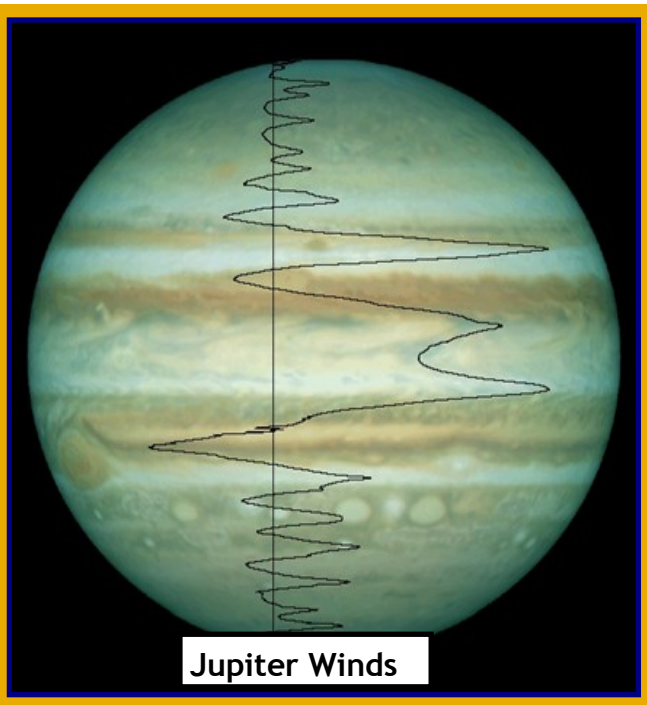
THE GOVERNOR'S SCHOOL
for
SCIENCE AND TECHNOLOGY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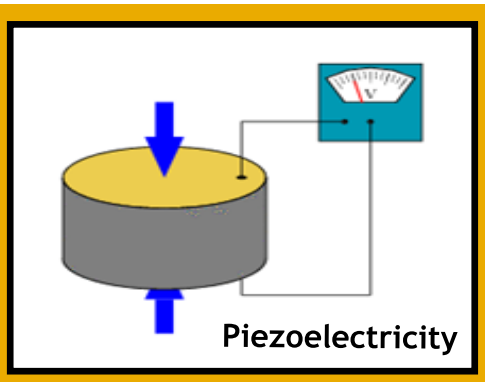
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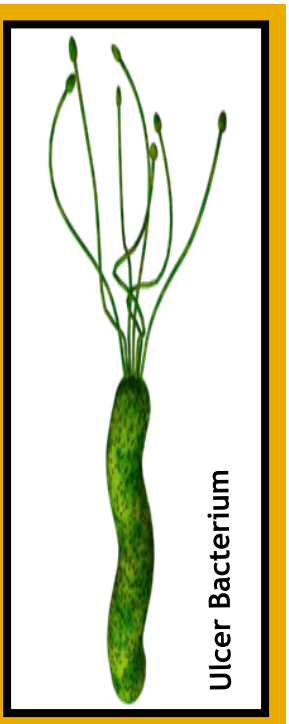
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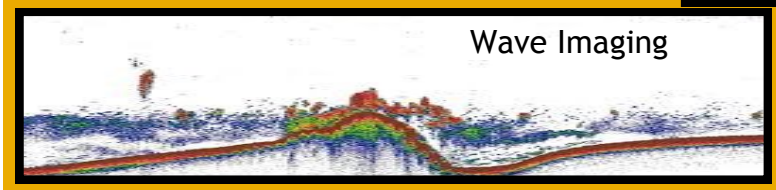
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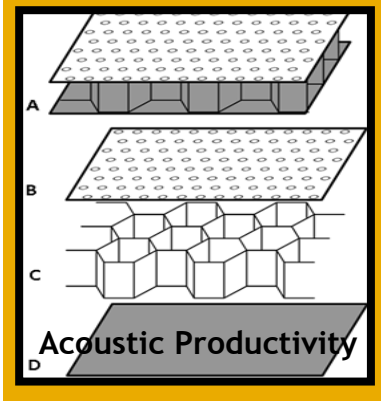

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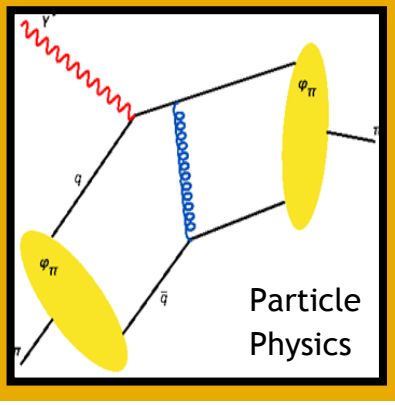
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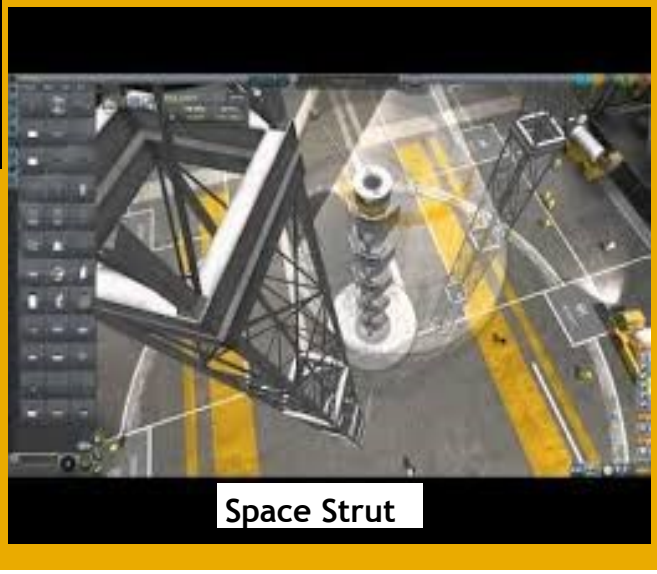

Space Strut

2017 Science Research Journal

Patient Compliance Rates in Type 2 Diabetics at Poquoson Pharmacy from October 2016 through May 2017

Allea Maurakis
Poquoson High School
Poquoson Public Schools

Abstract

Patient compliance is an ongoing problem in the pharmaceutical industry; it is the rate at which individuals follow their prescribed course of treatment from health care providers. Patient adherence, or patient compliance, is especially important in individuals with chronic diseases, like type 2 diabetes mellitus. It is crucial for individuals with diabetes to take their medications, because compliance can reduce the risk of disease-related issues.

Weekly over the course of eight months, the overall compliance rates for type 2 diabetics at Poquoson Pharmacy were analyzed. Overall maintenance medication compliance rates and diabetes-related medication compliance rates (expressed as percentages) were recorded, to observe if patient adherence varied at specific time periods of the year, and were calculated by PrescribeWellness on a scale of one to one hundred percent. For each type 2 diabetic patient in the system, a patient identification number, date of data collection, gender, age, date of birth, overall maintenance medication adherence, and overall diabetes-related medication adherence were recorded. These data were used in graphical analyses to observe compliance rates among patients and at various times of the year. Compliance fell in December, while it rose in the spring, and males had higher diabetes -related compliance compared to females. Maintenance medication adherence and diabetes -related adherence did not differ throughout the year, and 72% of patients were compliant throughout the study. The percentage of complaint patients was credited to the positive relationships formed with the pharmacists at the establishment, and females experienced lower compliance because they were less likely to receive the recommended medication monitoring. Compliance fell in December due to patients hitting the coverage gap of Medicaid, and the rise in the spring was credited to insurance plans resetting. The 28% of patients who were non-compliant increased their risk of grave health issues like hospitalizations from diabetes-related issues.

"Patient compliance is especially important in individuals with chronic diseases"

"The yearlong commitment I made to mentorship was one of the most beneficial opportunities in my education in high school. Thanks to my exceptional mentor at Poquoson Pharmacy, I was able to explore and experiment with a career field I was excited to pursue. The time I spent in the pharmacy taught me more than just the factual information that pertained to my study; my attendance led me into a career I am definite in pursuing and enriched professional and personal skills that are crucial in the pharmaceutical industry. My remarkable mentorship experience derived from the kind individuals and the valuable educational and life lessons I learned. My appreciation and gratitude for the unforgettable experience and opportunities I gained from mentorship are limitless."

Allea will be attending Christopher Newport University.

Translational Gap in Ongoing Clinical Trials for Glioma and Lung Cancer Research

Alecia F. Guishard
Smithfield High School
Isle of Wight County Schools

Abstract—Glioma

Despite vast amounts of information gathered about gliomas, the overall prognosis for glioma patients has not improved in the last four decades. This could partially be due to an apparent failure to include basic concepts of glioma biology into clinical trials. Specifically, there were few attempts to overcome the limitations of the blood brain barrier (BBB) and the chemoresistance of glioma stem cells (GSCs) in a study involving 29 Phase I/2 clinical trials (P2CT) published in 2011 (a phenomenon known as the translational gap, TG). This study updated observations with a new series of 100 ongoing P2CT in order to determine if there has been a TG reduction. The number of drugs each P2CT tested and whether concomitant radiotherapy was implemented were evaluated, as well as the ability of the drugs utilized to pass the BBB and to target GSCs. Compared to clinical trials published in 2011, ongoing trials had an increase in the percentage of P2CT using two drugs (from 24.1% to 44.9%), an increase in the number of drugs able to traverse the BBB (7.1% versus 64.3%) and target GSCs (0% versus 16.3%), and there was a decrease in the number of P2CT using concomitant radiotherapy (34.5% versus 18.37%). Results suggest only a modest improvement regarding reducing the TG, considering that the vast majority of ongoing P2CT do not incorporate well known concepts of glioma biology that are crucially important for treatment success.

"Translational Gap: a delay in the clinical application of important scientific discoveries"

Abstract—Lung Cancer

Research continues regarding the most effective therapies for lung cancer. However, the prognosis for this disease is still poor, at 18 months. Factors that may contribute to tumor relapse and chemo-resistance include intra-tumoral heterogeneity and the existence of cancer stem cells (CSCs). Many anticancer therapeutics are evaluated based on their ability to diminish tumors, but if the drugs do not eliminate CSCs, the cancer will soon relapse, often with new chemo-resistance. Though the importance of CSCs is evident, the presence of CSCs may not be considered when administering chemotherapies and/or other lung cancer interventions (e.g. radiation, etc.). The aim of this study was to potentially identify a translational gap (TG), a delay in the clinical applications of important scientific discoveries, between clinical trials published in 2004, one year before lung cancer stem cells (LCSCs) were first isolated, and those published in 2015.

One hundred Phase 2 and I/2 clinical trials (PI/2CT) published in 2004 and 2015 (50 per year) were evaluated, and information from each trial was catalogued; the number of drugs tested in each PI/2CT, whether concomitant radiotherapy (RT) was included in the trials, and the ability of the drugs to effectively target LCSCs were evaluated as indicators of the TG. When comparing the data sets (2004 versus 2015), significant increases in the percentage of studies that tested one drug (14% versus 30%) and those that tested three drugs at once (16% versus 36%) were observed, as well as a significant decrease in the percentage of PI/2CT that tested two drugs (70% versus 34%). There was no statistically significant difference between the clinical trials that implemented RT and those that tested drugs only . Of the PI/2CT published in 2004, 26% utilized LCSCs-targeting chemotherapy, while 32% of 2015 PI/2CT utilized them. The results indicate no significant difference in the consideration of LCSCs between 2004 and 2015. Therefore, a TG exists in lung cancer research.

Ashley F. Guishard
Smithfield High School
Isle of Wight County Schools

Alecia and Ashley will be attending Hampton University.

Frequentist Analysis of Rosenbluth Data: A Study of Proton Form Factor Measurements

Stephen Shamaiengar
Jamestown High School
Williamsburg James City County Schools

Abstract

Electron scattering has long been a primary method of probing the atomic nucleus. For elastic scattering, where the nucleus remains intact, deviations of actual data from calculations of the Mott scattering cross section (which treats protons as point particles) have been parametrized in terms of the form factors. The Fourier transforms of these form factors account for the spatial distribution of electric charge and magnetization within the nucleon. The form factors of the proton, the simplest nucleon, are extracted from scattering cross section data using a technique called Rosenbluth separation. One of the most well- known Rosenbluth experiments was done at the Stanford Linear Accelerator Center(SLAC NE11) in 1994. In the analysis of the data, the student applied a normalization factor to the cross section data from the 1.6 GeV spectrometer used in the experiment. This normalization of the spectrometer assumes it was calibrated improperly with respect to the 8 GeV spectrometer. Such a normalization greatly affects the Rosenbluth separation and thus the form factor values extracted.

The past analysis of raw Rosenbluth data was investigated to determine the effect of the normalization on the form factors. Programs were written in Python to reanalyze these SLAC NE11 cross section data. The results presented include the calculation of the values and uncertainties of proton electric and magnetic form factors for $1.75 \leq Q2 \leq 7.0$ (GeV/c^2), based on 8 GeV and 1.6 GeV cross section data. The analysis was repeated with neither set of cross section data normalized, then with only the 1.6 GeV cross section data normalized, and then with only the 8 GeV cross section data normalized where $\theta \approx 90$ degrees, and all three again with new radiative corrections applied. Form factor measurements were in accordance with those in the literature for the cases where neither normalization nor radiative corrections were applied and where both were applied. Also, form factor measurements without a normalization and/or with radiative corrections applied indicated a different distribution of electric charge and magnetization within the proton than described by previous Rosenbluth separation measurements, as well as less similarity between the distributions of electric charge and magnetization.

"... form factor measurements with corrections applied indicated a different distribution of electric change and magnetization within the proton ..."

"Through my experience at Jefferson Lab, I enhanced my computer science skills while applying them to the field of nuclear physics. I learned advanced techniques in physics and statistics, in addition to acquiring a greater ability to translate my knowledge and ideas from minutiae to the bigger picture when presenting my work. Through my project, I was able to attend a conference of the American Physical Society, and my mentor and I hope to publish our results in the coming months. My mentorship experience has fostered my growth as a researcher, a computer scientist, a mathematician, and a learner in general, and I am certain that what I gained through my time at the Lab will benefit me throughout college and throughout my career."

Stephen will be attending University of Virginia.

Abbigail Menge
Bruton High School
York County Public Schools

Two Component System Regulation of sabA Expression in the Gastric Pathogen on *Helicobacter pylori*

" [H. pylori] is highly adapted to the harsh environment of the stomach, a unique characteristic that has allowed it to infect a large number of people"

Abstract

Helicobacter pylori, a human-specific bacteria, chronically infects nearly 50% of the world population. *H. pylori* is highly adapted to the harsh environment of the stomach, a unique characteristic that has allowed it to infect such a large number of people and survive in the stomach for a lifetime of a host. In order to sense and respond to stimuli in the stomach, *H. pylori* utilizes three main two component systems (TCS) to respond to changing conditions within the stomach; the ArsR/S and FlgR/S systems respond to changes in pH. Using the adhesion protein *sabA* as an indicator, two hypotheses were tested investigating possible methods *H. pylori* uses to persist within the host. The first hypothesis investigated the possible crosstalk between ArsR and FlgS and when the component FlgS was deleted from the bacteria, a mutation of the main phosphorylation site of ArsR was unsuccessful. This result established that FlgR/S may in fact have a role in the phosphorylation of a mutated ArsR. The second hypothesis investigated possible methods of isolating the ArsR protein through the use of histidine codons. The eventual goal after "tagging" and isolating ArsR is to investigate the mechanisms used by ArsR to repress *sabA.* Multiple lengths for the histidine tag were tested and none were successfully integrated into the ArsR sequence. Although *H. pylori* infections are largely asymptomatic for many people, the approximately 10% of infections which lead to peptic ulcers, lymphoma, and gastric cancer was sufficient justification for the World Health Organization to declare *H. pylori* a class 1 carcinogen. Therefore, understanding the pathways the bacteria use to adapt to varied conditions is essential to determining how *H. pylori* is so successful at persisting in the stomach and to developing new antibiotics and treatments against it.

"I have to admit that I was slightly overwhelmed at the thought of working in a college laboratory, conducting research on a topic I knew little to nothing about among undergraduate students. But today I am in awe at how much I have learned and accomplished with my mentor over these past several months. I cannot thank GSST and my mentor enough for all the experience I have gained in completing my senior research project. I am extremely grateful for the opportunity and I know that everything I have learned will help me far beyond a laboratory or classroom."

Abbigail will be attending Virginia Commonwealth University.

Measuring Zonal Winds of Jupiter on Decadal Timescales

Julie Zhou
York High School
York County Public Schools

Abstract

The zonal winds of Jupiter are winds with a latitudinal flow and are the focus of a number of studies partly because their movements can reveal information on the atmosphere. Even though much research has indicated that wind velocities seem to be stable, there has not been a steady application of a technique to analyze the wind velocities from images taken by different robotic satellites. The lack of temporal coverage between the image sets makes it hard to pinpoint the reasons for any changes that may occur in the features. To solve this issue, a reliable, automated method of analysis was applied to the datasets to maintain continuity and track variations in the zonal winds.

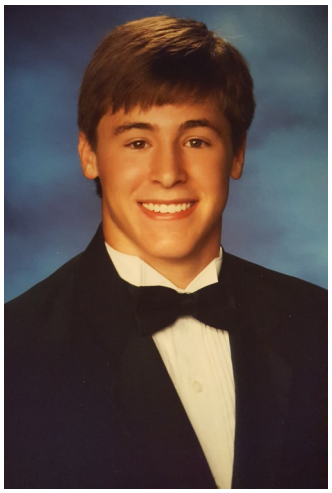
Images from Cassini and New Horizons were processed and analyzed through an automated method which compares cloud features in images in order to track their movement and calculate wind velocities. Wind profiles were created to display these velocities at each latitude, which produced the first global measurements for the New Horizons data. The zonal wind velocities aligned with results of past studies indicating stability but with slight variations at the equatorial region. These variations could possibly be due to Quasi-Quadrennial Oscillation (QQO) but more information needs to be gathered in order to be conclusive.

"Wind profiles were created to track movement and calculate velocities."

"I had the honor to work with my mentor, a NIA scientist and professor, and a graduate student at Hampton University and got actual research experience on a challenging but interesting topic. Because of this opportunity, I have also gotten the chance to publish my study. Even though one year is short, I was able to learn a lot of different things, skill and advice-wise, that will definitely help me as I go throughout my career."

Julie will be attending University of Virginia.

The Use of Different Truss Lacing Techniques and Node Specialization on Space Trusses for Mass Reduction



Stanley Smeltzer
Smithfield High School
Isle of Wight County Schools

Abstract

Many space missions are using methods of in-space assembly to finish assembling systems. In-space assembly opens a new approach to space technology for robotic systems to handle a large portion of the assembly, maintenance, and repair on almost all space systems. Creating a new truss lacing technique that would allow for a significant mass and volume reduction, along with cost reduction, would be very beneficial to continue growing technology. Minimization of launch mass is a critical goal for all missions. Creating specialized node types would help to simplify truss structures and reduce their overall mass. A combination of a new truss lacing technique and node type specialization created a very mass and volume efficient truss system, meeting and exceeding 30% efficiency. Different models were created based on a 4-longeron truss design and were tested for different elements of buckling and stiffness strengths. The stiffness and buckling values were analyzed for each option as a performance criterion, and the different models showed low readings for member buckling. The Double Bay Repeating Every Two Bays Option was found to be the optimal design. Furthermore, this design allowed for a very large drop in price (~40%), which could allow for a much more cost effective model. These truss systems will be used in space for many different applications and will make it possible to pack the systems more efficiently because they would carry less mass and volume.

"A combination of a new truss lacing technique and node type specialization created a very mass and volume efficient truss system."

"Having the opportunity and privilege to have a mentorship at NASA Langley Research Center, and work on advanced projects with doctorate level engineers, has been the most interesting and influential means of learning throughout my high school career. Learning how professionals work, act, and communicate in a field that I am eager to pursue gave me lots of insight and experience in real-world situations. Furthermore, my mentorship allowed me to challenge myself to work on advanced truss lacing techniques and node specialization to find mass and volume reductions in space trusses. I will always remember this experience as I use my new skills in the years to come."

Stanley will be attending Virginia Tech.

Development of a Polyurethane Bone Composite Ink for Solvent 3-D Printing

Brett Hodges
Poquoson High School
Poquoson Public Schools

"My time at Hampton University has allowed me to gain a better understanding of the fields of chemistry and chemical engineering. I was introduced to real world applications of the science I have grown so passionate about and developed research and other critical thinking skills that I will use during my college education."

Abstract

Polyurethanes are chemical polymers that are formed from the urethane linkage between an isocyanate and a polyol. Solvent casting has become the primary method of fabricating polyurethanes, and the solvent as well as the other polyurethane components directly influence the chemical and mechanical properties of the polyurethane. To attempt to produce a polyurethane bone composite ink that can be used in solvent 3D printing, these properties were explored for normal and bone composite casts. Testing included varying catalyst concentration, varying solvent volume, and layering polyurethanes similarly to the typical 3D printing process. Increasing the volume of catalyst in the cast decreased the cure time, but led to lower cast quality. Decreased solvent volume led to a decreased cure time and lower cast quality. Replications were made in at least triplicate to verify trends in cast quality following individual tests, with additional replications made as necessary. Fourier transform infrared spectroscopy was used to verify that all of the reactants were reacting to form urethane linkages in the gelling reaction. Complications in cast formation later in the study highlighted the multivariable nature of the urethane reaction, indicating the need for further experimentation with the bone composite formulation. Perfection of the formulation could allow the use of the bone composite ink for the fabrication of a polyurethane bone composite microfluidic device for additional studies.

Jeanju Paeng
Tabb High School
York County Public Schools

"complications in cast formulation highlighted the multivariable nature of the urethane reaction"

"GSST has given me a unique experience. I realized the importance of research. I learned firsthand how studies have relevance in the world and how researchers are indispensable to all fields of science for their rigor and determination. I will carry the experience of mentorship with me throughout the rest of my education and career."

Brett will be attending University of California-Davis and Jeanju will be attending Virginia Tech.

Lifetime Studies and Characterization of Polarized ^{3}He Target Cells

Elizabeth Horley
Jamestown High School
Williamsburg/James City County Schools

Abstract

Helium-3 (^{3}He) is used in nuclear physics research because the nuclear structure allows the neutron to be isolated and neutron spin structure to be studied. An aluminosilicate glass target cell is used to contain the ^{3}He and alkali metals. To polarize the ^{3}He, physicists employ spin-exchange optical pumping. The ^{3}He nuclei become polarized through spin-exchange collisions which transfer the spin of the alkali metal to the ^{3}He. There is a large variation between the two polarization values, with the level of ^{3}He polarization being much less than the alkali-metal polarization. The discrepancy between the polarization levels is thought to be caused by the lower polarization of the alkali-metals at certain areas of the cell, decreasing the overall ^{3}He polarization.

The amount of time it takes a cell to depolarize is known as the lifetime. A short lifetime could indicate poor cell quality or equipment malfunctions. Lifetime is dependent on depolarization factors, which include the presence of gradients and noise in the polarization system. AFP-NMR measurements were used to determine the lifetime of cells. Through the course of the lifetime studies, the lifetime of the cell Apfel increased from 12 h to 168 h. The cause of the shortened lifetimes was found to be related to gradients in the surrounding magnetic holding field caused by the thermocouples, noise in the RF amplifier, and the cell filling procedure.

EPR and AFP-NMR measurements of the cell Betty determined the ^{3}He polarization to be approximately 65%, verifying the ^{3}He polarization of 72% measured by NIST researchers. Faraday rotation measurements were used to determine the polarization of the alkali-metal throughout a W&M cell, and resulted in an alkali polarization of 68%. The results should show a lower polarization of the alkali-metals downstream of the pump laser. If a spatial polarization difference is observed, the polarization technique should be changed to increase alkali polarization, which should increase the ^{3}He polarization.

"...lifetime of cell Apfel increased from 12h to 168h"

"Over the course of the year, I gained invaluable experience installing optics, laser systems, and analyzing electrical systems, skills I will use throughout my future career. My mentorship allowed me to combine my interests in electrical engineering and physics, encouraging me to pursue both in college. I am extremely thankful to have had this opportunity, which was only available through the support of Governor's School."

Elizabeth will be attending Virginia Tech.

Determining the Cost Efficiency of Three Different Fish Feed Brands by Observing the Growth of *Amphiprion ocellaris*

Emma Kirschke
Grafton High School
York County Public Schools

Abstract

Aquaculture greatly contributes to the global and national markets and the sale of ornamental fish continues to increase. *Amphiprion ocellaris*, commonly known as the clownfish, is particularly popular among consumers. High demand for ornamental fish negatively impacts marine ecosystems as companies harvest fish from the oceans, resulting in a depletion of wild populations and a degradation of the surrounding wildlife. As a result, there is a need for information on how to breed marine fish in captivity efficiently. One factor that contributes to the cost effectiveness of raising fish is the feed administered. Growth of fish given three different brands of fish feed over an eight weeks period was compared. Otohime is manufactured in Japan and is known for its high nutritional quality. Otohime is significantly expensive. The Otohime feed was compared to two other feeds, Skretting Gemma and Zeigler, which have much lower costs than the Otohime brand. Despite its high price, Otohime did not result in significantly greater length or weight compared to the less expensive brands, Zeigler and Skretting Gemma. The growth of the clownfish was consistent among all three brands. Because the Zeigler brand has a lower price per pound, it is the most cost effective option.

"High demand for ornamental fish negatively impacts marine ecosystems"

"I began my mentorship with almost no idea of what career I would like to pursue, and knowing next to nothing about aquaculture. Luckily, my mentor was extremely welcoming despite my lack of knowledge on the subject. Although I am still uncertain regarding what career path I wish to take, I am extremely grateful to have been given this opportunity to gain experience in a field that I may have otherwise overlooked. The great thing about the mentorship program at the Governor's School is that it grants you the opportunity to explore the endless possibilities for future careers that

Emma will be attending University of Virginia.

Characterization of the Mutant m499 and its Role in Cardiovascular Development

Kylee Hockaday
York High School
York County Public Schools

"animal models has revealed fundamental principles that have improved our under-standing of congenital heart defects in children."

Abstract

Cardiovascular disease is a primary cause of morbidity and mortality in the United States. The study of cardiac developmental defects in animal models has revealed fundamental principles that have improved our understanding of congenital heart defects in children; however, they have also revealed key molecular and genetic mechanisms underlying adult cardiovascular disease. One process that is crucial during cardiac development is the growth of heart muscle (myocardium). Thickening of the myocardium during embryonic development (concentric myocardial growth) is necessary for the heart to generate the contractile strength required to maintain circulation of blood throughout the body. Analysis of zebrafish mutants has provided insights about the genetic control of early cardiac patterning. The autosomal recessive zebrafish mutant m499 exhibits a cardiovascular phenotype characterized by a dilated inflow tract and atrium. To characterize the m499 molecular defect, RNA was isolated from pools of wild-type and mutant embryos and used for RNA-seq (transcriptome analysis). Single nucleotide polymorphisms (snps) detected during sequencing were used to positionally clone the genetic mutation. We established linkage to a region of zebrafish chromosome 15 near the 14 Mbp (mega base pairs) position; we further identified a single nucleotide bp change in the zebrafish mutant pool which resulted in the formation of a stop codon within the tcaf2l gene. An anti-sense approach was used to knockdown mRNA levels of this gene, decreasing protein levels and producing a phenotype similar to the m499 genetic mutant. Analysis of the m499 mutant will help inform approaches for the treatment of cardiac disease in humans.

"My experience at mentorship was truly exceptional. Not only have I learned the various methods of gene expression analysis, but I have also been afforded the opportunity to work with an expert in a professional setting. Mentorship has not only taught me numerous scientific protocols but has also helped me to realize the importance of time management, perseverance, and, ultimately, ambition. We have been handed an opportunity that not many high schoolers are: to work with a professional and generate projects and papers on subjects that are not taught at an undergraduate level. I truly cannot express the gratitude for presenting me with such a great mentorship."

Kylee will be attending Virginia Commonwealth University.

Evaluation and Design of Variable-Depth Acoustic Liner Configurations

Miroslava Marinova
Grafton High School
York County Public Schools

Abstract

Aircraft engine noise, especially in frequencies between 500 Hz and 2000 Hz, is a major nuisance for many people. This noise is currently reduced through the use of resonant acoustic liners mounted in the walls of engine nacelles. Acoustic impedance is the key parameter used to determine the acoustic performance of these liners. A variety of constant-depth and one-dimensional, variable-depth liners were tested in the Normal Incidence Tube (NIT) at a set sound pressure level and range of frequencies. The resistance and reactance (real and imaginary components of impedance, respectively) spectra were predicted using a model originally designed for constant-depth liners. The predicted and measured impedance spectra compared favorably for the constant-depth liner, and showed similar trends for the variable-depth liners. A two-dimensional, variable-depth liner was designed with a compact chamber configuration to maximize absorption over the frequency range of 500 to 2000 Hz. The model was found to accurately predict the general trends of the data, with a slight shift in frequency. Potential sources of error included the phase effects on the sound waves exiting the liner, vibration transference within the liner, the effects of a facesheet, and the assumption in the model that the liner was composed of an acoustically rigid material. A new liner was then designed using this information, produced, and tested in the NIT. The bent-chambered liner was more compact and lightweight than the straight-chambered, yet it absorbed the same frequencies. These results supported the idea that bent-chambered liners could be used in place of straight-chambered.

"the bent chambered liner was more compact and light weight and absorbed the same frequencies"

"Mentorship was one of the most exciting parts of going to GSST. I am very grateful for the time and effort that my mentor at NASA Langley Research Center put into ensuring that I got as much as possible from my mentorship experience. With him, I was involved in all aspects of engineering, from hands-on experimentation to design work to data analysis. Our research will soon be published and hopefully used by others working in the same field. Aside from allowing me to learn about acoustics and airplane engine liners, mentorship also gave me a chance to work in a professional setting and develop skills that will be necessary throughout my life. I am very grateful for these amazing opportunities."

Miroslava will be attending Cornell University.

Prototyping and Analysis of Five Vertical Take-Off and Landing (VTOL) Aircraft

Michael Hendrickson
Phoebus High School
Hampton City Schools

Abstract

Both hovering and fixed wing fast forward flight (FFF) unmanned aerial vehicles (UAVs) are commonly used in a wide variety of applications such as surveillance, payload delivery, data acquisition, exploration, and much more. These vehicles are utilized because of their simplicity of design and control, and because of their specific mission capabilities. A vertical take-off and landing (VTOL) aircraft, with beneficial performance characteristics of both hovering and FFF vehicles, is capable of completing a wider range of missions than that of a hovering or FFF vehicle. By transitioning between a hovering and FFF flight profile mid-flight, a VTOL aircraft can launch and land in a hover, reducing needed land area for runways, and fly in FFF for better energy efficiencies.

Five unique VTOL vehicles were designed, constructed, and tested with the objective of identifying favorable characteristics with respect to the endurance, stability, controllability, maneuverability, payload capacity, and simplicity of each design. The KK 2.1.5 Flight Control Board with the open source OpenAeroVTOL software was used to the control each vehicle. The OpenAeroVTOL software is a program specially designed for controlling UAV VTOL aircraft using the KK 2.1.5 board. The vehicles were assessed using the Cooper-Harper scale, a standard rating system used to measure the pilot controllability and handling of an aircraft. Flight tests of each VTOL vehicle revealed the benefits of thrust vectoring compared to blown control surfaces with respect to controllability and stability, especially in hover, receiving Cooper-Harper ratings indicating a very controllable aircraft. The designs explored have the possibility to be implemented as a standardized design for widespread use to replace many current UAVs. The five aircraft tested offer simplified design options for VTOL aircraft, which have previously suffered from design complexities, creating points of failure and increasing costs. Along with modern UAV applications, the VTOL aircraft prototypes offer creative design features applicable to the NASA Mars Electric Reusable Flier (MERF) project, with a mission of using a UAV to explore the Mars surface.

"My mentorship experience alongside Josh at NASA Langley Research Center has been an invaluable experience, giving me hands on experience in a real-world team engineering project. I was exposed to advanced aerospace engineering topics in an interesting way and created many professional connections within the NASA facility that I believe will benefit me for many years to come. The work that I have done in my mentorship has led to a position in a NASA summer internship in which I will continue working with my mentor, and the submission of a patent for an innovation in the capabilities of one of our prototype aircraft."

"…. VTOL aircraft prototypes offer design features applicable to the NASA Mars Electric Reusable Flier project to explore the Mars surface."

Joshua Glaab
Kecoughtan High School
Hampton City Schools

"Mentorship has been one of the most challenging and rewarding experiences of my high school career. Working in a real engineering setting on real engineering problems was a refreshing change from book work and unrealistic examples of a classroom environment. I enjoyed working on a team to achieve a bigger goal than any on our team could have achieved individually. Working on a real project taught me how to research material that could be useful to me. With the research came presentations at conferences like Tidewater Science Fair and Virginia State Science Fair, where I met future leaders in my field. All in all, it was an experience that I will never forget. "

Joshua and Michael will be attending Virginia Tech .

Megan Roberts
Lafayette High School
Williamsburg James City

Gamma Knife Radiosurgery for Acoustic Neuromas

"....87% of patients had successful tumor control with Gamma Knife surgery"

Abstract

Acoustic neuromas are tumors that can cause hearing loss, facial nerve damage, dizziness, and other symptoms that can complicate the lives of those who suffer from them. Unfortunately, they typically develop later in life, which often makes the patients poor surgical candidates for craniotomies and partial resections. Gamma Knife® radiosurgery offers a less invasive and safer way to treat these tumors. The retrospective study assessed whether or not Gamma knife radiosurgery successfully reduced or maintained the size of acoustic neuromas for the 100 patients treated at Riverside Regional Medical Center from 2006-2016. Analysis was of the 47 patients with acoustic neuromas that had follow-up at Riverside.

Major factors analyzed were age, gender, initial tumor volume, follow-up tumor dimensions, preoperative symptoms, postoperative symptoms, and complications. None of the variables observed had a significant impact on tumor control. Since 87% of patients had successful treatment in terms of tumor control, Gamma Knife radiosurgery should be recommended as a viable treatment option for patients with acoustic neuromas.

"Mentorship gave me a window into the world of professional research, and it allowed almost complete independence on conducting important analysis of data that can help patients make a more informed choice on treatment options. Mentorship also gave me confidence and training that will give me an advantage when applying for other internships and research positions both in college and beyond."

Megan will be attending Yale University.

Studio9 Website Development and Analytics Using HTML and CSS

Chenyun Zhang
Grafton High School
York County Public Schools

Abstract

Many people are on the Internet visiting websites on a daily basis. Therefore, websites should have a high level of usability in order to attract potential customers. In order to determine the factors that play a major role in the success of a website, models, such as the two-factor model and the Quality in Use Integrated Measurement (QUIM) model, attempt to classify the important factors. Furthermore, in order to test the effectiveness of a website, testing methods, such as the System Usability Scale and surveys, can be utilized. By integrating the models and the testing methods, the Studio9 website focuses on having a high level of quality and usability.

Studio9 is a company that allows those that desire a professional setting to establish their idea while minimizing their spending by offering a shared office space. Potential Studio9 customers use the website to find information; therefore, the website must have a high level of usability to attract customers. In order to meet the requirements of a high level of content and usability, the website was programed with the languages HTML and CSS through multiple files that integrated the different factors that are given by the models.

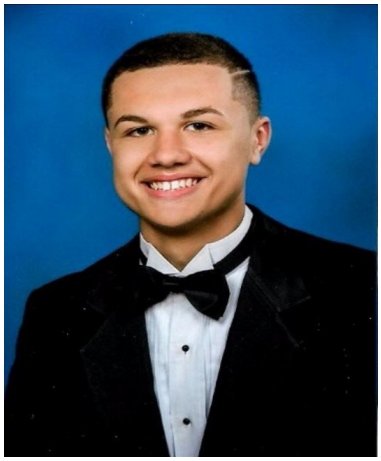
In a survey of the Studio9 website, participants gave the various components high ratings, such as agree and strongly agree. The survey also included questions that asked the participant to find specific information in the website; the participant answered these questions relatively quickly, which indicates that the participants were able to navigate the website easily. This suggests that the Studio9 website has a high level of usability and effectiveness. While all the factors in a website are important, the importance of each factor varies; the organization and appearance of the website appear more often in the models, which indicates that those factors are more important. The Studio9 website scored high in these categories, which contributed to the usability and success of the website.

"Websites should have a high level of usability in order to attract potential customers."

"Mentorship was a large part of my Governor's School experience. I had the honor of working with my mentor at Mellen Street Creative. I not only learned how to program and design a website, but I also learned how to interact with potential clients. Mentorship also exposed me to the challenges that are associated with the real world. This experience taught me many valuable lessons that I will continue to use throughout my life."

Chenyun will be attending University of California-Berkeley.

Ultra-High Energy Efficiency Footwear Power Generators



Tryston Raecke
Tabb High School
York County Public Schools

Abstract

Portability is an important selling point in a technology-infused world, therefore, new power solutions are needed to separate the consumer from the limiting force of cords and batteries. As technology continues to be infused in the battlefield, the United States Army personnel need to bring backup batteries which increases the exhaustion of personnel and limits the length of missions. Piezoelectric energy harvesters (PEHs) can tackle these problems by providing personal electronic devices that may be powered on-the-go.

Mesoscale models of PEHs have been studied for years with research beginning to delve into methods of powering personal electronics. By integrating the Hybrid Piezoelectric Energy Harvesting System (HYPEHT) into United States Army boots, the length of missions may be extended indefinitely as the steps taken in the field actively recharge the electronics carried. In order to effectively integrate this system, ATILA Finite Element Analysis software was used to aid in the modeling and construction of a more effective energy transportation and storage system. Success is deemed when one watt of power is produced by the PEH with a pre-integration weight at or below 450 grams and a broadband frequency response is displayed. Four primary tests were used to characterize HYPEHT in off-resonance: under a set load and frequency for energy output against model, against various resistances in comparison to model, comparison of electrical output of outers and inners across varying frequencies, and energy conversion efficiency under differing forces and frequencies. HYPEHT followed the model used, producing a peak electrical power output of 185 milliwatts under a forty Newton force at 530 Hertz with an energy conversion efficiency of forty-four percent. HYPEHT responded to broadband frequencies, but further claims cannot be made until the final integration into a Belleville 760 ST army combat boot is finished. This application shows promise to create path to commercialization for HYPEHT systems for use in charging personal electronics.

"Piezoelectric energy harvesters may provide power to devices on-the-go."

"Working at the National Institute of Aerospace (NIA) has been an amazing venture into the world of scientific discovery. My mentorship experience has given me knowledge in the fields of electrical engineering, materials science, and mechanical engineering. I was able to apply my knowledge by coming up with new applications for the technology. Given the ability to utilize new testing apparatuses at the National Institute of Aerospace (NIA) and the National Aeronautics and Space Administration (NASA), my mentorship project introduced me to both the theoretical and hands-on portion of scientific research. With the work done this past year at the NIA behind me, I have the opportunity to continue my involvement into novel applications of piezoelectric energy harvesters through an internship program that will continue through the summer and beyond. "

Tryston will be attending University of Virginia.

Reconstructing a Reconstruction Tool

Emily Vogt
Grafton High School
York County Public Schools

"The Internet contains a large amount of information that the world accesses at an increasing rate. However, pieces of that information can be lost forever if a website is lost."

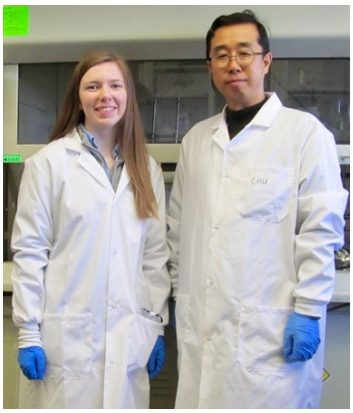
Abstract

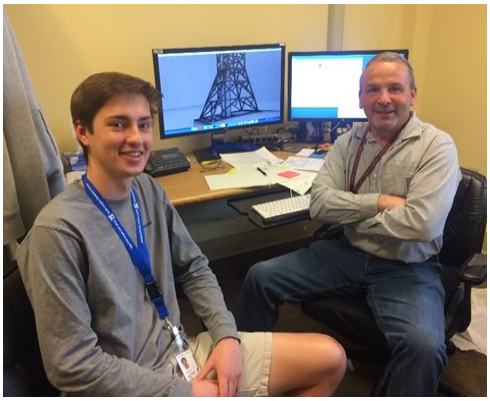
The Internet contains a large amount of information that the world accesses at an increasing rate. However, pieces of that information can be lost forever if a website is lost. Websites can be lost due to fire, flooding, hacking, viruses, or hard drive crash. It is incredibly easy and common to lose a website. Warrick is a website reconstruction tool that accesses web archives to help users reconstruct lost websites. However, Warrick 2.0 became outdated in 2010. Warrick 2.0 was updated with a more modern programming language, cross platform support (e.g., runs on Windows, iOS, and Linux operating systems), and use of recently developed web archive integration services (i.e., Memento). Warrick 3.0 meets current user and community demands and fills the current gap for a website recovery tool. The program requests the memento (an archived version of a website) of the URI from the TimeMap and iterates through the embedded resources and anchor tags to create a recovered website. On average, the tested websites had a 75% completion ratio when comparing the resources recovered to what was in the live websites. For all websites tested, Warrick 3.0 had a 100% recovery success ratio when comparing the resources recovered to what was available in the archives.

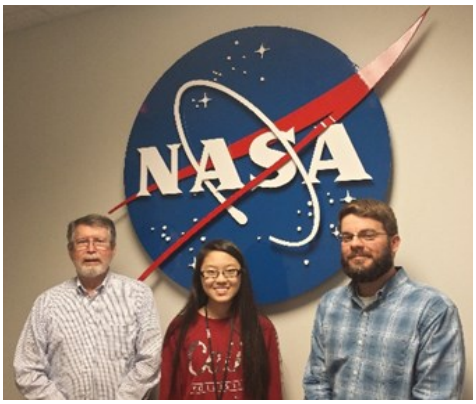
"Going into senior year, I was dead set on majoring in Computer Engineering. I enjoyed my computer science classes, but I did not want to be a "code monkey" for the rest of my life. My view of computer science drastically changed after my mentorship experience. At the MITRE Corporation. I was able to experience a collaborative lab environment that shifted what I thought computer scientists did. They were solving real world problems. My mentor invested a lot of his time teaching me what I needed to know for my project. He showed me how much fun computer science can be. Because of my experience at MITRE, I will be majoring in Computer Science. I am excited to be able to continue working at MITRE over the summer through an internship as a software developer."

Emily will be attending Liberty University.

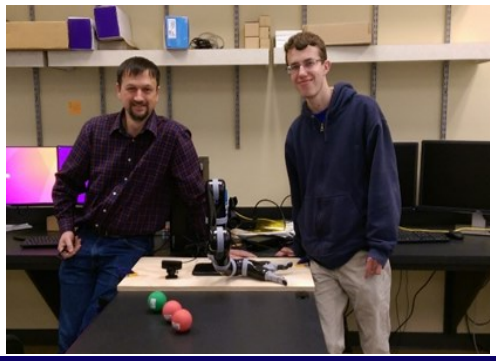
Mentorship Experiences



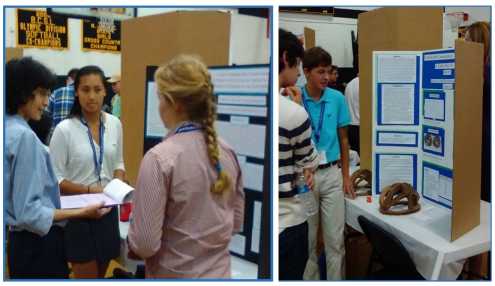


Conferences and Presentations

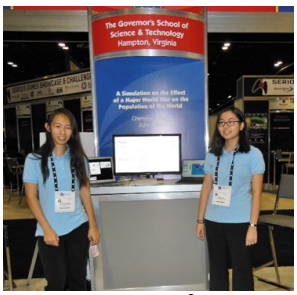
Tidewater Science & Engineering Fair
Old Dominion University

Institute for Creativity, Arts, & Technology
Virginia Tech

VA Junior Science & Humanities Symposium
James Madison University



National Consortium of Secondary STEM Schools
Hackensack, NJ



Interservice/Industry Technology, Simulation & Education Conference
Orlando, FL

Academic eXploration Outreach for Neuroscience
Hampton University

THE GOVERNOR'S SCHOOL for SCIENCE AND TECHNOLOGY

The Governor's School for Science and Technology
520 Butler Farm Road
Hampton, Virginia 23666
(757) 766-1100
Website: www.nhrec.org/governorsschool

Research: Key Component of the GSST Student Experience

A primary goal of the GSST is to provide students with an opportunity to conduct serious scientific research, engineering design, or computer programming projects.

All students take a junior-year course in Research Methods and Ethics, which introduces them to research methodology, statistics, critical thinking skills, and the skills of scientific writing and presentation. In the junior year, all students prepare a science fair project for submission to the Tidewater Science Fair. Students are encouraged to take their work to additional state and national competitions.

In their senior year, students design and conduct a year-long research project under the direction of a professional in their field of interest. The field component is supported by an in-school course which guides students through the entire process, from the selection of a problem to the final presentation. Major aspects of the mentorship experience include: preparation of a formal written proposal for their project, oral presentation of the proposal and a status report at mid year to GSST faculty, a final research document, and presentation of final results to a panel of professionals in appropriate fields at the GSST Spring Symposium. In addition, many students present their findings at local, regional, and national science competitions and symposia. Exceptional work has been published in professional journals.

Research sites that have participated in the GSST Honors Research/Mentorship program included NASA Langley Research Center, Thomas Jefferson National Accelerator Facility, Virginia Institute of Marine Science, College of William & Mary, Hampton University, Christopher Newport University, Virginia Living Museum, local engineering firms, hospitals, and numerous of medical and professional specialists.

New Horizons
REGIONAL EDUCATION CENTERS