



**Engineering World Health Summer Institute
Uganda 2017
Final Report**

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Executive Summary

This was the first year of the EWH-Duke Engage SI Uganda program, and overall the program made a meaningful contribution both to Ugandan hospitals, and to the education of 8 undergraduate participants from Duke University, (3 male and 5 female) and 5 participants from Makerere University (4 male and 1 female). We had one On-the-Ground-Coordinator from Engineering World Health, an instructor, Dr. Robert Ssekitoleko, from Makerere, as well as a program adviser from Duke, Dr. William (Monty) Reichert.

During the first month of the program, the participants underwent training at Makerere University in Kampala. This training included a study of the public health care system in Uganda; lectures and hands-on labs on medical repair and maintenance; and lectures and workshops on needs-based design in the developing world. The group enjoyed a cultural event with the Ndere Dance Troupe.

During the second month, participants rotated through 7 hospitals in Kampala and collectively **repaired over 100 pieces of equipment**. Equipment ranged in complexity from fetal stethoscopes to patient monitors. In addition, they completed preventative maintenance on 16 pieces of equipment.

Notable, high impact repairs include a grinder for orthotic braces that had been out of service for 6 years, installing new lighting in a workshop, and an autoclave that had been fished out of a dumpster and stored for 2 years before being repaired by our participants.

Participants completed multiple design projects that resulted in physical prototypes. Many of these projects were designed and built at Katalamwa Cheshire Home, a rehabilitation center that creates assistive devices for children with disabilities.

In summary, the Uganda SI was highly productive and an overall success. Participants gave a unanimous “yes” when asked if they would recommend this program. As a result, it is EWH’s and Duke’s intention to expand the program in 2018.

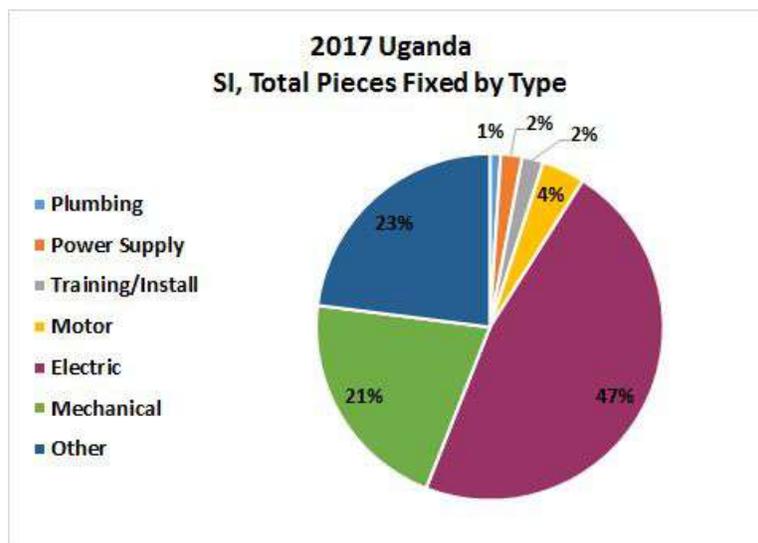
Types of Medical Equipment Repair

The 13 participants repaired 105 pieces of medical and hospital equipment, totaling approximately USD \$210,000 [1] of equipment repair service.

Repairs by Type of Equipment

Type of Equipment	Total Pieces Repaired	Type of Equipment	Total Pieces Repaired
Air Compressor	1	Lamp, examination	4
Air Conditioner	1	Microscope	12
Aspirator/Suction Machine	8	Oven, Lab	1
Autoclave	2	Oxygen Concentrator	2
Automatic Voltage Regulator	1	Patient Monitor	2
Blood Bank Refrigerator	2	Scale (laboratory and in wards)	8
Blood Pressure Device, Automatic	2	Shaker Machine	1
Blood Pressure Device, Manual	4	Thermometers	2
Fetal Stethoscope	1	Transformer	1
Furniture	28	X-Ray Film View Box	1
Infant Warmer (Radiant or other)	1	Other	17
Infusion Pumps	3		

Repairs by Type of Fix

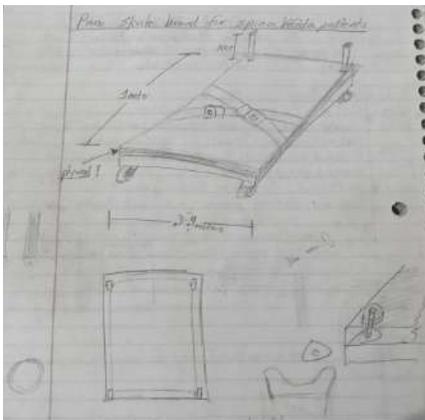


Design Projects

Essential to improving healthcare delivery in the developing world is having a deep understanding of the challenges faced in low-resource communities. We ask our participants to be observant throughout their time in the hospitals and try and identify some of the greatest needs. Participants conduct interviews with hospital staff to learn about the problem through the lens of various hospital branches (i.e. clinical staff, BMETs, health system leadership), then, working in groups, propose a solution to this problem. Each group consisted of two students from Duke University and one student from Makerere University. Based on these interviews, the following are the designs the participants created:

Group 1: Kelsey Li, Thomas Vincent, and Drake Amutuherire; Katalamwa Rehabilitation Center: This group had developed a number of potential design projects, but after speaking with staff members of the Occupational Therapy Department at Katalamwa, they discovered that a prone skateboard was a device that was greatly needed. There are many children with spina bifida at the center, with bed sores that make it painful to sit. A prone skateboard could help the children gain more mobility, while also providing them with a fun, interactive way to strengthen their muscles.

This group developed a prototype and was able to get feedback from the staff at Katalamwa, as well as Occupational Therapists at LSU via Skype. The group did research to improve their design, looking into different types of wheels to increase the types of terrain the skateboard can handle and improving the comfort of the board surface.



Preliminary Design



Prone Skateboard being tested



Prone Skateboard

Group 2: Yao Qi, Claire Niederriter, and Fred Bulodo; Katalemwa Rehabilitation Center: This group worked on developing a method for recycling P.O.P. (Plaster of Paris, a material used in casts) at Katalemwa, as another group had established that there was a great need for it at the center.

The group designed an experiment to determine optimal temperature and time to heat the used P.O.P. to get it as close to its brand new form as possible. Eventually, after testing many samples, they discovered the optimal process is to crush/grind the P.O.P., heat it in an oven above 100 degrees C to dehydrate, then store in plastic containers to prevent rehydration. They instructed staff members on this process, and left the program with the staff of Katalemwa fully able to continue recycling the P.O.P.



Experiments to find the best method



Crushed and baked POP

Group 3: Nathaniel Brooke, Helen Tan, Vincents Nteziryayo; ICU at Uganda Heart Institute: After conducting interviews in the ICU at Uganda Heart Institute, this group determined that a big problem in the hospital was the clogging of internal filters in the oxygen concentrators. This happens often and can be difficult and costly to remedy. This group developed an external, washable oxygen concentrator filter that can serve as a first line of defense, thus reducing the need for frequent cleaning and replacement of the internal filter.

They developed the filter to be washable and reusable with a light blue surface, so that red dust and debris would be more visible and assist the staff in knowing when it should be cleaned. Overall, this filter reduces dust buildup within the concentrator, eliminating filter clogs and helping staff prevent patient oxygen flow interruptions. The materials were still being perfected when the program concluded, so the group left Dr. Ssekitoleko and his biomedical engineering students at Makerere University with their designs, hoping that they will be able to discover an optimal material for the filter covering.



Preparing materials



Filter being tested

Group 4: Praruj Pant, Kat Vera, and Lydia Akino; Katalamwa Rehabilitation Center: This group worked with staff members in the Physical Therapy and Occupational Therapy departments of Katalamwa Rehabilitation Center. Through their interviews, they found that a device to help train elbow extension and rotator cuff mobility would be extremely useful in the ward. The group consulted with Occupational Therapists at LSU who helped them develop a design.

The group constructed a three bar vertical frame with the rim of a wheelchair attached to the middle bar. The wheel can be adjusted up or down, and the handle has been fitted with a comfortable grip. At the conclusion of the program, the group was finalizing ankle and wrist weights to be added should patients require.



Testing the device to strengthen arm movement

Other Katalemwa Designs: The participants also completed a few other design projects as a group for Katalemwa Rehabilitation Center. These projects are: a standing bed, manual dexterity toy, treadmill harness, and hand-eye coordination toy.



Standing Bed



Manual Dexterity Toy



Hand-eye coordination toy



Installed frame

Hospital Satisfaction Reports

To help us improve our work, our OTGC interviews a staff member in each hospital where participants are placed in order to learn about how the participants fared in the hospitals, what their biggest contributions were, and ways that we can do better.

Overall, the hospitals were very pleased with our participants and enjoyed having them contribute for the summer. The participants were described as humble, cooperative, inquisitive, friendly, and inclusive. Technicians in the hospital felt that the participants supported them, improved their work, and made them see what they had not previously been seeing.

Two hospitals stated the participants changed the whole face of the departments where they worked. Equipment is functioning so that whole wards are active, which has never previously happened. Their designs helped the patients get better services.

The main critique of the program was that they wished the participants could stay in each hospital longer than a week.

Participant Debriefs and Feedback

Engineering World Health seeks not only to assist the hospitals in which our participant volunteers work, but also to influence the volunteers' own development as engineers and as global citizens. Our participant feedback was generally very positive. Some of the words used to describe the program were meaningful, challenging, engaging, rewarding, inspiring, and perfect. Many participants felt that they left the program with increased confidence and felt much more comfortable getting out of their comfort zone, be it speaking with new people or taking on new projects. Some said the trainings helped them feel as if they could tackle any medical device and improved their attitude towards biomedical engineering. Overall, the participants felt that they achieved a level of personal growth with knowledge and perspective, and were grateful for the experience and the close relationships they built while in Uganda.

The instructor for this summer was Dr. Robert Ssekitoleko and other Makerere biomedical engineering staff, notably Catherine Nyamayega and Beryl Ngabirano. The Duke faculty advisor was Dr. William Reichert. Dr. Reichert visited the program for one week. The On-the-Ground-Coordinator was Maddy Bishop-Van Horn, EWH's Summer Institute Engineering and Curriculum Coordinator. Maddy also served as the teaching assistant. English is largely spoken in Kampala, so there was only one morning of Luganda classes. It was taught by Nkwanga Brian Senabulya, a graduate of the biomedical engineering program at Makerere.

[1] EWH estimates the mean value of each repair at USD\$2000