Communications  
**Wireless Enabled Remote Co-presence (WERC)**  
Joe Coshun and Ryan Hahn

The Wireless Enabled Remote Co-presence (WERC) team is working on a system to allow people with social and cognitive disorders to live and work more on their own. People (participants) with disorders such as PTSD and Asperger’s Syndrome often have to rely on an assistant (e.g., social coach or attendant) to perform daily tasks. However, the assistant/participant relationship can lead to dependence and/or stretch the resources of the social agency. WERCware 3.0 envisions a solution that allows a life-coach to remotely attend numerous participants with various disabilities via a Skype call on an Android phone. Calls may be voluntarily or auto-triggered.

This year, the WERC team has been analyzing ways to measure stress, as a threshold trigger for an automatic call from a participant to the coach. Prior work has shown that Galvanic Skin Response (GSR) can serve as such a stress indicator, but tends to conflate positive versus negative stress. Subsequent experiments have tested voice analysis using an Artificial Neural Network (ANN). The human voice typically has frequency characteristics that change due to stress. By passing multiple audio samples into its inputs, an ANN can be trained to accurately make “yes” or “no” decisions about stress, with a relatively high success rate. Future work for this project includes further testing and implementation of the ANN and other research involving Electroencephalography (EEG) to determine its potential to measure stress via characteristics of a person’s brain waves.

Disability Resources  
**Africa WASH and Disability Studies**  
Elizabeth Bashorem, Andrew Foley and Kaitlin Price

The AWDS seeks to improve the access to and use of water, sanitation, and hygiene (WASH) facilities for persons with disabilities through the development of simple, low-cost WASH technologies and modifications. Partnering with World Vision in the countries of Mali, Niger, and Ghana, project members are currently working to address difficulties associated with the access and transportation of water. Two initiatives are being pursued to mitigate these challenges. First, a water transportation device has been fabricated that couples with a jerry can tipper developed during a previous phase of the project. This allows users to more easily transport a jerry can to and from water access points and offers assistance when managing water in the home. Second, a pump handle extension has been designed that attaches to the end of an India Mark II pump handle. A standard handle consists of a long, thin rod and users are expected to grasp the rounded end of the bar. This attachment allows individuals to situate themselves in an ergonomic position while still utilizing the full mechanical advantage of the lever system.

Disability Resources  
**Mobility Tricycle Project: Front End Redesign**  
Rachel Mazurek

The Mobility Tricycle Project is working to improve and fine tune the current hand powered and electric tricycle models for people with limited mobility living in Burkina Faso, West Africa. Our goal is to produce a more comfortable and efficient tricycle while maintaining or lowering the cost of manufacture, maintenance, and operation. The front end redesign team focuses on the front portion of the tricycle structure, including the steering handle, head tube, fork, and front wheel, which impact tricycle handling and steering characteristics. As a result of different handling and straightening tests conducted during the past year, the front end redesign team detected an imbalance in the handling of the electric tricycle, which caused the tricycle to pull to the left. Further analysis revealed that this imbalance was due to an assembly defect that caused the fork to be permanently bent such that it was no longer symmetrical. This nonsymmetry occurs during the trike assembly process when the two blades of the fork are pulled apart, by hand, to accommodate different front wheel widths.
Since both blades are not of equal strength, the weaker one will bend out while the other remains mostly in place. The front end redesign team has recently produced a tool that aids in the manufacture of the front end of the tricycle and prevents any non-symmetrical bending of the fork.

**Energy**

**Energy Monitoring and Management System**  
Wesley Ashton and Matthew Wilkinson  
Solar power systems produce a limited amount of energy. People using these systems need a way to educate themselves about power usage, help them share the available power equitably, and prevent damage to the system that may result from overuse. We are designing a home energy meter that will measure power usage, give educational feedback to the user, and limit the consumption of individual buildings or circuits.

**Low Power Solar PV Systems**  
Elkan Nelson  
In many parts of the world the best solution to energy needs is Solar power. These systems range from large scale systems which power an entire clinic to small systems charging a battery for a single light bulb. Our project has developed inexpensive low power prototype designs capable of solving two wide-spread application needs. The first system is capable of powering a single well water pump and the second can provide the power needed by a small cluster of computers.

**Solar PV for the Theological College of Zimbabwe**  
Andrew Floro, Scott Kerstetter, Jessica Kline and Josiah Peck  
Electrical power in Zimbabwe is extremely unreliable and is frequently unavailable. Many of these incidents last for a few minutes but they can extend for several days. Students at TCZ have trouble completing their studies without consistent power. They find it particularly difficult to do school work when the library and computer labs do not have power. We have developed a proposal and chosen the major system components for a Solar PV system which would provide power for the Library and Computer lab. Most of the funding for this system has been provided by local churches and the organization Friends of TCZ is continuing the fundraising efforts. We have built a small scale system at Messiah College to practice the installation. The Solar PV, TCZ site team with travel to Bulawayo Zimbabwe in May 2015. After our visit in May, the system will be fully installed and operational. This will result in the computer labs and library being re-wired separate from the rest of the buildings/rooms. This new network will have sufficient power to function at all times, using power from solar panels, battery back-up from the panels, and the power grid.

**Thermo-Electric Generator Ventilation Hood**  
Brooks Arnold, Joel Ngui and Joel Sibi Mark  
In a recent study, it was found that nearly 2 billion people worldwide use open cook fires for common purposes such as making food and boiling water. Women often cook using open fires every day to provide the family with food, but what they don't realize is that the harmful products of burning biomass that settles within the household due to a lack of proper ventilation has been linked to various diseases including pneumonia in children, Chronic Obstructive Pulmonary Disease, asthma and other lung and heart diseases. While fan ventilation would solve this problem, people without electricity cannot use this simple solution. We are developing a ventilation system which uses the heat of the cookstove and a peltier device to generate the electricity needed to power a ventilation fan.
Affordable Sanitation

Adam Pozun and Gavin Stobie

The World Health Organization (WHO) currently estimates that only 45 percent of rural Africans have access to basic sanitation services. Therefore, the majority of the population in rural communities continues to rely on open defecation and is therefore subject to the transmission of fecal-oral diseases. In many cases, the prohibitive costs associated with the construction of pit latrines restrict access to effective sanitation. In response to this challenge, students and faculty at the Collaboratory at Messiah College are working on the Affordable Sanitation Project. It is the objective of this project to identify design solutions to reinforce the structural integrity and increase the lifespan of pit latrines, with careful attention to the life cycle cost of the solution. This project will seek design solutions that are both more functional and more affordable than the current designs.

Combined Heat and Power

Christian Rogerson

The Messiah College campus is embarking on an initiative to bring natural gas to campus, and to implement a combined heat and power (CHP) system in order to control energy costs. A student demonstration model is planned in parallel with the full-scale campus project in order to help College leadership communicate this technology to its various stakeholders.

Combined heat and power technology harnesses thermal energy in the exhaust gases from electrical generation processes. The waste heat can be used to meet heating - and cooling - needs with no additional energy cost, using energy that would otherwise be wasted. This project aims to design and build a functional model of a combined heat and power system that includes electric generation and harnessing the exhaust energy for the purposes of both heating and cooling in a demonstration interface.

Library Acoustics

Katie Barrett

The Library Acoustics Management project is working to foster a more productive study and work environment by reducing the amount of sound pollution in the library. Two years ago, the library underwent renovations to create a modern, open floor plan and a centrally located cafe. The open layout has led to a noisier environment than was historically the case for the library. The project team is partnering with library staff to seek solutions for noise mitigation without compromising the improvements made in the recent renovations.

Pedestrian Bridge in Panama

Andrew Joy

In the Bridge Project, we believe that everyone deserves the right to have safe and reliable access to essential life resources. With our partner, Rio Missions, we have identified communities in Panama with restricted access due to seasonal flooding, and are working to improve access to life-sustaining resources by designing and constructing pedestrian bridges. Last summer, we completed our first bridge in a community called Arraijan. This bridge now connects two halves of a community, and provides safe and reliable year-round access to the road where kids can travel to the local school. After the successful completion of the first bridge, we identified a new community called La Gigi. This community is cut-off from their local school and medical center by a seasonally flooding river, comparable to the Yellow Breaches. We are working with a service-oriented bridge building organization called Bridges-to-Prosperity and have recently finished designs for this 215ft cable suspended pedestrian bridge. We are planning a six week construction trip for this Summer starting in mid-May and finishing at the end of June.
Transportation  
**Cycle Advancements - Universal Hitch**  
Benjamin Sollenberger  

Utility transportation is becoming more popular in developing countries. Vehicles specifically designed for towing and power take off, such as Basic Utility Vehicles, are not as affordable as 100 - 125 cc motorcycles. Nonetheless in rural areas, a quick, reliable mode of transportation is necessary. However, small displacement vehicles are not designed to move equipment, crops, etc. Even so, small motorcycles are becoming increasingly popular in many developing regions around the world, including West Africa, South America, and Southeast Asia. Currently, the market is flooded with off-brand motorcycles that are manufactured quickly and efficiently in bulk, leading to products that are cheap and low quality.

The CART project team's goal is to design attachments for these motorcycles to increase utility in a wide variety of applications, as well as improve their longevity. Many of these bikes undergo loads much greater than intended by manufacturers; thus, high factors of safety must be incorporated into our designs. Additionally, a focus of the CART project is to create attachments that can be reproduced or repaired with the tools and resources available to those in our target area. Therefore, we must be mindful of our machining and assembly processes so that they are simple and cost effective. Ultimately, the purpose of this project is to improve the quality of life for those whose livelihood depends on the use small displacement motorcycles.

Transportation  
**Kenya Mobile Medical Clinic**  
Stephen Smeiles and Jason Wright  

The Kenya Mobile Medical Clinic (MMC) project seeks to outfit a small trailer as a mobile clinic primarily detecting and treating cervical cancer in the region of central Kenya. Our client is Dala development, a Christian-based healthcare organization located in Meru, Kenya. In East Africa, cancer is the third most common cause of death and Cervical cancer is a leading form. When it is detected at an early stage, cervical cancer is preventable and treatable. Dala Development came to the Collaboratory requesting a trailer which could make screenings and treatment more available to people in rural communities far from Meru. The project was started in the Fall semester of 2013 with the acquisition of a used trailer from another Collaboratory project. The Mobile Medical Clinic is set to be finished in May 2016 at which point it will be loaded into a shipping container and sent to Meru, Kenya.

Water  
**Garden Water Access Project**  
Luke Betteridge  

In order to meet the need for irrigation water during the dry season of Western Africa, the Garden Water Access Project has designed a hand-powered well drilling system and simple handpump. In conjunction with SIM and Open Door Development in Mahadaga, Burkina Faso, these systems are already providing water for dozens of families. In the final phase of the project, the drill bits were systematically tested and acceleration data analyzed in order to ensure their effectiveness.

Water  
**Hollow Fiber Membrane Filter Testing**  
Melanie Aronis, Kyle Margosian and Braden Olson  

The HFM (Hollow Fiber Membrane) Filtration Team designs and implements filtration systems that use Sawyer filters. Currently, the HFM Filtration Team is designing a testing system to complete a filter life study for Sawyer bucket filters in order to verify their given life expectancy of lasting several years and one million gallons (approximately 2.5 years of
The project proposed to meet the standards of Sawyer filters by re-circulating stream or spiked water through 24 filters in parallel through the use of a manifold and pump system. Flow and pressure through the system would be monitored to verify the functionality of the filter during forward flow and backwashing procedures. The life cycle test would be measured through the use of periodic biological tests in order to determine the amount of bacteria left in the filters after strenuous use. Data will be provided to Sawyer to verify or deny their proposed life expectancy for the filters.

**Water**

**Intelligent Water Project**
Jacob Sargent and Jacqui Young

Did you know that 36% of hand pumps in Sub-Saharan Africa do not deliver water to their communities? To combat this, the Intelligent Water Project is developing an automated, hand pump monitoring system that allows organizations to monitor the functionality of all of their pumps in the field. The information generated by IWP can be used to determine how much specific pumps are being used and to generate warnings of any pumps that are failing or have failed and are in need of repair. The information is collected via SMS in a database that can be accessed by authorized technicians online, anywhere in the world.

http://www.IntelligentWater.net

**Water**

**Limited Pass Village Water Ozonation System (VWOS) Design**
Elisabeth Chang, Gabrielle Clapper and Hing Jii Mea

The Village Water Ozonation System (VWOS) team has designed a new limited pass embodiment of their ozone-based water treatment technology that reduces tank size and cost while increasing portability. Previous designs purified water in large-tank batches. The new design allows clients to purify water as it is needed. This change also aims to widen the clientele for the system by enabling one mobile system to treat water for multiple customers, resulting in more customers each bearing a smaller portion of the capital cost of the VWOS system. The VWOS team will share their design modifications and performance testing work, and progress toward the goal of maintaining a constant inflow of raw water and an equal outflow of water that has been filtered and ozonated to an oxidation reduction potential of 750 mV.

**Water**

**Mechanized Percussion Well Drilling**
Amanda Luger and Kathryn Moyer

The goal of this project is to develop an engine-powered percussive well drilling system. This system will be used by our client in Burkina Faso, West Africa to produce shallow bore holes for water access. The machine reduces the labor required to manually drill wells, and interfaces with the drill bits that were designed previously by the Garden Water Access Project. This year we have focused on designing a wooden prototype of the mechanized drilling rig to test the concept, and discover any unforeseen problems. After the first prototype was built and tested, we used the conclusions from testing to guide the design of a steel frame for the mechanized system. In addition to this, we have also been working on designing a new steel tripod that will be beneficial for our team as we continue testing the mechanized system.