School of Engineering Newsletter

Fall 2019

School of Engineering

Excitement concerning the continuing development of the Engineering program at ORU encouraged the ORU Board of Trustees to reclassify the Engineering Department into the School of Engineering. Previously, the Board of Trustees only applied the title of "School" to divisions offering graduate degrees. The name change recognition endorses the Engineering faculty members' desire to develop the School of Engineering sufficiently to consider offering graduate degrees. To demonstrate additional support, $7 million was spent to purchase a 100,000 square-foot building to house both the College of Nursing and the School of Engineering, the Nursing and Engineering Complex (NEC.) Extensive renovations were done to create new Engineering laboratories, classrooms, computer labs, and faculty offices. Along with the main building, an adjacent 14,000 square-foot warehouse was purchased exclusively for the use of the School of Engineering to serve as our machine shop. The School of Engineering moved into the new buildings on 81st and Delaware during summer 2019 and classes are active in the spaces during fall 2019. An official ribbon-cutting and open house is scheduled during Homecoming, Friday November 8, 2019 at 2:00 p.m. We would love for you to join us!

Engineering Department Class of 2019

Left to Right: Dr. Ma, Dr. Fields, Dr. Gregg, Youngmin Lee, Dr. Weed, Emmaus Lyons, John Brandon Romer, Dr. Leland, Kenneth James, Daniel Leander, Paul Acheampong, Richard Ernst, Dr. Zhang, Ulisses Munguia, Miqueas Barreiro, Dr. Halsmer, Jose David Hernandez, William Ben Russell, Davi Lacerda, Emily Garvie, Landon Walker, Stephen Hilborn, Dal Dik, Seth Crosby, Dr. Matsson, Ben Johnson, Victor Mavika, Elizabeth Stapleton, Lydia Reynolds, Kevin Diaz, Solomon Tsuma, Tevin Macias, Joshua Cash Jackson, Dr. Liu, Prof. Akbar, Kerri Ophus, Daniel Dickie

One of our alums has created a LinkedIn group called the ORU Engineering Graduate Network. The purpose of this group is to facilitate networking within the community of ORU Engineering graduates. It will help alumni stay in touch with the university, each other and any potential opportunities that may arise.

Here is the link to join: **www.linkedin.com/groups/13737755/**

Summer 2019 Engineering Internships, Jobs and Missions

Internship Experience with Sandia National Laboratories

Josh Braun and Nolan Monnier

During the summer of 2019, Josh Braun, a senior Mechanical Engineering major, and Nolan Monnier, a senior Electrical Engineering major, interned at Sandia National Laboratories. This organization is a U.S. Department of Energy laboratory owned by the government and operated by Honeywell International. Sandia's primary mission is "ensuring the U.S. nuclear arsenal is safe, secure, reliable, and can fully support our nation's deterrence policy." This mission encourages them to promote innovation in multiple fields, including computational biology, mathematics, materials science, alternative energy, MEMS (microelectromechanical systems), psychology, and other forms of cognitive science. The specific area that Josh and Nolan worked in was a sub-organization called the Computer Science Research Institute (CSRI).

Josh worked on a project called EMPIRE (Electromagnetic Plasma in Realistic Environments), which aims to lead the next generation of plasma physics simulators on high-performance computers. Rather than working specifically on the plasma physics part of the project, his focus was on providing software engineering support. This mainly comprised of revamping scripts for building the software into an executable and for testing it to ensure proper behavior. These scripts were converted from a Linux shell-scripting language called Bash into a modern, full-fledged programming language called Python. The purpose of this was to provide a single set of scripts that were fully tested, well organized and excellently documented. Overall, Josh is very thankful for the experience he gained at his internship. He came into it interested in software development but uncertain as to whether he wanted to pursue it professionally. Although he has decided he prefers the mechanical engineering work of his major, he is confident that the software development skills he gained will continue to be of value in the increasingly computational-driven world of engineering.

Nolan worked on two academic projects for the High-Performance Computing division. The first project was for the Empress Metadata Mangement System, a database system designed to improve IO performance for scientific computing. On this project, Nolan researched database software differences and coded benchmarks to identify key design differences between said software. He then prepared academic publications documenting his results. For his second project, Nolan worked with Sandia's newest supercomputer, Astra. Nolan's job was to take this new ARM-based machine and profile its IO performance. Nolan likes to joke that he "got paid to break a supercomputer" because his task helped to identify key weaknesses in the prototype. Furthermore, Nolan's results from the project are currently being submitted to the IO500 board and to the SC19 (Super Computing 2019) conference. Even though Nolan is not planning on pursuing future jobs in this particular field, he is thankful for the experience at Sandia. The internship helped showcase the value and the quality of Nolan's education at ORU, helped further showcase his computer skills, and gave him an informed perspective on the current job market.

Josh Braun

Nolan Monnier

Supervisor at Magellan Midstream Partners

Harley Craig

Harley is a supervisor at Magellan Midstream Partners in their downtown Tulsa offices. The team of analysts and engineers he leads support the 24-hour Control Center that operates the company's thousands of miles of transportation pipelines. Analysts train the Controllers on how to operate the pipelines. The analysts manage the alarming that is presented to the Controllers. With data from the control systems, the analysts direct equipment maintenance. The engineers maintain and expand real-time hydraulic models of the pipelines. These software-based systems track product movements for the Controllers, note anomalies, and alert the Controllers on possible leaks. The team uses similar hydraulic models to run real-time training simulators for the Controllers. There are many layers of computer hardware, software, and systems integrated within the Control Room. In a typical day Harley meets with management, project managers, and engineers. Their work centers on new project development and resolving operational issues. Each day includes working with his team helping them apply their skills to maintain and improve Magellan operations. Every day is different, with new opportunities as Magellan continues to grow in its customer base and in offering new services. Working on his Engineering degree at ORU is expanding his understanding of many of the uderlying principles in Magellan's operations.

Magellan Midstream Partners, L.P. is mainly engaged in the transportation, storage and distribution of refined petroleum products such as gasoline, diesel, and jet fuel and crude oil. Magellan is made up of three business segments: Crude oil segment: approximately 2,200 miles of crude oil pipelines and storage facilities with an aggregate storage capacity of about 26 million barrels, of which 16 million are used for leased storage Refined products segment: 9,700-mile refined products pipeline system with 53 connected terminals as well as 27 independent terminals not connected to our pipeline system and our 1,100-mile ammonia pipeline system Marine storage segment: five marine terminals located along coastal waterways with an aggregate storage capacity of approximately 26 million barrels.

Our Mission Trip to Honduras

Jacob and Michael Huene

Honduras is one of the poorest countries in the western hemisphere and its capital has one of the highest murder rates in the world. Tegucigalpa, the capital of Honduras, is home to many who live in poverty with an annual income around $900. Due to Honduras's socialized medicine, everyone is able to obtain only basic medical treatment at no expense; however, the patients often go without treatment because of the government's socialized healthcare, the hospital's lack of supplies, and the patient's inability to pay for additional healthcare. With physicians who have very little experience as compared to physicians in the US, the people of Honduras have very little hope to receive any medical treatment that would take away their pain. With this mission, God collected a team of orthopedic surgeons and anyone who was willing to go to the capital.

GHO Global Health Outreach®

Global Health Outreach is a Christian medical mission organization that sends medical teams all over the world. With our specific team to Honduras doing orthopedic surgery, the team goes every six months and specializes in total joint replacements, particularly hips and knees. The members of the team come from all over the US and other parts of the world to perform and show God's healing power by giving new joints to people who cannot otherwise afford it.

Every day of the week before the teams left for the hospitals, everyone would pack the supplies that were needed for the day in trunks and load them on a bus. After arriving at the hospitals and getting the operating rooms (ORs) ready, the doctors would stop everyone in the OR and pray for the patient through a translator. The Honduran doctors worked alongside our team's doctors to gain experience and knowledge with the respective operation. Once all the surgeries for the day were finished, the team would meet with the patients and families and pray for their recovery.

Although we are not studying medicine and have very little experience in the field, we were able to perform many of the tasks in the OR. The main task during the surgery required opening supplies sterilely for the doctors and surgical technicians so that the patient would not get an infection. Every item, especially the expensive joint implants that were so generously donated by the companies Biomet and Zimmer, was carefully opened so that the technicians could grab the things they needed. After the surgery, all the instruments that were used were washed and wrapped in a special towel that would then be placed in a sterilization unit that heats them up to extreme temperatures.

It was amazing to see the way God moved in every situation during the week. The Honduran patients were always so kind and grateful for everything that the team was able to do. Although not every patient was able to be chosen for a surgery, the smiles and thanksgivings to God and the team never ceased. The patients after a surgery never complained about any major pain even though they were only given Tylenol instead of a narcotic. As can be expected, not everything went perfectly well. Some days we would run out of a certain supply and other days all of the clean instruments would be accidentally dropped on the floor. Nevertheless, God always provided a way to continue His work in the capital of Honduras and show the people His love.

Internship Experience with AAON, Inc.

Oluwafishomi Philip King

This summer I had a very nice experience working for AAON Inc, as a Quality Engineer Intern. I worked from June 5th to August 7th and in those 10 weeks I learned so much. I got the chance to experience real challenges, tasks, projects and opportunities in an Engineering setup and explore my potential. Being an international student, it was also a taste of corporate America. It was amazing to grow both personally and professionally as well as grow in a spectrum of skills. Critical skills like applying problem-solving skills and technical theoretical knowledge of classes like statics and dynamics outside the classroom, to soft skills like communication, work ethic and flexibility/adaptability in a multi-cultural team. As a result of this experience, I feel more confident about pursuing a career in Engineering. AAON is one of many successful companies in the HVAC industry. I worked closely with members of the Manufacturing Engineering department to assist in data gathering, analytical tasks, and collaborative design projects. I also developed Quality Control system designs to ensure final products meet customer specifications and performance requirements, and provided technical expertise to Quality Control Team members. The Quality Department at AAON audits test procedures as necessary to ensure compliance of Quality Control Processes and manufacturing adherence to Quality specifications. We also identified the proper tools used in product testing. Me and a few of the other interns regularly consulted with manufacturing, engineering, and other departments to resolve customer complaints and address field service technical problems. For the first half of the 10 weeks, I created corrective actions and preventative actions against Quality failure and utilized statistical analysis to maintain stable quality processes, and devised sampling procedures for inspecting products and services. For the second half, I focused on more hands-on mini-projects. Applying to get an internship was a slightly tiring process and one that took a lot of patience, so working here made it worth it.

Internship Experience with Unit Petroleum

Jacob Sullivan

This summer, I had the opportunity to work with a local oil and gas company, Unit Petroleum. Unit Petroleum is one of three branches that fall under the title of Unit Corporation; Unit Drilling, Unit Petroleum, and Superior Pipeline. Unit Petroleum handles all operations that fall between drilling the well and transporting the oil and gas through the pipeline. This stage of crude oil exploration is known as the production stage. The production stage includes primary refinement of the crude oil and separation of oil from natural gas and water.

Although Unit is headquartered in Tulsa, my position as a production engineer intern took me to the city of Chickasha, Oklahoma. Chickasha is located southwest of Oklahoma City, near Norman, and right on top of a lucrative pocket of oil called the Marchand Zone. Being that I was completely new to the petroleum industry, the first few weeks of the summer were full of learning terminology and asking question after question. The internship started with me riding with the well technicians as they went through their daily responsibilities. Most days consisted of a morning production meeting at 7:00 a.m. which outlined the significant focuses for the day. The well techs, Tyler and Cody, have the critical job of assessing wells that have failed to meet their typical daily production from the day before. I got to see everything from a heater treater cleanout to a tubing swab to a full-on tubing string workover while shadowing the well technicians.

After becoming more comfortable with the different forms of artificial lift and production equipment, I transitioned to riding with the pumpers. A pumper's job is to check-up on a specified route of wells and record their respective production numbers. The primary importance of riding with the pumpers was to become comfortable with finding all the wells. These locations are not marked on the maze of county roads, so without being shown where they were, I would have been completely lost.

Finally, it was time for me to set out on my own. After a few weeks of riding with the pumpers and well technicians, I was given a Unit Petroleum truck and my own set of duties for the day. I was predominantly in charge of checking the purity of crude oil that was ready to be loaded and trucked to refineries. The system used to test the purity is called a grindout. A sample of the oil is taken and mixed with mineral spirits. It is then heated to 140 degrees and spun in a centrifuge to force all the impurities into the bottom of the flask where a percentage of impurity can be determined. Along with this duty, I was also able to assist in some drilling rig operations, frac and wireline jobs, and had the opportunity to troubleshoot issues on some struggling wells.

This internship was an excellent introduction to the field of petroleum engineering. I genuinely believe that I learned in this summer what I could have never learned in the same amount of time in the classroom. Unit Corporation is an excellent company and I was honored to serve them and learn from them this summer.

ORU Engineering Alumni News

Lockheed Martin

Richard Ernst

Students, families, and fellow alumni,

It is a distinct honor to write about my transition from being an ORU engineering student to an ORU Alumnus, Research Scientist, and carrier of Oral Roberts' vision in the workplace. I pray that this brief reflection of my time working in industry will be an encouragement to those who read it.

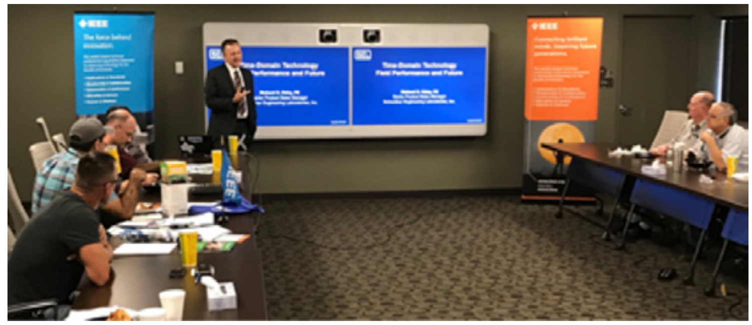
While college is a great experience and full of many challenges, especially for engineering students, life after graduation is incredible. Every day I have the opportunity to work on critical aspects of the F-35 Lightning II program, of which most of the work has been more Electrical Engineering minded than anything. I am passionate about what I do and have become obsessed with jets. My house is currently located within a military airbase's airspace, and every time I hear the howl of a jet fly overhead, I rush outside to see if I can identify the make and model. It brings a smile to my face when I hear what my company calls, "The Sound of Freedom" roar across the sky. It brings me great joy, knowing that what I work on helps protect our nation and the people within it. ORU has well-equipped me to enter the workforce and I will be forever grateful for the support I had from my peers and professors along the way.

Life after graduation has also been awakening in many regards. For example, it is rare for me to encounter others in my workplace that openly discuss their faith. While I now know a circle of fellow believers, my first few weeks at work felt lonely at times. ORU's culture imparts a wonderful boldness to discuss one's faith, and while it may not always be appropriate in the workplace, it is important not to stifle boldness when the time comes. To whoever may be reading this, I want to encourage you not to be afraid to be the first one to speak about your beliefs to those around you. May God lead and bless you on this journey of life.

Presentation at IEEE Luncheon

Richard Kirby

ORU Engineering Alumnus Richard D. Kirby was introduced to IEEE by the ORU IEEE student chapter in 1990. During fall 2018 he returned to Tulsa to present at an IEEE luncheon.



Abstract: Presentation will cover an introduction to Time-Domain (TD) protection and Traveling-Wave (TW) fault location principles and applications. Responding to transients fed with energy stored in the grid prior to the short circuit fault, this technology is far less dependent on the sources' output during a short circuit. This makes it a better choice for line protection near nonstandard generators, such as wind and solar farms. This cutting edge technology is solving some of the electric power industry's toughest problems by protecting, locating, and clearing faults much faster than ever before. This new technology is now installed in power systems around the world and are obtaining protection speeds and data resolution most engineers have never seen before. Presentation will also cover event analysis involving incremental quantities and TWs, from field cases including zone 1 trips in 2 ms, POTT trips below 3 ms, and TW-based 87 trips in 1.5 ms, plus an update on developments in adding dependable features in the future.

Bio: Richard D. Kirby, PE (S '90, M '96, SM '06), is a Senior Product Sales Manager at Schweitzer Engineering Laboratories, Inc. (SEL) in Houston, Texas. His current focus is Time Domain protection technology. He is a registered Professional Engineer in Arkansas, Louisiana, Michigan, Oklahoma, and Texas. He has 25 years of diverse electric power engineering experience in utility and industrial electric power engineering protection and control, solution development, project management and execution, and detailed engineering design. He received a BSE from Oral Roberts University in Tulsa, Oklahoma, in 1992. He started his career as a junior electrical engineer in Botswana, Africa, and worked for a consulting engineering firm. In 1995 he earned his MEng in electric power from Rensselaer Polytechnic Institute in Troy, New York. He then worked as a distribution engineer and later a protective relaying and control engineer at the Detroit Edison Company in Detroit, Michigan. In 1998 he joined Black & Veatch in Ann Arbor, Michigan. In 2002 he joined the General Electric Company and relocated to Houston, Texas. In 2004 he joined SEL as an application engineer in Houston, Texas. He is an IEEE Power & Energy Society and Industrial Applications Society senior member.

Graduate School at University of Minnesota

John Voth

In the spring of 2018, I graduated with an ME degree from ORU with my eyes set on grad school, and for the past year, I've been pursuing my Ph.D. in ME from the University of Minnesota. My research entails the mathematical modeling, mechanical design, and experimental testing of a novel hydraulic motor for an industrial application. It's a three-year, $3 million project funded by the DOE, and it's been a tremendous learning experience. The primary ME skills that this project requires include mathematical modeling, coding, optimization, mechanism kinetics and kinematics, machine design, and experimentation. I'd encourage every ORU upperclassman to at least consider grad school, especially if you're compelled by the adventure of research. There are pros and cons to grad school when compared to a full-time job and if you have any questions about the process, please don't hesitate to reach out to me at **voth0036@umn.edu** or any of your professors. Regardless if grad school is on your horizon, I'd encourage every ORU student to get as much real-world experience during your undergrad as possible; research with an ORU professor, an NSF summer REU, or an internship with a local company are all great options. Each of these grow skills that cannot be learned in the classroom, but will be invaluable for your engineering career.

Graduate School at Oklahoma State University

Conner McCain

- Graduated ORU in May 2018 with Bachelor of Science in Engineering (Concentration: Mechanical)
- Scheduled to graduate Oklahoma State University in May 2020 with Master of Science in Mechanical and Aerospace Engineering

After graduating from ORU in May of 2018, I was able to marry the love of my life, and we moved to Stillwater, Oklahoma where I am currently attending Oklahoma State University. Thankfully, I am now on track to graduate with my master's degree in Mechanical and Aerospace Engineering in May of 2020. My concentration in this program is aerospace propulsion and power. I was fortunate to make connections with a faculty member, Dr. Kurt Rouser, who brought me onto his research team before I even arrived in Stillwater. Dr. Rouser (my advisor) is a retired Air Force Lieutenant Colonel, and his 21-year Air Force career included assignments as an aerospace propulsion intelligence analyst, turbine engine maintenance engineer, KC-135 maintenance engineer and jet engine test squadron operations officer. My role on his research team is to work with Pratt & Whitney to develop maintenance, repair, and overhaul engineering tasks. Through that research, my thesis topic will be discussing the removal of aerospace engine fasteners using a hand-held electrical discharge machining system. But, I have also been able to assist other graduate students on my research teams with projects involving turboelectric systems for use on small, unmanned systems, and liquid-cooled nozzles for small, solid propellant rockets. I have also been able to connect with a number of my aerospace engineering professors, including Dr. Rouser, on a common spiritual level. Many of them have a strong relationship with God, and they want us to succeed not just for their own status, but because they genuinely care about us in and outside the classroom.

ORU ORAL ROBERTS UNIVERSITY

Minimizing Gauge Testing Process Using Test Fixture, Automation, and Cloud Database

Authors: Dal Dik, Davi Lacerda, Kenneth James

Introduction

The primary goal of this project was to help create a process that will ultimately increase the productivity and efficiency of testing gauges at Apergy. The problems that the company wanted to eliminate include having the test results stored in papers, having to waste time looking for five to ten years old records, and having the technicians making unproductive transfer from a building to another building for different testing equipment. These factors had reduced their productivity and efficiency, as well as risk the application failure due to missing history of the gauges tested.

Design

The test bench could support the largest weighted gauge with about 140 lbs. and accommodate the electrical and mechanical tools for testing. Modbus protocols and router were used for the communication between the gauge, surface readouts, and the computer. The gauge sent out DC signal to communicate with the surface readouts, while the surface readouts used RS-485 Modbus protocol to communicate to Modbus TCP converter to communicate with the computer. With the computer all wired up, the desktop application software then populated the test forms as needed and sent the data recorded from the reading of surface readouts and the other parameters entered by the technician to Azure SQL Database. Web-based application based on ASP.NET Core communicated with the Apergy SQL Server and its database, retrieved information as needed from the database. With web application deployed to the host Azure Microsoft Web App Service, it responded to the HTTP requests of the clients or browsers such as Firefox, Microsoft Edge, and Google Chrome from any mobile and computer devices.

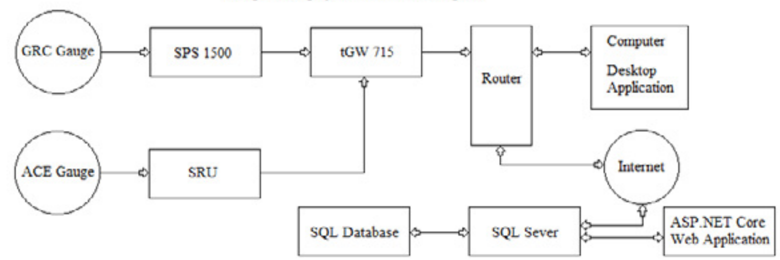
Results and Conclusion

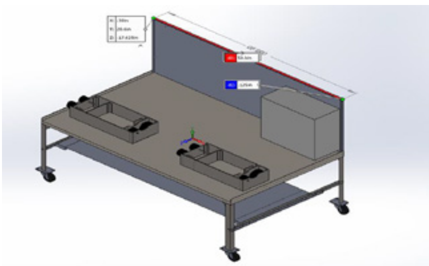
The test fixture can withstand and accommodate the gauge to be tested along with the measuring tools and communication devices. The software can do automated data entry, or manual when needed, and send the data to SQL database. The end-user can view information about a particular gauge that was tested in a browser. Each part of the solution is working and should be able to make significant improvement on productivity and efficiency.

Objectives

The objectives of the project involved providing a test bench, desktop application, and web application with access to a cloud database. The test bench should be able to withstand and accommodate the testing materials and equipment, while the desktop application show the gauge testing procedures, test forms, populate most parameters of a specific test form with a click according to the reading from surface readouts, and finally send the data to Azure SQL Database. Lastly, the web application with the cloud database should provide an easier way of tracking the history of the tested gauges

Gauge Testing System Schematic Diagram





Acknowledgments

We want to thank our advisors Dr. Xiaomin Ma, Dr. Robert Leland, Dr. John Matsson and especially to Brian Haapanen for making this project possible. We are also very grateful to every support from Ryan Dodson, Shelby Williams, and James Edwards from Apergy.

Robot-Assembled Power Take-Off Research

Team RAPTOR

Presenters: Richard Ernst, Stephen Hilborn, and Benjamin Russell

Overview

Robot-Assembled Power-Takeoff Research (RAPTOR) utilizes collaborative robot technology to assist in the production of a clutch pack assembly, a subassembly of a power-takeoff. A collaborative robot is capable of working in close proximity with humans due to prepackaged resistive force and optical sensors that create a safe work environment.

The purpose of this project is to increase Muncie Power Products' (MPP) production capabilities for a specific line of power-takeoffs, the CS-10. This purpose is accomplished when the collaborative robot of choice, the FANUC CR-15iA, is capable of assisting an assembler to complete the production of the clutch pack assembly in half of the current assembly time. The fulfillment of this project allows MPP to delegate their employees to work on other, less repetitive, assignments.

In order to accomplish this goal, Team RAPTOR began this project by gaining an understanding of the current assembly approach, researching collaborative robot technology, and contrasting different collaborative robot models. Next, time studies were conducted to investigate the median assembly time to be halved. These studies yielded a time of 14 minutes for the current assembly approach, making the project's desired assembly time 7 minutes. The next phase of this project included measuring and calculating the required parameters for the robot's gripper, such as the max stroke, max gripping force, and weight of the gripper. The gripper to be used will serve as a 'universal' gripper, completing all of the necessary movements and grips required for the robot's assembly input. Finally, fixtures were designed by team RAPTOR to aid in the robot's contribution to the assembly.

Robot Cell Layout

At the start of the second semester, team RAPTOR (Figure 1) worked to virtually map out the most effective collaborative assembly station. Efficient part presentation to robot and parallel workflows between the robot and assembler were developed to reduce takt time. Effectiveness of the robot cell station and the collaborative assembly process was determined by programming and timing the robot's assembly steps and comparing these durations to calculated assembly step times. From these results, an updated Return on Investment was calculated and presented to MPP management, which was approximately 13 months. The design philosophy behind the cell layout was to supply the robot with components in strategic pickup positions such that the robot motion would be minimized, thereby reducing the CS10 assembly time (Figure 2 and Figure 3).

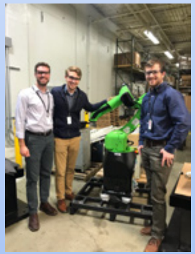
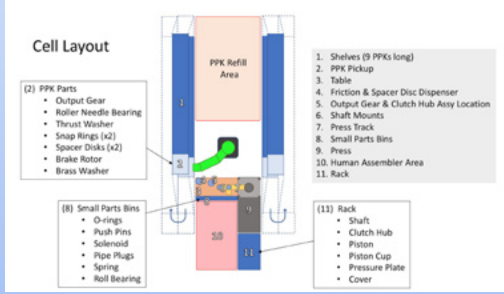


Figure 1: Team RAPTOR with Fanuc CR-15iA

Figure 2: Robot Cell Layout with label part locations


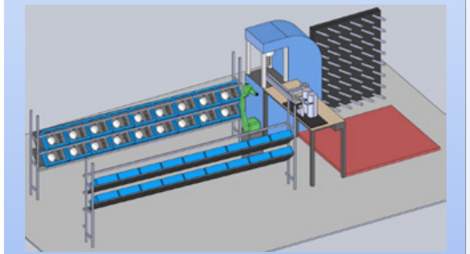


Figure 3: Robot Cell Layout SOLIDWORKS model

Fixtures

Two separate fixture concepts are currently utilized that will aid in decreasing assembly time. These are titled as follows: inner friction disk fixture and outer spacer disk fixture. The basic principles for the friction disk fixture and spacer disk fixtures are identical; these fixtures increase the angular and planar tolerances when adding the friction and spacer disks to the assembly. Figure 4 shows the new fixture concepts, which resemble funnels, and the CS10 assembly just before inserting the friction and spacer disks. The other primary area of focus was the part presentation to the robot for the parts of the CS10 assembly that would be handled by the robot. Figure 5 shows the Part Presentation Kit that is utilized to accomplish the task of delivering parts to the assembly robot.

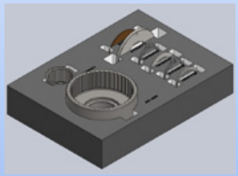


Figure 5: Part Presentation Kit

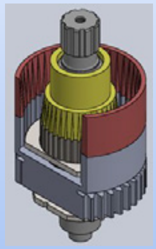


Figure 4: Sectioned view of shaft with fixtures

Acknowledgements

Team RAPTOR is incredibly grateful for the opportunity to partner with Muncie Power Products in this project. Muncie provided great direction and their contacts - Melissa Rucker and Clayton Young - have taught Team RAPTOR a lot of valuable industry knowledge.

In addition, Team RAPTOR thanks Dr. Leland for his advisory over this project for its first semester and Dr. Halsmer for his advisory over this project for its second semester.

Bibliography

Fanuc, "Fanuc Robot CR-15iA." Fanuc Corporation, Apr. 2018, PDF File.

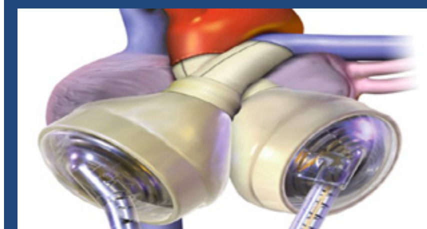
International Organization for Standardization. (2016). Robots and robotic devices -- Collaborative robots (ISO/TS 15066:2016). ISO/TC 299 Robotics. 25.040.30 Industrial robots. Manipulators.

Muncie Power Products. "Understanding Power Take-Off Systems." 6th ed., Rev. 7 - 08, 2008.

Rucker, Melissa. "ORU Senior Design Project 2018." Muncie Power Products. September 5, 2018.

3D Printed Artificial Heart

Matthew Kern, Jose David Hernandez, Jabulani Ndhlovu



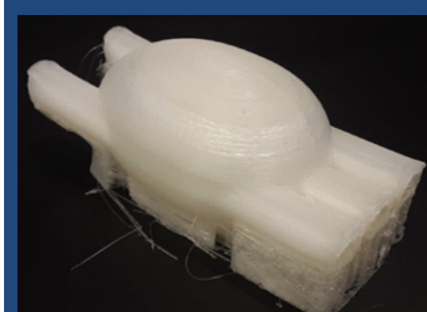
Many people around the world are in desperate need of a heart transplant. Due to a shortage of donors, research on total artificial hearts is greatly needed. The only artificial heart currently approved by the FDA is the Syncardia total artificial heart. This heart is very expensive, and its complexity increases the chance of a defect or malfunction. A new soft artificial heart was developed at the University of ETH in Zurich, Sweden. The researchers used a 3D-printed mold to create a soft artificial heart. Their design was able to pump liquid for more than thirty minutes without falling apart.

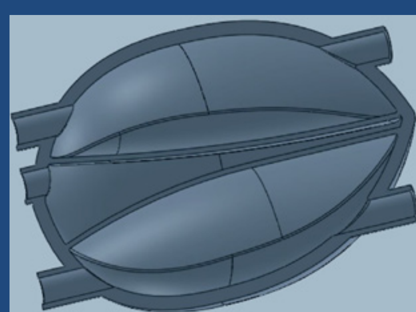
The purpose of our project is to design a soft artificial heart that can be created 3D printed in one piece. The goal is for our proof-of-concept heart to pump liquid for more than thirty minutes without falling apart.

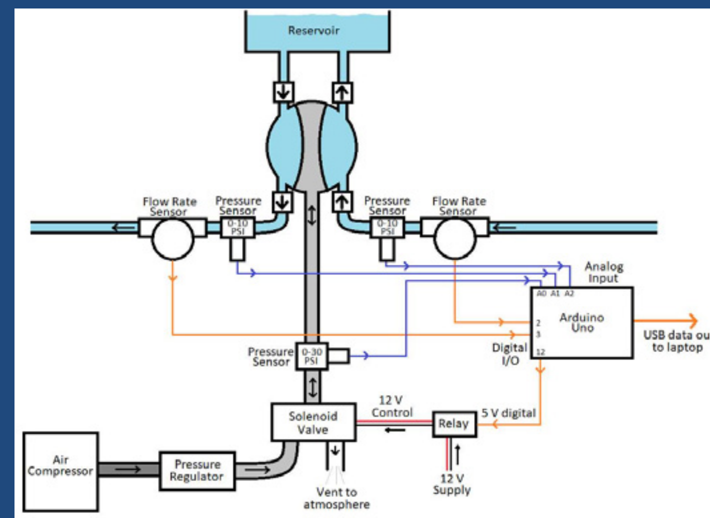
The human heart consists of four chambers, two atria and two ventricles. For simplicity and to follow in the footsteps of ETH Zurich, our model consists of only three chambers. Two of them are liquid chambers which allow liquid to flow in and out of the heart through unidirectional valves. There is an air chamber between the two liquid chambers.

When pressurized, the air chamber expands and pushes blood out of the fluid chambers. When the air chamber deflates, the pressure drops, allowing the fluid chambers to refill. The heart is then ready to pump again.

The barrier membrane between the air and liquid chambers is designed to buckle and invert when the air chamber is pressurized. Thus, the material must be very flexible to prevent damage to its structure.







Our first choice for material was the X 60 Ultra flexible filament. It stretches to seven times its original length without breaking. It is very durable and holds water remarkably well. These characteristics made it the perfect material to print the heart. Unfortunately, the manufacturer discontinued the filament and a new material had to be selected to finish the project.

The current filament used to 3D print the artificial heart is Ninjaflex. It has properties similar to X60 Ultra flexible filament, but is not as strong or stretchy. The thickness of the heart had to be increased and the shape changed in order to use the new filament effectively, to keep the membrane water-tight, and to improve fluid flow.

We used an Arduino Uno board to monitor sensors and control the air valve. Since the Arduino lacks onboard data storage, we output sensor logs to a laptop over USB.

We used inexpensive sensors to keep our costs down. Inexpensive flow sensors cannot report flow rate accurately over short intervals, but can watch for lasting anomalies, such as one side of the heart pumping significantly more fluid than the other.

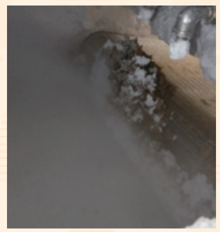
The pressure sensors have a response time of only 2 milliseconds, meaning we can poll them many times per second if desired. The main limitation is the speed of the Arduino's USB interface. This allows for a fairly detailed analysis of our heart's behavior.

National Steak & Poultry: Quality Meats (NSP)

Emmaus Lyon & Youngmin Lee

Purpose

CO_2 Tunnel Freezer in NSP often produces ball shape frozen meat fragment clumps. These frozen clumps lower customer satisfaction. NSP wants to get rid of the clumps and increase customer satisfaction.



Problem Statement

CO_2 tunnel freezer has an incline belt system for flipping product over and extending freezer dwelling time. Most of the clumps are built at the first drop of total 8 drop of the inclined belts in the freezer.

	Side [m]	Width [m]	Height [m]	Area [m^2]	Volume [m^3]	Characteristic Length, L_c [m]
Sample 1	5.5×10^{-2}	1.2×10^{-2}	0.7×10^{-2}	2.258×10^{-3}	4.62×10^{-6}	2.046×10^{-3}
Sample 2	5.0×10^{-2}	1.5×10^{-2}	0.5×10^{-2}	2.150×10^{-3}	3.75×10^{-6}	1.744×10^{-3}
Sample 3	5.0×10^{-2}	1.5×10^{-2}	0.7×10^{-2}	2.410×10^{-3}	5.25×10^{-6}	2.178×10^{-3}
Sample 4	4.7×10^{-2}	1.5×10^{-2}	0.6×10^{-2}	2.154×10^{-3}	4.23×10^{-6}	1.964×10^{-3}
Average	5.05×10^{-2}	1.43×10^{-2}	0.625×10^{-2}	2.243×10^{-3}	4.46×10^{-6}	1.990×10^{-3}
Standard Deviation	0.003317	0.001500	0.000957	0.000122	0.000001	0.000182

Initial Temp of the Product	Final Temp of the Product	Mean Temp of the Freezer	Time of the Freezer Takes	Density of Lean Beef (ρ)	Specific Heat of Lean Beef (C_p)
81.1 C	-47.2 C	-49.7 C	340 s	1090 [$\frac{kg}{m^3}$]	3540 [$\frac{J}{kg \cdot C}$]

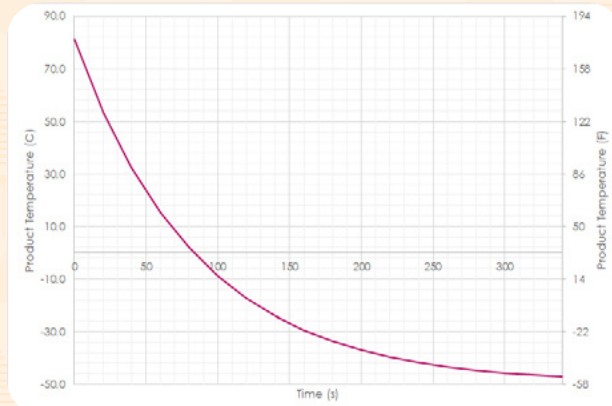
time (s)	Product Temp (C)	Product Temp (F)
0	81.1	178.0
20	53.9	129.1
40	32.4	90.3
60	15.3	59.6
80	1.8	35.3
100	-8.9	16.0
120	-17.4	0.8
140	-24.1	-11.3
160	-29.4	-20.9
180	-33.6	-28.5
200	-37.0	-34.5
220	-39.6	-39.3
240	-41.7	-43.1
260	-43.4	-46.1
280	-44.7	-48.4
300	-45.7	-50.3
320	-46.5	-51.8
340	-47.2	-53.0

Lump System Analysis

$$\frac{T(t)-T_\infty}{T_i-T_\infty} = e^{-\frac{hA_S}{\rho V C_P}t}, \quad h = \ln\left(\frac{T(t)-T_\infty}{T_i-T_\infty}\right)\frac{\rho L_C C_P}{t} = 89.4\,\frac{W}{m^2 \cdot C}$$

$$T(t) = (T_i - T_\infty)e^{-\frac{hA_S}{\rho V C_P}t} + T_\infty$$

Analysis



- NSP is overusing CO_2. They can save money by reducing CO_2 usage.

  They can stop the process line at t=110s since 10.4F is the product desired temperature.

- The fragments on the meat surface get frozen before they reach to the second drop of the belt.

$$\frac{Running\ Time}{Number\ of\ Drops} = \frac{340s}{8} = \mathbf{42.5s}$$

T(t=85s)=32F

Suggestions

- Installing a chiller in front of the freezer to freeze the products surface before they touch the first drop.
- Replace the first inclined belt system to a flat belt system.

ORU ORAL ROBERTS UNIVERSITY

COLLEGE OF ENGINEERING

TEAM: Kevin Diaz, Emily Garvie, Caleb Gomez, Daniel Leander, Tevin Macias

ADVISOR: Dr. Robert Leland

THE PROBLEM

There is a growing concern for the safety of students and the public across the United States of America. As mass public shootings increase in frequency and deadliness. During these situations, time is of the essence. TSS, Total Security Solutions, states that shooting incidents last anywhere between 2-5 minutes. During those incidents, an "unchallenged active shooter will maim or kill at least one person every thirty seconds." Proactive prevention is always the first concern because when shots are fired, seconds are the difference between life and death.

THE SOLUTION

Drone Reconnaissance And Confrontation, DRAC, is a multi-discipline project with the goal of deterring active shooters on school campuses. It is a response drone equipped with distractive platforms used to deter active shooters. DRAC was started in an effort to prevent casualties in schools. The goal of the drone is to challenge, distract, and deter an active shooter. This will increase the time schools and the proper authorities have to respond. The drone will operate in tandem with school security and the information technology departments to enable fast response from the drone. Panic buttons will alert the local authorities, security, pilots, and the drones. Once the pilot is alerted,

they will search for the active shooter using the camera and image recognition equipped on the drone. When the shooter is encountered, distracting deterrents can be enabled through the controller which connects over Wi-Fi.

APPROACH

How the drone works

The drone is designed to lift approximately 2kg for roughly 10 minutes. Its determined operating payload is 1kg. The payloads account for deterrents added to the drone. To meet this requirement, an X8 model was chosen to produce enough lift force. Two 5,000 mAh batteries account for the power draw of 8 motors.

Flashing lights, sirens, and a placeholder payload servo motor are the deterrents used. They are triggered by a USB controller connected to the Mission Planner CPU.

Ultrasonic sensors help avoid collisions by measuring the drone's proximity to obstacles by monitoring from the top, left, right, front, and back of the drone. An IoT (Internet of Things) panic button alerts local authorities, schools, and pilots. The ESP8266 WiFi Module responds to the push of a button and sends alerts through a host server to local authorities and security.

Controls and flight data are monitored through the Navio 2. The Raspberry Pi 3B+ hosts the code, interprets flight data, and provides access to Wi-Fi, object recognition, and output video. The softwares used include: Ardupilot, Raspbian, and Mission Planner. Ardupilot receives flight data and commands and sends them to the Raspbian software. Raspbian is the OS native to the Raspberry Pi. Raspbian provides a place for information to be accessed, edited, received, and sent. This information is sent to Mission Planner. Mission Planner is a GUI that displays flight data and commands. It is also a platform through which commands can be sent to the drone.

OBJECTIVES

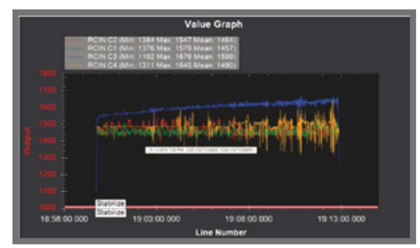
1. Navigate Hallways
2. Confront
3. Deter
4. Identify
5. Stream Video
6. 15 Minute Flight Time
7. Save Lives

STANDARDS

ASTM F2910-14 Design and Construction of a Small Unmanned Aircraft System (sUAS)

CONCLUSION

The project successfully navigates hallways with a ceiling, provides assisted flight for the pilot, streams video content, and has three fully controllable deterrents. With further trials, this could be a successful method for deterring school shootings. We achieved 13.5 minutes of flight time with a load of 1kg.



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Dr. Leland

Caleb Gomez

Submerged Cleaner with Undulating Tracing Execution (SCUTE)

Authors: Miqueas Barreiro, Lydia Reynolds, & Brandon Romer Advisor: Dr. John Matsson

Introduction

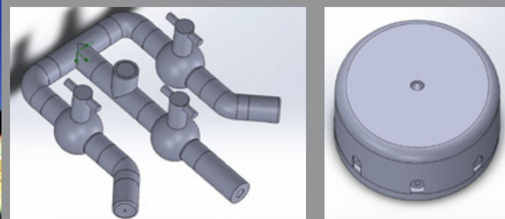
The Jenks Oklahoma Aquarium has expressed the need for a device that will regularly scrub, clean, and remove algae from the bottom of their quarantine tanks. The algae can develop into multiple colored strands that require different amounts of force to remove. SCUTE has been developed as an automatic algae cleaning device that has no electric parts, can withstand saltwater and bleach, and interacts safely with the animals.

Design

SCUTE is a device consisting of a fiberglass shell and base, two brushes, and a PVC pipe propulsion system. The fiberglass shell and base provide a smooth surface for the animal's safety. The brushes scrub the algae as the device moves along the tank floor. Figures 1-2 show the device's final SOLIDWORKS design. The PVC pipe propulsion system is the driving force that allows the device to move forward in a circular motion.

Theory

Water is pumped from the top of the tank through the hose and out of the propulsion system, creating enough force to propel the device forward. Newton's second law was used to calculate the thrust force necessary to propel the device. Linear-momentum equations were used to determine the pressure supplied by the pump that would produce enough thrust force flowing out of the device.



Figures 1 & 2: SolidWorks design

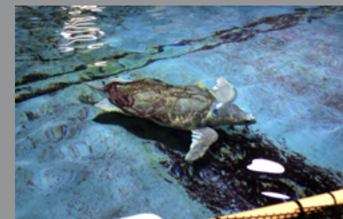


Figure 3: Algae on tank floor

Figures 4 - 6: Prototype design

Figure 7: Prototype outlet test

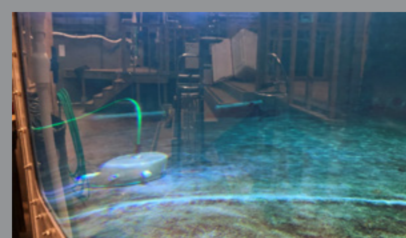


Figure 9: Prototype cleaning tank bottom

Figure 8: Pump setup for test

Table 1: Comparison of results

Goal Name	Hand Calculation Results	Simplified Version Simulation Results	Actual Version Simulation Results
Outlet Velocity	36.2 m/s	30.2 m/s	27.5 m/s
Inlet Velocity	9.04 m/s	7.54 m/s	7.67 m/s
Inlet Pressure	724319 Pa	724319 Pa	724319 Pa
Outlet Pressure	30648 Pa	30648 Pa	30648 Pa
Force in x direction	179 N	123 N	121 N
Force in y direction	412 N	365 N	365 N

Testing

Testing included SOLIDWORKS flow simulations and a full-scale prototype. Simplified and actual versions of the propulsion system were simulated to verify that the calculations were accurate. Table 1 displays the calculation and simulation results for the flow from the outlet to the inlet of the device. The results were similar which shows that the theory-based calculations are correct. The prototype, shown in Figures 4-6, was manufactured at ORU and tested at the aquarium, shown in Figures 7-9.

Conclusion

The current prototype requires a pump with a higher horsepower to overcome the pressure losses through the hose. In theory, the device should work with a pump that supplies the correct pressure and volume flow rate. After reevaluating the calculations and simulations, a few recommendations to change the device were determined:

- Removing of the main outlet transition
- Examining different size pipes
- Testing with a higher horsepower pump

Acknowledgements

Special thanks to Dr. John Matsson, the Oklahoma Aquarium, and ORU Engineering Department for support through the course of this project.