

# 15<sup>th</sup> Annual School of Science, Engineering, and Health Symposium

## Engineering IPC Presentations

May 4, 2018



**8:20 AM**      ***Bringing Sustainable Mobility to Persons Living with Disability in Rural West Africa***

**Frey 110**      Presented by Jakob Davenport, Kristen C Frawley, & Joshua D Kunkle

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 partnership with the Center for the Advancement of the Handicapped (CAH) in rural Burkina Faso, West Africa.

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. We are working towards 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. In the past year, the Sustainable Mobility team has made significant progress towards preparing professional-quality documentation for the fabrication and assembly of our electric tricycle, which will allow us to pursue the formation of a business model and supply chains.

**8:40 AM**      ***WERCware Test Bench***

**Frey 110**      Presented by Mark A Musselman, Derrick N Peterson, & Josh D Thomas

The Wireless Enabled Remote Co-presence (WERCware) team has focused most recently on the goal of broadly verifying the viability of voice analysis for human stress detection, since stress can indicate the need for social intervention or remediation in people with high functioning autism. To facilitate this goal, WERCware has been designing a research-oriented testbench (WERCbench) including a convenient Graphic User Interface, and an Artificial Neural Network (ANN) previously developed for voice analysis. The ANN determines whether voice data of a human subject is stressed by analyzing recorded experimental data, after having been trained on sample data from the same subject. Running as an app on a laptop, WERCbench uses an attached microphone to record audio, processes the audio, and provide time-stamped indicators for the user. Thus, WERCbench serves as a research tool to help broadly verify the viability of audio stress detection, which will work toward the development of an overall assistive system to provide more efficient and cost effective remote social coaching for those who need it.

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**9:00 AM**  
**Frey 110**

***Safety and Design of 3D Printed Prostheses and Orthotics at CURE Kenya***  
Presented by Erik Dyrli, Emma K Vogan, & Daniel J Yeisley

The Rapid Orthotics for CURE Kenya (ROCK) team has been working in conjunction with CURE International and their hospital in Kijabe, Kenya to implement a system to 3D print prosthetic devices. In the summer of 2017, our team successfully delivered a 3D printing system to Kenya and conducted a two week training for hospital staff. This year, we had two major follow up endeavors: to expand the capabilities of the system to include 3D printing of orthotic devices and to quantify the safety of the 3D printed prosthetic devices. Our team successfully assessed the safety and viability of the current prosthetic design by conducting mechanical tests on the sockets and 3D printed PLA. ASTM D368 and modified ISO 10328 were used to conduct tensile and compressive tests on our devices. Test results indicate that the 3D printed prosthetics are safe up to a load of 1200 pounds, far exceeding how a prosthetic would be loaded when in use by a patient. We have also used the material properties derived from the test results to create an empirically validated finite element model that will be used for further testing and design.

**9:20 AM**  
**Frey 110**

***Pico-Hydro Electric Power Generation for the Developing World***  
Presented by Shane D Braunworth, Jonathan J Rogers, & Caleb C Sisson

The goal of the Pico-hydro project is to provide Engineering Ministries International (EMI) with an in-stream, tested hydroelectric generator capable of generating between 300-800W of electric power. The driving motivation for the project is to help meet the existing electrical need of people in developing communities around the world. In the academic year 2016-2017, testing was conducted on three prototypes provided by EMI in order to determine their feasibilities. These prototypes were deemed insufficient to produce the required power output at low stream velocities. As a result, the team is no longer considering them, and in the summer of 2017, the pico-hydro team decided to pursue an undershot water wheel design that is being designed, manufactured, and tested during the academic year 2017-2018. Currently, the team is working on manufacturing a testing rig and waterwheel to be tested in the spring of 2018. In addition, the team has chosen a generator to use and is currently designing a housing system.

**9:40 AM**  
**Frey 110**

***Block Press***  
Presented by Adam T Janney, Addison A Morrone, & Brandon M Shirk

The Block Press project is developing a manual block press to produce compressed earth blocks used for building residential housing off the east coast of Nicaragua. The Block Press group has collaborated with Tim Johnston of Friends in Action to design a simple manual press requiring 1-2 people to operate. A SolidWorks model was designed, analyzed and used to fabricate a block press that was tested in Nicaragua in June, 2017. The prototype was brought back to Messiah College and modifications were made. A new Block Press will be permanently taken down to Nicaragua before May, 2018.

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**10:00 AM**  
**Frey 110**

### ***Making Clean Water in Developing Countries Sustainable***

Presented by Matthew Eshleman, Robert D MacBride, & Owen P McCullum

In 2010, the United Nations General Assembly explicitly recognized the human right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to the realization of all human rights. NGO's throughout the world attempt to address this need by installing wells and pumps to provide access to clean water. The problem our project addresses is the sustainability of the water access points provided by our partner NGO Water4 in the smallest and poorest communities it serves in Ghana. Water4's approach is to hire community members for the construction and upkeep of wells and pumps. By charging fees for water usage, Water4 hope to lay the foundation for sustained access to clean water for the community and provide economic growth for those responsible for the wells. This will provide not only the clean water needed by each community, but also a dependable source of work for community members. The goal of our project, PumpMinder, is to enable Water4 to meter hand pump use in order to collect maintenance fees used to maintain pump equipment and ensure the long-term presence of water assets. Water4 does all the on-the-ground social work and installation in rural communities in Ghana. Our team has designed the tool necessary to monitor the fees charged by the local community member employed by Water4. This year we have focused on delivery of units for a pilot program in south west Ghana and on refining the functionality and ease of use of the system.

**10:20 AM**  
**Frey 110**

### ***Remote Monitoring of Water Pump Health in Developing Countries***

Presented by Kelsey E Nichols & Sandra B Snozzi Solther

Millions of communities in developing countries rely on hand pumps installed by various non-governmental organizations (NGOs). Studies have shown that these pumps are often broken with significant delays before maintenance people arrive. The Intelligent Water Project (IWP) has developed an automated sensor to report failure of one of these hand pumps and provide data necessary for implementation of a proactive maintenance policy. Currently, there are 13 IWP systems installed in Ghana, Africa, the most recent installed by a site team in Summer 2017. Team efforts this past year have been in response to results obtained from the field. Testing and design changes to the battery and the accelerometer will extend system life. In an effort to gather information from fielded systems for remote diagnostics, system firmware has been modified and a new diagnostic board has been fabricated to collect and store performance data.

**10:40 AM**  
**Frey 110**

### ***Fire Protection for Developing Communities***

Presented by Jacob Film & Austin T Kratz

The Institute for Affordable Transportation (IAT) is a not-for-profit public charity "devoted to improving the lives of the world's poor by providing simple, low-cost vehicles in order to facilitate community transformation." The centerpiece of their work is the Basic Utility Vehicle or "BUV" Recognizing that the communities they serve seldom have access to proper firefighting resources, IAT has partnered with Messiah College, through the Collaboratory, on developing a way to enable the BUV with firefighting capability. The proposed solution is a "firefighting insert" which can be easily placed into the bed of the BUV. This insert is a relatively simple design which minimizes maintenance requirements and initial cost while being easy to use and store. The current design utilizes a wooden frame (called the skid) which supports water storage tanks, houses the necessary plumbing, and holds a small pump, engine, and hoses. The initial design is now complete as is acquisition of all major components. Once assembled, testing will be conducted which will, in turn, inform future refinement of the design.

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**11:00 AM**  
**Frey 110**

### ***Wheels for the World Wheelchair Project***

Presented by Daniel C Gallagher, Ryan D Moyer, Joseph J O'Connell, Antonio G Ortiz,  
& Wesley N Ramirez

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 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 be fully adjustable 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.

The team has constructed a prototype which is being used to make final modifications to the design. A manufacturing manual and assembly manual, which are to be provided with the design, have been completed.

The next step in the process is that the Wheels for the World organization will begin constructing additional prototypes in their facilities and determine additional adjustments to improve manufacturability to be incorporated into the final design.

**1:00 PM**  
**Frey 110**

### ***Gravity Fed Water System for Vanuatu***

Presented by Jamar A Gittens, Nathan J Hardman, & Shung Yen Tan

Approximately 30 villages in Espiritu Santo, Vanuatu have been identified to lack direct access to safe and potable water. This deficiency can have significant effects on the physical health and livelihood of the communities in Vanuatu while severely limiting their ability to grow socially and economically. Therefore, Friends in Action International has partnered with a local church in one of the villages to produce a suitable solution, specifically a gravity-fed water distribution system. The system--which has a zero-energy footprint--aims to transport safe, potable water to all the villages from a water source located at a higher altitude relative to these villages. The Gravity-Fed Water team has been working with Tim Johnston, the executive director of Friends in Action International, to design this system for the villages. It is the team's hope that the implementation of the system will also aid in improving the health and livelihood of the villagers while providing the opportunity for them to grow and achieve social and economic stability.

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**1:00 PM**      ***Design of a Solar PV Power System for the Living Love Ministries  
Children's Home in Ol Kalou, Kenya***  
**Frey 150**      Presented by Jessica R Kline, David J Moretz, & Joshua D Patterson

A lack of reliable electricity can prove a significant hindrance to any organization. Living Love Ministries (LLM), in Ol Kalou, Kenya, has experienced just that. While trying to minister to the needs of thirty orphans living at their Children's Home, and with a hope to expand the number of children taken care of in the next few years, LLM has been impeded by the unreliable Kenyan electric grid, which can go off unexpectedly for days to weeks at a time. Without a consistent source of refrigeration for their food supply, light in the evenings for the children to complete their homework, or the power necessary for the staff to use their essential laptops and computers, LLM has been looking for a new solution. As part of that solution, the Solar PV team of the Collaboratory has designed a 3.8 kW, off-grid solar panel system, and plans to install this during a three week site team trip at the end of May. The details of this design and site team plan will be presented in this presentation.

**1:20 PM**      ***Sawyer Filter Test System***  
**Frey 110**      Presented by David Patawaran

The Sawyer PointOne(TM) household water filters have been proven effective in removing microorganisms from drinking water and have been shown to reduce waterborne diseases in communities where the filters are implemented. This project is examining the long-term performance of these filters in a laboratory setting. Twenty-four filters are being run in parallel with continuous flow and periodic back-flushing. The flow and pressure through the filters is measured over time and the filters have been tested periodically for bacteria breakthrough. All filters have shown that they continue to remove 100% of bacteria after 60,000 gallons each and meet EPA removal standards.

**1:20 PM**      ***Flight Tracking and Messaging Systems (FTMS) Development***  
**Frey 150**      Presented by Hoang H Nguyen & Samuel A Rice

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 on redesigning AFFS for more advanced technology modes to increase its value in the field. This includes replacing the existing Single Board Computer (SBC) in AFFS 1.0 with the UDOO QUAD board for prototyping. The team also created a redesigned pilot display board prototype and fully verified its functionality. To facilitate testing, the FTMS team bypassed the HF modem of AFFS 1.0 via an RS-232 serial communication link, successfully transmitting GPS and flight critical information from the pilot module to a ground-based monitor running AFFSWin (AFFS software for Windows). Through research and testing, the team also determined necessary power requirements of the future Aircraft Control Unit (ACU) power supply.

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1:40 PM  
Frey 110

### ***Sustainable Water Treatment System***

Presented by Daria Eshelman & Erwens Fleurant

Some communities all over the world, including regions of Latin America, Africa, and Asia, do not have sufficient access to clean and sanitary water for daily use. They may not have any form of effective water treatment systems, or they may have systems that are effective, but do not have a sufficient output to reliably provide for the whole community. The mission of the Sustainable Water Treatment System project is to provide a cost-efficient water treatment system that can handle higher outputs of water. The SWTS team is partnering with the Christian engineering nonprofit organization, Water Mission, to create a design for a water treatment system that can be adapted for various locations and implemented in a rural community in the Intibuca region of Honduras. Successfully developing and implementing a system with these standards would benefit many communities, found in countries such as Honduras, Peru, and Tanzania to have sufficient access to clean and potable water for daily use. A key requirement of the project design is to develop processes that can utilize locally available materials and minimize electricity use. The project's deliverable is a complete design for a water treatment plant that Water Mission (NGO) can take and easily convert to a physical plant.

1:40 PM  
Frey 150

### ***Biofuels: Straight Vegetable Oil Research***

Presented by Kyle M Doll, Ryan M Kuhn, & Aaron W Ladeau

The Collaboratory's Biofuels: Straight Vegetable Oil Research team has been working with Open Door Development (ODD) over the past two years researching potential ways of helping a small missions village in Mahadaga, Burkina Faso. The team hopes to reduce their dependence on imported fossil fuels used to run their agricultural diesel engines as a way to support and empower their local economy. Although focused on ODD, there is potential to produce a modular fuel system that can be used across the world in order to ease the dependence on imported diesel fuel in the developing world, making energy more accessible to people everywhere. The team has researched potential vegetable oils and found that cottonseed oil was the best option for the client and research team. To limit the possible damage and wear on engine components, the vegetable oil's viscosity needed to be lowered to the ASTM specification for biodiesel. A 70% diesel to 30% cottonseed oil by volume blend and preheating straight cottonseed oil were tested as possible fuel options. Testing methods for measuring engine power, engine wear, and fuel consumption were written. Multiple engine components, ranging from heat exchangers to fuel systems were fabricated and tested to verify the functionality of the components. The team is now working to finalize and compile the necessary documentation for our final recommendation to the client.

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**2:00 PM**  
**Frey 110**

### ***Village Water Ozonation System***

Presented by Daniel Ma & Ted Sindabizera Ntwari

In 2015, the United Nations established the goal to achieve universal and equitable access to safe and affordable drinking water for all by 2030. Since 2008, the Village Water Ozonation Systems team has aimed to provide communities with the cleanest water they can sustainably afford by designing and installing water treatment systems to meet local needs as part of the global effort to increase access to safe and affordable drinking water. Many people contract illnesses from consuming contaminated water. In response to this pressing health issue, increasing access to a point-of-use water treatment system capable of providing a clean drinking water source becomes paramount to enhancing the physical well-being of a community.

VWOS develops affordable, clean drinking water solutions by first recognizing that infrastructure and engagement are key aspects to transforming any community's drinking water scene. In previous years, VWOS successfully installed ozonation systems in multiple locations in Latin America. The team has the exciting opportunity to continue work this year with the Trigo Community in Oaxaca, Mexico, where a VWOS unit was installed in 2016. In addition to working with ozonation systems, VWOS also evaluates and adapts other water treatment methods such as UV disinfection and biosand filtration to meet the needs of potential clients. The team considers past designs and investigates new water purifying technologies to formulate holistic solutions for each community based on local water quality and individual client needs.

**2:00 PM**  
**Frey 150**

### ***Landmine Neutralization***

Presented by Justin L Barber, Michael A Ritenour, & Rachel D Siepelina

This talk will be about the Landmine Neutralization Project within the Messiah College Collaboratory. The project's goal is to create a safer way to destroy landmines, IEDs, and other unexploded ordnance (UXO). To accomplish this, the project team is working with the Halo Trust, the world's largest demining NGO. The most common method of destroying UXO is to use a small explosive charge to detonate the mines in place. However, this method is dangerous and explosives are expensive and highly regulated in many areas where Halo is working. Instead of the use of secondary explosives, the team believes that with the right characteristics, mines can be burned and rendered inert without detonation. To serve as the source of flame, the team is using a hybrid-thermal lance (HTL) which is based upon a hybrid rocket motor. Over Easter break, Dr. Don Pratt, the team's project manager, travelled to Afghanistan to test the team's initial prototype. With the successful test results, proof of concept and field testing have been established. Moving forward, the team hopes to make modifications to the HTL in order to better serve Halo's needs.

**2:20 PM**  
**Frey 110**

### ***Aeroponics***

Presented by Matthew L Brenneman & Erin Kelley

The Aeroponics team believes that all people deserve access to proper nutrition and that sustainable agriculture is the best way to improve food access world-wide. This belief has led the team to research and develop a cost effective Aeroponics system specifically for a single family in rural Burkina Faso where soil conditions are poor and access to water especially in the dry season is difficult. Aeroponics uniquely situates the roots of the plants vertically and then delivers nutrients to these roots without the use of soil. The benefit of such a system is that it conserves both water and space, and it can be used when traditional farming is not viable.

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**2:20 PM**  
**Frey 150**

### ***Panama Cargo Lift***

Presented by Conner Reyer, Calvin Trimble, & Nathaniel W Yeoman

The Panama Cargo Lift Project partners with YWAM Ships base, Outpost Panama. Outpost is located on the island of Bastimento off the Northern coast of Bocas Del Toro, Panama. At Outpost Panama, Tom and Holly Schmidt focus on training youth to be the next generation of missionaries and outreaching to their surrounding indigenous communities. The base is isolated at the top of a hill on their island which creates various challenges since everything they use and consume must be brought in by boat from the main island and carried up to the base. The Panama Cargo Lift Project aims to design and install a system to transport materials and supplies up to the base from the bottom of the hill. This system will empower their ministry and allow Tom and Holly to focus more on their missional goals and extend the time they can stay in the mission field.

**2:40 PM**  
**Frey 110**

### ***Capture of HIV-1 envelope protein gp120 using immobilized heparin***

Presented by Danielle C Reimer & Brianne N Roper

The HIV virus is endemic in sub-Saharan Africa with recent WHO reports estimating that over 88% of the world's HIV-positive children reside in the area. While viral load monitoring is essential for successful treatment, industry-standard nucleic acid assays are often costly or inaccessible to many regions. An important first step in our viral load testing is isolation and concentration of viruses from whole blood. We have opted to explore a viral isolation method using immobilized heparin-agarose microspheres to capture the virus and remove it from the blood sample. We are currently optimizing the protocol to achieve capture of HIV-1 envelope protein gp120 on immobilized heparin using an immunofluorescent staining protocol. To do this, we are testing heparin-agarose capture of isolated gp120 and its insect variant using gp120 specific primary antibodies followed by a fluorescent secondary antibody. We are using different primary antibodies to target the gp120 in its natural state along with its bound state to maximize our ability to tag a gp120-heparin complex.

**2:40 PM**  
**Frey 150**

### ***Paxton Ministries - Site Drainage***

Presented by Zachary D Engle, Brenden P Good, & Sean P McCormick

Paxton Ministries is a non-profit organization that provides affordable housing and support services for adults of all ages, many of whom are challenged with poverty, mental illness, and intellectual disabilities. Paxton Ministries operates a residential facility in Harrisburg, PA, and their site location currently experiences excess runoff coming from a stormwater pipe that discharges onto their property. This creates frequent flooding at the site and restricts usable space and access to the tennis court area. The site is also located in karst topography, a geologic condition that is prone to sinkhole development. The ponded water associated with the flooding appears to exacerbate existing sinkholes as well as contribute to formation of new sinkholes.

The goal of the Paxton Ministries Site Drainage Team is to research and develop potential solutions to this problem using Best Management Practices (BMPs) that meet applicable stormwater management regulations. The design feasibility of various alternatives was evaluated with consideration to on-site detention, off-site discharge, costs, and site limitations. The team has worked with Paxton Ministries to summarize options and costs in order to facilitate an optimal and economical solution for the site.

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**4:00 PM**  
**Frey 110**

### ***Muscle-Activated Prosthetic Hand for Pediatric Client***

Presented by Alaric A Kobzowicz & Keith Wei Luen Lim

Due to the rapid growth of children, and the complexity of myoelectric technology, children are not given the same opportunities to use myoelectric prosthetics as adults. This report focuses on the progress of the Muscle Activated Prosthesis (MAP) team in creating an affordable trans-radial myoelectric prosthesis for a nine-year-old girl. The basic mechanism by which this device operates is as follows: a muscle contraction emits an electrical signal that will be detected and used to control the hand in various set patterns of grip. Comprised in this device will be an EMG sensor, electrodes, a development board, motors and tendons to emulate finger motion, feedback, and a battery. We have created a prototype “bionic hand” prosthesis that will be tested by our client in summer 2018.

**4:00 PM**  
**Frey 150**

### ***Nicaragua Bridge***

Presented by Caleb M Comeaux & Mark J Simpkins

The Nicaragua Bridge Project is partnering with Friends in Action to aid in the development of a new, mainland Nicaragua community for the Rama Cay people. A channel on the new property is being cleared to create an inlet for the community shrimping canoes. This project has designed a new bridge to cross this channel that will unify the community by creating ease of access between the church, health clinic, and boat dock on one side and the baseball field and housing on the other side.

**4:20 PM**  
**Frey 110**

### ***Cunningham Clubfoot Brace***

Presented by Vy T Ho, Luke W Redcay, & Paul J Stoltzfus

Clubfoot is a congenital musculoskeletal disorder that describes several foot abnormalities characterized by an inward-rotated foot. The current method for correction involves several rounds of casting 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 and its dynamic design encourages muscle development throughout treatment. The Collaboratory Cunningham Clubfoot Brace project seeks to increase accessibility to the brace. Currently, the brace can only be made by the designer Mr. Jerald Cunningham and those he has trained. The process involves molding the material into the correct shape, cutting, polishing, and assembling various components. This method has several issues with reproducibility as well as cost. To improve accessibility, lower costs, and tighten production tolerances, we are exploring new molding techniques, fasteners, and 3-D printing using materials that are flexible yet stiff enough to allow correction. To validate the modified designs, we are measuring the forces created and applied by the brace. Previously, there was no quantitative way to determine the brace characteristics. However, our newly developed force-testing apparatus can be used to validate various designs. More research is being conducted on effectively measuring the biomechanical aspects of the brace.

**4:20 PM**  
**Frey 150**

### ***Oakwood Hills Pedestrian Access***

Presented by Kevin J Breisch, Alex H Issis, & Caleb C Stevens

The Oakwood Hills Pedestrian Access project seeks to provide an efficient and safe way for pedestrians to travel between Messiah College and the future Oakwood Hills development. This project serves the commercial developer, Rider Musser Development, LLC, and the Messiah College Office of Operations. This project allows students to design and construct solutions to this issue that will affect Messiah College and the surrounding community.

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**4:40 PM**  
**Frey 110**

### ***Prosthetic Knee for Burkina Faso***

Presented by Kaleb E Burch, Ashley Hah, & Marissa K Kuhns

In Mahadaga, Burkina Faso, the Centre for the Advancement of the Handicapped was once able to create full prosthetic legs. The Centre accepted prosthetic knees from a donor and made the rest of the leg with their own resources; however, they have exhausted the supply of donated knees and are no longer able to assist leg amputees. Our group aims to design a simpler prosthetic knee that can be manufactured in Mahadaga, and is compatible with the rest of the leg that the Centre has been using.

This presentation will recap the testing that we did in November with a volunteer amputee using our design prototype. From this test we were able to collect large amounts of data that have been analyzed in a few different ways. We were able to collect and analyze acceleration from 8 different accelerometers placed on the volunteer as well as collect and analyze slow motion video of our subject walking. This presentation will also touch on the new “pyramidal attachment” that we have been designing and how that process is coming along.

**4:40 PM**  
**Frey 150**

### ***Affordable Sanitation***

Presented by Rachel L Aukamp & Adam Barley

The Affordable Sanitation Project is working in partnership with World Vision to design pit latrine liners for the Upper East Region of Ghana. Pit latrines consist of holes dug in the ground covered by a protective slab and superstructure. Many families in the Upper East Region do not have access to affordable sanitation technologies like the pit latrine, and those who do have access are deterred from using them because latrines in this region are prone to collapse during the rainy season when the ground becomes completely saturated and the stability of the pit walls is jeopardized. Because of the lack of facilities and the collapse of existing latrines, people in Ghana resort to open defecation which can lead to the spread of diseases. World Vision has tasked the Affordable Sanitation project with designing a latrine liner that will stabilize the walls of the pit while being affordable to communities in Ghana. Over the past year, the team has finalized two designs for liners - the ferrocement and rebar-reinforced liners - and travelled to Ghana to implement these liner designs. Through the trip, the team has learned of many strengths and weaknesses of each liner and is now modifying and finalizing the designs implemented in Ghana. The team is also developing a survey to monitor the implemented liners with the hopes that they will provide a lasting, affordable solution to the issue of pit latrine collapse and open defecation in the Upper East Region of Ghana.

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**5:00 PM**      ***Energy Monitoring and Management System: Promoting Energy Availability in Developing Countries***

**Frey 110**      Presented by Joshua L Conrady, Michael K Gray, David J Nicolais, & Nathan D Ressler

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 is working towards completing a redesign of the system's power sense module to increase performance to meet client specifications. We are also working towards finalizing an official testing procedure to ensure that the meter design and construction are properly evaluated before they are installed for long-term operation. Finally, we are in the process of creating a data logging system for our meter, which will expedite our ability to gather and analyze test results. This presentation will detail the steps made to improve the power sense module as well as explain the testing procedures and data logging process.

**5:00 PM**      ***Mechanized Percussion Well Drilling***

**Frey 150**      Presented by Andrew C Dunmire, John P Hannon, Althea G Mavros, Aaron D Mishler, & Greg M Shirk

Open Door Development (ODD), a subsidiary ministry of SIM, seeks to make water accessible to all in Burkina Faso. This will be accomplished by a business model built upon a network of locally owned and operated well drilling businesses with varying capabilities to accomplish any water project. The Collaboratory and the Mechanized Percussion Well Drilling (MPWD) team have partnered with ODD to assist in the advancement of a part of their overall vision, through the creation of a mechanized percussion well drilling system. This system will be used to enhance the drilling capabilities of the local people compared to equipment more readily available and familiar to them.

This has been a multi-year project to research and test various components of the proposed MPWD system. Following a trip to Burkina Faso in summer 2017, the team has focused on manufacturing and testing components of the project that will be sent to Burkina Faso with our client to further advance the project development in country. We prioritized producing refined tools and processes for boring casing as well as prototyping a wooden capstan substitute for the system's current aluminum capstan. Field testing was also performed to develop and document better drilling practices when in advancing through submerged soil layers.