16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Posters
May 3, 2019

Design of a Solar Powered Water Pumping System for Living Love Ministries in Ol Kalou, Kenya

Presented by Christopher Benner, Joshua Kripas, Meghan Sampson, and Trey Witmer

The Solar Photovoltaics team is working with Living Love Ministries (LLM) in Ol Kalou, Kenya to help meet water needs for domestic use and irrigation with a solar powered water pumping system. LLM currently relies on a diesel generator to power their well pump. Solar power will be both more reliable and more financially practical in the long-term. Stanley Earth has partnered with the Solar PV team and LLM to donate a motor, pump, and pump controller system as well as a second backup system. Some important design questions considered this year were solar array sizing, wire sizing, panel mounting location, and the effect of mounting orientation. The Solar team is traveling to LLM this May to install the well pump and a 26 panel, 6.9kW solar array on Pamoja Hall at LLM to power the pump.

The Prosthetic Knee Project

Presented by Bryson Boettger and Matthew Tavani

Our project, The Prosthetic Knee Project, is partnered with the Centre for the Advancement of the Handicapped in Mahadaga, Burkina Faso, Africa and now with Cure Kenya. Due to a large number of trans-femoral (above the knee) amputees in these locations, our project aims to provide a low-cost prosthetic knee design (~$20) that can be easily manufactured using the tools and machinery readily available in both of these partner locations, and that can be compatible with the rest of the leg that our partners are able to provide. Throughout past semesters we have successfully researched, designed, and tested our knee and alternative device (pyramidal adapter) connecting the knee to the femoral and shank components of the leg. This poster will recap our knee design and testing with a local amputee and discuss further on our recent project work. Specifically, we will focus on our work on finalizing the alternative pyramidal adapter design. We will also discuss the fatigue and strength testing that our project has been able to perform and how that data impacts our knee design. With the help of Applied Health Science majors, we have also been working at creating a rehabilitation protocol for the amputees to use after their amputation. Finally, we will talk about our partnership with CURE Kenya, our upcoming trip to Kenya in May this summer, and how this will impact our project moving forward.

Panama Bridge Project

Presented by Erin Brenneman, Samuel Gobeille, and Nathan Myers

The Panama Bridge project has partnered with Rio Missions Panama to design a bridge for the village of Peñas Blancas, Panama. The mountain community of Peñas Blancas experiences heavy rainfall during the rainy seasons. A stream runs along the community, with mountainside homes to the north, and the main village to the south. While passable during dry seasons, the stream floods and becomes impassable after heavy rains. The mountain residents are effectively cut off from the village during this time.

To accommodate this need, the Panama Bridge Team has spent the 2018-2019 school year designing an aluminum truss bridge, spanning 80 feet. The design includes a unique construction strategy to deal with challenging site constraints.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Remote Hand Pump Monitoring in West Africa

Presented by Cory Brubaker and Amanda Issis

Although millions of households in sub-Saharan West Africa rely on hand pumps installed by various non-government organizations, 30 to 50 percent of these pumps are currently inoperative. Under the sponsorship of AlignedWorks, the Intelligent Water Project (IWP) is continuing to develop remote monitoring devices that track the usage and health of hand pumps. These devices allow organizations to catch pump failure early so that these water pumps can remain operational, continually providing fresh water. After installing thirteen of these devices in the summer of 2017, the IWP has been working to correct problems that were discovered from these field tests, while also improving system accuracy and robustness, and preparing for mass manufacturing.

Oakwood Hills Pedestrian Access

Presented by Matthew Burlew and Christian Cornelius

This year, the Oakwood Hills Pedestrian Access Team has been working with Rider Musser Development, LLC to expand their trail network with the creation of a pedestrian crossing of the on site stream. The team has worked to determine possible options and assess them to find solutions that would satisfy the crossing criteria. In determining the greatest option, the team has created a decision matrix, stream survey and conceptual Type, Size, and Location report to deliver our findings to Rider Musser.

All-terrain, Customizable Wheelchair for Wheels for the World

Presented by Emily D'Amico, Carlie Adair, Sam Fino, and Ivan Chun Hao Oon

The Wheels for the World Team strives to create a practical mobility option for individuals in developing nations who are unable to move on their own. The device will allow the same mobility as a wheelchair while remaining affordable and practical. This project is working with Wheels for the World (an outreach of Joni and Friends) to create a design which will be capable of being mass-produced at a low cost in the United States, shipped anywhere in the world in a box, and then assembled in the country of use. A major requirement for the design is that it should be fully customizable to fit different users and be fully collapsible for easy storage and transportation.

The team has developed a design for this device which is similar to a tricycle; however, in this design the third wheel is in the back. This design uses plates and bolts to hold together telescoping square tubing, which acts as the backbone of the design with the seat, wheels, and a footrest attached to this tubing. A shock absorber system was also included to reduce impacts from road variations. A manufacturing manual and assembly manual, which are to be provided with the design, have been completed.

The team is currently in the process of redesigning the wheelchair, making several adjustments recommended by our client and physical therapists from Messiah's Doctor of Physical Therapy program. A new prototype will be built in order to evaluate the redesigned wheelchair. The team will finish documentation of all redesigned parts and update the manufacturing and assembly manuals accordingly.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Developing a Low-Cost Optical HIV Viral Load Detection System

Presented by Alicia Decker, Nathan Chan, Brant Meier, and Morris Taylor

Our client, the Macha Mission Hospital in Zambia, has asked our team to create a low-cost point of care device for measuring HIV viral load in infected patients.

Our team plans to detect HIV using a fluorescent recombinant protein that binds to HIV specifically. Fluorescence Correlation Spectroscopy (FCS), a laser-based technique, is then used to quantify the viral load. Currently, we have developed a tentative method for viral isolation from a blood sample, produced and validated a fluorescent protein probe, designed a prototype printed circuit board for detecting single-photon fluorescence, and implemented hardware to process the signal and display results to the end user.

Optimization of the Design of a Solar Oven for Refugees Use in the Kiziba Camp, Rwanda

Presented by Miriam Dixon, Justus Danielsen, Jason Landis, and Mitchell Lauer

The project team is working with our client Dr. Michael Pucci, Director of GO-ED. The team's goal is to create a solar oven for the community in the Kiziba Refugee Camp, Rwanda. The camp was founded for Congolese refugees with Rwandan cultural roots who had fled to Rwanda to escape the genocide wracking the Congo. It is still dangerous for the people to return there, and they are not likely to be resettled elsewhere, so they are left trying to integrate into the local community. Recent changes to the distribution and amount of UN resources has further strained their already tenuous financial position. The team hopes to design an affordable solar oven that can heat up to 300°F to be able to render tallow and be made of locally sourced materials with a cost of less than 10000 RWF ($12 USD). This, in turn, will then provide the refugees with a marketable product and a sustainable and profitable business model. GO-ED would like to use this to create a "business in a box" where they would standardize the oven's use in a franchise model that would include training, equipment, contracts, and licenses. This in turn could be shared with other NGOs.

Energy Monitoring and Management System

Presented by Nathen Feldgus, Zachery Holsinger, Zachary Schmidt, and Ben Weaver

The Energy Monitoring and Management System facilitates access to electric power in regions with limited energy by increasing energy conservation and education. The solution consists of a meter which allocates a configurable daily energy limit per facility, and a display that provides practical information to the user including reporting how much energy they have used and how much they have left before their power is automatically cut off until the next day.

The current version of the system has successfully been installed in multiple facilities in Burkina Faso and Zimbabwe. Currently, the team has completed the redesign of the system's power sense module to increase performance to meet client specifications. In addition, we have increased the manufacturability of our enclosure through redesigning our baseplate. Finally, we developed a full manufacturing process for our meter, as we are traveling to Zimbabwe this May and need to manufacture 30 meters. This presentation will detail the steps made to redesign the power sense module as well as baseplate redesign and manufacturing process leading up to our Zimbabwe site team trip.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Cunningham Clubfoot Brace

Presented by Aaron Bashore, Rebekah Forshey, Liam Lilienthal, Michelle Lo, Benjamin Mellott, and Leigha Southall

Clubfoot is a musculoskeletal birth defect that describes several foot abnormalities characterized by an inward-rotated foot. The current method for correction involves several casts and a boots-and-bar maintenance brace. This method requires 5 years of bracing and has issues with compliance, comfort, and social stigma. The Cunningham brace reduces treatment time to 2-3 years. It can be concealed, reducing the social stigma, and improves the child's mobility while encouraging muscle growth and development throughout treatment. The Collaboratory Cunningham Clubfoot Brace project seeks to increase accessibility to the brace and test the effectiveness of the design. The project has shown that the brace can be 3D printed using a reinforced nylon polymer. The 3D models developed by the team have allowed our client and brace designer, Mr. Jerald Cunningham, to move forward with injection molding of the three parts of the brace. Currently, we are working on validating the Cunningham Brace by measuring the biomechanical forces created and applied by the brace. This will happen through a series of pressure sensors that are attached to the brace and then placed on a child's foot. Along with a clinical study that was started in Kijabe, Kenya and the patient data analysis being conducted by Dr. Emily Farrar, this data will hopefully provide the needed evidence that the Cunningham Brace works so that it will be more widely accepted and used for treatment around the world.

Sustainable Agriculture: Soil Free Farming

Presented by Jared Fonda, Landon Hacker, and Noah Shreiner

The sustainable agriculture team is dedicated to developing alternative and sustainable agricultural solutions to alleviate poverty. The team is currently working with Sheltering Wings in Yako, Burkina Faso. Sheltering Wings is a women's shelter and orphanage that has a nonfunctional aquaponics system. The goal of this project is to troubleshoot and fix the aquaponics system through developing cost-efficient modifications and supplying a working procedure on the operation and maintenance of the aquaponics system. In order to achieve this goal, the sustainable agriculture team needs to be able to understand how an aquaponics system works in the areas of biology, irrigation, structural design, and vegetation. Following research and testing, the team designed and built a system prototype, along with a greenhouse. The team will move forward with testing the system prototype in the semesters to come.

Mechanized Percussion Well Drilling

Presented by Nathan Henry, Nate Harnish, and Chris Martin

The Mechanized Percussion Well Drilling Project seeks to design a simple mechanized well drilling system to be used for drilling shallow water wells in Burkina Faso, Africa. These systems will be operated by local drilling teams, allowing them to earn an income for themselves and their families. Currently our client, Open Door Development, has trouble drilling through hard rock layers, and often must abandon holes due to inadequate equipment. The goal of this project is to enable our client to efficiently drill through these rock layers with a mechanized percussion rig and supporting drilling equipment.

One of the areas the project has focused on this year was increasing the life of the cathead, a critical piece of the drilling rig which severely wore during in-country testing in the summer of 2017. The team determined that the aluminum cathead was not able to resist the wear of the rope, which had particles of dirt and rock embedded in it. The team tested catheads made of steel, wood, and different plastics, and steel was found to be the most viable solution. In order to verify the life of the cathead, the team designed and manufactured an automated testing rig. This rig will allow the team to test the cathead continuously and determine if a steel cathead will last for at least 50 hours of drilling.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Living Love Ministries - Kenya Land Development

Presented by Isaac Albrite and Jacob Holderman

The Land Development in Kenya team has partnered with Living Love Ministries (LLM), an organization that operates a children's home in Ol Kalou, Kenya, to design an irrigation system to help grow year-round produce and crops to increase self-sufficiency at their facility. The LLM community experiences a significant hot and dry season that affects their ability to grow crops during this time, and they have requested that the Land Development team initially design a system to irrigate two acres of cultivated fields at the children's home. The irrigation system will tie into LLM's elevated water tower currently used to supply water for daily operations. Water will overflow from this tower to an auxiliary storage tank to provide additional water capacity for the irrigation system. A booster pump will be used to pressurize a main trunk line of a drip irrigation system that will feed a series of emitters which control irrigation specific to plant types and row configurations over a nominal 2-acre area. The team has planned a site trip to Kenya in late May 2019 to install the main components of this initial system, and hopes to modularize the system so that LLM will be able to expand their irrigation in a simple and effective manner.

Flight Following System Redesign

Presented by Matt Hoppe and Eric Marra

Outside radar range, small planes flying in remote locations must be tracked by other means. Emergency relief, humanitarian development, and missionary organizations need to follow such flights, for safety and management. The Automatic Flight Following System (AFFS) owned by JAARS has been safety tested and used extensively for this purpose but has been replaced in many cases by new options. Thus, the Flight Tracking and Messaging Systems (FTMS) team has been working with stakeholder Cary Cupka to redesign AFFS 1.0 with updated and more advanced technology modes to increase its value in the field. For proof of concept testing, this includes replacing internal components of the existing AFFS Aircraft Control Unit (ACU) with a new single board computer (SBC A62), upgraded custom display board, and new HF transceiver (LimeSDR). In addition, the ground monitoring unit will have a matched LimeSDR HF transciever, and UDOO QUAD computer with display. Currently the team is developing code for the aircraft (FLIGHTsoft), for the ground unit (GROUNDsoft), and configuring the HF communications link.

Fluency Assistive Device (FAD)

Presented by Michael Jenkins, Jessica Paulus, and Larry Vega

Currently, in the world, about 1% of the population (70 million people) have a stutter. Approximately 5% of children stutter for about 6 months and 1% have a long term stutter. This device, originally known as the Edinburg Masker, was created to assist people who have a stutter, but have not been helped by therapy. A stutter has been defined by the American Speech-Language-Hearing Association (ASHA) as a fluency disorder. Few fluency assistive devices exist for this population, and the ones available are highly expensive or unreliable. The Fluency Assistive Device (FAD) team strives to address this deficiency. Our client, Dave Germeyer, serves a niche community of people who rely on a masker. Improvements are needed to update the components and apply new methods recommended by our client. The FAD team will conduct research and testing to develop an upgraded prototype solution. In the future, we will move towards a new design to serve this community more effectively.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Village Water Ozonation System

Presented by Jordan Criddle and John Khamis

Safe drinking water is a basic human necessity. People around the world face issues like water scarcity, severe contamination, and limited access on a daily basis. Alleviating global water-related illnesses and deaths remains a prevailing challenge to overcome. Therefore, the Village Water Ozonation Systems (VWOS) team contributes to the worldwide effort to increase access to safe drinking water. For the past two years VWOS had the privilege of walking alongside our partner communities in Mexico, Pakistan, and Nicaragua to develop sustainable drinking water solutions. Through collaborations with several Christian organizations such as Forward Edge International in Mexico, Full Gospel Assemblies of Pakistan and, more recently, Friends in Action International in Nicaragua, the team has acquired an increased awareness of drinking water needs and issues across the world. Each individual partnership presents unique challenges with regards to culture, economics, and local environment that require a complete understanding of our partners' needs, the proper application of water treatment knowledge, and the prioritization of health in all aspects of the design process. In order to address the unique challenges facing each of our partners, the team relies on past experience as well as new research to develop the most appropriate solution, evaluating the feasibility of a project from technical, financial, and cultural perspectives.

Disarming Improvised Explosive Devices (IEDs)

Presented by Justin Barber, Hunter Casey, Nuttapat Kueakomoldej, and Andrew Kurian

Our client, the HALO Trust is an NGO that works with many governments around the world to remove landmines and defuse explosive devices. We are tasked by our client to build a remotely activated wire cutter that will be used to defuse improvised explosive devices (I.E.D). While there are readily available commercial alternatives, these are either too expensive, use explosive components that are restricted in many places where HALO is working, or lack the cutting precision they would like to have. For this device, they want a cutter that is waterproof, sand proof, mud proof and shockproof, which will make it suitable for the harsh conditions in which they often have to work. We came up with 3 designs for our prototypes, a ceramic blade shear cutter, a steel blade shear cutter, and an anvil cutter. All of the prototypes are powered by a waterproof linear actuator. The actuator gives enough power to cut the required thickness of wires the de-miners will face in the field.

Nicaragua Manual Block Press

Presented by John McGarry and Kathryn Rose

The Block Press project is developing a manual block press to produce compressed earth blocks used to construct various buildings on the east coast of Nicaragua. Friends In Action International tasked the project to design an easily mobile, lightweight (2-3 people can carry), simple manual press for the Rama community requiring only 1-2 people to operate. The press needs to make an interlocking 12”x6”x4.25” clay-sand-cement brick efficiently (~200 a day) to be used for the new buildings. A SolidWorks model was designed, analyzed and used to fabricate the first block press that was tested in Nicaragua in June 2017. The first press was brought back to Messiah College and modifications were made. A second press made of stainless steel to combat the rusting problem in the first press was fabricated by E&E Metal Fab. Inc., based on the modifications done to the first press. The second press' viability as well as five block mixtures are currently being tested by the 2018-2019 Block Press team. This testing allowed for an improved design for a third press. The 2018-2019 team has sent the 3D model and engineering drawings to E&E Metal Fab. Inc. for fabrication. Once tested and assured of the third press's viability, it will be given to Tim Johnston and Friends In Action International. Two to three more presses will be fabricated for Friends In Action International from this third press design if the testing goes well.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Design of a Gravity Fed Water System to Deliver Safe Drinking Water to Villages in Vanuatu

Presented by Sarah Aldrich, Jordan Higley, and Ella Sobek

In the Big Bay region of Espiritu Santo island, Vanuatu, approximately 1350 people living in 30 rural villages lack direct access to safe and potable water. This deficiency can have significant negative effects on the health and livelihood of these communities and may limit their ability to grow both socially and economically. Therefore, the Gravity Fed Water - Vanuatu project, in partnership with Friends in Action International, has designed a gravity fed water system to be implemented to provide easy access to clean, safe, and drinkable water. The system consists of an intake structure at the water source and continues with about 16 miles of pipe to deliver water from the source to storage tanks in the villages along the route; the system requires no external energy to run. Friends in Action International plans to begin construction of the system in the summer of 2020. The team hopes that implementing the gravity fed water system will help to improve the health and livelihood of the villagers and to provide more opportunities for social and economic growth.

Pico Hydro Design for the Developing World

Presented by Robert Dickey, Johnny Greaser, Cameron Kantner, and Caleb Southwick

Access to renewable and sustainable energy plays a vital role in eliminating poverty and enabling economic opportunities. The Pico-Hydro team has the unique opportunity to design a product that gives a point of access to renewable and sustainable energy via small scale hydro power. This poster outlines the team's progress toward a general hydro prototype which will be deployable in streams worldwide fitting certain stream parameters, as well as a site-specific hydro design opportunity in Panama.

Design of 3D printed orthotics and bacterial testing on silicone liners for CURE Kenya

Presented by Emma Vogan and Shane Curry

Our project, Rapid Orthotics for CURE Kenya, partners with CURE International's charitable hospital in Kijabe, Kenya, in order to implement a 3D printing system into their orthopedics department to rapidly produce orthopedic and prosthetic devices. CURE is a Christian nonprofit organization that provides medical care to children who suffer from orthopedic and neurological conditions. They asked us to design a 3D printing system that helps them shorten the time it takes them to make prosthetics and orthotics while also lowering the cost. One of the requests from the client during our site team trip in 2018 was a way of producing their dynamic ankle-foot orthotics using their current 3D printing system. As of now, we are in the process of finishing a training manual with instructions for making the newly designed 3D printed dynamic ankle-foot orthotics to deliver during our site team trip in May 2019. Additionally, our client asked us to analyze the feasibility of replacing their current Ethylene Vinyl Acetate prosthetic liners with silicone prosthetic liners. One major concern with this is that the tight fit produced by silicone liners may be dangerous in low-resource settings and humid environments due to harmful levels of bacterial growth. This has led to the designing and testing of a procedure to analyze bacterial growth on silicone liners. From this we want to be able to inform them of the feasibility of using these liners by May 2020.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Sight and Sound Remote Latching System

Presented by Cory Hurst and Alexander Vollert

The Sight and Sound Remote Latching System team is partnering with Sight and Sound Theater in Lancaster, Pennsylvania to develop a remote-operated latching system for the theater to use in its shows. Sight and Sound Theatre, a theater company which produces Biblical-based musical performances, uses massive set pieces for visual displays and stages for actors to perform on. Some of these set pieces must be connected together and are joined using hand-operated latches. Occasionally these latches are in hard-to-reach places or need to be operated at inopportune times, which increases stress on performers and stagehands. The goal of our team is to develop a latching mechanism which will eliminate the need for these hand-operated latches.

Our team began by looking at various latching mechanisms and ultimately decided to base our design on a common cabinet latch. The basic design consists of two parts each attached to a different set piece: a pneumatic cylinder on one set piece, and the latching mechanism on the other. The piston extends a bolt head towards the latch which clamps onto the head of the piston. This allows the pneumatic cylinder to pull the two set pieces together and securely hold them until the end of the scene. For this use, we had to scale up this design of the latch mechanism from a common cabinet latch and modify the design significantly. We created virtual models of the mechanism parts in a solid modeling software and produced plastic prototypes of our latching mechanism using 3D printers. After revisions were made based on these models, we fabricated a steel prototype for physical analysis.

This metal prototype was tested in different configurations and for reliability, wear, and strength. This led to more design changes and retesting. The final design was attached to real set pieces belonging to the client. After months of testing the latch prototype, we have confirmed that the design functions as intended.

Sustainable Mobility for Persons Living with Disability in West Africa

Presented by Helen Wiley, Katie Bunch, Dylan Derstine, Matthew Higgs, Faith Kerlen, and Emma Workman

The Sustainable Mobility Project empowers people living with a disability in the developing world to fully participate in family and community life and makes possible the pursuit of educational and work opportunities. The Collaboratory 3-wheeled off-road wheelchair design is well-regarded among mobility practitioners. Our design has already transformed the lives of dozens of clients through a partnership with the Center of Hope in Fada, Burkina Faso. Now to reach more people in new locations with more partners, the Sustainable Mobility team is reducing manufacturing time and cost, developing supply chains to bring parts and materials to build sites, and developing a turn-key business model that puts local fabricators to work building tricycles wherever they are needed. With our client, SIM Burkina Faso, we are establishing a mobility manufacturing center in Fada, Burkina Faso. Finally, we will work to facilitate the formation of a new independent entity to manage supply chains and to facilitate the formation of additional small businesses that will produce our design in the developing world.

16th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

May 3, 2019

Design of Muscle Activated Prosthesis

Presented by Nicholas Ports, TJ Quintilian, Samuel Whittle, and Ryan Yoder

Children are among the primary patients needing a prosthetic device as over 2,250 children per year are born with a residual limb. However, many children do not have access to the health insurance benefits that would allow them to afford an appropriate device before the age of 14 since a realistic-looking, functioning myoelectric prosthesis costs more than $20,000. Our local partner, Eric Shoemaker of Ability Prosthetics and Orthotics, has a 11-year-old patient who would particularly benefit from a myoelectric prosthetic device, an externally powered artificial limb that is controlled by the electrical signals generated by one's own muscles to give the user more freedom and movement than a mechanical prosthesis. Our team will use biomedical, electrical, and mechanical engineering principles to design a low-cost (estimated $1000) muscle-activated prosthesis utilizing 3-D printing technology to print the hand, forearm and socket customized for the anatomy of our patient. After reading electrical signals from the muscles, sensors relay various patterns and intensities of muscle contractions to a microprocessor that then converts the data into commands for electric motors to move finger joints to open and close the prosthetic hand. We hope through this project to make the best possible treatment available to our client and other patients in need of a prosthetic device.