MAY 12
2017
10 a.m. – 4 p.m.
ARC

UNDERGRADUATE RESEARCH
AND Creative Practice SYMPOSIUM

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FEATURING RESEARCH SCHOLARSHIP AND CREATIVE WORK!
Undergraduate Research and Creative Practice Symposium
Event Schedule

10 am  
**Opening Remarks**  
*ARC Top Floor,*  
*Tanya Kumar, ASUWB President*

10:15 am – 12:30 pm  
**Poster Session 1**  
*ARC Top Floor*

10:15 – 12:30 pm  
**STEM Oral Presentations**  
*UW1-103*

12:30 – 1:30 pm  
**Presentation of Chancellor’s Distinguished Undergraduate Research and Creative Practice Faculty Mentor Award**  
*ACR Top Floor*  
*Chancellor Wolf Yeigh*

1:30 – 3:30 pm  
**Clamor Presentations**  
*ARC 121*

1:30 – 3:45 pm  
**Poster Session 2**  
*ARC Top Floor*
Assessing the Correlation between Active Learning Practices and Student Attitudes in Introductory Biology

Author(s): Katie Pham
Mentor: Dr. Bryan White

Abstract: There is an ongoing movement to improve undergraduate biology courses by elevating student learning beyond rote memorization toward thinking about science as experts do. Previous research indicates that most students leave introductory biology with novice-like perceptions of science. We hypothesize that these scientific ways of thinking can be cultivated in an active learning environment where students take ownership of their learning, and instructors question and facilitate understanding rather than dispense knowledge. In addition, there is not substantial empirical evidence, nor are there delineations of a single paradigm of active learning that optimizes student learning. In our project, we analyzed if student attitudes and expert-like thinking improved throughout an introductory biology course at UW Bothell. In addition, we analyzed the active learning teaching practices in this course to see if these practices correlate with improving student attitudes. During the first and last weeks of class, students voluntarily completed the CLASS (Colorado Learning Attitudes about Science Survey), a 32-piece questionnaire developed by educators at the University of Colorado Boulder inquiring about enjoyment, real-world connections, problem solving and conceptual understanding in biology (5 classes analyzed). We coded results using a published tool, with pre and post data separated for comparison. Classroom lectures were recorded using Panopto, and sessions will be evaluated using PORTAAL (Practical Observation Rubric to Assess Active Learning), a tool that allows for the assessment of the extent of active learning in the curriculum. With this data, we will be able to gauge the effectiveness of active learning methods in an introductory biology class and see if they correlate with a transition towards expert-like perceptions of biology. It is our hope that with this data, these pedagogical techniques can be refined and adopted more widely in academia to produce students that are motivated and highly capable scientific thinkers.

An organic electrochemical transistor with a novel double-in-plane gate electrode

Author(s): Anna Kirchan, Kyoung-Tae Kim, and Malia K. Steward
Mentor: Dr. Seungkeun Choi
Abstract: PEDOT:PSS-based organic electrochemical transistor (OECT) has been widely used for various sensing applications such as glucose, antigen, DNA, and pH sensing thanks to the much lower working voltages, typically less than 1 V, and known biocompatibility of a PEDOT:PSS. OECT comprises three electrodes (source, drain, and gate), a PEDOT:PSS channel between source and drain, and electrolyte solution of analytes. Electric current flows through the conductive PEDOT:PSS channel. However, upon the application of a positive gate voltage, cations from the electrolyte are injected into the channel, decreasing a conductivity of the PEDOT:PSS. Hence, electric current decreases as a gate voltage becomes more positive. In general, OECT is implemented by submerging a separate gate electrode in an electrolyte solution, thereby, making this only suitable for a laboratory environment. However, reports dealing with the impact of in-plane gate electrode on the OECT performance are relatively scarce. The proposed double-in-plane gate electrode for OECTs possesses great potential for the development of highly integrated OECT where each transistor can be separately controlled from its own gate electrode. All electrodes (gate, source, and drain) were placed in the same plane. High conductivity PEDOT:PSS was used to create a channel between source and drain. A PBS (Phosphate-Buffered Saline) was used as an electrolyte and pH value was adjusted with a hydrochloric acid. A drop of electrolyte of pH 3, 4, 5 or, 7.4 was placed just over the channel and the gate electrode. Compared to the transistor with a single gate, the double-gate transistor exhibited much higher transconductance of 35 mS. This means that the double-gate transistor can modulate larger current at the same gate voltage. Such a high transconductance with in-plane architecture will allow the development of portable OECT arrays for various chemical/biological sensing applications.

10:45 – 11 am
A Spectral Subgradient Method for Non-Smooth Optimization
Author(s): Yiting Xu, David Kotval and David Richmond
Mentor: Dr. Milagros Loreto

Abstract: To solve nonsmooth unconstrained minimization problems, we propose the Spectral Subgradient method. We focus on the interesting case in which the objective function is continuously differentiable almost everywhere, and it is often not differentiable at minimizers. The proposed Spectral Subgradient method provides efficient solutions for large scale nonsmooth optimization problems, which arise from image/signal processing, data mining, statistics, etc. It requires very low memory requirements and low computational cost per iteration. Nonsmooth unconstrained minimization problems are usually solved by using the subgradient methods, whose convergence is guaranteed if the optimal value of the objective function is known. The purpose of our work is to combine the classical subgradient method with the spectral step length, which does not require either exact or approximated estimates of the optimal value. Since subgradient methods are not descent methods, we add a nonmonotone globalization strategy to ensure sufficient progress is made. We also present numerical results on a set of non-differentiable test functions. These numerical results indicate that using a spectral step length can improve the performance of subgradient methods.

11:00 – 11:15 am
An Intrusion Detection Framework for Internet of Things
Author(s): Pavel Krivopustov
Mentor: Dr. Geetha Thamilarasu
Abstract: Internet of Things (IoT) represents the next big digital revolution where every day physical objects such as refrigerators and toasters are connected to the internet through embedded systems and sensors. IoT devices are however found to be vulnerable to a number of security attacks, potentially leading to disclosure, modification, and disruption of access to private data. Since these devices have limited computational and power resources, conventional security solution cannot be applied to them. In this project, we propose a lightweight Intrusion Detection Device (IDD), which provides security as service (SAS) to all the connected devices on the IoT network. The IDD uses machine-learning algorithms to monitor the network and detect any anomalous behavior in the network.

11:15 – 11:30 am
Incorporating Sustainability Education across Horizontal Disciplines in Higher Education
Author(s): Tanya Saxby and John Kuykendall
Mentor: Dr. Abigail Lynam
Abstract: Through the efforts of such organizations as the American Association of Sustainability in Higher Education (AASHE), the United Nations Decade of Education for Sustainable Development (UN DESD), the concept of sustainability is gaining increasing visibility and momentum among higher education institutions. Universities exploring the integration of sustainability education (SE) into their curricula have applied varying research methods to address three key issues. First, assessing the level of interest and commitment of the faculty and staff in incorporating this concept into existing curricula; second, determining the relevancy to the core disciplines being taught; and finally, identifying the barriers to delivering SE to their students. Research conducted to date has identified common themes in response to these issues. Notably, faculty’s perception and lack of awareness of sustainability concepts contributes to their reluctance to integrate SE into their curricula, as does the concern of an already over-crowded curriculum. Effective methodologies and analyses identified in prior research were used to create a similar study at Cascadia College in Bothell, Washington. A survey of full-time faculty members was conducted in January 2017 to assess the interests, opportunities and barriers in integrating SE into broader disciplinary curricula. The goal of the study was two-fold: first, to identify early interest and support in developing sustainable education lesson plans for incorporation into their existing curricula (our capstone project) and second, to make decisions and take appropriate actions to foster greater awareness and inspire campus-wide engagement and participation in sustainable practices. The methodology of the survey, results and progress to date will be shared at the symposium.

11:30 – 11:45 am
Foundation of Consumption
Author(s): Jillian Kraker
Mentor: Dr. Jennifer Atkinson
Abstract: The ideology of consumerism is highly influential in American society and institutions. Although consumerism does have benefits to the economy, product accessibility and ease of lifestyle, it detracts from core American values. The founding fathers set forth ideologies they believed were important for this nation as written in the Declaration of Independence. Through a comparison of American consumerism and the American values found in the Declaration of Independence, it is concluded that present-day American consumerism is contrary to founding American ideologies.
Reach for the Stars

Author(s): Jemini Abides
Mentor: Dr. Joey Key

Abstract: The North American Nanohertz Observatory for Gravitational waves (NANOGrav) is a collaboration of professional and student scientists researching pulsars to measure gravitational waves. The first detection of gravitational waves was in September of 2015 by two Laser Interferometer Gravitational-wave Observatory (LIGO) detectors. LIGO uses interferometry, a sensitive and complex system of lasers and mirrors to detect gravitational waves. NANOGrav observes gravitational waves by monitoring pulsars using radio telescopes around the world. The pulsars form a galactic scale observatory for gravitational waves in the nanohertz frequency. The new science of gravitational wave astronomy can be presented to young curious minds via outreach programs. The NANOGrav collaboration has recently adapted the Space Public Outreach Team (SPOT) to share gravitational wave astronomy with students across the country. SPOT started 20 years ago as a NASA education effort based at Montana State University. The University of Washington Bothell (UWB) is a member of the NANOGrav collaboration, participating in gravitational wave data analysis, pulsar observing, and establishing a NANOGrav SPOT program in Washington. As a NANOGrav student researcher I contribute to the observation of pulsars and share this work with the local community through NANOGrav SPOT presentations. Along with other NANOGrav SPOT programs across the country, the UWB gravitational wave astronomy group is engaging with the local community to share our research and encourage students to study science, technology, engineering, and mathematics (STEM).

Crow Vocalization

Author(s): Benjamin Walzer, Chun (Jack) Lam and Tiffany Kuespert
Mentor: Dr. Shima Abadi and Dr. Doug Wacker

Abstract: American Crows (Corvus brachyrhynchos) are an extremely intelligent species of bird, which possess significant high-level cognitive capabilities. For example, they appear to have a system of vocalizations used in response to certain stimuli such as the presence of danger, food, etc. This project attempts to better understand the crow’s system of vocalizations by recognizing patterns in their vocal outputs. To achieve this, we plan to set up a series of microphones in a crow-dense location on the roof of Discovery Hall of UW Bothell to record crows during various times of day and during certain events. With the data collected, we will use MATLAB to localize callers and detect patterns and correlations within their vocalizations. The primary method to localize the vocalizations will be through Difference Time of Arrival (DTOA). This is optimal in a system of four stationary microphones where vocalizations occur within the array. For each pair of microphones, the time difference will give us a set of potential locations of the crow, defined by a hyperbola. With the given data, we will construct hyperbolas between all possible microphone pairs of the four microphones in which the point/region of intersection between the hyperbolas is the most likely source of a vocalization.

Formation of Nitrous Oxide from Ammonia-Oxidizing Bacteria via a Putative Denitrification Pathway

Author(s): Mike Nevala, Mustika Rahmawati and Fong Ning Liew
Mentor: Dr. Hyung J Kim

Abstract: The nitrosifying bacteria Nitrosomonas europaea converts NH₃ to NO₂⁻ (nitrification) via two enzymes: Ammonia Monoxygenase which oxidizes NH₃ to NH₂OH and Hydroxylamine Oxidoreductase (HAO) which oxidizes NH₂OH to NO₂⁻. *N. europaea* also exhibits denitrification activity where NO₂⁻ is converted to nitrous oxide (N₂O) – a greenhouse gas. The overall conversion of NH₃ to NO₂⁻ to N₂O is a critical process in the global nitrogen cycle with environmental and agricultural implications. The enzymatic pathway for denitrification in *N. europaea*, however, has yet to be established. In this work, we attempt to identify this important bioenergetic pathway and its associated enzymes using a combination of enzymatic assays, protein chromatography, gel electrophoresis, and mass spectrometry. We also explore the role of specific protein-protein interactions on the production of N₂O via the denitrification pathway.
Clamor Presentations

| 1:30 – 3:30 pm | ARC 121 |

1:30 – 1:45 pm
No Way Out But Through: A Talk on Art and Mental Illness
Author: Corbin Louis
Second year MFA student in Creative Writing and Poetics

1:45 – 2 pm
Deck of Truths
Author: Yohandra Cabello
Second year MFA student in Creative Writing and Poetics

2 – 2:15 pm
Blood
Author: Jessica Kunder
Senior, Biology

2:15 pm – 2:30 pm
The Missing Hour
Author: Allison Morton
Second year MFA student in Creative Writing and Poetics

2:30 – 2:45 pm
Author: Meghan Sonenthal
Senior, Media and Communication Studies

2:45 pm – 3:00 pm
The Sword
When Merlin Fell Asleep
Author: Nathaniel P. Creed
Comparison of Backward Air Mass Trajectory on Western US sites and MBO

O$_3$ Concentration

Author(s): Wenxi Wang
Mentor: Dr. Dan Jaffe
Easel: 1

Abstract: Over the years, ozone (O$_3$) has directly threatened human health and ecosystems. It is important to understand O$_3$. Our project’s goal was to figure out the relationship between O$_3$ at Mt. Bachelor Observatory (MBO) at 8 other sites in western US and how trajectories affect O$_3$. We found that the O$_3$ concentration at MBO in 2015 was generally higher than in the previous 7 years. The seasonal variation was very clear with the lowest O$_3$ concentration in fall and the highest in spring. May 2015 showed the highest monthly average O$_3$ concentration among all the monthly averages of the 8 year period. The O$_3$ concentration in May 2015 was enhanced by about 9 ppb compared to the 2008-2014 mean. We also found the high O$_3$ concentration in May 2015 had a direct correlation with air mass trajectory travel distances. Overall, reduced winds has and corresponding shorter wind travel distances, may have caused the high O$_3$ concentration in 2015. In the future, we would like to look for more factors that impact O$_3$.

The Eye Project

Author(s): Chiayi Lin
Mentor: Dr. Hung Cao
Easel: 2

Abstract: Rapid-Eye-Movement (REM) sleep has been studied for decades in neuroscience and sleep medicine to reveal the correlation of sleep stages with the development of neuro-diseases such as depression, autism and Alzheimer’s disease. REM sleep stages can be detected directly through electrooculography (EOG) measurement or optical approaches or indirectly via Electroencephalogram (EEG) assessment. While optical approaches are not useful because animals change sleeping position, EOG and EEG approaches require wearable devices attached to the face or skull, which may affect the patient and bring discomfort. Further, all these methods require extensive signal processing which makes it hard to interpret data in real time for distanced monitoring or further close-loop stimulation and treatment. To account for these issues of misalignment, invasive data, and the complex signal processing, a wirelessly coupled coil set could be used to improve data capture. (Comment the connection between the problem and the solution is not clear to a general audience. If you can add a connecting thought or sentence here that might help.) During the past decade, inductive coupling has been widely utilized for wireless power transfer for numerous applications, from consumer electronics to healthcare devices, as well as remote sensing. Antenna design, 2-coil and multiple-coil approaches, as well as efficiency enhancement have been thoroughly investigated. For powering applications between planar antennas, misalignment has been well-known to reduce the efficiency and thus the receiver may not obtain enough power to operate the device. In this work, we propose to
exploit misalignment between two LC tanks resonating at 13.56 MHz in order to detect REM sleep. The transmitter coil is located at an “eye gear” around the eye while the receiver coil is embedded in a contact lens. A Vector Network Analyzer (VNA) is used to tune the frequency and to detect the misalignment based on the fluctuation of the transmission coefficient S21. An apparatus imitating the eye’s movement horizontally move from -65 to +65 degree was created to validate the actual operation. Preliminary data indicated that this novel simple and unobtrusive approach can be reliably used for the detection of REM sleep stages.

Nitrous Oxide Evokes Changes in Neuroendocrine Stress Responses and Cardiovascular Variables in a Model of Drug-Induced Allostasis

Author(s): Andreas Cipman
Mentor: Dr. Salwa Al-Noori
Easel: 3

Abstract: Nitrous oxide (N\textsubscript{2}O) is a pharmacologically active gas used clinically in dentistry and medicine. It is also an abused inhalant. N\textsubscript{2}O’s effect on the release of peripheral stress hormones via the hypothalamic-pituitary-adrenal (HPA) axis and/or the autonomic sympathetic system are largely unknown. This study aims to determine the effect 60% N\textsubscript{2}O exposure on plasma concentrations of corticosterone (CORT), epinephrine (EPI), and norepinephrine (NEPI) in male Long-Evans rats. To this end, 60% N\textsubscript{2}O was administered for 2 hours in a gas-tight chamber and blood samples were collected remotely via an indwelling jugular vein catheter at various time points. Our findings are as follows: plasma CORT (n=9) was significantly elevated above baseline levels at all three time-points (repeated measures ANOVA, p=0.002), EPI and NEPI were significantly elevated (n=8, p<0.02) with EPI response resolving more rapidly whereas CORT and NEPI exhibiting sustained increases. In a separate pilot study, we examined the effects of N\textsubscript{2}O exposure on cardiovascular variables (CVV), including heart rate (HR), systolic blood pressure (SBP), and mean arterial pressure (MAP), obtained via an implanted radiotelemetric device during an initial and repeated N\textsubscript{2}O administrations. A dramatic increase in HR, MAP, and SBP is observed when comparing N\textsubscript{2}O exposures. The increases in these CVV implicate involvement of the cardiovascular system in the hyperthermic sign-reversal we have observed in core temperature (Tcore) during N\textsubscript{2}O inhalation, possibly through changes in energy expenditure. These findings have important physiological implications and serve as a basis for future studies addressing how these effects of N\textsubscript{2}O exposure address important questions in the fields of physiological regulation and drug addiction.

ECG Monitoring for Multiple Zebrafish Simultaneously

Author(s): Ang (Sam) Sherpa
Mentor: Dr. Hung Cao
Easel: 4

Abstract: Among many animal models used for drug testing, zebrafish has been proven as an ideal vertebrate for phenotype-based screening owing to their physiological similarity to mammals. Unlike humans, zebrafish hearts can fully regenerate following cardiac injury, thereby providing a tractable model system to study endogenous heart regeneration. Studies have shown that drug induced cardiotoxicity is difficult to predict on humans. The cardiac toxicities of new drugs are one of the most important areas of investigation in new drug development, and it is an area of intense pharmaceutical and academic research. Scientists have been using electrocardiogram (ECG) assessment as a means to
monitor the development, regeneration and remodeling of zebrafish hearts. However, the commercial available ECG acquisition systems, i.e. iWORX (Dover, NH), provide only single-channel ECG, are usually bulky and unable to detect the T waves. To this day, there is no system which can measure multiple zebrafish at the same time. The ECG is a time-resolved vector measure of electrical activity of the heart at the body surface and is one of the most important diagnostic tools in assessing cardiac dysfunction and evaluating potential drug side effects. In this work, we propose to develop an apparatus that measure ECG of multiple zebrafish simultaneously. Once we succeed in designing and developing an apparatus, we can test specific drug on zebrafish to see the effects of drug on the ECG of Zebrafish and compare the drug induced ECG with a normal ECG.

**Designing Competitive Inhibitors of the Smallpox Virus**

*Author(s): Brianna Keen*

*Mentor: Dr. Peter Anderson*

*Easel: 5*

**Abstract:** The variola virus is the causative agent of smallpox, a serious disease that presents itself as a maculopapular rash that later transforms into fluid-filled blisters. There are two known strains, Variola major, the deadly strain, and Variola minor, which is considered to be much more mild. Since the introduction of the smallpox vaccine, there have been no natural outbreaks of smallpox. Nevertheless, Variola major is now estimated to be a biothreat agent of great concern. Variola major contains a protein called DNA topoisomerase 1. This protein enters the host cell’s cytoplasm and uses the host’s enzymes to replicate. The host cell is then forced to use the virus’s genetic information for its replication instead of its own DNA. The protein DNA topoisomerase 1 wraps around the DNA, and cleaves and reattaches the DNA strands to reduce the amount of strain experienced from the positive supercoiling of the replication. This enzyme is crucial for the survival of variola viruses, and if it could be inhibited, then the vitality of the virus would decrease significantly, as the DNA would remain supercoiled. For these reasons, it would be beneficial to identify novel small molecules that have higher binding affinity for topoisomerase 1B than does the host DNA. We have used computational methods to identify lead compounds that bind with high affinity to topoisomerase 1B. Research methods used during this project include identifying enzymes that are required for Variola major survival, molecular modeling, and molecular docking. These methods yielded a significant list of lead compounds, of which the top three compounds with the highest binding affinities were chosen. Future research will be conducted starting from these top-scoring lead compounds to identify additional compounds with even higher binding affinities. It would then be expected that these molecules would inhibit the binding of topoisomerase 1B, potentially reducing the vitality and virulence of Variola major and reducing its biothreat potential.

**Mechanistic Approach To Understanding I-LtrW1: Applications For Targeted Gene Modification**

*Author(s): David Adil, Vaughn Shepherd and David Dionne*

*Mentor: Dr. Lori Robins*

*Easel: 6*

**Abstract:** Targeted gene modification and correction is a transformative technology that is currently progressing from basic research and development to applications in medicine, industry and agriculture. Gene targeting systems include four types of targeted nucleases: LAGLIDADG homing endonucleases
LHEs, zinc-finger nucleases, TAL effector nucleases, and clustered regularly interspaced short palindromic repeats, and CRISPR-associated endonucleases (CRISPR/Cas). Each of these systems has the ability to make double strand breaks in DNA. LHEs are promising tools for gene targeting due to their small size (~35 kDa) and high specificity (14-20 bp). One specific LAGLIDADG homing endonuclease is I-LtrW1. To fully understand the LHE family, wildtype, and six variants of I-LtrW1 were overexpressed and purified by nickel affinity chromatography. Using site-directed mutagenesis, variants of I-LtrW1 were generated with an amino acid residue change in the catalytic sites. The purified enzymes were assayed for activity using supercoiled DNA containing a target DNA sequence specific to I-LtrW1. The activity was monitored by agarose gel electrophoresis in an effort to understand catalytically important residues. The results will be used to develop a general method for converting LHEs into LHE nickases, enzymes that make single-strand breaks in target DNA sequences. LHE nickases can lead to advancements in targeted gene modification for genetic diseases such as cystic fibrosis.

**Fourier Transform Infrared (FTIR) Spectroscopy for Material Characterization at the University of Washington Bothell**

*Author(s): Luke Daanomah and Bryce Dennis*

*Mentor: Dr. John Bridge*

*Easel: 7*

**Abstract:** Sustainable materials for a variety of purposes are of increasing interest in today’s society. Cob—a mixture of sand, clay, straw, and water—is an environmentally friendly material that is also very economical for use in sustainable housing. Cob bricks provide a sustainable alternative construction material in the housing industry. However, no standards exist that could be used to show that cob houses will meet housing codes, which vary by location. In an effort to help determine properties of this material, mechanical testing using a MTS universal test machine was performed according to ASTM C67-14 to determine the compressive strength and modulus of rupture for cob bricks from the San Juan Islands in Washington State. The average compressive strength from a 3-point bend test and modulus of rupture test was 0.056 ± 0.007 kPa (0.008 psi) and 0.031 ± 0.005 MPa (4.47 psi), respectively. Additional testing is currently underway to characterize the properties of cob bricks from multiple cobbers from the States of Oregon and California in order to determine the average properties of the material. Dissemination of the results of this project for local cobbers will be considered successful completion of this project.

**Experimental Applications of Differential Scanning Calorimetry to Test and Characterize Polymers at the University of Washington Bothell**

*Author(s): Kaleb Dempsey*

*Mentor: Dr. John Bridge*

*Easel: 8*

**Abstract:** Differential Scanning Calorimetry (DSC) is used for analyzing the thermal properties of polymeric materials used in many engineering applications. The data produced by DSC generates a heat flow curve that reflects the amount of energy required to heat a sample per degree Celsius over time, and heat capacities can be calculated. In addition to comparing enthalpies (Δh) for different materials, DSC is also a powerful tool to determine other important material characteristics such as melting temperatures (Tm), thermal glass transition temperatures (Tg), degree of crystallinity, and environmental oxidation. Also, the use of DSC coupled with other analytical techniques, such as Fourier
Transform Infrared Spectroscopy (FTIR), Gas Chromatography (GC), and Nuclear Magnetic Resonance (NMR) spectroscopy, gives insight to changes in material molecular composition. This paper describes several projects at UW Bothell where DSC was effectively utilized to evaluate actual industrial/sports applications of various polymers with the goal of understanding their respective thermal properties. The hands-on experience facilitates making connections with material science concepts learned in-class, and emphasizes the importance of material selection that engineers are involved with throughout their careers. Projects discussed involve degradation mechanisms in hydrocarbon-based binders used in sport track surfaces, analysis of premature cracking and failure of polyurethane molded covers used in electrical transformer housings, determination of an unknown polymer used in high temperature fluid filtration systems, and comparisons of poly vinyl-acetate adhesives used in composite materials.

**Accelerated Weathering Using an Ultraviolet Environmental Degradation Chamber at the University of Washington Bothell**

*Author(s): Kaleb Dempsey, Brian Farkas and Jacky Yeung*

*Mentor: Dr. John Bridge*

*Easel: 9*

**Abstract:** An ultraviolet (UV) environmental degradation chamber is used to perform accelerated weathering of a material by simulating a material’s reaction to prolonged exposure from sunlight and provide insight on how it may degrade a material’s properties over time at a given temperature. To perform accelerated weathering at the University of Washington Bothell, students designed and built an environmental chamber in the Materials Testing and Characterization Laboratory (MTCL) to confirm that the UV radiation of granular composite binder coatings is the primary source of degradation of the material. Fourier Transform Infrared (FTIR) Spectroscopy and Differential Scanning Calorimetry (DSC) are primarily used to quantify the results after UV exposure of the samples and determine any changes in a material’s thermal and mechanical properties. The results of this experimentation will provide the test methods and procedures for future research on a variety of different materials.

**Smart Wheelchair**

*Author(s): Danny Robinson, Vincent Valdez and Perapat Tantawarak*

*Mentor: Dr. W. Jong Yoon*

*Easel: 10*

**Abstract:** Moving an elderly and/or disabled patient from their wheelchair onto the toilet can be a difficult and painful ordeal, particularly in public venues. As of 2016, there are approximately 3.3 million wheelchair users in the US alone; half of which reported difficulty in moving onto and using the toilet. Due to this difficulty, many patients require assistance to use the toilet, which may make them feel embarrassed and avoid going out in public, leading to depression and social anxiety. To make it easier for wheelchair users to access toilets, we developed a “Smart Wheelchair” which will provide access to most forms of public toilets. By determining the most common or popular wheelchair model, a modular kit can be compiled to transform a typical folding wheelchair into a toilet-friendly “Smart Wheelchair”. Limitations in the development of the Smart Wheelchair include clearance between the chair and toilet, lifting mechanisms (particularly the movement in translation), as well as ensuring that the necessary load can be supported. To make this practical and affordable, a piece-by-piece kit must be created to ensure that existing owners of the wheelchair do not need any special tools or machining work done to
their current chairs. To achieve the desired results, the existing (straight) crossbars were replaced with longer, curved crossbars, and a worm gear driven jack at the base of each crossbar to get the necessary lift was attached. The jacks are powered by a driveline and gearbox that is attached to hand cranks that the patient will use to raise and lower the chair. This design can increase the freedom that a wheelchair-bound patient can have by increasing their mobility. Currently, a prototype is in development for testing to demonstrate the practicality of the design.

**What are the Sources of Microbial Contamination in the North Creek Wetlands?**

**Author(s): Vaughn Shepherd**  
**Mentor: Dr. Keya Sen**  
**Easel: 11**  
**Abstract:** The North Creek watershed in Bothell contains elevated levels of fecal coliforms, including *E. coli*. The contamination of surface waters by this watershed is of concern because the North Creek feeds into the Sammamish River. This research is primarily concerned with the characterization of the *E. coli* present in the North Creek watershed and what the possible sources of contamination are. *E. coli* isolates have been obtained from North Creek where genotyping methods are employed to screen for extraintestinal pathogenic strains and intestinal pathogenic strains. The extraintestinal pathogenic strains are determined through the presence or absence of certain virulence genes. Some of these virulence genes include genes that encode for invasins, adhesins, toxins, and siderophores. *E. coli* isolates obtained during June and July of 2016 tested positive for multiple extraintestinal pathogenic genes with 33% for TraT, 22.2% for PAI, 11.1% for iutA, 22.2% fyuA, 25.0% for KpsmtII, 2.8% for sfa/foc, and 13.9% for papEF. Further virulence testing with more recent isolates are currently in process. Additionally, amplified iutA PCR products from a few isolates have been sequenced and used in a BLAST search through NCBI to determine their source. The ones in which had successful sequencing primarily point towards an avian origin but more source tracking methods will be utilized to make the source determination more precise and reliable.

**Chemical and Fecal Coliform Analysis of North Creek and the Horse Creek Tributaries: A Case Study in Bothell Washington**

**Author(s): Dylan Kline and Alicia Bradley**  
**Mentor: Dr. Abigail Lynam**  
**Cascadia College**  
**Easel: 12**  
**Abstract:** Monitoring key water quality parameters is critical to establishing and maintaining salmonid habitat in heavily urbanized regions. The purpose of this study is to establish baseline water quality data that will help scientists and planners better understand the impact of two Horse Creek bypasses and North Creek on the aquatic health of the Sammamish River. Our primary research objective is to determine if North Creek contributes higher levels of fecal coliform and other destabilizing factors into the river than either of the Horse Creek bypasses. This project also provides data on key water quality parameters upstream and downstream of the North Creek wetland to increase our understanding of the wetland’s capacity to filter out the excess fecal bacteria produced by the large number of nesting crows which utilize the site as a winter roost location. Results from all sampling locations were compared to Washington State Department of Ecology standards to identify exceedances. Sampling was completed in March, 2017 and data analysis will be completed by May. The initial analysis of the data suggests high
Comparing Fungal Endophytes in Aeroponic Gardening Systems

Author(s): Gerald MacKenzie
Mentor: Dr. Charlotte Rasmussen
Easel: 13

Abstract: Arbuscular (endo) mycorrhizae and Trichoderma are fungal endophytes that form mutualistic relationships with a wide array of plants throughout the world, resulting in improved yield, disease resistance, drought tolerance, water-use efficiency, and nutrient uptake. It is also widely believed that complementary relationships between various species of arbuscular mycorrhizae, Trichoderma, and Bacillus similarly occurs when present simultaneously. Fungal endophytes are rarely sold as a single species and most products are comprised of a complex blend of Trichoderma, mycorrhizae, and in many cases, beneficial bacterium from the Bacillus genus. The extent to which the endophyte associations are beneficial when applied simultaneously is not well understood and previous research has yielded conflicting results. These products are commonly marketed to hydroponics and aeroponics gardeners, despite the limited amount of research illustrating their effectiveness. It is thus necessary to further investigate the effectiveness of the relationships between the commonly used fungal endophyte species *Trichoderma harzianum*, *Rhizophagus irregularis* (formerly *Glomus intricacies*), and Bacillus spp. in recirculating gardening systems. Basil plants will be inoculated with fungal endophytes via liquid application in aeroponic gardening systems. After clonal propagation in Viagrow aeroponics cloners plants will be transferred to Tower Garden aeroponics systems where treatment groups will consist of *T. harzianum*, *R. irregularis*, *T. harzianum x R. irregularis*, and a water control. Analysis of plant growth, water usage, total plant weight, and pathogenic biofilm will be used to measure any benefits that derive from inoculation of fungal endophytes. This study will help determine the effectiveness of two common fungal endophyte species when applied simultaneously in recirculating gardening systems.

Stochastic Radiation in Gravitational Wave Astronomy

Author(s): Holly Gummelt
Mentor: Dr. Joey Key
Easel: 14

Abstract: The new field of gravitational wave astronomy has the potential to answer leading questions in astrophysics. With the latest technology of LIGO (Laser Interferometer Gravitational wave Observatory) and contributions from over 1000 scientists from around the world, we have made the first detection of a merger of two black holes which occurred more than one billion light years from Earth. The first few black hole mergers that have been observed by LIGO imply a merger rate in the Universe that is higher than expected. It can be estimated that there is an upper limit of three black hole mergers per hour somewhere in the Universe. If the black holes are significantly far away they will not be able to give a strong enough signal to see through the background noise. However, many distant mergers could produce a combined background signal. Currently, LIGO utilizes a Bayesian wavelet decomposition to match strong nearby signals to a template in the database, but a frequentist method to search for a stochastic background signal. Our research is a novel approach, using an adapted version of the Bayesian algorithm...
to extract the background signal emitted by these black hole mergers. The goal of this research is to find patterns in the stochastic background signal of the O1 and O2 observation runs of LIGO and from these create algorithms for future data analysis of gravitational waves. The more that is known about gravitational waves, the more we are able to learn about the nature of gravity and therefore the Universe itself.

**Searching for Pulsars Using NANOGrav**

*Author(s): Edward Hanes*

*Mentor: Dr. Joey Key*

*Easel: 15*

*Abstract:* Detecting gravitational waves from the merging of supermassive black hole binaries (SMBH) in the centers of galaxies is the focus of intense interest. I am interested in collaborating with other scientists and students to locate and catalogue undiscovered pulsars with data collected by the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) radio telescopes Green Bank Telescope (GBT) and Arecibo Observatory. By contributing to the data collection of known pulsar signals with remote observing sessions and employing data reduction techniques using the pulsar searching program PRESTO, on already collected data, we will be able to detect additional pulsars. Pulsars are neutron stars that have dense rotating magnetic fields that transmit electromagnetic radiation in the form of radio waves. The pulsars that have spin rates of once per one thousandth of a second, known as millisecond pulsars (MSP), are of particular interest as their spin periods are highly regular. The goal in finding new pulsars is to establish a Pulsar Timing Array (PTA) in which the signals have a timing precision on the scale of 200 nanoseconds for decades. The NANOGrav PTA consists of 30 millisecond pulsars dispersed throughout the galaxy acting as a system of galactic clocks. This could allow for the monitoring of gravitational waves that exhibit frequencies in the nanohertz range, allowing these waves to be detected by analyzing the unique properties in their signals. As we add to the NANOGrav observations we become capable of studying the evolution of galaxy formation.

**Characterization of Non-Gravitational Noise Transients in LIGO Data Using BayesWave**

*Author(s): Katherine Reyes*

*Mentor: Dr. Joey Key*

*Easel: 16*

*Abstract:*

**Gravitational Waves from Cosmic String Loops**

*Author(s): Wook-Jin Kim*

*Mentor: Dr. Matthew DePies*

*Easel: 17*

*Abstract:* Cosmic strings are topological defects that have formed as the Universe underwent symmetry-breaking phase transitions, and these strings often break into loops which radiate energy in the form of gravitational waves. Significance of cosmic strings comes from string theory, a theory that attempts to describe all the fundamental forces in our universe with a single equation/theory. Cosmic strings can be shown in context of string theory, where elementary particles are described using one-dimensional objects in space, which could be described as cosmic strings. Expanding on potential boundaries in which we could discover cosmic strings by searching for their gravitational wave, if measured, could serve as a first
compelling evidence to string theory. Purpose of this research is to contribute to those boundaries for possible discovery. Our goal is to calculate the scale factor of the Universe using Mathematica. By solving the Friedmann equations taking into account the different contents of the Universe, we can numerically solve for the scale factor at all times. Purpose of scale factor is to calculate length of a cosmic string loop and determine the loop’s fundamental frequency. Because gravitational waves of cosmic string loops are in the form of perfect harmonic modes, we will calculate strain for each mode of frequency by means of Fourier transformation and eventually plot strain versus frequency graph. This result will be used to compare sensitivity of gravitational waves and a space based satellite, the Laser Interferometer Space Antenna (LISA) to possibly increase our chance of detecting gravitational waves from cosmic string loops.

**LIGO Launches Gravity Spy**

*Author(s): Jomardee Perkins*

*Mentor: Dr. Joey Key*

*Easel: 18*

*Abstract:* The search for gravitational waves is one of the most sensitive experiments ever developed. The Laser Interferometer Gravitational-wave Observatory (LIGO) not only picks up gravitational wave signals, but also non-astronomical noise transients that interfere with the LIGO data analysis. These transients are known as “glitches”. In the data, there are thousands of unclassified glitches that are constantly detected as a result of local vibrations caused by human activity to large collisions of binary black holes. However, LIGO has developed an algorithmic computational tool to recognize when glitches with similar patterns appear in the data, known as Gravity Spy. The goal of Gravity Spy is to have certain common glitches accounted for so that they can be quickly detected and removed eliminating unwanted noises that are recorded in the data. In this project, we are given a time-frequency transient graph from an engineering run (ER) and observing run (O1 and O2) next to a set of glitches where they are identified and categorized. When they are classified, new glitches are shown while the previous glitches is stored in its category. It is citizen scientists’ responsibility to detect and categorize certain glitches using Gravity Spy to keep LIGO data as clean as possible and help improve the machine learning algorithm.

**Gravity Spy Sources of Unwanted Noise**

*Author(s): Erdene Enkhzaya*

*Mentor: Dr. Joey Key*

*Easel: 19*

*Abstract:* Gravity Spy is an online free program that allows anyone in the world to help physicists search for evidence of gravitational waves. Gravitational waves are ripples in the spacetime that make up the universe. These waves are caused by extremely dense objects interacting with each other. For example, two black holes can merge together to become one black hole. In order to find evidence for the collision of super dense objects merging together, we need a very sensitive instrument that can detect gravitational waves. LIGO (Laser Interferometer Gravitational wave Observatory) is one of the most sensitive instruments ever developed to measure the stretching and shrinking of spacetime. However, when you have an instrument so sensitive that it can basically hear two black holes that have merged over a billion years ago, you tend to detect other sounds or noise called glitches. These noises can come from cars driving by, to the expansion of a nitrogen cooling tank heating up from the sun. Gravity Spy allows anyone to classify glitches as well as classify new glitches that have not yet been classified. With Gravity Spy, physicists now might have an easier time removing glitches and this is what I wanted to
understand better. Do the classifications made by random people; improve the compute algorithms enough to be beneficial for LIGO scientists’?

**Gravitational Waves from Cosmic String Cusps**

*Author(s): Andrew Clark*

*Mentor: Dr. Joey Key*

*Easel: 20*

*Abstract:* On September 14, 2015 Laser Interferometer Gravitational wave Observatories (LIGO) made the first incident detection of gravitational waves. Gravitational waves are predicted by general relativity and had previously been inferred from their effects on binary pulsar systems. With a method of measuring gravitational waves we can begin looking for evidence of theoretical astrophysical phenomena that may produce gravitational waves such as cosmic strings. So far no evidence has been found of gravitational waves caused by cosmic strings. We will present a new search technique for cosmic strings focusing on the gravitational radiation from cusps and kinks that may be detectable in the gravitational wave data collected by LIGO. Cosmic strings with relatively high string tension, \( G_\mu \), may form networks of cusps and kinks due to intersection and recombination. Current estimates place the upper constraints at \( G_\mu < 10^{-8} \) \[2\] for cosmic strings we can detect from cosmic microwave background measurements. To validate our new technique we will inject a theoretical waveform into the LIGO data and attempt to recover it. Recovery of this simulated waveform shows we have a valid search technique that is capable of identifying cosmic string signatures from gravitational wave measurements.

**Exoskeleton and Wheelchair Mount for Ventilator-Oxygen-Cough-Suction-Nebulizer (VOCSN) Device**

*Author(s): Randa Mustafa, Andy Chapman and Wilson Yuwanto*

*Mentor: Dr. Pierre Mourad*

*Easel: 21*

*Abstract:* Ventec Life Systems is a local company in Bothell working on a medical device to help respiratory patients and their caregivers. They’ve created a device called VOCSN, which stands for Ventilator, Oxygen, Cough, Suction, and Nebulizer, that combines five respiratory therapies into a single, compact device. Most ventilator patients use a wheelchair, and currently, VOCSNs have no mounting system in place for wheelchair users. Our team at the University of Washington Bothell has partnered with Ventec to create an exoskeleton and mount for the VOCSN. Our research has involved talking with patients and their caregivers, visiting wheelchair manufacturers, and researching existing devices in the market to determine our final designs. Notably, wheelchair patients want to prevent damaging their VOCSN from common bumps and jolts they encounter while going about their day, requiring us to design an exoskeleton that connects to the mount using a t-slot. The exoskeleton freely rotates so that it remains vertical when the wheelchair reclines. The mount design consists of an adjustable-length bar that can be clamped to currently existing bars and handles on wheelchairs. Current work has involved collecting immense background research, brainstorming various solutions and determining feasibility of proposed ideas, creating CAD models, and finalizing the exoskeleton/mount solution. Our next steps are creating prototypes and testing followed by optimizing our design and retesting as needed.
Terrapin: Cloud-Based Stormwater Monitoring System

Author(s): Nat Henderson-Cox, Simranjeet Singh, Vincent Valdez, Brian Mostrom, Zachary Carpenter and Greg Wright  
Mentor: Dr. Pierre Mourad  
Easel: 22

Abstract: This University of Washington Bothell Capstone project, in conjunction with StormSensor, seeks to disrupt the Environmental Monitoring Market by introducing a new automated monitoring platform at a lower price point compared to the cost of current systems on the market. The Terrapin Cloud-Based Stormwater Monitoring System will be able to be placed in catch basins and drains to provide autonomous data collection of a number of important factors, including temperature, flow, pH, and turbidity. As responsible stewards of the lands we use, it is important to monitor the water runoff from the drain systems on our facilities in order to ensure that we prevent stormwater runoff from washing harmful pollutants into local surface waters. Current methods of monitoring require expensive equipment and trained operators to travel to multiple locations in order to take samples and readings. Data is then manually entered into various systems for tracking and monitoring, an expensive and time-consuming process prone to significant human error. The Terrapin System aims to solve these problems by significantly reducing the cost of traditional monitoring and eliminating the need for an operator to take samples. With its autonomous nature, the Terrapin System also reduces the risk of human error in reporting important environmental data. Lastly, by allowing organizations to have a sensor suite, known as a Scute, installed at the monitoring locations, organizations can ensure that they will be able to take readings whenever a rain event occurs as the sensing suite is already in place. By utilizing a self-constructing and self-healing mesh topology for relaying data to the cloud, the Terrapin system allows for easy deployments in diverse environments.

SAGe Farm; Hydronic Radiant Heat System

Author(s): Shayan Ebrahimi, Yang Bai and Spencer Roberts  
Mentor: Dr. Steven Collins  
Easel: 23

Abstract: This project provides an economical solution for heating germination beds in a Sammamish Valley farm. The project sponsor is SAGe (Sustainable Agriculture Education) farm. The farm does not have access to electricity. The system maintains the surface temperature of plant tables where the trays of germinated plants are placed at a designated temperature range during the colder winter months. The system uses root zone heating as an option providing heat directly to the growing media, rather than heating the full space of greenhouse air. The output of this system design results in faster production, higher quality crops and energy savings while being completely off of the amenities grid. Our proposed Hydronic Radiant Heat system uses propane fuel to heat water in a heat exchanger, an electric pump to circulate the hot water through the pipes underneath the tables, a solar panel to produce electricity which is stored within car batteries to run a water pump. This hybrid system is autonomous and efficient, saving time and money for the user.

Disruptively Innovating by Creating a 3D Printed Composite Prosthetic Socket

Author(s): Daniel Korchemny, Daniel Huynh and Megan Hewitt  
Mentor: Dr. Pierre Mourad  
Easel: 24
Abstract: The loss of a limb, whether through trauma or medical intervention, is a life changing occurrence. Such an event leads to not only a loss of physical capabilities, but potentially mental health disorders or even social isolation. Amputees have an option to obtain a prosthetic limb to regain some physical functionality and semblance of their previous life. However, these devices come at a high cost which many can’t afford, especially those in underdeveloped countries and young amputees that quickly grow out of their prosthetic. One of the reasons the cost is so high is because the socket needs to be custom fit using a tedious and lengthy molding process that is done by a skilled professional. Our goal is to disrupt this current process by introducing the quickly advancing 3D printing technology into the prosthetic socket building business. The commonly used polylactide filament yield 3D printed parts that are weak and brittle. So, we have decided to search for an ideal combination of advanced printing filament, resin, and reinforcing face layers such as carbon fiber to build a strong and cost effective socket. We will complete this study by creating specimens and testing potential options in accordance with the ASTM D3039 testing specification. Once we find the optimal combination empirically, we will perform a 3D scan of an amputee’s residual limb and attempt to create a socket using our new method of using a 3D printed skeleton structure. If we succeed we will show that 3D printing has become advanced enough to be implemented in the medical industry, and most importantly, we will provide a cheaper and quicker manufactured prosthetic socket for amputees all over the world.

Investigation of Copper Plating for Organic Solar Cells
Author(s): Zhan Shi and Malia Steward
Mentor: Dr. Seungkeun Choi
Easel: 25
Abstract: There has been tremendous interest in new metallization strategies in silicon photovoltaics mainly driven by increasing silver prices and reduced silicon wafer thicknesses. In silicon photovoltaic technology, industry attractive screen-printing technology has been widely used to coat silver electrodes followed by a light induced plating (ILD) of Cu in order to improve the conductance of silver. Therefore, very little silver (Ag) is required as a seed layer, hence, decreasing materials cost significantly. In organic photovoltaics (OPV), application of the electroplating process has been limited to the bottom electrode of indium-tin-oxide (ITO) as the ITO significantly limits the performance of large-area OPV due to its lower conductivity, typically two orders lower, when compared to the opaque top electrodes such as silver or aluminum. However, increased cost of silver also impedes the large-scale deployment of OPV. Particularly, it is difficult to apply an electroplating process to the completed OPV device because of the sensitivity of organic semiconductors to the acids and water. In this work, we report improved performance of OPV by electroplating copper (Cu) on top of thin Ag electrode as a top electrode. 200 nm of Cu was electroplated on top of existing Ag (30 nm) electrode, showing improved fill factor (FF) and the power conversion efficiency (PCE) by 35% and 25%, respectively. The completed device had an active area of 0.3 cm² and an inverted OPV structure of Glass/ITO/PEIE/P3HT:PCBM/MoO3/Ag.

A Multilevel Resistive Memory Device based on Molybdenum Oxide
Author(s): Dinh Lam
Mentor: Dr. Seungkeun Choi
Easel: 26
Abstract: Research into Resistive Random Access Memory (ReRAM) in order to replace conventional flash memory due to its lower programming voltage and faster read/write speed is expanding. In a ReRAM device, information is stored in a varying resistor whose resistance value can stay longer without an external power supply, hence making this as a good nonvolatile memory device. The resistance value can be changed by applying set/reset voltages and read by applying very small voltages. Furthermore, a ReRAM can be highly dense by implementing a cross-point array structure to store information. Recently, there has been great interest in a multilevel ReRAM in which one memory cell can have many different resistance states. This means that one memory cell can store more than one bit of digital information, hence, enabling high density and miniaturization memory cell implementation. We have fabricated a three-layered structure ReRAM device: the bottom electrode is a 150 nm layer of Indium-Tin-Oxide (ITO) and a 10 nm thick active layer molybdenum oxide deposited by thermal evaporation and the top electrode of Ag (150nm) deposited through a shadow mask by thermal evaporation. A Current-Voltage (I-V) curve was measured by applying voltage between top and bottom electrode. The voltage was incremented from -2 to 2 Volts with 5 mV steps. A compliance current, or limiting current, was set to avoid breakdown due to the large current flow. The device exhibited 4 different resistance states by sweeping the device with different compliance current (10µA, 1mA, 10mA, and 100mA). Once the resistance states were set to a new value, original resistance values would not be restored. The irreversible characteristic of this device makes it suitable for many applications that need Write-Once-Read-Many (WORM) memory technology such as BIOS for computer and portable electronics.

Wireless Bio-potential Sensor for Firefighter
Author(s): Tuen Lung Lau
Mentor: Dr. Hung Cao
Easel: 27

Abstract: Firefighters (FFs) have an increased risk for cardiac arrest while responding to incidences of significant magnitude. Current procedures in firefighter standards NRFA 1584 require several rehab activities such as measuring body temperature and electrocardiogram (ECG) every 25 minutes during said incidences. Though bulky and expensive, the existing fire entry suit has just a carbon monoxide (CO) sensor for ambient environment monitoring and provides no indication of the wearer’s health status. This means that there are limited sensors to monitor the ambient environment and physical condition of the FFs. This paper proposes a method of integrating a novel wirelessly powered, flexible, a non-contact bio-potential sensor with wireless communication between external and base layers of the fire entry suit for continuous monitoring of FF’s bio-potentials. A battery unit located on the fire entry suit powers a set of resonating coils using a class-E amplifier at 6.78 MHz to deliver power to flexible biopotential sensors. The coils serve to maintain the integrity of the thermal barrier in the fire entry suit. The method utilized in this paper can be implemented to obtain other important measurements that promote FF safety. The whole design would be cost effective since it will not change the existing suits which have been used and familiar with the FFs. We believe our design could provide safer protection for our next generation firefighters.

Low Frequency Beamforming in Shallow Water Environments
Author(s): Collette Amaratunge, Shima Abadi, Gavin Boyd, Mathew Daniels, and Derek Thurmer
Mentor: Dr. Shima Abadi
Abstract: Ray theory is a high frequency approximation of the wave equation solution. Beamforming is a spatial filtering method that uses the ray theory to estimate the arrival angle from the array recordings. However, the ray theory is restricted to situations where the water column is much deeper than the propagated wavelength and fails when water depth is smaller than the acoustic wavelength (i.e. in shallow-water low-frequency propagation). In this situation, the underwater sound propagation is modeled by normal-modes theory, the exact solution of the wave equation. In the theory of normal modes, each mode propagates at a different incident angle and the total field is composed of a discrete sum of the propagation modes excited at the broadcast frequency. In this situation, the beamforming performance degrades because of the interference between individual mode incident angles. As an attempt to discover the cause(s) of the discrepancy, we will experimentally measure and then model the discrepancy. We investigated the performance of conventional beamforming technique when low frequency signals are propagated in shallow water environments and recorded by either a vertical or a horizontal linear array of hydrophones. Simulations are undertaken to understand how the resolved angle from the conventional beamforming method is related to the bearing angle and the incident angle of each mode. By measuring the degree of error, we found certain variables to be more of a factor than others and are exploring these variables further.

20,000 Volts Under The Sea. *Significantly Less Volts Then Advertised

Author(s): Alec Irwin, Tian Li and Tyler Matthews

Mentor: Dr. Pierre Mourad

Abstract: In partnership with the University of Washington's Applied Physics Lab, and as part of Mechanical Engineering capstone, our research has been in support of implementing underwater power transfer for the means of charging underwater devices. Oceanography researchers use many sensors and instruments for various forms of data collection that contribute to climate models, environmental research and many other fields. Current methods require these underwater devices to be placed for some amount of time and then retrieved with no communication happening in between. This results in a costly and tedious process of placing and resetting these electrical devices in order to retrieve data and to replace power supply. Our research involves implementing wireless power transfer technology, carried by underwater ROV, to be used underwater and for the purpose of transmitting power and receiving data. This allows us a more convenient, consistent and long-term solution to the maintenance of underwater devices. Our research to date has involved designing an electrical system that implements sensors, data collection, and Wibotic’s wireless power transfer coils that will allow for the successful transfer of both data and power. Transmitting this power will be a modified ROV with it’s own set of electronics that will send power to the sensor array, and receive data from it. Our system will also include an open, underwater garage that is meant to house the sensor array and give the ROV a docking station to facilitate this transfer. The user must then simply pilot the modified ROV into the garage, initiate power transfer, and then wait for completion. This proposed solution will allow for data collection to continue uninterrupted while also ensuring data is collected at potentially much shorter intervals than with traditional methods. Our research will continue into next quarter where we are expecting to build our designed system and carry out proof of concept testing before testing it in real world conditions.
**Mighty Morphin Quadcopter**  
*Author(s): Case Isaac, Huy Hoa and Young-man Ashworth*  
*Mentor: Dr. Pierre Mourad*  
Easel: 30

**Abstract:** The capstone project is focused on the design of an amphibious quadcopter with a retractable float system to meet the requirements of the specifications outlined by the Applied Physics Lab. This system, when retracted, is aerodynamic for flight, and shaped such that it aids propeller efficiency. When deployed, the floats serve to raise the chassis of the quadcopter up away from the water, thus allowing sufficient clearance between the propellers and water surface for lift off. Further, the shape is such that the stability in the water is greatly increased. Because the system is retractable, the floats are also entirely removable. This convenience allows for different attachments, should the end use change. In a land-only configuration, no floats would be required, saving weight and reducing the front profile during flight. Our team has taken this project from design to construction and we are set to begin building in April. The ultimate design goal for this quadcopter is to make it autonomous and thus, allowing users to attach a radar/IR imaging system on the quadcopter to deploy it and collect data in an offshore environment.

**The Augmented Reality of Stroke**  
*Author(s): Ryan O’Connor and Tony Tran*  
*Mentor: Dr. Pierre Mourad*  
Easel: 31

**Abstract:** Stroke is the third leading cause of death in the United States amounting to 765,000 strokes annually. One third of these incidents are fatal. Stroke survivors usually have moderate to severe limitation of their movements in some regions of their body. We are creating a glove that will help with the rehabilitation of their hand movements from pinching to gripping. Since the hand/arm is the most versatile limb on our body, we focused on how to rehabilitate its essential motions first. Current rehabilitation exercises are repetitive and boring, and many patients discontinue the rehabilitation after becoming disgruntled and dissatisfied because they do not see improvement. We are integrating an Augmented Reality (AR) game into our design to encourage patients to play and exercise. Our game will feature a butterfly crushing activity that requires users to grip and pinch. Crushing these butterflies will help the progress of their recovery while maintaining a fun environment. Our game will allow the user/patient to visually see the result of their rehabilitation in real time, providing positive reinforcement and encouragement to continue with their rehabilitation. The game will be visualized using a phone or a similar platform with a camera, which allows the user some portability in an already restricted lifestyle. To design and build this device, we have researched various sensors that are crucial for measuring the user’s hand movements and pinch pressure. The sensors will then send data wirelessly to our AR game to provide input on the platform screen. Utilizing this device with patients will speed up their rehabilitation time, allow them to recover lost movements of the hand/arm, and increase their ability to reintegrate into their normal lifestyles.

**Converting Waste to Energy: "It's a Gas!"**  
*Author(s): Christopher Sohlberg and Matthew Dunaway*
Mentor: Dr. Pierre Mourad
Easel: 32

Abstract: Whether you have been trapped in the belly of a whale, marveled over the four chambers of a cow's stomach, or have reached for some Tums after eating a blue cheese angus burger; you have been exposed to an anaerobic system. After being approached by Farmer Frog, a communal off-grid farm, to provide a green energy system capable of heating water for an aquaponics system, a biodigester design was proposed. A bio-digester is a synthetic “stomach” that takes various types of waste products and utilizes the natural, chemical anaerobic reaction to produce a biogas. By creating a bio-digester that can capture this biogas byproduct, route the gas through a filtration system to produce a clean methane gas that can then be stored for use in such devices as methane fueled heat exchangers we can provide heating and power generation for an off-grid site. To incorporate modern technology, sensors will be utilized to give real-time feedback of the bio-digester’s status. In conjunction with a phone app, the user of our bio-digester system will be notified of critical data, displaying pH levels of the filtration system, the volume of gas being produced, when to add more waste to the digester, and when storage tanks are reaching their maximum capacity. Expansion of this technology in third world countries, could be useful in replacing homeowner's dependency on grid power, and potentially constructing large biogas production plants capable of powering small towns and villages.

A Linearized Optimization Framework for Sizing and Siting of Renewable Energy-Based DG Units in Distribution Systems
Author(s): Anthony Suherli
Mentor: Dr. Mahmoud Ghofrani
Easel: 33

Abstract: As the demand for clean and non-fossil energy escalates, integration of renewable power sources into distribution systems increases. Renewable energy distributed generation (DG) has the potential to reduce the environmental impact of power generation when its integration is well-optimized. Distributed generation are small-scale power generators that are installed within the distribution network. However, without careful planning, serious technical issues might occur within the system if the integration is not implemented properly. My research proposes an optimization method by simplifying the problem using linearization. Linearization is an old, well-developed technique to find the equilibrium of a non-linear function or data points. The power flow equations are linearized at steady-state operating points and linear sensitivity coefficients are calculated for constraints such as voltage and flow limits of distribution systems. From that, we set up a linear programming problem, which is then used to find the optimal siting and sizing of DG units. The proposed method is more efficient for large-scale deployment as compared to commonly used artificial intelligence (AI) techniques for DG optimal siting and sizing which are computationally excessive, particularly for large scale systems. This makes the proposed framework a more appropriate practice for planning applications in which efficiency and time are of importance. In this research, we also did a case study on a four-node system and compared the results we get from both the proposed method and an AI method. The results from the case study concludes that our method produces solutions that are as accurate to that resulted from using the AI method, but with a significantly faster computation time, which is often a huge problem when using an AI method especially in larger systems.
U'Dub Sub (UW Sub)

Author(s): Stefan Zelenovic, Daniel Pillay and Brett Bauman
Mentor: Dr. Pierre Mourad
Easel: 34

Abstract: To help shipping companies avoid harm and disturbance of the whales while navigating Puget Sound, the Applied Physic Lab would like to develop a remote operated vehicle (ROV). The ROV will aid in the research of underwater sea life, specifically the detection of Baleen whales in Puget Sound shipping lanes. When modified, ROVs of this nature are able to travel at various depths and tow sensors that can triangulate Baleen whales. Initially, background research on hydrodynamics, drag, and ROV hardware was conducted in order to determine the most optimal shape and modification strategy for the completion of the desired tasks. Additionally, this project incorporated computational fluid dynamics and computer aided design (CAD) software packages in order to create and optimize the design modifications. This is to ensure that our changes do not have an impact on the ROV’s performance. The first iterative designs for the modifications will be optimized and tested.

Monitoring Vegetation Cover in the UWB/CC Wetlands to Assess Ecological Succession

Author(s): Eleanor Smith, Johnathan Rutledge and Kristen Biondo
Mentor(s): Dr. Maura Shelton, Dr. Warren Gold, Dr. Santiago Lopez and Dr. Charlotte Rasmussen
Easel: 35

Abstract: The North Creek Wetlands are a successfully restored and functioning floodplain ecosystem on the UW Bothell/Cascadia College joint campus. In 2013, the GeoDatabase (GDB) Team, a student lead research group focusing on mapping the vegetation, hydrology, and biological organisms in the wetlands using Geographic Information Systems (GIS) was formed. GIS data can be processed into visual images and maps, and shared with other researchers. The GeoDatabase and associated maps can provide information valuable information on the function of the campus wetland ecosystem to aid our understanding the ecosystem services such as flood water retention and water filtration, and habitats for both aquatic and terrestrial native species that the wetlands supply. Our current project is to determine the percent cover of vegetative species at 50 established monitoring points across the wetlands to assess the spatial and temporal changes in vegetation communities over time. Quantitative percent data, as well as qualitative data including unique terrain features such as boulders, water flow, topography, and hazards are recorded, formatted and analyzed in ArcMap to create visualizations of the approximated percentages of individual species present between the canopy and floor at each original planting plot. These 50 monitoring points were last assessed in 2009. Currently we have determined the percent cover for 7 plots. Going forward, the remaining monitoring points will be assessed for percent cover and be displayed on the campus map to provide an overview of a specified attribute across all monitoring points. Once data collection is complete for each monitoring point, then further analysis can be done on the changes in vegetation and the implications for the success of the restoration efforts.

Bird Diversity in Restoration Sites at Various Stages of Restoration

Author(s): Meghan Carpenter
Mentor(s): Dr. Ursula Valdez
Easel: 36

Abstract: Habitat loss and degradation due to urban development has had major effects on species and ecosystems. Efforts to restore natural habitats in urban areas are increasing in western Washington.
Specifically, the University of Washington Restoration Ecology Network (REN) capstone program has been instrumental in joining student teams with private landowners to restore small patches of natural habitat. These patches appear to attract certain avian species, but avian frequency and use of these areas has not been quantified. This project will determine the value of restored sites and the impact that restored site age has on local avifauna. My hypothesis, that the older restoration sites have greater diversity and use by avian species, will be assessed by determining the composition of avifauna and their habitat use in restoration sites and degraded sites (non-restored sites vs. 1-3 and +3 years since site was restored) of North Creek Forest, Cotton Hill Park, and Crestwoods Park. By conducting visual and auditory surveys of avian species in each of these locations, and performing focal observations of the activities of individuals of each species (foraging, displaying, singing, mating, nesting, etc.) during winter of 2017, I detected a total of eight avian species in all sites, of which the North Creek Forest 204th Ave. NE site had the highest number of species (8) and the North Creek Forest 112th Ave. NE Bothell had the lowest number (4). I am currently assessing the spring activity at all sites and will be continuing this study into the summer. Mapping the location and diversity of plant species within each restoration site and data regarding how birds utilize them will provide valuable information regarding usage of plant species by local avifauna with the expectation of having greater avian diversity at older restoration sites compared to the more recently established restoration sites.
A Qualitative Study of Stories that Form Parents’ Deliefs About Vaccination

Author(s): Lindsey Eaton, Wegahta Mehreteab Kidane, Jenny Nguyen, Ana Pekic, Scott Richard Samuels and Aeron Perlman

Mentor: Dr. Dan Bustillos

Abstract: Vaccination has proven a controversial parenting decision despite conclusive scientific evidence and consensus among healthcare communities of immunization’s preventive public health benefits and its low risks. This qualitative study will use narrative interviews to examine the structures, tropes and themes of the stories people use to form and reflect on their beliefs of the practice of vaccination, with the hope that a comparison between the stories used by people of varying beliefs can aid a more constructive conversation between these groups to emerge. This qualitative study of stories uses narrative interviews of parents along the anti-/pro-vaccination spectrum of belief. The stories that our participants use to form and navigate their identity as anti-vaccination, vaccine-hesitant, or pro-vaccination are transcribed and coded for their various themes, tropes and structures. We will use the data derived from our structured, transcribed interviews to compare and contrast our findings across the different groups. We will then use these interpretations to provide helpful insights and strategies in fostering more productive communication between these groups, and propose policy recommendations in future publications and conference presentations.

Collaboration as Activism: Building Bridges to Support Survivors of Sexual Assault

Author(s): Kyra Laughlin

Mentor: Dr. Lauren Lichty

Abstract: The highest risk for experiencing sexual assault is among college age people with 21% of transgender, genderqueer, and gender nonconforming (TGQN) college students, 18% of cisgender females, and 4% of cisgender males reporting they have been sexually assaulted (RAINN, 2017). Given these high rates of sexual assault, it’s imperative that universities take action to prevent sexual violence and provide resources to support survivors. The Washington State Coalition Against Domestic Violence (WSCADV) recommends addressing root causes, shifting culture, building skills, and promoting healthy relationships (WSCADV, 2014). With these strategies in mind, we began assessing our campus’ online sexual violence resources. When we typed “sexual assault,” into the University of Washington Bothell search engine, the first result was a webpage designed by campus safety as part of their “Emergency Response” content. Using an empowerment, trauma-informed framework, we examined this page from the perspective of a recent sexual violence survivor and as such, reviewed the resources listed, language used, and navigability. It became evident that the webpage was not serving its intended purpose in disseminating critical information to survivors. In order to gather potential content revisions, students were invited to review the webpage and offer feedback through Facebook and in-person class sessions. Survivors and non-survivors alike indicated they found the webpage troubling, and students universally requested the current content be removed and replaced with a list of community and campus resources.
along with clear action steps for survivors and their allies. After completing this data collection, we contacted the Directors of Campus Safety and Administration and Planning, to discuss their goals for the website and to propose our recommended revisions. Within weeks, the website was fully revised in accordance with student recommendations. This positive outcome demonstrates what institutional responsiveness can look like and the meaningful, high-impact benefits this collaborative approach yields.

**From the Womb to the Tomb- Qualitative Analysis on Community-based Agencies as Resistance to Violence against Women in India**

*Author(s): Tanya Kumar*

*Mentor: Dr. Lauren Lichty*

*Easel: 3*

**Abstract:** The dynamics of gender, caste, class, and religion have propelled violence against women in India. By examining the community-based response to gaps in the Indian justice system that fail to protect women from sexual violence, the question of “How do agencies serving Indian women who survive sexual violence resist cultural and legal norms and provide safe, brave spaces of survival”? will be addressed. This project includes an examination of the difference in India’s global “outward” versus the internal “inward” facing commitment to women’s rights. Using a multi-phase approach; from literature research to self-funding a trip to India to interview three X number of people non-profit and non-governmental agencies and understand what their perception of the gaps of the moral and legal system, and their methods to protect and empower women. Thematic content analysis of transcribed and translated interviews will surface patterns of experience described at agencies that support Indian women. Preliminary analysis suggests that Indian agencies have developed and adopted creative and empowering methods for supporting women. Insights into their strategies for resistance may be useful for other agencies in India as well as US-based agencies to help support sexual survivors in need all over the world.

**The Social Construction of Gender: Women’s Roles in Guatemala**

*Author(s): Sukhaman Kaur, Briana Hermes and MyKa’La Alexander*

*Mentor: Dr. Julie Shayne*

*Easel: 4*

**Abstract:** In July 2016, I was a part of an exploration seminar (Global Health Promotion: Health Services Delivery in Resource-poor Settings’ led by Professor Mabel Ezeonwu) where students spent two weeks in Guatemala. While conducting research in six rural villages, my team, Briana Hermes, MyKa’La Alexander and I asked the question: “What are the gender roles for women, especially within a healthcare setting?” We worked from feminist theory, arguing that gender is a social construction where gender norms are created, performed, and normalized. As researchers, we conducted participant observation through observing the patients receiving health assessments through the clinics we set up. Our participation included delivering basic health care provisions as well as hygiene and dental education. As we worked alongside and within the communities, we observed women’s and men’s roles in an attempt to understand more fully the daily expectations and responsibilities of village women. We also conducted research, looking for trends and patterns in women’s expected roles while in a health care setting. Here, we found women to be timid while explaining symptoms, in addition to refusing some medical services. Through our research, we conclude that Guatemalan women in these six communities are still limited by “traditional” gender expectations. These customary expectations
include being caretaker of the children, cooking and cleaning, a perception which positions women’s roles as subordinate to men’s. Our research raises awareness of gender inequities in cultures all around the world, necessary to create a more conscious and positive change in our own society.

**Disparities in Cervical Cancer Screening among Vietnamese American Women**

*Author(s): Qendresa Hasani, Jenny Le, and Michael Pham*

*Mentor: Dr. Hoa Appel*

*Easel: 5*

**Abstract:** The Asian American population has increased rapidly in the United States. Studies show that Vietnamese women have the highest rate of cervical cancer among Asian American subgroups and one of the lowest cancer screening rates among all ethnic groups. Our hypothesis is socioeconomic factors and education affect receiving cancer screening tests. A mixed research method will be used in order to conduct focus groups and surveys of 300 Vietnamese women in the Seattle King County area. Participants will be recruited from area churches, nail salons, and other public locations. The survey is available in English and Vietnamese. We will obtain demographic information such as nativity or years in the U.S., measure knowledge of cancer screening, income, and other factors that act as barriers to Vietnamese women obtaining Pap smears and cancer screening. It is expected that the results of this study, like other current research, will demonstrate Vietnamese women have multiple family and job responsibilities and balance different cultures, and that these factors may deter them from receiving cancer screening. In addition, insufficient knowledge and education may play an important role in their lack of cancer screening. Although recent studies have identified family responsibilities, the lack of knowledge and income as possible contributors to the lack of cancer screening, our research will look at other risk factors such as age, smoking, and location that may play a role in receiving cancer screening. By helping Vietnamese American women re-evaluate their health care needs, including cancer screening, we will decrease the health disparities they face and assist them with receiving appropriate and timely care.

**Keys for Communication Media in Teamwork**

*Author(s): Ziye Wang*

*Mentor: Dr. Deanna Kennedy*

*Easel: 6*

**Abstract:** Today’s teamwork strategies must reckon that team members are not always in the same place at the same time. Communication media allows for teamwork to proceed regardless of where members are located. There are many types of media available including phone, email, and communication applications such as Skype, Messenger, WeChat and so on. However, the communication media itself is also an important factor influencing the effectiveness of teamwork. This research focuses on studying teamwork from the perspective of individual communication media preferences rather than just the objective productivity potential. I present my insights to date, drawn from a literature review about communication media and teamwork, pointing the way to a theoretical framework for the way communication media preferences influence outcomes. The framework displays two approaches affecting outcomes: 1) the quantitative approach that affects the quantity of information being carried out during a given period, and 2) the qualitative approach of quality that impacts the precision, specificity and directness of information. Finally, my future research steps are presented including a survey for testing the theorized framework using students completing a team
project, and potentially other workforce teams. The work will advance knowledge about effective teamwork that can help organizations be more productive.

**Household Air Pollution and its Repercussions on Health in Developing Countries**  
*Author(s): Federico Pastoris*  
*Mentor: Dr. Benjamin Gardner*  
*Easel: 7*

**Abstract:** Almost 3 billion people, coming mostly from low-middle income countries, still rely on unprocessed solid fuels (wood, dung, crop, waste, kerosene, charcoal) as their main source of energy to fulfill daily needs, such as cooking, heating and lighting. The prolonged exposure to this form of pollution is strongly correlated to pneumonia and acute respiratory infections (ARI) in children and to chronic obstructive pulmonary disease (COPD) in women. A preliminary field study in Granada, Nicaragua, was conducted to examine the elements involved in adoption levels of alternative cookstoves and the effectiveness of such programs. Speaking fluent Spanish allowed me to collaborate with a Nicaraguan NGO that manufactures, sells and distributes clean cookstoves. Through this organization I was able to conduct both participant and nonparticipant observations of local cooking practices and fuel uses by community members from a rural area near Granada. These observations were supported by informal semi-structured interviews about costs, logistics and household financial management dynamics involved in fuel purchasing (wood). By analyzing the implementation of wood for cooking practices and the related cultural elements I was able to determine that the long-standing cultural tradition of cooking on a big open-air fire using large quantities of wood correlates with prestige and wealth within the community and serves as a cultural impediment to adoption of the cleaner cookstoves. These early findings have informed a second study that will be carried out in July and August 2017 in Nicaragua, which addresses more specific questions about the cultural appropriateness of different alternative cookstoves and the related adoption levels.

**Characterization of Cob Bricks for Use in Sustainable Housing**  
*Author(s): Luke Daanomah*  
*Mentor: Dr. Cassandra Wright*  
*Easel: 8*

**Abstract:** Fourier Transform Infrared (FTIR) Spectroscopy is a powerful technique for material analysis. It can be used alone as a quick material characterization tool, as well as in complement with other techniques such as Differential Scanning Calorimetry (DSC), Gas Chromatography (GC), Nuclear Magnetic Resonance (NMR), and/or Raman Spectroscopy to gain the complete physical and chemical makeup of a material. FTIR techniques are being used to analyze synthetic granular composites used on horse racetracks, crumb rubber from artificial turf and rubber flooring material (RFM), and for comparative studies of polymers such as polyvinyl acetate (PVAc). Within the granular composite track surface, FTIR tests indicated oxidation degradation of the wax binder used to hold sand, polymer fiber, and rubber constituents together. In the RFM, the FTIR spectra exhibits the presence of strong C-H and C-C bonds at approximately 2850 cm\(^{-1}\) and 915 cm\(^{-1}\) respectively. Also, shown was the presence of calcium stearate at 1600 cm\(^{-1}\), calcite at 1400cm\(^{-1}\), and zinc oxide (ZnO) at 690 cm\(^{-1}\) that gives RFM its waterproofing, scratch hardness, and UV protection properties, which are especially important properties desired in the tire industry. Finally, in the comparative study of PVA, FTIR revealed that different amounts of acrylic contents in PVAc give it slightly different properties. The PVAc sample with higher acrylic content shows
a peak in the FTIR spectra around 1173 cm$^{-1}$ which is of the acrylate copolymer group. This gives PVAc “special properties”—a disruption in the crystal structure of the PVAc, making it more flexible at room temperature.

Sex Education 2.0: A Content Analysis of Online Teen Sexual Health Forums

Author(s): Sara Cole
Mentor: Dr. Jody Early
Easel: 9

Abstract: Sex education is an essential part of human development and contributes to a healthy lifestyle. According to the Pew Research Center, the majority of U.S. teens use the internet to find information relating to their sexual health. The purpose of this study was to analyze the content of questions that adolescents have posed on three of the most popular online teen sexual health forums and determine if the topical content of the questions posed in these forums have been addressed within the National Sexuality Education Standards Curriculum (NSESC) for K-12. Data has been collected from the following websites: Teenhelp.org, Sexetc.org and Scarleteen.com, and analyzed by identifying emerging categories and themes using the tool WordCounter from Databasic.io. Descriptive data analysis provides count and frequencies of words and topics. Preliminary data shows there is a need to address non-heteronormative communities that have been left out of the curriculum, as well as information on contraception and sex positivity, of which are all fundamental components to provide an inclusive sex education. This study serves to close the gap within the growing body of literature on the importance of what content should be included to strengthen comprehensive and inclusive sex health education for adolescents.

Game Design of Ghostlight Manor Multiplayer

Author(s): Robert Griswold
Mentor: Aina Braxton
Easel: 10

Abstract: The Digital Future Lab (DFL) is an interactive media production studio on University of Washington Bothell. The lab designs and develops both commercial and educational games including Ghostlight Manor, Corrupted, and Hug the Line. At the start of my DFL internship, the lab was still prototyping a multiplayer implementation of Ghostlight. As a designer and programmer, my primary challenge for multiplayer Ghostlight was determining how to make player interactions the core of the multiplayer experience. Initial design proposals struggled to create an experience that did not feel chaotic or arbitrary to the player. My suggestion of a cyclic style of targeting players to not only limit the number of attacks that the player can instantly receive, but also to open the possibility of strategized attacks is being implemented. Another multiplayer issue is the lack of information about opponent progress. Players are currently unable to see opponent board states, unable to see the effects of the attacks they send, and are limited in strategy options. One solution I proposed is to send the player temporarily to their opponent’s board to launch an attack, however this would be particularly difficult to implement and breaks up the flow of the game. A better solution currently under consideration with more reasonable development time is to create a toggleable overlay that displays a simplified view of all opponents’ boards. Much of my time spent at the DFL has been working with the team reconciling ideas, playtesting, and implementing new features based on feedback received. Although multiplayer
Ghostlight is still in development, the work we have completed through iterative design, prototyping, and polishing will create an enjoyable and integrated multiplayer experience.

**Ghostlight Manor Multiplayer**  
*Author(s): Roman Krichilskiy*  
*Mentor: Aina Braxton*  
*Easel: 11*

**Abstract:** The Digital Future Lab (DFL) is a radically diverse interactive media production studio, committed to providing a creative and commercially rigorous learning environment. The studio develops commercial games like Ghostlight Manor which is now on the Steam distribution platform. During my capstone, I have been working on implementing a multiplayer experience into Ghostlight Manor. A major implementation challenge for the multiplayer experience was how to handle the network needs for an efficient match making system. By utilizing server client based networks which allows for a player computer to act as a host, serving as a communication bridge for all other players, the network problem was solved. Using rapid prototyping, talking to peer developers, and searching the web for guidance, I created a matchmaker prototype that would check the list of all games and join users in the first available game. While testing this system, I found that matchmaker put players into games that were full or had already started. I consulted the developers and they suggested creating an event system to notify the server to close the game during all instances when the game should not be available. With that in mind I determined how to communicate to the server API to change the state of the lobby listing to be closed. I learned this by reviewing Unity forums online and other documentation like code solutions made by others. By using rapid prototyping, consulting with my teammates and using online documentation I was able to implement all the networking needs.

**Quality Assurance Testing: I Play Games and Complain About it**  
*Author(s): Stephen Roberts*  
*Mentor: Aina Braxton*  
*Easel: 12*

**Abstract:** The Digital Future Lab (DFL) is an interactive media production studio on the University of Washington Bothell campus. The DFL focuses on the creation of 2D games to be released commercially, including Ghostlight Manor, Corrupted, and Hug the Line. To improve game performance and decrease development time, Quality assurance (QA) testing is necessary. A QA tester continuously tests and monitors games as they change throughout the development cycle and provides data to inform production decisions. QA testers also identify bugs: problems that make the game not function as intended. Streamlining the QA processes for providing gameplay data by creating analytic readouts and spreadsheets to collect both qualitative and quantitative data and ‘Design testing’, or finding how new changes affect the game logic, are the areas of QA I focused on. To inform the QA testing process I learn the game’s logic by playing the game, review design documentation, talk to team leads and consult with the art and project management to understand the goals for the project. Once I have learned a game’s logic, bugs can be located by performing ‘Black Box Tests’, in which I do not see the game code or Unity Engine files to provide a testing environment that is similar to what a player would experience. When a bug is located, it is reported in JIRA, a project management application used by the DFL to track and plan software development, by listing how to reproduce it, what behavior is expected instead of the bug, suggestions to how the bug might be fixed in terms of the game logic, and any design concerns that the
bug raises. By streamlining data collection and focusing on design testing, I have been able to meaningfully contribute to the development of the lab’s games.

**Character Design and Human Interaction**  
*Author(s): Morgan Thomas*  
*Mentor: Dr. Jason Pace*  
*Easel: 13*

**Abstract:** Proper world building and character design is what makes a video game sell. This work is often referred to as concept work, and this alone can influence a person’s decision to engage with the media. Concept art is a critical part of building an environment that promotes the personal connection between the game and the player, and that’s crucial to creating a product that will sell well. Using the art direction from the studio, as well as my own software, technical and illustration skills, and other resources from around the web, I created concepts for nearly every part of the world of *Corrupted*, a game being developed by the University of Washington Bothell’s own Digital Future Lab, as well as an interactive comic for the game’s release. By studying works from many major studios such as Riot, Bioware, and Blizzard Entertainment to see what part of their iconic styles and designs promotes that intimate human connection, I was able to determine the factors that allow for human connection while incorporating more diversity into character design. What makes the Digital Future Lab stand out from these other studios is the commitment to diversity in the characters we design. In my work, I show the research I did for designing different faces and body structures to exemplify this concept. My characters don’t fit one type of design – which makes their design more accessible to a larger more diverse audience.

**Character Conceptualization in the Video Game Industry**  
*Author(s): John Ignacio*  
*Mentor: Aina Braxton*  
*Easel: 14*

**Abstract:** At the Digital Future Lab at UW Bothell, I’m currently working as a concept artist on our project, Ghostlight Manor, a monster-themed computer game. Players take control of Lightbot, who uses a flashlight to scare away monsters. After completing the last level, players can earn an alternate “Valkyrie” skin. In video games, “skins” describes cosmetic reimaginations of its universe’s characters. For my research, I want to answer how we could further expand the concept of skins beyond making slight modifications on the model. One of the skins, Popstar Light, was inspired by Korean pop culture. With my drawing tablet, I used online references of hair, clothing, and more to sketch designs in Photoshop. In character skin concepting, I analyzed what makes Lightbot recognizable as the character. For example, one identifying characteristic of Lightbot is the flashlight on its back. When I sketched Popstar Light, I visually translated that into a microphone. Instead of flashing a bright light, Popstar Light sings holographic song lyrics towards the monsters. Throughout the whole process, my concepts went through many iterations where I regularly applied critiques from other DFL members to refine my work. What inspired me to do this research was my passion for video games, a domain within which I regularly generate lots of fan-content. When the lab was producing the “Valkyrie” skin, I saw potential to diversify Lightbots and add four more skins. This set also included new animations, particles, and other visual additions along with the model. Entire events themed after the new skins could also generate more updates for the game in the form of stories, stages, and music. By the end of this research, I hope I can engage more players with the world of Ghostlight Manor as well as provide more
options to be their own Lightbot. Opening up those conversations between players and the DFL staff is what I define as success.

Game Development with a Purpose
Author(s): Darren Kriner
Mentor: Aina Braxton
Easel: 15
Abstract: The Digital Future Lab (DFL) is a group of radically diverse students and faculty whose original purpose was to create game-based learning tools for introductory programming classes. This goal evolved into creating professional level games and the result is a hybrid of research and commercial development combining academia and industry. As an aspiring game developer, I understand that interpersonal skills are as important as technical ability in the industry. The DFL is an opportunity to develop skills in both disciplines. The main goal of this capstone was to become a valued team member and provide notable contributions to the prototyping process of converting a DFL game called Hug the Line (HTL) to 3D. The main question I faced: How do interdisciplinary teams work together to produce a cohesive product? I found that my work depended heavily on contributions from the designers, therefore collaboration was essential to achieve progress. To do this I often reached out to my supervisor regarding conflicting or unspecified details that concerned myself and other teams. This led to team discussions to resolve these problems. Regular weekly meetings were another medium in which these issues were settled with assistance from the entire lab. Although HTL is still far from being complete, my work in the DFL has been a successful endeavor. The game has seen significant progress thanks to the collaboration of all teams. What was once a back-burner project has been rightfully restored as an ambitious project and excitement in its potential has returned.

Exploring an Algorithm about the Worst Case Analysis
Author(s): Zhan Shi
Mentor: Dr. Hrair Aintablian
Easel: 16
Abstract: The purpose of this project is to investigate worse case analysis (WCA) techniques used to ensure the performance of circuits in extreme conditions. Circuits are widely used in various fields including communications, power systems, and digital electronics. For these commercial and security purposes, companies tend to predict the behaviors of circuits in extreme environments before manufacturing such circuits. WCA detects circuit failures that cause loss of important data and result in financial loss. There are three approaches to WCA: Extreme Value Analysis (EVA), Monte Carlo (MC) and Root Mean Square (RSS). EVA evaluates the performance of a circuit for worse case variations of circuit parameter values. MC predicts circuit behavior with randomly selected samples of parameter values specified within a given range. The RSS approach assumes that the circuit parameters have normal distributions and predicts circuit behavior from a manufacturing perspective. The proposed research involves performing WCA using these three different approaches, for various candidate circuits. WCA is performed using both circuit simulation (Spice) and mathematical modeling (MATLAB). The results from each method are compared and advantages and disadvantages of each method are highlighted. In addition, the tools used for performing WCA (MATLAB and Spice) are compared in terms of accuracy, complexity, and speed. The goal of WCA is to ensure circuit reliability and performance of hardware
under virtually all operating conditions. WCA can identify design problems and save cost by reducing hardware design iterations. This research is going to provide the results of this research can be used by engineers in the electronics industry to decide which method of WCA analysis to use for a given application. It will help them evaluate which tool to use and the benefits associated with each tool. Symbolic mathematical tools, such as MATLAB or Wolfram Alpha, would make possible analytical solutions for worst case analysis of complex systems.

A Spectral Subgradient Method for Non-Smooth Optimization

**Author(s):** Yiting Xu, David Kotval and David Richmond

**Mentor:** Dr. Milagros C. Loreto

**Easel:** 17

**Abstract:** To solve nonsmooth unconstrained minimization problems, we propose the Spectral Subgradient method. We focus on the interesting case in which the objective function is continuously differentiable almost everywhere, and it is often not differentiable at minimizers. The proposed Spectral Subgradient method provides efficient solutions for large scale nonsmooth optimization problems, which arise from image/signal processing, data mining, statistics, etc. It requires very low memory requirements and low computational cost per iteration. Nonsmooth unconstrained minimization problems are usually solved by using the subgradient methods, whose convergence is guaranteed if the optimal value of the objective function is known. The purpose of our work is to combine the classical subgradient method with the spectral step length, which does not require either exact or approximated estimates of the optimal value. Since subgradient methods are not descent methods, we add a nonmonotone globalization strategy to ensure sufficient progress is made. We also present numerical results on a set of non-differentiable test functions. These numerical results indicate that using a spectral step length can improve the performance of subgradient methods.”

Three Material Decomposition using Dual Energy Computed Tomography

**Author(s):** Ryan McGarity and Kevin Uy

**Mentor:** Dr. Thomas Humphries

**Easel:** 18

**Abstract:** Material decomposition is a medical imaging technique that uses data from a CT scan to determine the proportion of materials that an object contains at a given location, such as bone, soft tissue, or fat. Recent advances in technology allow for two sets of CT data to be taken simultaneously, which under certain assumptions make it possible to find a three-material decomposition of an object. In our experiment, we evaluate two different approaches to solving the three-material decomposition problem; one that makes use of the CT dataset directly and one that uses information taken from the images that the CT dataset produces. Both approaches require a reconstruction algorithm to produce images from the data. A commonly used reconstruction algorithm is an analytic technique known as filtered back projection. However, using filtered back projection is known to introduce artifacts caused by beam hardening, which degrade the quality of the image. To try and improve the accuracy of our analysis, we instead investigated using iterative methods to reconstruct the images from our simulated CT data and also looked into using smoothing techniques to further reduce the errors caused by artifacts and noise. The problem of finding the three-material decomposition is observed to be very sensitive to input when using either approach. From our experiments, we have seen that the choice of energy spectra, as well as the choice of decomposition materials, heavily affects the conditioning of the
problem. We also found additional factors that lead to computational error such as noise from non-exact imaging, inconsistency between low and high energy spectra data, physical artifacts, and the discretization of the model. Our work presents a quantitative comparison between the two approaches of solving the three-material decomposition problem.

A Survey, Model Design, & Benchmark Test Implementation of Agent--Based Applications

Author(s): **Caleb Yang**
Mentor: **Dr. Munehiro Fukuda**
Easel: 19

**Abstract:** Agent-based modeling techniques where a chosen micro-behavior for agents produce the simulation’s macro-behavior are used by researchers in a variety of fields including biology, business/industry, and economics/social sciences. The Distributed Systems Laboratory at the University of Washington Bothell seeks to develop and release an agent-based simulator (Multi-Agent Spatial Simulation C++) that uses identified core logic of new agent-based models by coding them as a benchmark test program, further improving the in-house simulator through the benchmark analysis. The benchmark analysis will compare speed, performance efficiency, and scalability with RepastHPC and FLAME. RepastHPC and FLAME will be considered the alternatives because of their known popularity and usability in the research of agent-based modeling. Results indicate that not all applications will be capable of being directly ported because of factors such as an agent’s micro-behavior, how agents communicate, even how the topology is constructed. This information can be used to improve the in-house simulator’s library for future releases and determine if it is a better alternative for researchers.

Analytical Techniques to Characterize the Degradation of Crumb Rubber Infill found in Synthetic Turf Surfaces

Author(s): **Bryce Denis and Kaleb Dempsey**
Mentor: **Dr. John Bridge**
Easel: 20

**Abstract:** Across the United States, many college-level athletic fields consist of an artificial turf surface composed of synthetic grass fibers, silica, and a crumb rubber infill. When under typical operating conditions, the crumb rubber is exposed to ultraviolet (UV) radiation, temperature fluctuations and mechanical wear. The primary purpose of the crumb rubber in sports fields is to cushion physical impacts that may occur on the field while withstanding the environmental elements. The goal of this research is to understand the degradation mechanisms of the crumb rubber when exposed to these conditions and replicate them, in part, in the Materials Testing and Characterization Laboratory (MTCL) at the University of Washington Bothell. This will be achieved by performing accelerated weathering using an UV environmental degradation chamber. Analytical techniques, such as Fourier Transform Infrared Spectroscopy (FTIR), mass percent composition, and scanning electron microscopy (SEM) will be utilized to quantify and determine chemical and morphological differences in samples across different locations and time periods.

Linearly Reciprocating Ball-on-Flat Sliding Wear Tester to Test the Wear Properties Between Material Interfaces at the University of Washington Bothell

Author(s): **Kaleb Dempsey, Cameron Whalen and Luke Daanomah**
Abstract: A Linearly Reciprocating Ball-on-Flat Sliding Wear Tester (LWT) is used in tribology, the study of material interfaces in relative motion, for analyzing material wear properties and wear mechanisms when two material surfaces interact with each other in dynamic motion. Material interactions of interest may include a combination of polymers, metals, ceramics, or composites. The data produced by the LWT allows for the determination of material contact/interaction properties, such as wear, wear volume loss, the force of friction, and the coefficients of friction between two material interfaces in a given environment. In general, linear wear testing involves applying a normal load on top of two material surfaces that are directly in contact with each other and providing a linearly reciprocating sliding motion that occurs in a back and forth, periodic fashion. Furthermore, a force transducer is implemented into the LWT such that the friction forces generated as a result of the sliding motion may be recorded. This project entails the full research, development, design, and build of a LWT in accordance with the ASTM G133 wear specification. This is being accomplished by an undergraduate mechanical engineering capstone team at the University of Washington Bothell. This project allows students to directly apply mechanical engineering skills learned to create a unique machine that can be used for both research and classroom lab exercises while providing valuable hands-on design and build experience for their future careers.

Single Diode Modeling of Photovoltaic Cells
Author(s): Law Cribb
Mentor: Dr. Subramanian Ramachandran
Abstract: Single and two diode modeling to simulate the steady-state I-V characteristics of solar cells is a well-researched field. We have utilized a single diode model to simulate the I-V characteristics of monocrystalline Si and Cadmium Sulfide solar cells. The simulated data has been verified against the data published in the literature for these cells. In addition, using limited cell performance data, the design parameters for the monocrystalline Si and Cadmium Sulfide solar cells have been solved using a numerical method. We are currently working to experimentally measure the I-V characteristics of pristine solar cells under standard conditions. For future work, the performance of the solar cells following deliberate abuse will be experimentally measured. The cell parameters of the single diode model will be altered to understand the failure mechanism. A model with altered cell parameter(s) will be used to simulate the performance of the ‘abused’ cell and the results will be compared to the experimental data.

Identifying Maize Drought Response Genes Targeted by RdDM and Induced by ABA
Author(s): Bita Asadnejadseysan, Thelma Madzima
Mentor: Dr. Thelma Madzima
Abstract: The world population is increasing and is expected to rise by more than 2.4 billion people by 2050. In order to feed the growing population, agricultural food production needs to increase by 70% by 2050 (Frontiersin.org). Corn (maize) is a major food source in the U.S. leading to the importance of understanding how environmental stresses affect its growth. Different environmental stresses, such as
salinity, heat and drought, negatively impact the plant growth and productivity; moreover, these stresses are the main cause of crop losses worldwide. The goal of this study is to identify maize drought response genes that are targeted by the RNA-directed DNA Methylation (RdDM) pathway, and are induced by the stressed-related hormone, Abscisic Acid (ABA). In plants, the RdDM pathway is involved in epigenetic regulation of gene expression, and ABA induces transcriptional responses to stress. The putative maize orthologs of published drought responsive genes from other model plants were identified using the Drought Stress Gene Database (DroughtDB). Using the Maize Genetics and Genomics Database (MaizeGDB), we identified genes with transposons within -3000 base pairs upstream, and +3000 base pairs downstream of the coding sequence. We then used the PlantPan2 website to identify CG islands and ABA-response elements in the promoter of these genes. Genomic DNA from ABA-treated and non-treated maize plants will be subjected to bisulfite conversion and PCR of the promoter regions to analyze DNA methylation. In bisulfite treatment of DNA, unmethylated cytosines are converted to uracil, but methylated cytosines remain unchanged. These changes will be analyzed using the Kismeth website. We will also design primers to be used in gene expression studies. Understanding the epigenetic mechanisms and major hormone functions during the stress period would help us to devise different methods to promote healthy growth of plants under stress.

Non-Breeding American Crow Vocalizations and Behavioral Responses in Pre-Roost Aggregations

Author(s): Shelby Gramer, Hannah Choi and Andrea Bilotta
Mentor: Dr. Douglas Wacker
Easel: 24

Abstract: American Crows (Corvus brachyrhynchos) form predictable groups called pre-roost aggregations shortly before moving to their communal roost each night. Tens to hundreds of crows reliably congregate on these highly vocal aggregations, thus providing an excellent opportunity to investigate social communication. We predict that there are associations between call characteristics (caw quality, number of syllables, etc.) and behavioral responses of listening crows on pre-roost aggregations. We have begun to test this hypothesis by placing remotely-activated field cameras in strategic locations on the roof of Discovery Hall at the University of Washington Bothell, a known pre-roost aggregation site. These cameras take videos every five minutes throughout the pre-roosting period on multiple evenings. We use charcoal to mark a grid on the roof to track crow movements during each recording. We then analyze each recording, noting all discernable vocalizations, movements, and behaviors. Preliminary analyses suggest that most vocalizations are produced by the same few crows on any given aggregation, and that most of these vocalizations have three or fewer syllables. We have begun to examine whether the acoustic characteristics of these crow calls predictably relate to observed behavioral responses. We will use data gathered in this study to create audio files of calls for future playback studies to experimentally determine if certain crow call characteristics elicit specific behavioral responses.

Tests for Coevolution in a Microbial Mutualism

Author(s): Navriti Sharma, Norhan Al Getany, and Colin Feng
Mentor: Dr. Kristina Hillesland
Easel: 25
Abstract: Bees and flowers trade nectar for reproduction. Rhinoceroses provide food to birds in exchange for removal of parasites. Mutually beneficial interactions like these pervade the natural world, but their impact on the process of evolution is not well understood. Here, we test whether each species in a microbial mutualism repeatedly adapts to the changes in their partners, in a process called coevolution. In our model system 22 communities of the Methanococcus maripaludis (archaea) and Desulfovibrio vulgaris (sulfate reducing bacteria) evolved for over 3000 generations in the laboratory. To test whether coevolution occurred, we separated the D. vulgaris and the M. maripaludis in the mutualistic community at 1000 generations. We then paired these 1000 generation D. vulgaris populations with M. maripaludis at different evolutionary time points and measured the growth rate and yield of each population. If M. maripaludis coevolved with D. vulgaris then we would expect the 1000 generation D. vulgaris to perform better with future partners (0-1000 generations) than past partners (1000-2000 generations) because mutualists are expected to have positive effects on each other's fitness. A preliminary experiment with 6 communities indicated the opposite, that D. vulgaris grew faster with past generations compared to future generations. The yield of communities was similar across pairings. These results could indicate D. vulgaris has coevolved with M. maripaludis, and that there is an underlying antagonism between these species that has not been recognized. We will present the results of a more extensive experiment, testing more mutualistic communities at more time points, and looking for patterns of coevolution in both species.

Finding Protein-Protein Interaction Inhibitors to Cure Malaria Infection

Author(s): Becka Warfield
Mentor: Dr. Peter Anderson
Easel: 26

Abstract: Malaria infection, which is caused by parasites of the genus Plasmodium, can lead to severe illness and death. Worldwide, most malaria-related deaths are caused by Plasmodium falciparum, which contains a protein called 4V3D. The 4V3D protein consists of a CIDRα domain of HB3var03 PfEMP1 which binds to the endothelial protein C receptor (EPCR) found in humans. HB3var03 PfEMP1 is part of the PfEMP1 surface protein family, found in P. falciparum. It is necessary for the P. falciparum 4V3D surface proteins to bind to EPCR in order to infect the host. If the interaction between the CIDRα domain and EPCR can be inhibited, severe malaria infection could be prevented. Therefore, a new molecule with the ability to bind to one of the domains with greater binding affinity must be found. Research methods used in this project include determining the peptide segment that makes the greatest contribution to the binding energy of the two domains, pharmacophore searching, molecular modeling, and docking simulations. These methods were performed to yield sixty lead compounds total. Of the sixty total molecules, the top three compounds were selected, which have binding energies around -8.6 to -8.7 kcal/mol. These top molecules have been optimized, giving more favorable binding energies. Currently, a new avenue is being investigated regarding cryptic binding sites. Searches to identify cryptic binding site(s) on the interface between the two domains have been performed. Further research will involve screening and optimizing molecules that could bind into the identified cryptic binding site(s) to act as inhibitors.

Pathogenticy and Virulence of Campylobacter jejuni from the American Crow Corvus brachyrhynchos in the Seattle Metro Area

Author(s): Tanner Berglund
Mentor: Dr. Keya Sen  
Easel: 27  

Abstract: *Campylobacter jejuni* infection is the most frequent diarrhea causing bacterial infection in the United States (CDC, 2014). *C. jejuni* can be present in many different warm blooded species without causing diarrhea (Griffiths and Park, 1990). The ability to infect a host and severity of infection are a direct result of the presence of virulence genes in the bacteria. In previous studies virulence genes from *C. jejuni* were identified and were tested using PCR and gel electrophoreses (Laprade et al., 2016). In this study *C. jejuni* was isolated from crows in the Seattle metro area. As crows move to and from a roost during the day it is important to know what possible risk to human health they can pose through their fecal droppings. The isolates obtained from the fecal droppings were tested for the motility gene flaA; the colonization genes dnaJ, racR, ciaB, and pldA; and the antibiotic resistance gene tetO using the method created by Laprade et al. Twenty-three fecal isolates were tested; 100% tested positive for flaA; 100% tested positive for dnaJ; 60.87% tested positive for racR; 43.48% tested positive for tetO; 91.30% tested positive for ciaB, and 13.04% tested positive for pldA. Presence of other virulence genes such as toxin genes from the cdtABC gene cluster need to be determined. My preliminary results indicate that crows in the Seattle metro area that carry *C. jejuni* may carry a virulent or pathogenic form of the bacteria.

Finding an Inhibitor for Helicobacter Pylori Aldo-Keto Reductase Using Michaelis-Menten Kinetics  

Author(s): Meerit Said, Katie Pham, Troy Martins, and Kimly Lay  
Mentor: Dr. Lori Robins  
Easel: 28  

Abstract: *Helicobacter pylori* is a bacterium that resides in the gastric mucosa layer of the stomach, thriving in a highly acidic environment with a pH of 4.5-5.0. It is found in over 50% of the human population and has been implicated in the etiology of gastric ulcers and stomach cancer. To elucidate the mechanisms that facilitate the persistence of *H. pylori* in such conditions, its genome was sequenced and gene 1193 was identified as one vital for survival in an acidic environment. This particular gene codes for the expression of *H. pylori* Aldo-Keto Reductase (HpAKR). Therefore, inhibiting HpAKR through competitive inhibition could be a potential method to eradicate *H. pylori* infections. The gene encoding HpAKR was transformed into Rosetta cells, and induced in a three liter LB solution for protein expression. The resultant protein was purified using a nickel-affinity column. The purified protein will be used to conduct activity assays in the absence and presence of inhibitors that have been identified computationally, and analyze the data using Michaelis-Menten kinetics to determine which molecule was most effective at inhibiting HpAKR activity.

Effects of Climate Change-Related Drought Simulation on Underground and Aboveground Biomass of Arabidopsis Thaliana  

Author(s): Jaymar Golveo, Noelle Ahn  
Mentor: Dr. Cynthia Chang  
Easel: 29  

Abstract: The goal of this project is to examine phenotypic responses of *Arabidopsis thaliana* to watering treatments simulating drought resulting from climate change; specifically investigating both
above and below ground biomass response. We examined 6 genotypes; 4 wildtypes and 2 mutants to examine phenotype variation exhibits among these differing genotypes. This project will both utilize and contribute to the online database for unPAK, Undergraduate Phenotyping of Arabidopsis Knockouts, a multi-undergraduate institution effort which logs phenotypes of Arabidopsis lines (both mutant and wildtype) that have gene knockout mutations in them. The experiment consisted of collecting above and belowground biomass data of 360 plants: one control group of 180 plants that will receive 20 mL of water every 2 days and one experimental group of another 180 plants that will receive the same total amount of water as the control over the course of the experiment, but will receive it in the form of 60 mL every 6 days. Plant data collected from this experiment will include only vertical growth of above ground biomass. Although we are still in the process of analyzing our data, we expect that the experimental group will have an average smaller biomass than our control due to excess stress on the experimental plants. Through this research the scientific community will be able to better understand the effects of climate change on above ground biomass. In the future, we will further inspect below the affects of water variability on below ground biomass, which hasn’t been explored thoroughly in the past due to the difficulty in recovering intact roots after growth under experimental treatments.

Effects of Water Variability and Competition Treatments on Model Plant Arabidopsis Thaliana to Mimic Potential Global Climate Change Conditions

Author(s): Jennifer Berger, Jennifer Berger, Rachel Gunselman and Julie Rogers
Mentor: Dr. Cynthia Chang
Easel: 30

Abstract: Climate change is an ongoing and increasing fact. It's effects manifest differently in different parts of the world. One of these effects is water stress. Although drought is a well studied aspect of water stress, water variability, another effect of climate change, is not well understood. Water variability is where plants receive water all at once instead of steadily over time, something that is projected to happen with more frequency in some areas. The aim of our research is to study plants grown alone or with one other plant while under either high or low water variability treatments. Both treatments received the same amount of water over the course of the experiment. Five genotypes of the model organism Arabidopsis Thaliana were obtained from the Arabidopsis Thaliana research database unPAK and grown in our campus' greenhouse during fall quarter 2016. The five genotypes were the parent line, two thought to have shorter root lengths, and two thought to put down longer roots. Fitness, rosette diameter, above-ground biomass, and other data was collected to measure plant response to the water variability and competition treatments. This investigation is still in progress as the below-ground biomass data is still being collected. Data is still being analyzed and no trends are apparent yet.

Simulating the Light and Soil Conditions Under a Conifer Tree on Mt. St. Helens to determine the impact on Grass and Conifer Seeds establishment

Author(s): Daviel O’Niell and Gabriela Leon
Mentor: Dr. Cynthia Chang
Easel: 31
Abstract: Many factors, such as nutrient levels, light access and water availability, can affect the plant colonization of a disturbed ecosystem recovering from a volcanic eruption. By simulating the environmental conditions under a conifer tree growing on Mt. St. Helens (MSH), we hope to learn more about how two particular factors, light availability and microbial soil composition, affect the establishment of seeds in a recovering ecosystem. We attempted to answer two main questions: 1) How will the soil microbial composition on MSH affect the germination rate and growth of wild grass seeds collected on MSH and store-bought conifer seeds? 2) How will the shade cast by a conifer affect the germination and growth of grass seeds collected from MSH, and that of store-bought conifer seeds? We conducted a greenhouse study in which 2 species, *Agrostis pallescens* and *Abies procera*, were subjected to 2 treatments: shade and soil microbial content, in a fully crossed design. Over the course of the experiment, we will determine how each species responds to the treatments, and extrapolate those results to make assumptions about future populations on Mt. St. Helens, now nearly four decades post-eruption. The information gleaned from this experiment will increase our understanding of succession patterns of native plants, aid in restoration efforts of disturbed sites, and potentially in the creation of models that contribute to public understanding of ecosystem changes.

Exploring Nature’s Regrowth Through Math: Data Visualizations of Plant Regrowth on Mt. St. Helens

Author(s): Kayla Neal and Katie Stanley
Mentor: Dr. Robin Angotti
Easel: 32

Abstract: Data visualization is a form of communication derived from mathematics. Through the visualization of data, one can better understand almost any topic. Politics, natural resources, even human themselves can be better understood by constructing and analyzing data through different methods of visualization. In this project, we aim to better understand plant regrowth on Mt. St. Helens since the 1980 volcanic eruption. Using Tableau Software and data gathered at various sites of Mt. St. Helens every year since 1981 meaningful data visualizations that can be easily understood by the average person will be created. This project will aid the process of translating and constructing visualizations from qualitative information on how to construct a meaningful visualization.

A Kinetic Isotope Effect Study of the Mechanism of Hydrolysis for the Oxoester Formyl Choline

Author(s): Samantha Sarrett and Joshua Gallo
Mentor: Dr. Lori Robins
Easel: 33

Abstract: Thioester reactions are essential for performing all types of biochemical and organic processes. The reactive C-S bond serves as a gateway to other acyl groups in a multitude of organic chemistry reactions, and thioesters are necessary for processes such as thioester exchange, Claisen condensations, and hydrolysis. These reactions are typically enzyme-catalyzed and are vital for controlling levels of acyl CoAs, S-palmitoylation, and for fatty acid biosynthesis. Due to the strong reactive center of a thioester, the mechanism for thioester hydrolysis is not as extensively studied or completely known as the mechanism for the oxoester. Two mechanisms of thioester hydrolysis include a step-wise mechanism with formation of a tetrahedral intermediate or a concerted mechanism where the nucleophile and leaving group leave simultaneously. This research concentrates on comparing the
hydrolysis mechanism of the thioester formylthiocholine with the oxoester analog, formyl choline, which is synthesized in the lab. In addition to synthesizing formyl choline, the isotopic derivated deutero-formyl choline was made. To study the transition-state structure, deutero-formyl choline (d-Fch) and hydrogen-formyl choline (h-Fch) are mixed together and reacted in acidic, basic, and neutral conditions. Kinetic isotope effect values are obtained by measuring the rates of hydrolysis by NMR spectroscopy. To date, the KIEs for the formyl-H have been determined in basic conditions and yield an inverse KIE. This suggests that the rate determining step is during the formation of the tetrahedral intermediate, where the carbonyl-C undergoes an sp2-sp3 conversion. This knowledge provides initial data for the comparison with the thioester to understand the mechanism of hydrolysis.

**Status and restoration potential of native kokanee salmon in North Lake Washington**

*Author(s): Travis Priest, James Solberg and Uyen Ngo*

*Mentor: Dr. Jeffrey Jensen*

Easel: 34

*Abstract:* Native kokanee salmon, a landlocked form of sockeye, were once abundant in the Lake Washington/Sammamish watershed. Beginning in the 1920’s kokanee populations crashed, and the only known remaining native kokanee populations are restricted to a few streams entering Lake Sammamish. Other possible native kokanee may exist elsewhere in the basin, but their current status is unknown. Our goals are 1) to determine if native kokanee remain in Lake Washington and 2) to assess the potential for restoring these fish to viable population levels. Current native kokanee presence will be assessed by genetically and morphologically comparing modern possible kokanee to known native populations (collected from Lake Washington before the population crash and from Lake Sammamish). Genetic comparisons are being made by extracting DNA from fresh material and from formalin fixed specimens dating to the 1880’s and sequencing sections of the Cytochrome oxidase gene (CO1). Currently we have successfully sequenced CO1 from both fresh and fixed material. Morphological comparisons focus on gill raker anatomy variation among modern, historic, and possibly native kokanee populations. Kokanee are known to have gill rakers that are longer and more numerous than those of sockeye. Gill rakers are visualized and measured using CT scanning, and mean values will be compared among population sources. Restoration potential is being assessed by extensively surveying the lower reaches of Lyon Creek in the town of Lake Forest Park Washington. This stream historically had large kokanee populations, and this survey will assess riffle and pool quality, map creek features such as obstructions and woody debris, assess canopy coverage, and measure spawning area abundance and quality. Measurements of stream quality will enable us to estimate the approximate spawning carrying capacity of lower Lyon Creek, and will inform future restoration efforts.

**The Effect of Water Variability on Gene Expression in Arabidopsis Thaliana Mutants Grown in Competition**

*Author(s): Kathy Tran*

*Mentor: Dr. Thelma Madzima*

Easel: 35

*Abstract:* Plants play a vital role in maintaining a healthy ecosystem such as providing oxygen, food and shelter. Global climate change can create selective pressures that have the potential to affect plants physiologically, and their genes provide the plants with the ability to potentially adapt to climate
change. In regards to water, climate change may not just be about drought but also the increase of variable precipitation, where there are longer periods of drought followed by a large amount of rainfall. This is likely to also affect expression of drought tolerance genes in plants. By studying the gene expression response in genetically different plants grown alone and in competition under variable water treatments, we can gain better insight into the genotype-phenotype relationship of drought tolerance in plants, and the molecular changes that initiate these responses. During harvesting, plant biomass was measured and then shoot tissue was frozen with liquid nitrogen and stored at -80 °C. To correlate the collected phenotype data to gene expression, five genes known to be involved in drought response in Arabidopsis thaliana and expressed in shoots were picked from the Drought Stress Gene Database (DroughtDB) and the Arabidopsis Information Resource (TAIR). RNA will be isolated from the harvested shoot tissue, and reverse transcription and PCR will be used to measure the changes of gene expression of the drought response genes. This research will help us understand how environmental changes affect gene expression, as well as how genetically diverse plants interact with each other under stress conditions and how this affects productivity. In the long term, this understanding can be used to improve plant productivity to maintain a healthy ecosystem especially when the climate is changing drastically.

Accuracy of GPS Location: Traditional Collection Methods vs Trimble Juno 3B

Author(s): Kristen Biondo
Mentor: Santiago Lopez
Easel: 36

Abstract: Global Navigation Satellite Systems (GNSS)-based surveying methods are becoming more common. The GNSS methods of data collection have an inherent range of errors for determining geographic position. We used a Trimble Juno 3B unit to locate trees at a local level. This type of unit has a stated location accuracy of 3-5 meters after differential correction, but in difficult environments such as landscapes with dense canopies or tall buildings the accuracy decreases significantly because of multi-path trajectories of the signal. The Trimble Juno 3B collects global positioning system (GPS) data using code signals, which are less accurate at determining location than carrier signals. Code signals calculate the distance between a set base location and the receiver, using the difference between the signal from the base and the signal from the receiver. Carrier signals have variable reference points, reducing the amount of error in the location measurement. The study area is located on the University of Washington Bothell campus, to the north of Discovery Hall. This area is characterized by high tree density, close proximity to buildings, and variable topography. To examine the amount in the variation between the Trimble Juno 3B and the correct geographic location, GPS and survey measurements of bearing and distance were taken from individual trees and then mapped to compare locations and quantify errors using a root mean square error approach. The results of these comparisons were visually assessed using Light Detection and Ranging (LiDAR) data and summarized using location and distance error measurements. These data indicate the distances that should be accounted for when using this type of device to collect location information in areas that have many difficult characteristics.
Important Dates for 2017 - 2018

- Undergraduate Research Fair: **Oct 11, 2017**
- UWB Founder’s Fellow Application Deadline: **December 4, 2017**
- Undergraduate Research Week: **January 22 - 26, 2018**
- Undergraduate Research and Creative Practice Symposium: **May 11, 2018 (Tentative)**