Engineering World Health Summer Institute
Rwanda 2018
Final Report

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Executive Summary

In 2018 Engineering World Health ran its sixth Summer Institute in Rwanda. The 2018 Institute, run in partnership with Texas A&M University, hosted 18 participants from 3 different countries. Due to impressive recruitment efforts by Dr. Michael Moreno, 10 of these participants came from Texas A&M.

The participants stayed with homestay families for the first month, and mostly in guest houses for the second month. During the first four weeks of the program, the group underwent intensive technical and language (Kinyarwanda) training conducted at IPRC, a technical school in Kigali. Their technical training included both lab and lecture, with one weekly visit to a Kigali hospital to provide the participants with hands-on experience before beginning their hospital placements.

After their training, participants were transported to one of our partner hospitals, located throughout Rwanda, to work in groups of two. This summer, we were able to work with 9 hospitals in Rwanda. During their 5-week placements, **the participants repaired 236 pieces of equipment worth approximately US $472,000[1].**

The participant feedback was very positive. All reported enjoying their time working in the hospital and that they felt very needed. This group was able to accomplish a lot, both by way of equipment repair and secondary projects. Many infant incubators, including transport incubators, were repaired and immediately put into use. Very notably, one group networked through Facebook to fundraise and order 20 oxygen pressure regulators for their hospital.

In addition to our regular activities, we were able to provide SolarSPELLs to some of our partner hospitals in Rwanda thanks to the work of Sarah Patterson, one of our Tanzania On the Ground Coordinators. SolarSPELL is a Solar Powered Educational Learning Library: a ruggedized, portable solar-powered digital library over an off-line WiFi hotspot, designed to simulate an online experience. It helps to provide content to BMETs in low-resource areas, giving them improved access to resources and help them fix life-saving pieces of equipment. These resources include textbooks, lessons, service manuals, equipment overviews, troubleshooting flow charts, and more. Our participants installed the devices and trained technical staff on their use.

We are grateful to all who helped make this program not only possible, but a success in the eyes of our participants and our partners in Rwanda.

Medical Equipment Repair

The 18 participants repaired or completed preventative maintenance on **236 pieces** of medical and hospital equipment, totaling approximately USD $472,000[1] of equipment repair service. Their work is summarized in the following charts:

Repairs/Maintenance by Type of Equipment

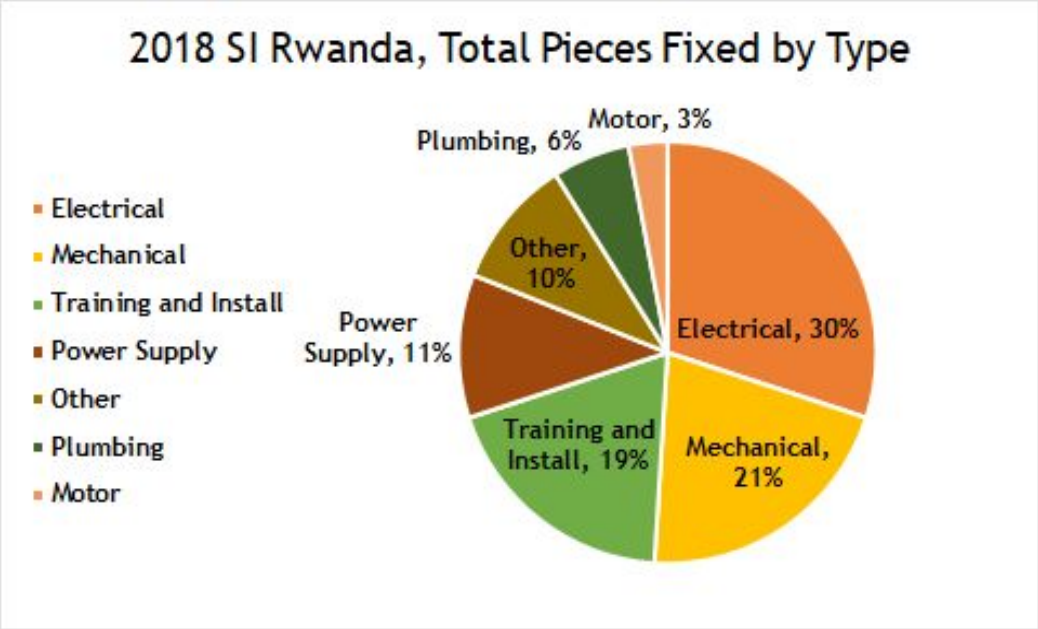
Type of Equipment	Total Pieces	Type of Equipment	Total Pieces
Anesthesia Machine	2	Lamp, surgical	5
Aspirator/Suction Machine	15	Microscope	8
Autoclave	7	Nebulizer	6
Automatic Voltage Regulator	2	Oxygen Concentrator	18
Bed, delivery	1	Patient Monitor	10
Blood Pressure Device, Automatic	3	Phototherapy Device	6
Centrifuge (electric or hand operated)	2	Printer	2
Distiller	1	Pulse Oximeter	16
ECG	1	Respiration monitor	1
Electrosurgery Machine*	1	Scale (laboratory and in wards)	11
Fetal Stethoscope	7	Ultrasound machine (imaging)	2
Furniture	20	UPS (various)	7
Glucose level kit (or glucometer)	1	Vaccine Refrigerator	5
Incubator (infant)	19	Vacuum Extractor (for delivery)	10
Infant Warmer (Radiant or other)	14	Washing Machine	1
Infusion Pumps	1	Other	30
Iron (for clothing)	1		

*User training and/or low voltage and peripherals repairs only

Repairs by Hospital

Hospital	Items Touched	Repaired	Abandoned	Repair Percentage
Hospital 1	47	32	15	68
Hospital 2	45	25	20	56%
Hospital 3	19	10	9	53%
Hospital 4	44	37	7	84%
Hospital 5	54	43	11	80%
Hospital 6	45	20	25	44%
Hospital 7	17	12	5	71%
Hospital 8	35	20	15	57%
Hospital 9	53	37	16	69%
Total	**359**	**236**	**123**	**66% avg**

Repairs by Type of Repair



Secondary Projects

Each team is encouraged to complete a secondary project for their hospital during their placement. Through interviews with hospital staff, the participants identify a need in the hospital, then are given a budget of $100 per person to use in a creative way to provide for that need.

Hospital 1

This group worked mainly in the neonatal department with UNICEF volunteers. The UNICEF volunteers made them aware of two main problems causing a nearly 20% neonatal mortality rate: hypoxia and hypothermia. There was a surplus of oxygen cylinders, but only 5 working regulators, forcing the hospital to split oxygen tubing. Up to 5 babies were being given oxygen from the same cylinder, leading to higher chances of hypoxia (and spread of infectious disease). There was also no system of organizing which oxygen tanks were full or empty. A major source of the hypothermia problem was the transportation from maternity to neonatal. The nurses were simply picking the babies up and running with them, subjecting them to heat loss and harmful vibration. This group came up with a three-part solution: 1) to create a labeling system for the oxygen cylinders, 2) to provide the hospital with more regulators, and 3) to create a transport incubator.

The labels were fairly straightforward: they created labels with “FULL” in English, Kinyarwanda, and French, and printed and laminated them. They then dispersed the labels across all departments that used oxygen tanks and educated the nurses on how to use the new system.

The regulators presented more of a problem. A regulator in Rwanda costs approximately $250, a huge amount when compared to a regulator in the US which can cost from $10-50. Importing regulators from the US was not an option, because there is an import fee of about $1,000 coming into Rwanda. The solution turned out to be through networking: the volunteers joined a facebook group called Expats in Rwanda and found a woman coming to Rwanda that month with room in her suitcase for regulators. Additionally, they secured a $1,000 donation from a doctor’s office back home and were able to order and deliver 20 new regulators to the hospital.

Oxygen Cylinder with Label

Oxygen Regulators

To help with the issue of hypothermia during transportation, they built a transport trolley. They found a broken, unused incubator in an otherwise empty room in pediatrics and salvaged the body of it. The heating element did not work, so they sewed a homemade “Space Cocoon” out of mylar (the material that heat reflecting blankets are made of), party balloons, and a baby blanket. They found and repaired a broken small SpO2 monitor. They took out the humidification chamber and made the hole slightly bigger in order to store a small oxygen tank. In the end, they had built a very functionable transport incubator that was the praise of the UNICEF staff.

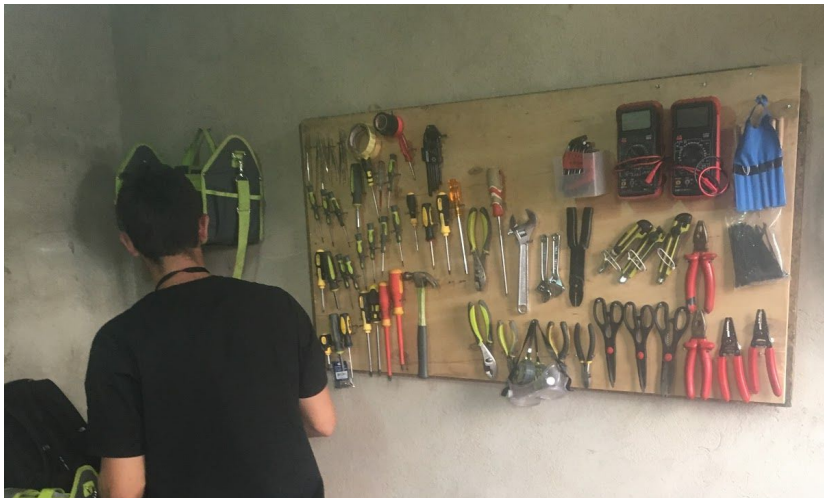
Space Cocoon

Transport Trolley

<u>Hospital 2</u>

During the participant’s month here, the maintenance staff was moved to a different building that was much smaller than the old workshop. In order to make the most out of the small space, this group decided to build a tool rack to help clean the area and

create more surface space. They laid out all the tools and hammered in nails in order to replicate a pegboard tool rack as closely as possible. The maintenance staff appreciated the tool rack and the organization it brought to the space.



Finished Tool Rack

Hospital 3

This group had two secondary projects: building a workstation and creating an inverter. They worked with local carpenters to provide the hospital and BMET with a workbench or assist in his work and keep the space organized.

Work in Progress

Final Product

Inverters convert DC battery voltages to AC voltage to power other electronics, which can be helpful in the hospital. Perfect sine wave inverters are very expensive and difficult to build. However, square wave inverters are relatively easy and inexpensive.

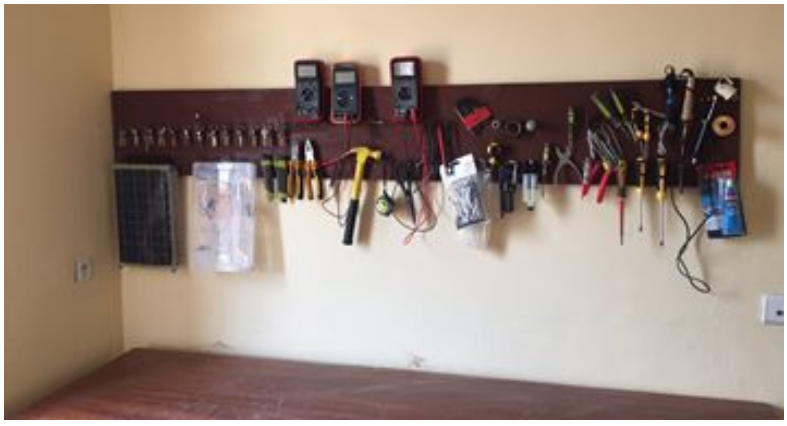
The main disadvantage is that square waves cannot drive AC motors because the edges are too sharp. However, they can be used to power anything else such as patient monitors.

To start, the participant created an initial design and simulated it. Once concluding that the simulation design worked, the device was built. Multiple testing methods were used to ensure that the device is functional.

Exterior and Interior Views of the Inverter

Hospital 4

This group's secondary project was building a tool rack to organize the workshop and better keep track of the tools in the hospital. They worked with the local BMET and interns to purchase wood, which came pre-stained. Installing the tool rack provided them and the hospital BMET with a cleaner and more organized work space.



Finished Tool Rack

Hospital 5

Through interviews with various hospital staff, this group realized the critical role that oxygen plays to keep the hospital up and running. They also learned that out of the three available ambulances, only one was fitted with oxygen. This was a major limiting factor in the type of patients the ambulances could carry. Thus, they decided that their secondary project would be to install oxygen holders into the remaining two ambulances. They focused on the safety of the occupants inside the ambulance as well the ease of exchanging empty tanks for full ones. Due to the rough terrain, the oxygen holders needed to hold variable sizes of tanks yet minimize the amount of room the tank has to move. Through sketches and paper prototypes, they finished a design and worked with the hospital's welder to complete the holders.

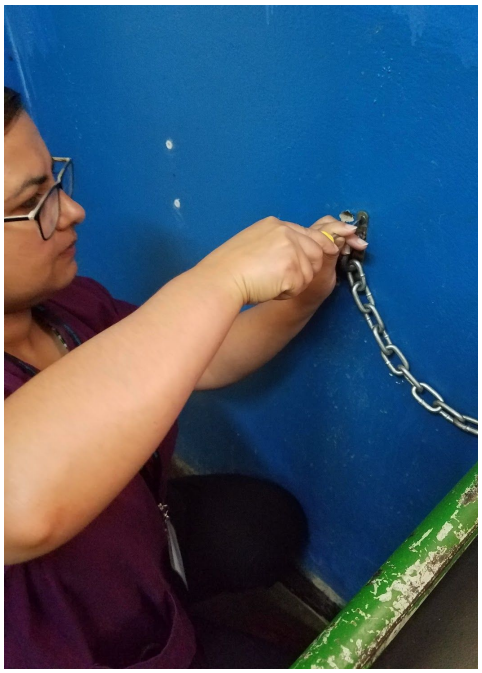
Ambulance with Installed Oxygen Tank

Hospital 6

This group had a number of projects, defined as "main" and "mini" projects. The main projects were repairing and furnishing 41 broken chairs found in the hospital's basement and designing, constructing, and fixing 5 oxygen cylinder holders in various wards. The mini projects were fixing a bench found in the scrap yard and installing an electrical line in an empty space to make an office area for the staff.

All of the projects were deemed successful and handed over to the hospital. The chairs were highly needed throughout the hospital and the repair of the cylinder holders helped improve safety measures in the hospital.

Repaired Chairs in Conference Room



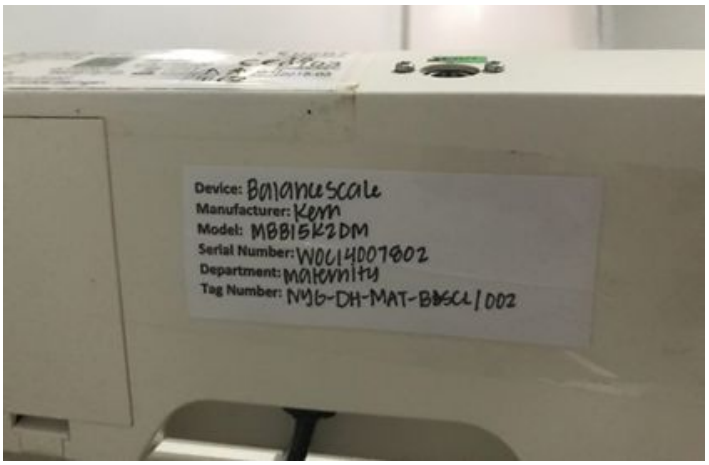
Installing Chains for Cylinder Holders

Secured Oxygen Cylinder

Installing Electrical Line

Hospital 7

This group created tags for all the equipment in the hospital. The tag includes the name of the equipment, manufacturer, model number, serial number, department, and a unique ID tag number created by the Ministry of Health). They then created an elaborate excel program to assist the hospital in keep a better inventory and track the progress of items in service and out of service, and provided direct links to troubleshooting flow charts and preventative maintenance procedures specific for that type of equipment. They trained the hospital's BMET on the system and reported that he was very glad to have the system to assist him in organizing his maintenance notes.



Piece of Equipment with ID Tag

Hospital 8

This group worked with the BMET at the hospital to decide on the secondary project, who informed them of an issue regarding oxygen tanks. The tanks were being transported and stored in strenuous and dangerous ways around the hospital and the weight of the tanks was causing damage to the floors. Previously, multiple workers would carry the tank, drop it on the floor after carrying, sometimes with such force that it would chip the concrete, a dangerous practice. They could only move the tanks by swiveling them around on the ground, causing further concrete, and possibly tank, damage. To remedy this problem, the group decided to replace the concrete floors with wood and add ramps in each room to make moving the tanks easier.

The participants worked with hospital employees to prepare and install the wood for the floors. After the flooring and ramp was installed, the participants painted and sealed the wood. The final product provided the hospital with a safer and easier way to transport and store the oxygen tanks.

Before

After

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 very positive. When asked if they would recommend this program, nearly everyone answered yes. Some of the words used to describe the program were inspiring, transformative, different, and enlightening. The On The Ground Coordinators received very positive feedback. All participants said they enjoyed working in the hospitals, though some found it to be a challenge unlike other challenges they have faced before. One participant said he "learned way more about what it means to be a well-rounded human being on this trip than any engineering lesson...it was an eye-opening trip and I would not trade it for the world." Another said this program helped him "create professional relationships and gain work experience in a very unique situation. This program will undoubtedly help me in my future professional goals after graduation."

Acknowledgements

The On the Ground Coordinators were Taylor Boles and Seth Thompson. The engineering courses were taught by Professor Michael Moreno of Texas A&M University. Language and cultural training were provided by IPRC Kigali. Thank you to all who helped make this program possible.

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