. Now, most of them are entirely dystopian and can often be connected to direct events that have happened. This pattern follows very similar patterns seen in the USSR and other neighboring countries. Recognizing these patterns add to the study of politics and science fiction. It also gives a basis to go off as the political situation in Venezuela continues to evolve.

Poster Presentation # 003
US Humanitarian Intervention in Bosnia and Somalia: A Case Comparison

Sarah Moore
Dalton Lin, PhD (International Affairs)

This research seeks to explore the factors involved in the comparable cases of US intervention to fight genocide in Bosnia and Somalia. The main goal is to determine what key differences in these similar cases led the United States to successfully stop the genocide in Bosnia but not in Somalia. These cases were chosen for analysis based on the large number of control variables, including lack of US strategic interest in the area, purely humanitarian justification of intervention, similar time frame, lack of authoritative body in the state, and falling appropriately under the United Nations definition of genocide. Based on this context, I was able to utilize Mill's Method of Difference to parse through the cases and find variables that were present in the case of success and absent in the case of failure. Through my research, I identified a number of pertinent independent variables such as the post-intervention end goal, timing of decisions, rebuilding of domestic factors, political agenda, objective to rebuild the state, and political administration at the time. Using these data, I was able to draw conclusions explaining what causes US action to successfully end a conflict in one case but not the other. The implications of this research are huge, with the possibility to save millions of lives if this knowledge is effectively applied to future policy to end a foreign state's genocide. My hope is that this theory may be used to analyze ongoing cases like Liberia and Syria and thereby strengthen the overall generalizability.

Poster Presentation # 001
Recurrent Neural Network Analysis of International Trade

Abhinav Tirath
Usha Nair-Reichert, PhD (Economics)

I am working with Dr. Nair-Reichert to analyze current and past industrial-level trade relationships using recurrent neural networks. We will use analyses to suggest potential future relationships that will be stable and have consistent growth. As a step towards this goal, we will use recurrent neural networks to improve the prediction accuracy of overall international bilateral trade amounts between nations in the Spring 2019 semester. Neural networks may have an advantage over technical analysis because they easily capture complex, non-linear relationships and make no assumptions about the inputs. The only two studies to apply neural networks to trade data on an international scale were published fairly recently and simply show that they will be useful in this field. As globalization and interdependency between nations continue to rise, accurate predictions of international trade for the upcoming few years will inform important trade policy and investment decisions. Furthermore, these predictions will complement existing trade analysis with more nuanced insights about complex trading relationships, identify existing strong trade relationships, and help suggest future sustainable trade expansion paths.

Poster Presentation # 004
Fundamental Disagreements: Why ISIS and Al Qaeda Central are in Competition and the Future for Counter Terrorism

Molly Weston
Jenna Jordan PhD (International Affairs)

In the counter terrorism field of study and consultation, there exists a debate surrounding the most effective form of counter insurgency policy. Events following the 2011 Arab Spring have proven that not all fundamentalist groups are similar, thus challenging previous tactics. This project answers two primary questions: (1) "are the Islamic State of Iraq and Syria (ISIS) and al Qaeda in competition with each other?"; (2) "should the differences existing among these terrorist organizations be the cause of a revision of counter terrorism policy?". Despite the fact that ISIS and its predecessor al Qaeda in Iraq stem from the same organization, the actions and rhetoric of ISIS's leaders has significantly diverged from the al Qaeda parent organization,

contributing to both a rivalry and excommunication of ISIS. I source data from international Think Tanks such as Brookings and Reuters, compiling evidence and first hand accounts on the goals, structure, and tactics of the salafi jihads, triangulating my findings with counter insurgency research published in International Affairs journals. First I identify and group together fundamental, categorical differences between ISIS and al Qaeda, concluding the inter-group competition stems from conflicting views on tactics, caliphate establishment and enemy perceptions. Second, I argue the fundamental differences between ISIS and al Qaeda provide evidence to the fact that Islamism is not monolithic, thus requiring tailored counter terrorism policy. Third, I advise that counter terrorism policy surrounding ISIS should be fundamentally different from that of al Qaeda, focusing undermining the legitimacy of their state institutions.
of the period based on contemporaneous primary documents. This analysis reveals that hierarchical culture may aid in the development and conduct of cohesive disinformation campaigns. However, there is not enough evidence to support the assertion that hierarchical culture inevitably leads to cohesive disinformation campaigns.

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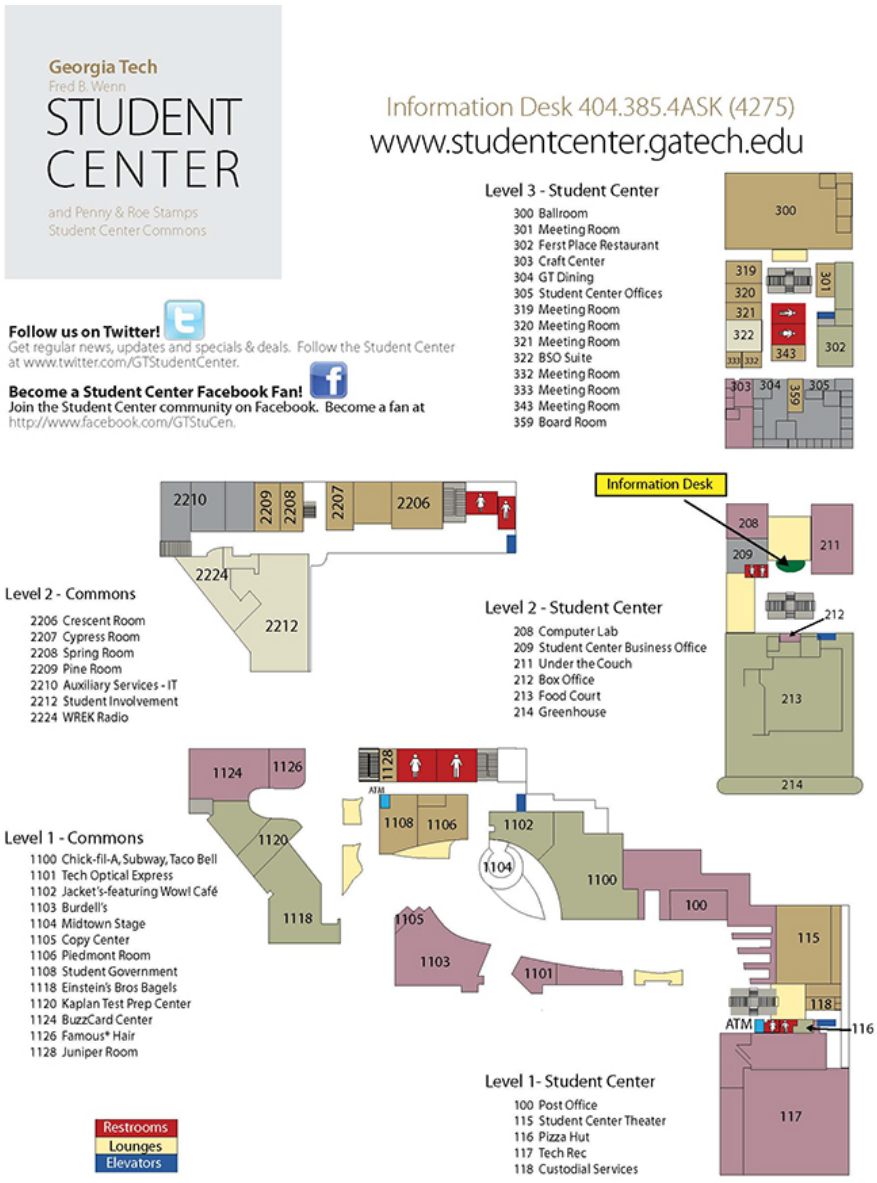
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