11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

9:00 a.m. ***Welcome***

9:05 a.m. ***Electrical Systems of the Solar Commuter Vehicle***

Matthew Bergey

The electric motorcycle project is now in its second and final phase, with only a few remaining electrical systems to be completed. The battery pack and motor controller have already been successfully integrated into the motorcycle. Electrical systems to be completed include accessory systems, which provide battery monitoring and protection. This presentation will explore the system designs and proposed implementation of battery balancing and battery monitoring systems on the electric motorcycle.

9:25 a.m. ***Solar Commuter Vehicle Drive System Redesign***

Zachariah Steeves

Last year, problems were discovered between the 1997 Solar Car motor and the 1999 Solar Car motor controller. The team decided to use the '99 motor to alleviate these interface problems. There are many advantages associated with the '99 motor, but first, obstacles had to be overcome. The entire rear axle of the Solar Commuter Vehicle (SCV) needed to be redesigned to accommodate the new motor. The '99 motor has different mounting requirements than its predecessor. This rear axle redesign has been the major focus of the SCV group this academic year. The entire process, including initial design, Finite Element Modeling (FEM) analysis, prototyping, and machining, has been performed in-house by the SCV group.

9:45 a.m. ***Kenya Mobile Medical Clinic***

Aaron Black, Lukas Murrill, and Benjamin Richter

Proper medical care is not readily available to many people who live in remote areas of Kenya. The Mobile Medical Clinic project aims to equip a trailer as a mobile clinic to provide medical examinations and screenings to the people of Western Kenya where healthcare services are inaccessible. The project began in the Fall of 2013 and the team is currently developing a suspension system and finalizing the design parameters of the trailer to be able to efficiently use the space as a clinic and safely carry equipment on unimproved roads.

10:05 a.m. ***Mobility Electric Tricycle: Front End Redesign***

Lauren Long, and John Nordstrom

Proper The Mobility Tricycle Project designs electric and hand-powered tricycles for people living with physical disabilities in Burkina Faso, West Africa. To date, a majority of the tricycle design has been carefully reviewed and optimized, however, one area in particular, the front-end of the tricycle, still can benefit from a systematic redesign. With the current tricycle design, the rider must constantly exert a force on the steering handle in order to maintain a straight path and as the tricycle reaches higher speeds, the steering begins to wobble left and right. These handling characteristics are undesirable and troublesome for many of our clients who have limited upper body strength. The first aspect of our project looks to evaluate the geometry of the front-end with an eye toward improving the handling and steering characteristics of the tricycle, particularly the electric tricycle. Head tube angle, an important quantity for defining the geometry of the front end, may play a significant role in tricycle handling. In order to test the relationship between head tube angle and handling characteristics, we designed and built an experimental test setup, which allows us to vary this angle and evaluate the resultant handling response. With this setup, we are able to conduct a number of different tests including a test for wobble using accelerometers, a test for the force required to keep the tricycle going in a straight line, and a test for the force required to turn the tricycle. We have also developed a handling test to qualitatively analyze the handling and stability of the tricycle. We analyzed the data from these tests and were able to determine an optimal head tube angle.

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

10:25 a.m. ***Mobility Electric Tricycle: Brake Redesign***

Austin Galaska, and Luke Herwig

Since the caliber brakes used initially in the design of the electric tricycle developed by the Disability Resources group were unreliable and ineffective, a new band brake design was developed last year. Although this design proved to be far more reliable and effective than the caliper brakes, there were still some issues with the design which had to be resolved before this new design was finalized.

This year the Brake Redesign group revised the design to make the braking and accelerating functions of the tricycle completely independent. The group also tested band materials which could reliably provide the necessary braking force to determine the wear on these materials under both clean and dirty conditions. The clean trials gave a good baseline for our testing, while the dirty samples were intended to replicate conditions in Burkina Faso. This testing gave important data regarding the durability and reliability of each of the band materials. Combining this data with information about availability and cost of these materials in Burkina Faso, we are able to recommend a band material to be used.

10:45 a.m. ***Mobility Electric Tricycle: Rear Axle Design Evaluation***

Seth Betteridge, and Justin Henry

The Mobility Tricycle Project designs electric and hand-powered tricycles for persons with disabilities in Burkina Faso, West Africa. In 2009, the tricycle frame was redesigned to include advancements in manufacturability, strength and ergonomics. This frame supported the rear axles only on one side similar to how traditional wheelchairs are supported; our previous frame designs supported the axles on both sides, similar to how standard bicycle axles are supported. Data collected from Burkina Faso and from extensive testing at Messiah College demonstrated that the axles used on the new frame design fail prematurely in the electric version of the tricycle.

The goal of the current project is to increase the life of the axles while delivering a sustainable solution that utilizes locally available materials and manufacturing processes. Our team tested and evaluated different axle designs developed by previous teams. After evaluating several variations of the single-sided axle support, we ultimately decided to return to a double-sided axle support configuration. This configuration utilizes local materials, is easy to manufacture and is expected to provide improved part life. Computer simulations were used to show that this solution is viable, and we constructed prototypes for experimental testing. Currently the design is being evaluated through long-term testing to verify that the axle wear problem has been solved. In addition, we have compared two different variations of this double-sided axle support design and used computer simulation to determine which design is the best choice. The next step is to integrate this design into the rest of the frame in order to increase ease of manufacturing.

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

11:05 a.m. ***Flight Tracking and Messaging Systems (FTMS)***

Joel Love

The Outside radar range, small planes flying in remote locations must be tracked by alternative means. Organizations aimed at emergency relief, humanitarian development and missionary support follow such flights, to insure safety. The Automatic Flight Following System (AFFS) has been extensively tested by JAARS for this purpose, but its central microcontroller--a small single board computer (SBC) has become obsolete. The FTMS team has been upgrading AFFS to version 2.0 by replacing the SBC with a newer one on the market. This past year, the team has been testing functionality of the newly ported code for the system by interfacing the SBC with the PACTOR modem (which turns text messages into radiowaves) and sending data from this modem to AFFSWin - a computer program used by the ground-based flight monitor. For test purposes, the team has successfully sent data from the SBC to its Pactor modem (pilot-side), established a link between the pilot side modem and a second modem representing the ground-based monitor, and parsed the data into AFFSWin. The team has also begun interfacing the SBC with the GPS unit through a serial connection, and is trying to establish a working link between these two devices. Vision for future work includes interoperability with other communications modes including satellite links, so as to make AFFS 2.0 a more flexible system useful for a variety of organizations.

11:25 a.m. ***Wireless Enabled Remote Co-presence (WERC)***

Chad Clemens, and Stephen Powers

The Wireless Enabled Remote Co-presence (WERC) team is working together with SymBionyx to develop a system that dispenses coaching services via a remote link. People with cognitive disabilities and traumatic brain injuries often need an assistant to help them learn or re-learn daily tasks. However, assistance by a life-coach or attendant-care provider in person can foster dependency, and limit the ability of social agencies to meet the need long term. WERCware aims to revolutionize this strategy, by enabling one attendant to serve multiple participants from a remote location, and fostering more independent development by the participant. WERCware 3.0 initiates and maintains contact between attendant and participant via a Skype call over an Android smartphone worn by the participant via a pendant-style adjustable holster. This presentation reports on development of the StressAlyrter (SA) as a component of the WERCware system. The SA system is intended to monitor the emotional status of the participant, so as to automatically initiate a call to the remote attendant when encountering a stressful situation. Specialized biometric sensors have been researched and tested. For example, the Q-sensor utilizes galvanic skin response (GSR) to gauge human stress. Such

sensors require an Application Programming Interface (API) to feed data to the smartphone. Development of an API for this purpose has been initiated. Using voice with an artificial neural network to discriminate between positive and negative stressors has been explored. Future work will involve fully developing the biometric sensors with an API as an effective StressAlyrter for the WERCware system.

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

12:55 p.m. ***Welcome***

1:00 p.m. ***Handpump Sustainability Study***

Matthew Kulp

Obtaining clean water is an ongoing struggle for villages across Africa. Many villages have implemented wells with handpumps to reach potable groundwater. Unfortunately, mechanical failure in village handpumps such as the India MK II leaves many pumps unusable often within a year of their installation. The Handpump Sustainability Study project (HSS) is working to redesign and improve failure-prone components of the India MKII Handpump to improve reliability and access to water. HSS is currently in the process of providing two prototype designs: a machined steel poppet valve to replace the standard cast stainless steel valve, and an oil-impregnated iron bushing to replace the ball bearings at the pivot point of the pump handle. In addition to these prototypes, HSS has designed and built a testing apparatus to be able to perform in-house fatigue tests on the India MK II Handpump.

1:20 p.m. ***Intelligent Water Management System (IWMS)***

Nicholas Martin, Rachel Morris, and Tyler Kratz

The 36% of handpumps in Africa are nonfunctional at any given time. Upon the completion of our project, the many rural users of the India Mark II pump will have a system set up that automatically and remotely informs pump technicians of current or ensuing problems and provides water resource planners with real-time hydrology data. Such a system, by wirelessly notifying the pump technician of a failure, would help avoid situations where villages are without water for days while people travel to get a pump technician to fix the problem. These advances would improve the reliability of rural water supply systems and promote the likelihood of acceptance among villages that have yet to receive a handpump. Minor failures, when not properly addressed, propagate more costly failures in the future. Rural community members often do not report problems until there is a critical failure. Catching problems early via IWMS would prevent more costly repairs. Water resource planners and hydrologists would benefit from daily water extraction data from well sites. They would be able to analyze aquifer extraction and recharge, the impact of weather events on aquifers, and – when networked among many sites – hydraulic trends throughout extensive regions.

1:40 p.m. ***Garden Water Access Project***

Lindsey Adomat, Marcus Upton, and David Wilson

The Collaboratory Water group is partnering with Serving in Missions (SIM) and Open Door Development in Burkina Faso to design low cost well drilling and water lifting technologies to complement their Survival Garden program. In January of this year we went on a site trip to Burkina Faso to meet with our client. This year we have completed construction of our well drilling equipment and begun testing. We have also worked on some revisions to our pump design.

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

2:00 p.m. ***Hollow Fiber Membrane Filtration System***

Darin Horst

The Hollow Fiber Membrane (HFM) Team works to design, build, innovate, and implement cutting-edge water filtration technology in collaboration with Sawyer Products. The goal of the project is to provide underprivileged communities around the world with an inexpensive and self-sustaining water filtration system. The HFM filter is gravity-fed and can be backwashed and reused for at least 10 years. The team is currently gathering feedback on the larger and more expensive HFM 1.0 system, and providing support for systems like these that have been installed in Burkina Faso. The team is also prototyping the HFM 2.1 system which uses several smaller, less expensive filters in parallel and eliminates the need for backwashing tanks. Testing has been done on the new system to determine the flow rate with varying numbers of filters, minimum required pressure for the backwashing procedure to work, and maximum pressure allowed to avoid damaging the filters. Documentation of assembly and operation procedures for the new system has also been completed and will be used by our client in India to install several systems in locations where they are needed.

2:20 p.m. ***Village Water Ozonation System (VWOS)***

Amy Heindel, and Amanda Schneider

The Village Water Ozonation System (VWOS) is a village scale water purification system that uses a combination of filters and ozone to disinfect water. This project strives to create a product that is both economically and culturally sustainable. With a moderate supply of electricity, a VWOS could be implemented in small communities to provide a source of potable water. Recently the VWOS team has partnered with Forward Edge International. In May of this year, some of the VWOS team members and other Collaboratory volunteers will be installing a prototype at Villa Esperanza Girls Orphanage in Managua, Nicaragua. This past year, the team has been running tests to ensure proper functionality of the system as well as preparing materials such as a user manual, detailed parts list, and logistics for installation in May.

2:40 p.m. ***The Macha Oxygen Concentrator Project: Prolonging medical device lifespans in a rural care facility***

Wyatt Albert, and Michael Madea

The Macha Oxygen Concentrator project team works in conjunction with the Macha Mission Hospital in Zambia, Africa to provide engineering support for respiratory devices. They are currently engaged in troubleshooting early failures experienced with the hospital's oxygen concentrators, devices which replace conventional tanked oxygen for patients with respiratory issues. These devices take ambient air in and separate the oxygen from the other gases in the air via a material called zeolite. The team has found that this material can become contaminated by high humidity and dust, both of which are prevalent in the environment at Macha. They have been focusing their efforts on designing an alternate intake filter for the concentrators that can adequately reduce the amount of humidity and dust the zeolite is exposed to. The team has also provided training to the maintenance staff at Macha enabling them to repair concentrators at the facility. The team has sent a team member to Macha in May of 2013 to evaluate an initial filter prototype and has plans to send another team in January of 2015.

3:00 p.m. ***Poster Session***

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

4:00 p.m. ***Solar Power Used To Reduce Dependence On Unreliable Electric Grid***

Taylor Everett, Taran King, Ryan Slater

The public electric power grid in many emerging countries is unreliable. Customers must deal with the unpredictable loss of electric power for hours or days. Solar Power (PV) systems can provide the bridge over these times of power loss. This presentation gives an overview of this type of PV system intended to supplement an unreliable power grid. We will explore the important factors that must be considered during system design with specific examples from our current work with the Theological College of Zimbabwe.

4:20 p.m. ***Solar PV System for the Theological College of Zimbabwe***

Taylor Everett, Taran King, and Ryan Slater

As in many emerging countries, Zimbabwe has an unreliable power grid. Because of this, the students at the Theological College of Zimbabwe (TCZ) must deal with regular loss of electric power for hours or days. This talk provides a detailed overview of the components chosen for a Solar Photovoltaic (PV) system designed to provide power for TCZ's computer lab and library. One central component, the MATE, which is the user interface for these system components, is then described in detail along with current plans for the system installation in May 2015.

4:40 p.m. ***Reducing Indoor Cooking Smoke Hazards for Those Without Electric Power***

Abhishek Jacob

In a recent study, it was found that nearly 2 billion people worldwide use open cook fires in an indoor environment for cooking food and boiling water. Because these cook fires use biomass like wood and leaves for fuel, harmful byproducts are emitted that settle within the indoor environment causing disease and nearly 1.5 million deaths annually.

To address this problem, we have been developing a ventilation system which can be affordably manufactured in our client communities. This system uses a fan that draws smoke from the fire through a filtered ventilation hood. The reusable filter eliminates most of the carbon particulate from the smoke. This smoke is then vented outside the home via a duct in the ceiling or wall. Since many clients in need of such a ventilation system do not have access to electric power, we are experimenting with an alternative energy source which uses a Thermo Electric module to convert waste heat from the cook stove to the electricity needed to power the fan.

This talk will describe the experimental data used to identify our current design. This prototype will be implemented in Oaxaca, Mexico in partnership with Forward Edge International on August 2014. This project has provided us with an excellent opportunity to use our abilities and resources to externalize God's love for us through our service, sharing the hope of Christ.

5:00 p.m. ***Automating the Sharing of Limited Solar Power***

Carl Satterberg

In Missionaries, NGOs, and communities in remote locations do not have the luxury of unlimited energy availability that we often take for granted in the United States. Even when they have solar electric systems, the energy is limited and has to be used wisely. This talk is about a solution to this problem: an electricity meter that allows communities to allocate and share the electricity available to them while educating the users about better energy usage habits.

11th Annual School of Science, Engineering, and Health Symposium

Engineering IPC Presentations

Frey 110 – May 2, 2014

5:20 p.m. ***Seed Pressing and Biodiesel Production in Burkina Faso***

Meagan Miller

Biodiesel is a form of diesel fuel manufactured from vegetable oils, animal fats, or recycled restaurant greases. It is safe, biodegradable, and produces less air pollutants than petroleum-based diesel. Oils used in the biodiesel production process can be obtained through a seed pressing oil extraction process. The various Biofuels projects within the Energy Group work to produce biodiesel fuel at home and abroad, in conjunction with our local community and partners around the world, in order to educate and promote environmental and economic sustainability. The Burkina Faso Seed Pressing and Production team is focused on biodiesel production in developing communities. The team recently returned from a site team trip in January to work with one of our partners in Burkina Faso. Significant progress was made in developing an oil extraction process that is applicable to a developing world setting. This presentation will give an overview of the team's progress in extracting oil from Jatropha seeds in order to produce biodiesel in Mahadaga, Burkina Faso.

5:40 p.m. ***Seed Pressing Process Modifications***

Jeff Thomas Carson, Daniel Nesbitt, and Mark Wagner

The Bio-Fuels projects within the Energy Group exist to contribute to a more environmentally sustainable fuel option at Messiah and for our partners in other countries. In recent years we have been able to demonstrate that growing and pressing sunflower seeds on the Messiah College campus is a cost effective source of cooking oil for use in campus dining halls. The major focus of the Seed Pressing team this year has been to modify the seed pressing process to move from a Proof of Concept to a Production system. The intent is for clubs and organizations to be able to take over from Engineering once the process has been modified and documented so they are able to operate the machinery without difficulty. This talk will discuss the modification of the seed pressing equipment in the basement of the Women's Restoration House in order to streamline and simplify the seed pressing procedure.