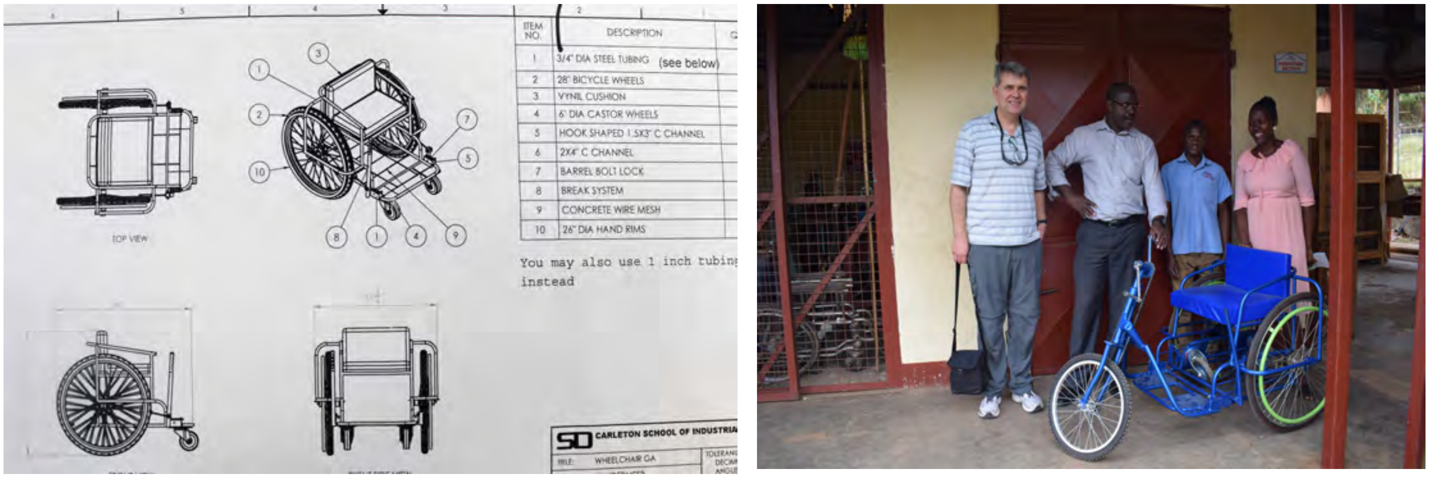
INTRODUCTION



(Figure 1)

The Promobilia Mbili-Kwa-Moja internship emerged from an ongoing collaboration between Carleton University's school of industrial design and the Research Accessibility and Design Initiative (READ), in partnership with the Canadian NGO CanUgan Disability Support to assist people with disabilities in Uganda (Hallgrimsson, 2018). The design of the new mobility device has been moving progressively in the past few years. One of the most recent advancement has been to send engineering drawings of the prototype to local manufacturers in Uganda to see if they can recreate it. The purpose behind this step is to see if the university students and staff can communicate their design improvements with Uganda locals. The results were successful, as the local manufacturers in Uganda were not only able to recreate the mobility device but they were also able to make improvements to the model. In (Figure 1) the left image displays the technical drawings of the prototype and the right image is the prototype that was created by local Uganda manufacturers based on those technical drawings. The ability to successfully communicate ideas back and forth between the locals in Uganda and University personnel is vitally important for the sustainability of this project. This notion established an important basis for this internship position. One of the goals of this internship is to be able to create a computer CAD open source model of the prototype, on Autodesk Fusion 360, that can be accessed by anyone in the world for free. This is an excellent way of communicating design improvements among people all over the world who would find this mobility device beneficial to their community. Once the CAD model is complete, the next task is to start making incremental improvements to the existing two-in-one design, an example would be to simplify the casters-to-bike connection mechanism. The improvements made by locals in Uganda that was mentioned previously will also be included in this internship research. The last goal is to start organizing information and structure for a universal website. The idea is to have a website that contains all the content needed to rebuild this mobility device including the CAD models. In total, there are three goals for this internship position and this report will go through what has been accomplished through the course of 11 weeks. The following is an overview of the 3 goals that were previously mentioned:

Goal 1: Create a computer CAD open source model on Autodesk Fusion 360, that can be accessed by anyone in the world who can download the program for free

Goal 2: To incrementally make improvements to the existing two-in-one design, for example, reduce front wheel diameter for better traction, look at simplifying connection mechanisms

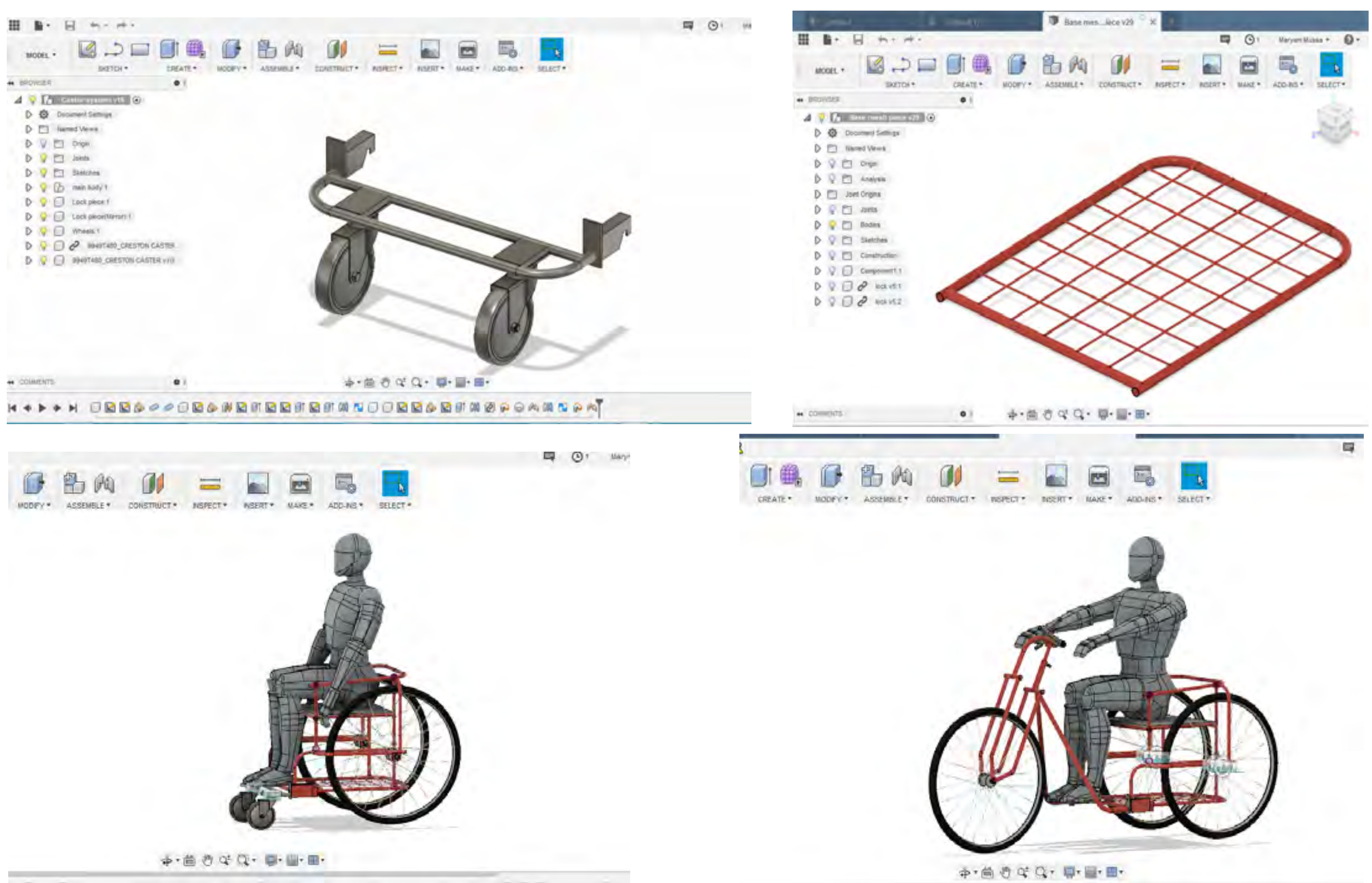
Goal 3: To start organizing information and structure for a website.

For this internship, a design team was involved in this internship including myself (a student), a director, and technicians. This design team will be referenced throughout the report as I have worked very closely with them.

WEEK 1-3

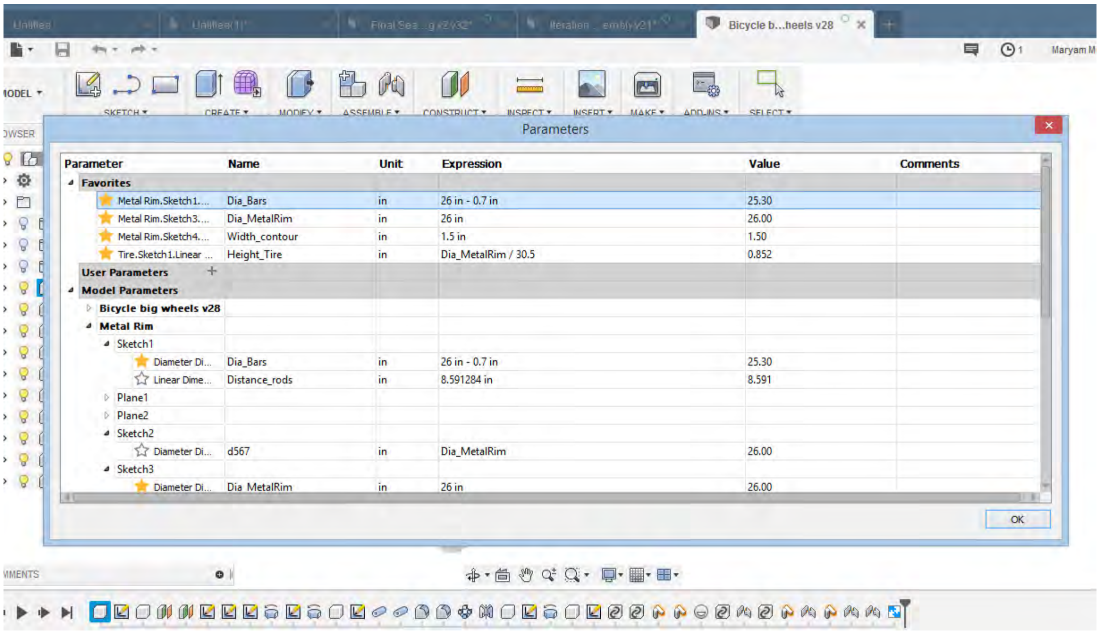
During the first 3 weeks of this Internship, I was given an introduction to the Internship position. This is where I received documents of the dimension drawings that Vandermeer created. I also read documents about the maintenance of a wheelchair and standards in Uganda. The two documents are the Health and Mobility and Care and Maintenance Guide for Wheelchair users, and the Uganda Standards: Code of Practice for the Design, Production, Supply, and Provision of Wheelchairs and Tricycles. I also began to learn how to use the Autodesk Fusion 360 software. I did this by watching tutorials on YouTube and practicing how to make different 3D products. Once I was comfortable with the AutoCAD Fusion software I began to take measurements of the wheelchair prototype. Although I was provided with technical drawings of the model, I needed more detailed dimensions to be able to accurately replicate the physical model in the CAD software. Being precise with measurements is necessary if anyone wants to recreate a physical model from scratch or if anyone wants to improve the model in the future.

During the process of measuring the physical model, I noticed that the dimensions of Jenifer's technical drawings were off. The seat width on the drawing is 34.75" while the physical model measured to be 30". Since manufacturers in Uganda created a wheelchair replica based on the drawings, they build the seat wider than necessary. The wheelchair replica in Uganda did not fit through doors. To have an extra 4" taken off the seat width is a huge relief. Do note however that mistakes are inevitable and can be expected due to human error.



(Figure.2) The first top photos dispay the CAD model of parts of the mobility device while the bottom two photos show how the parts come together to form and assembley.)

After recording some dimensions, I started to develop the CAD model. I did this by creating different parts of the wheelchair/bike system and putting it all together in an assembly file. The idea behind creating different parts is to provide opportunities for anyone with access to this file, to change parts of the wheelchair system without having to affect the entire model.



(Figure.3)

I also looked at a fascinating feature called Parameters in Fusion 360. A Parameter is a table that contains a list of dimensions and functions of the CAD model, that can be altered by anyone. This makes the process of changing dimensions a lot easier since the alternative to do so is to manually change dimensions of a sketch. (Figure.3) shows a parameter table.

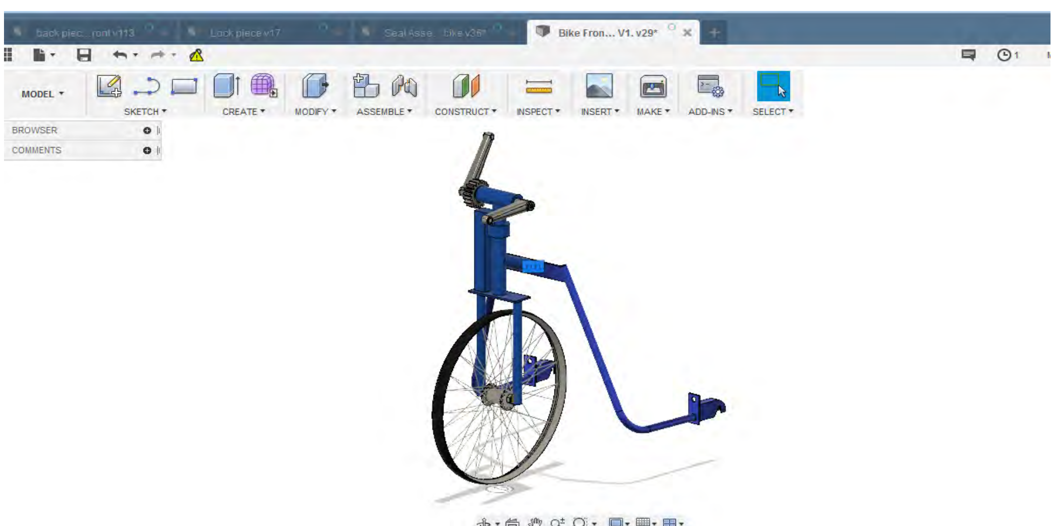
WEEK 4-5

(Figure 4)

(Figure 4.1) This imge displayes the prototype that Vandermeer has created. The front bike

(Figure 4.2) This image displays the newer prototype that local Uganda manufactuerers created. It has a smaller wheel domension of 20".

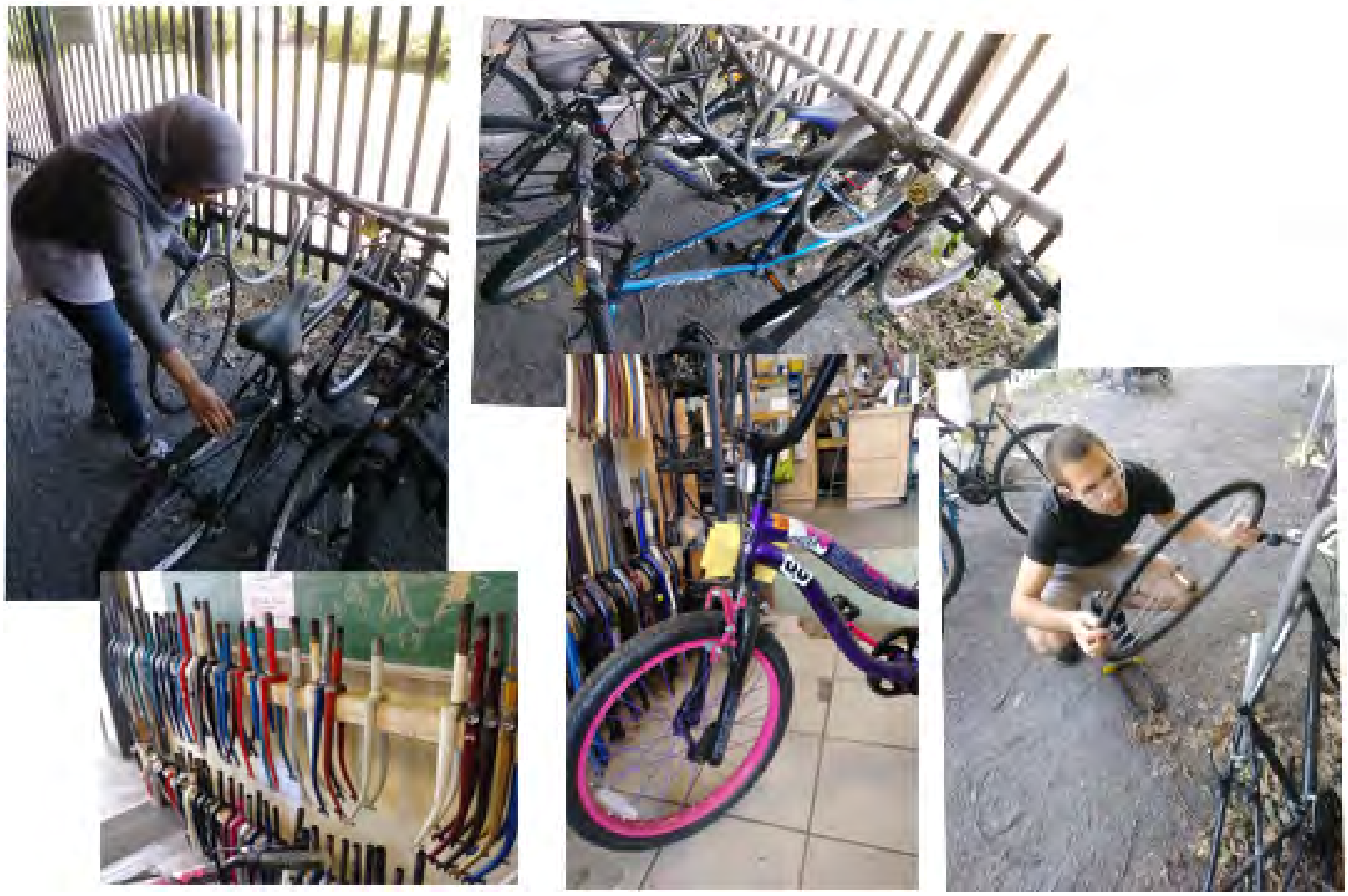
At this phase of the internship, the CAD model of the wheelchair is complete which means that Goal 1.0 has been accomplished. There is now time to make iterations to the model. The iteration made by local Uganda manufacturers is thoroughly investigated at this stage of the project. As can be seen in (Figure.4), the front bicycle wheel was reduced from 28" to 20". A smaller front wheel was reduced for better traction since the bigger wheel had issues staying intact on a straight and forward position (the tire kept skidding left and right). Because the front wheel was reduced, the front bike attachment piece was altered to suit the diameter of the wheel. An example would be the bike fork which is a lot smaller than the original model. The older model contained two forks to withstand the flex caused by having a



(Figure 5)

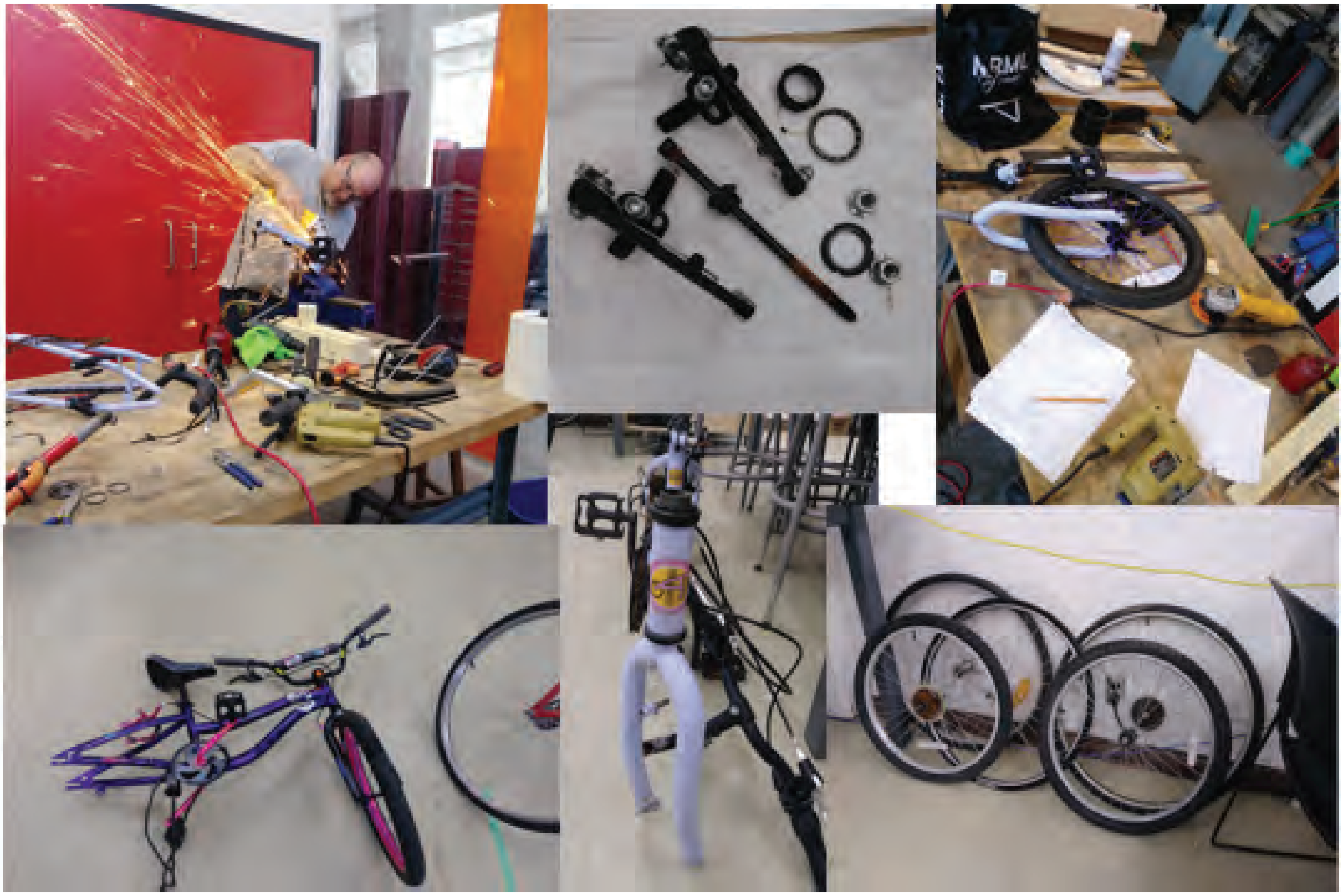
For documentation purposes, a CAD model of this new iteration was created as can be seen in Figure 5

(Figure 6)



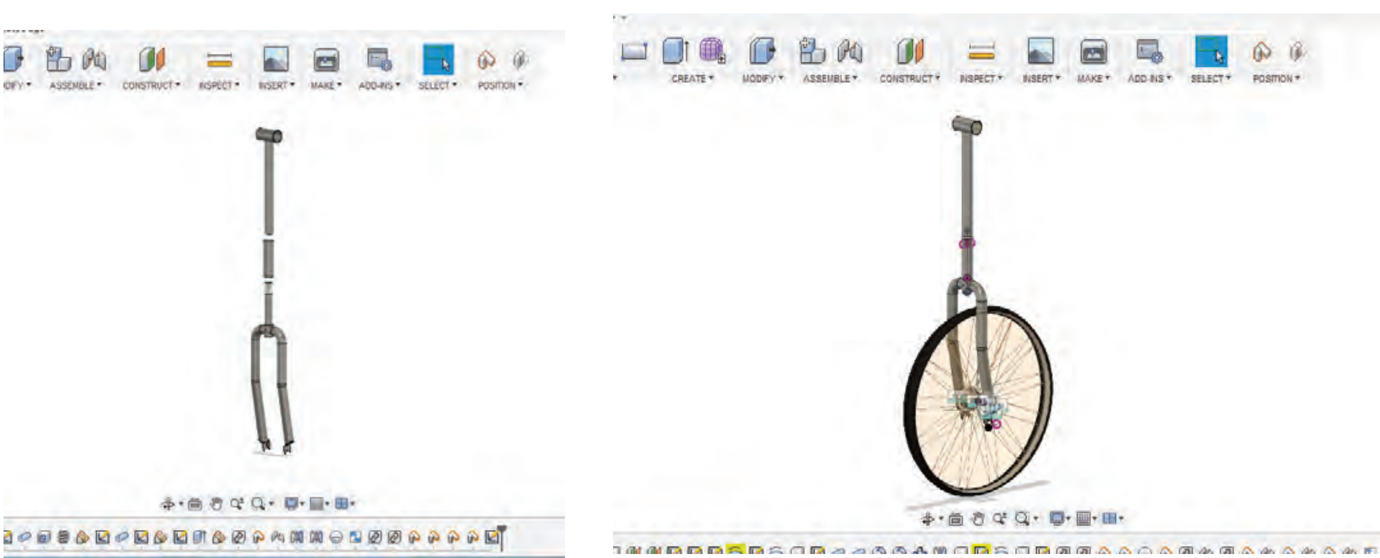
To have a physical understanding of the Uganda iteration, the design team decided that we should recreate the model in the shops. Creating a duplicate of the front bike concept is necessary for us to get a physical feel of the use cycle of the product and it also allows us to physically compare the new front wheel concept from the older one. Once this design is replicated we can expand on it and solve issues in depth around the use cycle of the mobility device. To replicate the model, bicycle parts were gathered from various bike facilities in Ottawa such as storage facility at Carleton University and the Cycle salvation bike shop as seen in Figure 6. The intention is to be able to make this front bike component from recycled bikes, just as the local Ugandan manufacturers have done. There was a lot of learning done about bicycle parts to find the bikes needed for this job.

WEEK 6 - 7



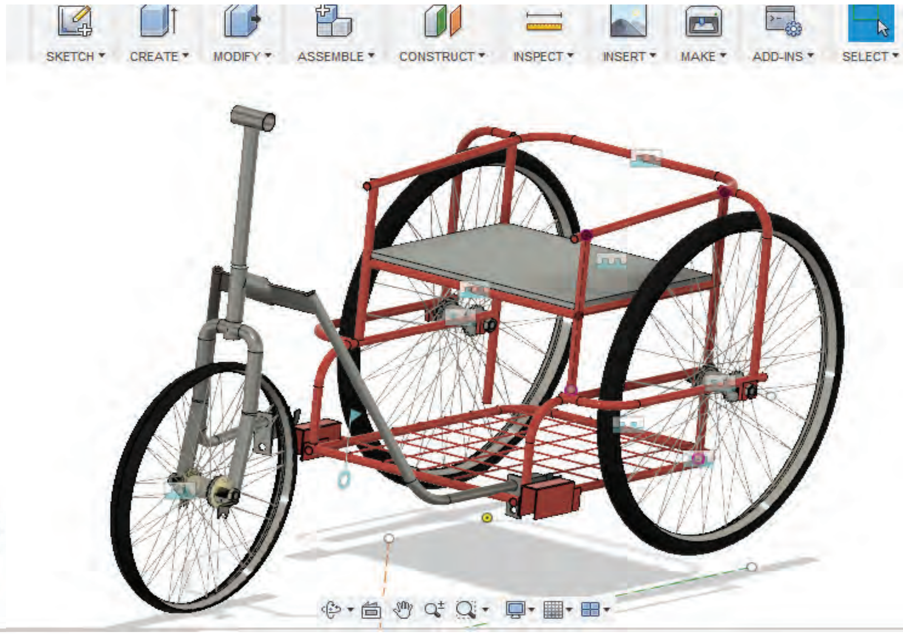
(Figure 7)

In this phase of the project, the bikes from the facilities that were visited were taken to our metal shop. Different parts from multiple bikes were dismantled for the new mockup. Parts that were needed to be included: a bike fork, a 20" wheel, a steering tube, steer head and chains.



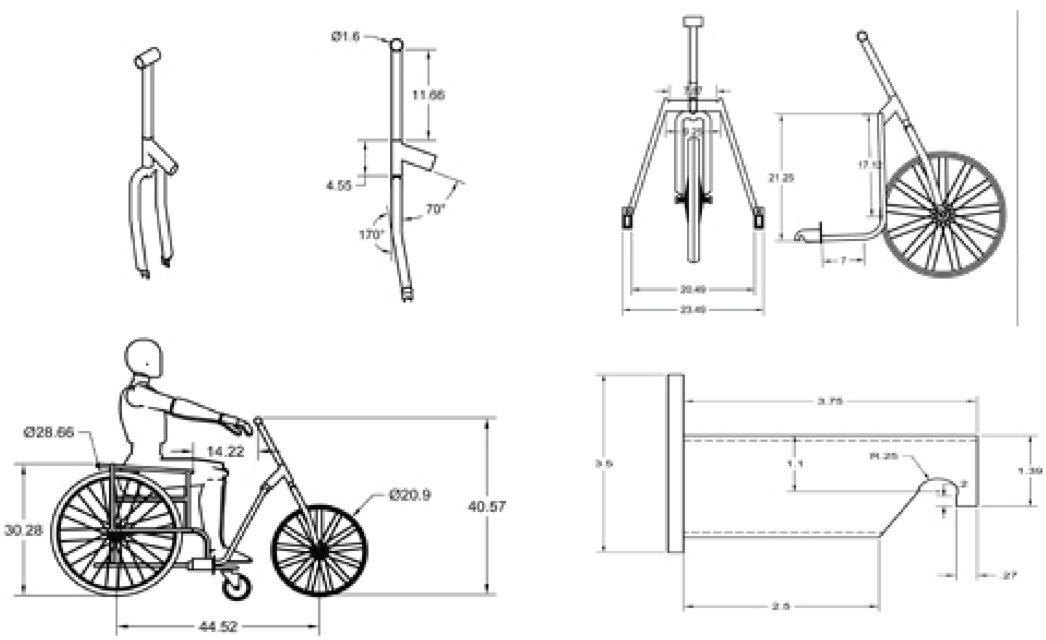
(Figure 8) CAD representation of the bike parts from the shops.

(Figure 8.1)
This is an image of the conncetor piece that is connects the bike front piece to the wheel-chair frame.



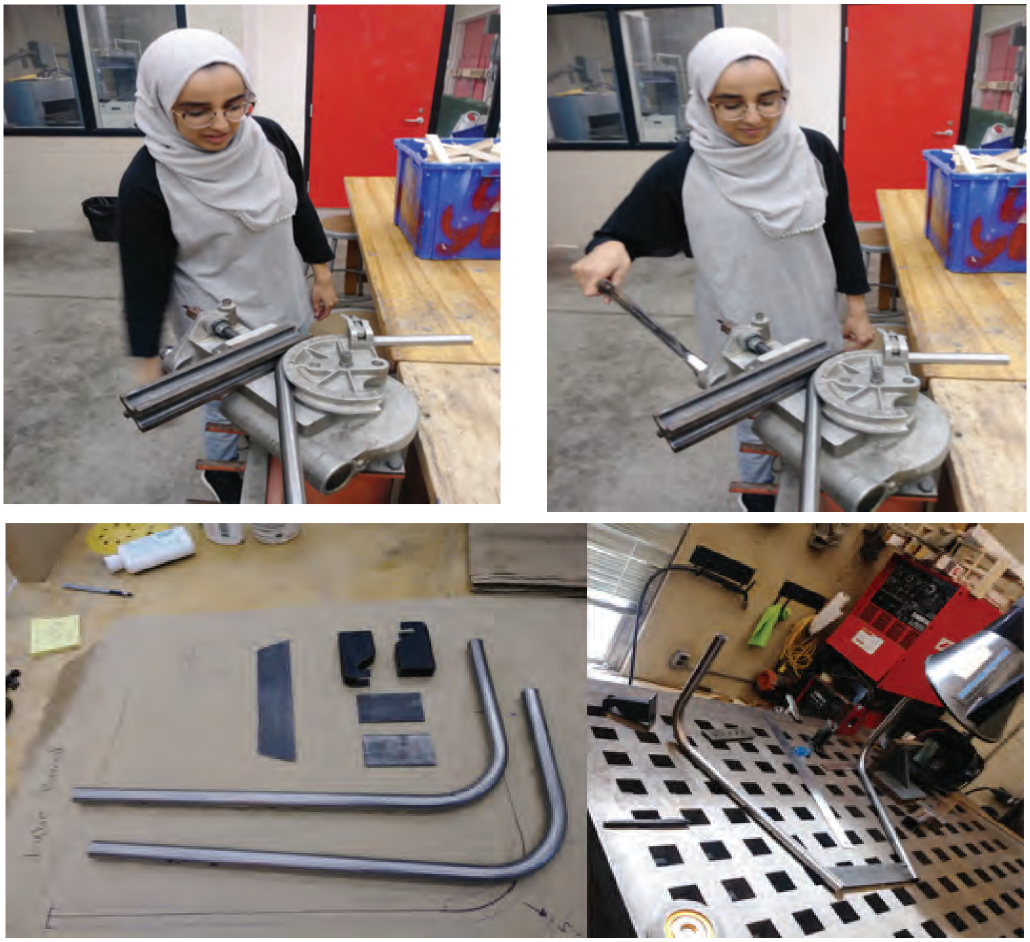
(Figure 8.2)
This is an image of the new bike front piece and connector attached to the wheelchair in an assembly.

Since we are using recycled bike parts to create the model, it was suggested by shop technicians, to create CAD representation of each part that we wanted to use (see figure . By accomplishing this task, I was able to play around with different bike parts in a CAD assembly to get the shape and structure that I needed to recreate the Ugandan iteration of the front bike component.



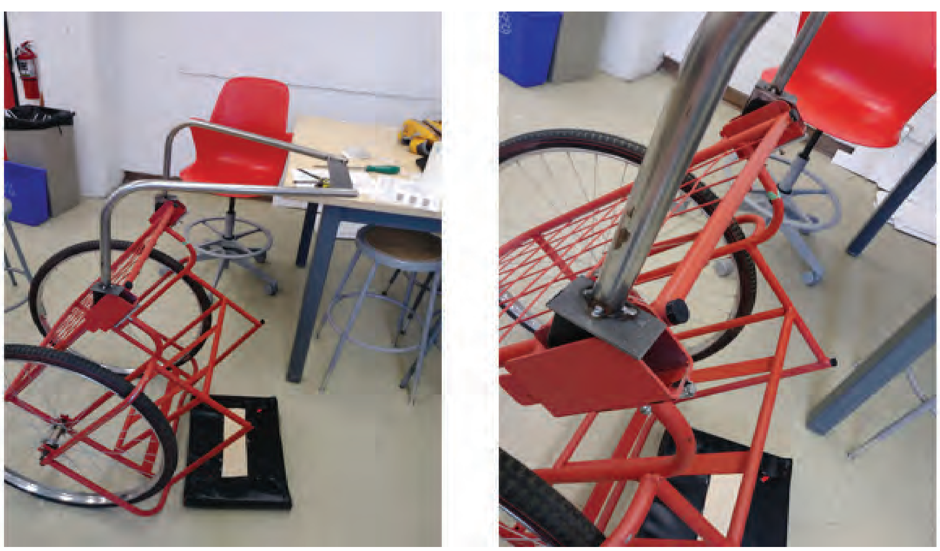
(Figure 9)

By week 7, the CAD model for the bike parts are completed. I put the parts in an assembly with the original wheel chair seat. CAD drawings were then created for dimensions (Figure 9). Full scale 1:1 drawing was also created by hand for shop technicians to work from.



(Figure 10)
The process of making the connector piece at the shop.

At the shop, the connector piece from (Figure 8.1) was produced. I did not have to create a bike front piece as shown in (Figure 8) because those are the pieces that came from used bikes.

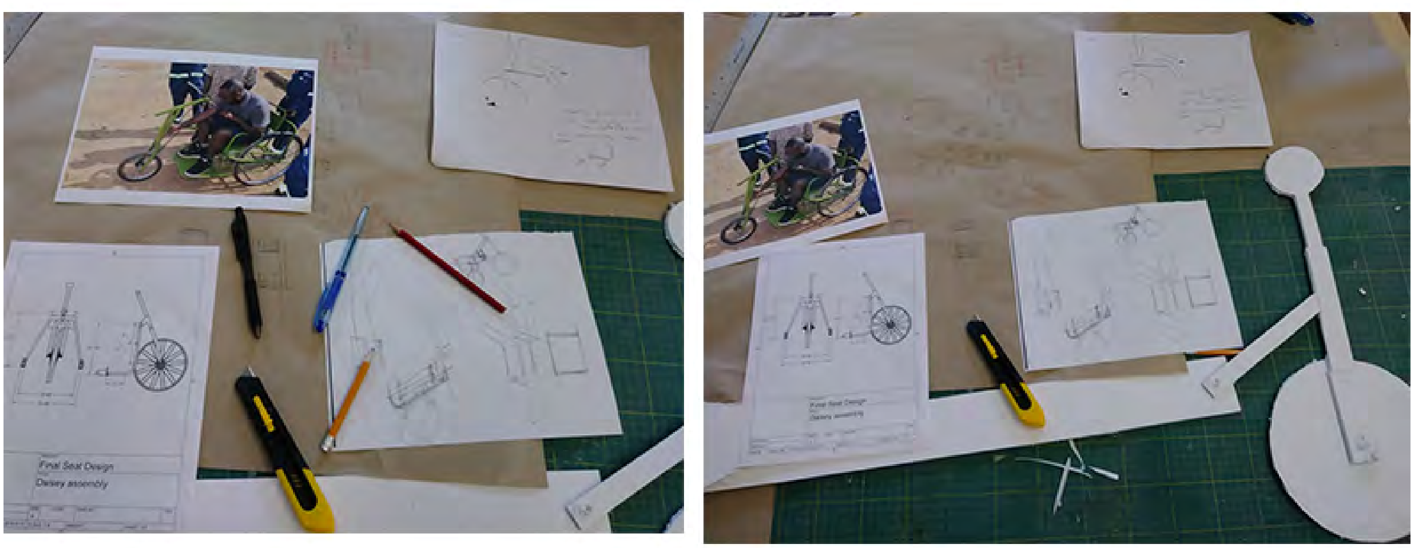


After the connector piece was made, I tried putting the piece inside the wheelchair frame however the connector piece had issues fitting into the frame profile. This is because of the locking male mechanism piece was 0.25" shorter than female locking mechanism receptor which meant that they two pieces did not align properly cause the piece to get stuck in the process. While struggling with the locking mechanism we concluded that the locking mechanism should be replaced due to its complex shape. An easier alternative should be investigated.

WEEK 8

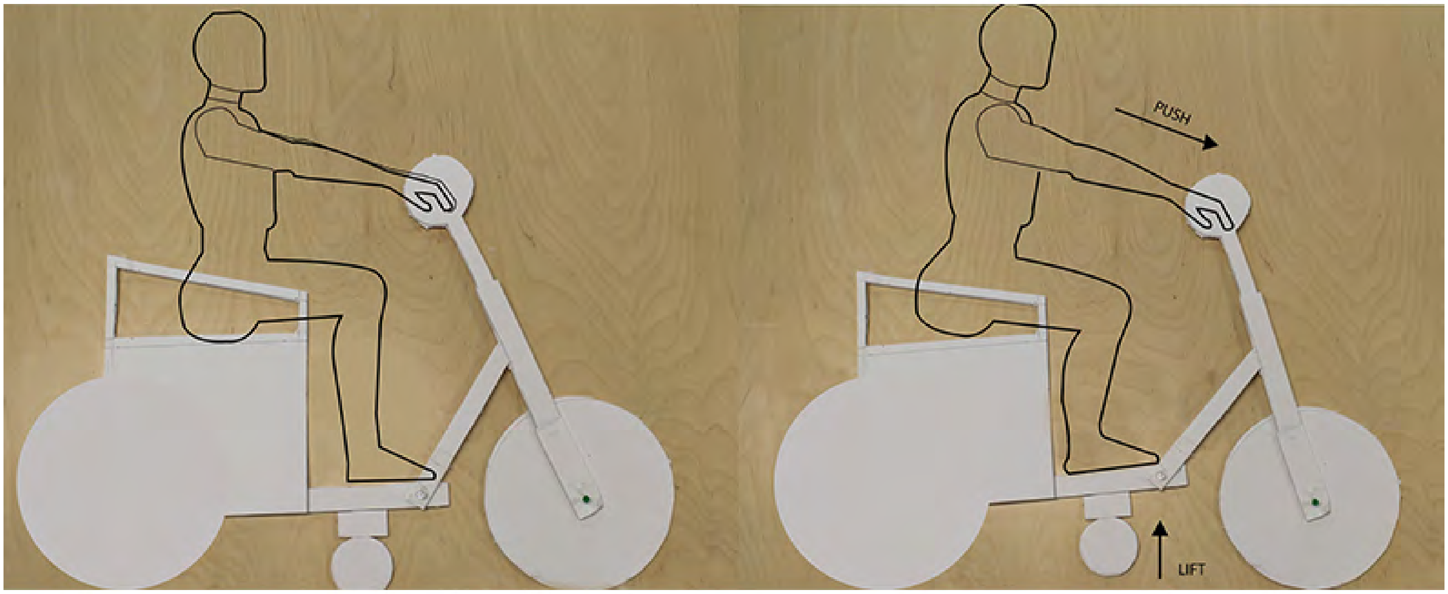
(Figure 12) The image on the left is the Motivation wheelchair.

This week, the design team got together to come up with ideas to replace the locking mechanism of the wheelchair bike system. This is due to the complications that we found in the mockup created in week 6-7. We began to conduct some research and came across a wheelchair made by a UK based charity named the Motivation Charitable Trust (Motivation , n.d.). The wheelchair was developed to provide mobility for people living in third world countries. This wheelchair has a square tubing that connects in the mid-center of the seat and at the end of it is a caster.



(Figure 13)

While comparing our current wheelchair prototype and the Uganda iteration prototype, to motivations', we decided that our design could be made a lot easier if we used a single long square tube with one castor just like the motivation wheelchair. We believe that by having one connector mechanism in the middle of the seat, it would be easier for users to locate and reach the castor to take them off.



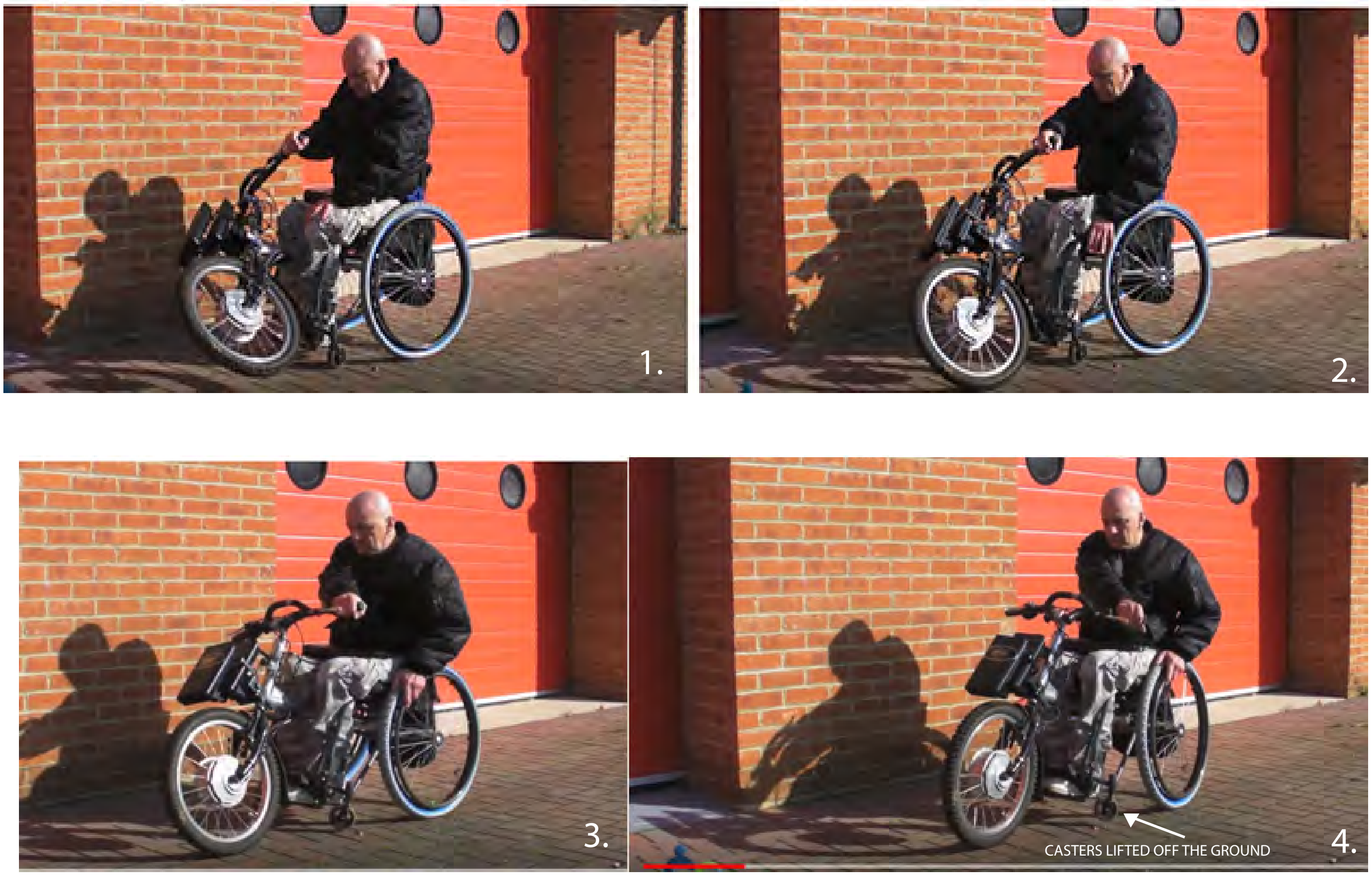
(Figure 14)
Explanation of the pulley system idea.

While discussing this idea, we came up with a pulley system that lifts the wheelchair when the bike steer tube is pushed forward by the user. The point is to allow the wheelchair frame to lift for the user to take off the casters while they are seated. As soon as the casters come off, the user can put the steer tube back in its original position and start driving the tricycle. The pully system is developed by a series of lock pins to allow it to pivot and lock in place when needed.

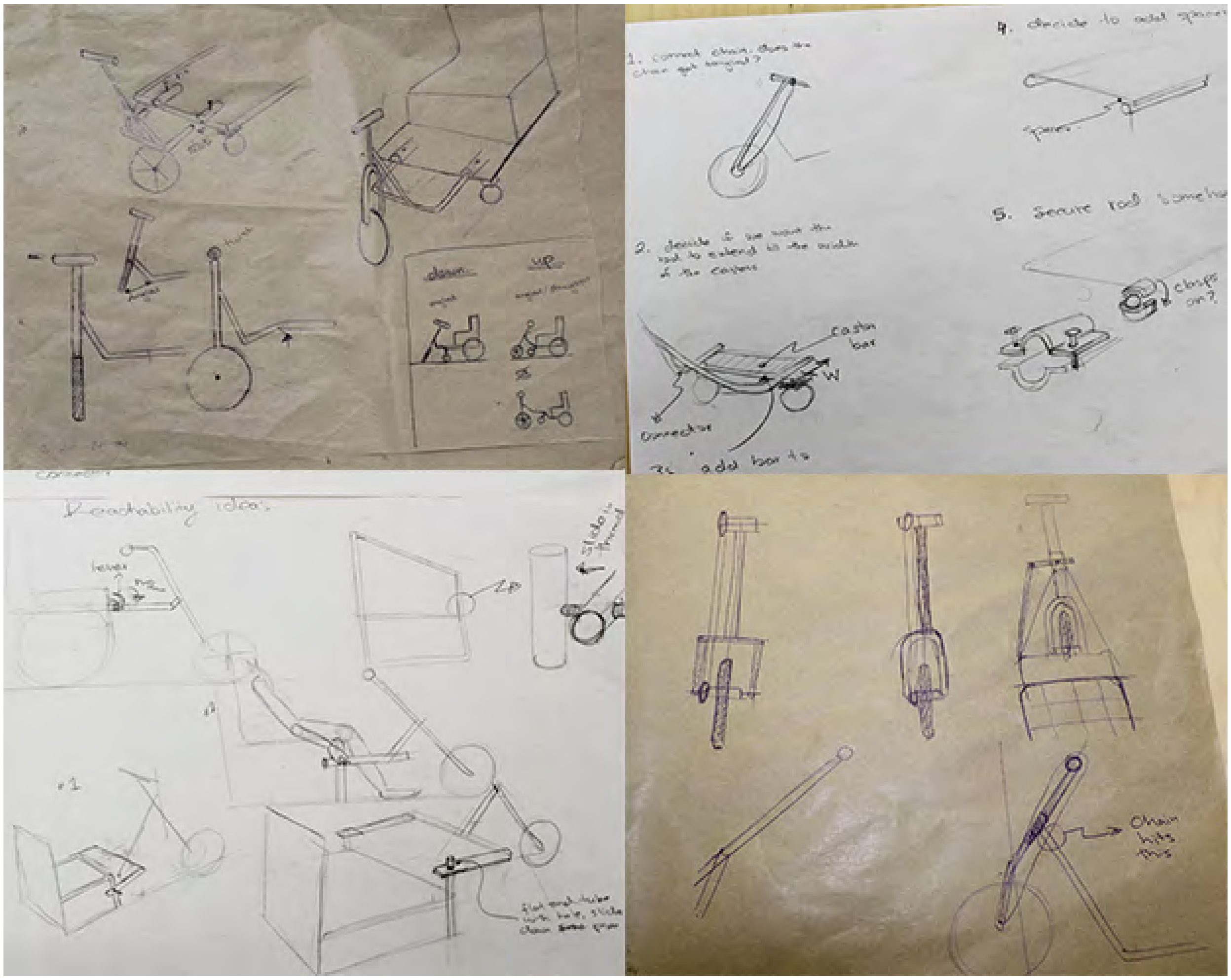
(Figure 15)
Images of the mockup made out of foam core.

Mockups and sketches were developed for a deeper understanding of the idea which I decided to call concept 1.0.

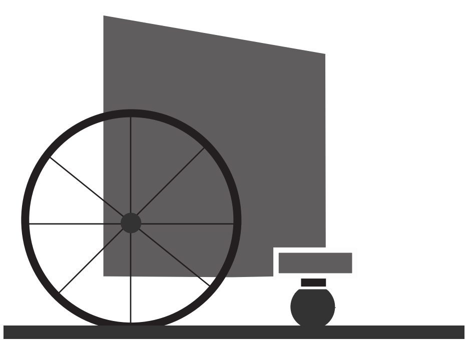
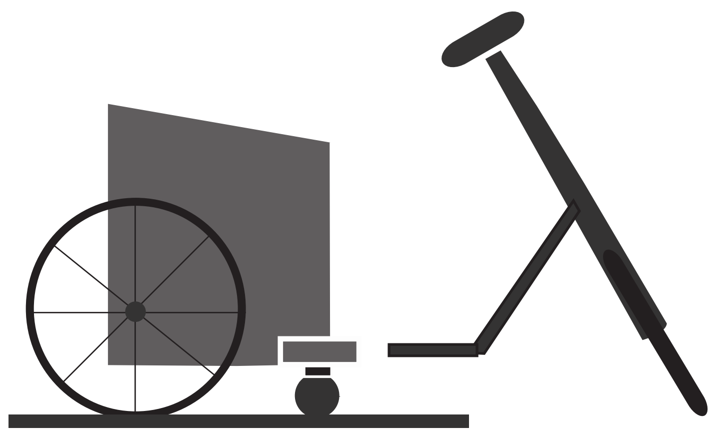
WEEK 9



During this week the design team got together again to observe the mockup that was created for concept 1.0. We played around with the mockup pieces and discussed different locking mechanisms to lock the tube in place during travel periods. While brainstorming ideas, we researched more about lifting mechanisms and stumbled upon a manual handcycle attachment made by UK company, Team Hybrid (Handcycles, 2015). They came up with a handcycle attachment that lifts the wheelchair seat frame through rotation of the bike front wheel attachment. Since the wheelchair frame is lifted, the casters are also lifted and no longer touches the ground. For our purpose, it is necessary that the casters come completely off because of the uneven terrain of Uganda. Even if the casters are lifted off the ground but are attached to the seat, they can get in contact with the ground if the wheelchair hits any bumps or rides over rocks. In previous years, user testing in Uganda indicated that casters will break off easily once in contact with the ground. Furthermore, the idea of rotating the front bike wheel to get the wheelchair to lift seemed like a simple solution compared to concept 1.0. We decided that using the rotation of the front bike wheel as a lifting mechanism is a simpler solution that doesn't require extra parts or mechanisms.



The team and I decided that using the rotation of the front bike wheel as a lifting mechanism is a simpler solution that doesn't require extra parts or mechanisms. I developed a series of sketches to try to understand this concept.

We came up with a new simple connector mechanism. The connector will be made of metal pipes that will slide into another two metal pipe receptors with a slightly larger radius.