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New in 2016:
Spotlights on Collaboration

Mentors of the Year:
Dr. Leonardo De La Fuente
Dr. Elizabeth Lipke

AUJUS is a collaborative effort by students at Auburn University

Andy McErlean graduated with a BFA in Graphic Design from Auburn University in 2012. Currently, he is a UI / UX (user interface / user experience) designer working in Austin, TX.

Andy's image, used for the cover, is an example of camera-less photography created by layering objects on light sensitive paper and exposing the composition to sunlight.

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About the Editors



Connor Dobson graduated from Auburn in May 2016 with a Bachelor's of Science in Chemical Engineering (specialization in Biomedical Engineering). While at Auburn, Connor worked as an Undergraduate Research Fellow under the guidance of Dr. Robert Arnold in the Harrison School of Pharmacy to develop nanocomposite drug delivery systems for cancer therapy and diagnosis. He is also the founder and president of the Auburn chapter of the Biomedical Engineering Society and co-founder of the Auburn University 3-Design Lab, which is intended to give Auburn students open access to 3D printing technology. In his free time, he enjoys cooking, supporting Auburn athletics, traveling, and surfing during the summer. As of Fall 2016, Connor will pursue a PhD in Biological Engineering at the Massachusetts Institute of Technology (MIT) with the support of a graduate research fellowship from the National Science Foundation.



Ellen Rankins is a recent graduate of Auburn University with a Bachelor of Science in Animal Sciences – Equine Science. Her undergraduate research, under the guidance of Dr. Wagner and Dr. Weimar, focused on equine movement. She was an active member of both Ag Ambassadors and Block and Bridle. During her spare time, she can be found volunteering and teaching at Storybook Farm, a therapeutic riding center, where she is dedicated to bringing "Hope On Horseback" to their special riders. She is now pursuing a Master of Science in Animal Sciences at the University of Florida.



Elise Mann is a junior pursuing Bachelor of Science degrees in both Nutrition Sciences and Biomedical Sciences, concentrating in pre-medicine. She is an Undergraduate Research Fellow in the Department of Kinesiology under the direction of Dr. Heidi Kluess. Her research focuses on biomarkers in human blood. She is a Communications Assistant for the Office of Undergraduate Research and serves in the Student Government Association as the President of the Undergraduate Research Ambassadors. Elise's other on-campus involvement includes serving as Director of the Involvement Awards Banquet, she is an Honors College Ambassador, a Leadership Chair for her social sorority, and a member of Omicron Delta Kappa honor society. In her spare time, she enjoys volunteering in the radiology department at East Alabama Medical Center and plans to attend medical school upon graduation.



Daniel Buxton is a senior pursuing Bachelor of Arts degrees in both Public Relations and Political Science. He is a Communications Assistant for the Office of Undergraduate Research and promotes undergraduate research involvement using public relations tactics and strategies. In addition to his coursework, Daniel has served on the executive team of Beat Bama Food Drive; served as an IMPACT Project Coordinator at the Boys and Girls Club of Auburn and at the Community Market of East Alabama; and was a member of the Auburn University Marching Band. Upon graduation in December 2016, Daniel hopes to join the Peace Corps to serve as an English teacher abroad.

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MENTORS OF THE YEAR

Dr. Leonardo de la Fuente by Elise Mann

"The concepts learned through undergraduate research experiences are applicable beyond the practice of research itself," Dr. Leonardo De La Fuente explains. "Science is based on observations and evidence. Therefore, students must learn how to pay attention, answer questions, and recognize what they do not know." De La Fuente strives to teach his students concepts that apply outside of the laboratory. According to De La Fuente, research challenges students by forcing full knowledge and understanding of a subject on a deep level. Not only does research provide students with opportunities to gain further knowledge about a particular topic, but also provides opportunities for students to gain professional skills.

"Science is based on observations and evidence. Therefore, students must learn how to pay attention, answer questions, and recognize what they do not know."

"I place a huge emphasis on the scientific process," De La Fuente claims. "Learning how to perform an experiment, how to control for certain factors, and understanding what is being studied and how to study it is important and the concepts can be applied to any aspect of life." Professor De La Fuente's passion for undergraduate research is a result of his own positive research experience as an undergraduate student. As a student, De La Fuente worked with bacteria that are beneficial to plants. Through his coursework, he became intrigued with the processes of disease and infection.

Originally, De La Fuente researched disease relevant to humans and animals. Killing mice, however, disturbed him. "It was sad to me to kill the mice," De La Fuente somberly expresses. "I decided to redirect my research focus to bacteria that affects plants." At Auburn, De La Fuente continues to focus his research on plant bacteria, specifically, bacteria that affect the plant's vascular system. The goal of his research is to understand how infection occurs and what can be done to help control disease.

"Discussions, presentations, and publications were very exciting to me as an undergraduate student," Dr. De La Fuente states. "I want to give students at Auburn the same opportunities that I was given so that they can experience the same excitement that I did." De La Fuente also notes that he loved attending conferences as an undergraduate student. "I was in awe at the people, the research, and the conversations at conferences." De La Fuente laughs as he comments, "I had very few presentations as an undergraduate student. I was so excited about my first poster presentation, but it went horribly and was definitely a learning experience. My poster was mainly all text and

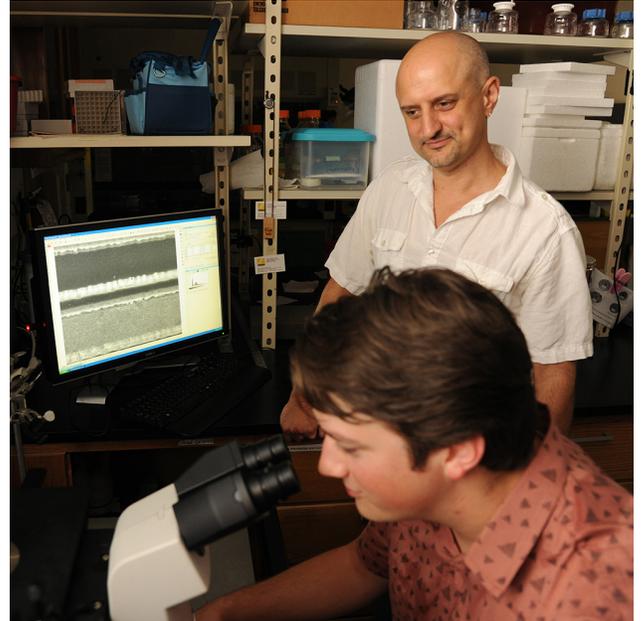


Photo: Dr. Leonardo de la Fuente mentoring an undergraduate student in his lab.

extremely boring to my viewers. You learn, however, that each conference, presentation, and discussion improves with practice and experience. However, I learned a very valuable lesson that day of my first poster presentation. People do not like to read large blocks of research text. Posters should include figures that are eye appealing or the poster will not attract any attention."

Dr. De La Fuente takes pride in the achievements of his

"I want to give students at Auburn the same opportunities that I was given so that they can experience the same excitement that I did."

undergraduate students. When asked what he enjoys most about being a mentor, De La Fuente smiles and states that he enjoys watching his students present at conferences. "I feel as if it is my own child presenting. It is a wonderful feeling to know how hard they have worked and how much they have learned. I am proud of them as they present their material and answer challenging questions." To De La Fuente, being a mentor is rewarding because he sees the effect of his mentorship on his students. He understands that the lessons and teachings in the lab are far more important than the subject itself that they are studying. "It is important for students to engage in research. The skills and concepts learned by involvement in research are important, regardless of the student's future plans."

Dr. Elizabeth Lipke by Elise Mann



Photo: Dr. Elizabeth Lipke in her lab mentoring two undergraduate students.

Dr. Lipke's immense love for research is evident. Lipke first got involved in research as an undergraduate at Johns Hopkins University. She now mentors undergraduates in research on tissue engineering. According to Lipke, she and her research team "build the dorm rooms for the cells leaving their home town." In other words, she and her students create environments that provide cells with the scaffolding necessary to carry out the same functions that they normally would in the body. The tissues engineered in Dr. Lipke's lab provide a suitable environment for cells. When the engineered environments are similar to the natural ones, the cells will act in the same manner as they would in the body. After the environments are created, the cells of the engineered tissue are tested with different biofactors, such as electrical conductivity and density.

"Research is a lot about failing well. Sometimes things move very quickly, but sometimes things move slowly. Problems cannot always be solved the way that they are first attempted."

Currently, Professor Lipke works with five undergraduate students. Her goal is to help them gain a good perspective not only of how research is done in the lab, but also of how the small contributions of each researcher together contribute to overall improvements. Lipke remarked that although one person might win a noble prize, there are many people involved in the discovery of something award winning. "Success is defined in small steps," Lipke states. "Small steps lead to larger successes over time." Lipke aims for her undergraduate students to realize that the work they are doing, no matter how small the contribution, is valuable and, with other contributions, can be life changing. With this idea in mind, students are encouraged to continue working

through the obstacles they face while conducting research. "Research is a lot about failing well," Lipke remarked. "Sometimes things move very quickly, but sometimes things move slowly. Problems cannot always be solved the way that they are first attempted." Lipke hopes that students understand that research takes time and patience. She aims for her students to develop persistency and willingness to take risks and completely change the direction of a project, if needed.

When asked what she found most beneficial about serving as a mentor, Lipke said, "Watching those you have worked with achieve their goals." She enjoys understanding her student's passions and helping them make strides toward achieving what they want. "Seeing people achieve their goal, or even progress on the path to achieving their goal, is the biggest reward to me." Lipke explained that, as a mentor, one needs to understand the student's ambitions and look at that goal from the student's perspective. She adds that one must also consider the student's skill set. "Understanding both components will help you, as a mentor, serve your student in the most beneficial way to them and the research project."

Lipke expressed that she has learned a lot from the her own research mentors. She credits Professors Duke and Davis, both at Auburn, with teaching her a lot about being a mentor and serving students in the best way possible. For future students looking to get involved in research, Dr. Lipke stresses the importance of persistency. "You have to be persistent," Dr. Lipke expressed. "You cannot expect as an undergraduate that just because a faculty member did not email you back the first time you contacted them that they did not want to talk to you. You have to make an effort to network and pursue what you want to do."

Pilot Study on Access to Care in the Spanish Universal Healthcare System: Gynecology and Cardiology Appointments and Hospitalizations in the Canary Islands

Lauren Chastain, Stephanie Ostrowski, James C. Wright, Antonio Cabrera de León

ABSTRACT

In this paper, we examine characteristics of the Spanish universal healthcare system through data obtained from the Hospital Universitario Nuestra Señora de Candelaria (HUNSC), a public hospital on the Spanish island of Tenerife. We were interested in whether or not the regionalized structure of the Spanish national health care system of 2014 is able to provide timely and affordable access to care for its citizens. The dataset in this study was focused on affordable access to and efficient provision of cardiology and OB/GYN care at the HUNSC on Tenerife. Appointment and hospital admissions data for the month of March 2014 were obtained. Data consisted of Cardiology and Obstetrics/Gynecology (OB/GYN) services as indicated by hospitalization and appointment records. The data fields included home postal codes, wait time in days for medical appointments, reason for hospitalization or consultation, length of time hospitalized, and— for cardiology— discharge status. Records were further analyzed using home postal codes to determine average driving distance and time traveled. The average driving distance and time traveled for cardiology appointments and hospitalizations and for gynecology hospitalizations was approximately 40 kilometers and 40 minutes. Patients who scheduled gynecology specialty appointments traveled an average distance of 49.7 kilometers and 64.5 minutes. Twenty-five percent (25%) of all patient appointments were scheduled within 14 days and 50% occurred within one month. The question of affordable access could not be determined from the data; however, an author's (LC) observation and indirect assessment indicated that Spain's universal healthcare system is affordable. A descriptive analysis of the data as well as personal observations indicate that patients are receiving timely and affordable access to specialty care in these services, as intended.

BACKGROUND

Under the Spanish Constitution of 1978, all citizens were provided the right to health protection; the Spanish government then began the task of creating a universal healthcare system to provide free and equal access to both preventive and curative medicine, as well as rehabilitation services. A newly created Spanish National Institute of Health provided the managerial role in organization of the new national healthcare system.¹ From 1978 to 1986, an important shift occurred from the previous system of primarily private insurance providers and hospitals to a network of national public hospitals supported by taxes. In 1981,

seventeen autonomous sub-national organizational regions ("communities") were created across Spain to decentralize the healthcare services. Each autonomous region were further organized into Health Areas and Basic Health Zones based on demographic, cultural, and epidemiologic factors as well as other criteria. This arrangement was intended to better provide local healthcare services to citizens throughout large regions. On average, each Health Area serves 200,000 to 250,000 people and contains at least one central hospital. This is further divided into Basic Health Zones, each of which serves 5,000 to 25,000 people. Basic Health Zones are intended to deliver primary care services at the local level; the goal being to have a primary care center located within fifteen minutes of any residence. Since establishment of the General Health Services Act in 1986, patients have been free to choose a doctor within their local Health Area.¹

The General Health Services Act of 1986 created the present National Health System, which defined the range of services required to be publicly funded, providing preventive, curative, and rehabilitative health services for each autonomous region.^{1, 2} Spain's national healthcare system is binomial, comprised of both primary care centers and specialty clinics and hospitals. Individuals are strongly encouraged to consult a primary care physician about any new health issue. A primary care team may comprise general practitioners, pediatricians, nurses, and administrative staff, as well as social workers, midwives, and physical therapists. The goal is to provide general medical care with 24-hour accessibility for diagnostic services, minor surgeries, family planning, prenatal and obstetric care, health promotion, and other healthcare services. Specialists are seen through primary referral or emergency care, and in some cases, self-referral.¹ Although delivery of care is free, there often is a co-pay of 40% for pharmaceuticals prescribed to outpatients under the age of 65.³

Although Spanish healthcare is universal and is provided for each citizen by the government, a parallel system of private insurers and hospitals remains. Approximately one in six citizens holds private health insurance, which provides additional benefits not covered by the National Health System such as dental care, pharmaceutical coverage, and more direct and quicker access to physicians. The distribution and accessibility of private hospitals varies by region. Many private hospitals also participate in government contracts and provide additional or surge capacity for the public health system – e.g., beds for patients under the care of the public sector.^{1,4}

From 2000 to 2011, Spain's average annual growth rate per capita in health expenditure was slightly negative – approximately -0.5%. In 2007, the country spent \$2,671 per person on healthcare, or 8.5% of the GDP. After an increase in 2009 at nearly 11% of the GDP, the 2011 spending dropped to approximately \$3,000 per person, or 9.3% of GDP. In 2011, outpatient care accounted for 38% of funding, followed by inpatient care (26%), medical goods (21%), long-term care (11%), and collective services (5%).^{1,5}

The Canary Islands are designated as one of the seventeen autonomous communities; they consist of seven large islands and six smaller islands, with a total of 2.1 million inhabitants. The population is concentrated on two large islands – Tenerife and Gran Canaria.³ On the island of Tenerife, HUNSC serves as a main hospital within a previously defined Health Area. The hospital is surrounded by primary care facilities in the Basic Health Zones that make up the defined Health Area. Inside this Health Area there also are various small (private sector) hospitals holding government public contracts; these are frequently used to discharge the less severe inpatients from the main HUNSC. The hospital is located close to a second large public hospital (approximately 2 miles and 8 minutes by public tram), which serves the neighboring Health Area.

HYPOTHESIS AND STUDY DESIGN

We hypothesize that the regionalized structure of the Spanish national health care system of 2014 is able to provide timely and affordable access to specialty and emergency care for the majority of its citizens within an acceptable distance from their homes. As of 2014, no data had yet been compiled regarding waiting periods for specialty care appointments and hospital admissions at HUNSC. Because the HUNSC is a specialty hospital and referral center, rather than a primary care facility, the “15-minutes requirement” for primary care access does not apply, and no equivalent metric had been established. In this pilot study we examined access to and efficient provision of two categories of specialty care – cardiology and OB/GYN services at HUNSC on Tenerife.

METHODS

Institutional Research Board (IRB) exemption

An IRB exemption was received from both Auburn University and HUNSC prior to initiation of data collection. Only aggregate hospital admissions data were accessed for this project, and no questionnaire was used during the data collection; thus no direct interaction with human subjects was required.

Data

Only descriptive data analysis was performed on this pilot study. A subset of appointment and hospital admissions data (for gynecology and cardiology appointments) included all hospitalizations and medical appointments at HUNSC for the month of March 2014. Data elements included type of clinical service (referral appointment versus emergency services), home postal code (in order to determine distance traveled), date of appointment request, date of appointment or admission, and either the presenting complaint (appointments) or the diagnosis (emergency admissions). No personal patient identification

fields (name, age, gender, address) were part of this data set. For appointment data, emergent cases were given a negative or zero wait time because these cases represented unexpected patients that were worked into the schedule on the same day; electronically they were processed differently from routine appointments by the administrative personnel. Because these data points could not provide accurate information and served to skew the data set, they were removed from the admissions appointment dataset. There were 490 such cases within the unprocessed OB/GYN appointment data and 25 cases within the cardiology appointment data.

Downloaded OB/GYN and cardiology data were sorted using Epi InfoTM (release version 3.5.4, Centers for Disease Control and Prevention), then entered and stored using Excel (release version 14.42, Microsoft office). Data within each specialty were sorted by distance and time travelled, reason for visit, and appointment wait time. Cardiology and OB/GYN data included hospitalization and appointment records. Average driving distance was calculated using home and HUNSC postal codes, and time traveled was determined. The averages then were weighted to better reflect the frequency of patients coming from each postal code area. Distance traveled and time required to complete the one-way trip were determined using the Distance Calculator at the website <http://www.distancecalculator.globefeed.com>.

RESULTS

Appointment Data

I. Cardiology Appointments

Data were analyzed for 225 cardiology appointments during the month of March 2014 (Figure 1). Approximately 25% of patients were seen within 14 days of scheduling an appointment, and 50% were seen within 33 days. The average distance traveled was 24.2 kilometers with an average travel time of 27.5 minutes. Diagnostic and therapeutic indications for cardiology appointments included: heart failure (31.1%), general cardiology evaluation (26.2%), congenital heart disorders (20.9%), and arrhythmias (20.0%).

II. Gynecology Appointments

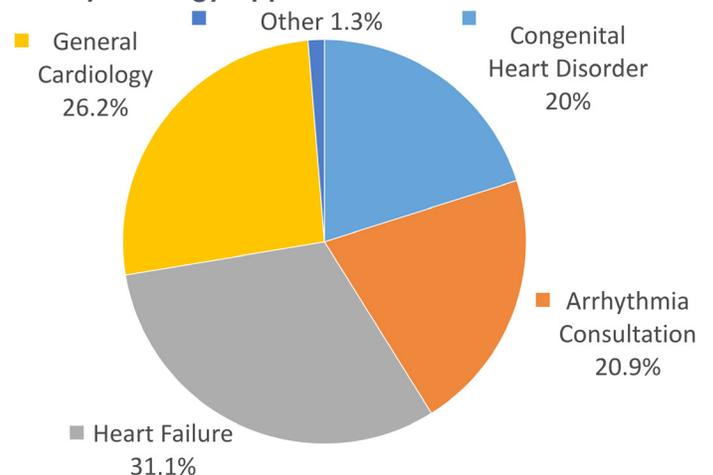


Figure 1: Reasons for Cardiology Consultations

During March 2014, there were 1,995 gynecology patient appointments (Figure 2). Gynecology consultations contained a large number of categories (Figure 3). The most common OB/GYN procedure was for ultrasound examination (28.0% of visits), followed by evaluation of fetal pathology (11.9%), other obstetrical pathology (11.1%), and oncology cases (7.4%). Approximately 25% of patients were seen within 14 days of scheduling an appointment, and 50% within 32 days. The average distance traveled for OB/GYN appointments was calculated as 49.7 kilometers and 64.5 minutes (approximately twice the distance and time compared to cardiology appointments).

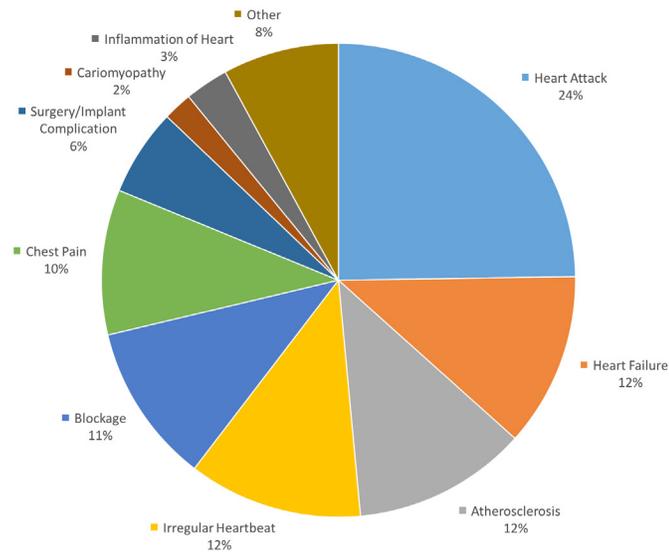


Figure 2: Reasons for Cardiology Hospitalization

Hospitalization Data

I. Cardiology Hospitalizations

Data was obtained for 250 cardiology patients hospitalized during March 2014 (Figure 3). Data included postal code of residence, reason for hospitalization, time (days) of hospitalization, and ultimate destination of the patient, including discharge, hospital transfer, and death. The average distance traveled was 31.4 kilometers with an average travel time of approximately 38 minutes.

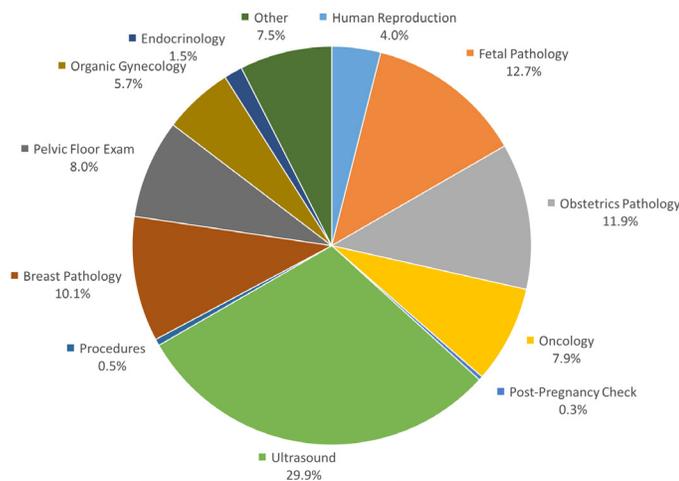


Figure 3: Reasons for Gynecology Consultations

Reasons for emergent cardiac hospitalizations (Figure 3) included heart attack (25%), followed by atherosclerosis (12%), heart failure (12%), and irregular heartbeat (12%). Over 50% of hospitalizations were five days or less, and most cases (80%) were hospitalized less than eight days. Approximately 90% of cardiac patients were ultimately discharged, and 8% were transferred to another hospital; only 2% resulted in patient death.

II. Gynecology Hospitalizations

Data was collected for 373 gynecology appointments and hospitalizations during March 2014 (Figure 4). Data included postal code of residence, reason for appointment or hospitalization, and duration in days of hospitalization events.

Forty percent (40%) of OB/GYN hospitalizations were for deliveries (births), followed by pregnancy complications (29%) and cancers (10%) (Figure 5). Almost 50% of hospitalizations lasted 0-2 days; 95% of cases resolved ≤ eight days. The average distance traveled was 35.1 kilometers, with an average time of approximately 35 minutes. For patient discharge status, approximately 2% elected to leave the hospital prior to medical release and 98% were discharged.

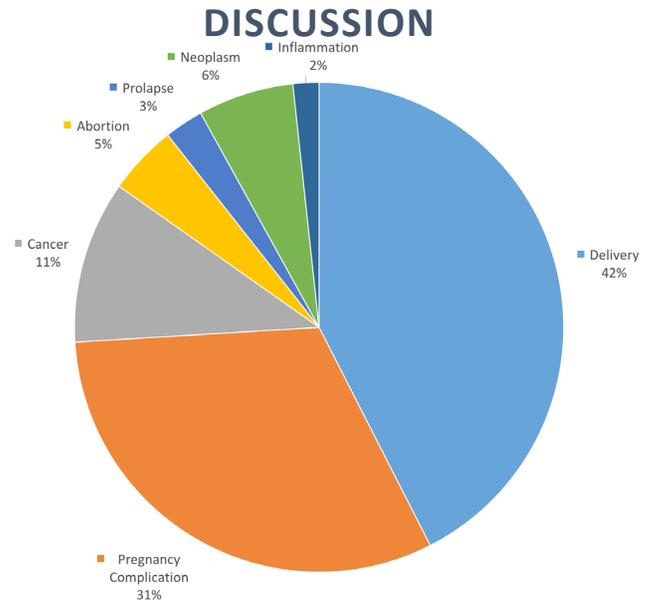


Figure 4: Reasons for Gynecology Hospitalization

Spanish healthcare system hospitals serve as referral centers for specialty consultations, surgeries, and emergencies. Patients receive timely primary care services at their local health care facility located within their Basic Health Zone. Because routine care is mostly provided at primary care facilities, HUNSC appointments are for specialty care rather than routine examinations. At HUNSC on the Spanish Canary Island of Tenerife, the average driving distance and time for these two types of specialty care was approximately 40 kilometers and 40 minutes. Patients with gynecology specialty appointments traveled further — 49.7 kilometers and 64.5 minutes. In terms of timeliness, approximately 25% of all patient specialty appointments were scheduled within 14 days and 50% within a month. These wait times do not indicate any lack of access to either primary or emergency care because during the appointment wait time, patients continue to receive care from their primary care doctor

closer to home and have similar access to emergency services. Thus, the seemingly extensive travel distance and time for specialty gynecological appointments does not imply a lack of access to care, but rather substantiates the extent to which local primary care facilities serve as the primary providers of timely and adequate general care.

Primary care facilities also provide prenatal care and classes rather than having the woman travel to the hospital for each check-up. Further, because gynecology is a commonly needed specialty for women, general gynecological care may be provided at public ambulatory clinics. This would explain the larger travel distance and travel time calculated for specialty gynecology appointments and hospitalizations, as women would need to travel further only when specialty care or facilities were required. Of the 373 hospitalized gynecology patients, ~98% were discharged routinely, ~2% left voluntarily before medical, and none died.

In contrast, cardiology serves a different patient population with different outcomes. Patients may need to drive farther to seek specialty diagnostic and medical care, explaining the greater travel distance and time for cardiology appointments. Also, life-threatening emergency events requiring advanced medical and surgical support are more frequently encountered. Of the 250 hospitalized cardiology patients within the data set, 90% were discharged, 8% were transferred, and 2% died. The reasons for transfer may include a closer proximity to home or additional required specialty care at another hospital.

Hospitalization travel times for gynecology and cardiology may be slightly skewed and difficult to compare because there were no data on how each patient arrived at the hospital. Actual average travel time may be less for patients arriving by ambulance or other emergency transportation. Patients from neighboring islands may be transferred by medical helicopter rather than taking a ferry or boat, thus decreasing the travel time for the same distance.

How does this compare with the United States? Based on a 2014 U.S. survey of physician appointment wait times, the average appointment wait time to see a cardiologist in the United States was 16.8 days, while the average time to see a gynecologist was 17.3 days. This provides a reasonable comparison point between the universal healthcare system in Spain and the United States private healthcare system, suggesting that the average wait time in the Spanish healthcare system may be a few days shorter than in the United States.

This pilot study provides a template that can be used for future studies. Future work could include analysis of the complete dataset for 2014 specialty appointment and hospital admissions data in the Canary Islands to determine whether this limited dataset is truly representative. Not only the OB/GYN and cardiology services, but data for other clinical specialties – as well as average travel time to primary care— should be compared across the 17 autonomous Regions in Spain. Comparing data from Tenerife with specialty appointment and hospitals admission throughout the other 16 autonomous healthcare Regions in Spain would provide further insight into whether Tenerife is an outlier in terms of access to healthcare services or if such distances and percentages hold true throughout the country. It is likely that regional differences in geography

and population density across the healthcare Regions would affect proximity and timeliness of access to primary care. Further research into the Spanish healthcare system could include a count of gynecology ambulatory centers, number of total births versus percent of babies born in hospitals, number of primary care centers throughout the island, and a comparison to the statistics of the other two hospitals on the island.

Of interest also would be a parallel study comparing the Spanish data to that of a local American hospital and state of comparable size to provide critical insight between the differing healthcare systems. These studies could include a comparison of travel distances and times, reasons for appointments/hospitalizations, and average hospitalization duration. Further investigation of cardiology discharge status statistics could be compared to those for the United States and other countries to suggest quality and success of care for various cardiac hospitalizations. The final step would be to compare and contrast the Spanish universal healthcare system with several other universal healthcare systems across the globe.

CONCLUSION

In Spain, the General Health Services Act of 1986 provides the framework for a national public healthcare system for all citizens. The results of this study suggest that, in addition to being able to access primary care (including OB/GYN services), patients receive specialty care appointments at referral centers within an appropriate time frame based on the urgency of their medical conditions. Patients are able to access advanced care facilities on an urgent basis, and have a high rate of discharge when hospitalized for cardiac and OB/GYN conditions. Objective data analysis and broad conclusions concerning access to timely and affordable care within the Spanish universal healthcare system are beyond the scope of our dataset; however, our observations and limited indirect assessment indicated that Spain's universal healthcare system appears to be affordable as well as generally accessible in the Canary Islands, fulfilling the promises of the 1978 Spanish Constitution.

ACKNOWLEDGMENTS

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RESEARCH HIGHLIGHTS

Brief summaries of student engagement in research

Exploring Elementary Pre-Service Teacher's Perceptions of Student Attitudes and Struggles with Mathematical Content

Madison Hutto

The purpose of this study was to explore and analyze elementary pre-service teacher's perceptions of elementary students' attitudes and struggles with mathematical content. This research is important as it will help determine pre-service teachers' professional noticing skills, how to identify the trends where students lack basic skills in mathematics, and how to pinpoint and ultimately address negative student behaviors at the elementary level.

This study involved the analysis of twenty-two pre-service teachers' "Kidwatching Notes," taken on the students they observed in a local school system's summer school program in Auburn, Alabama. The program served approximately 150 students who were identified as struggling in the areas of mathematics and/or reading. The students ranged from kindergarten to fifth grade. Each pre-service teacher chose one or two subjects to observe. The subjects were observed for three weeks (15 school days).

The notes containing the teachers' observations were analyzed to look for patterns and to categorize those patterns to determine what the majority of pre-service teachers noticed. After analyzing the pre-service teachers' notes, I found seven themes, including attitude, symbols and keywords, manipulatives, number lines, place value, regrouping, and algorithms. These results show that pre-service teachers shared connections between attitude and achievement. In addition to taking notes about students with negative emotions who struggled in mathematics, they also noted the relationship between attitude and success when students experienced change. The majority of pre-service teachers' observation notes outlined the importance of student attitudes toward mathematics. Their notes suggest it was vital to encourage students to succeed in mathematics, and to help to build their confidence levels if their attitudes were negative.

Ultimately, granting pre-service teachers more opportunities to work one-on-one with students would provide the chance to observe individual students progressing from counting on their fingers, to frequently using number lines, manipulatives, pictures, and other strategies to solve problems. Relating the observations to what is known about student learning trajectories and the content the pre-service teachers are learning in their coursework can help the pre-service teachers learn what to do to push students forward in their mathematical thinking. It is also important for pre-service

teachers to understand the importance of the conceptual understanding of mathematics in place of procedural understandings. Observing students individually can help pre-service teachers see the misconceptions that can form when teachers are not using professional noticings to make instructional decisions to support student growth.

Statement of Research Advisor:

There has been little research performed at the undergraduate level, so Madison hopes that her research will serve as a catalyst for other undergraduate students to complete research in the field of education.

- Dr. Megan Burton, Curriculum & Teaching

Detrital Zircon Age Populations from the Lower and Upper Levels of the Moine Supergroup, Scotland, and their Implications for Tectonic Evolution

Kelly Kindgren, Mark Steltenpohl

During the middle parts of the Paleozoic Era, between ~450 to 400 million years ago (m.y.a), the ancient protocontinents of Laurentia (today North America and Greenland) and Baltica (northwestern Europe) collided to help form the supercontinent Pangaea. The resulting mountain chain that sutured these continental masses is called the Appalachians in eastern North America and the Caledonides in east Greenland, Scotland and Scandinavia.

Structural geologists seek to understand the pre-Pangaea (before ~ 450 m.y.a) arrangement of major continents and how they have since evolved. Northwest Scotland is the focus of this study because of its geologic complexity and location at the center of the Caledonian - Appalachian mountain chain. The Moine Supergroup is a sedimentary rock unit exposed in Scotland that was deposited roughly 1,000 m.y.a. along the eastern margin of Laurentia as the obscure, pre-Pangaeian supercontinent of Rodinia began to rift apart and disperse. However, the Moine Supergroup is so complexly dissected by multiple Caledonian-aged (450 m.y.a) thrust faults that its original stratigraphic order and source area is uncertain.

Identifying the source of the rocks of the Moine Supergroup is vital to understanding Scotland's plate tectonic role in the configuration of Earth's continents. Sediments formed from the erosion of mountain systems contain trace amounts of the mineral zircon, a durable mineral that can be isotopically dated. Zircon contains the isotopes U-238 and U-235, which decay into Pb-206 and Pb-207, respectively.

Once a zircon crystal is formed within a cooling magma, the ratio of uranium (U) to lead (Pb) is locked into its crystalline structure. By measuring the current ratios of these isotopes, and using their half lives and decay constants, the time of crystallization can be calculated. Zircons obtained from two samples, one from the Loch Eil Group (top of Moine Supergroup) and another from the Morar Group (base of Moine Supergroup), were dated using Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICPMS) (J. Schwartz, personal communication, 10/16/15). Results can be used to correlate the Moine Supergroup to sequences and source areas of the widely dispersed continents.

The purpose of this research is to better understand one of the most tectonically complex areas in the world. Land is the most indispensable element to all of human kind. In the early 1800's, Charles Lyell, a founding father of Geology said "The past is key to the present." History of Earth's land masses and the processes that formed them, therefore, are crucial to understanding how life evolved and valuable clues into how we might sustain it into the future.

Statement of Research Advisor:

Kelly's research provides valuable new information on the depositional age, source areas, and pre-Caledonian extent of the Moine Supergroup. Her work suggests that the Moine actually contains two separate units of rocks, rather than one, with one package appearing to be far younger than was previously thought for the Moine.

– Dr. Mark Steltenpohl, Geosciences

The Influence of Carbohydrate Beverages on Salivary Neuropeptide Y and Dipeptidyl Peptidase IV Activity

Elise Mann, Heidi Kluess, Leslie Neidert, Caroline Hubbard

The focus of our study was to examine the activity and function of the serine protease Dipeptidyl Peptidase IV, also known as DPP-IV, in saliva. We know that DPP-IV is present in the blood because it inhibits GLP-1 in the gastrointestinal tract, which decreases the release of insulin from the pancreas. DPP-IV acts to alter the structure of neuropeptides, such as neuropeptide Y, which in turn, activates the Y2 receptors on the taste buds. Y2 receptors communicate with the hypothalamus in the brain to signal to the body that it is satiated, or full. For this study, we examined whether the introduction of carbohydrate beverages would change DPP-IV activity.

Our study used 28 healthy college students who each went through four separate trials. Each participant: (1)

ingested 8oz Sierra Mist (2) ingested 8oz Diet Sierra Mist (3) swished 10ml Sierra Mist (4) swished 10 ml Diet Sierra Mist on four separate days. Saliva and a small blood sample were collected 10 minutes after the condition to test the activity of DPP-IV. After gathering the samples, we extracted the plasma from the blood and ran the plasma and saliva through a fluorescent assay to test for DPP-IV activity. We also tested blood glucose levels. All data were analyzed using a 1-way repeated measure ANOVA and post hoc analysis when appropriate.

Each line in Figure 1 represents an individual participant (*= $p < 0.05$ different from pre). Salivary DPP-IV decreased ($p < 0.05$) with the ingestion of regular (see Figure 1A) and diet soda (change from pre: $-8 \pm 8 \text{UL-1}$) and swish of regular

soda ($-13 \pm 12 \text{UL}^{-1}$), but not with the swish of diet soda. No change in plasma DPP-IV activity was observed with any of the conditions (for regular soda ingest see Figure 1B). We saw an increase in blood glucose with ingestion of regular soda (Figure 1C), but no change with diet soda or swish of regular soda. These findings suggest that sweetened beverages may result in a decrease in activation of the Y2 receptor on the taste buds and possibly a decrease in satiety. This decrease occurs with both diet and sugar-sweetened beverages.

Future research will examine studies related to the serine protease DPP-IV in the saliva. We are interested in macronutrients such as protein and the effect they have on DPP-IV activity. Conducting similar studies may lead to a discovery in the relationship between macronutrients and their influence on satiety. Ultimately we are interested in the function of DPP-IV in the saliva and how that function differs from the DPP-IV found in the plasma. Comparing DPP-IV activity influenced by differing nutrient sources may answer the question of which nutrients increase DPP-IV activity and which nutrients decrease DPP-IV activity. In a world of increasing obesity, satiety and food consumption is important in maintaining a moderate and healthy diet. Our study suggests that if you drink sweetened beverages with your meal, you may eat more.

Statement of Research Advisor:

This project was a group effort by my doctoral student, Leslie Neidert, and two undergraduate researchers, Caroline Hubbard and Elise Mann. Elise was involved with data collection for the entire project and also performed some of the data analysis.

- Dr. Heidi Kluess, Exercise Science

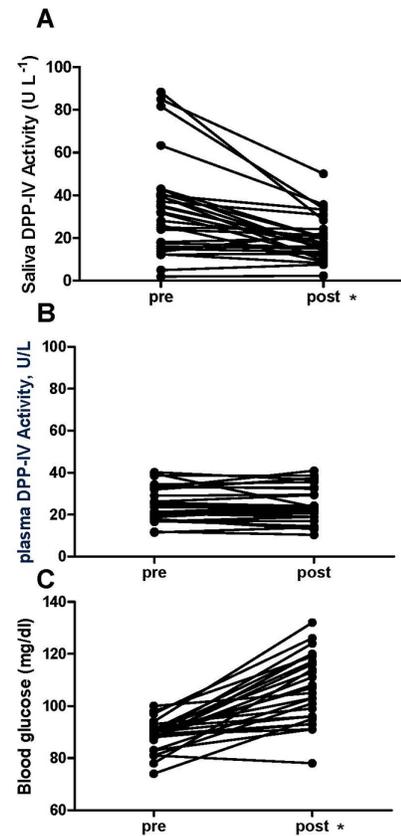


Figure 1: For all panels in the figure, each line represents an individual. (A) depicts a decrease in salivary DPP-IV activity was observed during the regular soda ingest condition. (B) depicts no change in plasma DPP-IV activity with the regular soda ingest condition. (C) depicts an increase in blood glucose in the regular soda ingest condition. * $p < 0.05$ different from pre.

Irradiance Effects on Clownfish Sea Anemones: Tentacle Morphology and Physiology

Anna Robinson

Solar irradiance impacts the daily lives of humans and animals alike. Light exposure is essential to life, providing necessary vitamins to our bodies, as well as driving primary production through photosynthesis. However, irradiance also can damage cellular structures; ultraviolet (UV) rays alter DNA proteins causing skin cells to become cancerous when overexposed to the sun.

Effects of irradiance on tentacle shape in clownfish sea anemones *Entacmaea quadricolor* (bulb-tentacle anemones) have been a topic of speculation for some time. This sea anemone is unique in that some individuals produce "bulbs", or extreme swellings on the tips of their tentacles. The cause of bulb formation is unknown, although some anecdotal evidence indicates a correlation with exposure to irradiance (Delbeek, 2002). It is possible these bulbs may reduce the negative effects of high irradiance on the anemones in shallow tropical seas. Sea anemones

can serve as model organisms to better understand how animals respond to damage from solar irradiance, due to their simplicity and ease of experimental manipulation. Information gained from studies on anemones could teach humans how to better protect ourselves from harmful effects of the sun.

To test impacts of irradiance on these creatures, my project examined both morphological and physiological responses. Anemones initially were exposed to different light levels in a morphological experiment: controls received no alteration of light, while experimental groups were exposed to enhanced irradiance at wavelengths of 400-450 nm, which is the range of Photosynthetically Active Radiation (PAR). This range of wavelengths is utilized by the animals' zooxanthellae, which are microalgal endosymbionts living inside the anemone's endoderm and providing them with photosynthesized fuel. Changes in tentacle shape then

were measured in both groups. After increasing PAR levels, a slight but not significant decrease in tentacle width was quantified. However, two specimens developed bulbous tentacles before PAR was altered, then after brief exposure to darkness, their bulbs rapidly deflated. I conclude that removing light may cause bulb dissolution, but enhanced PAR does not appear to induce bulb formation in *Entacmaea quadricolor*.

In the second, physiological-focused experiment, I increased emission of UV irradiance (320-290 nm) on the anemones and quantified responses of both tentacle shape and microalgal abundance. The algal populations were measured monthly for 4 months, allowing appropriate time for a physiological change. Microalgal abundance changed abundantly, but not as predicted, as the numbers spiked just after addition of UV emission then returned to their normal levels at the following collection period, and anemone tentacle shapes remained statistically constant after UV exposure.

Observations from these experiments indicate a connection between irradiance, bulb formation, and anemone microalgal populations, but more experimentation is needed to clarify that relationship. Future projects should try to isolate UV emission from visible PAR emission on these laboratory animals, to detect its sole effects on their morphology and physiology. Learning the correlation between irradiance and cnidarian responses could give the human race new ideas of how to better protect ourselves from the harmful effects of the sun, through potentially new sunscreen mechanisms that will better prevent cancer caused from sun exposure.

Statement of Research Advisor:

Anna's project addressed an important question regarding the giant sea anemones that host clownfishes on Indo-Pacific coral reefs. If we can figure out why and how tentacle bulbs form on these anemones, we can then induce bulb formation to enhance the value of anemones for the ornamental aquarium trade. As well, we may learn how they adapt morphologically and physiologically to high levels of UV or other wavelengths of solar irradiance which damage their cells. This information can help us to understand how humans also can protect ourselves from harm due to sun exposure. Although Anna's results were not definitive, they provide preliminary evidence and methods to further pursue this topic in our research laboratory.

- Dr. Nanette Chadwick, Biological Sciences

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Delbeek, C. J. (2002). The effects of lighting on bulb-tip development in the bulb tentacle anemone, *Entacmaea quadricolor* (Rüppell and Leukart, 1828), with additional observations on sexual reproduction in *E. quadricolor* and *Stichodactyla gigantea* (Forsskål, 1775). *Advanced Aquarist*, 1. Retrieved from <http://www.advancedaquarist.com/issues/nov2002/feature.htm>



Figure 1: Temporary formation of tentacle bulbs on a giant sea anemone in our laboratory at Auburn University.

SPOTLIGHTS ON COLLABORATION

American Society of Civil Engineers (ASCE)

The Auburn University Student Chapter of the American Society of Civil Engineers (ASCE) competes each year at the Southeastern Regional Conference. The southeastern region includes 26 schools within Alabama, Georgia, Florida, Tennessee, and Puerto Rico. Regional competitions change each year, but usually align to specialty areas of civil engineering: geotechnical, transportation, structural, environmental, and hydraulics. There is also a surveying competition, visual display competition, t-shirt design competition, and a mystery competition. The mystery competition is not known until the day of the conference and typically requires no background engineering knowledge or preparation.

Successful preparation for the competition requires dedicated members. For instance, the steel bridge construction requires hours of work cutting the steel pieces, filing them down, and welding them together. Almost every weekend in the Spring is dedicated to constructing the bridge or the concrete canoe, another construction event.

The team is divided into small groups focused on specific tasks. For the steel bridge, there is a captain for the design, a captain for the fabrication, and a captain for the rules. For the concrete canoe, there is a team for the concrete mix design and for the design of the canoe itself. Other members are assigned to these subgroups, according to their interests.

The concrete canoe competition is sponsored by the National ASCE organization. The basic concept of the competition never changes, but there are certain criteria that the canoe must meet, and these change every year.

These criteria include the maximum dimensions of the canoe, the concrete mix, and the reinforcement of the concrete. Planning for the competition begins before the National ASCE releases the current year's criteria. Planning typically involves creating an ideal timeline for the testing and construction of the canoe, figuring out what method will be used for the mold for the canoe, and coming up with a theme for the canoe display. In order to choose the best design for the canoe and its concrete mix, the team seeks advice from professors and graduate students who specialize in materials. With this advice, the team mixes concrete samples with different ratios of concrete, water, and aggregates. After the samples are made, the team runs tests on the concretes to determine which mix is the best for the canoe.

“Planning typically involves creating an ideal timeline for the testing and construction of the canoe, figuring out what method will be used for the mold for the canoe, and coming up with a theme for the canoe display.”

Although the canoe that ASCE took to the 2015 conference in Chattanooga performed well, it was slow because of its weight. Reducing weight will be a focus in designing the 2016 canoe, to be held at the University of Alabama in Tuscaloosa, AL.



Photo: Members of the Auburn University chapter of the ASCE testing their concrete canoe.



Photo: A member of the Auburn University chapter of the ASCE making the cast of the concrete canoe.

Baja Student Automotive Engineers (SAE)

Saxon Alexander, Harrison McCrorie

Auburn Baja Student Automotive Engineers (SAE) is a student-led organization that designs and constructs an off-road racing car each year in pursuit of a perfect balance of speed, strength, and endurance. Students design, build, fund, and race the car themselves with some help from corporate partners and private citizens. Auburn Baja was founded in 1977, and in the second year of the competition, won first place overall. The team has had many top ten finishes since, including another first place overall win in 2007. The current team consists of a mix of class levels. The majority of members are majoring in engineering, although a minority are studying other majors.

“Design goals are to minimize weight, maximize efficiency, and create the most effective suspension.”

Each year, the team begins with a blank piece of paper. The team must design the car from scratch with the design limited only by a series of safety rules, including a mandated roll cage and a specified engine. Design goals are to minimize weight, maximize efficiency, and create the most effective suspension. All goals aim to make the best car within the challenging rule limitations. While each car design stands on its own, the experience of previous years informs the next year's design, as we can build off a design that works, modify one that does not work, or design something different altogether.

Design does not end until the completion of a full car model in the Solidworks computer program. A complete model precedes any construction and requires the integration of a team of three to seven designers. The teamwork required here is evident, as all the pieces of the design must fit perfectly. Each senior designer has an understudy, who learns the general skills of design and the specific skills of that system. After a year, these understudies become designers who work alone and replace graduated members. The passing of knowledge to less experienced members not only prepares team members for competition but also for education and career applications.

Baja SAE prepares members to use real-world applications of engineering principles. Team members are practically trained for collaborative designing, critical thinking, and independent decision-making. Baja team members regularly pursue graduate degrees, careers in the automotive field, and jobs in other high-profile fields.

Our final product of SAE Baja is a four wheeled off-road vehicle capable of handling most obstacles. The drivetrain design gears for acceleration without sacrificing top speed; the suspension aims for the tightest maneuverability at high speeds; and the frame needs minimum weight with maximum safety. When the car enters a race, it is accompanied by a detailed cost report, professional design report, and market-researched sales presentation. These requirements highlight the need for versatility and require a team with a diverse set of skills.



Photo: Members of the Auburn University Baja SAE stand with their off-road racing car.



Photo: An Auburn University student driving the off-road racing car designed and built by Auburn Baja SAE.

Engineers Without Borders

Auburn University Student Chapter

Engineers Without Borders (EWB) is an organization of Auburn students that has been dedicated to outreach since 2008. Over the years, the group has had many different names and affiliations. During the organization's experience in Bolivia, the group was unaffiliated with the Engineers Without Borders name and acted solely as an engineering outreach group from Auburn. In December of 2014, the organization received its charter and became an official EWB chapter. It is exciting to work alongside the national organization and to help communities in need around the world. Even after receiving the charter, work in Bolivia was not completed.

Despite the changes to the organization throughout the years, the one thing that has stayed true is the group's dedication to complete the irrigation project located in Quesimpuco, Bolivia. SIFAT (Servant in Faith and Technology) and the Auburn United Methodist Church provided a connection to a Quesimpuco community in need. Engineers were needed to bring water to those in the community. Without water, the people of Quesimpuco could not grow crops. Without crops, the community struggled to make a living during the dry season which lasts half of the year.

The community is located high in the Andes Mountains on once fertile lands. During colonization, the Spaniards razed the mountainside in search of precious metals. This destruction left behind a barren mountainside in their wake. The citizens of Quesimpuco took the once barren land and are in the process of bringing lush vegetation back to the mountains. Bringing back the lush land will help to sustain the community and provide growth to the struggling Quesimpucan economy.

“Bringing back the lush land will help to sustain the community and provide growth to the struggling Quesimpucan economy.”

As of 2015, EWB has worked with this community for seven years. For the first two years, EWB travelled to the community at the beginning of August and built a relationship with the community. The chapter initially surveyed the area to determine the best way to provide water for the fields along the mountain. The team decided that, since the mountain is at a roughly 45 degree slope and there was a small unused stream that created a small waterfall off of the top of the mountain, that a gravity fed irrigation system would be the best fit for the community. The group created building designs for a collection tank and a water catchment system. Before returning the next year, the community had built the entire design independently with great accuracy to the original design plans.

The next year was spent surveying the fields to determine how to best layout the pipe system to most efficiently water the fields. We decided to focus on completing one section of the pipe near the tank to water a few fields and prove that our design would function. Once we returned from that year's assessment trip, we worked nonstop consulting



Photo: Members of the Auburn University chapter of the ASCE testing their concrete canoe.

experts and making plans for how to build this irrigation system. By August of 2013, we were ready to start building an irrigation system with the Quesimpucan community.

During our first implementation trip, we worked tirelessly alongside the community. After six long days, the group laid the last pipe and attached a hose and sprinkler to the end. After waiting for the water to stop flowing and the pressure to build up in the system, the team tested the sprinkler. The valve opened and after a small delay, the water travelled to the sprinkler and sprayed out of the top. A grown man and member of the community fell to his knees in tears. He knew that with our help, in that moment, the possibilities for he and his community expanded in ways that they had never imagined.

After that trip, the group returned to Auburn with heads held high. However, the work was not done yet. For the next two years, the team worked with this community to expand the system and implement new pressure reducing valves used for water flow control. In August of 2015, EWB returned to Quesimpuco and helped with repairs. The group also implemented a small filtration system to stop rocks from falling into the tank. To the group's surprise, the community had built an entirely separate tank irrigation system that worked just as well as the first one.

If there is one thing that members of the Auburn chapter

“If there is one thing that members of the Auburn chapter of EWB have learned, it is that you do not need to be a trained engineer to engineer great things.”

of EWB have learned, it is that you do not need to be a trained engineer to engineer great things. For example, one man named Casimiro worked harder on the irrigation system than anyone else. Not being able to speak a word

LLUSTAKALA IRRIGATION PROJECT *QUESIMPUCO, BOLIVIA*

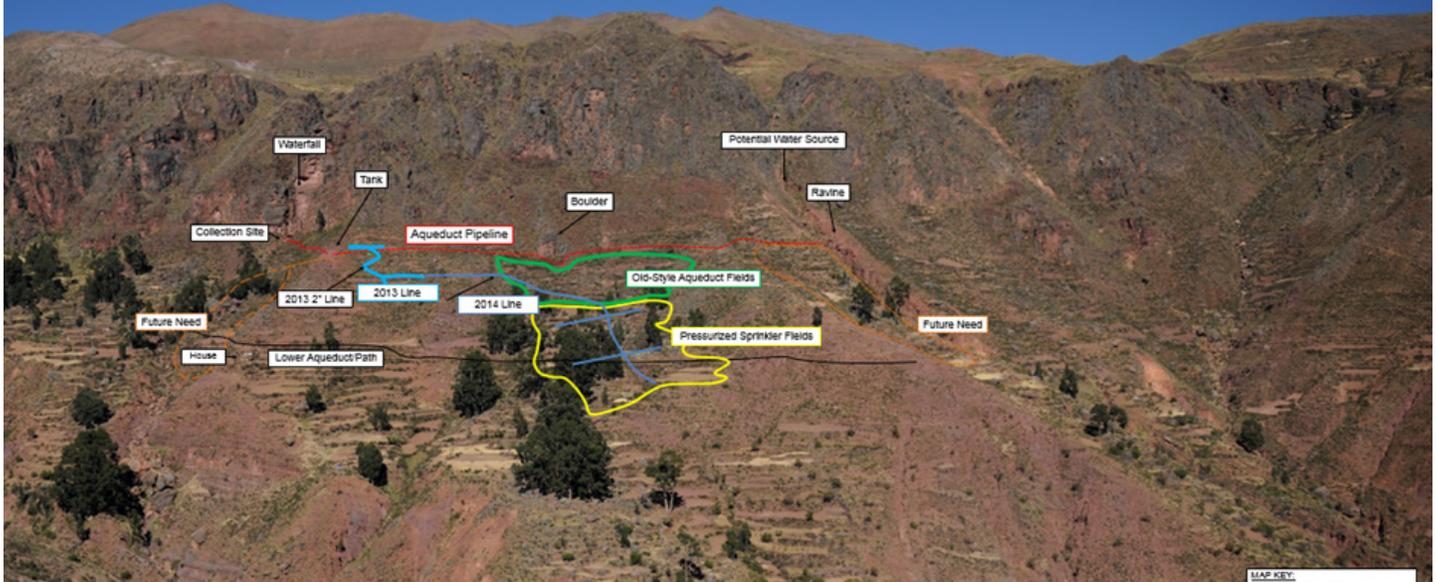


Photo: A map of the Llustakala Irrigation Project in Quesimpuco, Bolivia.

of English, he worked alongside the Auburn family with no engineering experience. At one point, the entire group of trained engineering students could not figure out how to get a pipe around a corner they were not expecting. Casimiro took a pipe wrench, a tool he had never used before, and solved the problem.

“The point of this project was not only to build an irrigation system, but to also work with the community and build the system with them.”

The point of this project was not only to build an irrigation system, but to also work with the community and build the system with them. The team wanted the community to be the engineers of the system so that they could fix the system in the team's absence. There is no doubt that the citizens of Quesimpuco are prepared to repair this system and to continue building and growing other systems on their own in the future.

Formula Student Automotive Engineers (SAE)

Formula Roots

Auburn University Formula SAE (AUFSAE) unveiled its first racing vehicle in 1996. At the time the team had relatively few members, the budget was small, and the car was basic in its design approach. The charter members of AUFSAE lacked many of the tools the 2016 team employs today. This scarcity of resources, however, did not stop the inaugural team from designing and fielding a racing vehicle. Despite two decades of separation, both the past and current teams share the drive to be the best formula team in the country.

The Design

The goal of any racing team is to win, but in the FSAE world, "winning" means more than just going fast. "Winning" means having a fast car, an innovative design proven to work, and a professional business and vehicle design presentation. In FSAE competitions entries are judged based on the completeness of the team and the team's presence as a professional organization, not just which team sets fastest lap times.

Every year, AUFSAE competes in two international FSAE events that challenge cars fielded from colleges around the world to compete in different categories. Some of these categories are static challenges – design presentation, business presentation, marketing plan – while others are dynamic challenges, including highest fuel economy, fastest acceleration, and quickest auto-cross lap time. As such, each team must create its vehicle and present itself to be the best-rounded organization possible to secure a top spot in competition.

Of course, FSAE competitions are not without rules. Though the specific regulations vary between countries, each and every vehicle that enters an FSAE competition must conform to safety, noise, vehicle size, and vehicle engine displacement and other restrictions. As of July 2015, FSAE rules mandated that each vehicle driven by a gasoline engine could not employ a power plant that exceeded 610 cubic centimeters and emitted more than 110 decibels of exhaust noise. Based around these parameters alone, the 2015 AUFSAE team knew that a winning vehicle would have to be extremely light and equally nimble to make up for the inevitable power limitations resulting from the engine displacement rules.

Challenges AUFSAE Faced in 2016

Without a doubt, the largest challenge facing AUFSAE's 2016 racing vehicle is the design, fabrication, and implementation of a full aerodynamics package.

Previous iterations of the AUFSAE vehicle always maintained design philosophies that centered on a light scale-weight and higher horsepower numbers. In fact, the racing vehicle built for the 2014 competition season weighed in at only 384 pounds – the lightest vehicle AUFSAE has ever produced – and managed a 0 to 60 mph time of less than three seconds.



Photo: A member of Formula SAE competing in a race driving the vehicle design and built by Auburn University Students.

It became clear after the 2015 FSAE competition at Michigan International Speedway that a light scale-weight and high horsepower figures would not be on the cutting edge of competition in the years to come. With this in mind, the 2016 AUFSAE team set out to design the first aerodynamics package employed on any AUFSAE vehicle to wear the Orange and Blue.

When it came to actually designing and fabricating an aerodynamics package, the AUFSAE team was quite literally starting from scratch. Senior designer Michael Moritz was elected to lead the aerodynamics project for the 2016 race vehicle starting summer of 2015. Of course, designing a completely novel, yet integral part of the race vehicle's chassis was no quick job. Michael and a small team of designers spent hundreds of hours over the summer researching design approaches, running computer simulations, and mining data from the 2015 vehicle's in-car sensors.

To the lay observer, in-vehicle data analytics may not appear to be a huge factor in designing what is basically a component that bolts on to the outside of the vehicle. However, thanks to a generous data acquisition software sponsorship from Bosch Electronics, Michael and his team were able to incorporate a range of data on the vehicle's performance into their design calculations. This advanced method of acquiring data enables AUFSAE engineers to streamline vehicle component design tests so that new components like the aerodynamics package may be tested in computer-driven testing programs before spending time and materials to tune and perfect the final component on the vehicle.

The Final Vehicle

The final iteration of AUFSAE 2015 was not the fastest car to come from the War Eagle Motorsports shop. It was, however, one of the most innovative designs the team has created to date.

In keeping with the designs proven effective by the 2013 and 2014 AUFSAE vehicles, the 2015 AUFSAE vehicle employs a bonded-carbon-fiber monocoque chassis designed and built by Auburn students. A Formula-1 inspired design, this chassis combines a tubular steel sub-frame that incorporates the engine as a structural member to aid in weight reduction as well as component access. The monocoque weighs only 52 pounds, yet makes up almost 2/3 of the vehicle's overall structure.

To power the 2015 race vehicle, AUFSAE once again sourced a power plant from Yamaha's R6 sport bike. Though the Yamaha mill is a stout design from the factory, the power-train team tore the engine down to bare metal for a complete performance-oriented rebuild. The 2015 race vehicle also has a custom-designed intake manifold made from 100% carbon fiber. This allows for a lighter-weight drivetrain with a slightly-lowered center of gravity overall.

The result of the extensive engine tuning was, of course, increased exhaust noise. In previous years, managing the amount of exhaust noise had never been a problem for AUFSAE, as each car's design incorporated an off-the-shelf sport bike muffler. For the 2015 vehicle, the team determined that a retail performance sport bike muffler would restrict the power output of the engine to unacceptable levels. Since running the engine un-muffled would violate FSAE noise restrictions, AUFSAE team-member and Auburn student Daniel Hardin designed and fabricated a muffler specifically for the 2015 vehicle's performance and entry requirements.

Impact of the Work and the Future of AUFSAE

The hard work and dedication that members of AUFSAE bring to the organization go beyond just the race track. Yes, every student on the team gets to say that they helped to build an internationally competitive racing vehicle, but they also get to use the skills they learned while on the team as resources in the real-world and on the job market.

When a member of the AUFSAE team sits down for an interview with a potential employer, they bring with them a skillset developed for a specific purpose and experience gained from hands-on work with an internationally-recognized organization.



Photo: A member of Formula SAE working on an engine.

Auburn University Space Club

Officially recognized as of Fall 2014, the Space Club is an Auburn University-affiliated club supported by the Alabama Space Grant Consortium. Space Club can be thought of as a "conglomerate" of interdisciplinary design teams, each of which will be detailed within this article. These design teams mostly develop systems for competitions, such as NASA's Robotic Mining Competition, NASA's Human Exploration Rover Challenge, NASA's University Launch Initiative, and recently added, the CanSat competition hosted by the American Institute of Aeronautics and Astronautics (AIAA) and the American Astronautical Society (AAS). Alongside these technical design teams, Club Europa has recently joined the group under the Space Club umbrella.

In addition to financial support from the Consortium, Space Club receives supplemental funding from the university and its affiliates. The Consortium grants funding to university groups that reflect a "workforce development program." This criterion is the key premise of any group within the club. The driving factor for the design teams is that each helps foster an environment that leads to the development of professional skills for the students involved. We These skills are needed for the careers available upon graduation. Skills include everything from working on teams comprised of people with various backgrounds, to technical skills students are not taught in classrooms.

Experience working on design teams gives students a chance to apply what they learn in the classroom, as well as an introduction to real world problems. Students bring different expertise and backgrounds, yet all must interface their design elements with those of the other members. Students are each given a specific portion of a design that they adopt and make their own. Students then come together at the end to make it all work. Our team introduces the aspect of working on a budget, as all teams have deadlines and budgets that must be met. Students are also taught valuable skills and trades that may not be

offered within their curriculum or a class within their major. These skills include technical writing and documentation, machining, soldering, PCB design, fabrication, etc.

In addition to the technical elements, projects include aspects such as public relations, grant writing, recruiting, and public speaking. Communication skills, both interpersonal and formal, are core aspects of a workforce. Being able to communicate with the people on your team, the public, colleagues, and potential donors is a skill developed in the projects. The team is now developing programs to introduce and attract primary and secondary education students to STEM fields.

Robotic Mining Competition

In May 2015, the Space Club participated in the 6th Annual Robotic Mining Competition hosted by NASA in Cape Canaveral, Florida. The purpose of this competition is to develop an autonomous mining system employing methods that are potentially applicable in an actual Martian mission. The competition entails a rover placed in a mining arena filled with roughly 30 cm of lunar simulant, BP-1 sulfate, laid atop roughly 30 cm of gravel. This regolith (BP-1) is the closest substance on earth to the composition of lunar soil. This mining arena is divided into three sections, the starting area, obstacle area, and mining area. On the outside of the starting area is a collection bin for excavated regolith. The objective is to, within ten minutes, make as many trips through the obstacle area, collect the regolith in the mining area, and to bring it back to the collection bin. The rover is allowed to make as many attempts as possible within the ten-minute window to collect as much regolith as possible.

There were many obstacles the team faced throughout the design for this competition. Most of the obstacles stemmed from the fact this was a new design team. None of the members had ever competed in this



Photo: Members of the Auburn University Robotic Mining Competition Team before their first round of competition standing with the rover they designed and built.

competition, nor were they aware of all that it entailed prior to arriving Florida. Performing as a new team meant members had to create a design entirely from scratch. While other teams had been competing for years, our team had to design an unfamiliar system. For a first-year team, we excelled. Where many of the teams, including veterans, were not able to move their rover, we were able to traverse the course and excavate. We are vastly more prepared to come back the next year.

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CanSat Competition

Starting fall 2015, the Space Club will sponsor another competition team from Auburn University to travel to Texas and compete against other universities from across the nation. The CanSat is similar to a Design-Build-Fly (DBF) competition. However, unlike a traditional DBF competition, the CanSat is the payload and not the vehicle itself. The intended outcome of the competition is to develop mission-feasible technologies and methodologies to implement on a Martian glider mission.

The team must build a passive descent system that is capable of taking atmospheric measurements and video images. All the collected data are reported to a group station in real-time. The other aspect of the competition is a strong influence of the systems engineering methodology used by major players in the aerospace industry.



Photo: Members of the Auburn University Rocketry Association carrying their rocket to a launch site.

The major obstacle to be overcome by this design team is the adolescence of the program. Trying to get any new project up and running is a major hurdle. Recruitment and training is a daunting task, especially when novice group of students is training a less experienced group of students to develop a system. Luckily, the forced emphasis on systems engineering provides a solid structure throughout the design and development process. The other advantage for the Auburn University team is a testing platform. Working closely with the students of the Auburn University Rocketry Association (AURA), the CanSat design team will be able to test their system on a vehicle similar to actual system.

*Faculty Advisor: Dr. Daniel Harris
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Auburn University Rocketry Association (AURA)

Every May at the Marshall Space Flight Center, Auburn University sends a team of students to compete at the NASA University Student Launch Initiative Program. Auburn University has been selected to compete in the 2016 Rocket Launch Challenge. For this competition, the team will participate in a Design-Build-Fly project, where a vehicle will be designed to carry payloads in a mission feasible manner for the Space Launch System (SLS) currently being developed by NASA.

Every year poses a different challenge for the team. NASA releases a "Request for Proposals" at the beginning phase of each annual competition. Each request focuses on a different issue, such as a payload, a target altitude, or new methods for developing a ground station for instructing the vehicle. This changing objective means that every year the team must pivot the focus of their design.

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Club Europa

One of the big obstacles of Space Club is emphasis on technology. Club Europa allows for students who do not want to get involved with a technical design but wish to share their passion for space with like-minded individuals. Club Europa encourages fellowship for all students interested in everything from astronomy, emerging space technology, and brainstorming concepts for future space missions and projects. Activities hosted by this group are industry guest speakers, star gazes, field trips, and outreach initiatives.

Human Exploration Rover Challenge

Annually held in Huntsville, Alabama, is the Human Exploration Rover Challenge competition hosted by NASA. This team designs what we affectionately refer to as the "Moonbuggy." The Moonbuggy is effectively a four-wheeled tandem bicycle. Two riders pedal the system across an obstacle course in competition with other universities throughout the country. Much like the mining competition, the goal is to develop feasible methodology for extraterrestrial missions. Students on this team spend the entire year designing, machining, and fabricating a unique structure.



Photo: An Auburn University Student driving the human-powered rover at a competition in Huntsville, Alabama.

New rules with the most recent event posed a unique challenge for the team. The wheels were to be five inches across and non-pneumatic. The developed system required students to learn about new techniques for using materials that are not standard in a classroom. Carbon fiber and Kevlar were found to be valuable resources for the developed system. The team was able to create wheels that are like the loosely woven tires seen on regular vehicles. Through this design, the team was honored with the Neil Armstrong Design Award for ingenuity. The team ultimately placed 13th in the 2015 competition.

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More than technology

Space Club is a university organization based on principles of workforce development, interdisciplinary collaboration, and passion for space. We provide an environment where students are able to combine their passions for space technologies and sciences while also being able to develop professional skills and experience. This emphasis allows Auburn University graduates to enter the professional world with an advantage over other potential candidates. Learning aspects from technical trades to communication skills and networking, students who participate in our programs have an added level of investment in their future that will open them to a world of opportunities.



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