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8:20 AM ***Remote Coaching Solution (WERCware) - Sensor and System Integration***
Frey 110 Presented by Matthew Bohn, Joseph A Coshun, and Ryan E Hahn

Individuals in society with various developmental disabilities currently rely on habilitation assistants to help them learn or relearn daily tasks. Such in-person social coaching may foster dependency in the long term, and may not represent the most efficient business model. WERCware seeks to revolutionize this service industry, ultimately offering the ability for one coach to provide services to multiple participants from a remote location, while creating the potential for more independence among those being taught and supervised. The WERCware systems consists of an Android-based smartphone interfaced with various stress-detecting bio-sensors. When the system identifies stress in the user, a video conferencing call will be initiated from the smartphone to the coach that allows the coach to help manage the user's stress. If the user enters a private area, video and audio transmission will be temporarily halted when the system is in close proximity to Bluetooth beacons deployed in these areas. Recent progress includes the implementation of artificial intelligence for real-time detection of stress in the human voice, as well as development of a custom Android application (app) to facilitate component interaction and video conferencing.

8:40 AM ***Flight Tracking and Messaging System (FTMS): Aircraft Control Unit Redesign***
Frey 110 Presented by Hoang H Nguyen, Samuel A Rice, and Michael A Torres

Once outside radar range, small planes flying in remote locations must be tracked by alternative means. Organizations focused on emergency relief, humanitarian development and missionary support need to follow such flights, for safety and management. The Automatic Flight Following System (AFFS) owned by JAARS has been extensively employed for such flight tracking, but is no longer in use due to emerging alternatives. Thus, the Flight Tracking and Messaging Systems (FTMS) team is now working with stakeholder Cary Cupka to redesign AFFS to include more advanced technology modes. This includes replacing the existing Single Board Computer (SBC) in AFFS 1.0 with a new microcontroller capable of similar functions and open to further expansion. The UDOO QUAD prototyping board and Qseven 928 industrial module have now been selected as the SBC for this redesign. Careful study of the existing Aircraft Control Unit (ACU) display board has enabled the redesigned layout and implementation of an upgraded version, to save space. RS - 232 serial communication has been established between the SBC and AFFSWin (Automatic Flight Following System for Windows) to simulate sending messages from the ACU to the ground station during ongoing development.

9:00 AM ***Mechanized Percussion Well Drilling***
Frey 110 Presented by Tyler Collier, Dan C Eckman, and Damaris R Gehman

The Mechanized Percussion Well Drilling Project seeks to design a simple mechanized well drilling system to be used by our client for drilling shallow water wells in Burkina Faso, Africa. Currently our client has trouble drilling through hard rock layers, and often has to 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. As of April 2017, a prototype of the mechanized rig has been built and tested on campus, and a safety training video for the rig has been created. In addition, a steel mast superstructure has been designed and manufactured that will replace the conventional tripod. This will allow for more space around the well site and give the operator more control over drilling operations. Other supporting equipment that was designed and manufactured includes: a drilling jar, casing hammer, and casing pulling system. The project is preparing to travel to Burkina Faso in the Summer of 2017 to meet with the client and assess client need.

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9:20 AM ***Basic Utility Vehicle: Firetruck, BUV:F***

Frey 110 Presented by John D Keeports, Michael T Padovano, and Jeffrey A Weaver

The Basic Utility Vehicle: Firetruck, or BUV: F project works to meet the emergency response needs of people in poor rural areas in Africa. The BUV: F project partners with the Institute for Affordable Transportation to explore options to easily and effectively convert existing utility vehicles into mobile fire-fighting platforms, complete with versatile operating ranges and powerful delivery systems. Lessons learned from the first prototype's construction will help the BUV: F project meet its final criteria--a 25 mph firefighting vehicle capable of transporting and deploying over 200 gallons to even the most remote blaze.

9:40 AM ***Intelligent Water Project: Remote Sensing of Pump Health for Promotion of Clean Water Access In Developing Countries***

Frey 110 Presented by Lydia O Goodwin and John C Harro

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 a remote sensor to report failure of one of these hand pumps and provide data necessary for implementation of a proactive maintenance policy. Currently, there are 12 IWP systems installed in Ghana, Africa. This past year, the IWP team analyzed data gathered from these field units and implemented design changes to ensure functionality, increase serviceability, and prepare for mass production of the IWP unit.

10:00 AM ***Pump Minder: A Water Meter to Promote Sustainable Access to Clean Water in Developing Countries***

Frey 110 Presented by Shawn R Bordner and Chad E Brubaker

The Pump Minder project is a component in an overall plan to increase clean water access in areas where safe water is scarce. Our clients, Water4 and Access Development, are developing sustainable models for hand pumps in Ghana, West Africa, allowing water access for much longer than the typical lifespan of a pump. In order for this sustainable model to be achieved, a small fee must be charged for the delivery of water. This money funds upgrades and maintenance projects as well as the salary for a person to manage the usage of the pump. This worker, called the pump minder, is the inspiration for the name of the project. Our project is directly involved in the transaction between the pump minder and the local community by developing water sensors measuring the amount of water pumped out of the nozzle. This provides accountability for the pump minder so the price of water stays at a reasonable cost. If this accountability was not in place, people could revert to finding water from the same contaminated sources before the hand pump was installed. In this presentation, the discussion will focus on the third revision of this water sensor. This redesign is highlighted by cost savings, increase in battery life, ease of manufacturability, and the retrieval of data using a laptop computer.

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10:20 AM ***Breath of Life: Pressure Swing Adsorption Oxygen Concentration for Hospitals in the Developing World***

Frey 110 Presented by Devin M Esch, Katie E Heindel, Spencer L Petersheim, and Michael B Smith

The Breath of Life project team has partnered with Macha Mission Hospital in Zambia to meet the need for medical oxygen at developing world hospitals situated in tropical climates. High humidity levels damage the zeolite particle beds in pressure swing absorption oxygen concentrators, which in turn causes premature failure of the devices. This drives up the cost of healthcare in these areas. In a developing world context, the lack of ready access to parts and maintenance means that the failure of oxygen concentrators can leave patients in respiratory distress without the oxygen they need to survive. Our team is designing a dehumidifier using electrostatic precipitation that is attachable to the air intake of oxygen concentrators to remove moisture from the ambient air before it enters the machine. Our current prototype uses a high voltage potential to charge and collect water particles out of the air. A long-term solution that is currently being developed is a hospital-wide oxygen system that is primarily driven by compressed air to create concentrated oxygen when the power is out. The system will use compression and rapid expansion to dry the ambient air before it enters modular oxygen concentrators and travels throughout the hospital.

10:40 AM ***Landmine Detection***

Frey 110 Presented by Will F Cochran, Grant B Garber, and Raul Serrano

The Landmine Detection project seeks to offer a viable option for the detection of landmines to address a crucial need of the citizens in Banteay Meanchey Province, Cambodia. This project is currently in the process of exploring multiple, efficient methods of detecting various types of landmines and other unexploded ordnance (UXO). Possible methods include infrared technology or ground penetrating radar. An advanced deployment vehicle for the transportation of the detection technology is being explored with possiblities such as drones and blimps. Through experimentation and development, the project aims to explore the application of state of the art technology to detect landmines. The Landmine Detection project seeks to improve the safety of the citizens of Banteay Meanchey Province, Cambodia in regards to active landmine interaction.

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11:00 AM ***Sustainable Mobility: Taking an Assistive Mobility Technology from Prototype to Production***

Frey 110 Presented by Daniel P Barrett, Cordell P King, Anders W Laub, Matthew P Tomasetti, and Matthew P Tomasetti

The mission of the Sustainable Mobility Project is to equip our partner, the Centers for the Advancement of the Handicapped in Burkina Faso, West Africa, with an appropriate and sustainable method for locally building and distributing our mobility tricycle design to those in need. In rural West Africa, this personal mobility technology brings freedom and empowerment to some of the most marginalized persons in the world. Within the past year, we have shifted our focus to the development of tools and processes to facilitate scaling the manufacture of Collaboratory electric tricycles from single to multiple units. Ultimately, we aim to provide our partner with the ability to effectively meet the mobility needs in their community.

Specifically, this year the Sustainable Mobility Project has focused on the manufacturing development of the structural frame, the drive train assembly, the motor cast housing, and the electrical control system. In each of these areas, we evaluated former manufacturing techniques and improved these techniques to be more successful in future production of mobility tricycles in multiple international locations. In January 2017, for the first time ever, the team built five electric tricycles with our Burkinabé partners in Fada, Burkina Faso. Moving forward, the team will further develop and test tricycle manufacturing to generate a complete design and manufacturing handbook for our current and future partners.

1:00 PM ***3D-printed Prosthetic Hands for Kids***

Frey 110 Presented by Timothy J Gover and Jessica L Raboci

Every year, approximately 1,500 babies are born in the US with an upper limb deformity. These children often have to go without assistive prosthetic devices because of cost. Prosthetic hands can cost $20,000 or more and children need a new device every year due to growth. Our project, affectionately named “Raptor Hand” due to the whimsical dinosaur-ish design of our device, aims to provide a low cost prosthetic hand to children. Emily Hoffman, a six year old girl from the Philadelphia area, has been the first child to receive one of our hands. Our team created a custom 3-D printed prosthetic hand for Emily using designs from E-Nable and the Flexy Hand 2. Our newest prototype, delivered to Emily in Spring 2017, has extensive design features including thumb opposition, compliant grip, and a personalized palm socket.

1:00 PM ***Aeroponics***

Frey 150 Presented by Georgia M Ernst and Erin E Sharkey

The Aeroponics Project aims to turn the western concept of aeroponics into something that can be made and used in developing contexts, such as those of our client, Open Door Development (ODD) in Mahadaga, Burkina Faso. While soil and available space are not the limiting factors, reducing the amount of water needed for agriculture leaves more available for the community to drink and use. ODD is not the only possible client, either; communities experience drought and limited water supplies all over the world, all the time. Our hope is that aeroponics systems can improve access to fresh food via a sustainable approach to agriculture.

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1:20 PM ***Design of a Muscle-Activated Prosthetic Hand***
Frey 110 Presented by Keith Wei Luen Lim, Jonathan A Lord, and Jason L Yoder

Due to the financial burden in purchasing a myoelectric prosthesis, which can cost upwards of $75,000, this project aims to design a low-cost alternative. Such devices are sought after because of their ability to closely mimic the anatomy and motion of the human hand through a combination of functionality, versatility, and natural appearance. This prosthesis is controlled via electrical signals generated by muscle contractions in the residual limb, which are read by a Myoware muscle sensor and accompanying electrodes. An A/D converter, Arduino, and motor driver then work in conjunction to interpret the intensity and pattern of the signal in order to output a certain set of commands to 3 motors, which accordingly move the prosthetic fingers to fixed grip patterns. Worm and spur gear couplings and pinned mechanical linkages achieve the latter. The current design designates one motor to the movement of the thumb, one to control both the first and second digits, and one to control both the third and fourth digits. To further alleviate costs, the structure of the prosthesis is to primarily be 3-D printed using available resources at Messiah College. This device is planned for a patient with a transradial (below the elbow) amputation and will be custom fitted and sized on a client-to-client basis. As a standard of measure, the overall cost is intended to remain below $1,000.

1:20 PM ***Africa Wash Disability Studies Project***
Frey 150 Presented by Jordan T Birdsall and Jacob L Younger

Persons with disabilities (PWDS) living in some developing communities face extreme challenge in getting access to WASH services. The African Wash Disability Studies Project (AWDS) project works with World Vision to strengthen WASH services through low cost hardware improvements and educational outreach. During the current academic year, the project designed an inclusive handwashing station (Tippy Tap), created a technology handbook for dissemination of the assistive technologies previously developed by AWDS, and designed an assistive crawling device. These were accomplished through focused work on empowering those who are disabled, and bringing inclusive WASH to selected western African communities. The team tested three designs of the Tippy Tap to determine what additions could be made to allow for easier use by persons with disability. These additions include a wider foot pedal, a change in the ropes used to pull the container that holds the water, and additional supports for the frame. A technology handbook design was drafted with technical drawing and text and was outsourced to a Messiah College art and design class for a more professional creation. The handbook includes three of the assistive technologies developed by AWDS: the latrine chair, bucket tipper, and the water cart. The handbook design is focused on presenting these technologies in an easy to read manner for use by World Vision in countries they work in.

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1:40 PM ***Rapid Orthotics for CURE Kenya***
Frey 110 Presented by Nathan Chambers, Lyndsy N Shaubach, and Daniel J Yeisley

The goal of the Rapid Orthotics for CURE Kenya (ROCK) team is to help hospitals in the developing world be able to 3-D print prosthetic devices. Our first client in this endeavor is CURE International, whose hospital in Kijabe, Kenya is a leading center of prosthetics in East Africa. 3-D printing will help increase the number of patients who can receive a prosthetic from CURE Kenya by decreasing the time and cost of manufacturing. This is critically important, as lower limb amputations are most prevalent in the developing world, which is also where there is the lowest incidence of orthopedic surgeons and technicians. The system we have designed for the CURE Kenya includes a 3-D scanner, software for prosthetic design, and a 3-D printer. We will deploy the system at the CURE hospital in Kenya in May 2017. We will also provide two weeks of training on the system, a training manual, and continued support and troubleshooting throughout the 2017-2018 school year. We hope to continue to partner with them in their use of the 3-D prosthetics system in order to expand their abilities and collaborate towards increasingly impactful prosthetics solutions for the developing world.

1:40 PM ***Affordable Solutions to Pit Latrine Collapse***
Frey 150 Presented by Kenton W Grossnickle, Connor C McGovern, Sydney E Schandel, and Duane Troyer

The Affordable Sanitation Project is trying to address the issue of pit latrine collapse in Ghana, specifically Northern Ghana. Pit latrines are holes dug in the ground that provide a means for people to safely relieve themselves. They are used to prevent open defecation which leads to the spread of disease. However, most latrines are not lined and as such have a tendency to collapse. In Ghana there is a dry season and a rainy season. During the rainy season it rains nearly every day which completely saturates the typical sandy soil. This exacerbates the instability of the latrine walls and can lead to their collapse. Collapsing latrines leads to fears in using them which can cause a reversion to open defecation. To prevent this reversion, World Vision has tasked the Affordable Sanitation project of the Collaboratory with designing a latrine liner that will stabilize the hole while remaining affordable to communities in Northern Ghana. Over the past year the team has visited the affected areas in Northern Ghana and gained valuable feedback. Since then four possible solutions have surfaced. These are the Plastic tub, Sand bag, Ferro-cement, and Rebar-reinforced fabric liners. Through testing and research the plastic tub liner was rejected as a solution whereas the Sand bag, Ferro-cement, and Rebar-reinforced liners were retained. The rebar-reinforced liner was constructed and tested in Ghana last summer and was reported to have stabilized the hole. The team is now focused on optimizing the design of these three possible solutions.

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2:00 PM ***A Low-Cost Dynamic Light Scattering System for Detection of Viral Aggregates***

Frey 110 Presented by Lindsey A Barner and Alexander G Roth

Access to HIV diagnostics and viral load monitoring in developing nations with endemic HIV-1 infections, such as many sub-Saharan African countries is limited. Current methods are either high-cost diagnostics that quantify viral load, typically in central facilities, after weeks of processing, or else fast but non-quantitative methods unable to measure viral load. Because treatment must be adjusted depending on viral load, a low-cost diagnostic that can quantitatively identify how many viral copies a patient carries would improve treatment outcome. Partnered with the Macha Research Center in Zambia, Diagnostics for Viral Diseases aims to design such a diagnostic device by combining recombinant protein engineering with an optics-based particle-sizing technique, dynamic light scattering (DLS). We have explored designing a low-cost DLS apparatus and have assessed its capabilities and limitations. Among our innovations is the use of silicon photomultiplier detectors with custom signal processing circuitry and field-programmable gate array (FPGA) technology. This system could potentially serve as DVD's capability to size and thus diagnose viral aggregates.

2:00 PM ***Cumberland Pointe Futsal (Soccer) Project***

Frey 150 Presented by Jacob L Artuso, Peter J Burt, and Emily S Quatrale

The CP Futsal team is working with AROMA Missions to provide a playing area to teach futsal (soccer) to the kids living in the Cumberland Pointe Apartment Complex in Mechanicsburg, Pennsylvania. The team has developed conceptual plans, a permit application, and construction drawings for AROMA to use for fundraising purposes as well as construction of the playing facility.

2:20 PM ***Cunningham Club Foot***

Frey 110 Presented by Noah C Charleston, Micah J Curtis, and Luke W Redcay

The Cunningham Clubfoot project is focused on aiding children in Kijabe, Kenya that are born with clubfoot. If clubfoot is left uncorrected it can affect one's ability to walk on their own which can inhibit one's ability to be independent and provide for themselves and/or their family later in life. Our goal is to provide a more comfortable, convenient, and effective clubfoot brace than what is currently utilized. One of our partners, Mr. Jerald Cunningham, a board-certified prosthetist and orthotist, invented and developed the Cunningham Clubfoot Brace and currently manufactures them at Cunningham Prosthetic Care. Our Collaboratory team is in the process of replicating Cunningham's design so that it may be 3D printed and used in Kijabe, Kenya with the assistance of our other partner, CURE International. Our presentation will focus on clearly defining clubfoot, force analysis of the Cunningham Clubfoot Maintenance Brace, 3D printing results to date, and initial investigation into hygiene concerns with 3D printed products.

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2:20 PM ***Gravity Fed Water System***
Frey 150 Presented by Nolan M Goss and Frederic A Warden

The Gravity Fed Water Systems project aims to build a sustainable clean water filtration system with zero energy footprint for a village in rural Lombok Island, Indonesia in cooperation with Access Life International. ALI Lombok serves the poor in hilly rural areas by building clean water systems and has been doing so since 2013. The students on this project performed hydraulic design and analysis of the system, design of biosand filtration, and made suggestions on system layout, pipe sizes, and other technical design to connect the spring capture to the ferrocement tank in the village allowing for clean, drinkable water on demand.

2:40 PM ***Design of a Solar Power System for Ekuphileni Bible Institute***
Frey 110 Presented by Scott E Kerstetter and Josiah C Peck

The solar team of the Collaboratory at Messiah College in Mechanicsburg, Pennsylvania has partnered with the Ekuphileni Bible Institute (EBI) of Zimbabwe to design and install a solar photovoltaic system, providing reliable and sustainable electricity for the students and faculty. The need for sustainable electricity arose since power production in Zimbabwe is not sufficient to meet the consumer demand; thus, load shedding is used to reduce the demand. Due to load shedding, the grid inadequately supports EBI as it leaves them without power several times a week. The design work began with a preliminary site-survey in May 2015, and detailed design has continued into Spring 2016. An upcoming site-team installation is planned for May into June 2017.

2:40 PM ***Village Water Ozonation Systems***
Frey 150 Presented by Elisabeth M Chang and Daniel Ma

According to the World Health Organization, over 600 million people do not have access to clean water. Without clean water, waterbourne illnesses are common and can decrease the average lifespan of a community. The Village Water Ozonation Team strives after the ideal that every community should have access to the cleanest water they can sustainably afford. This year has focused on the development of two lower cost options for water sanitation, biosands filtration and ultraviolet (UV) purification.

The UV system passes water through a pump, filters, and a UV lamp that operates in the UV-C spectrum. The filters remove particles larger than 5 microns that would impede the ability of UV light to contact pathogens. It effectively deactivates the DNA of pathogens making them incapable of reproduction. The focus of working with this system has been to optimize the system for developing communities, and to develop reliable ways to test for the system's efficacy.

The biosands filtration system is being designed to treat 60 gallons of water daily, for a school of 120 children in Honduras. It is composed of fine sand, separating gravel, and drainage gravel layers. The sand media size and the developed biolayer play key roles in the removal of pathogens. The water passes through the biolayer and sand layers to remove particulates and pathogens. The focus of the work on this system has been sizing the layers to optimize flow rate and efficacy. The system's water treatment performance will be of interest in the Fall Semester.

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4:00 PM ***Moving Towards a Modular Design for the Energy Monitoring and Management System***

Frey 110 Presented by Paul C Tajiri, Greg P Talamo, and Michael J Zigarelli

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

The current version of our system has successfully been installed in multiple facilities in Burkina Faso and Zimbabwe. The current version of our meter fulfills the base requirements of allocating a configurable daily energy limit per facility but is not conducive to easy feature upgrades. This year we began the redesign of the system to move to a more modular design. Subdividing functionality into plug in modules makes it possible to add or upgrade features without replacing the entire meter. The first step towards modularity has been developing SPI communications between the circuit boards, and the creation of the meter's first 'module'. Now that the modular nature of the meter has been realized, we are in a position to add improvements such as a 'pay-as-you-go' version of the meter as well as remote administration by a small business energy provider.

4:00 PM ***Cycle Advancements for Rugged Terrain (CART)***

Frey 150 Presented by Jonathan M Bright, Spencer A Lowman, and Adam D Peris

The goal of the CART project is to create new uses for the small motorcycles that are used in developing countries. By adding a universal hitch and various vehicular attachments, these motorcycles will become a useful tool.

After careful research, two different hitch designs were created. A prototype of one of these designs was fabricated and attached to the motorcycle. It was found that the prototype offered a large range of motion and had no adverse effects on the handling, even when the trailer was loaded to 350 lbs.

In order to look at durability of the hitch design, strain gages were attached to the hitch at three locations. Impact loading and field testing that simulated various real-world operating conditions were conducted using this strain-gaged hitch . The collected strain data was used in a SolidWorks finite element model to determine the point of maximum stress on the hitch. This maximum stress was used to calculate how long the hitch could be expected to last before failure. This was found to be more than sufficient, indicating that the hitch design will hold up to repeated real-world use.

Looking forward, the CART team is looking to distribute drawings of the hitch to developing countries so more hitches can be built and feedback can be received and used for improvement. The team is also looking to design a trailer that is optimized for the hitch and offers greater safety and usability than the homemade trailers that are often used in developing countries.

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4:20 PM ***Preparing for Future Expansion of the Energy Monitoring and Management System***

Frey 110 Presented by Thomas D Martin, Karine A Moussa, and Nathaniel D Pardoe

The Energy Monitoring and Management System is an energy allocation device which is being used to conserve energy in regions with a limited amount of power. The meter allows an administrator to assign a daily power allotment to ensure that each individual user cannot expend the community's total shared supply of power. The system includes an interactive display which provides practical information to the user, reporting how much energy they have used or have left before they use their daily allotment. EMMS currently has 5 meters installed in Burkina Faso for a SIM mission organization, and 14 meters installed in The Theological College of Zimbabwe; these meters have been successful in conserving energy and reducing financial energy expenditure by 50%.

Our project is working toward long-term goals of achieving modularity - the ability to add more functions to the original product - and designing a robust testing procedure. Modularity is an important attribute for clients who would like to add certain features, such as a pay-as-you go feature or wifi. An official testing procedure is needed to ensure that meters are properly evaluated and modified before they are installed for long-term operation. This presentation will detail some of the changes made to the meter to accommodate expected future modules, as well as the development of test procedures used to evaluate the accuracy and operation of our meter.

4:20 PM ***Block Press: Providing Access to Sustainable Housing Solutions***

Frey 150 Presented by Samuel H Hsu

The Block Press project develops and tests mechanical presses to produce structural building blocks used for residential housing. Currently the project is serving a community off the east coast of Nicaragua. The indigenous people known as the Rama are migrating from the island Rama Cay to the mainland. The Rama are making this transition through the help of Friends In Action International. The press that the Rama had been using is too heavy to move in small boats and takes 3-4 people to operate. The project is designing a simple manual press that will only require 1-2 people to operate. The presentation will focus on the prototype developed for the site team trip in early June 2017.

4:40 PM ***Woodcrest Bridge Project***

Frey 110 Presented by Dylan G Clemente, Dexter B Ehrenzeller, and Bradley D Sloop

The purpose of this project is to design and build a bridge to connect a hiking trail at Woodcrest Retreat, a Christian camping facility in Ephrata, PA. We have designed a suspended bridge to cross over a drainage swale that currently separates the trail. The bridge is also located near the entrance road to the camp, and it is intended to provide a site landmark feature of the retreat. Our goal is to use our talents to design the bridge in such a way that honors God.

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4:40 PM ***Combined Cooling, Heating and Power Demonstration Model***
Frey 150 Presented by Ethan Z Jacoby, Mitchell s Kauffman, Timothy E Mast, and Nathan k Musser

Messiah College recently partnered with UGI Performance Solutions to build a 1 MW electric power plant on our campus with Combined Cooling, Heating and Power (CCHP) capability. Half or more of the thermal energy driving most electric power plants is lost to the environment. CCHP locates electric power generation near thermal loads where the waste thermal energy stream may be captured and put to work. Messiah College requested that the Collaboratory develop a micro-scale demonstration model to highlight the College's commitment to sustainability and to educate visitors and the public about CCHP technology. We approached UGI performance solutions to ask them for sponsorship and mentorship on the project. To demonstrate CCHP technology, we designed a system that captures energy from the exhaust stream of a 1000-Watt generator. The system heats water and air while also refrigerating an enclosure. Hot exhaust gasses run through three heat exchangers in series to perform the heating and cooling functions. Users may interact with heated water, heated air, and the refrigerated enclosure to experience first-hand the benefits of CCHP technology.

5:00 PM ***Pedestrian Bridge for Mexican Ministry Center***
Frey 110 Presented by Zachary D Engle, Benjamin E Reinert, and Nathaniel W Yeoman

The Mexico Bridge Project is a continuation of a previous partnership between The Collaboratory, Forward Edge International, and a local community center Trigo y Miel. This partnership has empowered the community center with clean water to support their various tutoring, lunch, and ministry programs. The Mexico Bridge Project aims to continue to empower the center by addressing problems with pedestrian access to the facility. Currently, a seasonally flooding drainage ditch interrupts southern access to the community center, causing a half-mile detour across muddy roads. The Mexico Bridge Project aims to identify an appropriate structure type, and complete all design and construction work in order to prepare a group of students to partner with locals in building the selected structure.

5:00 PM ***Pico Hydro: Powering Developing Communities with Run-of-Stream Hydroelectricity***
Frey 150 Presented by Tyler P Criddle, Daniel J Loefstedt, and Joshua M Pardoe

Many rural communities in the developing world lack access to basic utilities, such as electric power generation. The Pico Hydro project team has partnered with Engineering Ministries International (EMI) to develop a run-of-stream hydroelectric generator capable of generating 300 to 800 Watts of electrical power in communities that have access to a stream. The project team has tested three generator prototypes provided by EMI. With the results of those tests, along with research and outside sources, the team is formulating, constructing, and testing their own design for a hydroelectric generator with improved cost and reliability performance.

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5:20 PM ***Oakwood Hills Pedestrian Access***
Frey 110 Presented by Kevin J Breisch and Benjamin P Holderman

The Oakwood Hills Pedestrian Access project seeks to provide an efficient and safe way to provide pedestrian access from Messiah College to future commercial development locations. This project serves the commercial developer, Rider Musser Development Corporation, and their land architect, H. Edward Black & Associates. This project allows students to design, develop, and construct solutions to this transportation problem that faces Messiah College students wishing to have pedestrian access to this new development area.

5:20 PM ***Design of Instructional Kits for STEAM Education***
Frey 150 Presented by Timothy E Mast, Mayim J Moore, and Michael J Pasti

The STEAM (Science, Technology, Engineering, Art, Mathematics) Education project aims to develop a kit that, in the spirit of the LEGO EV3 Robotics kit, is reconfigurable and designed with the intent to engage and educate middle-high school students. Unlike the EV3 kit, however, this kit will cost less than $100 and have individual “modules” that will communicate a specific STEAM concept (i.e. provide a visualization of how the Pythagorean theorem works, facilitate an interactive game that teaches the user to recognize particular musical tones, demonstrate how changing the variables in the circle equation affects the shape a circle, etc.).