DREXEL UNIVERSITY
Office of
Undergraduate Research
Pennoni Honors College

2015

STAR SCHOLARS
SUMMER SHOWCASE

Thursday, August 27th

Edmund D. Bossone Research Center

10:00am - 5:00pm

DREXEL UNIVERSITY
Office of
Undergraduate Research
Pennoni Honors College

Suzanne Rocheleau, Ph.D.
Associate Dean, Pennoni Honors College
Director, Office of Undergraduate Research

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Office of Undergraduate Research

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Program Assistant (Co-Op)
Office of Undergraduate Research

The STAR Scholars Program is administered by the Office of Undergraduate Research, a unit of the Pennoni Honors College.

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Schedule of Events

10:00am - 12:00pm
Poster Session A
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Luncheon for STAR Scholars & Mentors
Bossone Research Center
Third Floor Atrium

1:30pm - 3:30pm
Poster Session B
Bossone Research Center
First Floor Lobby

4:00pm-5:00pm
Recognition Ceremony
Bossone Research Center
Mitchell Auditorium

A Message From THE DIRECTOR & DEAN

Welcome to the 2015 STAR Scholars Summer Showcase.

Over the past thirteen years of the STAR Scholars Program, we have witnessed the impact that Drexel's focus on undergraduate research has had, not only on our students and their faculty mentors, but on our broader Drexel community, the City of Philadelphia, and our wider world.

Since the Program's inception, more than 1,000 Drexel students have participated in the STAR Scholars Program, and the research, scholarly, and creative partnerships of our STARs and their faculty mentors continue to produce exceptional results. STAR Scholars are retained at a high level within the University, go on to graduate school in higher numbers than their peers, secure premier co-ops and prestigious fellowships, and graduate to outstanding careers. We are confident that our 2014-15 class of STAR Scholars will shine as brightly.

This year, 145 STAR Scholars and 8 iSTAR Scholars, including our first 4 Drexel students from the Antoinette Westphal College of Media Arts & Design who traveled to Los Angeles for the summer, have completed faculty- and professionally mentored projects, working in 10 colleges and schools. Under the direction of their outstanding mentors, our rising sophomore researchers have been studying the possibility of harnessing bodily movement as a source of power, creating conceptual models to represent college students' understanding of data breaches, and identifying plants that can be used for green architectural elements through the use of digital photography imaging.

Each summer, as we meet with our STAR Scholars, we see them grow in competence, confidence, and maturity as they begin to reimagine their lives as a result of this extraordinary experience. It is our hope that, as you see the result of their work, you are inspired, as well.

Dr. Suzanne Rocheleau, Director
Office of Undergraduate Research

Dr. Paula Marantz Cohen, Dean
Pennoni Honors College

OUTSTANDING Mentor of the Year

The critical piece of the STAR Scholars Program that makes it such a valuable experience for the students is, without a doubt, their Mentors. The STAR Mentors give much to their students' summer experiences and do so with no compensation.

In Summer 2011, the Office of Undergraduate Research created a process to recognize the STAR Mentors and to particularly celebrate the Outstanding Mentor of the Year. STAR Scholars are given the opportunity to nominate their faculty mentors or graduate student mentors for the "Outstanding Mentor of the Year" award, which provides the awardee with a $1,000 award to futher his or her research with undergraduate students.

Each nominated mentor receives a letter signed by Provost Blake that outlines the common characteristics held by all nominated Mentors, and each letter includes excerpts from the students' nomination letters to provide an individualized account of just how these Mentors have contributed to those specific students' experiences.

Based on these nominations, outstanding Mentors:

- Are passionate experts in their field who freely share their expertise with students
- Care deeply about their students and treat them with respect
- Generously foster students' intellectual and professional development
- Actively engage students in learning and celebrate their success
- Go above and beyond in supporting their students

All of our mentors go beyond the call in their work with STAR Scholars, and we are genuinely grateful for the time and effort they commit to furthering the education of undergraduate students.

2014 Outstanding Mentor of the Year
Dr. MURUGAN ANANDARAJAN

The 2014 Outstanding STAR Mentor of the Year Award was presented to Dr. Murugan Anandarajan (Management, LeBow College of Business) at the 2014 STAR Summer Showcase. Dr. Anandarajan received a plaque engraved with his name, as well as a $1,000 grant to support his further work with undergraduate researchers, which he has used to purchase research materials, as well as to support his students' attendance at professional conferences.

"For me, Dr. Anandarajan is not just the person I work with; he is my professor, mentor and advisor at the same time... He has always been patient in explaining to me the steps that I have to take in my work... he would always find time in his schedule to work with me. Every time he talked about the project, I would feel challenged to work harder to achieve the best results... he makes me want to aspire higher... Now, I feel more convinced about continuing my education after graduating."

- Irina-Marcela Nedelcu

Dr. Anandarajan's willingness to go above and beyond as an instructor and mentor has been an inspiration to many students over the years. He began teaching a four-credit course each Spring term to all Business STAR students and interested STAR Humanities students to introduce them to the research methods they need to succeed in the STAR Scholars Program. Additionally, because Dr. Anandarajan has tirelessly championed research as a part of a well-rounded curriculum, the LeBow College has created the LeBow Business Fellowship Program, which gives students more opportunities to explore research-based work at Drexel.

It is for Dr. Anandarajan's commitment to educating and mentoring students, both in the STAR program and in the classroom, that we honor him as our 2014 Outstanding Mentor of the Year.

Understanding Digital Cultural Heritage with the James Dexter House and Peale's Museum

Ryan Rasing
Antoinette Westphal College of Media Arts & Design
Game Art & Production

Dr. Glen Muschio
Faculty Mentor
Digital Media

James Oronoco Dexter and Charles Wilson Peale are two notable figures whose contributions helped shape key parts of Philadelphia's history. As a manumitted slave, James Oronoco Dexter was a founding member of the African Episcopal Church of St. Thomas in 1792, a church still active today. Meetings that led to the founding of the church were held in his home where the National Constitution Center now stands. Around the same time, Charles Wilson Peale, a painter and naturalist, was tending to his natural history museum, filled with artifacts, specimens, and portraits, eventually moving it to the Old Pennsylvania State House, now known as Independence Hall, in 1802.

This summer I worked at the Archaeology Lab of Independence National Historical Park, recording data obtained through scanning and photogrammetry methods that produced 3D models of archaeological artifacts. The models will be used in two Public Service Announcements to be shown on the PECO building in October. One will announce a free archaeology event about Philadelphia's buried past; the other will announce October is Pennsylvania Archaeology Month.

I also helped digitize mounted bird specimens at the Academy of Natural Sciences to create virtual dioramas based on those exhibited in Peale's Museum. My long-term plan for the work completed this summer is to produce an educational game in which players would learn about the challenges of race, class, and religion faced by the people of Philadelphia in Peale and Dexter's time, and to better understand the consequences of those struggles we still experience today.

Rearranging a Broadway Production, Breach of Contract or Copyright Infringement?

Julia Davis
Antoinette Westphal College of Media Arts & Design
Entertainment & Arts Management

Mr. M. Brannon Wiles
Faculty Mentor
Entertainment & Arts Management

Hands on a Hardbody (HOHB), a Broadway production written by Doug Wright, with music by Trey Anastaio and Amanda Green, and lyrics by Amanda Green, was closed after only 28 performances. A theater in Houston Texas, Theater Under the Stars (TUTS), bought the licensing right to produce the play. The play was modified by director Bruce Lumpkin without consent of the HOHB licensor, Samuel French, Inc. After Samuel French learned of the alterations, it sent a cease and desist letter to TUTS. The play closed as a result of this action. Lumpkin argued that he did not change the artistic intent of the play; he merely reordered the play's content. Samuel French, Inc. and those involved in the Broadway production of HOHB agreed that Lumpkin's changes were a breach of the licensing agreement.

My research focused on determining whether there is evidence which establishes that the changes made to HOHB at TUTS was not only was a breach of the licensing agreement, but also a violation of the Copyright Act of 1976. By researching similar licensing violation and copyright infringement cases, such as Feist Publications, Inc. v. Rural Telephone Service Co., Inc., I was able to analyze the HOHB fact pattern and predict whether the creators of HOHB would win a copyright infringement case if it were brought to a court of law.

Tauheed Baukman
College of Engineering
Chemical Engineering

Ms. Genevieve Dion
Faculty Mentor
Fashion Design

Wearable Power

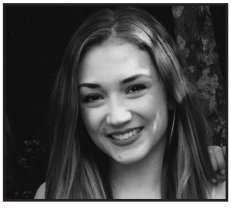
Wearable technology is an expanding field with so much potential. From the Apple Watch, to Google Glass, and heart rate monitors these systems and devices require some sort of power supply for functionality. Imagine being able to be your own efficient power source, storing the energy you use from your daily movements. The goal of this project was to demonstrate that it is feasible to create a knitted device with electromagnetic capabilities that can store power produced from bodily movement. This functionality requires transferring kinetic energy into electrical energy before it can be to store it. To achieve this, we implemented Faraday's Law into our knitted structure, which consists of passing magnets back and forth through coils of wire to generate a voltage. This knitted device was developed at the Shima Seiki Haute Tech Lab, using Shima Seiki SDS-One Apex design software, the SSG122SV knitting machine, and the SWG041N knitting machine. We experimented with different knit structures for the magnet wire to find the maximum power that can be produced. Materials used for this knitted device include: magnet wire, neodymium magnets, clear PVC tubing, and yarn.

Wearable Power

At the Shima Seiki Haute Technology Laboratory fashion designers, engineers and scientists work together to integrate technology into textiles on a deeper level. We work to shorten the gap between the invention and industrial manufacturing process. The goal of this project was to design and invent wearable energy generated that can be an easily manufactured. This prototype uses electromagnetic induction to generate electricity. The design of the electromagnetic generator was based on the Faraday Flashlight. We started our design by creating a small rectangle of fabric and a tubular structure using magnet wire that would run through the middle of the fabric, using the Shima software. We inserted an oiled PVC tube in the tubular structure and placed 3mm neodymium magnets in the PVC tube. As the user shakes the piece of fabric, the magnets will pass through the magnet wire coil and induce a current through the wire. Using the Shima Seiki knitting machines and software, we are able to quickly reproduce this prototype electrical generator and perform little post-production work.

Keith Taylor
College of Engineering
Mechanical Engineering

Ms. Genevieve Dion
Faculty Mentor
Fashion Design



Rebecca Oswald

Antoinette Westphal College of Media Arts & Design

Graphic Design

Ms. Jody Graff

Faculty Mentor

Graphic Design

Ms. Clare Sauro

Mentor

Curator
Historic Costume Collection

Paul Poiret and the Collaboration of Design Disciplines

The Robert and Penny Fox Historic Costume Collection (FHCC), was created in the 1890s supporting the belief of A.J. Drexel that art, craft and design are vital components to the educational philosophy of art, industry, and science. The FHCC contains over 12,000 historic pieces of apparel, and accessories dating back as far as the 18th century. Another Westphal collection, The Charles Evans Fashion library containing a collection of Vogue, Harpers Bazaar, and other significant publications, is also a resource for students and faculty in the Westphal community. They date as far back as the early 20th century and include the work of many noted photographers, illustrators, and graphic designers. These Westphal collections are a reflection of the collaborative spirit of design disciplines and how they work together to benefit one another.

Paul Poiret, a fashion designer from the 1910s is an archetype of this mutually beneficial interdisciplinary relationship. At the turn of the 20th century, traditional ways of life and the roles women played in society were being challenged. Poiret was critical in changing the way women were dressed as lifestyles began to change, and in many ways was implementing that change with his ideas. He often worked with textile designers, illustrators, fine artists, and organizations such as the Wiener Werkstatte to develop, produce, and promote his revolution in women's clothing.

Renovation Plan for the Drexel University Psychology Department

This research project examined the interior spaces occupied by the Drexel University Psychology Department located in Stratton Hall. Combining clinical, educational, and faculty environments, the goal of this project was to create a cohesive environment that marries the psychology of space, color, and atmosphere with improved traffic flow, functionality and the overall emotive feel of the space. The work began in the clinical area by defining the scope of the project and indentifying the most common patient types and conditions seen at the institution. From there, researching standards and safety guidelines for clinical facilities was the main priority. The psychology of color, art, light, human reaction behavior were also examined by means of investigating research and case studies. In addition to research publications, meetings with faculty revealed a need for better lighting, acoustics, and the creation of a more home-inspired and soothing environment through natural imagery. Along with the clinical spaces, some of the department's academic areas were also examined and research was conducted to determine the design elements required to create a positive working environment. Based on the data collected, an implementation plan was developed, identifying specific changes that need to occur in order to create an environment which is appropriate for the identified functions.

Maya Miller
Antoinette Westphal College of Media Arts & Design
Interior Design

Ms. Ada Tremonte
Faculty Mentor
Interior Design

Annell Cordero

Antoinette Westphal College of Media Arts & Design

Screenwriting & Playwriting

Mr. Ian Abrams

Faculty Mentor

Screenwriting & Playwriting
iSTAR in LA

The View From the Bottom of the Hollywood Food Chain

Being a writer in Hollywood is like being stuck in Hell's waiting room. There's thousands of you packed together in a hot place and no one knows what to really expect. But for some reason we're happy. "Maybe Hell will be different for me because I'm special! Once they read my work, they'll know how special I am!"

It's hard to be special when everyone has a "spec script" which is an original feature or an episode of a current television series. Or when they have a quirky and original "elevator pitch" which is just when a superior asks what you want to do with your life, you have an "unforgettable" answer. If everyone has the same tools, how do you stand out from the crowd?

For a month I was tasked with figuring this out. Constantly sending my resume everywhere and trying to make myself special and different. Finally I got a call from my boss who was interested in a play I wrote which was set in Brooklyn. My boss happened to be from Brooklyn. I finally stood out and I landed my internship at a production company. I have an hour and a half stop and go drive and I sit in a room with hardly any sunlight, but I'm happy. I now know how things work behind the scenes.

So the formula is simple. You get to Los Angeles, you sweat it out, and you stand out from the rest of the crowd, and then prepare yourself because it's a Hell of a ride from there.

iSTAR in LA

Grip & Electric: The Skeleton of the Independent Film Crew

On a feature film set, the Grip & Electric (G&E) team is responsible for the rigging and powering of lights and the organization of complex equipment. The challenges for G&E are diverse and many in how the team is expected to safely run power and rig lights whether in a studio or on a remote location. Without a competent G&E team, there is no light to enhance the narrative, and there is no power to keep the production moving.

From running a twenty-five foot power line to DIT, to rigging a 4K light setup, the challenges G&E commonly face change depending on what the scene requires: a single three-point lighting setup, an interior daytime scene to be shot during darkness or reverse.

Maintaining organization allows the grips (handymen) to pull equipment at a moment's notice. My job as Best Boy is to make sure that all equipment is accounted for during production and safely transported from location to location. When equipment is transported, ensuring that all materials are safely buckled down in their respective compartments prevents damage and loss ten-fold. If equipment is damaged or lost on an independent feature, this hurts both G&E's inventory and the film's budget. If a four-by-four diffusion is missing, this slows down production. In the film industry, time is money and the purpose of a solid G&E team is to be able to solve problems quickly and effectively through physical strength and mental agility.

Kevin Quinn
Antoinette Westphal College of Media Arts & Design
Film & Video

Mr. Ian Abrams
Faculty Mentor
Screenwriting & Playwriting
iSTAR in LA

Ian Thomas
Mentor
Grip & Electric

Ramone Saraza
Independent
Gaffer

iSTAR in LA

Critical decision making in the production of film

Lucy Moroukian

Antoinette Westphal College of Media Arts & Design

Film & Video

Mr. Ian Abrams

Faculty Mentor

Screenwriting & Playwriting
iSTAR in LA

Ricardo Diaz

Mentor

Cinematographer

First Girl I Loved was produced by PHS Collective, made up of Ross Putnam, Kerem Sanga and David Hunter; their indie film The Young Kieslowski won the LA film festival audience award in 2014 and is going into distribution this fall. Working with a team that knew their work ethic so well was an amazing experience, and it showed in the production of *First Girl I Loved* in the communication between departments and a common goal at the end of the film. The role of data manager and camera assistant on the feature film *First Girl I Loved* entailed a great number of responsibilities. It begins with the basics of checking for duplicates of footage on hard drives and making sure everything has transferred from camera to computer to post house. The data manager also has the responsibility of checking continuity with the script supervisor and showing selected print takes to the director and being involved in final decision making for what takes should be brought to the editor for a cut of the film. Critical decision-making was central to bringing on actors like Pamela Adlon (Louie) and stand up comedian Cameron Esposito, who came on to help with the progression of this project. Seeing the project from the other end of the workflow was a truly amazing and unique experience.

iSTAR in LA

Production Techniques and Issues of Pop Music

Being a music producer means being a part of every aspect of the creation of a song. Performance, arrangement, vocal processing, instrumentation, budgeting and songwriting are just a few of the many responsibilities of a popular music producer. Naturally, the producer encounters issues through the production of a song. Specific techniques are used to foster creativity, avoid issues in production, and to reach the intended goal. This summer allowed me the pleasure of shadowing Lenny Skolnik, an acclaimed music producer. Mr. Skolnik has worked with bands such as Theory of A Deadman, Rascal Flatts and the Goo Goo Dolls. Working with Howard Benson, a renowned producer who has produced several platinum and multiplatinum records for artists like Daughtry, Kelly Clarkson, My Chemical Romance, and others allowed for an even deeper analysis of popular music production techniques. Working with two experienced producers provided insight on the process of building a fully produced song in a group setting. This summer, the production of ten songs were analyzed for vocal techniques and processing, instrumentation, mixing, and song lyrics. Four popular genres of music were also analyzed for various issues and techniques. Production techniques are the most crucial part of producing a song. Throughout the years production techniques change, and using modern techniques is always favored.

Luis Rodriguez
Antoinette Westphal College of Media Arts & Design
Music Industry

Mr. Ryan Schwabe
Faculty Mentor
Music Industry
iSTAR in LA

Lenny Skolnik
Mentor
Alumnus

iSTAR in LA

Carl Durkow

Antoinette Westphal College of Media Arts & Design

Product Design

Mr. Michael Glaser

Faculty Mentor

Product Design

Inclusivity in Design: Hairdryer for Arthritic Hands

My research revolved around a specific type of Industrial Design known as Inclusive Design. I focused on identifying and solving a common issue adult women with arthritis of the hands confront in their daily routine: the use of a hairdryer.

Inclusive Design is the design of products or systems that are usable to the greatest extent possible by everyone, regardless of age, ability or status in life. My project began with researching ailments that affect large groups of people to find a target group for which was an opportunity for design. After observing my father who is unable to perform simple tasks such as opening a water bottle due to his arthritis, I found that this affliction would provide me with a great opportunity, as hands are the main interface between humans and the products we use.

I began the design process by developing methods for interviewing subjects to understand their daily experiences. I created two activities that I had each subject do. The activities consisted of creating a simple graph of when they experienced the most stiffness in their hands and completing two matrices to organize products and activities based on difficulty of use. After analyzing the data, I concluded that one of the most difficult items for my subjects to use was the hairdryer, as it requires them to use all of their gripping strength to operate. I then proceeded to study the hairdryer to better understand it and find opportunity for redesign.

The Design of Inclusive Shower Products

Inclusive Design has recently become a major focus of interest for product designers throughout the world. It is the design of products or systems that are usable by the largest population possible, regardless of age, ability, or social status. We decided to create products that are designed to help one specific person but are also useful for most others.

The design process for our research began with discovering what exactly Inclusive Design is and what ailments and disabilities affect the most Americans today. Our research then became more specific: I decided to focus on designing for young adults (ages 18 to 30) who have temporary or permanent loss of use of one of their arms, whether through an injury, surgery, or amputation. Once a focus was chosen, interviews were conducted with people fitting our descriptions. Using matrix and timeline activities along with a set of questions we gained valuable insight into how these individuals interact with products in their daily lives and if/how they have had to alter their routines due to their impairment. Through the analysis of data from the interviews, we identified the needs and challenges of our interviewees in order to find opportunity for design.

I discovered that one of the most difficult tasks an individual with the use of only one arm must perform is showering unassisted. I am therefore designing shower products that incorporate good design principles and improve functionality in a way that everyone can benefit.

Laeticia Mabilais Estevez

Antoinette Westphal College of Media Arts & Design

Product Design

Mr. Michael Glaser

Faculty Mentor

Product Design

Erik Stefans
Antoinette Westphal College of Media Arts & Design
Product Design

Mr. Michael Glaser
Faculty Mentor
Product Design

Designing Inclusive Garden Equipment

Inclusive Design is the design of products or systems that are usable by the largest population possible, regardless of age, ability or status in life. As a strategy, we used a user-centered design process in which we focused on an individual with a specific disability in a specific situation, with the goal of improving the functionality of a product from which everyone can benefit.

I focused on people with temporary or permanent loss of arm function over the age of 40 who are avid gardeners.

The first step in this process was to educate ourselves about inclusive design by reading articles, researching existing products in the field, talking to people with disabilities and conducting an experiment in which we spent an entire day without using our non-dominant arm. We then formed visual hierarchies called matrices as a tool to critically think about the information we collected.

After choosing my design focus, I volunteered at a community garden in Kensington to observe how people garden. This helped in my interview with a 76 year-old man who became amputated in an accident in the Navy. I created activities for my interviewee that would help me find opportunities for improving a gardening tool.

Organizational Governance & Internal Audits

George Spiro Armentani

Bennett S. LeBow College of Business

Finance & Marketing

Dr. Hubert Glover

Faculty Mentor

Accounting

Dr. Kevin Jones

Faculty Mentor

The Institute of Internal Auditors' definition of internal audit states that "internal auditing is an independent, objective assurance and consulting activity designed to add value and improve an organization's operations. It helps an organization accomplish its objectives by bringing a systematic, disciplined approach to evaluate and improve the effectiveness of risk management, control, and governance processes." Fraud and poorly evaluated internal audits have led to some of the largest business scandals of all time such as the ENRON scandal in 2001 and the WorldCom scandal in 2002. Because of these occurrences, the government implemented new auditing guidelines and procedures when it passed the Sarbanes-Oxley Act of 2002 (SOX).

We are conducting a study to determine how the Sarbanes-Oxley Act of 2002 (SOX) impacted the internal audit profession. Specifically, we are seeking to determine how SOX impacted organizations' internal audit departments (IAD) in the areas of leadership, staffing, scope of services, budget and perception. The survey will be sent out to the Philadelphia Audit committee and then depending on the feedback, we plan to send this out nationwide. I developed a survey using the survey building program Qualtrics. This is from where my data will be collected. The next step will be performed by my mentors in which they will conduct a pilot and then a full scale survey. When the results are obtained we hope to have a better understanding about what exactly SOX achieved and how it has changed the way internal audits are conducted.

Athira Sivan

Bennett S. LeBow College of Business

Legal Studies-International Business

Dr. Hubert Glover

Faculty Mentor

Accounting

Women Studies in Business

Women have been struggling in recent years for equality in all aspects of living that were previously closed off to them. In the past decades, a prevailing struggle that has been brought to light is the plight of the Women in Business. It is not until the strong feminist movements of the 1970's, that research on women in business have begun to accumulate on a stronger scale. Through this research project we seek to gather the research thus recovered on the different aspects of women in business in order to find trends according to which topics have been looked into more in depth as time has passed; along with continuing to see how women have flourished in business facing the obstacles in front of them. We gathered research papers structured through decades and key terms to discover the amount of research done on the specific topics at each time and to see the increase of research done on varying keywords of women in business including: entrepreneurship, gender difference, glass ceiling, harassment and work life conflict. The articles were acquired through searching and citing from the Drexel Libraries database. We found that there was an overall trend of increasing results for each category over time with "Women in Business" being the leading category followed by "Entrepreneurship". The categories "Work Life" and "Harassment" consistently resulted in the lowest number of articles in each decade. We also find that in the 20th century there is a sharp increase in results for all keywords.

Multi-Period Portfolio Optimization with American-Style Asian Options

Brendan M. Stec

Bennett S. LeBow College of Business

Business and Engineering

Dr. Hande Benson

Faculty Mentor

Decision Sciences

Portfolio optimization, the selection of proportions of various assets to be held in a portfolio, is one of the crucial arms of modern financial theory. Theorists implement expected returns, variances, and covariances of different equities, bonds, and derivatives in order to build a theoretically efficient and diversified portfolio. This research builds a multi-period portfolio with American-style Asian options, a unique breed of "exotic" financial derivatives that allow for exercise at any time during the timeline of ownership. Ten different equities from the Dow Jones Industrial Average were also selected for the portfolio. Using five-year historical pricing data and a Monte Carlo simulation in MATLAB, a forecast was made for 200 daily periods in the future. Mixed integer programming found the optimal proportion of equities and Asian options, as well as the optimal times during the forecast to exercise the options for an optimal risk-adjusted return. In practicality, these techniques could be used to find a benchmark number of derivatives to act as insurance for a portfolio of equities. This research also expands on traditional multi-period portfolio optimization by including an American-style (not European-style) Asian option. This component lends itself better to a typical investor's portfolio, as the early exercise is convenient for frequent re-balancing. Coupled with lower volatility due to the averaging function and the resulting lower price, American-style Asian options are a timely and interesting research area in finance.

Jared Edelstein

Bennett S. LeBow
College of Business

Finance and
Business Analytics

Dr. David Becher

Faculty Mentor

Finance

Technically Compliant? Corporate Governance in Tech Firms

Technology's influence can be found everywhere, from how people interact to how business is conducted. But who is pulling the strings? Many CEOs of today's tech firms founded their companies, such as Google's Sergey Brin and Larry Page or Facebook's Mark Zuckerberg. There is a growing concern, however, that these CEO-founders are not experienced enough to run the firms. Zuckerberg, for example, was 20 when he founded Facebook. With the CEO having so much control, who is monitoring their actions? My research investigates the independent directors delegated with this task to understand who they are and how they are selected.

Following numerous high-profile accounting scandals in the early 2000s, Congress passed the Sarbanes-Oxley Act, partly designed to address responsibilities of executives and board members. This legislation encouraged firms to create a higher-ranking position for the outside board members, commonly known as a Lead Independent Director or Presiding Director (LID).

Analyzing nearly 100,000 directors at over 1,700 public firms, I find that 30% of all tech firms have a LID, but the position can be arbitrary. For example, some companies annually choose a LID by alphabetically rotating among board members, raising the question if these LIDs are effective monitors. This is particularly important in the tech industry, where 70% of firms have a CEO-Chairman and almost 33% have no outside CEO monitor. This calls into question the need for more oversight in the tech industry, especially since industry experts suggest tech CEOs may be overconfident and need strong outside supervision.

Too Many Cooks in the Kitchen?

Ankira Patel
Bennett S. LeBow College of Business
Accounting

Dr. David Becher
Faculty Mentor
Finance

After accounting scandals such as Enron, regulators such as the SEC and NYSE have suggested a new, unbiased role to help guide firms: lead independent director or LID. These directors are responsible for providing oversight when a CEO duals as Chairman of the Board, in hopes to prevent potential conflicts of interests. My research analyzes board structures through proxy statements of 1,700 firms from 2000 to 2011. To determine the impact of the LID position, I studied each firm's stock and accounting performances.

My results indicated that LID's are not necessary for a firm's financial prosperity. For example, firms that share a CEO and chairman have an average stock return of 17% per year, whereas companies that separate these positions perform similarly with an average stock return of 13.7% per year. Firms that have consistently performed tend not to introduce a LID, likely due to their confidence in their existing board structure. Firms with less confidence in their board structures sought a LID to stabilize their financial performance. My data, however, does not demonstrate that a LID will improve stock return. Stock performance actually decreases by an annual average of 1.8%, after a company adds a LID to oversee an existing CEO-Chairman.

Overall, my findings demonstrate that the suggestion to create a LID may be misplaced, because not every firm requires this role to thrive financially. The key to success appears to lie in implementing a strong system of checks and balances that suits the needs of each company themselves.

Options Listing Affect on Gold

Sneha Agrawal
Bennett S. LeBow
College of Business
Finance

Dr. Erik Benrud
Faculty Mentor
Finance

Commodity based trading has seen a pivotal shift in the last twenty years with the introduction of Echange-Traded Funds (ETFs). These vehicles allow most investors to make investments in assets that once required a high level of sophistication and high net worth. Accessible, affordable, and marketable, asset-backed ETFs in gold and silver provide alternatives to buying and selling the physical commodities. By tracking the underlying prices of gold bars or coins, ETFs can be used to reflect the value of the commodity while trading as easily as stocks on an exchange. These eliminate the need to 'know the right people' and overcome the steep minimum-investment-level barrier associated with trading such assets. They also offer the opportunity for arbitrage and options trading. With increased use by more investors, there may be more volatility and inflated prices. We have analyed the development of the gold ETF market, the introduction of derivatives on those ETFs, and the associated changes in the market activity for the ETFs. It appears that there has been a remarkable increase in activity in gold ETFs as the market has expanded and even more products have been introduced. Those products include leveraged ETFs and inverse ETFs, which move in the opposite direction of the price of gold. Future research will assess the extent to which these developments will have a net positive effect on financial markets and the health of investors' portfolios or will lead to instability and future crises.

Affect of Risk Management on Bank Risk

Did the Dodd Frank Wall Street Reform and Consumer Protection Act, installed by President Barak Obama in 2010, actually help banks reduce the risk they take on? Analyzing the proxy statements, documents informing shareholders of the decisions made by executives, of over 100 financial institutions for 10 year-periods, the research team aims to determine when risk committee members were appointed and if they in fact had previous experience dealing with risk. Steps in the analysis process include collecting and sorting proxy statements for over 100 financial institutions, determining which year risk committees were installed and if risk committee members were independent from the company and had prior experience dealing with risk, and recording results for 10 successive years, 2005 to 2014 inclusive, in collaboration with the Cleveland Ohio Branch of the Federal Reserve System.
The objective of the implementation of the risk committee is to prevent another financial crisis due to the excess taking of risk. Here, the risk committee's main function is to manage risk. Ultimately, in Dr. Naveen's research, the question arises whether financial institutions are learning from their mistakes made in the 2008 crisis.

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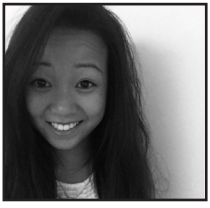

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Leveraged Lending

Recently, covenant lite loans have been widely issued in the syndicated loan market. Covenant lite loans are riskier than traditional loans due to the absence of protective financial covenants, which once served as early warning signs for lenders. Therefore, this significant increase in covenant lite lending can potentially have an adverse effect of contributing to the collapse of financial institutions, especially banks. Alternatively, covenant lite loans may provide additional flexibility for some borrowers without a significant increase in risk. We investigate the types of firms that receive covenant lite loans. An idea is companies backed by private equity firms are more suited to obtain covenant lite loans. Further, we examine companies who have violated their financial covenant to determine whether there is a correlation based on their past performance. After discovering which companies have breached any covenant, we compile hundreds of credit agreements and record the existence of certain financial ratios, incremental term or revolving loan, equity cure rights and separate voting rights. Ultimately, this data will help explain any correlation between certain companies and covenant lite loans and help distinguish whether the loans represent risky lending practices or provide optimal financial flexibility.

Backchannel: An Integration Study in Various Course Disciplines

Increasing classroom participation assist in a student's understanding of the subject. In every classroom, the frontchannel includes the lecture from the professor to the students and the questions from the students to the teacher. Where the backchannel includes the communication outside of the frontchannel—like note-passing, whispers, and other distracting interactions between students. Digital backchannels are mediums of communication such as Twitter, SpeakUp, and Backstage that attempt to enhance the frontchannel instead of distracting from the frontchannel. Researchers, who previously conducted studies on digital backchannels, usually analyzed large undergraduate courses in the STEM fields. We analyzed the transcripts of education, accounting, and general business courses—which contain sizes less than 40 students—to suggest that backchannel allow students to enhance the conversation through questions, to draw conclusions from the lesson, and to connect to past knowledge.

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Knowledge Leveraging: a new model for the knowledge sharing process

Knowledge sharing has become one of a company's greatest assets and most competitive resources. In fact, Fortune 500 companies lose an estimated $30 billion through failure to share knowledge within their organizations. Although knowledge sharing is instructive on the flow of knowledge from point A to point B, it lacks the ability to grasp why an individual chooses to use their knowledge. Researchers have attempted to fill this gap by studying the knowledge reuse construct, which focuses on the degree to which something is codified and the extent to which that codified knowledge is accessed.

This study attempts to go even further and make a unique contribution to existing literature on knowledge sharing and reuse by conducting an extensive literature review and developing a new model that portrays why individuals leverage knowledge. By definition, knowledge leveraging is the proactive effort to take accumulated knowledge and use it to improve the strategic performance of an organization through mission critical activities. Six hypotheses have been developed to further our understanding on the key antecedents to knowledge leveraging.

Study of the Effectiveness of Fraud and Identity Theft Video Advertisements

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In 2014, there was a new identity fraud victim every two seconds, 12.7 million in total, with $16 billion stolen from these victims. The government, public and private service companies, banks, and interest groups have all taken part attempting to educate the public on identity theft by releasing and airing several commercials. By performing visual content analysis on these commercials using semiotic modes, I was able to dissect the different aspects of scenes from every video in my population of samples retrieved from the Internet. A few of the aspects examined include: frame, social distance, gaze, music, as well as how the videos were organized. The commercials had two general agendas, building awareness of identity theft and teaching how to prevent the individual from becoming victims themselves. I will then test how effective these videos are in portraying their message and influence individuals to take action, then look at my previous analyzed data and find the correlation between the most effective videos and what they are composed of. With this information, the players releasing the commercials will incorporate the effect elements for more beneficial advertisements.

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Risk Communication on Data Breaches Among College Students

This study seeks to better understand the level of knowledge of college students in the area of data breaches and identity theft. College students are some of the most vulnerable to data breaches, given that the American education industry saw 9% of higher education institutions breached in some way in 2013, the consequences of which are still not fully understood. College students also keep more information online than their older counterparts, with three quarters of people within the traditional college age group having created at least one social media account. This study involved a series of protocol-based interviews where subjects were asked open-ended questions on the subject of data breaches. This information was then translated into mental models, or visual representations of their knowledge. The mental models were then compared to an expert's opinion to determine how much the students knew about data breaches and whether what they thought to be true was correct, incorrect or incomplete. This knowledge gap analysis would determine the best way to convey correct information on the subject to this key demographic so that they could make the best decisions to protect their information.

Future Outlook for Retail Payment Options and Security

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In the past few years, identity theft and cybercrime have compromised the security of current methods of personal payment. As a result, new technologies have debuted to offer options besides the typical credit/debit card or cash selection. This systematic overview examines the influential force of current parties such as consumers, merchants, the government, and financial institutions on the state of payment forms such as Micro-chip protected cards, Near-Field Communication (touch-free) devices, classical credit cards, debit cards with pin codes and cash, among other choices.

The strength of the force was calculated based on comparisons between parties and importance of features in payment method, such as security, cost, convenience, merchant acceptance, and reliability. The technologies within the bounds of the study were then ranked based on the highest prevalence of all factors important to each party to predict their prevalence in the future.

I have concluded that consumers are focused on convenience, merchants opt for the most cost-effective option, government aims for security, and financial institutions' interests align with consumers and government. The option that will overwhelmingly take hold of the market will be a combination of mobile and card technologies that incorporate personal identity verification such as a PIN or biometric identification. New developments such as ApplePay™ have recently disrupted the payment ecosystem and the next decade will reveal whether customers reach to embrace such options.

State Governments and Entrepreneurship: How State Policies Affect Entrepreneurship Across the United States

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When one considers which states are strong in entrepreneurship, most likely California comes to mind because of Silicon Valley, or perhaps New York with its city's abundance of capital and new businesses. It would probably be surprising to to learn then, that there are proportionally more people starting their own business in rural Alaska then there are in California or New York. How could this be when Alaska has little access to venture capital funding, is sparsely populated and relies heavily on natural resource extraction? The policies of each state's government are an important part of the answer.

This project focuses on the extent to which the actions of a state's government affect the entrepreneurship levels of the state. Twelve states of varying sizes, economies, regions and political affiliations were selected to examine the circumstances under which state governments do the most to influence entrepreneurship. Using the Kauffman Rate of New Entrepreneurs by State, which measures the average number of people in a population that start a new business per month as the standard of entrepreneurship for each state, I examined how well changes in government policy at the state level (such as income tax hikes) correlated with changes in the entrepreneurship rate. Factors outside the control of state governments were considered as well, including the general economy of the country and unemployment levels. Finally, consideration was given to important variables which could not be easily quantified, such as the dependency of a state on specific industries.

Examining the Impact of Disability Legislation on Global Tourism

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Domestic and global tourism provide a substantial impact on the economies of most countries that recognize the benefits of welcoming out-of-town visitors. An aspect of tourism that's often overlooked is the accessibility of the destination for disabled travelers, including vital accessibility information necessary for decision making for this market segment. It is estimated that 15-20% of the world's population has a disability, and profits generated from disabled tourists could be multiplied because this segment commonly travels with a larger group of people than non-disabled tourists. A list of the top 100 vacation destinations representing 49 countries based upon the number of international visitors was examined for this study. Specifically, we sought to link the existence or absence of disability legislation to the availability of accessibility information on the official visitor's websites for each of the 100 destinations. We then tested the accessibility of these websites in terms of their conformance with online accessibility guidelines from the World Wide Web Consortia using the Sort-Site evaluation tool. Disabled tourists require information regarding accessibility in order to make travel decisions, and this information is a key component to ensuring a favorable experience. Destinations could realize greater profitability from these travelers, but it begins with the accessibility within the preliminary information gathering process.

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Syncopation in Advertising and Consumer Perception of Brands

Music is a very important part of most cultures, and minority cultures tend to be associated with music that is generally more syncopated than non-minority cultures. We argue that companies use socio-musical cues to signal status within their industry; brands which have the most market share (i.e. dominant brands) use less syncopation in communications, while brands with less market share (i.e. subordinate brands) use syncopation to leverage their status relative to bigger brands. By analyzing the audio tendencies of companies with varying status in several different industries, we not only measured whether brands are using these sorts of social cues, but also whether consumers are picking up on it. The purpose of this project is to identify different industries and record detailed data on their advertisements vs. their status in the business world. Next steps for the project include collecting data on consumer reactions, and gauging if the consumers pick up on the trend or not.

The Role of Shapes in the Recall of Product Prices

Many people have researched the interference of memory on the recall of numbers or prices. People have studied how the shape around a price or the design of product packaging affects buying patterns. No researcher has actually delved into the territory to see if the shape around or near an advertised or printed price will have an effect on how the consumer recalls that number. This project itself has not involved tracking consumers' satisfaction with products, but has a main goal to discover how humans are able to effectively recall prices, and also identify any obstacles that would hinder this action. We have focused mainly on the marketing aspects, but have explored the world of psychology as well. Through avid research and literature reviews, we have seen that it is highly likely that fluency is a positive factor in price recall (i.e. angular number within or near an angular shape; rounded number within or near a rounded shape). This means that people will usually associate rounded numbers with rounded shapes (i.e. 8, circle) and vice versa (i.e. 4, hexagon), which aids them in most accurately recalling prices in these situations.

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Humor In Online Reviews

Electronic word-of-mouth (eWOM), also referred to as online reviews, assumes a great importance in the buying process in online channels of retail. In the absence of touch and feel of the product, prospective customers rely heavily on online reviews during the decision making process. Additionally, electronic word-of-mouth has greater reach and speed; making this area an interesting avenue for academic research. Researchers have extensively studied variables related to the review and the reviewer in an attempt to better understand the usefulness of these reviews. There is evidence in the literature as to the effect of humor in making the complaint in online review appear less negative. The current study explores the effect of four different styles of humor on the helpfulness of the review. Affect created through the review is proposed to mediate this effect.

Pulling the Curiosity Trigger

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For the better part of the past century, companies' interaction with consumers has been dominated through a traditionally linear approach to marketing products. This approach entailed marketers showing a product, usually surrounded by abnormally beautiful people, with the accompaniment of a catchy tag to differentiate their brand. With the dawn of a new millennium, the linear relationship has evolved. The emergence of the Internet as an online tool for discovery now offers consumers endless information sources, which has allowed for a new facet of marketing to flourish in tandem with the technological craze: consumer curiosity. Consumer curiosity is dimensional; it creates a "curiosity journey" that weaves emotional connections through empowerment, which ultimately results in customer loyalty. Curiosity creates this empowerment; consumers feel ownership of their "discovery" and thus feel more inclined to become advocates or brand ambassadors. Consumer curiosity is simply put designed to generate the spirit of inquiry— a spirit that leads to an increase in consumer motivation, boosts brand awareness and leaves the customer with an overwhelming desire to inquire. Our research looks at what will happen to consumers and their behaviors when marketing stimuli such as commercials, ads, packages, etc. trigger their curiosity. Examples of advertisements that used consumer curiosity to market their product were collected from a variety of sources. These campaigns were analyzed through the study of industry awards, companies market shares before and after campaign launches as well as the product/brands social media presence.

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Tortilla Chip Fat Absorption

Tortilla chips are a staple in many pantries throughout the world. We can't always avoid eating them regardless of the fact that we know they're not always the healthiest options available. The purpose of this experiment is to help create a reduced fat corn tortilla chip by adding modified food starch to the mesa, corn flour, to prevent oil uptake while fried. Thus, the amount of oil in the tortilla chip needed to be determined. To do this we fried tortilla chips with the addition of two different modified food starches - Hi-zana and baka-snak - at percentages of 25%, 10%, 5%, and 2% by weight. The chips were blended into hexane and then heated to evaporate the hexane to give the percentage of the oil present in the chip. Another component to this experiment was the temperature of the masa dough before frying. For the trials with Hi-zana, one set of trials was run with cold dough into a fryer while the other set used room temperature dough. After running the experiment, it is unclear if either
Hi-maza or baka-snak made any difference in the oil absorption, for the percentage of oil in the chips remains relatively similar no matter the type of starch or amount. Despite this, we found that the trials with cold dough (Hi-zana trials only) had approximately 2% less oil than the room temperature dough.

Characterization of Late Cretaceous Fossil Wood from the Hornerstown Formation, Mantua Township, New Jersey

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The Inversand fossil site in Mantua Township, New Jersey, has yielded a substantial number of Late Cretaceous marine fossils including vertebrate remains of turtles, crocodiles, mosasaurs, and invertebrates such as clams, oysters, and snails, all found in the main fossiliferous layer of the Hornerstown Formation. This study sought to histologically characterize two samples of fossil wood, also discovered at this shallow marine site, and to investigate potential causes of their black discoloration. Broad goals of such an investigation include potentially elucidating the chemical history of the environment. Finding evidence of combustion, permineralization, fungal decay, etc. is of interest as it can provide a small window of insight into the 65-million-year history of the wood and its possible relationship to the K/Pg extinction event of this site. Utilizing light and petrographic microscopy, both samples were identified to be gymnosperm wood and evidence of both fungal decay and permineralization were observed. Future direction of this study could include a targeted chemical analysis for perylene, a biomarker for fungal decay, and for several polycyclic aromatic hydrocarbons (PAHs), which are associated with the combustion of plant material. This can also be supplemented by identifying the minerals seen in the permineralized wood sample by investigating qualities such as mineral birefringence, surface relief, or fracture. Such analyses of wood will help further understanding of the environment at the time of the extinction event and its impact on ancient life forms.

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Bivouac checking behavior and species abundance in ant-following birds

In tropical forests, many insectivorous birds follow army ants in order to capture arthropods escaping ant raids. In order to track the location of the mobile ant colonies, many ant following bird species periodically check the location of army ant bivouacs. We asked whether certain target bird species are more common at army ant bivouacs as opposed to arbitrary locations in the forest, and how population density of those target species has changed over the past several years. By mist netting at bivouacs and away from bivouacs (control sites) in Monteverde, Costa Rica, we tested whether presumed ant following bird species: Ruddy Woodcreeper, White-eared Ground Sparrow, and Orange-billed Nightingale Thrush- display bivouac checking behavior. Residual statistics suggest that Ruddy Woodcreepers were significantly more common at bivouacs than the other target species. This shows that this species potentially bivouac checks more frequently in order to obtain food. We also compared our mist net data from 2015 to that of 2012 and 2013 to see if and how relative abundance changed over the years. We found a lower number of Ruddy Woodcreepers in 2015 than previous years, and higher numbers of White-eared Ground Sparrows and Orange-billed Nightingale Thrush. We conclude there is high inter-annual variation in abundance of ant following birds.

iSTAR in Costa Rica

Poster Session B

Close Encounters of the Bird Kind: Using a Novel Telemetry System to Track Tropical Forest Birds associated with Army Ants

In tropical forests, many bird species follow army ants in order to capture arthropods fleeing from army ant raids. Some of these bird species exhibit a specialized behavior called ant bivouac (nest) checking in order to gauge army ant activity. However, little is known of the ecology or behavior of many ant-following bird species. We used a novel automated radio telemetry system ("Encounternet") to investigate the interactions and spatial movements of ant-following birds in Monteverde, Costa Rica, in 2015. We deployed 21 Encounternet tags on birds from five resident bird species that attend army ant raids: Blue-diademed Motmot (n=1), Ruddy Woodcreeper (n=4), Clay-colored Thrush (n=3), White-throated Thrush (n=2), and White-eared Ground Sparrow (n=11). Tags were programmed to transmit a unique ID pulse, which were logged by 14 portable receiver stations we deployed in our study area. We used tags' interaction data to ask whether any target species exhibited bivouac-checking behavior and found some evidence of bivouac checking by Ruddy Woodcreepers. We also used tags' spatial data to ask how far birds moved after being tagged and whether this might indicate home range or ant following behavior. Ruddy Woodcreepers moved more often and over greater distances, which may be linked to their ant-following behavior.

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Experience-dependent regulation of FMRP phosphorylation in olfactory axons

Fragile X syndrome, the most common single gene form of autism, is caused by transcriptional silencing of the FMR1 gene which results in loss of the Fragile X mental retardation protein (FMRP). FMRP is an RNA binding protein that inhibits the translation of mRNAs important for experience dependent plasticity in the brain. FMRP dephosphorylation in response to stimuli removes this inhibition, leading to more protein synthesis. However, in Fragile X patients this regulation does not occur and the brain reacts inappropriately to stimuli. Most research into the role of FMRP has focused on dendrites and cell bodies of neurons. Consequently, the role of FMRP in axons has been largely unexplored. Recent work has identified an axon-specific FMRP-containing ribonucleoprotein particle, the Fragile X granule (FXG). FXGs also contain the Fragile X related proteins FXR1P and FXR2P, ribosomes, and RNA. To determine whether experience regulates the phosphorylation state of axonal FMRP in FXGs, I exposed mice to the odorant isoamyl acetate (a banana scent) and then took samples of olfactory brain tissue to stain for FMRP and pFMRP (phosphorylated-FMRP). Preliminary data suggest that odor exposure results in dephosphorylation of FMRP in FXGs because pFMRP levels decrease while FMRP levels slightly increase after odor presentation. In the short term, we will extend these findings by including additional animals and time points. In the future, we will investigate whether pairing odorants with a behaviorally-relevant stimulus (e.g., reward) alters this effect as well as dissecting the signaling events that regulate FMRP phosphorylation in axons.

Biophilic Algae for Living Interiors Project

Urban food deserts occur when food stores with nutritious and affordable goods are not readily available within 1 mile of a specific locality, causing inhabitants difficulty in accessing healthy food. In order to make produce more accessible to the urban population, the biophilic algae project promotes the cultivation of plants by using nitrogen-fixing cyanobacteria as a natural fertilizer in indoor algal ponds. The nitrogen-rich fertilizer can be used to grow fresh produce where indoor space is maximized, and the growth and health of the produce is not compromised. In this project, several designs were developed for algal ponds to use in an indoor urban setting, that are recyclable, stackable, and compressible yet durable. Physical models were generated using Model Magic, then transposed with AutoCAD software and 3-D printed with a Makerbot. These designs and the nitrogen-rich fertilizer will be tested in underserved urban regions, such as the Mantua neighborhood of Philadelphia to grow produce. By using cyanobacteria as fertilizer in a compact indoor setting, growing and eating healthy food can be a more accessible option for urban indoor environments.

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Analysis of Putative Extracellular Matrix Proteins in Cyanobacteria

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Trichodesmium erythraeum IMS 101 is a nitrogen-fixing cyanobacteria that forms blooms toxic to marine organisms. This organism contains gene sequences that code for proteins resembling the extracellular matrix (ECM) proteins of eukaryotes, including an integrin-like protein. Our goal is to discover the role of this integrin protein in *T. erythraeum*. Generally, in eukaryotes, integrin is a receptor protein that facilitates attachment of cells to each other and to the ECM. Based on the known function of integrin, we hypothesize that this putative protein in T. erythraeum is used to join adjacent cells in filaments, and neighboring filaments to one another. Inputting the amino acid sequence of the protein into a genomic database and using BLAST analysis revealed similar proteins in a wide distribution of organisms ranging from cyanobacteria to mammals. Top hits from BLAST analysis were then run through Clustal Omega, a multiple sequence alignment software, to determine conserved regions amongst the protein sequences. A phylogenetic tree showing potential evolutionary relationships was also assembled from these data. Submitting the sequence to I-TASSER generated possible structural models of the Trichodesmium integrin protein, which were analyzed to determine conserved domains and structure-function relationships. Ultimately, understanding the function of this protein in cyanobacteria will provide insight for controlling the proliferation of toxic blooms.

Transport inhibition of digoxin using several common P-gp expressing cell lines is not necessarily reporting only on inhibitor binding to P-gp

P-glycoprotein (P-gp) is a cellular receptor that inhibits the passage of certain molecules across the cell membrane and has been studied extensively due to its importance to human health. In order to develop an understanding of the transport kinetics of P-gp and its role in drug-drug interactions, data concerning the inhibition of digoxin across a cell monolayer and uptake of 15 P-gp inhibitors were analyzed, with a focus on 8 of the 'better' inhibitors, in earlier work. In this study, the IC50 values of the remaining 7 'lesser' inhibitors were examined and fitted, using different kinetic parameters. The IC50 values for each of the 7 inhibitors across three different cell lines (MDCKII-hMRD1-NKI, Caco-2, and LLCPK) from 10 different pharmaceutical labs were examined. Those that displayed the expected sigmoidal shape were then fitted using a particle swarm algorithm.

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Investigating the mechanisms underlying Tip60 HAT activity in epigenetic gene control in Drosophila nervous system

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Environmental stimuli provide specific neurons in the brain with instructive information critical for shaping synaptic connections that directly impacts cognitive ability. External information received by the brain is converted into intracellular signals that epigenetically 'program' coordinated gene expression programs that promote sustained cognitive neuroadaptation.
Disruption of such response programs results in significant cognitive impairment. Importantly, environmental enrichment (EE) conditions have profound beneficial effects for reinstating cognitive ability in neuropathological conditions, providing promise for early developmental non-invasive treatments. While such EE benefits involve epigenetic gene control mechanisms that comprise histone acetylation, the select HATs involved remain largely unknown.

Our lab focuses on understanding the epigenetic role of the HAT Tip60 in learning and memory. Previously we have shown that Tip60 HAT action plays a neuroprotective role on cognition linked neuronal circuits under Alzheimer's disease linked neurodegeneration. Here, we investigate how such regulation takes place in the nervous system.
Our previous bioinformatics data reveals that clusters of Tip60 cognition genes are enriched for common transcription factor (TF) binding motifs with known neural function. To better understand the interaction between Tip60 and specific transcription factors, I specifically chose Hunchback, Squeeze, Abnormal-A and Zeste based on our previous study. By researching related scientific articles, I am specifically interested in one TF, Zeste, which affects DNA and histone packaging. This information and further experimental tests can potentially provide some insight into the mechanism of how Tip60 regulates certain gene expression.

Gene Regulation in Response to Environmental Enrichment in Drosophila Nervous System

Environmental enrichment (EE) conditions have profound beneficial effects for reinstating cognitive ability in neuropathological conditions such as Alzheimer's disease (AD). Histone acetylation plays a vital role in the response to EE. It was previously discovered that the HAT Tip60 is required in the Drosophila mushroom body (MB) for beneficial responses to EE. Increased expression of genes for enhancing cognitive function in Tip60 HAT mutant brains was observed, demonstrating that EE causes beneficial neuroadaptive responses in the Drosophila MB, and that Tip60 plays a crucial role in the process. It also leads to the question of how Tip60 HAT activity promotes a neuroadaptive response to EE by specific gene regulation. While previously Tip60 was found to associate with DNA-binding transcription factors (TFs) to control gene transcription, the identity of TFs involved in Tip60 neural gene control remains unknown.

In this project, potential TFs that function in response to EE after HAT activity are identified and further investigated by carrying out genomic analysis, pinpointing specific motifs within the Drosophila genome, and identifying TFs with consensus sequences in their DNA-binding domains. Here we proposed a model that Tip60 controls neuroprotective gene sets in concert via its recruitment to these loci by common DNA-binding TFs and that Tip60 HAT action is required for this recruitment. Further tests on specific TFs will be carried out to provide more insight into understanding the mechanism underlying Tip60 HAT activity mediated gene regulation.

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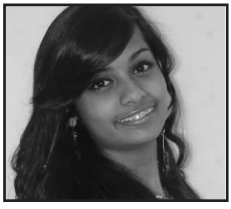

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Do Endoplasmic Reticulum Chaperones Play a Role in Terminal Seam Cell Differentiation?

HSP-4 is a *C. elegans* homologue of an endoplasmic reticulum chaperone called BiP that is induced by the unfolded protein response to facilitate the folding of proteins in cells. However, preliminary data shows that this protein that is normally induced in stress situations is also highly expressed following asymmetric division of stem-like seam cells when they terminally differentiate into alae producing cells. Thus arose our question: what is the functional purpose of a stress induced protein in this differentiation process? In order to understand HSP-4's role in seam cell differentiation, the transcription of hsp-4 was downregulated in worm models to determine if there was any resulting changes in this terminal differentiation process during development. Our data showed that inhibiting hsp-4 expression yielded a change in the expression pattern of a seam cell specific protein marker in the beginning stages of terminal differentiation but not in the ending stages. This indicates that HSP-4 does play a role in the terminal differentiation process of seam cells. We further hypothesize that HSP-4 might have an effect on the time at which the fate of the resulting anterior daughter cells are determined during terminal differentiation, the asymmetric versus symmetric qualities of seam cell division into daughter cells, or the expression of a seam cell specific protein within the daughter cells. Further understanding the role of this chaperone in the terminal differentiation of seam cells can offer us insight into the mechanics of other important terminal differentiations, such as the vital differentiation of B cells into antibody-secreting plasma cells within the human immune system response.

Potential Promiscuous Possible Putative Sugar Kinase in Dictyostelium discoideum

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Glucose, the primary source of energy used by all cells, is broken down by the process of glycolysis. The first step of glycolysis is the phosphorylation of glucose to glucose-6-phosphate by hexokinase. Glucose, however, is not the only source of energy in cells – other sugars, such as galactose, may be used, as well as proteins and lipids. The first step of the metabolism of galactose is also phosphorylation; galactose becomes galactose-1-phosphate, a reaction catalyzed by galactose kinase. A search in the *Dictyostelium discoideum* genome revealed a putative orthologue to galactose kinase, but no apparent orthologue to hexokinase was identified, raising the question of the purpose of this putative kinase. Until the specific purpose of the putative protein can be determined, it has been dubbed a putative sugar kinase. Further *in silico* investigations revealed that the putative sugar kinase bears a strong similarity to N-acetylgalactosamine kinase, a promiscuous kinase able to catalyze phosphorylations of multiple different monosaccharide substrates. This similarity implies that the putative sugar kinase may itself be promiscuous, and be able to catalyze reactions of different isomers of glucose, including galactose. By transfecting *D. discoideum* with plasmids designed to produce an antisense transcript of this gene, we hope to knock down the production of the putative sugar kinase and experimentally determine the purpose it plays, if any, in sugar metabolism.

Determining Cyclopamine's Effects on Alzheimer's Disease Using Drosophila melanogaster as an In Vivo Model

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Alzheimer's disease (AD) is a neurodegenerative disorder and a major cause of dementia in older adults. AD is characterized by the cleavage of amyloid precursor protein (APP) by β- and γ-secretases. This creates toxic amyloid β (Aβ) plaques in the brain, resulting in cognitive decline. In HeLa cells and primary cortical neurons, we have shown that cyclopamine decreases γ-secretase mediated APP cleavage. Cyclopamine, a phytosterol, is an antagonist of the Smoothened (Smo) receptor in the Sonic Hedgehog signaling pathway. The concerns with using cyclopamine as a potential therapeutic for AD are that it's teratogenic, unstable in stomach acid, and insufficient at crossing the blood-brain-barrier. In Drosophila melanogaster, the Gal4-UAS driver is used to overexpress human APP and β-secretase, creating an in-vivo model of AD. The goal of this project is to test the ability of cyclopamine to reduce the AD detrimental phenotypes. Other Smo antagonists, GDC-0449 and Itraconazole (Itra), as well as 10 cyclopamine analogs are being tested to see if they have similar rescue effects. Larval crawling and adult climbing assays were conducted to observe the effects on the central nervous system and motor reflex behavior of the AD flies, respectively. For further studies, we plan to test the drugs with the most substantial effects in neuroanatomy and learning and memory, as well as move into mammalian studies.

Role of the 3' Untranslated Region in the Hypoxic Upregulation of Histone Deacetylase 5

Histone deacetylase 5 (HDAC5) is a protein that controls the acetylation level of histones and, in turn, regulates the activation status of DNA transcription. Previous research has shown that HDAC5 can upregulate hypoxia-inducible factor 1 (HIF-1), which is a master transcription regulator that aids tumor cells in adapting to an environment of hypoxia, or low oxygen. Many cancer cells suffer from hypoxia due to the insufficient blood supply caused by their high proliferating rate and impaired vascularization development. Therefore, HIF-1 plays a vital role in the survival and growth of tumor cells. Our lab has found that HIF-1 can be stabilized by HDAC5 to promote tumor cell proliferation. Currently, we are interested in whether hypoxia or HIF-1 can affect the expression level of HDAC5 as a feedback. Specifically, this project investigates whether and how HDAC5 mRNA level is regulated under hypoxia. Using real-time qPCR, we observed that the HDAC5 mRNA level was upregulated under the condition of hypoxia. Then, with the luciferase assay system, we confirmed that 3' untranslated region of HDAC5 mRNA was not responsible for the regulation. We plan to further investigate the underlying mechanism of hypoxia-induced change of HDAC5 mRNA level, and whether HIF-1 is involved in its regulation. Understanding the relationship between HDAC5 and hypoxia may allow for the development of more specific chemotherapies to better target and destroy tumor cells.

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Luminescent Complexes of Inner Transition Metal Ions

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This research focuses on the synthesis and fluorescence of benzimidazole complexes of lanthanides and actinides. Under ultraviolet radiation, these complexes luminescence with different colors. Luminescent complex molecules are important because they allow an expansion of previous work to detect new complexes. They also allow a stronger understanding of synthesizing and purifying these complexes. Some benzimidazole derivatives are hard to obtain in good yield because of side-reactions. To determine an appropriate method for binding these transition metals with benzimidazole derivatives. Prior work has been taken into account. The ligand, BEPC (6-(1H-benzimidazol-2-yl) pyridinecarboxylic acid), was prepared using Phillips method by refluxing dipicolinic acid with o-phenylaminediamine, with a 1:1 mole ratio, over 10 hours then recrystallized from ethanol. When the metal complex was achieved, the precipitated complex was filtered off. These new ligand complexes are then observed and tested. A principal finding has been what lanthanides or transition metals fluoresce with the benzimidazole ligand. Gadolinium is known to not luminesce unless connected to another element and a ligand in the special configuration known as a 'super antenna.' Europium (III) has an orange fluorescence, but when gadolinium (III) is added, a bright neon pink luminescence formed. Other luminescent transition metal ions are samarium (III), terbium (III), and zinc (II).

Luminescence of Lanthanide and Transition Metal Complexes of BEPC

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Synthesis of 6-(1H-benzimidazol-2-yl)-2-pyridinecarboxylic acid; known as BEPC, can be achieved by reacting equimolar amounts of dipicolinic acid and o-phenylenediamine under reflux conditions and then purifying the solid product. The carboxylic acid functional group remaining in the final product means that BEPC can be used as an effective ligand for metal ions in the d and f blocks of the periodic table. When in solution with hot ethanol, BEPC and a chloride or nitrate salt of one of these metals can be combined, forming a complex based on the attraction between the positive metal ion and the negatively charged carboxylate form of one or more BEPC molecules - an equivalent number to the oxidation number of the metal ion. Some such compounds exhibit luminescence while others do not.
This project investigates which complexes of BEPC and metal ions exhibit luminescence under ultraviolet light and whether factors such as performing the reaction under basic conditions can affect the final complex. Purification by recrystallization, and characterization by mass spectroscopy and nuclear magnetic resonance spectroscopy, of these complexes are also explored.

Investigation of a New Synthesis Pathway for N-alkylated Benzimidazole Ligands

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Recent focus on benzimidazole-related ligands in inorganic chemistry has led to an exploration of synthesis pathways for *N*-alkylating these ligands. The question that fuels this research is how to incorporate alkyl or aryl groups that affect the fluorescence patterns of coordination complexes synthesized from the modified ligands and metal cations.

This research focuses on the specific ligand "bzimpy," 2,6-bis(2'-benzimidazolyl)pyridine and the alkylation, synthesis, characterization, and complexing of bzimpy-derived ligands. So far, the alkylation of bzimpy with hydrocarbon groups with secondary or tertiary carbons has not been achieved. Within ten weeks a relatively successful synthesis pathway has been formulated to address this issue.

This new synthesis pathway utilizes the idea of "starting from scratch" by adding alkyl groups early on in the process. *N*-alkylated *o*-nitroaniline compounds were produced, which, after purification, were reduced to produce singly *N*-alkylated *o*-phenylenediamines. This product may then be allowed to react to produce an *N,N'*-dialkylated bzimpy molecule which may be complexed to a metal cation. There has been significant success in the first few stages of this synthesis process. Five unique o-nitroaniline species have successfully been synthesized, and three of these iterations have been chemically reduced to the alkylated *o*-phenylenediamine states. The amines used to introduce alkylation are: benzylamine, (S)-1-phenylethylamine (a chiral amine), isopropylamine, tert-butylamine, and cyclohexylamine.

A Novel Multi-Step Synthesis for the N-Alkylation of Benzimidazole Ligands

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2,6-Bis(2-benzimidazolyl)pyridine “bzimpy” is an organic ligand that has been used in the past to form luminescent complexes with a series of lanthanide metal cations. Previously, ligands have been *N*-alkylated with various primary hydrocarbon groups in an attempt to improve the intensity of their fluorescence under UV light when complexed with metals. However, since it is difficult to *N*-alkylate bzimpy directly, over the course of this research program a multi-step synthesis has been engineered. In this synthesis, o-fluoronitrobenzene is allowed to react with different amines and is then reduced with hydrazine and a Pd/C catalyst (or, alternatively, with a combination of Sn powder and concentrated HCl under reflux). These reductions form singly *N*-alkylated o-phenylenediamines which can in turn be allowed to react with dipicolinic acid to form *N,N'*-dialkylated bzimpy. Mass spectra and crystallographic analysis have suggested that this synthesis method has yielded the intended products, with varying degrees of purity. A series of purification techniques were attempted with differing amounts of success, in order to isolate the purest possible samples of these products.

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Identification of Lead Receptor-Specific Ligand Utilizing a de novo Ligand Design Approach and Molecular Docking Studies to Potently Inhibit RelA-Mediated Biofilm Synthesis

The stringent response affords bacteria a survival mechanism to prevent cell death under hostile environmental conditions, such as amino-acid starvation, antibacterial agents, and other lethal conditions. The stringent response is triggered by the accumulation of guanosine pentaphosphate and guanosine tetraphosphate, collectively referred to as (p)ppGpp, produced by RelA synthase activity. SpoT functions as a ribosome-independent (p)ppGpp hydrolase. The RelA-SpoT complex exhibits reciprocal activity by confirmation. This reciprocal confirmation bars the complex from uncontrollably cycling between GTP and GDP derivatives. The RelA-SpoT complex mediates biofilm synthesis/decomposition and modulates cellular transcription, replication, and translation. The synthase-ON/hydrolase-OFF, or RelA active/SpoT inactive, confirmation directly inhibits RNA synthesis effectively stalling the cell cycle to preserve the limited resources accessible. Thus, inhibition of the RelA synthase activity and activation of SpoT by reciprocal confirmation is a novel therapeutic target with vast applications, namely antibiotic-resistant bacteria. This research supports previous findings regarding the location of the RelA active pocket and presents an extensive analysis of the pocket's residues. Utilizing computer-assisted molecular docking studies, a library of compounds was screened to reveal pertinent residue interactions within the RelA active pocket. This data has facilitated our team's de novo ligand design approach to simultaneously optimize binding energy magnitude and significantly improve ligand-protein specificity. Ultimately, RelA is a remarkably underexplored therapeutic target that may significantly increase the effectiveness of current antibacterial agents and unlock a novel family of antibacterial drugs.

Controlled Electrochemical Deposition of Copper

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Over the past few years, three dimensional printing has become an innovative method encompassing numerous fields, including medicine and manufacturing. The common, standard method is layer-by-layer deposition, which is time consuming and limits options to simpler designs. A newer method, continuous liquid interface production, involves the use of optics to lift a specifically shaped object out of liquid. Based off of that idea, we attempted to use electrochemistry as a novel approach to produce structures through localized spot deposition of copper. This can be applied to electronic devices in which copper is the metal of choice. In a basic galvanic cell set up, deposition is seen over the entire cathode plate as the copper ions in a solution are reduced to solid copper, forming a film. However, we were able to induce copper deposits on a predetermined spot on a gold plated cathode in a copper sulfate and sulfuric acid solution using a glass encased platinum wire. The platinum was only exposed at the tip in order to prevent film formation on the entire plate. AC/DC voltage was applied to stimulate growth on the plate directly under the exposed wire tip. The final goal of the project is to induce copper growths, or pillars, which increase in height as the platinum electrode is raised at a constant rate. With the success of that technique, more electrodes would be added, allowing for fast and controlled assembly of copper pillars on a substrate.

Grassroots Community Research: Give and Go Athletics Participatory Research in Action

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Unlike traditional ethnography, Participatory Action Research (PAR) is built on a partnership between the researcher and stakeholders of a community organization. Both parties work together to frame research questions, collect data and interpret results. The goal is to produce research products that meet specific needs of the organization as well as the researcher. Give and Go Athletics is a grassroots non-profit located in the Brewerytown section of North Philadelphia that runs many cutting edge neighborhood sports programs, such as a camp that mainstream children with behavioral health diagnoses by providing continuous on-site therapeutic support. This project focused on their summer sports camp. Using mixed methods (ethnography, participant observation, key informant interviewing), a series of products were developed and tested that will allow Give and Go build an evidence base for their service model. These included: 1) interview schedules and questionnaires for campers, parents, coaches, volunteers and staff; 2) a data base linking demographic information and therapeutic status of the campers with questionnaire data; and 3) an series of evaluative tools aimed at documenting both the behavioral impact and fidelity of the model. It is hoped that these products will help Give and Go demonstrate the effectiveness of their program and access additional resources.

Ayahs and Mammies: Race and Child Care in the 19th-Century

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This project has two parts, the first was researching children and children's books in 19th century Britain. The second was writing two creative pieces about Ayahs, Indian women that watched British children in both London and India during the nineteenth-century, and Mammies, who were slaves in America during the nineteenth and twentieth-century. They both wet nursed and cared for the children in the house. Along with these two pieces I wrote a historical commentary to connect the two. Ayahs and Mammies were extremely valuable to the people that they work for, but they were not treated like people. Even though Ayahs were not slaves they were talked about as if they were. Because of this, they never get to tell their own stories. Ayahs almost never got more than two lines about them in a newspaper. Most stories told by women who were Mammies portray a great deal of abuse and trauma. So I wanted my project to show them in a new light without ventriloquizing them.

I did my research using the Drexel database to get secondary historical books and articles. The British NewsPaper's online archives for primary articles about Ayahs and the way they were spoken about. Also, the Library of congress's Born into Slavery archives provided first hand accounts from previously enslaved women. I did this to gather as much information as possible so that I can prove that even though these women may not have been able to use their voices they were still heard.

Media Influence on Public Opinion Regarding the ICC

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In 2007, Kenya faced great political violence after election results generated backlash throughout the nation. During this time, some of its prominent leaders, including Kenya's current president Uhuru Kenyatta, were allegedly involved in inciting protests. In the aftermath of the ethnic violence, the leaders were indicted by the International Criminal Court (ICC). Most literature suggests that media heavily influences public opinion. To test this I am conducting a content analysis on media coverage of the ICC in Kenya beginning with the largest and most accessible newspaper, The Daily Nation. By using a coding method to track positive and negative coverage of the court, we will be able to assess what influences, if any, the media has had on the public's view of the ICC. These findings would contribute to the understanding of the public's regard for the ICC as well as the media's power over public opinion.

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Image Processing

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Digital Image Processing uses mathematical techniques to assist scientists in a variety of fields including astronomy, satellite reconnaissance, and medicine. The human eye captures and transforms light into electrochemical signals for processing and interpretation in the visual cortices, and vision psychologists have observed the importance of edge-detection in human subjects. A component of many edge-detection algorithms, blurring via Gaussian convolution, is mathematically equivalent to heat diffusion in a homogeneous material. The initial temperature in the material corresponds to the grayscale intensity of the original image, and the diffused temperature corresponds to the blurred image. The DeVore & Zuazua 2014 paper, "Recovery of an initial temperature from discrete sampling", describes an algorithm for the reconstruction of the Fourier representation of an initial temperature distribution in a one-dimensional rod, given a sequence of temperature measurements at a fixed sensor location. We expand upon this work, describing an algorithm for similar reconstruction, given a sequence of temperature measurements at variable sensor locations. We use MATLAB to implement the algorithm numerically, and demonstrate its efficacy in several test cases.

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Amyloid Beta Confinement

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My research focused on the residues sixteen through twenty-two of the amyloid beta-protein. Amyloid Beta is a protein held to be in some connection with Alzheimer's, as it is prevalent in the brains of those afflicted with the disease. The amyloid beta-protein, associated with Alzheimer's disease, is prevalent in the brains of those afflicted with this disease. I studied computationally the aggregation dynamics under confinement of a fragment of this protein, amino acids 16 through 22, using molecular dynamics. I used two programs to create the simulations, Visual Molecular Dynamics and GROMACS. The VMD software allowed us to view the positioning of the protein and analyze their placement. GROMACS allowed the detailed simulation of the movement and energies involved. I used the software to run two types of programs. The first used a Fullerene sphere with radius of 20 angstroms, and the 6 protein fragments were trapped within it. A 20-angstrom radius was chosen for its comparability to the confinement found within a cell. The GROMACS software populated a set box with water molecules both inside and outside the fullerene. The water molecules were free to move in accordance to the OPLS molecular dynamics force field. The second set of simulations consisted of confinement without a fullerene barrier. Instead, the waters outside of radius 20 angstroms were frozen, unable to move like regular water molecules. The ones within that radius were free to move. After the submitting the simulations to run for one hundred nanoseconds with five hundred thousand steps, I examined the distances from the center and from each other of the residues. The results will show how this portion of the protein behaves under hydrophobic and hydrophilic confinement.

Magnetic Vortex Dynamics in Mesoscopic Particles

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Recently, nanoparticles have garnered much attention as potential information storage media, as well as for their demonstration of quantum mechanical behavior. Several micro-magnetic simulators have been developed to study the magnetization dynamics of these particles, and in this work we use the Object Oriented MicroMagnetic Framework (OOMMF) simulator developed at NIST to study magnetization evolution in nanoscale magnetic structures. For sub-micrometer Permalloy disks, a magnetic vortex configuration is a common equilibrium state, with an in-plane curling of magnetic moments and an out of plane core near the center of the disk. When the disk's magnetization relaxes to an equilibrium state, a vortex is formed with a core that oscillates around the center of the disk before coming to a rest. The frequency of the core's oscillations depends on the particle's geometry, the magnetic properties of the material, and the external magnetic field strength. Simulations were developed to model the effects of a superconductor in close proximity to such magnetic nanoparticles. When subjected to an external magnetic field, type-II superconductors form Abrikosov vortices, which can be modelled as a magnetic dipole nearby a nanoparticle. By changing the geometry of such a dipole, various superconducting materials and their effect on the magnetic nanoparticles' vortices can be approximated. Knowing the dynamics of these interactions is useful for developing high density magnetic memory storage, which can be used to create more efficient and longer lasting information storage media in quantum computers.

Observing the Seasonal Variance of Muons with IceCube

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High energy atomic nuclei accelerated in space known as cosmic rays are constantly hitting Earth's atmosphere, producing pions and kaons which decay into fundamental particles such as neutrinos and muons. The atmospheric muon flux depends on the density of the atmosphere. Because the density of the atmosphere depends heavily on temperature, we study the variance of the muon rate over the year using the IceCube South Pole Neutrino Observatory--a neutrino telescope buried under glacial ice at the geographic South Pole that is one cubic-kilometer in volume.

I analyzed a year's worth of IceCube data, seeking a trend in the seasonal variance of muon flux. A fellow STAR student, Eesha Das Gupta, analyzed neutrino flux in a similar way. The rate of muons followed a clear sinusoidal pattern with its peak in January and its trough in summer. Eesha, on the other hand, observed an opposite trend with a peak in June and a trough in winter.

Seasonal Variation of Atmospheric Neutrinos in IceCube

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Located at the South Pole, the IceCube experiment indirectly detects neutrinos, weakly interacting elementary particles. IceCube consists of a cubic kilometer of ice with over 5000 light sensors. High energy cosmic rays, which are atomic nuclei of extraterrestrial origins, continuously bombard Earth's atmosphere to produce pions and kaons. The decays of these atmospheric interactions yield both neutrinos and muons whose interactions with the Antarctic ice allow for observation. Variation in atmospheric density leads to variation in interactions of pions and kaons with the atmosphere. Atmospheric density varies with temperature, which in turn, varies seasonally. Using two years of IceCube data, I did a computational and statistical analysis of event rates for atmospheric neutrinos in the Northern Sky. I performed this analysis for six regions with varying latitude ranges since temperature varies with latitudes. A distinct pattern, showing an increase in neutrino flux during summertime and a decrease in wintertime was observed. This indicates a seasonal dependence of northern atmospheric neutrino flux. Ratio of production of pions to kaons is impacted by temperature. My research, if continued, can lead to determination of this ratio.

My fellow STAR student, Rachel Buttry did a similar analysis for muons from the South sky. When my results were compared with Rachel's results, we observed opposite trends, as was expected, since the South and North have opposite seasons.

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Exploring Distance Black Holes with Hubble Space Telescope

Quasars are galaxies that are actively accreting material into a central supermassive black hole. Some of the quasar's characteristics include a very bright central region, as well as being highly redshifted. Understanding the dynamics and properties of quasars can give us further information about the early universe.

We can collect the light from quasars both from ground- and space-based spectrographs, on instruments such as the Hubble Space Telescope (HST) and the Sloan Digital Sky Survey (SDSS). The SDSS, which is groundbased, can collect a spectral wavelength range of 3600-10000 Angstroms (360-1000 nanometers), whereas the HST, which is a space telescope, can detect light as wavelengths as short at 1150 Angstroms. Combining the two allows us to see emission from a wide range of elemental isotopes, e.g. CIV, MgII, and Hbeta. Without this ability, we would have to piece together the full "spectrum" from different objects at different distances/redshfits. By searching the HST Mikulski Archive for Space Telescopes (MAST) and the SDSS master quasar catalog, I was able select quasars with matching coordinates from both the HST and SDSS and prepare the dataset for FTP from the MAST archive server.

With both sets of data in hand, we will be able to estimate the masses of the black holes that power each quasar using multiple lines, which will help us determine which measurements are the most robust. This process should significantly improve our estimates of the black hole masses for the most distant quasars in the Universe.

Visualizing Cosmic Voids and Galaxies

By visualizing cosmic voids and the galaxies that inhabit the dense filaments, groups, and clusters that surround these voids, we can obtain information about the distribution, composition, and formation of the galaxies. Cosmic voids are vast regions of space that fill nearly 70% of the volume of the universe while only containing a very small 10% of the galaxies. The goal of our research is to be able to accurately display cosmic voids and the relevant galaxies in a way that allows for easy visualization and to analyze them for important information. The visualization includes allowing variable opacity of the voids and coloring the galaxies by values such as their metallicity, color emission, and other data values that are recorded. We are using different programming languages such as Python and MATLAB to determine the best way to convert the data, and then we are using a program called VisIt to create the plots from the newly converted data files. These plots will recreate a three dimensional rendering of the universe by merging the voids and galaxies onto a single plot. We are then able to rotate, zoom in and out, and change the viewpoint from which we observe cosmic voids and galaxies in the universe.

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Cognitive Abilities Related to Word Decoding in Youth with Down Syndrome

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Down syndrome (DS) is the most common genetic cause of intellectual disability, occurring in ~ 1 in 691 live births. Despite advanced screening methods, the rate of DS has increased compared to the rates of occurrence reported ~20 years ago (CDC, 1994). Thus, research on the cognitive underpinnings of intellectual disability and related difficulties, such as reading impairments, are as important as ever before. Individuals with DS typically experience cognitive impairments throughout their lives. Language, memory, motor abilities, and academic achievement tend to be areas where people with DS struggle compared to their typically developing peers. With regard to academic achievement, reading impairments are important to consider, as reading is a key functional skill for independence in adulthood. Unfortunately, reading ability is quite low in DS. Research suggests that on average reading levels tend to be in the first to third grade level in DS in adulthood. Research on the cognitive correlates of DS has shown that it is associated with deficits in cognitive skills that are closely related to reading ability, such as phonological awareness, phonological memory, working memory, and syntactic knowledge. However, longitudinal studies of children with DS have shown that cognitive abilities that predict reading ability in typical children (e.g., phonological awareness) are less predictive of reading in children with DS. Thus, the question arises: Are there other cognitive abilities that people with DS utilize to decode words? This is focus of the current research.

Underdetermined Naming: Varying Interactions Between Co-Activated Words During Picture Naming

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In the field of psycholinguistics, activation of a given word is thought to cause co-activation of other semantically related words that interact in different ways during word production. Their exact interactions, however, are not yet entirely clear. Name Agreement (NA), or the extent to which people agree about the name of a particular picture in a naming task, is related to the number of similar alternates available; words with low NA have been shown to take longer to name and cause more production errors (Kan & Thomson-Schill, 2004). The current study explores the interactions of co-activated words by examining the different reasons an item may have low NA. We seek to distinguish between sub-categories of low NA words to understand how they account for differences in word production during picture naming.

Words with similarly low NA were separated into two categories: alternate names and near semantic neighbors (NSN). Respectively, these were words with multiple labels that are essentially synonymous (e.g., present/gift) and words with very closely related but non-identical semantic neighbors (e.g., alligator/crocodile). The two categories, along with a third high NA category, were presented to healthy control subjects in a one-word, picture-naming task. Results showed significant differences in reaction times between the alternate names and NSN conditions, both of which also differed significantly from the high NA condition. The distinction between different types of low NA words was further supported by significantly higher error rates with NSN than alternate names items. Though the study is ongoing, the results suggest potential differences in the neural representation and access of low NA words.

Recovering Lesion-Symptom Connections

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Lesion-symptom relationships have revealed brain-behavior relationships since the mid 19th century. Recent advances in neuroimaging technology have allowed these lesion-symptom relationships to be analyzed in finer detail using Voxel-based Lesion Symptom Mapping (VLSM). In VLSM, a t-score is computed for each voxel that represents the strength of the relationship between damage in that voxel and a behavioral deficit or symptom. Because each voxel is tested individually, this powerful method suffers from the multiple comparisons problem: when testing a large number of voxels (hundreds of thousands), some are likely to show strong relationships purely by chance (i.e., false positives). One way to try to separate the signal from the noise is to find a cluster size (a group of contiguous voxels) that is unlikely to arise by chance. However, it is not known how the arbitrary thresholds used to define clusters will affect the balance between a correction that is too conservative or not conservative enough. To explore this issue, behavioral data was simulated such that it had a known relationship with specific areas in the brain. Different thresholds were applied to the cluster correction method to determine which could replicate the relationship the best.

Statistical Method for Discovering the Neural Basis of Speech Recognition Deficits Following Stroke

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The brain is responsible for language and cognition, however the way in which these processes are handled and in what regions is still widely debated within the field. This information is vital when presented with patients who have endured any type of brain injury. Even with the vast leaps made with technology, there is still a great deal of uncertainty when determining the relationship between lesion location and behavioral symptoms. In voxel-based lesion symptom mapping (VLSM) these relationships are studied by comparing behavioral performance of participants with and without lesions in each of hundreds of thousands of tiny brain regions ("voxels"). The multiple comparisons problem comes into play due to the fact that each individual voxel is tested independently, resulting in an abundance of opportunities for false positives. Just as it is necessary to remove rotten produce, the signal could be separated from the noise by focusing on clusters instead of individual voxels. We evaluated a permutation-based method for determining minimum cluster size. The method relies on arbitrary thresholds that are not transparently related to how conservative the results will be. For this study, data regarding speech recognition were used from 99 patients with left hemisphere stroke damage. Different thresholds were evaluated to assess whether they produce more conservative or less conservative conclusions about brain-behavior relationships.

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Graphical User Interface Development for Analysis of Complex Software Output

Plan Recognition is the act of identifying an agent's plans and goals through observations of the agent's actions and its environmental conditions. The Engine for LEXicalized Intent Recognition(ELEXIR) is a piece of software that performs this task. The output of each ELEXIR execution contains multiple explanations. Each explanation contains complex data structures that capture hypothesized possible plans, initial states before the plan was executed, final states after its execution, and statistics about the plans relative likelihood. Much of this information is the same across all explanations, but some of it differs. All of this information makes each explanation verbose and the redundancy makes it burdensome to distinguish the differences between explanations. Even finding the beginning and ending of a single explanation in a flat, text output file can take significant resources. Thus, to aid the analysis of the ELEXIR output files, I have developed an application called the ELEXIR EXPLANATION GUI (EEG). The EEG will display the critical information about each individual explanation in a modular and easily accessible manner. This will allow the system designer to quickly examine individual explanations. The EEG will also be capable of cross explanation comparison. This functionality will allow the user to select two explanations and have the EEG automatically highlight where they differ. This will greatly aid the user in differential diagnosis and domain construction. Thus the EEG will make the visualization of ELEXIR output files simple and intuitive and drastically improve users ability to analyze ELEXIR's output.

Smart Fabrics for Use in Health and Pregnancy Monitoring

In recent years, researchers have been studying and developing several alternatives to fetal and uterine monitoring techniques to be used in hospitals. This team of researchers is working on the design of a "smart" belly band, capable of wirelessly recording such medical data in real time, whether the patient is laying in a hospital bed or sitting comfortably at home. Using knitting machines to create a pattern of electrically conductive thread across the fabric, the band is able to act as a radio frequency identification (RFID) tag, enabling the retrieval of data using an RFID reader. To further minimize invasiveness, the band can be sewn into, or worn discretely under regular clothes without hampering the effectiveness of the device. Computer software specifically developed for the project is used to record the data produced. The data is analyzed using software such as Weka and SciPy (a scientific computing library for the Python programming language), that utilize statistical inference and machine learning techniques to create detailed mathematical models from data. The models allows medical experts to make informed decisions on the status of patients wearing the band.

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Artificial Intelligence in StarCraft

Though humans know what intelligence means in regards to living beings, the term becomes more complicated when considering what we refer to as “artificial” intelligence. This idea has yet to be achieved, so it cannot be said concretely the specifics of what it will mean, but what is widely regarded as one of the most important aspects of it is the ability to think and make decisions similarly to humans. The goal of this research was to try to analyze the boundaries of decision-making for small-scale artificial intelligences, to see if it is possible to have a computer play a complicated computer game, StarCraft, in a way similar to that of humans by utilizing the Monte Carlo Tree Search algorithm. This meant that the computer would be made to take in information about the game, make predictions about possible courses of action, and choose the one that has the highest likelihood of being beneficial. As of the time of writing, an absolute conclusion to the feasibility of this idea has not been reached. However, it has been determined that in order to make the use of the MCTS reasonable on a scale such as this, the computer running the algorithm would need to have exceptional processing power and ability to test many scenarios in a very short period of time. This poses a technological barrier to individual use, though access to a large system of computers would allow for such an algorithm to be used regularly, and to great effect.

Machine Learning and Classification

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Machine learning is still a developing field in the world of Computer Science, and commercial applications are often sought. Learning how to apply machine learning and statistical predictions to the commercial world can mean better results for consumers. There already are product prediction services available, but they can always be improved. What I wanted to do was see what I could learn about understanding the consumer using a database of movie ratings. GroupLens Research has provided data containing movie ratings and user information. I downloaded one of these data sets, containing 100,000 ratings, from 1000 users about 1700 films. For analysis I used a piece of software called Weka 3.6, a machine learning tool.

The process, after acquiring the data, involved figuring out how to process it. Weka would not work with the data in the form in which it was downloaded. I had to write a C++ utility to process the various files and compile them into one CSV-formatted file, which Weka can handle. Using primarily gender as my case study, I tried to find out which elements I should give to Weka to provide the most accurate results. The most important thing to me was "future-proofing" the tree, or preventing it from making decisions too specific to the current data, as the database will grow over time.

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Finding Patterns in Movie-Rating Data Set

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Lots of our information are stored in the form of digital data, which are collected through our interaction with the Internet. The data tells a lot about our behaviors, and there are patterns that are very beneficial for businesses and behavioral researches. Data mining is the technique used in the industry to find meaningful patterns from large data set. Our project looks at a data set of 100,000 movie ratings to find the patterns between users' basic biographic information (age, occupation, and gender) and the genres they rate highly. Our project uses the clustering function of Weka, a data mining software, to divide people into groups of users with different interests. Further tests and training on bigger sample size can teach the program to regconize more useful patterns, which can be used in movie recommendation and advertisement targeting potential age and/or occupation group.

Developing Data Analytics Software for fNIRS

fNIRS (functional Near-Infrared Spectroscopy) is a novel brain imaging technology that offers an inexpensive and portable alternative to technologies such as MRI. Oxygen in the bloodstream is tracked via the absorbance of specific wavelengths of light, which can be used to determine the parts of the brain that are active given particular stimuli. This can be used to determine practical constraints on a person's ability to process information. For example, fNIRS can quantify the level of stress experienced by people in high-pressure jobs, such as surgeons, and so provides insight into ways to reduce this stress in real-world settings.

One of the main deterrents of the spread of fNIRS technology is a lack of easy-to-use data processing tools. The Drexel AIR Lab has spent the last several months developing an application to analyze and visualize fNIRS output data. This program, entitled "The Drexel fNIRS Dashboard," builds upon existing applications while providing new functionality. Although the program is not complete, it embodies the software engineering principle of extensibility, which means the application can easily be augmented in the future. As a result, it has the potential to develop into a universally implemented and adaptive technology.

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Improving Tools for fNIRS Research

The field of Human-Computer Interaction (HCI) is concerned with the design of systems and technologies that allow people to use computers most effectively. In an increasingly mechanized and computer-dependent world, HCI is vital to the efficiency of workers and the viability of entire industries. One area of HCI technology that is currently being explored is the use of brain scanners and similar body-monitoring devices as computer inputs. The Advanced Interaction Research (AIR) lab at Drexel University is currently working with one such technology, called functional Near-Infrared Spectroscopy (fNIRS), which allows for the detection of blood flow in the brain via non-invasive sensors. This technology is useful for studying the brain activity of people interacting with computer systems, and may eventually be used to allow systems to adjust themselves based on the state of the user. One major limitation on the development of this technology is the lack of a well-designed, versatile, and free-standing tool for analyzing and visualizing the fNIRS data. The Drexel AIR Lab has been developing a tool for this purpose, and this project has involved improving the usability and portability of the program, particularly components related to the loading and storage of data. This has included the development of a user interface for importing data, as well as some general improvements to the code.

Drug Information Integration System

Healthcare is a prominent domain that affects every person in some manner, whether that person takes the role of a healthcare professional or a health consumer. In this ever-expanding world of technology and healthcare, researchers have developed a myriad of useful tools and resources for this realm. However, most of these tools are designated specifically for health professionals such as doctors and nurses. Many people that visit doctors do not have these resources available to them to learn more about medications they take and the associated information about those medications. We aim to improve the available resources by creating a user interface designed for these health consumers to give them access to important data regarding diseases and drugs. My role was to gather data from these resources, compile them into a database, and create an interface. If a person diagnosed with a disease is taking a medication where a certain side effect is detrimental for his or her work environment, he or she can use our tool to find potential alternative medications and discuss them with a doctor. With this project, these patients can benefit from having a refined means of educating themselves on the diseases they are diagnosed with and the medications they take. While doctors may be very experienced with medicine, a patient knows his or her body the best. Our goal is to empower the health consumer with these resources to improve their knowledge of medicine and ultimately their lives.

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Designing a Web-Based Interface to Improve Parental Communication with Special Education Teachers

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This research explored the use of technology in improving communication between special education teachers and parents. In special education, it is imperative that behavioral interventions are applied both in the context of school and home. However, typical systems of parent-teacher communication are unreliable and lacking in detail, which can cause frustration for all stakeholders and threaten student outcomes. This study introduces a new feature of Lilypad, a cross-platform tool for special education, as a solution. Lilypad allows teachers to easily collect data on behavioral trends in students via an iPad app; this research aimed to produce a web interface that would give parents access to the data, as well as providing a direct channel for communication with teachers. In order to provide an appealing option for parents of all levels of availability and involvement, we primarily addressed the questions of which data to include, how much detail to provide, and which design choices would make that data easy to consume. Our information was collected through focus groups with expert behavioral psychologists and usability testing with parents of children in special education. Use of this feature along with the Lilypad system as a whole promises to foster increased parental involvement in special education without placing more demands on teachers.

Determination of Lignin in Biomass

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Next to cellulose, lignin is the world's most abundant plant derived polymer and is found in almost all plant cell walls. Global lignin production is 1.1 million metric tons annually and is used in low amounts in application where its structure is more important than the quality. Lignin is found mostly in between plant cell walls and its function is regulating the transport of water within plants. Lignified wood is used for many applications as raw material such as fuel, preservatives, newsprint, etc. Newspapers change color with time, because of the amount of lignin that is preserved in high yield pulps. Lignin is present in all vascular plants. Each plant produces a unique lignin structure, which must be individually studied. This project seeks to determine the content of acid-insoluble lignin in two commercial batches of acquired biomass for potential use as a lignin source. Furthermore, this project aims to determine the optimal separation method to reduce waste and to increase efficiency. One conventional method for lignin quantification is to follow a standard procedure of Klason Lignin for Acid-Insoluble for Wood and Pulp. There is no definite answer to what the structure or atomic mass unit of lignin can be, however there are other methods in finding those answers. Characterization of lignin can be done using several techniques. One method to determine the functional groups of the filtered lignin to determine its structure as lignin is a Fourier transform infrared spectroscopy (FT-IR) by studying the absorption peaks in the mid IR range of 500 cm-1 to 4000 cm-1. A retained study of lignin content is given as a function of different uses pertaining parameters.

CuSbS2 Thin Films

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The demand for solar energy has been steadily increasing and thus so has the demand for better solar cells. Many previous cell designs have included absorber layers that used elements that were either toxic or not highly abundant and thus expensive. CuSbS2 is a recently studied absorber layer for solar cells that is made from earth abundant elements that are non-toxic and absorbs a useful range of light. The few previous attempts to produce these thin film layers have used more expensive and intensive processes. Our research sought alternative processes to produce CuSbS2 films. Two main processes were examined: the deposition of the film using a two-step chemical bath deposition and the production of nanocrystals to then be deposited on the appropriate substrate via drop-coating or spin-coating. With the two-step chemical bath deposition, various annealing conditions were examined to find optimal conditions. The annealing conditions were evaluated in terms of absorption coefficient (using UV-vis, FTIR, ellipsometry), morphology of the film (SEM), and crystalline phase (XRD). Higher annealing temperatures enabled growth of larger crystals, but at the expense of maintaining continuous films. The nanocrystal films showed strong absorption, however they were of the wrong crystal phase. Further research is being done to test the effect of precursor ratios on the final composition of the nanocrystals. Overall this research has opened several exciting new avenues of inquiry.

Effects of Aging Techniques on Waste Lipids

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Biodiesel can be made using lipids extracted from waste such as grease trap waste and sewage scum grease. The waste lipids are primarily made up of free fatty acids (FFAs, a long-chain carboxylic acid) and triglycerides (three fatty acids linked to glycerol as esters). Although natural fats and oils are primarily composed of triglycerides, the FFA content of waste lipids increases due to hydrolytic degradation of triglycerides through cooking, storage, etc. In this project, accelerated aging techniques were used to accelerate degradation of these triglycerides into FFAs. After fully degrading the waste lipids, the FFAs can be converted to biodiesel by an esterification reaction between FFAs and methanol. Aging experiments were conducted by placing grease and/or soybean oil samples and water in a shaker bath at a controlled temperature. Several mechanisms were studied to accelerate degradation including agitation, heat, and addition of the Eversa enzyme. This enzyme is usually used to produce biodiesel from FFAs and methanol but has also shown the ability to convert TAGs to FFAs. Preliminary results indicate that heat and agitation alone do not noticeably degrade the soybean oil to FFAs, even over a week-long span. Meanwhile, enzyme-based techniques were shown to convert about 30% of triglycerides in pure soybean oil to FFAs within 2 hours. Due to the current maximum conversion of 30%, future experiments will be conducted in order to find the limiting factor. Possible factors include lack of water, buildup of byproducts, or even the limitations of the enzyme.

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Caustic Washing for Acid Reduction in Biodiesel Production

Biodiesel is a drop-in fuel that can be produced from refined vegetable oils and waste greases. Waste greases contain impurities that must be removed to produce fuel grade biodiesel. Lipids extracted from waste greases are composed of mostly free fatty acids (FFAs) which can be esterified with methanol to create crude biodiesel. The crude biodiesel is then washed with water and distilled to get pure biodiesel. The focus of this research project is to improve the yield and biodiesel purity of the washing process. One purity requirement for biodiesel is the total acid number (TAN), which represents FFA content of the biodiesel, and must be below 0.50 mg-KOH/g-sample to meet fuel specifications. Prior to esterification the lipids typically have a TAN of 170 mg-KOH/g-sample and crude biodiesel typically has a TAN of about 0.50-2.00 mg-KOH/g-sample. Caustic washing removes FFA and reduces the TAN of crude biodiesel because bases react with FFAs to produce soaps, which can be washed out with water. However, soaps can form an emulsion containing some of the biodiesel, which lowers biodiesel yield. An acidulation of the soaps can be done to recover the FFAs and recycle them to the process and increase efficiency. The caustic washing procedure developed in this project varies temperature to see its role in soap removal. Results are inconclusive for warmer versus colder temperatures, but the TAN of warmer samples were on average 140% higher. TANs of samples were reduced from 15.00 to 0.30 mg-KOH/g-sample with an average yield of 75-85%.

Microcapsule Synthesis for Epoxy Composites

Epoxy composites have numerous industrial and commercial applications due to their high strength to weight ratio, however they undergo damage due to micro cracks and general wear resistance. Self-healing materials allow a material to heal fractures and recover a portion of their original strength. Previous work done by Pratama et al. focused on the encapsulation of maleimide-based healing agents for self-healing of furan functionalized epoxy networks through reversible Diels-Alder chemistry. In their study, urea-formaldehyde (UF) microcapsules containing a phenyl acetate-maleimide solution were created with an average diameter of 183 um. The addition of self-healing characteristics to smaller scale materials, such as protective coatings, require the creation of smaller capsules. By adjusting experimental parameters, such as reaction time and agitation speed, UF capsules with an average diameter of 43 um were created. Scanning electron microscopy and thermal gravimetric analysis were used to analyze particle size distribution and characterize capsule morphology. Future work will include incorporating microcapsules into epoxy-composites, and examining solvent diffusion behavior.

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Thin Film MOFs as Non-Precious Metal Electrocatalysts

Metal organic frameworks (MOFs) show promise as both heterogeneous and electrochemical catalysts as their open metal sites and infinite combinations of functionalized linkers facilitate control of their catalytic properties. MOFs are composed of metal ion nodes complexed by carboxylic acids that function as linkers between those nodes. This structure's morphology can be modified by changing variables including the type of metal ion, the identity of the organic linker, synthesis temperature and the solvent in which the MOFs are nucleated and grown. In this work we have identified a procedure for the synthesis of a MOF composed of Cu nodes and terephathalic acid linkers with the morphology of thin nanosheets consisting of lateral dimensions on the order of microns. The thin film morphology makes these MOFs ideal for interaction with metal based catalysts where diffusional resistance of the reactants to the catalyst surface is minimal and the open metal sites can act as a co-catalysts by facilitating adsorption of reactant molecules, aiding the initial charge transfer. By varying both the identity of the open metal sites and the functionality of the organic linkers, we have characterized the potential of these thin film MOFs as both catalytic promoters for alcohol oxidation and stand-alone nonprecious metal electrocatalysts for elementary electrochemical reactions including the oxygen reduction reaction (ORR) and the hydrogen evolution reaction (HER).

Analyzing Solid Electrolyte Interphase in Sodium-Ion Batteries

Lithium batteries have dominated the rechargeable energy storage market for the past twenty-five years. Unfortunately, lithium is not terribly abundant on Earth while sodium, which can be found in rock salt, is more than 1,300 times as plentiful as lithium in Earth's crust and therefore less expensive to acquire. This research investigates the chemistry of solid electrolyte interphase (SEI) formation in sodium ion batteries. The SEI is a layer of electrolyte decomposition products that grows on negative electrodes in lithium and sodium batteries. Little is understood of SEI formation and behavior in lithium-ion batteries, let alone sodium-ion systems, as the majority of non-aqueous electrolyte research has focused on trial-and-error improvement of performance and lifetime. This work develops a new method for quantifying the reversibility of electrolyte-solvent reactions of NaClO4 in PC using the rotating ring-disk electrode (RRDE) to conduct electrochemical collector-generator techniques for in-situ detection of electrolyte decomposition products in a new way.

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Applying UAVs to wireless sensors

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My research project was focused on structural health monitoring, primarily for bridges, with the use of Unmanned Aerial Vehicles (UAVs) and wireless sensors. The research started with me working on UAVs. We had one quadcopter, two hexacopters, and three dual quadcopters. During my time over the summer we were able to do one test on a bridge deck at the Rutgers New Brunswick campus, where we flew one of the hexacopters, holding two go pros and one infrared camera, and analyzed the results. Furthermore, we worked on setting up future experiments and calibrating the cameras. Setting up the experiment consisted of making sure that all of the UAVs were able to fly, which was more work than expected. Calibrating the cameras was performed using a MATLAB toolbox.

The second half of my summer was focused on wireless sensors. I was given 4 sensors total: 1 tri-axial tiltmeter, 1 strain gauge, 1 vibration sensor, and 1 displacement sensor. I had to understand them, and be able to correctly use them with the software that I was given: SenScope. In order to do this, I was taught how to use different pieces of equipment like a uniaxial tilt meter, and two calibration jigs to deform the strain gauge and to rotate the tiltmeter.

Once the summer ends, these two projects will come together. A MinnowBoard will be installed on a UAV to read the sensors, and the UAV will be used to fly around a structure instrumented with the wireless sensors.

Quantitative Health Risk Assessment for Ganga Water Users in Varanasi, India

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The River Ganga is the longest and most prominent river in India, flowing through several major cities in North India. Millions of residents living along the banks depend on the Ganga as a source of water for their daily needs. Further, as the river is religiously important to Hindus, it attracts millions of pilgrims every year. Despite being considered sacred, the Ganga is highly polluted by domestic and industrial waste water discharge.

The objective of this project was to identify pathogens in the Ganga around the densely populated pilgrimage city of Varanasi, and to estimate the health risks that it could pose to the daily users of the river. An extensive literature review was first conducted, which helped identify the presence of pathogenic E.Coli O157:H7 in the surface waters of the Ganga at Varanasi, which poses a risk of gastrointestinal disease to the users of the river. The data obtained from published documents were used to conduct a Quantitative Microbial Risk Assessment (QMRA) to estimate the risk of disease to the daily users of the river. Multiple exposure routes were considered for the wide range of water based activities conducted in the river. Using the EPA's guidelines for the amount of water ingested while performing these activities, the average dose of bacteria ingested by a person was calculated, which was then fed into a dose response model to estimate the probability of infection.

Using Digital Photography Imaging to Analyze Plant Speicefes For Green Architectural Elements

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The use of plants in structural and architectural elements is gaining increasing attention as it provides both an environmental and architectural benefit. This study consisted of analyzing low-height plants using digital photography imaging to assess whether certain plants are a viable option for architectural elements and whether they have a low gap fraction. Gap fraction is the probability of a ray of light passing through a vegetated canopy without encountering any plant elements. In this study, photography and MATLAB were used to estimate the gap fraction. The green color intensity, color distribution on a red, green, and blue scale, and the area of the plant elements verses the total plant area was calculated analyzing the pictures using the MATLAB functions created. Pictures of the canopy were taken under conditions of various illuminations and weather conditions. Certain shrubs such as the deciduous *Itea virginica* "Little Henry" and the evergreen *Prunus laurocerasus* "Otto Luyken" have proved to be viable solutions for structural elements such as green walls, green fences, and green roofs. This is due to a low gap fraction of 20% or less and due to the fact that the gaps in the canopy mainly only exist in the outer edges of the canopy, making them ideal for fences and roofs since these bio-structural elements consist of rows of the same plant.

Making the Unseen Seen: Vizualizations in Wireless Networking

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For an average person, wireless communication is difficult to visualize due to the invisibility of electromagnetic radiation. To make wireless networks more intuitive, visualization techniques are necessary to aid in the comprehension of signal transmission. In this work, different techniques are developed to visually display the separate phases of wireless communications via an augmented reality framework. A visualization of packet transmission was made using Matlab. The packets were shown in a wireless security context, being transmitted between three different nodes: the hacker, the server, and the user. For the visualization of radiation patterns, an augmented reality application was made for Android. The application would read the configuration of an antenna and overlay the corresponding radiation pattern on the device screen. By pointing the phone's camera at different routers, the user could see the differences between different antenna configurations. Ultimately, the visualization methods will aid as a tool for teaching. By making a normally abstract topic such as wireless communication more concrete, we hope the students will be able to deepen their understanding of the material.

Optimizing Production and Performance of Electroluminescent Fibers by Extrusion Methods

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Advances in materials science have enabled electroluminescent devices to be constructed on a new variety of substrates. Successfully creating and integrating these new materials with technologies of smart fabrics will lead to an electroluminescent display. Producing fibers that are comparable to their planar counterparts is a complicated process. By investigating methods such as painting, multiple extrusion techniques, and an automated system, a viable production method can be chosen. Among these methods, extrusion is the most effective. A two piece, 3D printed fluid bath with varying extrusion diameters produces the most reliable results. The fibers produced are characterized using microscope images to determine uniformity of the layers and SEM imaging to observe layer thicknesses of different samples.

Energy Police: Integrating the Localized Energy Awareness Program Beyond the Classroom

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There is an increasing concern for the planet's health as global reliance on electricity rises and the most widely used fuels decrease rapidly. More emphasis is being placed on utilizing renewable energy sources as cheaper, longer-lasting and more ecologically compatible alternatives to nonrenewable fuels. The National Academy of Engineering (NAE) acknowledges this issue in its Engineering Grand Challenges, where five of fourteen are energy-based. Demand for experts and education in renewable energy and related technologies is growing. For students and educators, however, foundational values in renewable energy and energy conservation are inconsistent and insufficient throughout the United States. The Localized Energy Awareness Program (LEAP), an educational program based on the Next Generation Science Standards (NGSS) for engineering and science practices, aims to combat this. LEAP modules examine various aspects of contemporary energy situations. One module in particular, Energy Police, prompts students in grades kindergarten through fifth to utilize problem-solving skills by creating and carrying out their own plans for conservation at home. By calling on students to determine energy-wasting practices in the home and compete with others to reduce such habits, this module creates a foundation of conservation values for larger-scale energy solutions. Once class has ended, the module extends LEAP into a learning project at home to help students retain the information taught throughout the program. The Energy Police module has been developed in full, but not yet tested. It will be implemented in the fall of 2015 with LEAP locally and nationally.

Autonomous Quadrotor Technology for Live Performance

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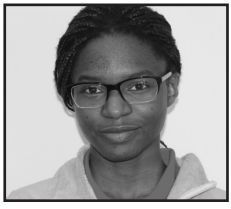
In the dance world, there has not been much interaction between machines and performers. The goal of this project is to develop a system that allows for the safe, autonomous flight of multiple quadrotors in coordination with dancers in a live theatre environment. A system using infrared cameras to track the quadrotors' and dancers' positions was implemented. The speed of each of the quadrotor's motors is set based on feedback from the cameras and the desired set point for the drone. This project focused on adding new features to this method of autonomous flight, such as rhythmic timing of movement with music, the mathematical smoothing of flight, and safety precautions that prevent the quadrotors from coming in contact with dancers.

Reviving FrankenHUBO: Powering and Rebuilding Adult-sized Humanoid Robots

Because the field of humanoid robotics is relatively new, there is still a lot of work to be done in order to develop self-contained and functional robots that can perform simple physical tasks like walking, dancing and opening doors. Robots have large computational needs and as a result, require multiple computers to handle their processing demands. HUBO is a humanoid robot at the ExCITe center that exhibits these needs but unfortunately cannot power all the required computers from its power board without modification. My work with HUBO involved creating a power system that would supply power to a high-processing computer from within the robot as well as rewiring and rebuilding another HUBO robot that had been stripped for parts. The bulk of the work in this project involved designing circuits, wiring electrical components, printing machine parts and assembling and disassembling machine parts. Further work to increase the performance of HUBO could be to acquire a computer with lower power requirements and machining more spare parts for the robot.



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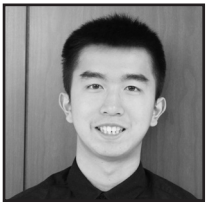

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Mobile Application Providing Assistance for Healthy Eating Through Caloric Search

Weight gain in college is problematic to many students. There are many mobile applications used to help people combat weight gain, however, most of them only help users count the calories they have already eaten. With my calorie counting application, users assign a calorie budget and a food type, and the app makes recommendations to guide the users. This caloric food search enables users to search for a food they want to eat, while also allowing them to set a calorie limit. The search tells the user which food they can eat and where they can buy the food. The information of food is uploaded to a web server. The web server was developed using Linux, Apache, MySQL, and PHP (LAMP). Apache is the server being run by Linux, which is the operating system. The raw data was store in a MySQL database. The PHP scripts were written to enter information into the database and allow 3rd party applications access to the database. I created an API (Application Programming Interface) that would allow external applications, such as mobile applications, to access and search this data. I plan to develop an android version of this application, which is an easy extension, because most of the work has been done in the API. In the future, I plan to partner with food trucks in Drexel to obtain their caloric information.

Real-time Tracking of Drexel Shuttles

The art of dancing has previously had nominal integration with current technology. The goal of this project is to fill that gap and provide a dynamic system of autonomous quadcopters that can safely fly in sync with a choreographed dance performance. An arrangement of motion-tracking cameras was used to track and provide flight paths for the quadcopters. The quadcopters give visual feedback to the audience by using LED lights that react to the dance. This project focused on new ways of stimulating an audience by utilizing applied robotics to determine a safe and effective way to have live performers interact with machines on stage. It also involved finding the most efficient way to track and smooth autonomous flight of quadcopters.

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Real-time Tracking of Drexel Shuttles

Many people utilize the Drexel transport shuttles on campus, be that as it may, there is no simple way to discover where these shuttles are. In order to address this, I worked with Drexel's App Lab to efficiently retrieve the locations of the Drexel University shuttles and track them in real-time with an iOS application. This is achieved by placing a cellular phone in each of the buses, and by using the phones' GPS to monitor their the current location. The locations are then uploaded to a database on a web server. We also developed an API that grants access to the location data from a variety of platforms (i.e., iOS, Android, Web). This allows the Drexel community to attain shuttle location information with a simple click of a button. Future work will include finding ways to better assist users with additional information and to expand this idea to other major transit associations like SEPTA and New Jersey Transit.

Mobile Application for Practicing Musical Instruments

Everyone likes music, and most have the desire to learn how to play music. However, learning and practicing music can be a very challenging task that requires a lot of discipline and dedication. Today, there are many mobile applications can be valuable tools that present sophisticated information in intuitive ways. Nevertheless, it is difficult for musicians to find an adequate app that aims to succor and motivate them to learn and practice instruments. Therefore, I have developed an app called “Easy Practice” that minimizes the tediousness and provides a quality practice experience for users by allowing the interaction between the app and the user in real time. The user can import and play along with his or her favorite song right from the music library. The app then creates interactive background that moves according to the song’s beat, and a waveform representation for that song. The user can also choose where in the song to play, repeat it or not, change the tempo, and assign sections for the song. All those features are designed to be easy to access. The ultimate goal is to make practicing music to be as fun as playing music.

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Wind Energy Study

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The scientific community has become increasingly troubled by rising global temperatures. These escalating temperatures are the result of rising levels of greenhouse gases which are a byproduct of burning fossil fuels. Wind energy is a powerful alternative source to fossil fuel energy. Although modern wind turbines have made great strides toward efficiency, there is always room for improvement. Research on the wind turbine innovation is exciting and has incredible potential to benefit the world through cleaner, more affordable energy. This summer I worked with Dr. Scoles on a wind energy project creating a tool for further study of wind turbines in a lab setting. Using 3D printed blades from the internet and a turbine hub that was created with Creo Parametrics a four inch diameter wind turbine was created. Using a PVC pipe and a 3D printed fitting designed for a 120mm computer fan a wind tunnel was created to establish a laminar flow for the turbine. Several fan speed control circuits were tested until a simple Darlington Circuit design was decided upon. This circuit allowed for fan speed control using a PWM signal from an Arduino. The Arduino was used as the hub of the project controlling the fan speed and several sensors. A hot wire design anemometer and a basic optical sensor were used to gather data on the system. A basic three blade horizontal axis wind turbine was used for testing purpose and was attached to a small electrical motor which allowed for efficiency calculations.

Layouts of CMOS Transistor and Inductive Wireless Power Transfer Systems

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The goal of this project was to design low power, high speed transistor circuits and to simulate integrated inductors which can be used to wirelessly charge medical implants. These circuits can lower the energy needed to power in vivo sensors which allows for a smaller design. Additionally, wireless chargers can improve implants by externally powering the monitors placed under the skin without any cord or attachments. This can be accomplished with a pair of inductors, eliminating the need for a battery altogether. As research into circuit designs and layouts continues, better coupling of inductors and improved use of energy by the circuitry can optimize the power transfer.

This project used Cadence Virtuoso to design layers of conductors and semiconductors in order to create a low power and time delay 8-bit Boolean CMOS adder. At 200MHz an 8-bit adiabatic adder showed an 250% improvement in power efficiency over the CMOS simulation. Furthermore, this research looked at different proposed inductors for power transfer and modelled the inductors. Power transfer efficiency ranges between 10% and 50% for inductors which use 130nm VLSI technology.

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Optical Tweezers

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An Optical Tweezer apparatus operates by using low-power coherent light in the form of a laser to trap dielectric particles that have the capability to be electrically polarized. In accordance with the respective refractive indices and dielectric environment of various particles, the light exhibits repulsive and attractive forces that keep the particle trapped within the focal point of the light. By then measuring the Brownian movement of the particles, it is possible to identify the chemical fingerprint of the particles through a process called Raman Spectroscopy.

In our Optical Tweezer setup, we passed a laser beam through a combination of mirrors into an objective on which micron sized polystyrene beads were placed. We used a quadrant photodiode (QPD), a system of four equally divided photosensitive quadrants, to detect the position of the laser beam in two dimension and a charged couple device (CCD) to capture the image of the trapped particle.
To comply with safety measures, we built an aluminum enclosure with a black interior that would absorb reflected light and keep harmful light away from the researchers. We drilled a hole into one of the side panels for the light to go through and cut an opening into the back panel for the wires of our QPD to get through. We placed brushes in the back to keep any extra light from getting into the system. The front panel was cut into three smaller symmetrical panels that would act as a sort of doorway for the Optical Tweezer setup.

Optical Tweezers

Optical tweezers are research tools that focuses laser light to trap particles ranging from 1 to 100 microns. As the laser light interacts with a particle, the photons experience a change in momentum, resulting in piconewton forces trapping the particle. This is a useful technique in the world of biophysics because it provides the user the ability to be able to analyze and manipulate various specimens like cells, DNA, and bacteria. Additionally, optical tweezers can be used to determine a particles chemical composition by analyzing its Brownian motion, a method known as Raman Spectroscopy.

Currently, in order to analyze a particle, the system requires a glass slide and a cover slip to be glued together to create a flow cell. These components would then be directly attached to a microscope objective. This method requires much preparation and the flow cell cannot be reused for other specimens. As a result, a recyclable flow chamber was designed using Creo 2.0 and was 3D printed to allow the user to be able to flow micro or nano sized particles suspended in a liquid or a gas. An eight component sandwich design allows for an air tight chamber for the user to analyze various types of specimens. Our optical tweezers system allows us to trap micro sized particle suspended in deionized water. Our design we will allows us to be able to flow nano sized particles in a gaseous state and perform Raman Spectroscopy.

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Optical Tweezers: Quadrant Photodiode Integration

Optical tweezers are tools that use focused photons from a laser beam to produce reflected and refracted piconewton forces. These forces are used to trap one or more microscopic dielectric particles (from 1 to 100 microns) in a three dimensional trap, allowing the user to be able to measure the forces on the particle. This tool is use by biophysicists to measure the forces between cells, proteins, nucleotides, and DNA. Additionally, this tool allows the user to be able to determine the chemical composition of particles based on its Brownian motion by using a technique known as Raman spectroscopy.

To keep track of Brownian motion of the trapped particles, a quadrant photodiode (QPD) was used to record the position of the particle in real time. The quadrant photodiode contains four photodiodes which convert the light into current based on the incidence of photons over the semiconductive material. To obtain the position of the particle, we proceed to calculate the differences of voltages on each photodiode and divide it by the voltage generated by the incidence of the whole beam. As a result, we can determine the position of a particle with a precision of 2 nm. Based on the data from the QPD, we will be able to determine the chemical composition of particles by the use of the Raman spectroscopy technique in future work.

A Wearable Electronic Tactile Sensory Aid: Transfer Characteristics and Optimization

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Haptics, the science and engineering of the sense of touch, is a rapidly developing research area. This project aims to create a wearable device, the first of its kind, capable of electronically enhancing touch, in the same way that a hearing aid enhances the auditory sense. The device utilizes electronic sensors (wide bandwidth MEMS accelerometers) worn on the finger to capture touch-induced vibrations of the skin. The importance of these signals to touch perception has been extensively documented in prior literature. Active, analog electronics are used to filter and amplify the resulting signals. A compact recoil transducer is used to accurately reproduce these signals, effectively enhancing the transient touch information that is produced when the finger contacts or slides against an object. The project measured and analyzed the frequency-domain transfer characteristics of this system using laboratory instrumentation and MATLAB software. The results were used to determine sensor-actuator configurations that would minimize feedback, increasing the range of feasible amplification. The resulting advances could be beneficial for individuals with impaired touch sensation due to peripheral neuropathy or prosthetic limbs. Future work includes improving the device's ergonomics and wearability, and testing based on a model task of roughness perception.

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Spin Coated MXene Films

Two dimensional (2D) materials are atomically thin and have properties that differ from their bulk counterparts. Graphene is the most well-known and well studied 2D material. Since then, much research has been dedicated to the discovery of other 2D materials of various chemistries. Among these is a family of early transition metal carbides and carbonitrides called MXenes, discovered at Drexel. Thin films of these materials are attractive because they are highly electrically conducting while being transparent to visible light and thus have potential for electronic and photonic applications, such as coatings on several products, energy storing devices, transparent conductive electrodes, and much more. To date, only one member of the MXene family was produced as a thin film (Ti_3C_2). In this work, thin films of MXenes (specifically Mo_2C, Ti_2C, and Mo_2TiC_2) are produced, through spin coating from a colloidal solution, on glass substrates. The focus for this research is to examine the optical and electrical properties of the spin coated MXene films through Ultraviolet-Visible Light Spectroscopy and the four point probe method. This work will lead to a better understanding of MXene films in general, as well as, help identify potential applications for them in the future.

Synthesis and Properties of Bulk Molybdenum Boride, Mo2Al2B2, and other Borides

Bulk samples of the layered ternary boride Mo2Al2B2 were fabricated by reactively hot-pressing stoichiometric ratios of molybdenum boride and aluminum powders to a relative density of about 94%. The atomic layering of Mo2Al2B2 was imaged on a transmission electron microscope (TEM). The thermal stability of this compound was tested in differential scanning calorimetry (DSC). The Vickers' microhardness was 4.3 GPa and the electrical resistivity was 1μΩ-meter, making it approximately 3 times more resistive than many MAX phases. The Mo2Al2B2 did not crack when dropped in water from 1000°C. Resistance to oxidation was also explored. Along with characterizing the properties of the Mo2Al2B2 phase, another goal of this work was to synthesize other single-phase bulk samples of chromium, iron and molybdenum ternary Al-borides. These latter compositions were synthesized by pressureless sintering, at various temperatures and durations and were then etched with 2M HCl to dissolve any extraneous intermetallics formed to obtain phase-pure powders.

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Effect of Cation Intercalation on Structure and Conductivity of MXenes

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Materials science and engineering is an important field to much of modern technology, from more efficient cars to nuclear fusion power. Materials researchers typically investigate the structure, processing, properties, and performance of materials. Our research group is focused on two-dimensional nanoscale materials, specifically a class of layered metal carbides called MXenes discovered at Drexel. MXenes are electrically conductive and capable of intercalating cations, but the effect of cation and MXene type on the structure and conductivity is not well understood. In this research, we etched Ti3AlC2, Ti2AlC, and Nb2AlC – MAX phases – converting them into MXenes using HF and LiCl or HCl and LiF. We then ion exchanged the Li cations with various organoammonium, alkali metal, and alkaline earth metal cations. Ion exchange of filtered films of delaminated MXene was also studied. We used X-ray diffraction to measure layer spacing, which varied with the size of the intercalated cations. Greater interlayer spacings, such as caused by the larger cations, resulted in a decrease in the DC conductivity. We also used cyclic voltammetry to measure the supercapacitive properties of the various intercalated MXenes. Changing the cations intercalated between the MXene layers can result in tunable conductivity, and even novel properties such as photosensitivity.

Alkali Metal Halides as Redox Active Materials for Ultra High Capacitance of 2D MXenes

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Supercapacitors are energy storage devices that store charges electrostatically in an electric double layer on high surface area carbon materials and are considered to be high power devices. Their energy density is lower than batteries, which hinders their use in several applications. One way to improve their energy density is to use pseudocapacitive materials which add Faradic capacitance via surface redox reactions, however the conductivity of these materials is low. To overcome this issue, pseudocapacitive materials are generally integrated on conductive substrates such as titanium carbide generally called MXene, (Ti3C2); MXene is a new family of 2D materials with metallic conductivity having general formula Mn+1 Xn Ty, where M is a transition metal, X is either carbon or nitrogen, and T is a terminating group, either OH, O, or F. Integrating pseudocapacitive material can be done either by modifying the surface of the electrode or the supporting electrolyte. The latter approach is efficient, cost effective, and less time consuming. Among other conductive substrates, titanium carbide has potential to replace other carbons as a substrate to deposit electroactive materials due to its very high conductivity and two dimensional morphology. Our approach was to use titanium carbide as an active material and to modify the electrolyte (1 M H2SO4) to demonstrate the redox reactions of alkali metal iodides, MI, where M can be any alkali metal from the periodic table (Li, Na, K, Rb or Cs). The tested alkali metal iodides showed improved capacitance, better rate capability, and high capacitance retention.

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Improving the Maximum Charging Voltage of Electrical Capacitors by Hybridizing Aqueous and Organic Electrolytes

As we continue to move away from traditional fossil fuel combustion and toward the electrical energy age, auto makers and other machine manufacturers are straining against the limits of battery technology. Not only are batteries bound by their relatively low storage rate and power density, but they are generally made from scarce and expensive materials.

As a result of these limitations, electrical capacitors (ECs) have arisen as a promising accessory if not an occasional alternative to batteries. ECs, or supercapacitors, can be charged and discharged much faster than batteries because energy is stored by physical adsorption of ions onto two polarized electrodes, whereas the energy in a battery is stored and released via chemical redox reactions. One of the most important components in a capacitor is the electrolyte, which can be divided into the following three categories: aqueous electrolytes, organic electrolytes, and ionic liquids.

The primary issue with capacitors is that they can store far less energy than batteries are capable of. Since the energy in a capacitor is directly proportional to both the capacitance and the square of the operating voltage, these are two targets for improving energy density. Aqueous electrolytes are very cheap, safe, and high performing when used correctly; however they begin to undergo a process known as hydrogen evolution when operated beyond their voltage range and are therefore limited to a relatively low "maximum charging voltage" (MCV) of ~ 1 V as compared to the higher MCVs of organic electrolytes or ionic liquids. This study aims to increase the 1 V operating voltage of a traditional aqueous electrolyte by hybridizing water and an organic solvent. This has been shown to reduce hydrogen evolution without decreasing the capacitance, increasing the MCV of the supercapacitor to at least 1.5 V.

Exploring A New Method of Electrochemical Energy Generation

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The world's energy future relies on both the discovery of novel materials and the design of sustainable systems for the optimization of charge storage. Evaporation, a constantly occurring process, is a primary mode of natural energy transfer in the Earth's atmosphere. Converging these two pieces of information leads to a fascinating proposition: could we successfully combine a conductive material with an abundant, natural source of energy to aid in satisfying the high power demand of the future? Electrochemical supercapacitors (ECs) are energy storage devices that have attracted significant attention in recent years towards satisfying this energy demand, primarily due to their high rates of energy transfer and their long life cycles. However, to overcome the challenge of an electrochemical supercapacitor's main disadvantage—low energy density, or the amount of energy stored within a specified region—new electrode materials must be both fabricated and integrated into these devices in novel ways. A promising class of materials known as MXenes, discovered at Drexel University in 2011, are two-dimensional, multilayered metal carbides exhibiting hydrophilic properties, conductive properties, and high volumetric capacitive performance compared to other carbon allotropes. Most importantly for this investigation is an MXene's hydrophilic nature, making it the most ideal material for dealing with evaporation. This research seeks to demonstrate and understand how the evaporation of deionized water from the surfaces of titanium carbide (Ti3C2) MXenes generates a potential difference. Various methods in titanium carbide (Ti3C2) fabrication, including solvent variations and coating techniques, were utilized to help discern the optimal method for maximizing this fascinating voltage effect.

Layer-by-layer assembly of MXene/ Graphene composite films by spray coating for high-performance supercapacitors

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Research into two-dimensional (2D) nanomaterials has greatly expanded due to their interesting physical and chemical properties. Recently, a new family of 2D transition metal carbides/carbonitrides, so called MXenes, was discovered. The MXenes have been demonstrated as promising electrode materials for electrochemical energy storage devices, such as supercapacitors and Li-ion batteries. However, the performance of free-standing MXene films, which are flexible and metallically conductive, is seriously limited by the compact stacking of MXene flakes. One effective strategy to resolve this issue is to introduce interlayer spacers, such as carbon nanotubes and graphene, between MXene flakes to improve the accessibility of electrolyte ions into MXene films.

Herein, large scale MXene/Graphene composite films with different graphene contents were manufactured by layer-by-layer assembly through spray coating methods. The as-obtained films are free-standing, flexible, and highly conductive. The electrochemical performance of these composite films were evaluated as electrodes for supercapacitors and optimized based on the graphene content. A capacitance of 190 F/g was achieved with composite films containing 5% graphene, an increase compared to pure MXene films. Additionally, benefiting from the simple and effective spray coating process, we were also able to produce a flexible letter-sized MXene/ Graphene composite paper. This work provides a simple and scalable technique for the large scale production of MXene-based electrode materials, which are highly promising in the applications of flexible energy storage devices, including supercapacitors and rechargeable batteries.

The Organizational Effects of Biomimetic Aggrecan on Collagen Gels

The potential to modify collagen structure could lead to a variety of applications in collagen related health issues. This study evaluates the addition of biomimetic aggrecan (BA) to collagen solutions and observes the tangible ways by which the protein's organization is affected. By preparing collagen gels containing BA molecules of two different sizes and imaging the final solutions with a confocal microscope we were able to look at a variety of properties. Half of the gels were made with BA molecule polyacrylic acid 10kDa- chondroitin sulfate and the other half with BA molecule polyacrylic acid 250kDa- chondroitin sulfate. Tracing the individual fibrils in the images gives quantitative feedback as to how BA affects the average length distribution of the collagen. Further processing in Matlab displays the fibril area distribution by both the total number of fibrils in each solution and by the fibril area percentage in each image. Finally, using the technique of fibrillogensis, we collected the absorbance spectra of collagen plus BA in multiple solutions. The solution's alteration in absorbance over time directly correlates with the time taken for the solution's gelation. By observing these properties, the results of the study demonstrate an apparent modification of collagen with the addition of different concentrations of BA.

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BA Infiltration Study

The infiltration of BA into healthy, nonarthritic cartilage was studied to determine a baseline for future applications of BA in cartilage degraded due to osteoarthritis. The BA solutions used were fluorescently tagged with DCCH (7-Diethylaminocoumarin-3-Carboxylic acid, Hydrazide). Using a hole saw drill bit, cartilage plugs were collected from mature bovine knee joints. These plugs were soaked in 1X PBS to equilibrate the samples and subsequently placed in solutions of BA so that the cartilage was entirely submerged.

Two different variables with a potential effect on the infiltration of BA into cartilage were observed within the study. First, the molecule size of the BA used in solution should affect the diffusion coefficient (i.e., the larger the molecule, the slower the diffusion will occur). For this portion, plugs were soaked in 10 mg/mL BA 250 in 1X PBS or 10 mg/mL BA 10 in 1X PBS. The ion contents of BA solutions were also observed. A higher solution ion content should increase the BA because the ion is able to neutralize high negative charges on the BA at a small length scale; as a result, the BA is expected to more efficiently infiltrate the cartilage. For this, plugs were soaked in 10 mg/mL BA 10 in 0.1X PBS or 10 mg/mL BA 10 in 10X PBS.

After a soaking period of 24 hours, these plugs were embedded, cryosectioned vertically, and observed using a confocal microscope to determine the amount and depth of BA infiltration.

Flow Properties of CS and BA Solutions

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Human joint cartilage break down is an inevitable feat, as molecular enzymes act upon different factors like old age, disease, or joint injury. Approximately 10% of cartilage is composed of a chondroitin sulfate (CS) proteoglycan called aggrecan. Aggrecan is composed of multiple domains that serve different functions, of which most importantly is the ability of cartilage and intervertebral discs to resist compressive loads. Degradation of aggrecan can be traced back to having a major role in cartilage breakdown and is closely associated to the development of osteoarthritis, which only adds to its clinical importance.

The Drexel Biomaterials Lab is studying two different biomimetic aggrecans (BA) of two different polyacrylic acid (PAA) sizes; PAA10kDa-CS and PAA250kDa-CS. Since these proteoglycans must be injected via gauge needles into live tissue that will lead into bloodstreams, their flow must be better understood in order to find the optimum method to incorporate them into future clinical applications. To study this, different solutions of the BA and of chondroitin 6-sulfate sodium salt from bovine cartilage were made at concentrations of 10, 25, 50, 100, and 200mg/ml. The BA and CS were both dissolved in a phosphate-buffered saline solution (PBS) since this best resembles the human body's isotonic characteristic, while also being non-toxic to most cells. These solutions were then ran through 16, 18, 21, 22, 25, and 33 gauge needles via a syringe under a constant force. As a result, the volumetric flow rates of the solutions dependent on release time were able to be found.

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Cation Stabilization for Lithium Ion Batteries through Chemical Preintercalation

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With current advancements in electric vehicles and grid storage, the demand for lithium-ion batteries continues to rise. In order to slow the use of our limited lithium supply, lifetimes of lithium-ion batteries must be extended. To achieve this, battery materials with increased cycling stability are highly desirable. Among several methods, chemical preintercalation is a viable, cost effective, and simple way to develop stable materials. Through wet chemical reactions, electrode materials can be synthesized with varying ions embedded between structural layers. The goal of this research was to develop preintercalated cathode materials through wet chemical approach for use in Li-ion batteries.

Vanadium oxide nanowires intercalated with Mg and Na ions were synthesized through wet chemical mixing, aging, and subsequent hydrothermal treatment. Energy dispersive X-ray spectroscopy confirmed successful chemical preintercalation, resulting in NaxV2O5 (x~0.42) and MgxV2O5 (x~0.26) nanowires. X-ray diffraction indicated both NaxV2O5 and MgxV2O5 intercalated samples crystalized in the bilayered phase. NaxV2O5 were found to have an interlayer spacing of ~11.12 Å, while MgxV2O5 samples had an interlayer spacing of ~11.03 Å, in good agreement with the difference in size of preintercalated ions. Materials with this structure are desirable for Li-ion electrodes because of large interlayer spacing, theoretically allowing for the facilitated insertion/extraction of Li+ ions during cycling. Electrochemical cycling in Li-ion batteries demonstrated initial discharge capacities of 229 mAh/g for NaxV2O5 and 125 mAh/g for MgxV2O5, suggesting that monovalent ions are more suited stabilization while retaining high capacity. We believe this is caused by larger interlayer spacing and lower charge of the stabilizing ion in NaxV2O5. Results obtained in this work suggest that the chemical preintercalation technique can be used to fabricate electrode materials with high capacity and good capacity retention.

Crosslinking Knit and Electrospun Poly(Vinyl Alcohol)

When polymer chains join together by forming an ionic or covalent bond, those bonds are called crosslinks. Crosslinking one material with another can affect that materials' mechanical or material properties, such as solubility and tensile modulus, allowing one to tailor the properties to a specific application. For this project, we investigated how the processing of a material affects the degree of crosslinking. Various knit and electrospun samples of poly(vinyl alcohol)were modified with sebacoyl chloride and glutaraldehyde. Jersey and ribbed knit samples made at two different tensions as well as aligned and random electrospun fibers were tested. T600, degree of swelling, melt, and Fourier transform infrared spectroscopy tests were used to determine if crosslinking occurred. Tensile tensile tests were performed to observe how the mechanical properties were impacted. Results show how the degree of crosslinking can be affected by structural changes of a material.

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Collection Assemblies for Electrospinning Nanofibers into Yarn

The creation of new fiber collection techniques is very important in terms of enhancing already established electrospinning methods to generate yarn from nanofibers. Electrospinning involves the production of extruding nano-scale fibers from various solutions in the presences of an electric field. Previous research illustrates a flaw in traditional collection assemblies, the inability to construct nanofibrous yarns. Therefore, our research focuses on the construction of new collection systems in order to fabricate a yarn of nanofibers. By expanding the types of assemblies for electrospinning nanofibers, we can improve upon production variation of fibers under different conditions without certain restrictions. Traditional collectors for nanofiber synthesis consists of direct current systems including both a metal, conductive plate for random collection and a two-prong apparatus for an aligned collection. Our lab assembled three additional types of electrospinning collectors: a needle-less system using alternating current which forms a cloud of fibers with the ability to be pulled into yarn, a drum collector devised from a lathe with controllable levels of fiber alignment, and a funnel collector incorporating an old trumpet used to make fibrous yarn when attached to an electric cone winder. With these collector prototypes, we hope to accomplish new methods to twist yarn of unique nanofibers with specific characteristics manufactured in order to enhance existing fabrics.

Ferroelectricity in bulk (1-x)[KNbO$_3$]-x[Ba(Ni$_{0.5}$Nb$_{0.5}$)O$_3$]

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Ferroelectric materials—materials with a spontaneous, switchable polarization when below their Curie temperature—have wide applications ranging from non-volatile memories to piezoelectric sensors. Recently, ferroelectric semiconductors have attracted considerable attention as an alternative to conventional semiconductor materials for photovoltaic solar energy conversion.

One particularly promising class of ferroelectric, photovoltaic semiconductors is the single-phase solid-solution oxide: (1-x)[KNb$_{O3}$]-x[BaNi$_{0.5}$Nb$_{0.5}$ O$_{3-\delta}$] (KBNNO). In the x = 0.1 composition, KBNNO has been reported to have exceptional photovoltaic and ferroelectric properties. An important property of ferroelectric materials is the Curie temperature, the maximum temperature at which ferroelectric materials retain their spontaneous polarization. Here, the ferroelectric phase transitions of the x = 0 and x = 0.1 KBNNO compositions are identified with Raman spectroscopy. Raman spectroscopy uses Raman scattering, inelastic scattering where incident photon energy is shifted by lattice and molecular vibrational states in a material, to directly probe the lattice structure of a crystal. Because the ferroelectric transition is driven by a lattice structure change, Raman spectroscopy can be used to identify the Curie temperature.

From these studies, we have identified the Curie temperature of the x = 0, or un-doped, composition as ~450^{o}C. Remarkably, the x = 0.1 composition shows a Curie temperature of ~230^{o}C.

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Soft Magnetic Composites Coated with Fe3O4 via Mechanical Milling

Soft Magnetic Composites (SMCs) incorporate magnetic, metallic particles, such as iron-, nickel- or cobalt alloys, coated with electrically insulating materials, and are strong candidates for more efficient electromagnetic devices. Compared to traditional steel laminates, SMCs have lower core losses, are magnetically isotropic, and allow for complex structures. Magnetite (Fe_3O_4), with a Curie temperature of 580°C, is a superior coating material because it can withstand high heating temperatures that degrade organic coatings such as epoxy resins. In this project, pure iron powder was mechanically milled with magnetite to improve magnetic saturation and reduce eddy current losses. Medium and fine iron powder sizes were used in the milling mixtures with micron- and nano-sized magnetite particles. We found that the iron powders were coated uniformly with magnetite after one hour of milling; however, nanoparticle coatings resulted in Fe_2O_3, nominally rust. The magnetization was found to be largely dependent on the iron particle size, and less on coating thickness, with the exception of the rust formation. The powders were successfully coated and therefore eddy current losses were reduced; testing to prove this theory is currently underway.

Evaluation of the Mechanical Properties of Grain Boundary Engineered 304 Stainless Steel

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Tailoring mechanical properties of materials to suit specific applications is becoming increasingly important as industries are expanding into new fields in which many materials are unsuitable. The ability to control these properties—such as fracture toughness, elasticity, plasticity, and tensile strength—through production without altering the alloy content of the metal would minimize the variety in stock required to manufacture materials to fit niche environments and applications, which could yield a lower manufacturing cost and increase usefulness of recycled components. Grain boundary engineered (GBE) microstructures were created in AISI 304 stainless steel through three iterative treatments of a 5 percent rolling reduction followed by a 2 hour solution anneal at 1020°C. GBE microstructures have relatively higher densities (>65%) of special boundaries, variants of Σ3n annealing twins, compared to non-GBE microstructure. Fracture toughness values were determined through 3-point bend tests performed according to ASTM E1820 using the crack compliance method. Tensile tests were performed according to ASTM E8. Novel software automatically processed fracture compliance data in a MATLAB script to return values for fracture toughness. Tensile tests compared elastic moduli, plastic hardening, yield and ultimate strengths, and ductility between the GBE and control. Results indicate that GBE increases fracture toughness, fatigue life, elasticity, yield strength, ultimate strength, and ductility, while maintaining practically the same plastic hardening.

Processing and Testing Ferromagnetic Powders for SMC Applications

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SMCs (soft magnetic composites) were developed using traditional powder metallurgy techniques for improved electromagnetic devices. These materials show heightened magnetic saturation and electrical resistivity as well as decreased core losses, when microstructure is optimized and powders are insulated properly. Applications for SMCs include DC brushless motors, alternators, rotating machinery, and transformer coils among numerous other products. Sieving iron powders into different size classifications, then ball milling powders for 1 h, allowed for comparison of different particle size dependence on magnetic and electrical properties. Annealing iron powders at temperatures below the recrystallization temperature, relieves plastic deformation previously induced from ball milling. Varying the annealing temperatures from 200oC to 700oC, allows for comparison of internal defects and grain size to magnetic saturaton and electrical resisitivity. Samples were subjected to varying magnetic fields in the VSM (vibrating sample magnetometer) in order to determine the magnetic moment fluctuation with respect to the magnetic field and determine properties such as coercivity, saturation magnetization, and remanent magnetization. Additionally, we designed a 3D printed stage for a Four-point probe method system to measure the resistance across each compact. Analyzing back scattered SEM (scanning electron microscopy) images correlated microstructure and grain size to VSM data as well as Four-point probe measurements. Our research will help determine optimal processing parameters for more efficient powders to be used in industry and in the creation of SMCs.

Vascularized Adipocyte Microfluidic Device to Investigate Inflammation in Metabolic Syndrome

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Metabolic syndrome, a cluster of cardiometabolic risk factors, is a serious health condition that affects about 25 percent of American adults. People affected by this syndrome are twice as likely to develop heart disease and five times as likely to develop diabetes compared to individuals who do not have the syndrome.

Metabolic syndrome is strongly associated with increased abdominal adipose tissue. As the adipose tissue grows, it becomes inflamed and begins to release harmful inflammatory cytokines. At the same time, blood flow to the adipose tissue decreases. While studies in large blood vessels show that decreased blood flow increases inflammation in the vascular endothelial cells, no studies have investigated whether low flow in adipose tissue microvasculature in obesity contributes to adipose tissue inflammation.

We hypothesized that a microfluidic device could be used to study adipocyte-endothelial cell interactions under blood flow conditions. To fabricate the device, we cross-linked a gelatin gel into a chamber made out of polydimethylsiloxane (PDMS, a silicone-based polymer) with a needle in the device center. After the gel solidified, the needle was removed to create a venule-sized channel. The device could maintain flow without any leakage. In the future, we will seed endothelial cells into the channel and adipocytes in the gelatin gel surrounding the channel.

This device will then be used to understand endothelial-adipocyte interactions under shear stress of blood flow, which will contribute to finding a treatment for chronic adipose tissue inflammation in metabolic syndrome.

Basic Monotonic Tensile Testing Accompanied by Digital Image Correlation and Infrared Thermography to Feed into Computational Modeling of Knitted Fabrics

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Tailoring mechanical properties of materials to suit specific applications is becoming increasingly important as industries are expanding into new fields in which many materials are unsuitable. The ability to control these properties—such as fracture toughness, elasticity, plasticity, and tensile strength—through production without altering the alloy content of the metal would minimize the variety in stock required to manufacture materials to fit niche environments and applications, which could yield a lower manufacturing cost and increase usefulness of recycled components. Grain boundary engineered (GBE) microstructures were created in AISI 304 stainless steel through three iterative treatments of a 5 percent rolling reduction followed by a 2 hour solution anneal at 1020°C. GBE microstructures have relatively higher densities (>65%) of special boundaries, variants of Σ3n annealing twins, compared to non-GBE microstructure. Fracture toughness values were determined through 3-point bend tests performed according to ASTM E1820 using the crack compliance method. Tensile tests were performed according to ASTM E8. Novel software automatically processed fracture compliance data in a MATLAB script to return values for fracture toughness. Tensile tests compared elastic moduli, plastic hardening, yield and ultimate strengths, and ductility between the GBE and control. Results indicate that GBE increases fracture toughness, fatigue life, elasticity, yield strength, ultimate strength, and ductility, while maintaining practically the same plastic hardening.

Computationally Deriving Stress-Strain Curves

Ultra high temperature ceramics are conductive materials that have potential use in aerospace due to their ability to withstand high temperatures while maintaining structural stability. However, these extreme temperatures prohibit routine tensile testing and either 4-point or uniformly loaded bend tests are used instead. In this work, we developed and refined a semi-inverse method to produce stress-strain curves, and thus evaluate standard mechanical properties, from the force deflection curves obtained during bending. This method was used to determine the temperature dependent elastic and plastic properties of several ultra high temperature ceramics including TaC, Ta2C and HfC.

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Field Emission Electric Propulsion

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This project is designed to create a proof of concept of an inexpensive electric propulsion system and through various testing procedures, review its effectiveness and ability to achieve the parameters it was designed to follow. By introducing an ionic liquid into a large electric field, electrostatic interactions between electrically charged particles in the liquid create a small amount of thrust. By recording the current and the voltage created by the ions the emitter releases, the power and the energy created by the propulsion system can be found. Through time-of-flight analysis the thrust, the mass flow rate, the specific impulse and the efficiency of the system can be found as well. Ion propulsion systems have so far been only able to create a small amount of thrust but allow for nearly instantaneous on/off capability, have a high specific impulse and high efficiency. In current applications, small satellites known as Cube Satellites are powered by ion propulsion systems that pack thousands of emitters into a centimeter squared. Cube Satellites have opened a door that can allow institutions and private companies to have a presence in space, an opportunity that motivated the study of ion propulsion to see if it could be implemented in Drexel's next Cube Satellite.

High-Altitude Balloon Vehicles

Helium-filled high-altitude balloons have been used for a variety of projects in the field of engineering. Their use extends from small atmospheric tests by high school and college students, all the way to large scale hardware tests by NASA. High-altitude balloons have even been used by Drexel students in the past to launch experiments. But while HABs have clearly demonstrated their use in stratospheric tests, their use in low-altitude applications has been limited. The goal of this project was to create a use for HABs in low-altitude flights. By keeping the balloon tethered, it could be limited to a height of around 250 feet, which is the maximum altitude available without the need to secure FAA approval. At this height, the balloon could be used to drop a variety of air vehicles in a short amount of time for tests, recreation, or possibly a competition setting. The plan was to create a competition centered around the balloon, using a platform to carry and launch projects created by the competitors.

At this point, most of the work on the first version of the platform has been completed. The main body of the platform is assembled, and the electronics are close to being integrated with the "brain" of the platform, an upper board which houses the electronics and connects the "body" platform to the balloon. Further work is needed to develop an auto-stabilizing component of the platform, however, version one is very close to seeing its first flight.

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Relationship of Blood Glucose Control and Co-morbidities of Diabetic High-Risk Pregnant Women Who Received Perinatal Home Visiting

It is estimated that over 9.2% of pregnancies in the United States are complicated by gestational diabetes (GD). Women who have GD are considered high-risk. If strict controls of blood glucose levels are not maintained, women with GD may develop complications such as pre-term birth, miscarriage, and pre-eclampsia. To help prevent these complications, obstetricians often refer routine home visits conducted by registered nurses with obstetrical nursing experience. Co morbidities can increase stress levels, making the management of GD more difficult and requiring higher levels of care. In this study, we measured the prevalence of different co morbidities in women with GD receiving home visits and the correlation these co morbidities had with GD management and overall outcome.
Co morbidities, blood glucose levels, nursing notes, and patient concerns were abstracted from records of home health visits during 2012 and entered into a Health Insurance Portability and Accountability Act (HIPPA) secured REDCap database. Data analysis was conducted using SPSS (version 23).
Preliminary results indicate a trend of co morbidities in this population. Data analysis to determine the prevalence and correlation with glucose control of these co morbidities is ongoing. It is important that health care providers are aware of the prevalence and impact of co morbidities in women with GD as this can alter treatment plans and outcomes.

Edema and Blood Glucose Control among Diabetic High-Risk Pregnant Women Who Received Perinatal Home Visiting

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Introduction: Maternal mortality and morbidity has dramatically increased in the United States with documented racial and ethnic disparities. Diabetes is a serious complication of pregnancy necessitating more intensive medical and nursing management. Advancing knowledge of symptom clusters indicative of worsening health is a research priority for NINR*. Women during pregnancy undergo many physiological changes, some cause discomfort. A common discomfort is edema. Edema is a condition that is characterized by the build up and accumulation of excess watery fluid collecting in the cavities or tissues of the body. An important role for nurses is to help women during pregnancy be as comfortable as possible when they experience edema and assess if it is normal or not. Understudied is edema in pregnant women with diabetes. This study examines if edema among pregnant women with diabetes is part of a symptom cluster of poor glucose control.

Study Population: Philadelphia pregnant women with diabetes (n=112) who received perinatal nurse home visits (total = 733) during 2012.

Methods: Detailed health data on key study variables (edema, blood glucose control, weight, patient concerns, and other health problems and medical diagnoses) were obtained from abstracted health records that were entered into a HIPPA secured REDCap database. De-identified data were exported into SPSS (version 23) for data analysis to compare those with and without edema.

Discussion: A deeper understanding of edema is needed so nurses can develop evidence-based symptom management practices when caring for high-risk pregnant women with diabetes. This warrants further research.

*NINR= National Institute of Nursing Research

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Nursing Nutritional Practice Survey

Malnutrition commonly affects older adults across the health care continuum and is associated with increased morbidity and mortality. Nutrition is an important component of nursing care. Nurses are the healthcare professionals that often provide the first nutrition screen for patients newly admitted to the hospital. Research suggests that basic nutritional care is too time-consuming and may be missed by U.S. hospital nurses; however, the current nutritional nursing procedures in place remain unknown. The purpose of this study is to collect information about current nursing nutritional practices in a range of care settings. Identifying current practices can lead to a better understanding of the existing practice gaps related to basic nutritional care so that interventions can be developed to improve health care overall. The Nursing Nutritional Practice Survey (NNPS) was developed using a Modified Delphi methodology. The NNPS items were developed based on previous survey questions and research findings. After several iterations of the survey, the NNPS was reviewed by four content experts. Based on their feedback, the final NNPS was prepared. The NNPS consists of 59 items that address: nutrition related practices, methods for measuring and monitoring food and fluid intake, oral nutritional supplement practices, and mealtime factors. The online survey (using Qualtrics: Online Survey & Insight Platform) will be launched once approved by IRB. Nurses enrolled in Drexel's RN-BSN and MSN programs will be invited to participate in the survey. In the future, the target audience will be nurses who are members of national and international nursing specialty organizations.

Characteristics of Two Young Adult Patient Populations Admitted to the Emergency Department of an Urban Medical Center in 2013

Transitioning into adulthood is a time of life that is encompassed by many changes. As seen in previous studies, if the changes are not perceived well, the resulting emotional distress can be positively correlated with depression, anxiety, alcohol abuse, and suicidal behaviors. The age cohorts of 18-year olds and 22-year olds may be especially problematic because stress related to early adulthood transitions and introductions into new environments results in poor decision making skills and self-injurious behaviors. The purpose of the study was to examine the differences between 18 and 22 year old patients with respect to: sociodemographic characteristics, chief complaints at admission, diagnoses, and disposition in order to understand the young adult population. This descriptive study was conducted using retrospective chart review. Data were abstracted from the medical records of 18 and 22 year old patients from the total patient population of 48,215 patients that presented to the emergency department of Hahnemann University Hospital between January 1 and December 31, 2013. Descriptive summary statistics of percentages and frequency distributions were used for data analysis. Results of descriptive analysis show that a 41% of 18 year olds presented with complaints of intoxication, with a significant majority receiving diagnoses of drug or alcohol abuse. In contrast, the most common chief complaints of 22-year olds were psychiatric problems and suicidal ideations. A greater percentage of 22-year olds required additional psychiatric care than 18 year olds. Further examination of the stressors of these two populations would aid in developing more effective strategies to help both age groups cope with their respective transitions and help prevent adverse psychiatric outcomes.

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Investigating the effects of SIRT3 on HBV Expression and Replication

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Hepatocellular carcinoma (HCC) is a cancer that originates from hepatocytes, the principle cell type of the liver, and represents the fifth most common cancer, as well the second most common cause of cancer-related death in the world. The leading risk factor for the majority of patients who develop HCC is a chronic infection with the hepatitis B virus (HBV). Our research group primarily focuses on exploring and developing a deeper understanding of the processes that are involved in HBV-mediated hepatocyte transformation. One cellular protein, Sirtuin 3 (SIRT3), a mitochondrial deacetylase, is thought to have an effect on HBV replication. Although the functions of the members of the sirtuin family are well documented, there is a limited understanding on the effect of these proteins, particularly SIRT3, on HBV. To begin to understand this process, we used several cell culture procedures and techniques. In this study, the effects of SIRT3 overexpression on HBV replication in HepG2 cells – a human hepatoblastoma cell line that serves as an in vitro model for the study of HBV biology – were observed. Using cell culturing and transfection methods, plasmids that encode for the SIRT3 protein were introduced to the cells and the effects of SIRT3 on protein expression and genome replication were tested and quantified using western and Southern blotting procedures. Recognizing the impacts of SIRT3 on viral replication will advance the current understanding of HBV biology and help potentially reveal future new, previously unexplored avenues of research.

Liposomes for Antiviral Drug Delivery

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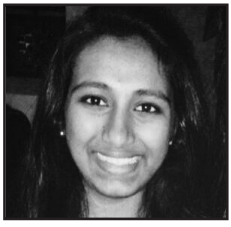
With approximately 33.4 million adults living with HIV worldwide, HIV represents one of the most significant threats to public health. Currently, to combat this infectious-disease, antiretroviral therapy (ART), a combination of drugs that target different stages of the HIV life-cycle, has been proven to be extremely effective at lowering patient HIV viral load. However, the strict daily prescription regimen has led to low patient adherence rates—prompting the search for a more compliable treatment.

It has been established that initial HIV entry occurs via the interaction between the HIV envelope glycoprotein, gp120, and the host cell CD4 receptor protein, leading to events that cause infection. To prevent this step, Chaiken lab has synthesized a cyclic peptide triazole known as AAR29-B, an entry inhibitor that blocks the attachment of gp120 to CD4. However, peptides as such suffer from serum instability and need a half-life extension. Therefore, we aim to utilize liposome technology as a drug delivery vehicle for AAR29-B, as liposomes have been demonstrated clinically to enable enhanced drug cargo efficacy, prolonged activity, and reduced systemic toxicity. My summer project has been to explore the possibility of obtaining long-circulating liposomes by modulating the lipid composition with either DPPC:Cholesterol or DSPC:Cholesterol. In vitro release experiments suggest that there is a sustained release of AAR29-B in liposomes formulated from DSPC:Cholesterol over a week-long period due to its slow release kinetics. Infection inhibition assays of AAR29-B encapsulated in liposomes formulated from DSPC:Cholesterol show promising antiviral effects against lab-adapted strains of HIV. Ongoing efforts are to study the release kinetics of liposome formulations in human serum.



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Immunosuppression and the Onset of Skin Cancer

Skin cancer is becoming an increasing problem in the United States. The environment and genetics can play a role in the incidence of skin cancer; however, exogenous factors such as medications can also have affect. Immunosuppressive medications have been proven helpful not only in various autoimmune and inflammatory diseases but also in post solid-organ transplants. However, despite their benefits, there has been increasing evidence of the association between these medications and the onset of skin cancer. This review examines the most up-to-date literature on immunosuppressant medications and autoimmune diseases. Through this review, we hope to raise awareness of this increased risk, for clinicians who care for these patients.

Immunosuppressive Therapy and the Role of Vaccination

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While vaccines are heavily recommended worldwide as preventative treatment for a plethora of infections and diseases, live-attenuated vaccines are not recommended for all patient populations. The number of patients that are immunosuppressed has steadily been increasing with the increasing use of organ transplantation and treatment of autoimmune disease. As vaccines work by targeting a person's immune system and eliciting a protective immune response, the immunosuppressed patient population is one such population that is especially important to study. New medications, such as biologic agents, i.e., anti-tumor necrosis factor α, along with other immunosuppressive agents are all immunomodulating therapies.

Live-attenuated vaccines (LAV), or vaccines that contain weakened strains of live viruses, are more susceptible to replication in a host's body—thus, making them more harmful to immunosuppressed patients than to immunocompetent patients. However, certain vaccines only come in a live form; thus, it is important to learn how to vaccinate immunosuppressed patients with live vaccines and minimize risks.

Therefore, in this study, we examined current recommendations for vaccinating immunosuppressed patients with live vaccines through a literature search and subsequently created and conducted a survey for dermatologists nationwide to examine what practices they employ. The final objective of this study is to assess the proportion of dermatologists who follow current vaccination guidelines for this patient population and to lead a discussion regarding potential, future guidelines that could be recommended.

Ethnomedical Therapies for Asthma in the Puerto Rican Community

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There is both a higher asthma prevalence and mortality rate among Puerto Rican children than any other ethnic group in the United States. This disparity has been attributed to a combination of genetic and environmental factors. However, sociocultural factors also play a large role in a patients' understanding of their illness. Studies have shown that up to 89% of Hispanic patients are familiar with ethnomedical remedies for asthma. The aim of this study is to identify which alternative medical practices Puerto Rican families use in the treatment of their child's asthma. This knowledge will ultimately be used in order for clinicians to tailor education and clinical management of asthma for this population. In order to ascertain this data, surveys were created based on folk remedies recorded in previous medical-anthropological literature. The surveys are four pages long and assess a variety of ethnomedical practices for both the prevention and treatment of asthma attacks, as well as demographic information about the caregiver. The IRB-approved surveys are being distributed to eligible participants (parents of asthmatic children ages 2-18 who self-identify as Puerto Rican) in the Asthma Care Clinic of the Center for the Urban Child at St. Christopher's Hospital for Children. To date, about thirty surveys have been conducted. When the goal of 135 completed surveys has been reached, statistical techniques will be carried out in order to identify trends in folk remedy use for the treatment of asthma for the Puerto Rican population served by St. Christopher's Hospital.

The Effect of Exercise on the Inflammatory Response and the Development of Neuropathic Pain After Cervical Spinal Cord Injury

More than two-thirds of people with spinal cord injury (SCI) develop chronic, incurable neuropathic pain. It is expressed as hyperalgesia, heightened response to painful stimulus, or allodynia, painful response to innocuous stimulus. SCI causes inflammation in the spinal cord. Immune cells called microglia and macrophages are recruited to the spinal cord and activated, and microglial activation is intimately associated with the development of SCI-induced neuropathic pain. Importantly, exercise has been shown to alleviate pain after SCI. Whether exercise alleviates pain after SCI by reducing microglial activation in the spinal cord is unknown. For this study, female Sprague-Dawley rats were randomly assigned to an SCI group or a control group. A C5 unilateral contusion was performed using the Infinite Horizons Impact Device. A subset of rats was exercised from 5 days post-injury (dpi) 20 minutes/day for 4 weeks. After SCI, pain was assessed using von Frey and operant testing. For von Frey testing, paw withdrawal thresholds were determined using calibrated monofilaments. The operant Mechanical Conflict Avoidance Paradigm assessed cognition of nociceptive stimuli. Rats were perfused at 33 dpi. The C4-6 cord was stained for Nissl-Myelin, and tissue sparing at the lesion epicenter was quantified using Stereo Investigator. We are currently analyzing C7-8 and L3-5 cord for microglial activation and phenotype (using Iba-1 and ED-1). With this data, we hope to understand the effect of exercise on microglia/macrophages in the spinal cord and resultant development of pain, which may help establish exercise and drug interventions as combinatorial therapy for SCI-induced neuropathic pain.

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Lifespan Extension in Humans

Mitochondrial dysfunction in cells may cause premature senescence and early death in humans. The laboratory of Dr. Christian Sell has shown that damaged mitochondria can promote the mTOR signaling pathway. This pathway inhibits autophagy, a critical pathway that maintains protein and mitochondrial homeostasis and manages damaged mitochondria. Inhibiting autophagy will thwart cells from recycling nutrients that are vital for survival; in doing so, the cell is prone to early aging and shortened lifespan. In fact, treatments that extend cellular longevity are known to promote autophagy. In this set of experiments, we used a human cell model to examine the effects of two autophagy-promoting cell treatments: the addition of rapamycin (an antifungal agent that inhibits mTOR) and restriction of methionine, both of which have been shown to extend organismal healthspan and lifespan. We also observed growth patterns of cells that were exposed to a combination of rapamycin treatment and methionine restriction. After comparing cells with these conditions to control cells that grew under normal circumstances, we concluded that the the methionine restricted cells had a longer lifespan than the control cells. Additionally, the rapamycin treated cells exhibited an increased lifespan when compared to the methionine restricted cells. Cells that were treated with a combination of both conditions had the longest lifespan overall and, ultimately, showed the most promising results with regards to increasing lifespan in the human population.

Bromodomain Protein Inhibitor JQ1 Attenuates Inflammatory Pain

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Inflammatory mediators released locally after tissue injury can directly stimulate and cause sensitization of pain-sensing nociceptors in peripheral tissues. As a result, inflammation causes acute pain and if left unresolved, can lead to the development of chronic pain. Epigenetic mechanisms including histone modification and DNA methylation can enhance or suppress gene expression without altering the DNA sequence. The bromodomain-containing family of proteins is an important class of histone modification readers that recognizes acetylated lysine residues within histone proteins. Previous studies have established the crucial role of bromodomain and extraterminal (BET) proteins in the transcription of pro-inflammatory cytokines. These reader proteins associate with promoters to "interpret" histone acetylation marks on these inflammatory genes. Though JQ1, a potent inhibitor of BET proteins, is known to inhibit cytokine production, its role in the possible prevention or alleviation of inflammatory pain is still unclear. Here, we investigated the effects of JQ1 in the attenuation of inflammatory pain using complete Freud's adjuvant (CFA) and formalin-induced inflammatory pain in mice. We compared the thermal, mechanical, and spontaneous pain levels of JQ1-treated to vehicle-treated animals. Though we did not observe a difference in their mechanical and thermal pain thresholds, JQ1 significantly reduced increased paw thickness resulting from CFA injection. JQ1 also significantly attenuated formalin-induced early and late phase spontaneous pain behavior. Additional studies investigating the molecular mechanisms underlying changes induced by JQ1 will be beneficial in further exploring the utility of bromodomain inhibitors in treating inflammatory pain.

Fractalkine (CX_3CL_1) Drives the Migration of Pancreatic Cancer Cells Through the CX_3CR_1 Chemokine Receptor

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Pancreatic ductal adenocarcinoma (PDAC) accounts for the vast majority of cases of pancreatic cancer, having an annual death rate nearly equal to its annual rate of diagnosis. Its particularly rapid rate of metastasis is among the most significant contributions to its lethality. This study investigated one of the potential mechanisms and unique paths by which metastasis occurs in PDAC cells. Our focus was on the relationship between the activation of pro-tumorigenic pathways and migratory activity of human and mouse PDAC cells that express CX_3CR_1, a chemokine receptor upregulated in PDAC patients and correlated with poor prognosis. We used Boyden chambers to assay the migration of PDAC cells stimulated by CX_3CL_1, the sole ligand of CX_3CR_1. Our data show that CX_3CL_1 increased migratory activity in 3 of the 4 cell lines. Protein immunoblots of CX_3CR_1 downstream effectors, AKT and MEK, which can drive several pro-tumorigenic pathways, showed an increase in activated pAKT and pMEK in response to CX_3CL_1. As CX_3CL_1 treatment augmented migration of the PDAC cells, we investigated whether a novel inhibitor of CX_3CR_1, JMS-17-2, could block cell motility. Our results indicate that PDAC cell migration stimulated with CX_3CL_1 is inhibited by JMS-17-2 in a dose dependent manner. Thus we conclude that the CX_3CL_1-CX_3CR_1 signaling axis stimulates PDAC cell migration and multiple pro-tumorigenic pathways in PDAC cells, establishing its importance in research on therapies to delay metastasis of PDAC tumors. Our data demonstrate that inhibiting this chemokine pathway may be a viable strategy in the treatment of metastatic pancreatic cancer.

Effect of Novel CX_3CR_1 Small Molecule Antagonists on Breast Cancer Cell Proliferation

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One in eight women in the United States will develop breast cancer during their lifetime, with 20% to 50% of patients experiencing metastasis. Of those patients with metastatic breast cancer, approximately 90% of patients will die from it. Consequently, an effective treatment for metastatic breast cancer is urgently needed. The CX_3CR_1 chemokine receptor has been found to be directly involved in the lodging of circulating breast cancer cells to the skeleton. Two small molecule antagonists, JMS-17-2 and JMS-68, have been developed to target the CX_3CR_1 receptor. *In vivo* studies in SCID murine models utilizing human MDA-MB-231 breast cancer cells demonstrate that JMS-17-2 and JMS-68 impede the seeding of metastatic tumors by cancer cells circulating in the blood. Furthermore, an unanticipated significant reduction in the growth of existing metastases was observed after antagonist administration. The mechanism by which these novel compounds block the progression and growth of metastatic tumors is not yet understood. In this study, the effects of JMS-17-2 and JMS-68 on tumor cell proliferation was assessed by immunocytochemistry targeting Ki-67, a recognized marker for cell proliferation, and bromodeoxyuridine (BrdU), an introduced thymidine analog which indicates movement through the S-phase of the cell cycle. Future work will aim to investigate other mechanisms by which the antagonists interfere with the interaction between tumor cells and stroma microenvironments to stop metastatic tumor progression.

Cytoplasmic Sequestration and Autophagic Degradation of HER2 By Small Molecule Sigma1 Modulators in HER2-Amplified Breast Cancer Cells

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HER2/Neu (HER2) is a receptor tyrosine kinase amplified in about 25% of breast cancers. HER2 amplification drives cancer cell growth and proliferation, and is associated with especially aggressive disease. Although HER2-targeted therapies are initially effective, most patients relapse, implying resistance to existing therapies. As an integral membrane protein, HER2 is synthesized in and transported through the secretory pathway, comprised of the endoplasmic reticulum (ER), Golgi, and associated compartments and vesicles. Nascent HER2 is stabilized and chaperoned, in part, by heat shock protein 90 family members. Our lab demonstrated that a unique protein called Sigma1 (also known as sigma1 receptor) contributes to protein homeostasis in the secretory pathway. We found that certain Sigma1 selective small molecule compounds can modulate Sigma1 mediated protein homeostasis, inducing ubiquitin proteasome system mediated degradation, the unfolded protein response, and autophagy.

This summer we hypothesized that pharmacological modulation of Sigma1 could disrupt transport and stability of HER2 in HER2-amplified breast cancer cell lines. To address this hypothesis, we used immunoblot and confocal microscopy techniques. We discovered that treatment with a prototypic Sigma1 modulator suppressed HER2 signaling and eventually eliminated HER2, in a HER2-amplified breast cancer cell line. These correspond with a two-step process comprising sequestration of nascent HER2 into ubiquitin-enriched autophagosomes and subsequent degradation. Furthermore, we found similar effects in a HER2-targeted therapy resistant breast cancer cell line. We have discovered a novel mechanism to suppress HER2, and provided further evidence in support of Sigma1 as a novel therapeutic target in treatment of breast cancer.

Wireless Sensor Network

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Wireless Sensor Networks (WSN) is in the front line of natural disaster detection by collecting early warning signs and valuable data when such event is happening. It is made from multiple nodes connected together to create a network that can monitor the conditions of a location. Each sensor node is usually composed of a battery pack, a radio transceiver, a microcontroller and other sensors depending on the purpose of the node. These parts are usually in a modular design so if any part of the node is damaged or outdated, it can be easily swapped out. WSNs are usually for industrial use and scientific research, but we wanted it to use in the consumer market. To achieve that, many other types of interchangeable parts would have to be created. I developed the Wi-Fi communication board with the help of my mentor Konstantin Mikhaylov. First a PCB design was needed to place all the components. Using EAGLE, I managed to design a dual layer PCB board with the main components being the WF-121A communication chip. A lot of calculation was done to ensure the shortest signal routes to improve efficiency. After the physical board was made, other components were then soldered on.

With some minor driver changes the board managed to communicate with other network of sensors, it can take power from the battery pack and it sent and received signals easily. The development of this chip is a stepping stone to the ultimate goal which is to develop interchangeable boards for every purpose needed.

Visible Light Communication

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Visible light communication(VLC) is a type of wireless communication that uses the visible spectrum. It can be considered a supplement to the radio frequency spectrum that is already in use. The RF spectrum is limited in terms of data rates. Besides the potential improved data rates, VLC is safe and cheap given that it can use simple tools such as LEDs and light bulbs. On the other hand VLC has some drawbacks such as line of sight and the difficulty of communicating outdoors, so it can not eliminate the usage of RF.

We are developing a front end printed circuit board for VLC which is capable of receiving an electric signal from digital to analog converter(DAC) and modulate the intensity of a transmitter LED light based on it. At the same time it can receive the modulated light from a photodiode, filter, amplify and forward the signal to an analog to digital converter(ADC). We have used FMC150 as the DAC and ADC and to control it we have developed an IP core on an FPGA board.

The end result is a microprocessor system which can act as VLC communication node. This system is implemented on Xilinx's ML605 evaluation board.

SAP's HANA In-Memory Database System

A common problem in the corporate world is that companies use database systems that are slow. These companies have very limited access to their data. This means that managers and CEOs are unable to make informed decisions for their companies' short term success. To be able to make timely decisions, fast database software must be implemented in their environments. SAP's HANA in-memory database system solves this problem because it runs solely in RAM, making it a very fast database. It is also specially designed for big data processing. SAP HANA runs in the cloud to transfer information globally and enable centralized data reporting. When an application is developed for SAP HANA, the CEO can see all current data on her global company from a mobile device or web browser by taking user input from workers and putting it into the database using an application server which contains additional business logic. The same application server can then send the data, now computed and formatted, to the CEO in an easily digestible format. She can then make accurate and timely decisions that are crucial for the success of her company.

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Using MazeSuite to Edit Virtual Environments

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New technology has led to many advances in neuroscience, and many new opportunities for research. Equipment such as the functional Near-Infrared Spectroscopy (fNIR) has allowed for brain signals to to be studied and analyzed in new ways. Researchers are using this technology to analyze neural activity, and even attempt to use this activity to control machinery. Certain computer programs such as MazeSuite are used to create virtual environments which can be used in experiments to study neural activity in different situations. The purpose of the STAR project is to use MazeSuite to create and edit virtual environments which are used in experiments. The program was used to create a virtual model of both real world environments as well as original backdrops. The mazes created for experiments edited to resemble the environment with as much detail as possible. Pictures of the area were taken and used a textures. Other aspects such as lighting were adjusted to match the model's real world equivalent. The virtual environments were continually adjusted so to meet the experimenter's requirements. Once adjusted, the mazes were explored by test subjects as the subject's neural activity was monitored by a fNIR machine. The mazes built allowed for the experiments to proceed and further neurological research.

Thoracic Deformity in Early Onset Scoliosis, and Pelvis Morphology in Normative and Adolescent Idiopathic Morphology

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Scoliosis, a disorder that affects millions in the United States alone every year, has a severe impact in the lives of those diagnosed. Early onset scoliosis (EOS) is typically diagnosed in children ages three years and under who demonstrate spinal deformity; however, this condition is very rare. Most commonly, scoliosis is diagnosed in children and adolescents between the ages of 10-18 years as adolescent idiopathic scoliosis (AIS). The objectives of the present study were to (1) Reconstruct the three-dimensional spine and rib cage structures in five EOS patients from CT scans, and (2) Develop automated landmark identification methods to characterize pelvis morphology in AIS patients and skeletally normal adolescents. EOS subject's CT scans obtained from the Children's Hospital of Philadelphia were segmented and reconstructed using MIMICS (Materialise Inc., Belgium), a medical image processing software. These 3D reconstructions will be further used for to correlate skeletal deformity with pulmonary function. Biplanar radiograph-based 3D reconstructions for 100 normative and 70 AIS subjects with varying Lenke curve types were obtained from the Setting Scoliosis Straight foundation. Development of an automated method to identify bony landmarks on the pelvis is underway. Using these landmarks, pelvis geometry measures such as pelvic tilt, pelvic incidence, depth, height etc., will be quantified.

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Osteonal Morphology, Distribution, & Drift in Porcine Femoral Midshaft

Analysis of bone microstructure (i.e. primary and secondary osteons) in porcine femoral samples can be used to make statistical comparisons regarding bone quality. The objective of this novel study is to quantify the osteonal morphology, distribution, and drift in the midshaft of the porcine femur. Specifically, the 50% femoral site of two-month-old (n=5) and six-month-old (n=5) pigs was sectioned and mounted to prepare samples that hold cross-sections of bone. These samples were then ground & polished with a Buehler PowerPro4000 (Buehler, Lake Bluff, IL) until they were adequately refined to be viewed under a microscope. Each of the ten samples was then imaged with a Zeiss microscope at 10X magnification using reflective microscopy. Next, the image portions for each sample were layered and flattened using the Adobe Photoshop program. Once masked so that only bone was visible, these images were input into MATLAB software (Mathworks Inc., Natwick, MA) to identify endosteal and periosteal borders, as well as six wedges of interest. After a distinction of endosteal versus periosteal bone was made in each image, two regions of interest were selected from each sample. These regions will be reimaged at 5X magnification and the encompassed primary and secondary osteons will be traced using a custom MATLAB code. The morphology and distribution of primary and secondary osteons will be computed to reveal differences between the microstructure of endosteal versus periosteal porcine femoral bone.

Nanomechanics of Weakly Linked Polymeric Hydrogels

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This study focuses on investigating the nanomechanical properties of hydrogen bonded hydrogel networks. The thickness in dry and wet states, swelling ratio, elastic and viscoelastic properties of this type of network are being explored thoroughly in this study. The specific network being studied is a polyacrylamide/polyacrylic acid (PAAm/PAA) network that is assembled using the layer-by-layer process. The thickness of this assembled "nanofilm" is measured using atomic force microscopy (AFM), in which the assembled networks differ in thickness, as controlled in assembly by varying the amount of bilayers (A bilayer consisting of an equal deposition of each polymer onto the substrate). In the dry state, the networks increase in thickness exponentially as the amount of bilayers increase.

One intrinsic property of hydrogels is that they swell when placed in fluid. These wet state networks are characterized as being immersed in fluid of varying pH and ionic strength. By controlling for pH and ionic strength, it is possible to modify the densities of the hydrogen cross-links, thus changing the thickness of the network in the wet state. It is possible to then simply compare the thicknesses of the networks in both states in order to determine the swelling ratio of this particular network.

In order to quantify the elastic and viscoelastic properties of this category of network, AFM is once again utilized. The analysis and understanding of these time-dependent nanomechanical properties are crucial in discerning the role of pH and ionic strength on the elasticity and viscoelasticity of weakly linked polymeric hydrogels.

Using fNIR to Measure Brain Hemodynamics and Other Physiological Signals In Healthy Volunteers

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Functional near-infrared (fNIR) spectroscopy uses optical imaging technology to measure relative changes in the concentrations of oxygenated and deoxygenated hemoglobin. In this study, two sensors were placed on the forehead and the neck. Each sensor had one light source and two photodetectors at a separation of 1.5 cm and 3 cm. The difference in separation from the light source allows the sensor to receive the fNIR signals from just below the surface and deeper under the skin. This technology was used to measure the physiological changes that occur as a result of changes in position. Twenty-five adult volunteers were recruited for this study. Using an operating room table each volunteer was placed in positions often found in the operating room and clinical settings. Before each different position, a baseline was measured to see the change that the position would cause on the subject. The positions included being placed head down, feet down, side to side, and head down with the feet in stirrups. The data was analyzed with reference to each baseline in order to quantify the effect of position changes on hemoglobin concentration in the brain. This evaluation has applications in research, clinical, and operating room settings.

Quantifying SCI Lesion Relative to Location

Spinal cord injury (SCI) affects over 313 million people in the United States limiting mobility, lower body function, or even leading to neuropathic pain. The purpose of this study is to quantify the extent of spinal cord lesions in order to compare it to data regarding pain sensitivity and behavioral outcomes. Approximately two-thirds of all reported cases of SCI are incomplete injuries that may result in the development of central neuropathic pain. To understand the relationship between the extent of the lesion and the development of pain, a rat model of spinal contusion is used. In this model it is difficult to make consistent injuries. Therefore, for each animal, a method to quantify the amount of healthy tissue remaining after an injury relative to its location on the spinal cord is needed. After the animals were perfused their spinal cords were sliced horizontally and stained with a nissl and myelin stain. Then pictures were taken of the slices and quantified utilizing ImageJ (www.nih.gov) to determine the total area of the tissue, the gray matter and the white matter--in lesioned models the density of the matter indicated whether or not the tissue was damaged or healthy. After quantifying the lesion the mean and standard deviation were calculated.

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Quantifying Lesion Size in SCI

The purpose of this research is to develop a method to quantify grey and white matter in the thoracic rat spinal cord using a measured section outside the area of interest. After a spinal cord injury, the extent of the spinal lesion can be a contributing factor to outcome. Determining lesion size is an important experimental method when studying the behavioral effects of SCI.

1.4 cm sections of spinal cord centered around T10 were collected and frozen. Coronal sections of the samples were then taken from predetermined locations relative to T10, stained for Nissl (grey matter) and myelin (white matter), and digitally imaged. The means and standard deviations of areas of grey and white matter were then calculated at each location of the spinal cord. The mean areas at each location were then normalized to the same distal segment and a normalization factor was determined for each location.

Using the normalization factors for each location on the thoracic spinal cord, we were able to predict the areas of the grey and white matter for a naïve animal. After a spinal cord injury, this method can be used to estimate the pre-injury amounts of grey and white matter such that the data can be expressed as the percentage of spared matter.

Hepatocellular Carcinoma Cell Invasion Depends on Interstitial Flow Velocity

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Hepatocellular carcinoma (HCC) is the most common form of liver cancer and has the third highest mortality rate among cancers worldwide. Due to HCC's propensity to invade throughout the liver, the five year survival rate is extremely low. Recently, much emphasis has been placed on studying the changes in biomechanical forces within the tumor microenvironment. Alterations in biomechanical forces such as interstitial fluid flow (IFF) have been shown to change cancer cell invasion and various cell behaviors. IFF velocity is increased in the tumor microenvironment due primarily to increased permeability of tumor-associated vasculature. Previous studies have shown that increased flow drives cancer invasion.

The objectives of this study were to (1) determine the time course of IFF-induced invasion in our HCC model and (2) demonstrate that invasion varies as a function of IFF velocity. Comparing invasion after 3, 6, and 24 hours of exposure to IFF, IFF-induced invasion increases with time. IFF-induced invasion was also significantly greater than static controls at 6 and 24 hours. We also showed that the cells exposed to a higher IFF velocity (0.35 μm/s) invaded significantly more than cells exposed to a lower IFF velocity (0.13 μm/s).

Understanding the effects of IFF in HCC could potentially be used to design better diagnosis and therapy options. If IFF velocity or cellular responses to flow affect HCC invasion, measuring IFF in patients could help physicians choose appropriate treatments.

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Finite Element Analysis (FEA) of the Resonance Behavior of Piezoelectric Plate Sensor (PEPS)

Harmful toxins, bacteria, and even indicators of different types of cancers can be exposed by studying samples of DNA found in blood. Doctors currently use polymerase chain reaction (PCR) for DNA detection, but this technique is neither fast nor inexpensive, since it requires gene isolation and amplification. To overcome this problem, the Sensor and Functional Materials Group has developed a lead magnesium niobate-lead titanate (PMN-PT) piezoelectric plate sensor (PEPS). It is able to self-amplify its detection signal by more than 1000 times due to its unique properties of the thin crystalline material, as well as recognize DNA with PCR-like sensitivity. Real-time, label-free DNA detection is completed by submerging the PEPS in a liquid sample and electrically monitoring the length-extension-mode (LEM) or width-extension-mode (WEM) resonance frequency shift after the target DNA binds to a receptor that has been immobilized on the PEPS surface. My STAR project focused on monitoring how sensor geometry affected the resonance peak position. Through ABAQUS, a 3D simulation software for FEA, I changed several factors that would affect the resonance peaks, such as material properties, boundary conditions, element sizes, length and width sizes, and frequency ranges. More specifically, tracking how the variation of the sensor's width affected the WEM resonance peak width, which has the potential to further improve PEPS detection performance from the higher frequencies of WEM. Future work includes analyzing the resonance behavior by testing non uniform width sizes, along with the surface cohesion interaction, in order to improve DNA recognition by lowering the detection concentration limit.

New Right Ventricular Assist Device with Magnetic Suspension for Pediatric Patients

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Congestive heart failure (CHF) is a debilitating disease that affects millions of patients with acquired and congenital heart disease. The limited number of donor organs necessitates the development of implantable ventricular assist devices (VADs) to provide temporary, bridge-to-transplant and long-term circulatory assistance to patients with left-sided or right-sided heart failure. Since fewer therapeutic alternatives exist for patients who have failing right ventricles, the BioCirc Research Laboratory in Drexel BIOMED is developing a novel right-sided VAD, or RVAD. Building upon a prior design, we present the new RVAD2. The geometry of the RVAD2 is more compact than that of the original VAD and will feature an impeller levitated using a novel magnetic suspension system. The target design of the RVAD2 is to generate blood flow rates of 4-7 L/min for pressure rises of 10-30 mmHg over rotational speeds of 7,000-13,000 RPM. Numerical simulations of the RVAD2 were performed using ANSYS CFX to compare the performance predictions of the optimized RVAD2 design to the RVAD. Computational studies showed that the RVAD2 achieved target design criteria and successfully maintained hydraulic performance despite being 42% smaller than the RVAD. These results support the continued development of this new blood pump for patients with right-sided heart failure.

Testing and Analysis of Cage-Impeller Designs for Blood Pump Device in Single Ventricle Physiology

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Each year, thousands of infants are born with severe congenital heart malformations. A percentage of these infants have only one functioning ventricle and require palliative surgeries that create a single ventricle physiology, or Fontan physiology. Since these patients have a single ventricle or pumping chamber doing the workload of two, they experience a steady and often rapid cardiovascular decline, reaching heart failure prematurely and necessitating a heart transplant. Given that donor organs are in short supply, the BioCirc Research Lab at Drexel University is developing a new intravascular axial flow blood pump that is intended to mechanically support the cavopulmonary circulation. The impeller of the pump rotates and imparts energy to the blood, while the outer cage protects the vessel wall from the rotating impeller. The purpose of this pump is to augment lung perfusion, cardiac output, and the pulmonary hemodynamics of the patient. The target design of this pump is to generate pressure rises of 2 to 25 mmHg at flow rates ranging from 0.5 to 5 L/min over rotational speeds of 3000 to 8000 RPM. This project involved the evaluation of new cage-impeller designs to determine which combination is optimal and meets target design performance. The study included 7 impeller designs and 5 cage designs, resulting in 42 cage-impeller combinations under consideration. Each prototype combination was investigated in a hydraulic test loop where pressure rise, flow rate, and rotational speed were measured. The 1E cage-impeller combination outperformed the other designs.

Optimizing a Platform to Deliver Oxygen to Hypoxic Regions in Tumors

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Ultrasound contrast agents (UCA), or microbubbles, are microscopic gas bubbles that are polymer, protein, or lipid stabilized. Their main purpose is to enhance the diagnostic power of clinical ultrasound. The filling gas is non-toxic and may be, bioactive. Chemotherapeutics can be co-encapsulated. Although UCA are mainly used for enhancing medical imaging, they also have great potential as agents for targeted therapy. Their size must be smaller than 8 microns to safely travel through the capillary beds that supply blood to tissue. Tumor angiogenesis is a process by which tumors recruit blood vessels from the existing circulatory system in the body. These new blood vessels often cannot compensate for the high metabolic rate of the rapidly dividing cells of the tumor. This leads to a hypoxic tumor microenvironment. The low level of oxygen present in hypoxic regions makes them inherently resistant to chemo- and radiation therapy.

SE61, an UCA developed in the Wheatley lab presents an opportunity to use a surfactant based microbubble to carry oxygen to the tumor to overcome hypoxia. To reach maximum potential, a method of separating the current agent into samples with a tight size range is essential. The purpose of this project was to fabricate SE61 and investigate the use of differential buoyancy to isolate SE61 microbubbles by respective size, and to characterize the resulting samples with respect to size, polydispersity and acoustic properties. We found that microbubble fractions varied in size, relative bubble concentration, and acoustic enhancement.

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Kindergarten Performance: Effects of Socio-Economic Status, Gender, Schedule, and Home Language on Achievement, Social Competence, and Approaches to Learning

The purpose of this study was to determine what roles home language, gender, socioeconomic status (SES) and kindergarten schedule play on kindergarten achievement, social competence, and approaches to learning at both the beginning and the end of kindergarten. Data from the Early Childhood Longitudinal Study- Kindergarten Cohort (ECLS-K) was used. 4137 kindergarten aged children were included in the sample. 2074 were male and 2063 were female. 1782 of the children went to all day kindergarten while 2089 children went to half day kindergarten. Results indicated that home language of the child played no role on achievement, social competence, or approaches to learning in the beginning or at the end of kindergarten. SES made a difference in achievement; high SES children scored higher in both math and reading at the beginning and the end of kindergarten. SES also made a difference in social competence; children in the high SES group scored higher in both self-control and interpersonal relationships. Children in high SES also scored higher on approaches to learning. Kindergarten schedule also made a difference. Children who went to all-day kindergarten had higher academic achievement while children who went to half-day kindergarten scored higher in social competence. In looking at gender, girls scored higher than boys in reading while boys scored higher than girls in math. Girls scored higher than boys for self-control, interpersonal relationships, and approaches to learning. The findings of this study are important for understanding what factors affect children's learning so that appropriate teaching strategies can be implemented.

Index by Student Last Name

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Index by Student Last Name

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