Undergraduate Research
@
Missouri University of Science and Technology

Undergraduate Research Day
at the Capitol
Tuesday – March 10, 2015

MISSOURI S&T

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Office of the Chancellor

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March 4, 2015

Dear Legislator:

Welcome to Missouri University of Science and Technology's Undergraduate Research Day at the Capitol! Our students are excited to have this opportunity to present to you their research projects.

As the state's technological research university, Missouri S&T is committed to engaging undergraduate students in learning experiences beyond those in the traditional classroom setting. With research touching on everything from energy to the environment, I think you'll see these students are already making important contributions.

Featured on the cover of this publication is just one example of Missouri S&T undergraduate students involved in research each year. Katherine Bartels is a sophomore in environmental engineering with a minor in sustainability from Independence. Her project, "Water Quality of Green Roof Leachate," will directly determine the water holding potential and nutrient leaching characteristics of different green roof media.

Katherine's work will impact the development of our predictive meteorology-based models that forecast cooling potential for green roofs to combat the urban heat island effect. Her study also typifies the type of relevant, real-world research projects Missouri S&T students undertake on a regular basis.

I am proud of the accomplishments of the students you will meet today. Thank you for taking time out of your busy schedule to meet a few of our outstanding undergraduate students and for your words of encouragement. I appreciate your continued support of Missouri S&T and higher education in our state.

Warmest regards,

Cheryl B Schrader

Cheryl B. Schrader, Ph.D.
Chancellor

Research Project

Green Roof Leachate Water Quality

Green roofs provide many environmental benefits such peak flow attenuation, runoff reduction, and increased roof life expectancy to buildings. However, green roofs need media that is fertile enough to sustain vegetation, requiring available nutrients. Nitrogen, potassium, and phosphorous are common nutrients in fertilizers present in commercial green roof media such as GAF to promote plant growth. Nitrogen and phosphorous are also limiting nutrients in bodies of water. Excess nitrogen and phosphorous contributes to eutrophication as observed in many Missouri waters and the Dead Zone in the Gulf of Mexico.

Water leaching from green roof media carries nutrients from the building and enters nearby water bodies. Prolonged leaching over time leads to eutrophic and anoxic conditions, and may result in inhibiting aquatic life and even fish kills. In addition to the nutrient concentration in the green roof runoff, total organic carbon and total suspended solids are of concern. Too much organic carbon in water leads to higher oxygen demand further lowering the oxygen availability, adding to oxygen depletion. Introduction of suspended solids can also contribute nutrients to the water body, as the nutrients are sorbed to the solids and may dissolve once in solution. Solids also add to streams and lake sedimentation.

To test for leaching, an *in-vitro* study used to simulate precipitation events typical to Missouri was performed to show the decrease of total suspended solids, total organic carbon, total nitrogen, and total phosphates in green roof leachate. The simulation consisted of three cylinders filled 3" deep with green roof media: GAF, Arkalyte, and one control of Thermoplastic Polyolefin (TPO), performed in triplicate. The apparatus to deliver simulated rainfall is set in parallel, using values to evenly distribute water to each cylinder at a rate equivalent to a 2 year 30 minute rainfall event for Rolla, MO. The media was allowed to dry between simulated rainfall events.

Results showed a general decrease over time of leached nutrients, solids, and carbon for the media tested. Arkalyte was shown to have the lowest impact, by having less initial and final concentrations of nutrients over time, about half of the concentration of nutrients found in GAF leachate. Assessing water quality and quantity is imperative to fully understanding the implications of green roof implementation. Accurate assessments will be incorporated into urban water quality models.

Major:	Environmental Engineering
Faculty Mentor:	Dr. Joel Burken
Mentor's Department:	Civil, Architectural, and Environmental Engineering
Funding Source:	Opportunities for Undergraduate Research Experiences (OURE)

Katherine Bartels
Independence, MO

House District 030
Senate District 11

Katherine Bartels is a sophomore in environmental engineering and is also planning on minoring in sustainability. On campus she is a member of the Water Environment Federation, Society of Women Engineers, and Eco Miners Students for a Sustainable Future. Her interests include playing tennis, photography, and crocheting.

"The opportunity to participate in undergraduate research has been the best part of my collegiate experience thus far. It has taught me a variety of important lessons that go beyond the classroom and has shown me that my dream of making the world a better place is actually a reality."

- Katherine Bartels

Adrian Black
Rolla, MO

House District 062
Senate District 16

Adrian Black is originally from Corydon, IA and is a senior majoring in biological sciences with a minor in chemistry at Missouri S&T. She works for the Missouri S&T Police as a Campus Service Officer, along with doing research in the microbiology lab. She will graduate in May 2015 and will be attending the School of Clinical Laboratory Science at Mercy Hospital in St Louis starting in June 2015.

"Undergraduate research has shown me the direction I want to take with my career. It has provided me with both the technical and professional skills needed to enter the field of Clinical Laboratory Science."

- Adrian Black

Missouri University of Science and Technology

Research Project

Quorum Sensing in *Bradyrhizobium japonicum*

Bradyrhizobium japonicum is a soil dwelling bacterium that is known to nodulate soybean roots and conduct nitrogen fixation for the plant. We hypothesize that for this to happen, a process known as quorum sensing is important. Quorum sensing is a density dependent process, and it is the way the way that *B. japonicum* communicate with each other. We predict that *B. japonicum* must have a gene that controls production of the quorum sensing molecule. By finding this gene, it may be possible to use this information to better use *B. japonicum* as a natural fertilizer. Companies currently sell pre-inoculated seedlings that grow and nodulate correctly in the lab, but in real world application the plants do not nodulate correctly. We believe that this may be because the plants are pre-inoculated at high concentrations, which allows quorum sensing molecules to be released at high concentrations. This high concentration of quorum sensing molecules may hinder the ability of the bacteria to nodulate properly.

Major:	Biological Sciences
Faculty Mentor:	Dr. Dave Westenberg
Mentor's Department:	Biological Sciences
Funding Source:	None

Research Project

Characterization of Acidophilic Microorganisms in Red Lake

Red Lake, located approximately 8 miles north of Columbia, Missouri, at the Rocky Fork/Finger Lakes Conservation Area, possesses many different types of extremophile microorganisms, primarily acidophilic ones. The lake maintains an average pH of 3.7 throughout the year due to the influx of acidic mine drainage from a number of seeps. Trees and other biomass enter the lake and decompose, signifying that there are biomass-degrading microorganisms working and living in the lake. My project goals are to isolate and characterize microorganisms responsible for biomass degradation from Red Lake, through the use of biochemical assays, microscopy techniques, and DNA analysis. The overall goal of this project is to find the enzymes that work in this acidic environment to break down the ligno-cellulose in biomass. Ultimately, these enzymes can be used to make the process of biofuel production more efficient and economical.

Major:	Biological Sciences
Faculty Mentor:	Dr. Melanie Mormile
Mentor's Department:	Biological Sciences
Funding Source:	Opportunities for Undergraduate Research Experiences (OURE)

Abagail Campbell
Rolla, MO

House District 062
Senate District 16

Abagail Campbell was born in Rolla, Missouri and is currently a sophomore majoring in biological sciences, with minors in chemistry and French. She serves on the Women's History Month Committee, is a student ambassador for the Biological Sciences department, and is a 2014 Sue Shear Fellow. Her interests include Québécois culture and intersectional feminism. After she completes her degree, she plans on matriculating at a graduate school of her choice.

"Undergraduate research has allowed me to build confidence in my ability to work in the lab and present my research to others."

- Abagail Campbell

Kelsey Crossen
Kansas City, MO

House District 016
Senate District 17

Kelsey Crossen is a senior in Biological Sciences with minors in Chemistry and Psychology. She is a member of the Missouri S&T International Genetically Engineered Machine (iGEM) Team and the biological sciences honor society Phi Sigma. She is also participating in Missouri S&T's Opportunities for Undergraduate Research Experience.

"Having the chance to do research as an undergraduate has shown me that I want to pursue a career in research to further scientific discovery."

- Kelsey Crossen

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Research Project

Clearing the Air: Nitrogen Oxide Fixation for the Remediation of Coal Flue Gases

The goal of this project is to modify the genome of Cyanothece 51142, a cyanobacterial species, to allow it to fix a variety of nitrogen oxide compounds that are major pollutants present in coal flue emissions. The Missouri S&T iGEM Team plans to clone and standardize genes from Pseudomonas aeruginosa and Escherichia coli that will allow Cyanothece 51142 to take up and convert nitrogen oxides into ammonium, a major component of fertilizer. This could lead to a method to reduce polluting emissions while producing fertilizer to offset the costs of scrubbing the emissions.

Major:	Biological Sciences
Faculty Mentor:	Dr. Dave Westenberg, Dr. Katie Shannon
Mentor's Department:	Biological Sciences
Funding Source:	None

Research Project

Developing Reading Comprehension Strategies in Chemistry I

In this project, Rebekah Harrah, a senior English Education major at Missouri University of Science and Technology, is studying exam questions for a college-level Introduction to Chemistry course. These exam questions will be aligned with the Webb Depth of Knowledge (DOK) scale developed by Normal L. Webb of the Wisconsin Research Center. Webb DOK is used by Missouri K-12 schools and the MO Department of Elementary and Secondary Education to chart learning outcomes for both the common core curriculum and Missouri standardized achievement testing. By aligning Chemistry I questions with Webb DOK scales, Rebekah will determine the intellectual ability needed by students to correctly answer questions on each test. Chemistry I instructors may therefore use the alignment matrix Rebekah is creating to assess course content rigor and Chemistry I student's intellectual progression. This alignment study can then potentially be used across the curriculum. Additionally, this alignment tool can assist instructors and administrators with student, course and program assessment. And if used across the curriculum, this alignment study could also potentially assess if Missouri state college readiness standards are transferable to course content during a student's first year in college. If applied widely and correlated with other student achievement data, this tool can be used in assessment studies to chart college readiness transference into first year college success.

Major:	English Education
Faculty Mentor:	Dr. Daniel Reardon
Mentor's Department:	English and Technical Communication
Funding Source:	None

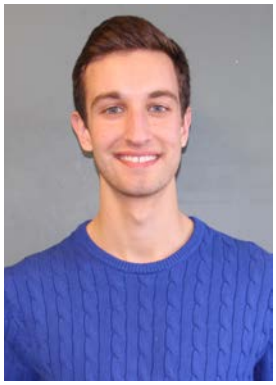
Rebekah Harrah
Rolla, MO

House District 062
Senate District 16

Rebekah Harrah is a senior in English Education at Missouri University of Science and Technology. She is a member of the Baptist Student Union, Phi Kappa Phi, and Student Missouri State Teacher's Association. She enjoys reading, writing, photography, and sharing her passion for English with students.

"Undergraduate research has opened doors for me to explore new ideas and contribute to academic discussions. I now have a better idea of what I want to do with my future!"

- Rebekah Harrah



Justin Hoyt
New Haven, MO

House District 061
Senate District 26

Justin Hoyt is a senior in Electrical Engineering at the Missouri University of Science and Technology. He is a member of IEEE, the Gamma Theta Chapter of Eta Kappa Nu, and the Missouri Beta Chapter of Tau Beta Pi. His interests outside of school and research include various outdoor activities, but especially soccer and mountain biking. After graduating, Justin plans to obtain his Master's Degree in Electrical Engineering.

"Participating in undergraduate research has provided me with new opportunities and experiences that I would not have dreamed of having otherwise at my young age. I've been able to interact with professors in areas that I'm interested in, gain valuable hands-on experience that will benefit me in my future career, and also travel to unique and exciting places. Undergraduate research has helped me to continue to grow into a well-rounded individual through its experiences."

- Justin Hoyt

Missouri University of Science and Technology

Research Project

Smart Rocks for Underwater Wireless Sensor Networks

Underwater infrastructure monitoring plays an important role in bridge health monitoring, river bank maintenance, quality assurance of aquatic ecosystems, and hydro-power plant safety monitoring, etc. Underwater mobile sensor networks, consisting of wireless sensors and gateway stations, can offer real-time sensing, low-cost maintenance, and flexible deployment for sensing dynamic underwater environments. This project proposes to develop smart rocks that are equipped with environmental monitoring sensors, wireless communication transceivers, and energy harvesting mechanism. We aim at low-cost, robust sensor rocks that can be deployed underwater and can work effectively for over 30 years. The significant technical challenges include the harsh environmental conditions for reliable communication and the lack of effective energy harvest/storage means. A prototype of a smart rock sensor network has been developed in Missouri University of Science and Technology, which consists of a variety of sensors, a short-range low-cost Magneto-Inductive (MI) communication system, a medium-range acoustic communication system, and gateway base stations. The research project is now focusing on optimizing the sensing capabilities, improving networking reliability, developing energy harvest system, and improving technology readiness. Several field tests were conducted in summer 2013 before and after the flooding in Missouri. The test results show that the wireless sensor network approach is a promising direction for underwater infrastructure monitoring.

Major:	Electrical Engineering
Faculty Mentor:	Dr. Y. Rosa Zheng
Mentor's Department:	Electrical and Computer Engineering
Funding Source:	NSF Research Experience for Undergraduates

Research Project

Mathematical modeling of recovery sleep after sleep deprivation and starvation

Sleep deprivation and starvation both produce increased waking in *Drosophila* during the period of treatment. Interestingly, these two treatments generate different responses to sleep loss. After flies undergo sleep deprivation an increase in sleep is observed compared to baseline. However, in flies that experience starvation conditions sleep tends to return to the pretreatment level. We will use mathematical modeling of sleep to determine any subtle differences in sleep patterns pre and post treatment.

Males and females of five different genotypes will be used in this experiment. These mutant genotypes include *per iso 9-15*, *per 01*, *tim 01*, *yellow-white tim 01* which lack a circadian rhythm. The wild type, *CS Skeath*, will be used as a control. These flies will be place in complete darkness for 48 hours and then are sleep deprived by either sleep deprivation or starvation for 8 hours. Post treatment sleep is measured for 48 hours and can be compared to pretreatment. These flies are between the age of seven and nine days old.

Mathematical models will be developed from the data and data analyzed using these models in collaboration with the Mathematics and Statistics department. This analysis includes clustering flies of the same genotype by similar amounts of sleep and wake. We will also use linear regression or the exponential model to bring out any underlying patterns in the pre and post treatment sleep. These models will be used to compare the mutant flies to wild type flies and their response to environmental manipulations.

Major:	Biological Sciences
Faculty Mentor:	Dr. Matthew Thimgan
Mentor's Department:	Biological Sciences
Funding Source:	None

Sahitya Injamuri
Ballwin, MO

House District 100
Senate District 15

Sahitya Injamuri was born in India and moved to the United States when she was four. She is a senior in Biological Sciences at Missouri University of Science and Technology. She is also the vice-president of Helix, the university's chapter of the American Society of Microbiology and a member of Phi Sigma, Biological Honors Society. After graduation, Sahitya plans to go to graduate school in pathology.

"I am grateful for the opportunity to participate in undergraduate research. It has allowed me to present my research to professionals in my area of study and network with them for future projects."

- Sahitya Kroenung

Lauren Kroenung
St. Louis, MO

House District 094
Senate District 01

Lauren Kroenung is a senior working on a Bachelor's degree of Computer Science. Her main areas of interest are web development and UI design. Lauren is involved in ACM-Women and ACM SIG-Security on campus.

"Undergraduate research has allowed me to gain real-world experience in my field, as well as solidify my ability to work on my own and within a team."

- Lauren Kroenung

Missouri University of Science and Technology

Research Project

**Joint project with Luke Simon*

Visualization for hyper-heuristics

Modern society is faced with ever more complex problems, many of which can be formulated as generate-and-test optimization problems. Such problems are characterized by the ability to generate trial solutions and evaluate their quality, so that in theory such problems can be solved by exhaustively generating all possible solutions and evaluating their quality. In practice, however, it is practically infeasible to generate even a fraction of the possible solutions, let alone all of them. Think of, for example, developing new cancer medications, modeling the stock market, designing optimal circuit diagrams for modern computer processors, identifying the most critical threats to our critical infrastructures and corresponding defenses, and many more. These problems have in common the extremely large number of potential solutions as well as that we do not need necessarily the theoretically best solution, but would be satisfied with a `good enough' solution. Heuristic search algorithms are a type of algorithm which employs 'rules of thumb' to efficiently search for a `good enough' solution; they obtain their efficiency at the expense of losing any guarantee of finding the theoretical best solution.

In the real-world, there are a plentitude of scenarios where many instances of the same problem class need to be repeatedly and efficiently solved; think, for instance, of optimally routing vehicle traffic over highways with constantly changing traffic flows. General-purpose optimization algorithms are typically not well suited for such scenarios, because they can be computationally expensive and are not targeted to a particular scenario. However, in such scenarios one typically can afford a large amount of a priori computational time to subsequently solve many problem instances drawn from the particular problem class associated with the scenario. That a priori computational time can be effectively employed by a special type of algorithm called a hyper-heuristic to automate the design of algorithms to create a custom algorithm for a particular scenario.

While such automated design has great advantages, it can often be hard to apply to real-world problems and difficult to understand exactly how a design was derived and why it should be trusted. This project aims to address these issues of usability and understandability, by creating an easy-to-use graphical user interface for hyper-heuristics, as well as easy-to-understand scientific visualization of the produced automated designs.

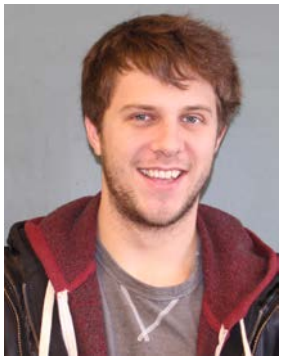
Major:	Computer Science
Faculty Mentor:	Dr. Daniel Tauritz
Mentor's Department:	Computer Science
Funding Source:	OURE + Sandia National Laboratories

Research Project

The Role of Soil Bacteria in Phytoremediation of Contaminated Soils

Bioremediation/phytoremediation is one of many methods used to clean up sites contaminated with toxic chemicals. These methods of biodegradation refer to the use of microorganisms/plants to breakdown compounds into smaller molecules that can be volatilized or used by other organisms. Contaminants such as benzene, toluene and catechol are of particular interest in this project. Select Gram-positive (GP) and Gram-negative (GN) bacteria are known to participate in the degradation of catechol (CAT) and polycyclic aromatic hydrocarbons (PAH) and the presence of these organisms is predicted to be associated with remediation. More specifically, the biodegradation of benzene, toluene and catechol, among many other compounds, have been linked to the catechol dioxygenase-specific enzymes and PAH-degradation pathways in these organisms. The presence of these enzymes for CAT and PAH degradation can be detected by specific DNA sequence which can be amplified by PCR. In this project we used PCR amplification as an assay for dioxygenase DNA sequences in soils undergoing phytoremediation.

Major:	Chemical and Biochemical Engineering
Faculty Mentors:	Dr. Dave Westenberg
Mentor's Department:	Biological Sciences
Funding Source:	DOW Chemical



John Plihal
Lee's Summit, MO

House District 034
Senate District 08

John Plihal was born in Lincoln, Nebraska and moved to the Kansas City area at three years old. Almost from the time he could walk, he has been curious about the world around him. As a child, it was not unusual for him to wander in the house holding a bee between his thumb and fingers, just because. John has had a lifelong interest in the outdoors and sports. He has always played on at least one team, whether it was baseball, soccer, football, or kayaking…. Combining his curiosity and his appreciation of the outdoors, culminated in his chosen field of study, Chemical Engineering with an emphasis in Biochemical Engineering.

"Undergraduate research has been a great experience and can be for anyone looking for a different perspective on how business is conducted within their discipline. Research has taught me the importance of good teamwork and communication along with a positive understanding on how to approach problem solving within the science and engineering field."

- John Plihal

Jonathan Roth
University City, MO

House District 087
Senate District 14

Jonathan Roth is a junior in nuclear engineering at Missouri S&T. He is from University City, MO and loves outdoor activities such as camping and hiking, along with watching and playing sports. After graduating, Jonathan intends to get a PhD in neuroscience and pursue research in imaging the brain, in order to discover the underlying cause of neurological disorders.

"Undergraduate research has been an amazing opportunity that has prepared me for graduate school and confirmed my desire to conduct research as a career. It has opened doors and opportunities that I did not think were possible for an undergraduate student."

- Jonathan Roth

MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Research Project

Fabrication of Flat Panel X-Ray Source

A novel flat-panel X-ray source is being developed in an ongoing project at Missouri University of Science and Technology for medical and industrial applications. The source can be used in radiography, tomography or tomosynthesis. This design uses a field emission cathode incorporating nitrogen doped Ultra-Nano-Crystalline Diamonds (UNCDs) that emit electrons which are accelerated towards the anode. The anode is comprised of a tungsten target integrated with an aluminum filter. The target generates X-rays by bremsstrahlung interactions while the Aluminum filters the low energy X-ray. The X-ray beam is then be collimated using a collimator designed by the team in order to reduce the angular distribution. Flat panel X-ray source can lessen the scattering inside the patient while providing better image resolution. This source finds its applications in the field of Non-destructive Testing and Evaluation (NDT & NDE).One of the potential application is to use the Flat Panel X-ray Source for determination of insertion of Trojan circuitry inside Integrated Circuits.

Major:	Nuclear Engineering
Faculty Mentor:	Dr. Lee
Mentor's Department:	Nuclear Engineering
Funding Source:	DARPA

Research Project

Implementation of Robust Data Reduction Techniques to Rapid Millimeter Wave Imaging

The goal of this project is to design an innovative millimeter wave imaging system (including advanced imaging algorithms) capable of real-time and high-resolution (3D) imaging. Previous work done by researchers at Missouri University of Science and Technology (S&T) have successfully developed and demonstrated a plethora of innovative and versatile microwave and millimeter wave imaging systems that have incorporated various advanced synthetic aperture radar (SAR) imaging algorithms for achieving high-resolution capability. This project will leverage the success of previous systems in order to develop a novel millimeter wave (100 GHz or higher) imaging system. This system will have the ability to randomly and electronically activate some of the (2D) imaging array elements or a portion of the imaging array in order to enable the inclusion of advanced data processing and data reduction algorithm(s) to reduce measurement time. To support these many capabilities, specialized antennas (including the imaging array) and supporting circuitry must be designed. Such a system may find application for structural health monitoring in many industries including space, aerospace, civil infrastructure, and security, as well as many other fields.

Major:	Electrical and Computer Engineering
Faculty Mentor:	Dr. Kristen Donnell
Mentor's Department:	Electrical and Computer Engineering
Funding Source:	United States Army (A14A-T003 STTR Phase I)

Thomas Roth
Weatherby Lake, MO

House District 013
Senate District 34

Thomas Roth is a senior at Missouri S&T pursuing degrees in electrical engineering and computer engineering. He has been involved in research for two years at the Applied Microwave Nondestructive Testing Laboratory. Here he has worked on a number of projects aimed at applying electromagnetic theory to make important measurements for interdisciplinary problems. In addition to his work at Missouri S&T, Thomas has also participated in two internships at Honeywell FM&T in Kansas City, where he worked in the RF Test Equipment and Radar Engineering departments. After graduation, Thomas will work at Sandia National Laboratories before beginning graduate school to continue his studies and research in electrical engineering.

"Undergraduate research has involved me in amazing opportunities that would not be available to me in any other way. It has been incredibly influential in my education, as well as shaping my future career."

- Thomas Roth

Luke Simon
Lee's Summit, MO

House District 034
Senate District 08

Luke Simon is currently a senior in Computer Science, an Undergraduate Research Assistant in the Natural Computation Laboratory, and heavily involved with Christian Campus Fellowship. When he's not doing things related to Computer Science, he enjoys traveling, the outdoors, and combining the two with photography. Luke will be returning to school to study Human Computer Interaction and soon thereafter working full time at Sandia National Laboratories.

"Undergraduate research gave me the opportunity to view an entirely different facet of computer science that classes did not show."

- Luke Simon

Research Project

**Joint project with Lauren Kroenung*

Visualization for hyper-heuristics

Modern society is faced with ever more complex problems, many of which can be formulated as generate-and-test optimization problems. Such problems are characterized by the ability to generate trial solutions and evaluate their quality, so that in theory such problems can be solved by exhaustively generating all possible solutions and evaluating their quality. In practice, however, it is practically infeasible to generate even a fraction of the possible solutions, let alone all of them. Think of, for example, developing new cancer medications, modeling the stock market, designing optimal circuit diagrams for modern computer processors, identifying the most critical threats to our critical infrastructures and corresponding defenses, and many more. These problems have in common the extremely large number of potential solutions as well as that we do not need necessarily the theoretically best solution, but would be satisfied with a `good enough' solution. Heuristic search algorithms are a type of algorithm which employs 'rules of thumb' to efficiently search for a `good enough' solution; they obtain their efficiency at the expense of losing any guarantee of finding the theoretical best solution.

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While such automated design has great advantages, it can often be hard to apply to real-world problems and difficult to understand exactly how a design was derived and why it should be trusted. This project aims to address these issues of usability and understandability, by creating an easy-to-use graphical user interface for hyper-heuristics, as well as easy-to-understand scientific visualization of the produced automated designs.

Major:	Computer Science
Faculty Mentor:	Daniel Tauritz
Mentor's Department:	Computer Science
Funding Source:	OURE + Sandia National Laboratories

Research Project

General Thermodynamic Modeling of Gasification of Diverse Biomasses

A thermodynamic equilibrium approach is used in a gasification process in order to create a model and program, via MATLAB, that calculates the composition of the product gas and the gasification temperature. The model is flexible, taking in diverse biomass feedstock, as well as a variety of gasification agents. Through equilibrium reactions and mass balances, the syngas composition is calculated. Then, energy balance calculates the gasification temperature using an iterative method. The model and program were created, and then the program was verified through convergence and validated with experimental data from other papers. Finally, a parametric study was run in order to examine the effects on syngas composition caused by gasification temperature, biomass moisture content, amount of air input, and carbon content of the feedstock. The model will in the future have more dimensions added, including the kinetics of the gasification process, and be used to optimize converting municipal waste to energy and syngas, which is a prime example of converting waste to wealth.

Alexandra Slimmer
Jefferson City, MO

House District 059
Senate District 06

Alexandra Slimmer is a senior in Chemical Engineering from Wildwood, MO. She has been doing research for the Chemical Engineering department for her entire undergraduate studies. She participates in Habitat for Humanity as well as Tau Beta Pi along with other honors societies. After graduation, she is going to work for Amec Foster Wheeler and later plans to obtain her PhD in Chemical Engineering.
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"Undergraduate research has challenged my mind, inspired me to work harder than I ever have before, and showed me what I want to do with my future in Chemical Engineering.**"**

- Alexandra Slimmer

Major:	Chemical Engineering
Faculty Mentors:	Dr. Muthanna Al-Dahhan
Mentor's Department:	Chemical and Biochemical Engineering
Funding Source:	AdaptiveARC

Austin Sutton
Liberty, MO

House District 038
Senate District 12

Austin Sutton was born and raised in Kansas City, MO where he obtained his high school diploma from the Liberty School District, a suburb that lies in North Kansas City. In addition to his dedication towards academics in high school, he also received several superior ratings in piano performance, and earned the rank of Eagle School through the Boy Scouts of America. At the beginning of his college career, Austin attended Metropolitan Community College – Maple Woods to study mechanical engineering, and tutor individuals who needed help in the areas of math and physics. After two years passed, Austin decided to enroll at the Missouri University of Science and Technology and continue his education to obtain his bachelor's in mechanical engineering. Currently, he is a senior and will graduate this spring. In the future, Austin intends on working towards his PhD in mechanical engineering with a focus in alternative energy, and power generation.

"The benefits that one gains by doing undergraduate research are priceless. Not only have I had the opportunity to network with individuals who are professionals in their field(s), but I have gained a tremendous amount of practical experience that will help me for the rest of my life."

- Austin Sutton

Missouri University of Science and Technolc

Research Project

Improvement of Fuel Cells for Use in Future Technology

As the movement towards renewable energy progresses, an increase in the number of unconventional methods for clean and efficient power production in the near future is inevitable. One such byproduct from this shift in mentality is a PEM (Proton Exchange Membrane) fuel cell, which is attractive due to its large power output, minimal harmful pollutant emissions, and low operating temperature. Although research in this particular field has yielded a lot of powerful results that provide crucial insight into the physics of the mechanism itself, and its overall cost and manufacturability, a large amount of work stills needs to be done in the variation of key parameters in order to increase the efficiency of these devices as a whole. Therefore, the primary focus of this project observes the effect of the alteration of one of these variables on the entire fuel cell itself. Specifically, the bio-inspired flow field design, recently proposed by researchers at Missouri University of Science and Technology, for both hydrogen and oxygen located on bipolar plates inside a fuel cell is optimized with the desire for uniform consumption across these components thereby increasing overall performance. To accomplish this goal, a program in MATLAB was created to perform all of the necessary optimization computations with the widths of the flow channels being design variables. In the end, the bio-inspired design was successfully optimized, substantially increasing the ability for the fuel cell to expel the waste products and to enhance its performance.

Major:	Mechanical Engineering
Faculty Mentor:	Dr. Umit Koylu
Mentor's Department:	Mechanical and Aerospace Engineering
Funding Source:	NSF-REU

Research Project

Simulated Shielding Methods for RF Analog Circuits in LCP Packages

Crosstalk between closely-spaced ICs in LCP packages can impact performance of high-frequency analog circuits. Possible methods of reducing package-to-package coupling over a 35 GHz band without harmfully increasing coupling within each package are being explored through simulations. Methods include placing lossy conductive sheets on top of each package and connecting them to the return plane through vias in the walls of each package. A 300 ohm/square sheet resistance with vias in the corners of each package has given the best performance to date.

Ben Toby
Kansas City, MO

House District 016
Senate District 17

Ben Toby is a senior in electrical engineering. A high school introductory electronics course piqued his interest in electrical engineering, and he turned that interest into a passion at the Missouri University of Science and Technology. Ben's non-academic interests include music and outdoor activities. He has been a DJ at KMNR—the campus free-format radio station—for three and a half years, as well as serving KMNR as the program director, trainee director, assistant engineer, and trainer.

"Participating in research has opened an incredible amount of doors for me. There is the obvious resume boost, of course, but there are much bigger benefits. It has given me confidence and motivation as a young professional, the opportunity to get to know professors, and allowed me to pursue academic and professional interests I never would have thought possible as an undergrad."

- Ben Toby

Major:	Electrical Engineering
Faculty Mentors:	Dr. Daryl Beetner
Mentor's Department:	Electrical and Computer Engineering
Funding Source:	Cobham, Inc. (through U.S. DOD)

Anthony Wellnitz
Rolla, MO

House District 062
Senate District 16

Tony Wellnitz grew up on a farm in Van Buren, AR. He developed a love for experimenting with electricity at a young age by taking appliances apart to see how they work. He became one of the youngest Master Electricians in the state of Arkansas at the age of 25. After working in the electrical trade for twenty years, he decided to pursue a degree in Electrical and Computer Engineering at Missouri S&T. He enjoys learning new things and is studying foreign languages on the side, such as Spanish and Russian. He also loves music and collects musical instruments. In May 2015, Tony will graduate with his B.S. and is already working toward his M.S and Ph.D. He hopes to go into research and development for alternative energy after receiving his Ph.D.

"Undergraduate research has been a great help in putting into practice concepts learned in class. Being able to work with graduate students and participating in research projects has greatly expanded my knowledge and has prepared me for graduate research. This has helped me get acquainted with more professors and professionals in my new field of study.**"**

- Anthony Wellnitz

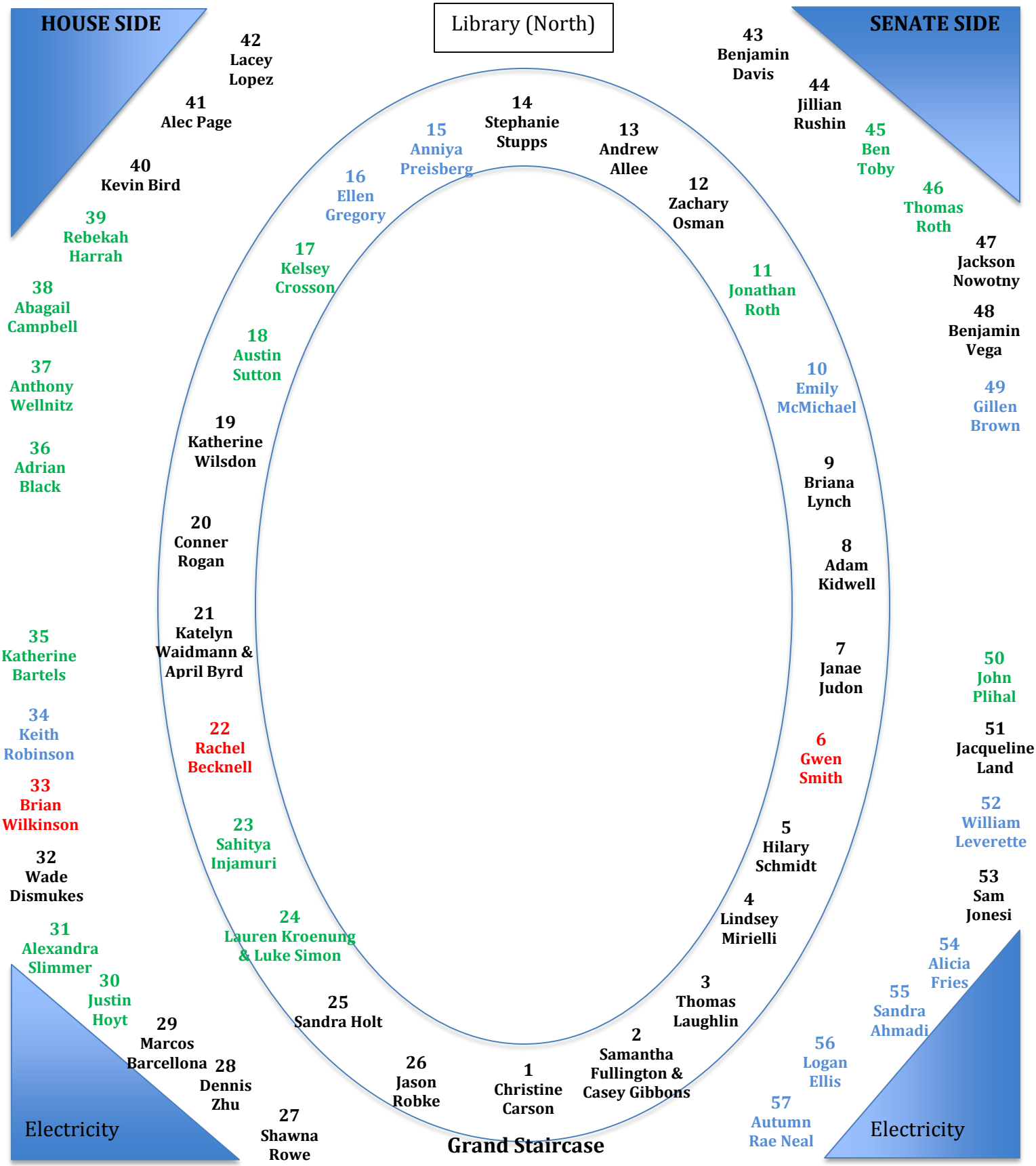
Research Project

Part DNA using RFID Tags in Metal-Reach Environment

RFID technology is rapidly expanding into every part of our lives. It is bridging the gap between computer systems and real-world environments. As the technology grows so does the need for research and development to fine tune that connection between source and RFID tag. Whether using them for tracking of material throughout the supply chain, fleet vehicles for corporations, or even pets, the demand for better RFID reliability is growing every day.

The Part DNA using RFID Tags in Metal-Reach Environment is one research project that is going to advance the reliability factor in harsh environments where metal and interference pose problems to normal RFID tag technology. The work being conducted on Impedance Switching Networks (ISN) is paving the way for solving these problems. Our work is to develop RFID technology that can adapt to its environment in order to maintain critical reliability in any specified application.

Major:	Electrical/Computer Engineering
Faculty Mentor:	Dr. Maciej Zawodniok
Mentor's Department:	Electrical and Computer Engineering
Funding Source:	None


HOUSE SIDE
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Library (North)
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40 Kevin Bird
39 Rebekah Harrah
38 Abagail Campbell
37 Anthony Wellnitz
36 Adrian Black
35 Katherine Bartels
34 Keith Robinson
33 Brian Wilkinson
32 Wade Dismukes
31 Alexandra Slimmer
30 Justin Hoyt
29 Marcos Barcellona
28 Dennis Zhu
27 Shawna Rowe
26 Jason Robke
25 Sandra Holt
24 Lauren Kroenung & Luke Simon
23 Sahitya Injamuri
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8 Adam Kidwell
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5 Hilary Schmidt
4 Lindsey Mirielli
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