Apr 27th, 2021 - Apr 29th, 202112:00 AM

16th Annual Undergraduate Research Conference Abstract Book

Missouri University of Science and Technology

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

16th Annual Undergraduate Research Conference

Making new molecules in the chemistry laboratory requires great skills and finding out whether a synthesis was successful marks the exciting coda of a chemist's day. Nuclear Magnetic Resonance (NMR) spectroscopy is the key method for structural analysis and researcher at Missouri S&T's Department of Chemistry can rely on the new 400 MHz liquid state NMR spectrometer for their analyses.
From left: Brian Jameson (PhD '23), Kaidi Yang (PhD '21), Kari Knobbe (BS '21), and Harmeet Bhoday (PhD '23).

A celebration of experiential learning at Missouri S&T

April 27-29, 2021

Virtual Event via Zoom

16th Annual
Undergraduate Research Conference
April 27-29, 2021

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Conference Judges

The Office of Academic Support wishes to thank the faculty, staff, and students for their valuable contributions to the 16th Annual Missouri S&T Undergraduate Research Conference.

Dr. Diana Ahmad of History & Political Science

Dr. Lana Alagha of Mining & Nuclear Engineering

Dr. Syed Alam of Nuclear Engineering & Radiation Science

Dr. Venkata Allada of Engineering Management & Systems Engineering

Dr. Casey Canfield of Engineering Management & Systems Engineering

Dr. Alex Chernatynskiy of Physics

Dr. Petra Dewitt of History & Political Science

Dr. David Duvernell of Biological Sciences

Dr. Arezoo Emdadi of Materials Science & Engineering

Dr. Rainer Glaser of Chemistry

Dr. Sarah Hercula of English & Technical Communication

Dr. Abdulmohsin Imqam of Geosciences & Geological & Petroleum Engineering

Ms. Rachel Morris of Academic Support

Dr. Chaman Sabharwal of Computer Science

Dr. Julie Semon of Biological Sciences

Dr. Ting Shen of Psychological Science

Dr. David Westenberg of Biological Sciences

Ms. Dedie Wilson of Academic Support

Dr. Maciej Zawodniok of Electrical & Computer Engineering

Oral Presentations

Tuesday – April 27, 2021

Arts and Humanities – zoom link, https://umsystem.zoom.us/j/96089572378

Name	Department	Time	Location
Anthony Watson	History	1:00 – 1:15 pm	Zoom

Engineering – zoom link, https://umsystem.zoom.us/j/96089572378

Name	Department	Time	Location
Derrick Barger	Mechanical Engineering	1:15 – 1:30 pm	Zoom
Maria Galbraith	Engineering Management	1:30 – 1:45 pm	Zoom
Peter Holtmann	Electrical Engineering	1:45 – 2:00 pm	Zoom

Sciences – zoom link, https://umsystem.zoom.us/j/96089572378

Name	Department	Time	Location
Sean Anderson	Physics	9:00 – 9:15 am	Zoom
Daniel Greenan	Chemistry	9:15 – 9:30 am	Zoom
Steven Karst	Physics	9:30 – 9:45 am	Zoom
Anthony Lonsdale	Physics	9:45 – 10:00 am	Zoom
Darren Schmidt	Applied Mathematics	10:00 – 10:15 am	Zoom
Megan Sly	Chemistry	10:15 – 10:30 am	Zoom

Sean Anderson

Department: Physics
Major: Physics
Research Advisor: Aleksandr Chernatynskiy
Advisor Department: Physics

Funding Source: Department of Energy's Nuclear Energy University Program

The Effect of Irradiating AlN on its Dielectric Properties

Aluminum Nitride is an active element of sensors that monitor the performance and well-being of the nuclear reactors due to its piezoelectric properties. Yet, the variations of its properties under irradiation are largely unexplored. Here, we report the results of the molecular dynamics simulations of the structural changes in AlN under irradiation via the knock-on atom technique. By creating and evolving the irradiation cascades due to energetic particle interaction with the atom of the crystalline lattice we determine the rate of the defect production as a function of the deposited energy. Further, we determine a displacement energy, a key characteristic that describes how efficient the defect production in the given material is. Comparison with the isostructural GaN is provided.

Sean Anderson is a Senior Physics major from Warrensburg, Missouri, and is also pursuing a minor in Computer Science. He is an active member of the Socity of Physics Students on campus, and serves as their Vice President. It is with the SPS that he first heard of and got the chance to work with Professor Chernatisnkiy, and worked with him for a semester before joining the OURE program.. He plans to graduate in 2022, and plans to move on to Grad School after that.

Derrick Barger

Department: Mechanical Engineering
Major: Mechanical Engineering w/ aerospace engineering minor
Research Advisor: Dr. Jonghyun Park
Advisor Department: Mechanical Engineering

Funding Source: National Science Foundation

Thermal modeling of li-ion batteries using SP+3D model

An ideal battery model must gather sufficient electrochemical data about the system while remaining being computationally efficient. To prevent failure from thermal runaway, understanding the thermal characteristics of a battery is essential.

To achieve this, we have developed a single particle (SP) model, a simplified but accurate approach to battery modeling, and compared this to a previously designed 3D model. After validating the battery electrochemistry, equations were introduced to calculate the heat generation with a coupled 3D heat transfer component to provide data on the cell temperature. This same model was used to simulate a multi-cell pack.

The results indicate close electrochemical and thermal accuracy between the two models at multiple discharge rates. However, the SP+3D model can reach these results more than 60 times faster than the 3D model. By more efficiently simulating the battery discharge, the SP+3D model can be applied to a variety of future test scenarios.

Derrick Barger is a mechanical engineering student that is passionate about reducing our reliance on fossil fuels. After riding his bicycle across the United States over the summer of 2019, he learned about the power of clean energy firsthand and wanted to make a difference. He joined this research project hoping to make a contribution to the field of battery science, and through the guidance of his mentors Dr. Park and Dr. Landers, Derrick has learned about the research process and is focused on designing simulated battery models to be used for experimentation. Derrick plans to pursue graduate school in Norway at the University of Tromso after graduating from Missouri S&T.

Department: Engineering Management and Systems Engineering
Major: Engineering Management
Research Advisor: Dr. Casey Canfield
Advisor Department: Engineering Management and Systems Engineering

Funding Source: Missouri Department of Transportation

Behavioral Science Can Increase Zipper Merge Usage

Research demonstrates that zipper merges (or late merges), under heavy traffic conditions, are safer and faster than a traditional early merge. In implementation, zipper merges can be less efficient due to a lack of compliance on the part of drivers, often more accustomed to early merging. Behavioral science has been applied to a many transportation-related challenges, such as increasing seat belt usage and decreasing drinking and driving but has not yet been applied to the zipper merge. We have identified six relevant behavioral science strategies including (1) social norms, (2) appeals to reason, (3) emotional appeals, (4) humor, (5) memory activators, and (6) information versus instructions. We coded the presence of these strategies in existing communications from U.S. state Departments of Transportation. We report our findings for road signs and web-based public communications. Although there were trends across each category, there was high variation between states. This review suggests that there is a need to further investigate the potential of more behaviorally informed communications to increase compliance for zipper merges.

Maria Galbraith is a senior studying Engineering Management with an emphasis in Management of Technology. She is an active member of the Rolla Catholic Newman Center, as well as working on this research project with Dr. Canfield since June. When not working or studying, Maria enjoys exploring the beautiful Rolla outdoors, singing or listening to music, acting with the local Fine Linen Theatre, and making and drinking coffee. After college, she plans to move to Kansas City and find a job she loves.

Daniel Greenan

Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Charliklia Sotiriou-Leventis
Advisor Department: Chemistry

Funding Source: National Science Foundation (NSF), Army Research Office (ARO)

Amorphous Carbon Aerogels from Xerogel Powders

Carbon aerogels are well known for their high surface areas and high porosities. Their applications have been demonstrated in a wide range of areas such as CO2 capture, electrodes for electrochemical cells, etc. They are typically made from pyrolysis of carbonizable polymeric aerogels, which in turn are synthesized via sol-gel methods. Preparation of those polymeric aerogels involves supercritical fluid drying of wet-gels by replacing the pore-filling solvent with liquid CO2 that can be vented off as a gas, thus allowing pores to retain their shape and size. In contrast, here a new alternative route is proposed for the synthesis of carbon aerogels from xerogel powders, which allows to speed-up the solvent exchange process and bypasses the supercritical fluid drying, resulting in time, energy, and materials efficient methodology for fabricating porous carbons. In this new method, crosslinked silica xerogel powders were prepared via free-radical surface-initiated polymerization of acrylonitrile on the network of silica suspension. Alternatively, cross-linked silica xerogel powders were prepared with a carbonizable polyurea derived from the reaction of an aromatic triisocyanate with different functional groups on the surface of silica suspension. Wet-gel powders were dried under vacuum, compressed into pellets and were then aromatized, pyrolyzed, and treated with HF and/or CO2 to remove SiO2 particles and/or carbon, creating porosity.

Daniel Greenan is a senior studying Chemistry from St. Peters, Missouri. He has been researching carbon aerogels with Dr. Sotiriou-Leventis since the Fall of 2019. In the Summer of 2019, he researched the causes of pyridoxine dependant epilespy with Dr. Gates. Daniel plans to pursue a PhD in Chemistry and to work in industry afterwards. Outside of research, he was involved in the Mars Rover Design Team for two years, and he enjoys spending his free time outside playing basketball or running

Peter Holtmann

Department: Electrical and Computer Engineering
Major: Electrical Engineering
Research Advisor: Dr. Jie Huang
Advisor Department: Electrical and Computer Engineering

Funding Source: Army Research Lab

Realtime Sensor for detecting Gallium Infiltration Attack

The proposed research is to create a real-time sensor for detecting aluminum degradation due to gallium infiltration attacks, specifically in military vehicles and structures. Gallium acts as a poison to aluminum, leading to catastrophic failures of structural integrity. The proliferation of educational material on this subject raises security concerns for the United States Military, where nearly all structures utilize aluminum due to its high-strength, light-weight profile. Utilizing Fiber-Bragg Grating (FBG) sensors and machine learning techniques, this research aims to develop a real-time sensor to detect these attacks.

Peter Holtmann is a graduating senior in Electrical Engineering. Peter is part of the Lightwave Technology Lab, a lab dedicated to the research and development of optical and microwave sensors applied to energy, intelligent infrastructures, clean-environment, and biomedical applications. Besides this, Peter is involved with the Intelligent Systems Center, where he has worked as the webmaster, and New Student Programs, where he is a PRO Leader. His research interests include applying machine learning and artificial intelligence to engineering applications, sensing techniques, and optics.

Steven Karst

Department: Physics
Major: Physics
Research Advisor: Dr. Shun Saito
Advisor Department: Physics

Funding Source: Missouri S&T National Merit Semifinalist Scholarship Package

Machine Learning Optimizes a Survey of Dark Energy

Measuring the history of cosmic expansion via the Baryon Acoustic Oscillation (BAO) scale from a three-dimensional galaxy map is a well established technique to probe the nature of dark energy. In fact, a forthcoming galaxy redshift survey, the Subaru Prime Focus Spectrograph (PFS), is designed mainly for this purpose. An essential optimization problem in such galaxy redshift surveys is the target selection. Namely, it is not clear how we should select our targets to maximize the number of galaxies which provide successful redshift measurement in a desired cosmic epoch, while avoiding other galaxies. Taking PFS as an example, we apply a modern machine learning algorithm to the target selection problem. In this project we analyze how well machine learning could optimize the PFS survey target selection compared to more conventional methods, and show that our new approach could play a crucial role in understanding dark energy.

Steven Karst is a junior at Missouri S&T majoring in Physics. Originally from Ballwin, Missouri, he is interested in AI development and astrophysics, and was introduced to the Institute For Multi-Messenger Astrophysics and Cosmology through the National Merit Semifinalist Package. He is active in several organizations around campus including the Underwater Robotics Team, the local chapter of the Society of Physics Students, STARS, ACM Arcade, ACM Game, and the MST FIRST Alumni Association, and also participates in weekly journal discussions with several cosmologists in the Midwest.

Anthony Lonsdale

Department: Physics
Major: Physics
Research Advisor: Dr. Aleksandr Chernatynskiy
Advisor Department: Physics

Funding Source: OURE

Effect of Magnetic Moment on Thermal Conductivity

Insulating non-magnetic solids conduct heat through the lattice vibrations, also colloquially known as phonons. However, in magnetic solids, additional channel for the heat transport is available through the interaction of magnetic moments with each-other. On the other hand, lattice vibrations couple with the magnetic moments on the atoms and thus provide additional resistance to the heat flow. Currently, there is no complete understanding of the magnitudes of these contributions and the overall effect of the magnetic contribution is largely unknown. Using a combination of spin dynamics and molecular dynamics simulations, we simulated the contribution of the magnetic subsystem to the lattice thermal conductivity across ferromagnetic to paramagnetic transitions in elemental Iron. Application of the approach to the anti-ferromagnetic materials are discussed on the example of technologically important material, uranium dioxide.

Anthony Lonsdale is a Junior undergraduate studying Physics at Missouri S&T. He is from Kansas City, Missouri and his interests include software development, financial markets and algorithmic finance. Anthony is an Eagle Scout, National level swimmer and entrepreneur. He started working with Dr. Chernatynskiy in the fall of 2019 under the FYRE program and presented his research for the Fuller Research Competition in the spring of 2020. He is currently working under the OURE program, and plans to continue until graduation. Anthony plans on developing a startup financial services company and working in the investment banking industry upon graduation.

Darren Schmidt

Department: Mathematics and Statistics
Major: Applied Mathematics and Computer Science Dual Major
Research Advisor: Dr. Insall
Advisor Department: Mathematics and Statistics

Funding Source: OURE Funding

Analysis of an Integral Metric on Hyperspaces

In this paper, we will be investigating how to compute the integral distance defined by Dr. Insall and Dr. Charatonik, and we will analyze the results from this computation. We develop a way to compute the integral distance by using Monte-Carlo Integration, and we analyze the time complexity and the error that results from this method of computation. We also investigate when this distance function is a metric, and how this metric compares to some other common metrics.

Darren is a senior from Fenton, Missouri studying applied mathematics and computer science. He is currently the president of the Academic Competition Organization at Missouri S&T. He plans to attend the University of Florida after graduating for a PhD in mathematics studying algebraic topology

Megan Sly

Department: Chemistry
Major: Chemistry BS
Research Advisor: Dr. Klaus Woelk
Advisor Department: Chemistry

Funding Source: OURE

Chemically Resolved Nuclear Spin Relaxation

In Nuclear Magnetic Resonance (NMR) Spectroscopy, the excitation of nuclear spins is used to generate spectra of radiofrequency resonance signals. The signal frequencies are typically used to determine the structure of chemical compounds, while the relaxation of the spins to thermodynamic equilibrium provides useful information about the molecular vicinity of a material. When a chemical compound occurs in different molecular environments, a single resonance signal can have multiple relaxation times. To quantify how much material is in how many different environments, a multi-exponential analysis was developed resolving resonance signals and relaxation times in two-dimensional contour plots. Samples of known resonance signals and relaxation times were used to test the implementation of the new technique. For a new type of polymer hydrogels, the contour plots provide information about how much of the gel-forming water is freely moving as bulk solvent and how much is restricted in motion as molecularly bound water.

Megan is currently finishing her sophomore year at Missouri S&T as a chemistry student. This is her first year doing undergraduate research on NMR spectroscopy. She plans on graduating in May of 2023 with her B.S. in Chemistry with no solidified plan for after graduation.

Anthony Watson

Department: History and Political Science
Major: History
Research Advisor: Dr. Petra Dewitt
Advisor Department: History

Funding Source:

A study of the modern progressive movement

From 1972 to 2020, the progressive wing of the Democratic party has evolved and adapted to follow a changing American society that looks drastically different today than the one that overwhelmingly rejected George McGovern in 1972 in favor of President Nixon. From being blamed for dragging down Democratic candidates through the 1970s and '80s to being sidelined by the "New Democrat" movement headlined by President's Clinton and Obama to resurging back into popularity in 2016 led by Bernard " Bernie" Sander's run for the Democratic nomination, the movement is now as strong as ever. This research looks at how progressives within the Democratic party attempted to influence the party's national platform from 1972 to 2020, how progressives managed to rise to prominence within the party in 2016, and what their sudden rise in political power and influence says about American society today.

Anthony Watson is a graduating senior in the Missouri S&T History and Political Science department pursuing a Bachelor of Science in History with minors in Psychology and Political Science. His areas of interest are in modern American politics and 19th and 20th century European history. He plans on hopefully attending graduate school in the fall studying political and military policy in the realms of national defense. He is currently the Vice President of Academic Affairs for Missouri S&T's Student Council.

Poster Presentations

Wednesday – April 28, 2021

Arts and Humanities – zoom link, https://umsystem.zoom.us/j/94911494682

Name	Department	Time	Location
Nikola Andric	Computer Science	1:00 – 1:15pm	Zoom
Dylan Clay	Aerospace Engineering	1:15 – 1:30pm	Zoom
Brian Lafser	History	1:30 – 1:45pm	Zoom
Jessi Schoolcraft	Environmental Engineering	1:45 – 2:00pm	Zoom

Engineering – zoom link, https://umsystem.zoom.us/j/94185412483

Name	Department	Time	Location
Casey Hines	Engineering Management	2:30 – 2:45pm	Zoom
James Kirtley	Chemical Engineering	2:45 – 3:00pm	Zoom
Hattie Matthews Divyesh Shelar	Architectural Engineering	3:15 – 3:30pm	Zoom

Research Proposal – zoom link, https://umsystem.zoom.us/j/94185412483

Name	Department	Time	Location
Joshua Carpenter	Geology and Geophysics	3:30 – 3:45pm	Zoom

Sciences – zoom link, https://umsystem.zoom.us/j/97241073305

Name	Department	Time	Location
Arpan Das	Computer Engineering	9:00 – 9:15am	Zoom
Isabella Feltenstein	Chemistry	9:15 – 9:30am	Zoom
Elizabeth Feth	Biological Sciences	9:30 – 9:45am	Zoom
Natalie Gardner	Chemical Engineering	9:45 – 10:00am	Zoom
Bethany Huinker	Biological Sciences	10:00 – 10:15am	Zoom
Zachary Miller	Physics	10:15 – 10:30am	Zoom
Nathan Skelton	Computer Science	10:30 – 10:45am	Zoom

Social Sciences – zoom link, https://umsystem.zoom.us/j/94911494682

Name	Department	Time	Location
Jessica Frame	Psychology	2:00 – 2:15pm	Zoom

Nikola Andric

Department: Computer Science
Major: Computer Science
Research Advisor: Dr. Diana L. Ahmad
Advisor Department: History and Political Science

Funding Source: Dr. Diana L. Ahmad

A Man Out West is a Man

The goal of this research is to analyze who the cowboys were and show how the standard set for the cowboy in novels remained consistent during the period between 1902 and 1953. The presentation allows readers to think of their idea of a cowboy and then compare it with the idea of the cowboy drawn from the books used in the research. It is a great opportunity to find out who the perfect cowboy is, what cowboys' relationships with their horses look like, what is considered good, and what is considered evil during those fifty years. Above all, the most important thing drawn from the books is the moral life lessons that will be passed to the readers of the novels, as well as the poster, with hope that they will embrace the same values.

Nikola Andric is an international student from Serbia majoring in computer science. Nikola came to Missouri S&T as a member of the Missouri S&T basketball team. He also played basketball for Vincennes University in Indiana and is currently a member of the S&T Campus Security Officer unit and a Department of Computer Science as a research assistant. His main goal is to become a computer scientist with a company involved in innovation. Nikola is a hard working person, ready to help and influence others. In addition, he was also a member of a Missouri S&T Mars Rover Design team where he contributed to developing software to control the rover. Nikola loves everything he does and tries to influence people to do the same!

Joshua Carpenter

Department: Geosciences and Geological and Petroleum Engineering
Major: Geology & Geophyiscs
Research Advisor: John Hogan
Advisor Department: Geosciences and Geological and Petroleum Engineering

Funding Source: Unfunded

Dynamic Topography of the St. Francois Mountains

The purpose of this research project was to search for evidence of relict topographic surfaces in the St. Francois Mountains that preserve a history of regional and/or global forces. To accomplish this, topographic cross-sections were taken in Google Earth to examine changes in the region's topography with focus towards the following features: sub-horizontal surfaces, knickpoints, and valley floors. Elevation data was then collected and plotted in Excel. This revealed sub-horizontal surfaces between elevations of ~1780-1545 ft; knickpoints between ~1700-900 ft; and valley floors at ~1470-1350 ft. and ~1200-900 ft. The sub-horizontal surfaces are interpreted as relict peneplains preserved during periods of reduced geologic activity. The knickpoints reflect intervals of increased erosion caused by uplift or base-level changes. Bimodal valley floors may reflect similar base-level changes on a local scale. Future research will involve field work and the use of geographic information systems (GIS) for more effective collection and analysis of data. The field of study may expand to other sub-provinces of the Ozark Plateau to compare similar topographies.

Joshua Carpenter is a sophomore majoring in Geology & Geophysics with an interest in geographic information systems and their various applications. He is a dedicated Air Force ROTC cadet and member of the C.L. Dake Geological Society. In his free time, he enjoys fencing, reading, and playing video games.

Dylan Clay

Department: Mechanical and Aerospace Engineering
Major: Aerospace Engineering
Research Advisor: Dr. Diana Ahmad
Advisor Department: Humanities and Social Sciences

Funding Source: Dr. Diana Ahmad

Fear to Cooperation: A Brief History of the Space Race

In 1957, the United States and the Soviet Union engaged in a space race that, ironically, resulted in joint United States-Soviet Union missions with the 1975 Apollo-Soyuz program. Starting in the 1950s, the Cold War between the two nations led to a feeling of unease from the world populace, especially with uncertainty surrounding the superpowers' capabilities. In the late 1950s, the United States feared that they would lose the race to space because of Sputnik's success, but American efforts led to far greater success with American Astronauts landing on the moon, effectively ending the race to space. With both nations successful, a decision was made to work together in the Apollo-Soyuz program. This unprecedented collaboration will be shown by reconstructing a brief timeline of events that preceded the launch of Sputnik and show the fallout of this aerospace achievement on the psyche of the American populace. Using archives newspapers and primary sources, I will describe how Americans originally believed they were falling behind, yet came to win the race.

Dylan Clay is a senior in aerospace engineering specializing in orbital mechanics. He is from the Springfield, Missouri area and grew up in the rural parts of the metropolitan area. He is passionate about his field from a combination of childhood interest and excitement about the field as it develops. He enjoys working in the satellite lab on S&T's campus and learning about the applications of engineering in space. He is excited to continue his development with the astronautics sector of aerospace and how to continue to push the community to success.

Arpan Das

Department: Computer Science
Major: Computer Engineering
Research Advisor: Dr. Sajal Das
Advisor Department: Computer Science

Funding Source: NSF

Twitter Sentiment Analysis of Major US Topics

The user base for social media platforms have seen sharp increases in nearly every year since their inception, to the point where it is a part of a daily routine in today’s society. Social media provides a powerful public platform for people to express their opinions and intentions regarding almost any topic. The objective of this study was to determine how the opinions of topics related to United States politics shift over the course of the election cycle and through the inauguration of the next president. These topics included the opinions of major events such as the major presidential candidates Joe Biden and Donald Trump, appointment of Supreme Court Justice Amy Coney Barrett, the #BlackLivesMatter movement, the 2021 Storming of the United States Capitol, and the controversy surrounding mail-in ballots. The Twitter API was accessed using the tweepy library to survey public opinion and collect the sample size of over 1 million tweets. The data was then analyzed using the nltk and text2emotion libraries. The sentiment of the tweets were analyzed by search keyword, by date, and by sentiment over time by keyword.

Arpan Das is a senior studying Computer Engineering at the Missouri University of Science and Technology, and is expected to get his B.S. in May 2021. Along with being an undergraduate research assistant, he also works for New Student Programs as a PRO Leader. He is also a member of the Missouri S&T Band and Orchestra, playing the violin, and is a member of the Honorary Band Fraternity Kappa Kappa Psi.

Isabella Feltenstein

Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Manashi Nath
Advisor Department: Chemistry

Funding Source: National Science Foundation(Department of Materials Research)

Water Splitting by Mixed Chalcogenide Catalysts

The depleting supply of fossil fuels has led to deeper investigation of water-splitting as a sustainable energy source. Specifically, using transition metal chalcogenides to catalyze the water-splitting reaction through oxygen and hydrogen evolution reactions. While the decreasing electronegativity of the chalcogenide group increases their activity, it also decreases their stability, leading to the investigation of mixed anion chalcogenides in order to keep both the stability and activity high. This research will further the understanding and efficiency of water-splitting for energy storage and inspire more research in the future. In these experiments, cobalt telluroselenide (Cox-Tey-Sez) and nickel telluroselenide (Nix-Tey-Sez) catalysts were created and their oxygen evolution activity and stability were recorded, and it was observed that the catalytic activity of the telluroselenides was higher than the selenide, but lower than the telluride by itself, because of the increase in anion electronegativity which decreased its catalytic activity.

Isabella Feltenstein is a sophomore at Missouri S&T majoring in Chemistry with a Biochemistry emphasis. Her interest in research began when she received her first microscope as a young girl, and has progressed from there. On campus, she is a member of Chi Omega sorority, networking chair of the Society of Women Engineers, and runs varsity cross country and track for the miners. In her free time, she enjoys reading, running, and hanging out with friends and family.

Elizabeth Feth

Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Dr. Robin Verble
Advisor Department: Biological Sciences

Funding Source: OURE

Gender and Ethnicity Bias in Wildland Fire Journals

Despite numerous efforts to improve both ethnic and gender diversity, STEM continues to be dominated by white men, particularly in field-based and management-driven disciplines of biology. The Association for Fire Ecology and the International Association for Wildland Fire have both formed diversity and inclusion committees since 2010 to examine and promote a more inclusive and balanced field; however, progress in these arenas can be slow. We examined peer reviewer discrimination against women and ethnic minorities in the International Journal of Wildland Fire in papers published from 2010 to 2019 utilizing the number of days in review compared against the total number of paper citations as a measure of discrimination. We found that the ethnicity and gender of the paper's first author both influenced the time that a paper spent in review, and to a lesser extent, the gender and ethnicity of the paper's last author also had an effect.

Elizabeth Feth is a senior Biological Sciences major with an interest in Conservation and Ecology. Her hometown is Beaufort, Missouri where she lives on a small farm that spurred her passion for animals and being outdoors. On campus she is the Vice President of the National Society of Leadership and Success (NSLS), and the President of the Equestrian Club, a member of Phi Sigma Biological Honor Society and a member of the Ceramic Artists at Missouri S&T (CAST). In her spare time, she enjoys volunteering at Camp David and the Rolla Mission as well as spending time with her barn family.

Jessica Frame

Department: Psychological Sciences
Major: B.S. Psychology
Research Advisor: Dr. Jessica Cundiff
Advisor Department: Psychological Sciences

Funding Source: FYRE

Evaluating a Game Designed to Teach Gender Bias

Gender bias is prevelent in today's work force; while it doesn't look like it did a few decades ago, it is still very critical to detect and address it. With how unconcious and covert gender bias can be, it is difficult to teach in a normal enviornment without some backlash and varying information due to teaching styles, leading to differed outcomes of processing information. The WAGES Project, WAGES standing for Workshop Activity for Gender Equity Simulation, is an interactive research-based activity that showcases how gender bias within the workforce is relevant in a manner different than that of a basic powerpoint lecture. The board game highlights how the effects of unconcious bias unfolds over time within a job setting for different groups of people. Random assignment was used within the experiment to place participants in either a powerpoint lecture learning enviornment or the WAGES simulation. After the initial testing, data was collected 3 months later where participants were asked to recall themes. We coded these responses for the overall learning outcome and found no statistical significance. While powerpoint lectures were able to better teach intersectionality, WAGES was seemingly much more engaging for participants. During presentation, strategies for implementation will be discussed.

Jessica Frame is a current student at Missouri S&T, majoring in Psychological Sciences with working minors in Biology and Chemistry. This past semester she has participated in her first research opportunity with Dr. Cundiff. Jessica is passionate about her chosen major and plans to further her education past her bachelors to persue a Ph.D in Clinical Psychology in hopes to become an established researcher and to better understand the human mind in the hopes to better the lives of others.

Natalie Gardner

Department: Sciences
Major: Biochemical Engineering
Research Advisor: Matthew Thimgan
Advisor Department: Biological Sciences

Funding Source: NIGMS

Effects of Sleep Deprivation on Learning in Fruit Flies

The fruit fly Drosophila Melanogaster is an optimal research specimen when observing the effects of sleep deprivation on spatial learning. A fly's sleep can be tracked using locomotion while it is undisturbed and while it undergoes sleep deprivation. To measure a fly's visuospatial awareness, a region at a comfortable 24 degrees Celcius, among the rest of the arena yielding an uncomfortable temperature ranging from 36-37 degrees Celcius, is fit with a specific visual cue that the fly is able to identify. This region, along with it's visual cue, is rotated around the arena every 3 minutes, and the amount of time it takes for the fly to reach this region is recorded. By comparing a sleep deprived fly to a fly with a normal circadian rhythm, one can observe the effects of sleep deprivation the night before implementing the assay. The objective of this research is to investigate the crucial role of healthy sleep in spatial learning.

Natalie Gardner is a junior Biochemical Engineering Major pursuing a minor in Biomedical Engineering. Originally from Nixa, Missouri, she attended Colorado State University her freshman year before transferring to S&T her sophomore year. In that time she has been an avid member of The Society of Women Engineers, including holding the Fundraising chair her first year. Her undergraduate research is coordinated by Dr. Matthew Thimgan in the Biological Sciences department at S&T. She hopes to incorporate her passion for the biological sciences and her aptitude in engineering to work towards helping others in the medical field.

Casey Hines

Department: Engineering Management & Systems Engineering
Major: Engineering Management
Research Advisor: Dr. Casey Canfield
Advisor Department: Engineering Management & Systems Engineering

Funding Source: National Science Foundation - NSF

CO-Designing AI Tools to Reduce Kidney Discard

Currently, there are about 94,000 people on the kidney transplant waiting list. Less than one-third will receive a new kidney this year. Unfortunately, some kidneys that could have been transplanted into a new recipient, end up being discarded. The largest group of discarded kidneys are ones that are high-risk. At present, an organ procurement organization will send out offers for an available kidney to transplant centers. These offers go out in chronological order following the kidney transplant waiting list. A single high-risk kidney could potentially go through hundreds of offers before being accepted by a transplant center. The longer the kidney is outside of the donor’s body, the less likely it can be transplanted successfully. Therefore, we need a better approach to make this process more efficient. Through the use of artificial intelligence, our team hopes to find a way to help reduce kidney discard, and help patients in need of a new kidney, find a match sooner. In order to develop an effective AI system, we hosted a virtual design-a-thon workshop with stakeholders from transplant centers, organ procurement organizations, and transplant patients. By completing design activities, these stakeholders helped us describe the potential solution space and prioritize our development efforts.

Casey Hines is a senior studying Engineering Management with an emphasis in Industrial Engineering. After graduation, Casey will be attending graduate school to pursue a master's degree in Systems Engineering. He has been an active member of Engineers Without Borders for seven semesters while at MST. Additionally, He is an active member of the Sigma Chi Fraternity. When not working on schoolwork, he enjoys spending his time outdoors flying his drone, hiking, or spending time with friends.

Bethany Huinker

Department: Biological Sciences
Major: Biological Sciences
Research Advisor: Katie Shannon
Advisor Department: Biological Sciences

Funding Source: OURE

Protein-protein interaction important for cytokinesis

During cytokinesis a ring containing actin and myosin forms and contracts, pinching the cell into two daughter cells. In budding yeast cells the gene Iqg1 is a gene necessary for proper actin ring formation and contraction. We have shown that Iqg1 interacts with the yeast formin proteins. This project will determine which domains of Iqg1 mediate the protein-protein interactions, which is important to understand the function of the binding between Iqg1 and formins in cytokinesis. We will use a GST pull down assay to study the binding of Iqg1 to the yeast formins Bni1 and Bnr1. We will compare binding of formins to full length Iqg1 to the ability of formins to bind deletion mutants of Iqg1. The expected outcome is that using the assay, we will identify which region or regions of the Iqg1 protein are required for binding to the formins. This area of research is important for new therapeutic targets in cancer treatment.

Bethany Huinker is a sophomore in Biological Sciences at Missouri S&T. She is from St. Louis, Missouri. She is involved in the genetic engineering design team on campus. After graduation, Bethany is interested in working in genetic research on familial disorders.

James Kirtley

Department: Chemical and Biological Engineering
Major: Chemical Engineering
Research Advisor: Xinhua Liang
Advisor Department: Chemical and Biological Engineering

Funding Source: National Science Foundation

Recovery of Degraded Lithium Ion Cathode Particles

This project focuses on recovering the cathode materials of lithium ion batteries through atomic layer deposition (ALD) thin film coating. In industry, when a cathode material for a lithium ion battery are stored, it reacts with CO2 and moisture in the air creating Li2CO3 and LiOH on the particle surface. The harmful substances on the surfaces have a negative impact on battery performance and battery life. In this study, we found that when Li2Ni0.8Mn0.1Co0.1 (Ni-Rich NMC) is exposed to a high amount of moisture it degrades and the performance is reduced. For example, the discharge capacity of Degraded Ni-Rich NMC (DNMC) was much lower than the discharge capacity of pristine Ni-Rich NMC. When applying Al2O3 ALD thin film coating on the surface of DNMC particles, the discharge capacity was able to be restored. According to the electrochemical performance, the 2Al-DNMC (2 cycles of Al2O3 ALD) was able to perform at a similar level as the non-degraded NMC. The increase in performance is likely due to the surface of the DNMC being corroded when exposed to moisture and Al2O3 ALD thin film coating can fix the corroded part, leading to the recovery of discharge capacity. With an Al2O3 ALD film thicker than 2 cycles of ALD, the performance of DNMC was further improved. We will study the coating to figure out the best ratio of coating and then study the mechanism that is driving the increase in performance.

Jimmie Kirtley is a motivated student who is always eager to learn more about a given topic. While he is passionate about school he also has interests in athletics, service, and the outdoors.

Brian Lafser

Department: History/Political Science
Major: History
Research Advisor: Dr. Ahmad
Advisor Department: History/Political Science

Funding Source: Self

Unhappy Feet: Fred's Experience with Americans

"Unhappy Feet" is an examination of the environmental impact of human settlement in Antarctica, and the effects that human-influenced Global Warming have had on some of its inhabitants. As told through the perspective of Fred, an Emperor Penguin, who developed a personal relationship with the author of this project during his nineteen month stay on the Southern Continent. It also points out flaws in the Non-Interference policies surrounding interaction with animals that have been put in place by the United States Antarctic Program. The aforementioned flaws are discussed through the use of primary sources, eyewitness accounts and pictures taken from the author's personal collection.

Brian Lafser comes from a small family from St Louis Missouri. He is a Marine Corps Veteran and Senior Undergrad with a major in history at Missouri S&T. He has a two year old German Shepherd named Eden that demands most of his attention, and has a passion for painting miniatures, tabletop games and video games. He has a strong fondness for the cold and visited the South Pole a couple times, and once shook the hand of President Barack Obama.

Hattie Matthews

Joint project with Divyesh Shelar

Department: Civil, Architectural, and Environmental Engineering
Major: Architectural Engineering
Research Advisor: Dr. Stuart Baur
Advisor Department: CArEE

Funding Source: Opportunities for Undergraduate Research Experience

Solar Panel Recycling in The United States

The last decade has seen enormous growth in the solar industry across the globe. According to the International Renewable Energy Agency (IREnA) in 2015 solar energy produced about 222 gigawatts worldwide with expected growth to top 4500 gigawatts by 2050. By comparison the United States is expected to see an additional 10.6 gigawatts in 2018. The Midwest has seen similar growth in the solar industry within the past decade. The problem is the technology used to convert the sun’s rays into electrical energy does not last forever. On average the industry rates a solar panel's life span around 25-30 years. Up to now limited quantities from early installations have been retired. The forecast for such systems will continue to grow. The once small quantities of glass and photovoltaic components will begin to grow from hundreds to thousands to millions of tons of material waste. This research provide a roadmap to the potential growth and opportunity to recycling solar technologies. It also illustrates some of the possible economic barriers including policy, transportation, value, and cost effective processes.

Hattie Matthews is a 22 year old graduating senior in Architectural Engineering. Hattie grew up on a ranch in Muskogee, Oklahoma with her parents and older sister. Her goals include uptaining her professional license and making an impact on our world.

Zachary Miller

Department: Physics
Major: Physics and Applied Mathematics
Research Advisor: Dr. Thomas Vojta
Advisor Department: Physics

Funding Source: Cottrell Seed Award (ResCorp) and National Science Foundation

Tempered FBM with Reflecting Walls

Fractional Brownian Motion (FBM) is a Gaussian stochastic process with long-range correlations and a paradigmatic model for anomalous diffusion. For FBM confined by reflecting boundaries, recent work [1] demonstrated unusual accumulation and depletion of particles close to the walls. In many applications of FBM to physics, chemistry, and beyond, the long-range correlations are cut off (tempered) beyond a certain time scale [2]. Here, we study the behavior of tempered FBM in the presence of reflecting walls. More specifically, we analyze the probability density of tempered FBM on a one-dimensional interval between two reflecting wall.

Zachary Miller is a junior dual major in math and physics who has been doing research work on this project continuously since his sophomore year. He has remained involved on campus in leadership and honors organizations as well as he has been the president of the Society of Physics students since his sophomore year. He has had presented on this very same work to March Meeting, an international physics conference. He is hoping to complete a paper on this work by the end of this semester.

Jessi Schoolcraft

Department: Civil, Architectural, and Environmental Engineering
Major: Environmental Engineering
Research Advisor: Dr. Audra Merfeld-Langston
Advisor Department: Arts, Languages, and Philosophy

Funding Source: OURE

Credibility and Divination in the Age of Reason

Credibility is vital for comprehending the world around us. This is as true today as it was in the 18th century when Diderot and d'Alembert were producing France's first Encyclopédie. Translating articles from this body of knowledge provides insight into public perceptions of credibility. Designed to collect and share knowledge, the Encyclopédie required extensive collaboration among experts and editors. Article topics ranged from philosophy to the arts to physical science. What made these articles credible? Was it the oversight of well-known editors, the use of already verified sources, or the seal of approval from the State? Or was it a mix of these? What if the topics strayed into mystical territory? Numerous articles delve into the realm of divination, exploring types, procedures, and history. How were entries on ophiomancy, pyromancy, alectryomancy, and other types of divination legitimized? What does this reveal about credibility in the Age of Enlightenment?

Jessi Schoolcraft is a junior working toward her Bachelor's degrees in Environmental Engineering and Multidisciplinary Studies. During her time at S&T, she has been active in the Honors Academy and Chi Epsilon, while working as a Student Ambassador for the Office of Admissions. This is her second year participating in the OURE program in the Department of Arts, Languages, and Philosophy and she hopes to continue her work after she comes back from studying and interning abroad in France during the 2021-2022 academic year as part of the Global Engineering Program.

Divyesh Shelar
Joint project with Hattie Matthews

Department: Civil, Architectural, and Environmental Engineering
Major: Architectural Engineering
Research Advisor: Dr. Stuart Baur
Advisor Department: Civil, Architectural, and Environmental Engineering

Funding Source:

Solar Panel Recycling in The United States

The last decade has seen enormous growth in the solar industry across the globe. According to the International Renewable Energy Agency (IREnA) in 2015 solar energy produced about 222 gigawatts worldwide with expected growth to top 4500 gigawatts by 2050. By comparison the United States is expected to see an additional 10.6 gigawatts in 2018. The Midwest has seen similar growth in the solar industry within the past decade. The problem is the technology used to convert the sun’s rays into electrical energy does not last forever. On average the industry rates a solar panel's life span around 25-30 years. Up to now limited quantities from early installations have been retired. The forecast for such systems will continue to grow. The once small quantities of glass and photovoltaic components will begin to grow from hundreds to thousands to millions of tons of material waste. This research provide a roadmap to the potential growth and opportunity to recycling solar technologies. It also illustrates some of the possible economic barriers including policy, transportation, value, and cost effective processes.

Divyesh Shelar is a 32 year old senior pursuing a Bachelor's in Architectural Engineering. He also holds a Bachelor's degree in Business Economics from Southern Illinois University. His plans for the future are to assimilate the knowlege of his two fields and work toward building ecomonically sustainable housing.

Nathaniel Skelton

Department: Computer Science
Major: Computer Science
Research Advisor: Sajal Das
Advisor Department: Computer Science

Funding Source: N/A

Small-Scale Wind Power Prediction

This study is focused on the development of viable power generation modeling for small scale wind power installations. Armed with a viable model, businesses and individuals would have another option to reliably power small-scale buildings or installations. This study defines small-scale wind power turbines as those installed on buildings, or otherwise operating under 30 meters (~100 feet). Both of these installation environments provide inconsistent wind speeds, among other properties, that most wind power models do not address. Through the development of a sample wind turbine and accompanying weather station, multiple methods of prediction have been implemented with varying degrees of success.

Nathan Skelton is a senior studying Computer Science at the Missouri University of Science and Technology, and is expected to get his B.S. in May 2021. Along with his undergraduate research, he is the current CEO of the Missouri S&T Mars Rover Design Team.

Oral Fellows Final Oral Presentation 2020-2021

Thursday – April 29, 2021

Zoom link, https://umsystem.zoom.us/j/93268555793

Name	Department	Time	Location
Zachary Foulks	Chemistry	1:00 – 1:15pm	Zoom
Gladwin Labrague	Chemistry	1:15 – 1:30pm	Zoom
Kaysi Lee	Chemistry	1:30 – 1:45pm	Zoom
Raelynn Twohy	Psychology	1:45 – 2:00pm	Zoom
Dominic Zucchini	Electrical Engineering	2:00 – 2:15pm	Zoom

OURE Fellows Proposal Oral Applicants 2021-2022

Thursday – April 29, 2021

Zoom link, https://umsystem.zoom.us/j/93268555793

Name	Department	Time	Location
Derrick Barger	Mechanical and Aerospace Engineering	9:00 – 9:15am	Zoom
Alex Daniels	Biological Sciences	9:15 – 9:30am	Zoom
Gabrielle Hightower	Biological Sciences	9:30 – 9:45am	Zoom
Gladwin Labrague	Chemistry	9:45 – 10:00am	Zoom
Sara McCauley	Chemistry	10:00 – 10:15am	Zoom
Ethan Prior	History and Political Science	10:15 – 10:30am	Zoom

OURE Fellows Program

Oral Abstracts

Final

Zachary Foulks

Department: Chemistry
Major: Chemistry and Biological Sciences
Research Advisor: Honglan Shi
Advisor Department: Chemistry

Funding Source: NIH

Analysis of Pteridines in Isogenic Breast Cancer Model

The biosynthetic pathways responsible for elevated concentrations of pteridine derivatives in urine samples of women with breast cancer are not well understood. This study aimed to characterize pteridine levels and related metabolic rates in a progressive breast cancer cell line model that included the following lineages: MCF10A (non-cancerous), MCF 10AT (premalignant), and MCF10CA1a (metastatic). Pteridine derivatives were quantified using a previously developed high-performance liquid chromatography – tandem mass spectrometry (HPLC-MS/MS) workflow alongside a newly developed pteridine extraction protocol that together enabled rapid and sensitive simultaneous determination. Intracellular and extracellular pteridine levels were compared across progressive stages of the cell lineages with folic acid and guanosine triphosphate (GTP) precursor dosing. The results of these dosing studies demonstrated that most of the cellularly-created pteridines either remained in the extracellular space or were extracellularly transported, as over 99% of the total pteridine mass in most treatment groups was found in extracellular samples. Additionally, the pattern of pteridine production suggests that there are reactions in the biosynthetic pathway which are altered due to the presence of cancer, suggesting possible cancer-induced changes that can be monitored in future breast cancer diagnostic procedures using only urine samples.

Zachary Foulks is a Super Senior at Missouri S&T who is double majoring in Chemistry and Biological Sciences and double minoring in Biomedical Engineering and Psychology. He has been conducting research with Dr. Honglan Shi for almost 3 years, and he plans on enrolling in an MD/PhD dual degree program after he graduates this May.

Gladwin Bryan Labrague

Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Thomas Schuman
Advisor Department: Chemistry

Funding Source: None

Synthesis of Modified Portland Cement Particles

Portland cement is dehydrated limestone mixed with gypsum (calcium sulfate), which inhibits hydration from instantaneous reaction to approximately five hours. This becomes a problem when the cement 'sets' right in the truck and ruins the truck's mixing drum. At the same time, if cement were to be poured or applied, it takes another roughly another five hours for it to set. Hydration was controlled through surface modification of Portland cement using various combinations of certain compounds. Results show that one layer of compound B dissolved in solvent 2 and thirty-two layers of compound A dissolved in solvent 2 completely retarded the hydration of Portland cement for more than twenty-four hours. Furthermore, using eight and thirty-two layers of compound C dissolved in solvent 6, using four, eight, and thirty-two layers of compound C dissolved in solvent 2, and using thirty-layers of compound A dissolved in solvent 1 can delay hydration reaction for up to at least eight hours.

Gladwin Bryan Labrague is a current junior majoring in Chemistry with emphasis in Polymers and Coatings Science. He currently works as a tutor at the Student Success Center and as a PRO (Preview, Registration, and Orientation) Leader at the New Student Programs of Missouri S&T. Aside from chemistry, Gladwin also likes creative arts. He is currently the president and editor of Southwinds Creative Arts Magazine of the Department of English and Technical Communication at Missouri S&T. On his leisure time, he likes to play tennis and learn about fashion.

Kaysi M. Lee

Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Nuran Ercal
Advisor Department: Chemistry

Funding Source: OURE Fellows

The Effects of Nanodimonds on Tiopronin

In 2019, 65.2 million people suffered from cataracts. Cataracts form when reactive oxygen species (ROS) damage proteins in the lens of the eye, resulting in loss of transparency. High levels of endogenous antioxidants remove most ROS, but the abundance of these antioxidants decreases with age. It is hypothesized that antioxidant drugs may be able to prevent or slow cataract formation when endogenous antioxidant defenses are insufficient. Tiopronin (MPG), an FDA-approved antioxidant drug, has demonstrated some anti-cataract effects in live-cell and animal models. Its effectiveness may be limited by its uptake in the lens, but it could be improved with the use of nanodiamonds (NDs). To investigate how NDs effect MPG's antioxidant activity, 2,2-diphenyl-1-picrylhydrazyl (DPPH) radical scavenging kinetics and cupric reducing antioxidant capacity (CUPRAC) were analyzed for solutions of MPG and suspensions of MPG adsorbed to ND. Methodology was also developed to overcome challenges due to the turbid suspensions of ND. The information gathered from this study will aid in the optimization of ND as an ocular drug delivery platform.

Kaysi M. Lee is a graduating senior of chemistry at Missouri S&T. She began her research career as a freshman in the 2018 FYRE program of the College of Arts, Science and Business (CASB). Her work included several poster presentations at regional and international conferences as well as a talk at the Missouri Academy of Science annual meeting and the Southeastern Undergraduate Research Conference (SURC 2019). Her passion for research was featured in October/November 2018 on the S&T web portal and portrayed in the newspaper St. Louis American. Kaysi now works as an OURE Fellows for Dr. Ercal.

Department: Psychological Science
Major: Biological Sciences and Psychology
Research Advisor: Dr. Amy Belfi
Advisor Department: Psychological Sciences

Funding Source:

Cognitive Effects of Concussions on Student Athletes

In recent years, concussions have become a critical public health issue for athletes at all levels. For this study, we analyzed data from the ImPACT (Immediate Post-Concussion Assessment and Cognitive Testing) collected by the Student Health Center at Missouri University of Science and Technology, a public research university with NCAA Division II athletics. Data were obtained from 125 student-athletes from a variety of sports. Baseline evaluations were completed before the player began practices for their sport and post-injury measurements were taken within 24 hours of initial injury. We performed k-means clustering analysis to identify clusters of players with similar post-concussion outcomes, and sought to identify whether these clusters systematically mapped on to particular sports. This analysis yielded three distinct clusters: one cluster of players who showed increases in ImPACT scores, one cluster who showed minimal decreases in ImPACT scores, and one cluster who showed more substantial decreases in ImPACT scores. There was no clear pattern of the sports associated with each cluster; follow-up ANOVAs also indicated no significant differences between sports in terms of post-concussion cognitive outcomes. This suggest that other variables, such as location of impact, force of impact, and individual differences may have a stronger influence on cognitive effects of concussion than the particular sport played.

Raelynn Twohy is a senior in biological sciences and psychology. She has worked with Dr. Amy Belfi for the past three years on several projects. She has also be involved in the arts on campus.

Dominic Zucchini

Department: Computer and Electrical Engineering
Major: Electrical Engineering
Research Advisor: Rohit Dua
Advisor Department: Computer and Electrical Engineering

Funding Source: Self-funded

FPGA-based Digital FM Music Synthesizer

In the field of sound design, no other form of musical synthesis is recognized for its unique timbre like FM (frequency modulation) synthesis. The versatility of this technique was used in many early keyboard synthesizers, such as the Yamaha DX7, and synthesizer chips for game consoles such as the Sega Genesis using the Yamaha YM2612. Some modern iterations of FM synthesis exist now in the form of virtual instruments (VSTs) in digital audio workstations (DAWs) such as FL Studio's Sytrus FM synthesizer. The goal of this research was to integrate the feature set of FM synthesizers such as these in an FGPA-based environment using the concepts taught in courses such as DSM (digital system modeling) and RT-DSP (real-time digital signal processing). This report covers the methods discovered such as DDS (direct digital synthesis) as well as the limitations and possible improvements to the approach. In order the features under review will be waveform generation through a numerically controlled oscillator, envelope gain, MIDI interfacing, FM using phase manipulation, mixing of signals, the unison effect, and filtering.

Dominic Zucchini is senior in at the S&T Cooperative Engineering program in Springfield. He is studying for his degree major in Electrical Engineering and minor in Computer Engineering. He has taken all courses in computer engineering available in the cooperative program and is now exploring curriculum outside of the classroom through research projects such as the WIMP AVR and FPGA-based Digital FM Music Synthesizer.

OURE Fellows Program

Oral Abstracts

Applicants

Department: Mechanical Engineering
Major: Mechanical Engineering w/ aerospace engineering minor
Research Advisor: Dr. Jonghyun Park
Advisor Department: Mechanical Engineering

Funding Source: National Science Foundation

The impact of degredation physics on cell temperature

Understanding the cell temperature of batteries while discharging is vital to ensure their safety and prolong their lifespan. Previously, a battery model that utilizes a standard single particle battery model with a coupled 3D heat transfer component has been used to simulate the battery temperature across a 3D space. While this has proven to yield accurate results and be computationally efficient, it lacks the necessary information to describe a battery throughout its life cycle.

Batteries degrade overtime, and this degradation contributes to increased cell temperature. Using the relationship between established battery degradation physics and temperature, accurate heating and cell temperature can be simulated throughout the lifespan of a battery.

These results will be corroborated with a fully 3D model utilizing degradation physics, with the expected outcome being nearly identical cell temperature and electrochemistry but simulated in a fraction of the time.

Derrick Barger is a mechanical engineering student that is very passionate about reducing our reliance on fossil fuels. After riding his bicycle across the United States over the summer of 2019, he learned about the power of clean energy firsthand and wanted to make a difference. He joined this research project hoping to make a contribution to the field of battery science, and through the guidance of his mentors Dr. Park and Dr. Landers, Derrick has learned about the research process and is focused on designing simulated battery models to be used for experimentation. Derrick plans to pursue graduate school in Norway at the University of Tromso after graduating from Missouri S&T.

Alex Daniels

Department: Biological Sciences
Major: Biological Science Secondary Education Emphasis
Research Advisor: David Westenberg
Advisor Department: Biological Sciences

Funding Source: Biology Department

Assessing Nanoparticles Affects on Bacterial Cells

Ionic copper and silver (Cu2+ ~ 0.3 mg/L, and Ag+ ~ 0.02 mg/L) can be an effective, long-term approach for controlling bacterial infections in hospitals. Cu2+ and Ag+ treatments are low cost, easy to install and maintain, and the presence of the residual disinfectants throughout the system present potential for longterm lasting effects. CuO nanoparticles also exhibit good effectiveness in treating bacterial contamination. However, there are limited studies on the effect of Cu2+/Ag+ against bacteria and their mode of anti-bacterial activity. Together with the research group of Dr. Honglan Shi in the Missouri S&T Chemistry department, we have been using single particle (SP)-ICP-MS and single cell (SC)-ICP-MS to evaluate the effectiveness of silver and copper-based nanoparticles. To complement this research, we propose to construct biosensor strains of Escherichia coli that respond to various types of cell damage. This strategy has been employed to identify the mode of action of various antibiotics (reference Eltzov paper) and this work will be the first time such biosensors have been used to investigate the antibacterial properties of silver and copper nanoparticles.

Alex Daniels is a sophomore student in Biology education who has worked in the lab of Dr. Westenberg for the past year and a half. She came from a background of PLTW classes in high school, and has been developing further lab skills during her time at S&T. Alex enjoys working with bacteria and discovering their various roles and applications in medicine and is excited about this upcoming Fellows project.

Gabrielle Hightower

Department: Biology
Major: Biology
Research Advisor: David Westenberg
Advisor Department: Biology

Funding Source: EPA & OURE Fellows

Quantifying Nanoparticle Toxicity for Bacterial Cells

The techniques commonly used to eliminate Legionella include thermal eradication, hyperchlorination, ozone, and UV treatments. However, these treatments have notable disadvantages, such as the risk of scalding and recolonization that occurs in a few months, the risk of pipe corrosion, and the formation of disinfection by-products. Ionic copper and silver (Cu^{2+} ~ 0.3 mg/L, and Ag^{+} ~ 0.02 mg/L) have been shown to be an effective long-term approach for controlling Legionella in hospital hot water system. Compared to other disinfection techniques, Cu^{2+} and Ag^{+} treatments are low cost, easy to install and maintain, and the presence of the residual disinfectants throughout the system. In addition, their minimum effective concentrations are well below the maximum contaminant levels (MCLs) (1.3 mg/L for Cu and 0.05 mg/L for Ag). CuO nanoparticles were also observed to exhibit good effectiveness in treating Legionella. However, there are limited studies on the effect of Cu^{2+}/Ag^{+} against Legionella. Therefore, a comprehensive systematic study is needed to optimize the treatment efficiency. This study will use single particle (SP)-ICP-MS and single cell (SC)-ICP-MS to evaluate the treatment effectiveness of copper-based nanoparticle to treat Legionella.

Gabrielle Hightower is a sophomore at Missouri S&T majoring in Biological Sciences. Her goal is to get minors in Cognitive Neuroscience, Chemistry, and Spanish. Gabrielle has participated in both the FYRE and OURE program under the direction of Dr. Ting Shen. During this time she worked on a meta anaylsis researching the effects of executive functioning interventions on children with ADHD and Autism. She graduated from Liberty North High School in May of 2019 and is tentatively graduating S&T in May 2023. After earning her Bachelor's of Science Degree she plans on going to graduate school to get her PhD so she can study how human genetics can influence how medication and diseases interact in the body.

Gladwin Bryan Labrague

Department: Department of Chemistry
Major: Chemistry
Research Advisor: Dr. Thomas Schuman
Advisor Department: Department of Chemistry

Funding Source: N/A

Synthesis and Characterization of Portland Cement

Portland cement is dehydrated limestone mixed with gypsum (calcium sulfate), which inhibits hydration from instantaneous reaction to about five hours. This becomes a problem when the cement ‘sets’ right in the truck and ruins the truck's mixing drum. At the same time, if cement were to be poured or applied, it takes another roughly another five hours for it to set. Hydration of Portland cement was found to be susceptible to being delayed for up to about ten hours up to twenty-two hours through surface modifications using various combinations of certain compounds. However, this also poses a problem on when the cement can be useful because it forces it users to wait for the duration of the delay. With that, this project aims to determine ways of the 'reactivate' the hydration process of Portland cement when desired. This is significant because it allows construction companies to reduce the waste of unused hardened cement and to transport cement without worrying about its 'lifespan' inside a truck. Lastly, this benefits companies financially as they will lessen the maintenance needed for trucks and the cost of materials used.

Gladwin Bryan Labrague is a current junior majoring in Chemistry with emphasis in Polymers and Coatings Science. He currently works as a tutor at the Student Success Center and as an Orientation Leader in the New Student Programs of Missouri S&T. Aside from chemistry, Gladwin also likes creative arts. He is currently the president and layout editor of the Southwinds Creative Arts Magazine of the Department of English and Technical Communication at Missouri S&T. On his leisure time, he likes to play tennis and learn about fashion and grooming.

Sara McCauley

Department: Chemistry
Major: Chemistry
Research Advisor: Dr. Rainer Glaser
Advisor Department: Chemistry

Funding Source: FYRE, OURE, NSF

Colorimetry and Improving Access to STEM Education

Educational inequality is a large problem in the United States, and the gap between high and low achieving students has grown over the past years. We want to help reduce this gap in chemistry education. Specifically, we propose to develop a cost-effective titration experiment that does not require an expensive spectrometer. We developed a new colorimetric method that does not require a spectrometer and instead employs computational image analysis. We will transfer this new research know-how into Missouri high school classrooms to improve chemistry education. We will pursue this goal with three specific aims in mind. First, we aim to improve the prototype software with rigorous testing and validation. Second, we will expand the scope of the experiment and test carefully under a variety of conditions, including two different experimental setups and with a variety of pH indicators. This will allow us to optimize the experiment with a high school audience in mind. Third, we will create a set of detailed instruction manuals for each experiment along with complete sample write-ups so as to facilitate its easy adoption and widespread implementation.

Sara McCauley is a 3rd-year undergraduate in the Chemistry Department at Missouri S&T. She is currently working with Dr. Rainer Glaser to study the kinetics of Belousov-Zhabotinsky oscillating reactions. Her work has focused on computational studies of iron-phenanthroline complexes, as well as in developing analytical colorimetric methods of determining concentration. This work recently resulted in publication in the analytical chemistry journal Talanta.

Ethan Prior

Department: History and Political Science
Major: B. A. History
Research Advisor: Dr. Andrew Behrendt
Advisor Department: History and Political Science

Funding Source: Personal Resources and Advisor's Faculty Support Account

From Bricks to Canvas

Through my research with OURE in the 2020-2021 school year, I argued for a new form of periodization for the graffiti on the Berlin wall. The periodization I proposed was based on times when there was no graffiti, political graffiti, and when the graffiti was seemingly a chaotic mix of messages over art, politics, and personal life. This theory of periodization was based on one specific area on the Berlin wall, near the Brandenburg gate, called Potsdamer Platz. For my research, I would like to test my theory on other parts of the wall. I would like to look at more than just Potsdamer Platz to see if my theory stands for more areas, allowing for a stronger argument for it. I would also like to find more causes for the changing graffiti, while also finding more meaning behind what was put on the wall itself. Using the graffiti to strengthen my arguments, my research will delve into media studies, Germanic studies, and even German politics of the Cold War era. The OURE Fellows program will allow me to have the necessary resources to commit to this research by helping me to fund and find primary resource materials like German newspapers from the decades the wall stood. My research will use interpretations of graffiti on the Berlin wall to strengthen my earlier arguments of its periodization, while also giving a deeper insight into the thoughts and feelings of the civilians who lived near the wall and how they changed over the decades.

Ethan Prior is a Junior working on a B. A. in history at the Missouri University of Science and Technology. After graduation, Ethan plans on moving forward to earning a masters and doctorite in history, with hopes on becoming a professor.

Academic Support

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