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Garden Water Access Project

Aaron Film, 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.

Village Water Ozonation System (VWOS)

Katy Howell, and Laura Penwell

The Village Water Ozonation System (VWOS) is a small, community-sized water purification system. It uses two loops - a filtration loop and a purification loop. The purification loop uses a venturi to inject ozone into the system to purify the water. Our client is Forward Edge International and in May 2014, we are installing the system at a girls' orphanage in Nicaragua.

Hollow Fiber Membrane Filtration System

Jonathan Hepner, Darin Horst, and Rebecca Ports

The Hollow Fiber Membrane (HFM) Team works to design, build, innovate, and implement cutting-edge gravity-fed water filtration technology in collaboration with Sawyer Products. The HFM filter can be washed and reused for at least 10 years but requires clean pressurized water for backwashing. Currently the team is gathering feedback on the HFM 1.0 System which consists of backwashing tanks, a charcoal filter, and one large HFM filter, as well as prototyping the HFM 2.1 system which uses smaller filters in parallel without using backwashing tanks.

Intelligent Water Management System (IWMS)

Ken Kok

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.

Handpump Sustainability Studies

Stephen Angowski, and David Houck

Obtaining clean water access has been an ongoing struggle for villages across Africa. As a solution, many villages have implemented wells with handpumps to reach safe drinkable water. Unfortunately, mechanical failure leaves many of these pumps unusable often within a year of their installation. The Handpump Sustainability Studies project (HSS), is working to redesign and improve failure-prone components of the pump so to elongate their lifespan. HSS is currently in the process of providing two prototype designs: a machined poppet valve to replace the standard cast-iron valve, and an oil-impregnated iron bushing to replace the ball bearings at the pivot point of the handle. In addition to these prototypes, HSS has designed and built a testing apparatus to be able perform in-house testing of the India MK II pump.

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Mobility Electric Tricycle: Reducing Wear in Drive Shaft

Luke Barton, and Madison Brunk

Electric tricycles, which have been designed by the Disability Resources group for the clients of the Center for the Advancement of the Handicapped in Burkina Faso, use a planetary gear assembly to reduce the speed of the electric tricycle to an appropriate riding speed. In recent years the splines on the planetary gear assembly's socket have been wearing prematurely resulting in immobile tricycles.

Our team's goal is to redesign the mate between the planetary gear assembly's splined socket output and the drive shaft in order to reduce the wear that is occurring at this mate. Previous teams have developed several design changes with some success. We have focused on replacing the planetary assembly made from sintered metal with one made from steel (a much harder metal).

We are conducting both field and accelerated testing to compare the wear between these two options to see if there is sufficient decrease in wear with steel to justify the increased cost. At this time we have completed these tests with the planetary gear made of sintered metal and are in the beginning stages of testing the new planetary gear made of steel.

Flight Tracking & Messaging Systems (FTMS)

John Deseno

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.

Wireless Enabled Remote Co-presence (WERC)

Kelly Kulp

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, while fostering more independent development by the participant. WERCware 3.0 initiates and maintains contact between attendant and participant via Skype over an Android smartphone worn by the participant via a pendant-style adjustable holster. This presentation reports on the automatic cut-off solution, a component of the WERCware system that automatically turns off any video and sound feed for privacy in identified areas, whether for personal or work-related reasons. A successful solution will correctly recognize when the participant has entered a private area. To do this, some wireless technologies considered include radio frequency, ultrasonic, and infrared emitter-detector pairs. After evaluating the options, ultrasonic detection was selected. Circuits for transmitting and receiving signals in the ultrasonic range have been tested. The optimized detector circuit will eventually interface with the Arduino microcontroller to integrate the solution with the smartphone. Future work includes developing biometric sensors interfaced with the Arduino to monitor the participant, implementing a successful automatic privacy shutoff, and developing an internet connectivity monitor.

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AWDS Project: Improving Access to Water, Sanitation and Hygiene Facilities for Persons with Disabilities in Africa

Elizabeth Bashore, Andrew Foley, and Kaitlin Price

The Africa WASH and Disabilities Study (AWDS) seeks to accomplish its mission of improving access to water, sanitation and hygiene facilities for persons with disabilities by modifying WASH facilities (hand-pumps, latrines and washing stations) and developing low-cost assistive technologies such as latrine chairs and water pouring devices. The focus areas of the AWDS include disability-friendly adaptations for hand-pumps, technologies to aid in the transportation of water and modifications to sanitation and hygiene facilities. The AWDS has worked to improve the design of hand pump superstructures by rendering them accessible with the addition of gradually sloped ramps, modified pump handles, seats and lifting stations. In addition, low-cost assistive technologies such as bucket tippers have been developed to aid persons with the management of water within the home. Adaptations have also been made to latrine facilities with the addition of hand supports and a disability-friendly latrine chair. Through a partnership with World Vision and a grant from the Conrad N. Hilton Foundation, the AWDS works with beneficiaries in East, West and Southern Africa.

Mobility Electric Tricycle: Head Tube Angle Redesign

Taylor Eberly, Lauren Long, and John Nordstrom

The Mobility Tricycle Project designs electric and hand-powered tricycles for people living with physical disabilities in Burkina Faso, West Africa. While much of the tricycle design has been carefully considered and optimized, one area in particular, the front-end of the tricycle, still can benefit from a systematic redesign. Our project was based on examining how the tricycle head tube angle, an important geometric aspect of the front end, affects the handling of the tricycle. To do so, we designed a test apparatus to allow us to adjust the head tube angle and installed it on the electric tricycle. Using this angle adjuster, we conducted several tests to examine the effect of the head tube angle on handling factors such as wobble (shaking left to right of the front wheel fork at higher speeds), ease of turning, and stability. In each test, we incrementally changed the head tube angle in order to examine what effect the head tube angle has on each of these factors. Our aim was to find the optimal head tube angle that would best decrease wobble while also making the tricycle easier to turn and more stable. Using our test data, we determined what angle would provide the best handling performance for the tricycle and we plan to implement this angle into the existing electric tricycle design.

Basic Utility Vehicle (BUV)

Wesley Loar, Garrett Myers, Nicholas Oland, and Robert Schmuck

The ability to move products and materials is crucial to the quality of life. In Africa, a Basic Utility Vehicle provides an affordable solution to faster transportation. BUVs are designed to withstand the rugged terrain while transporting large payloads. Our team hopes to integrate a power take-off system with a BUV; this will enable people to power other equipment using the BUV's motor. In time, we hope to apply similar technologies to small gas-powered scooters to improve their functionality. The BUV is a new project and has involved a great deal of communication with our consultant as we sought to define project objectives. This semester, we acquired a small diesel engine, mounted it to a test stand, and began testing to ensure that it would work properly. We have designed a prototype BUV frame and begun its assembly. The engine will power our prototype and provide flexibility in designing and testing various methods of power take-off.

Electrical Light Sport Aircraft (LSA)

Richard Dufrenne

The goal of the LSA project is to create an affordable and rugged light aircraft which can serve in rural and isolated areas for medical missions and pilot training. Some features include folding wings and short takeoff and landing (STOL) capabilities. At this point in time, the fuselage has been largely completed and the engine has been tested. The wings are in the beginning stages of construction. The goal of this semester is to mount the engine completely to the fuselage and make significant progress on both the wing folding and construction.

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Electrical Bio-fuels At Home and Abroad

Casey Bechard, Aaron Edgin, Andrew Gates, and Nathan Good

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. Our work to produce Bio-Diesel fuel at home and abroad, in conjunction with our local community and partners around the world, serves to educate and promote environmental and economic sustainability. We do this to proclaim the biblical truth that we are all stewards of the Earth. Our Seed Pressing operation here on campus has reached the phase of certifying that our process meets USDA standards for oil production so that we can sell locally grown sunflower oil to Dining Services. The Bio-Diesel Production team has been working on making our production process reliable, efficient, and properly documented. The Burkina Faso Production team recently returned from a site team trip in January. Significant progress was made in developing a bio-diesel production process that is applicable to a developing world setting.

Automated Sharing of Solar Power

Daniel Baker, Nathan Chaney, Ashley Evans, Aaron Gettemy, and Zachary Sorrell

Missionaries and NGOs 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 poster describes a solution to this problem: a electricity meter that allows communities to allocate and share the electricity available to them.

Solar Photovoltaic System Design Process For The Theological College of Zimbabwe

Benjamin Albert, Steven Daub, Josiah Kadar-Kallen, and Jillana Stauffer

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 poster describes our work designing a Solar Photovoltaic power plant to provide reliable power for TCZ's computer lab and library. This effort includes load analysis, component selection, system sizing, and installation layout design. We are currently planning to install this system in May of 2015.

The Briquettes Project: Realistic Alternatives to the Use of Charcoal and Wood in Malawi

Josiah Kelley

Malawi's forest resources are being harvested at alarming and unsustainable rates. Much of this deforestation is caused by the countries' demand for charcoal and wood to meet its daily energy requirements. It has been reported that 42% of Malawians use charcoal or wood as their primary source of energy for cooking, with over 85% of the population using charcoal or wood to some extent. In 2004, this amounted to a forest consumption rate of 15,000 hectares every year. Charcoal made from wood is often transported distances in excess of 40 miles on a bicycle for purchase by consumers. This raises the price of charcoal and creates the opportunity for alternative fuels to become more economically feasible. The goal of the Briquettes project is to significantly reduce charcoal and wood consumption in Malawi. We are developing a process using locally available equipment to convert abundant natural by-products into fuel briquettes which are an economically feasible alternative to charcoal.

Smoke Free Indoor Cooking

Christian Sagcal, Joshua Scholl, and Brenton Yost

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. The wood and leaves used to fuel these cook fires generate harmful byproducts which when unvented, cause disease and nearly 1.5 million deaths annually. This poster will present the work of the Thermoelectric Generator project within the Energy group whose mission is to develop a viable way for people in developing communities without access to electric power to reduce health risks by removing the smoke from their homes caused by indoor cooking.

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The Macha Oxygen Concentrator Project: Prolonging medical device lifespans in a rural care facility

Jilean Schutz, Erik Listor, and Chris Scheib

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 determined 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 in May of 2013 to evaluate an initial filter prototype and has plans to send another team in January of 2015.

A Pedestrian Bridge for Rio Missions (Panama)

Laura Castilow, Russell Woleslagle, Adam Pozun, and Christian Rogerson

We are engineering a timber-type pedestrian footbridge that will help a community in Panama cross a ravine that is otherwise impassable during the rainy season. The bridge will provide year-round access to essential life resources, including water, food, and schooling. These resources are found in a community center that is lead by a Panamanian pastor named Pastor Guerra. Rio Missions is supporting this pastor and his ministry by improving the community center, and now with us, bridging the literal and spiritual gap in Arraijan.

Kenya Mobile Medical Clinic

Benjamin Richter, Lukas Murrill, Aaron Black, and Joel Zeigler

Proper medical care is not readily available to many people who live in remote areas of Kenya. Working with Dala Development, 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.

Solar Commuter Vehicle Motor Integration Redesign

Glenn VanSickle

The Solar Commuter Vehicle (SCV) team discovered compatibility problems between the 1997 Solar Car motor and the 1999 Solar Car motor controller and therefore decided to substitute the 1999 motor for the presently applied 1997 motor. Due to geometric differences between the two motors, the motor mounts and axle required redesign. The older motor allowed the axle to pass completely through its center while the replacement motor was designed to have an axle on only one side. This difference mandated the design of a load-bearing motor mount and a single-sided axle system. The design, analysis, and fabrication of the motor and axle mounts
were the group's major points of focus this academic year.