DESIGN WITH UGANDA

A CONVERTIBLE WHEELCHAIR FOR PEOPLE WITH DISABILITIES IN RURAL UGANDA

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TABLE OF CONTENTS

LIST OF FIGURES

ACKNOWLEDGEMENTS

I would like to thank those who took the time and effort to help, support, and share their knowledge with me in this design project.

Dean Mellway and READ
Navin Parekh and CanUgan
Baluku Peter and KADUPEDI
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IDRC

INTRODUCTION

DESIGNING ASSISTIVE DEVICES FOR THOSE WITH DISABILITIES IN RURAL UGANDA

CanUgan in association with KADUPEDI presented the need for devices to assist people with disabilities in the rural areas of Uganda. The goal for this project is to design products that not only assist these users but also create empowerment by allowing these devices to contribute to the quality of life of the user, their families, and the community.

Navin Parekh founded CanUgan in 2010. It is a non-profit organization based solely on a volunteer basis and has partnered with KADUPEDI (Kasese District Union of Persons' with Disability) to protect, promote, and provide assistive devices to people with disabilities in Uganda. KADUPEDI is an organization located in Kasese that was founded in 1996 and has on 9 members of the executive committee both who work on a voluntary basis and all experience a disability themselves. The goal of KADUPEDI is to protect and improve the rights of all people with disabilities in the country.

This project is a continuation from the previous year's group who created devices that were based on creating a better structured tricycle design, a grinder that could be powered by the tricycle itself, a easy to produce walker made out of locally sourced steel, and a cell phone charging station that could be attached to the back of the tricycle. Although the objective for this project is to design assistive devices for those with disabilities, the focuses have expanded from the tricycle to other devices, users, and disabilities. For example, the grinder

and cell phone station were both innovative ways that people with disabilities could generate an income as well as benefit physically from the assistive device.

The objective of the first semester was to gain an in depth understanding of the context, the user, and the organization through primary and secondary research. Through this research we could start the ideation process, coming up with concepts through sketching and prototyping. As our research became more specific, our concepts were also narrowed down until one concept was decided before the end of the semester.

The second semester was about developing that chosen concept into a final design. This involved prototyping at a larger scale as well as user testing which helped finalize the design. I was given the opportunity to travel to Uganda in February, along with the other members of the group, where we met with the manufacturer and potential users to test and improve our designs in a real world context. A final design was produced through the improvements learned on this trip and full-scale, working prototype was reconstructed in March in order to be presented at the grad show in April.

The following report outlines a detailed summary of this year. More specifically, both research phases, the concept phase, the definitive design development and the final design development of the two in one wheelchair design I developed for my final project.

Members of KADUPEDI. Each member lives in the Kasese community, and each person experiences a disability themselves.

Photo taken from : http://www.canugan.org

RESEARCH AND IDEATION

TO DESIGN WITH THE COMMUNITY ONE MUST LEARN FROM THE COMMUNITY

Disabilities in Uganda

The population of Uganda is 35.8 million and has been steadily increasing at a fast rate. Within this population, it has been reported that 10% of the country suffers from a disability. Of the roughly 3.6 million people that are classified as disabled, 2.4 million are classified as chronically poor (Lwange-Ntale, 2003). Therefore, this research presents a clear link between disability and poverty in the country of Uganda (Lwanga-Ntale, 2003). Lwanga-Ntale has defined disability as:

"Any restriction or lack of ability (resulting from an impairment) to perform an activity in the manner or within the range considered normal for a human being. Disability may thus be considered to be functional limitations, occurring in any population, and people may be disabled by physical, intellectual, or sensory impairment, medical conditions or mental illness. Such impairments, conditions or illness may be permanent or transitory in nature." (Lwanga-Ntale, 2003).

Civil strife, lack of healthcare, diseases and accidents all contribute to the relatively high number of people with disabilities in Uganda. This is unfortunate as disability in Uganda is stigmatized as being of a supernatural origin. A disability

symbolizes a curse or illness that has struck a particular person and weighs in not only on the individual with the disability but also on that person's family (The World Bank, 1993). It is thanks to this stigma that disabled people in Uganda are often found in the core of the poorest people of the country. As The World Bank points out "...(it is) not an exaggeration to say disabled women are likely to represent the most miserable group of society as they are discriminated against because of their gender and their disability" (The World Bank, 1993).

Many developing countries consist of a dual economy, where there socio-economic status' exists on far ends of the spectrum and the population is divided between the extremely wealthy and the extremely poor. Those who experience poverty eventually have the inclination to migrate to larger cities, believing that more jobs exist when in reality they are now becoming limited. Schumacher believes that development efforts should be focused on bringing employment to rural areas and surpassing big cities all together. These efforts should be concerned with maximizing the number of work opportunities rather than the productivity of each individual. Schumacher states ," Unproductive work is better than idleness. It is more important that everybody should produce something than that a few people should each produce a great deal." (Schumacher, 1973).

"Poverty and disability are similar and mutual..." (Lwanga-Ntale, 2003)

When a disabled person lives in poverty it can be a hard cycle to break. In many cases the disabled person does not have a way of generating sufficient income. For curable disabilities, because they are poor in most cases, they don't have access to proper health care. For some conditions, lack of education about treatment can cause the disability to become worse. In many cases it is harder for someone with a disability to secure a job, which causes family members to try to support them or in some cases abandon them. For someone who is in poverty, they are unable to afford a mobility device (wheelchair, crutches, etc) without receiving aid. In some cases if a woman becomes disabled later in life they can be abandoned by their husband and family because they are seen as a financial burden.

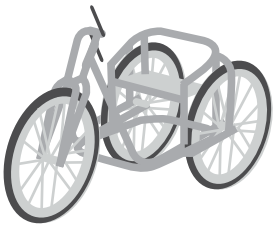
A man who had a simple, but not a long term solution to repairing a imported wheelchair when his chair broke.

It is important to note that disability is not inability. There are many examples of disabled people who are able to overcome their difficulties and not only provide for their families but also for their communities. A clear example of this, is the board of KADUPEDI, which is formed exclusively by disabled people; not only are they able to provide for their family but they are also able to provide precious aid to other disabled people in Kasese. Realizing the potential of disabled people in Uganda is of extreme importance in order to help break the cycle of poverty often surrounding them. contacts.

Children as a Target user

The concept before the second semester focused on designing a device specifically for children aged 6-12, who experience mobility impairment and that require a device to travel. This disability stems from various reasons such as accidents and birth defects as well as the majority of children suffer from cerebral palsy and polio. Due to the lack of knowledge about disabilities in the community, children are restricted from going to school, participating in both family chores and community events. Children who experience a disability often feel neglected, isolated, and have a low self esteem because of the reasons stated above or because of environmental limitations (Lwanga-Ntale). Despite the fact that the Uganda Constitu- tion in 1995 states, "All persons have a right to education", attendance is still difficult for children in rural areas, especially when they have a disabil- ity (Kristensen, Omagor-Loican, Onen & Okot, 2006). Education for all children is important for future income, for a study states that "Persons with a higher education level than primary school- ing have better access to microfinance services than those with no education" (Beisland & Mersland, 2012).

Right: Disabled child in Uganda
Left: Sign from a school that teaches disabled children



Hand Pedal Tricycle

Positives

- Ability to travel long distances
- Preferred by those wanting to start a business
- Durability for rural areas

Negatives

- Not suitable for indoors.
- Cannot be taken on public transportation

Concept Area

Huckstep Wheelchair

- More suitable for indoor and domestic use
- Durability for rural areas
- Can be built and fixed locally

- Not foldable, cannot be taken on public transportation
- Can be described as bulky

Donated Wheelchair

- Foldable, easy to take on public transportation
- Suitable for indoor use

- Lack of durability
- Imported and can not be fixed locally
- Donated wheelchairs most often come in adult sizes

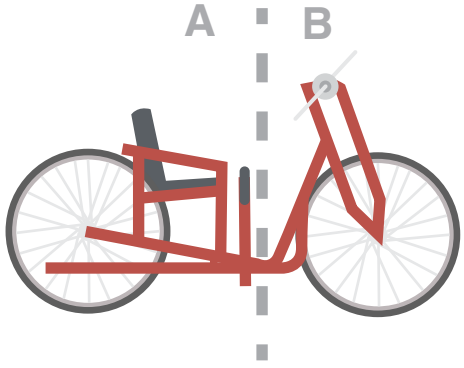
Information taken from: Feasibility study on production and provision of wheelchairs and tricycles in Uganda a SINTEF Report.

Scenario

Special education institutions in Uganda for children with disabilities are greatly lacking resources and can be unsuitable for certain children. Based on a study that evaluated 15 different special schools in Uganda, depending on the district, the pupil to teacher ratio varies greatly from 30:1 to 82:1. Specifically for children with motor disabilities, the study stated that 9 out of the 15 schools did not have ramps and 11 out of the 15 schools did not have wide enough doors (Kristensen, Omagor-Loican, Onen & Okot, 2006).

Transportation to school poses another barrier to children wanting to attend. A study conduced in 2004 assessed the differences between various mobile devices. Although tricycles can travel farther distances, they are not suitable for indoor use and cannot utilize public transportation. Donated wheelchairs can be folded and are more suited for indoor purposes, however, they are often low quality, easily breakable, and can not travel far distances (Oderud, SINTEF, Brodtkorb, NAD, Hotchkiss & WWI, 2004). In conclusion, there is a large disconnect between the capabilities of these devices. Reconciling these differences will allow children to be included members of society. (Please refer to appendix for scenario).

By comparing the limitations and benefits of the current products that exist within the country, my initial concept was to create a two in one system, where a wheelchair could become a tricycle at the users own will. This design would therefore combine both the benefits of the tricycle and the wheelchair and not limit a user from going indoors.



Bottom Left: Motivation tricycle
(Photo taken from: http://www.motivation.org.uk)
Top Right: Speedy Micro
(Photo taken from: http://www.cyclorama.net)
Bottom Right: Free Wheel
(Photo taken from: http://www.gofreewheel.com)
Top Left: Dragonfly
(Photo taken from: http://riomobility.com/en/)

Existing Products

After coming up with my initial design concept, I decided to research existing products and compare the features that make them successful. There are many different attachment products that exist on the market today, that users were capable of transforming wheelchairs into tricycles. These four images are some of the most popular solutions on the market. The first image was one of the few mobility devices with a detachable front wheel that was designed specifically for underdeveloped countries by an organization called "Motivation". The other three of these four, are manufactured in more developed countries and are designed for a North American market. Despite this, their products are still manufactured in China, and product distribution is based solely on donations. Although all of these products are limited to developed countries, it presents a great design opportunity for this project. All of these products have some sort of latching systems to secure the front to the back, are capable of tilting the back so that the small, front wheels are off the ground, and provide security and maneuverability to the user. Unfortunately, Kio, the manufacturer in Kasese, can reproduce none of these products.

PRIMARY RESEARCH

Primary research was especially helpful as it gave a first-hand account of individual experiences. Often primary research reveals issues that are not necessarily mentioned in secondary sources.

CanUgan Event

Alyssa Wongkee, one of four students to make up last year's team spoke about her experiences in Uganda at a fundraising event held by CanUgan, and provided even more insight into daily life in Uganda. The group was also introduced to important stakeholders in the organization and provided more information on how the organization was run and the structure as well as how donations were earned.

Sype Call with KADUPEDI

Baluku Peter (coordinator of KADUPEDI), Robert Bwambale (treasurer of KADUPEDI) and Phestus Mutebi (employee of KADUPEDI), as well as Kio Muikiika who manufactures the mobility devices in Kasese. Contacting KADUPEDI posed more of a problem than the other contacts due to the fact that they are located in Uganda and do not have constant access to electricity or wireless internet. Video and even telephone calls to them were frequently interrupted and inefficient at transferring information, however, e-mail was less confusing, though not as direct. Therefore, e-mail

Top Left: Skype Call with KADUPEDI
Bottom Left: Navin Parekh CanUgan
Right: Dean Mellway, READ

was used throughout this primary research phase and was the main source of communication with our personal contacts. contacts.

Personal Contacts

There were many people that I had contact with during this phase. Navin Parekh, one of the main coordinators of this project, was in close contact throughout the entire research process as well as has provided very valuable contacts. As stated above the members from KADUPEDI were contacted through email. Due to the fact that I was focusing on children as my target user group at the time, Navin provided me with the email of someone who could provide more information and a more in-depth perspective about children with disabilities. Maali Wilson is the founder of RAPCD (Rwenzori Association of Parents of Children with Disabilities). He started the organization 6 years ago and is currently the most successful organization-serving children with disabilities in the Kasese community. Through email I asked him various questions that confirm my secondary research but it also provided a greater perspective on my selected user group as well as people with disabilities as a whole.

I also tried contacting a representative from Whirl Wind Wheelchair, a organization that designs wheelchairs for third world environments located in San Francisco, but unfortunately no one responded to my inquires.

Other Presentations

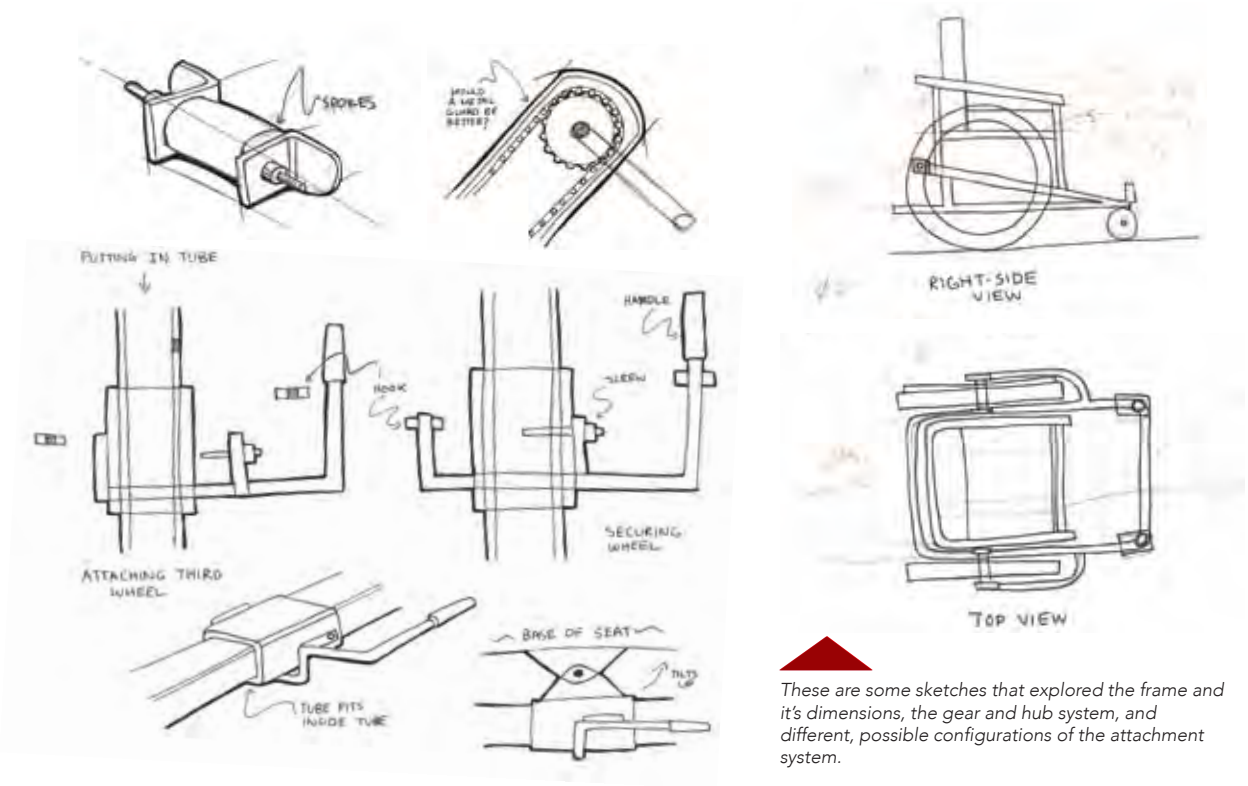
Professor Bjarki Hallgrimsson, who accompanied the students on their trip to Uganda last year, did a short presentation on his experiences as well as the devices designed by the students, which was held by the African Studies program at Carleton University during the beginning of the fall semester. His presentation, as well as feedback from the audience, was interesting and informative on the culture and differences between Canada and Uganda.

Sal Alajek from Engineers Without Borders hosted a conference at Carleton University and discussed different approaches to helping those in poverty. Though not focused directly on Uganda, his presentation gave a great foundation for appropriate and inappropriate ways of working in and with developing countries.

Bjarki Hallgrimsson presenting last years projects and explaining our involvement in this year.

PRELIMINARY DESIGN DEVELOPMENT

JANUARY BEGAN WITH DEFINING A TEST PLAN AND BUILDING TEST MODELS.



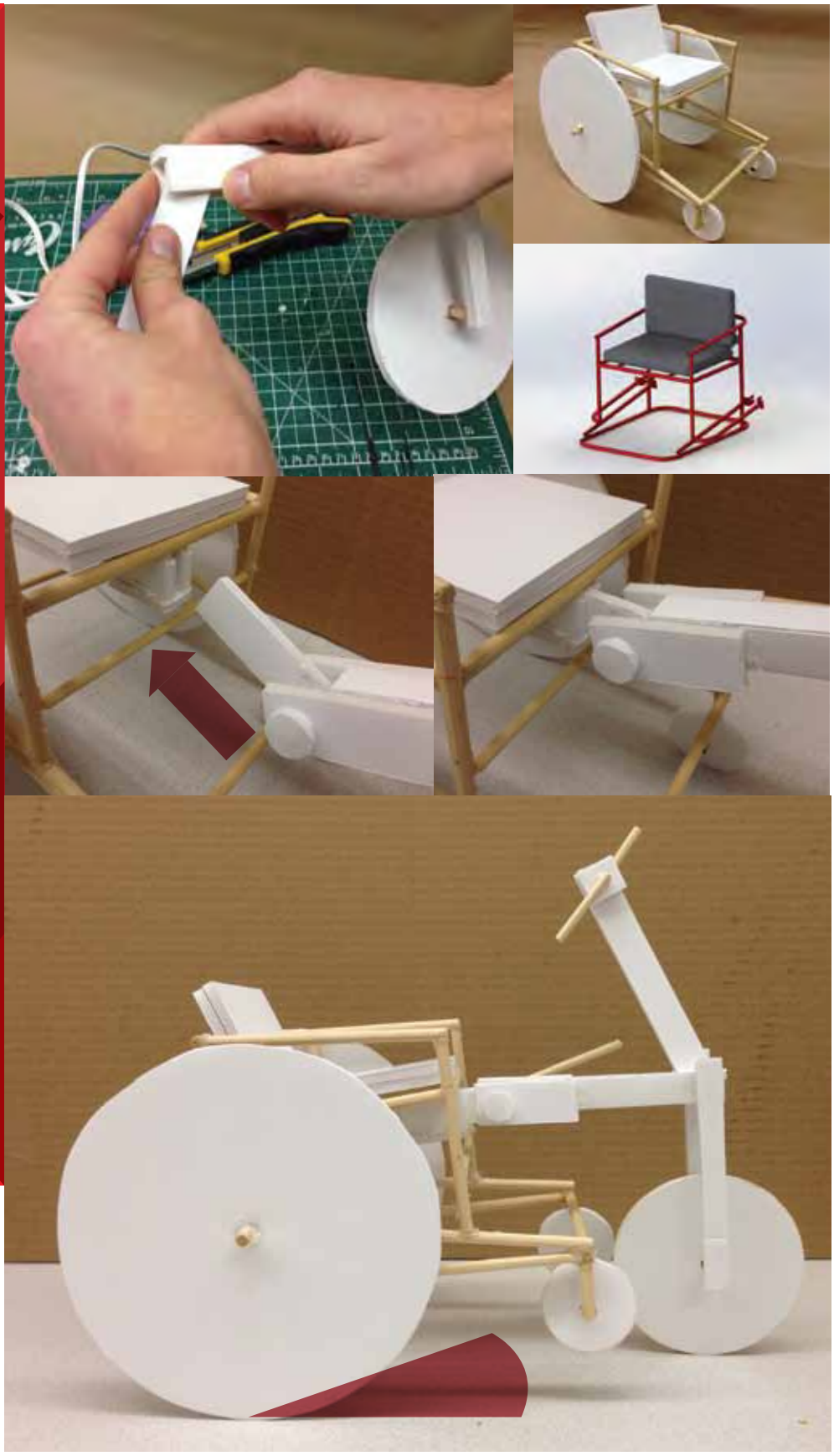
These are some sketches that explored the frame and it's dimensions, the gear and hub system, and different, possible configurations of the attachment system.

Concept Development

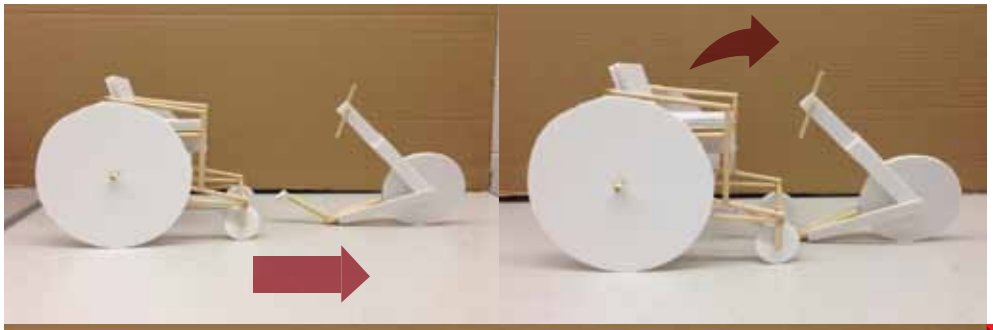
After I decided to focus on the two in one concept of a wheelchair that could turn into a tricycle (that was discovered through the previous research) it then began time to refine this concept into a feasible solution. Sketching became a major part of this further concept development. This continued to the second semester where it became more focused.

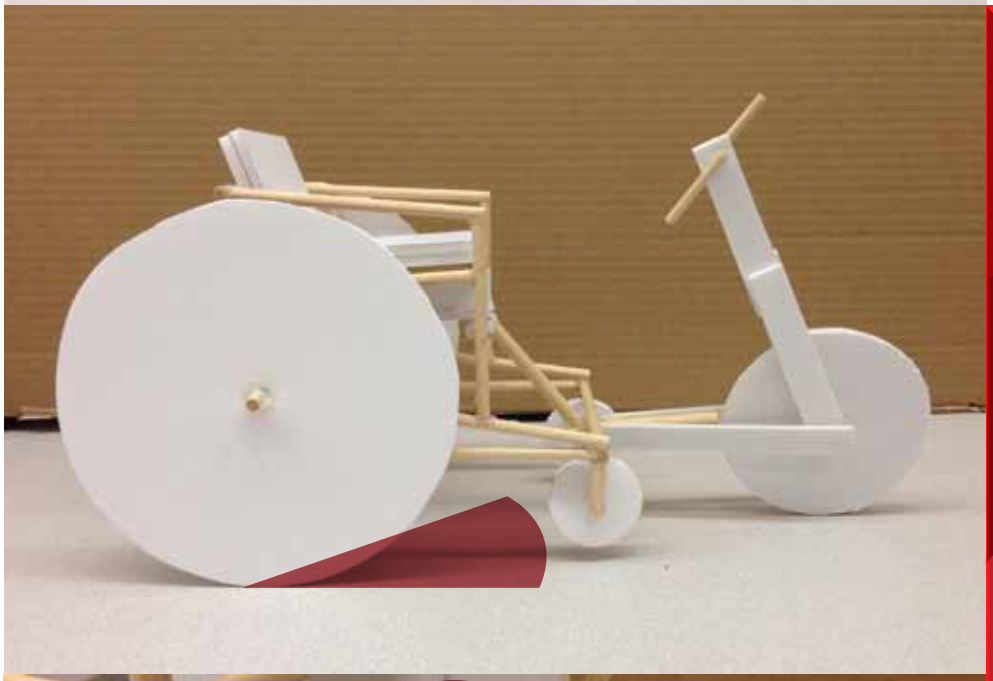
In coordination with sketches were quarter scale models made out of dowelling in order to test different frame configurations and proper sizing to ergonomic models. This helped greatly when entering the definitive design development stage for dimensions from these models helped me when trying to create this design in Solidworks. The bottom is a list of objectives that I always considered throughout the ideation process.

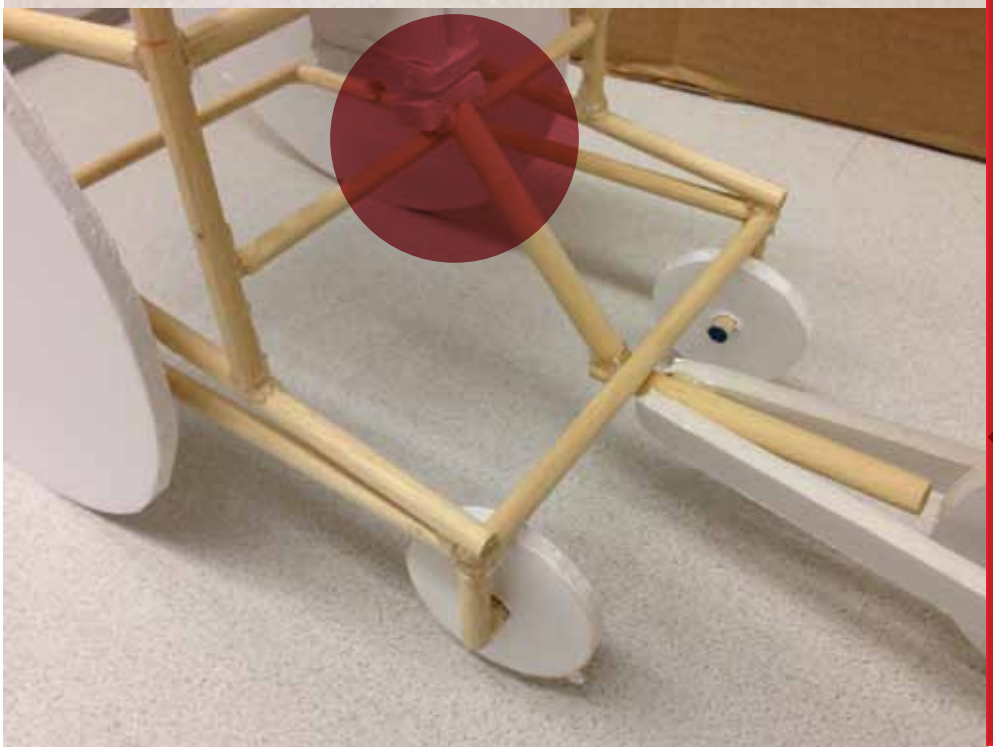
LOCAL MANUFACTURABILITY | **SAFETY ASSURANCE** | **ENVIRONMENT** | **ECONOMICALLY FEASIBLE** | **EMPOWERMENT**



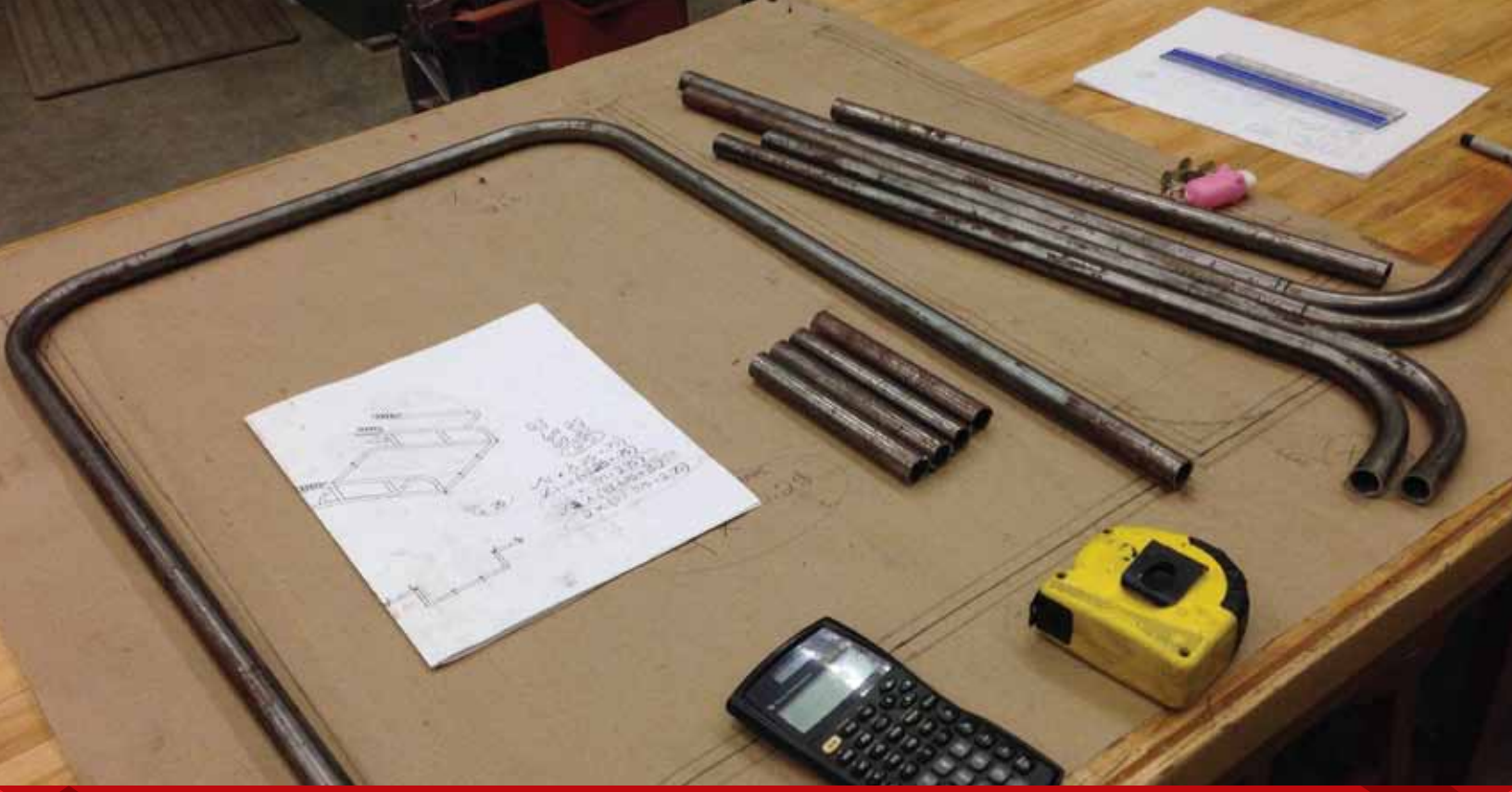
The first concept involved securing the mechanism then pulling a handle to incline the wheelchair.







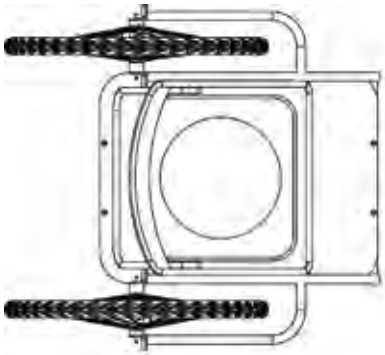
The second concept involved rolling over the attachment and by tilting the front wheel forwards, the wheelchair tilts backwards until it hooks on another tube, securing it in place.



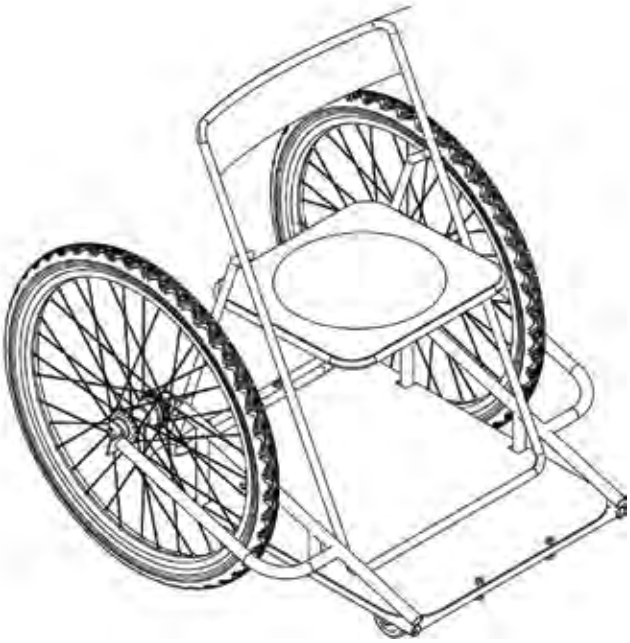
Prototyping in Canada

There was a general set of objectives that applied to all four of our projects. The design had to be economically feasible meaning it had to be, the product had to withstand the harsh environmental conditions, all the materials used in the design had to be locally sourced and manufactured by the local artisan, Kio, it needed to be safe to use and finally, it had to create empowerment by some means.

The first part of the semester was dedicated towards producing a concrete frame design for the wheelchair. If the wheelchair could not be manufactured then my design could not continue. I came up with a simplified design using the dowelling as mentioned before. I then decided to confirm this design by making a full-scale model of it. By using this model, I tested the positions of the back wheels as well as the appropriate size of the castors. The prototype contained multiple holes so that the bicycle wheels could be repositioned in eight different considerations. It was discovered that the most optimal position was just forward of the back post of the seat. This was a good position because it was far enough that prevented tipping but forward enough so that the user could still get a efficient grip on the wheels. The castor wheels used were five inches in diameter. I learned from testing that five inches were too small for going over obstacles, therefore for the final model, any castor wheels over five inches would be sufficient. The castor wheels were also too close together. By being too close together, the castor wheels fluttered when the wheelchair was in motion. Fluttering is a safety issue because it can increase the risk of tipping as well as the wheelchair is harder to push and maneuver. The wheelchair prototype could go over obstacles and still managed to go up hills, which are environments



These are technical drawings that helped me when building this prototype. The 3D model was created using SolidWorks.



that are most prevalent in the district of Kasese. All of these discoveries were incorporated into technical drawings that were sent to Kio a week before departure.

Due to the limited amount of time, the design of the attachment system was not completely finalized before the trip. In the drawings it was simply designated as two c-channels that would be bolted together. The design for the attachment was planned to be the main focus during the trip for the manufacturer and witnessing the conditions of the environment could provide better insight in the final form. The following images show the technical drawings and illustrations that I sent to Kio on February 2. These drawings changed dramatically after the trip and will be revealed later in the report.

Top Left: Prototype made in January, made of steel tubing and a folding chair.

Top Right: Wheel placement of castor wheels too close and need to be farther apart to reduce fluttering.

Bottom Left: Castor wheels are big enough to go over obstacles but was decided that they needed to be bigger.

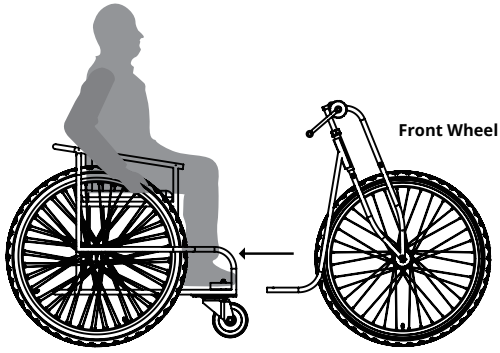
Bottom Right: Various hole placements to test wheels in different positions. Was most optimal forward of the seat.

Bottom of Previous Page: Prototype testing going up inclines and proved sufficient for Ugandan terrain.

Wheelchair Design for Kio
Page 1 of 8

This wheelchair has a similar structure as the tricycle. There are some differences. The bicycle wheels have been moved forward. The main frame has been shortened. The front wheel has been eliminated and replaced with two castor wheels.

Front wheel attachment slips into C-channels welded to the wheel-chair and is secured by bolts.

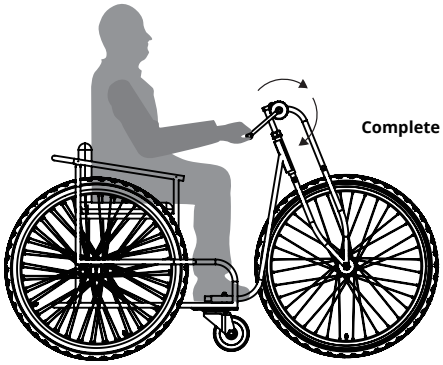


Front Wheel Attachment

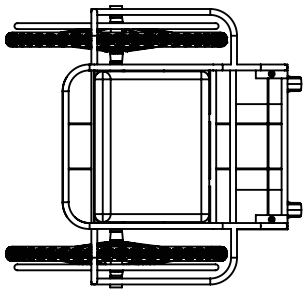
Wheelchair

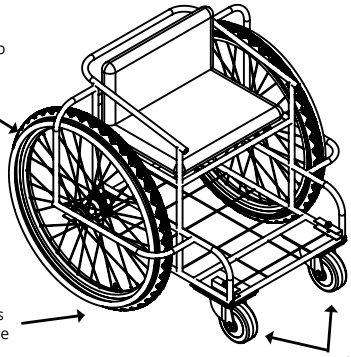
How it Works...
Page 2 of 8

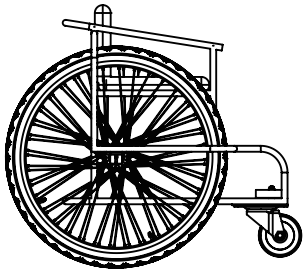
This is an attachment for the wheelchair design to turn it into another version of a tricycle. Therefore, someone with a wheelchair can attach this device and still travel long distances, and take it off when staying around the home.

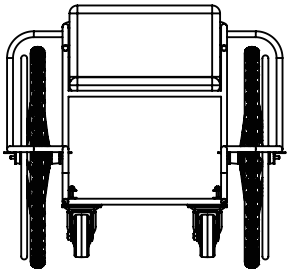


Complete Assembly

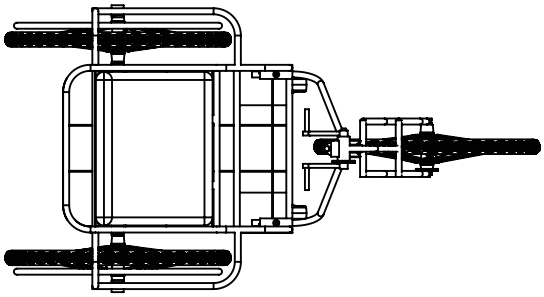


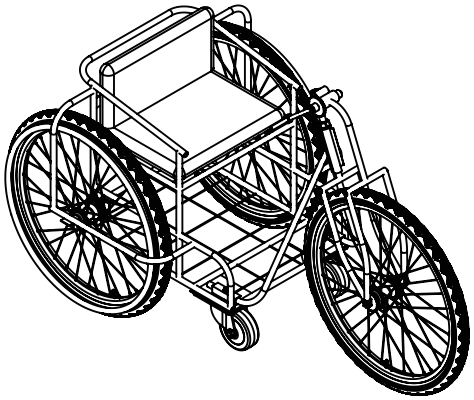


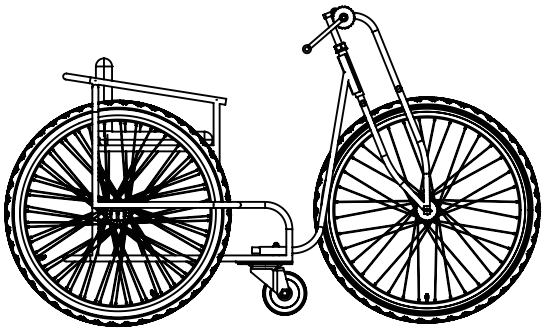


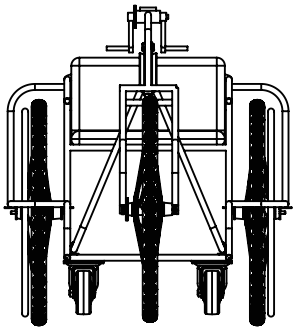


Wheelchair General Assembly
Page 3 of 8

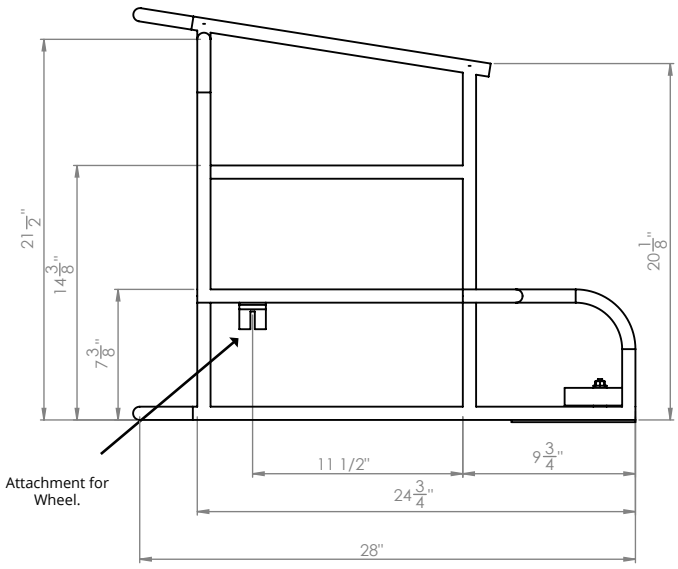


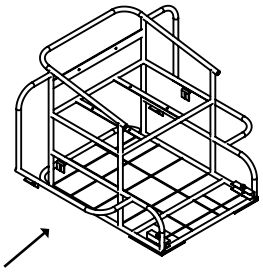






Complete Assembly
Page 4 of 8



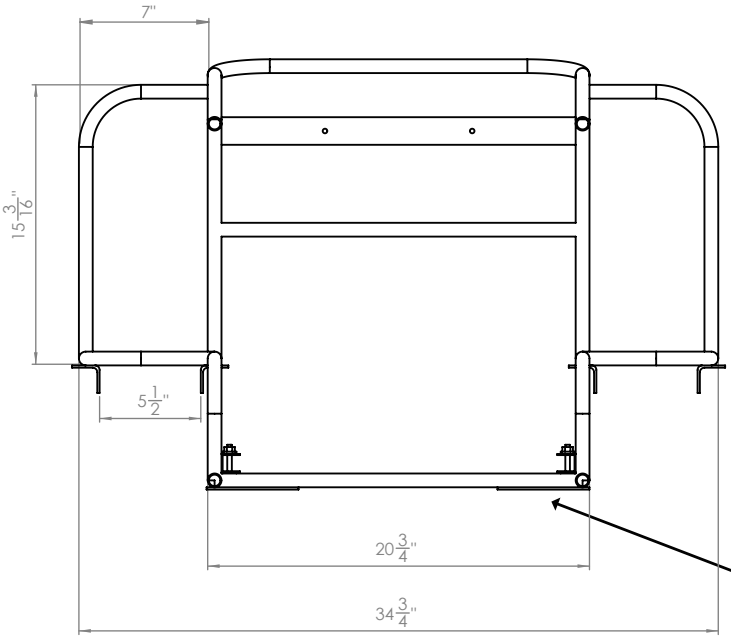


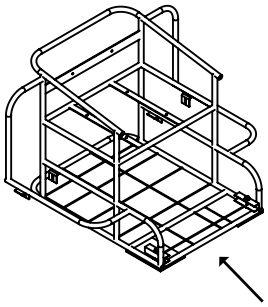
NOTE:

These dimensions are a guideline.

Tubine size is 3/4" OD.

Right Side View of Wheelchair Frame
Page 5 of 8





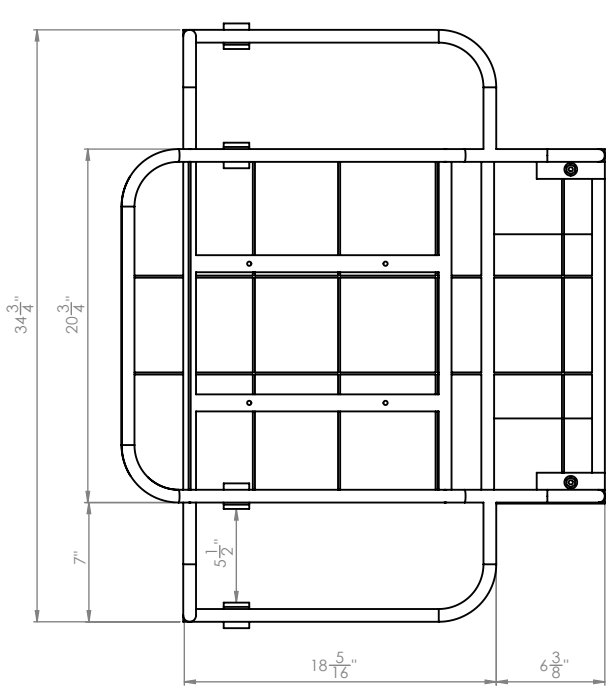
NOTE:

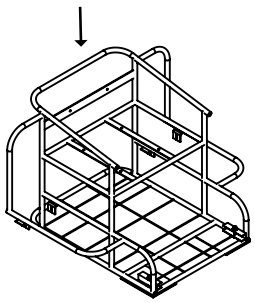
These dimensions are a guideline.

Tubine size is 3/4" OD.

Steel plate for castor wheels.
Do not attach until we come to Kasese.

Front View of Wheelchair Frame
Page 6 of 8



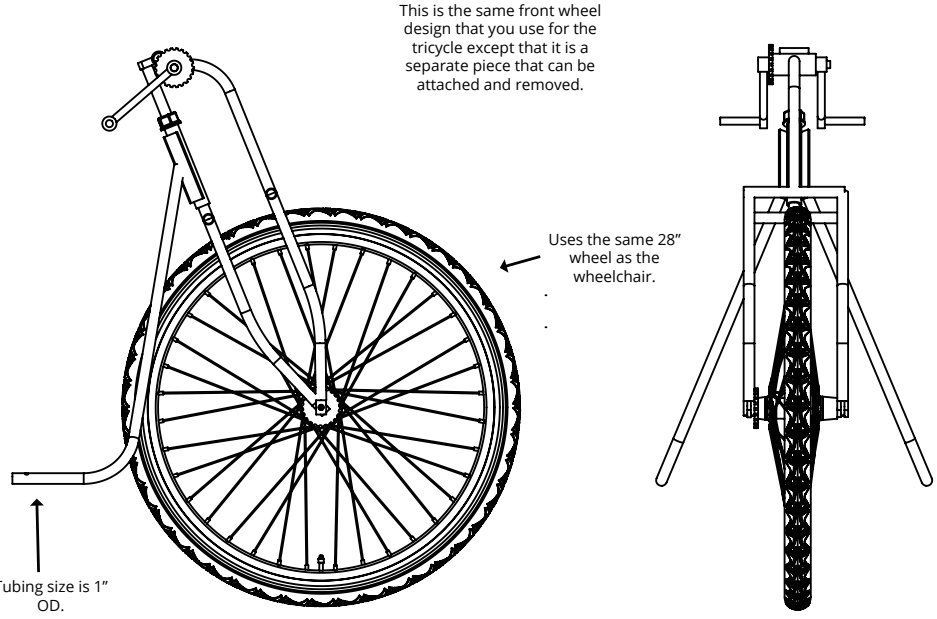


NOTE:

These dimensions are a guideline.

Tubine size is 3/4" OD.

Top View of Wheelchair Frame
Page 7 of 8



Front Wheel Attachment Assembly
Page 8 of 8

The results that were discovered during the prototypes testing and the drawings sent to Kiyo that incorporated these changes was presented to various professors on February 7th during the walk around. This page shows the poster as well as the previous prototyping models discussed in this report.

DEFINITIVE DESIGN DEVELOPMENT

PROTOTYPING AND USER TESTING IN THE RURAL AREA OF KASESE.

Prototype 1

From February 12th to 18th we visited the district of Kasese where we not only met the members from the organization but we met the manufacturer, Kiyo as well. Upon arrival, Kio had already built the main structure of the device. All he needed to do is attach the bicycle wheels and the castor wheels that we had brought with us from Canada. The prototype did not match my design completely, for it resembled the old method of building tricycles that Alyssa tried to fix last year in her project. This was unfortunate to witness, but for testing the attachment system the frame would not be a problem. The first prototype had two plates that sat side by side and bolted in place when the user wanted to change into a tricycle. This was a tedious way of changing vehicles and required a wrench in

order to tighten the bolts. This prototype attempted to resemble the North American products discovered in the secondary research where the wheelchair would be angled so that the castor wheels would hover above the ground in order to avoid hitting degree. This prototype worked and Kiyo was able to angle the wheelchair high enough that the wheels were off the ground. Even though the concept worked there was still a problem that could only be realized when testing in the actual country. Due to the unexpected, extreme conditions of the roads, the castor wheels were still exposed to large rocks. The castor wheels did spin around its ball bearings when coming into contact with small rocks. This allowed the tricycle to keep moving without hesitation. However, when they came in contact with large rocks, the tricycle would stop suddenly. This was a large safety concern and with this discovery it was realized that different measures had to be taken.

Prototype 2

Based on the discoveries from the previous prototype, we decided that the castor wheels needed to be cut off, making them their own separate component. This would ensure that the user could not have the castor wheels attached while in tricycle mode. As a result this decreased the probability of tipping due to user error. The attachment was similar to the previous prototype in terms of bolting it in place. The difference was that instead of plates, the castor wheel and hand pedaled component were attached by inserting two smaller tubes into two larger sized tubing that was attached to the wheelchair. Once the tubes were inserted, they were bolted in place.

Top: Kiyo grinding off castor wheels.
Middle: Castors as a separate component.
Bottom: Tricycle cannot be used when the castor wheels are attached. Front wheel is covering off the ground.

Top: The two different components attach by sliding smaller tubes into two larger tubes. This can be a very tedious action to perform especially if one experiences a disability.

Bottom Left: Both components are secured by four bolts, which are tightened by a wrench. Users could potentially loose the wrench and the bolts when transporting from place to place.

Bottom Right: Kiyo looking over the technical drawings that I sent him. Changes to the prototype could be easily changed on sight at Kiyo's outdoor shop.

Testing

Peter, a member of KADUPEDI, was one disabled person that tested out my tricycle design. He liked the wheel placement and the wheelchair design. He stressed that for the wheelchair it was essential that the push bar from the previous tricycle design was still incorporated into the new design. The space of the push bar had to be large enough that someone could push the wheelchair if he needed help as well as it would be helpful if the space could also be able to hold his crutches. Another thing Peter was concerned about was the attachment system. He believed it was too tedious to line up the tubes in order to slide it into one another. It was also difficult to secure the components in place with bolts. Not only did it take a long time to do, you needed a wrench to do it, which could get lost during transportation. He

Peter testing out the wheelchair. He experiences a mobility impairment. He provided a lot of improvements that was incorporated in the final design.

recommended simplifying the design in order to make it easier.

The device was tested multiple times in tricycle mode in order to insure the strength of the frame. The frame had to be able to withstand the harsh environmental conditions of the rural areas of Kasese. One tube, which attached the front wheel to the wheelchair, broke of during one of the trials. This was easily fixed by adding some triangular plates that reinforced the connection and prevented it from snapping again.

It was convenient that any changes to the prototype that were discovered through testing could be made immediately and on sight with the local artisan. This made it simple to improve the design.

Top: Tube that snapped when testing.
Middle: Kiyo adding reinforcement by welding a triangular plate onto the frame.
Bottom: Me testing the device in tricycle mode.

Outcomes

Before we went to Kasese, we visited Macarere University to present to a group of faculty who were interested in our project. During this meeting faculty assured me that the castor wheels could be easily sourced. This was initially a concern that I had before travelling to the country. Kio also confirmed this after meeting a few days after leaving the city of Kampala.

With this design, the device could be transported in the back of a van. The previous tricycle design was not capable of fitting into a vehicle. This was discovered when I travelled to visit Maali Wilson (one of my primary contacts at the beginning of the year) and his school for children with disabilities (RACPD). At the school I got to see up close the imported devices that I read about in my research. I also witnessed the size of the doors and the ramps that were built specifically for the school and my wheelchair was able to travel up and through such doorways. I did speak with some of the faculty at this school and they all agreed that it would be extremely useful to have this product available due to the fact that not all students lived at the school and had to travel from home each day.

The frame of the device was reduced greatly in size and weighed less than the previous tricycle design. User testing also revealed that this made it easier to maneuver and reduced the risk of tipping. Bjarki Hallgrimsson tested the angle of the hand pedaled component by hanging a gear from a piece of string and measuring the distance. We compared this distance with the distance of the previous tricycle design. The angle of this component was closer than the previous design, which made it easier to reach.

The braking system was also a concern. When the device is in tricycle mode, it is safer for the user to have a braking system in order to stop the vehicle. Based on the technical drawings sent from Canada, Kiyo adjusted the old breaking system that he used for the previous tricycle design (breaks that were U-shaped) to accommodate the new design. Kiyo made the new breaks into a C shape. This was essential, for the new shape did not interfere with the hand rim of the wheelchair.

Even though we did not get to build and attach a hand rim for the wheelchair, Kiyo assured me before we left Kasese that he could build a hand rim out of steel tubing and attach it to the inner rim of the bicycle wheels. A week after we returned from Uganda, I received an email from Robert (a member from KADUPEDI) informing me that Kiyo had built the hand rim.

So much was learned on this trip, and all of this insight was taken back to Canada and incorporated into the final design. The attachment system was proven to work, but it had to be simplified and made easier for the user to attach.

Left: Bjarki measuring the angle using a gear attached to a string.
Top Right: C shaped breaking system that does not interfere with a hand rim.
Bottom Right: Image attached in the email of a wheelchair with a hand rim that Kiyo had made using his limited tools.

FINAL DESIGN DEVELOPMENT

TAKING WHAT WAS LEARNED FROM KASESE AND MAKING A FINAL MODEL.

Building the Final Model

When I came back to Canada there was a lot of work to be done. The final design incorporated all of the improvements discovered in Uganda and followed all of the objectives outlined in the early stages of the concept development. The final model was made out of 3/4 inch steel tubing. The tubes were bent using a tube bender and was welded together with help from the school's metal shop technicians, Jim Dewar and Walter Zanetti. The

front of last year's tricycle was reused and modified to be the front wheel attachment. The hooks for the attachment system were made out of two c-channels. I drilled a hole and cut the hook shape with a band saw. I used a very simple layout that can easily be cut by Kiyo using a grinder. The barrel bolts were welded to the top the two bigger c-channels. The vinyl was typically used for boda boda seats but was used to incorporate some of the districts culture in the final model.

Once constructed, the parts were painted using water based paint and the bicycle wheels were attached to assemble it. The final design was presented at the grad show from April 12-15 on the fourth floor of the Canal Building at Carleton University.

Top Left: Priming the attachment components.
Top Right: Priming the wheelchair.
Bottom Left: The fully painted wheelchair before assembly.
Bottom Right: Presentation at the grad show.




The Final Design

For my final year of study, I set out to focus on increasing the benefits of the previous tricycle design by creating a two in one system. The product was a wheelchair that could turn into a tricycle. Now with this new product, users do not have to compromise between not being able to travel long distances and not being able to travel indoors.

The manufacturer can easily source all of the materials used in the device. The steel tubing as well as the 28-inch bicycle wheels can be sourced and more importantly can be fixed when they need repair, unlike the aluminum used in imported devices. These materials also increase the strength and rigidity of the device, and as a result, the device can withstand the harsh environmental conditions of rural Kasese. The breaks have been adjusted to not interfere with the hand rim. The hand rim could not only be built, but also worked with the entire system. In addition, the frame is made entirely out of right angles. This is easier and takes less time for the manufacturer to produce.

The attachment system was greatly simplified from the prototype that was made in Kasese. Instead of using two tubes that slide in one another, the design now uses two c-channels. One of these c-channels is shaped like a hook that hooks onto a solid bar that is located in the larger c-channels that are attached to the wheelchair. These c-channels are secured into place by a simple barrel bold that the user easily slides into place. These bolts are definitely a large improvement in comparison to the bolts that were used to secure the prototypes in Uganda. They also do not require any additional hardware, such as wrenches, and is impossible for users to loose any parts.

Having the castor wheels as a separate component ensures that the user cannot be in tricycle mode while the castor wheels were attached. This is a safety concern that has been addressed by changing the design. The bottom of the wheelchair has a grate that allows the users to place the castor wheel component when transporting from place to place when in tricycle mode. Breaks have also been incorporated to allow users to stop the vehicle in case of an emergency when in tricycle mode. By having the attachment system on the outer sides of the wheelchair, allowed the castor wheels to be farther apart, reducing the chance of fluttering, which was one of the concerns that arose from the first prototype made in the preliminary design development stage.

The frame size has been reduced significantly compared to the previous tricycle design and can be reduced even further when in wheelchair mode. The wheelchair allows users to maneuver in small spaces and even go indoors, which users were not capable of doing with the tricycle. The tricycle mode allows the users to travel long distances. As a result, this creates empowerment for a person who experiences a mobility impairment for they can adapt the device depending on their environment and needs. The reduced size also means that the device uses less metal. The weight is therefore, less than the previous design, which

means that it is not only easier for the user to maneuver, but it also means that the device costs less. The benefits the organization greatly for it costs less to produce, and as a result, more devices can be produced with the same amount of money.

In conclusion, my project changed the greatest after visiting the country of Uganda. Meeting the people of Kasese and potential end users was truly a great experience and had a huge role to play in the final form of my project. Hopefully, this device will be continued to be used by the orgnaization to assist people now that it is more refined. The biggest lesson I learned from the project is that you cannot designfor people, it must be with people. I will always remember this and apply it to all of my projects in the future.

The following pages include isometric and orthographic drawings of the final design as well as my ethics approval and signed forms and the final poster that was presented at the grad show.

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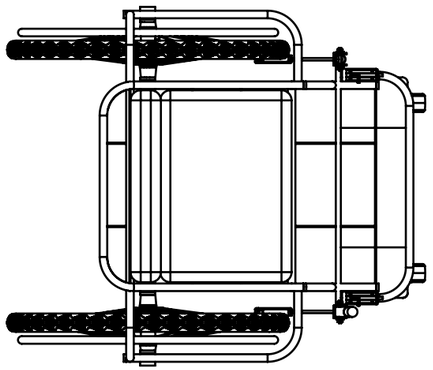
APPENDIX A: TECHNICAL DRAWINGS



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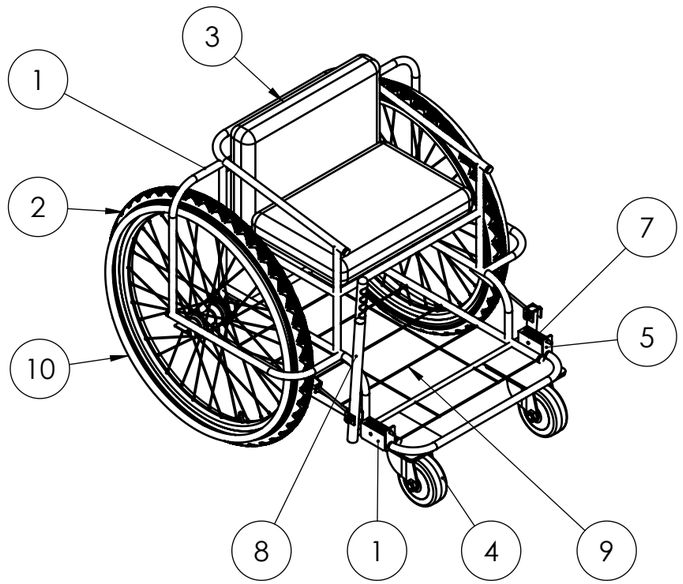

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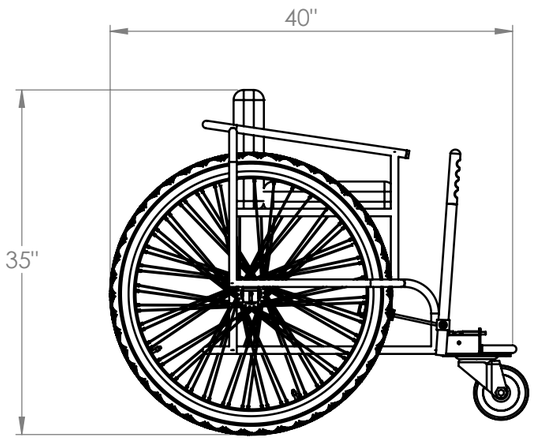
1	3/4" DIA STEEL TUBING	-
2	28" BICYCLE WHEELS	2
3	VYNIL CUSHION	2
4	6" DIA CASTOR WHEELS	2
5	HOOK SHAPED 1.5X3" C CHANNEL	2
6	2X4" C CHANNEL	2
7	BARREL BOLT LOCK	2
8	BREAK SYSTEM	1
9	CONCRETE WIRE MESH	1
10	26" DIA HAND RIMS	2



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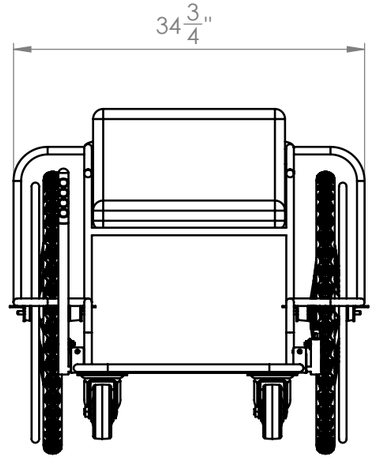

RIGHT SIDE VIEW

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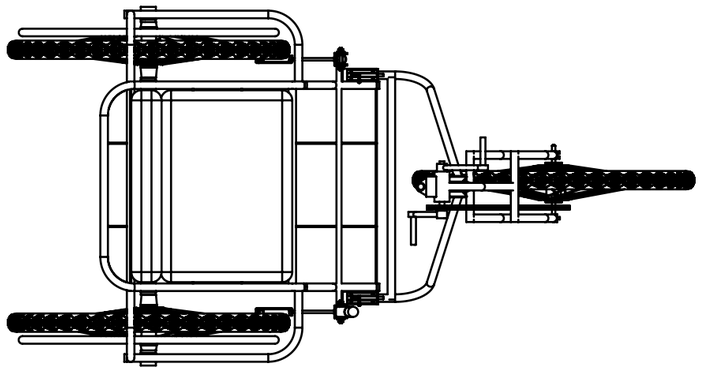

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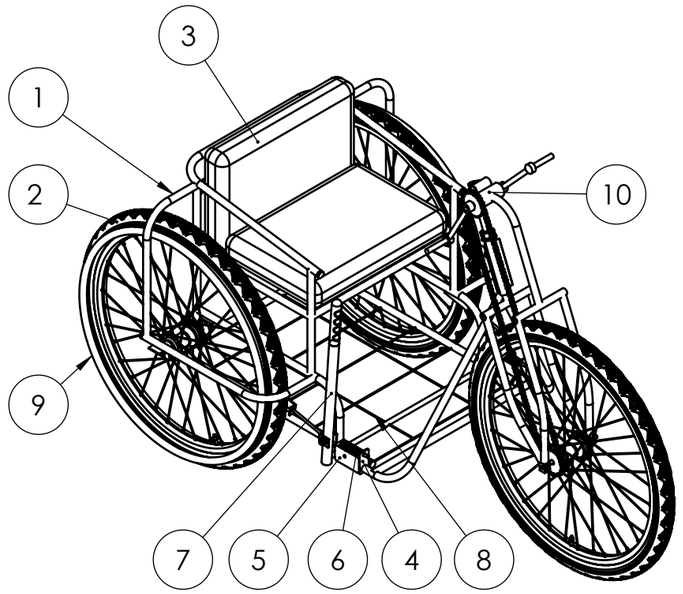
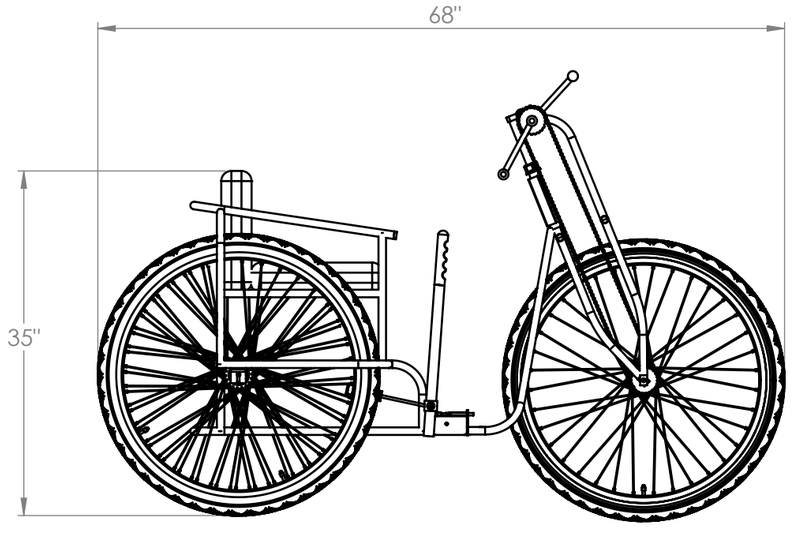


ITEM NO.	DESCRIPTION	QTY.
1	3/4" DIA STEEL TUBING	-
2	28" BICYCLE WHEELS	3
3	VYNIL CUSHION	2
4	HOOK SHAPED 1.5X3" C CHANNEL	2
5	2X4" C CHANNEL	2
6	BARREL BOLT LOCK	2
7	BREAK SYSTEM	1
8	CONCRETE WIRE MESH	1
9	26" DIA HAND RIMS	2
10	HAND POWERED GEAR SYSTEM	1



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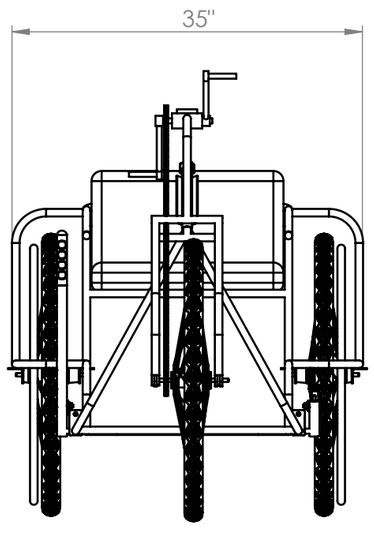

RIGHT SIDE VIEW

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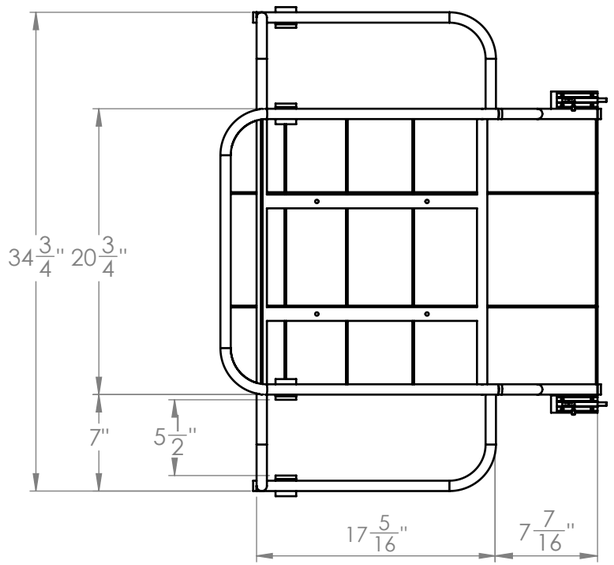

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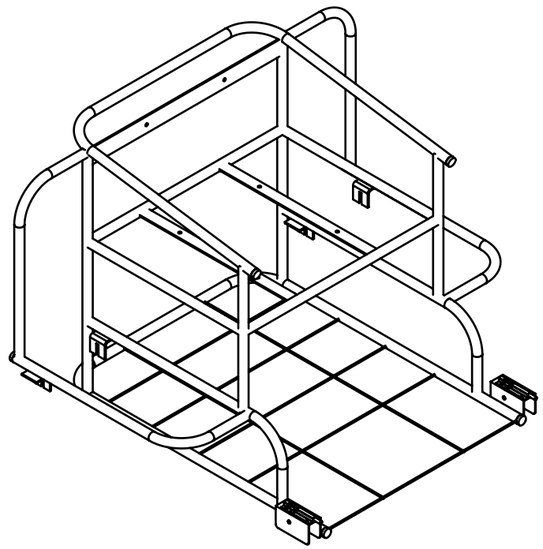

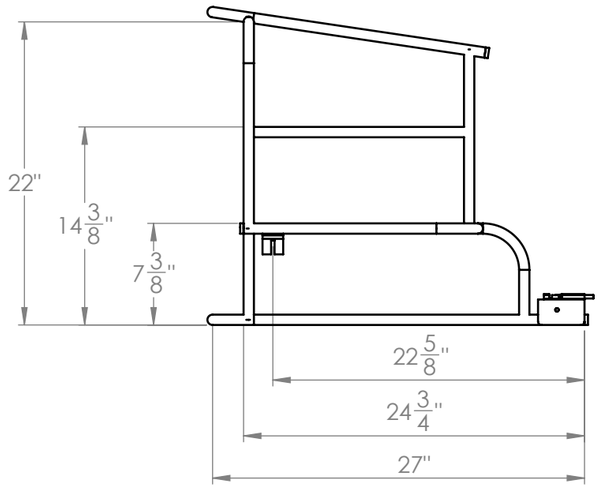

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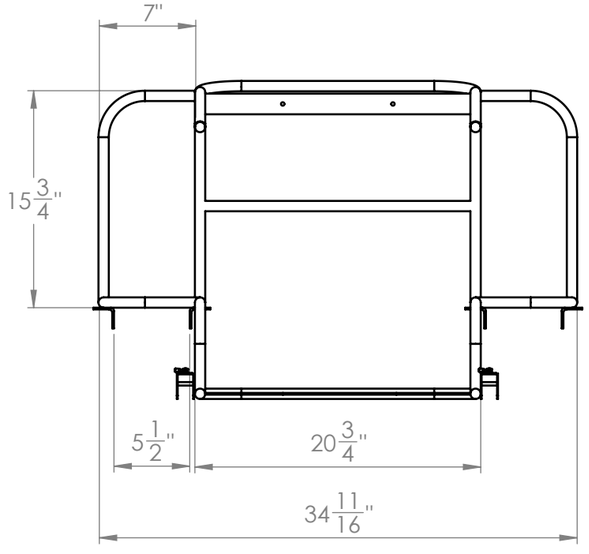

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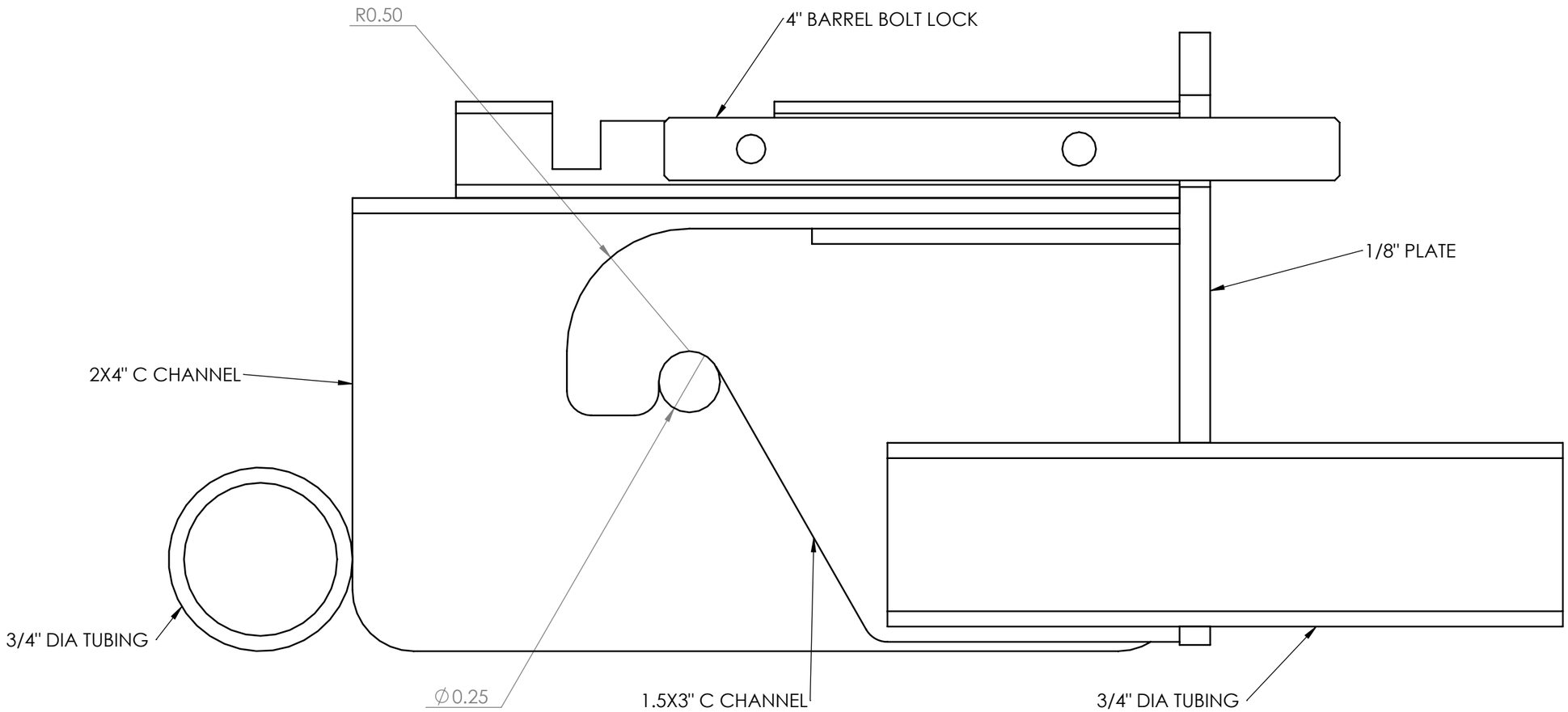

CROSS SECTION OF ATTACHMENT SYSTEM

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APPENDIX A: ETHICS APPLICATION AND SIGNED FORMS

Carleton UNIVERSITY
Canada's Capital University

Research Ethics Board
1325 Dunton Tower
Tel: 613-520-2517
ethics@carleton.ca

Research Ethics Protocol Application

Office use only:	
Project number:	Date received:
Type of review: ☐ Expedited ☐ Full	REB Review Date:

Section 1: Project Registration

1.1 Project Title:

Tricycle Attachment to Assist People with Mobility Impairments in Rural Uganda

1.2 Purpose of the research (one or two sentences):

The purpose of the research is to test an assistive device prototype in order to make improvements to the final design. The final product aims to assist those with disabilities, specifically those with mobility impairments, who live in the rural areas of Uganda.

1.3 Researcher Information: (Students must also complete the supervisor section)

Name: Jennifer Vandermeer

Department: School of Industrial Design

University E-mail Address: jennifervandermeer@cmail.carleton.ca

Position:

☐ Faculty Member ☐ Instructor or Sessional ☐ Library staff ☐ Post-Doctoral Fellow
☐ Ph.D. student ☐ Master's student ☑ 4th year project ☑ Undergraduate

1.4 Thesis or Project supervisor (Students only)

Name: Bjarki Hallgrimson

Department: School of Industrial Design

University E-mail Address: bjarki_hallgrimsson@carleton.ca

1.5 Was this project granted an Approval in Principle for the purpose of releasing research funds? ☐ Yes ☑ No

If **Yes:** Please provide the project number:

1.6 Is this protocol a main or umbrella application for others projects? ☐ Yes ☑ No

1.7 Proposed Research Dates:

Date to begin recruiting participants: February, 1, 2014

Date project will conclude: March 1, 2014

1.8 Other researchers: ☑ Not applicable

Name	E-mail Address	Role

1.8 Student Research Assistants: ☑ Not applicable ☐ To be named later

Name	Department/School	E-mail

1.9 Research funding: Is this project funded? ☑ Received ☐ Pending ☐ Not funded

Funding source and program

IDRC (International Development Research Centre)

If funded, will other protocols be submitted under this funding? ☐ Yes ☑ No

1.10 Researcher signature:
I agree to conduct this research in accordance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2nd edition* the *Carleton University Policies and Procedures for the Ethical Conduct of Research* and the conditions of clearance established by the Carleton University Research Ethics Board.

_____ _____
Signature of researcher Date

Research supervisor (Student projects only)
I have assisted with, read and approved the research ethics protocol. I will ensure that the student researcher conducts the research in accordance with the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans 2nd edition*, the *Carleton University Policies and Procedures for the Ethical Conduct of Research* and the conditions of clearance established by the Carleton University Research Ethics Board and agree to provide all necessary supervision to the student.

Signature _____ Date: _____

Section 2: Research Project Information (Complete all sections below)

2.1 Description of research project and its objectives: (Limit 200 words.)

For the final year of undergraduate study, the final project is to design an assistive device to aid those with disabilities who live in the rural, mountainous areas of the district of Kasese. Uganda. This project is a wheelchair design that allows the user to attach and detach a front, third wheel that provides greater stability when traveling over rough terrain. Participants are both children and adults that require an assistive device, such as a wheelchair, due to mobility impairment. The research will consist of the participants performing a series of tasks while using the device that will be observed and photographed (based on the participants consent), followed by questions that will be asked with the help of a translator.

2.2 Methodology/Procedures: Describe all methods and procedures that will be used to obtain data

The methods and procedures that will be used to obtain data include asking the participants to perform certain tasks in order to test the device and interviews that will follow each task.

2.3 Location where the research will take place:

☐ Carleton University ☐ Region of Ottawa-Carleton

☐ Canada (please specify):

☑ Other (please specify): Kasese, Uganda

2.4 Will additional ethics reviews be required? ☐ Yes ☑ No

If Yes, please provide the name, address and contact information/person for each board or committee.

2.5 Visa or research license required:

☐ Yes. Documentation attached ☑ Yes. Documentation to follow ☐ No

Faculty projects only:

2.6 Training and supervision of student researchers: ☐ Yes ☐ No

a) Training/experience: Please outline the training that student researchers will receive before commencing work on this project. Include information about their experience to date and their qualifications to work on the project.

N/A

b) Supervision: Please outline the supervision plan for student researchers.

N/A

Section 3: Research Participants

3.1 Recruitment

a) Describe how potential research participants will be identified and recruited. (Include information on recruitment methods; i.e. email, letter, poster, etc., and where applicable the location of recruitment.)

Potential research participants will be recruited by contacts from the organizations CanUgan and KADUPEDI (the organizations that the project is partnering with). They will notify them by word of mouth.

b) Proposed number of participants in the study:

The number of participants proposed for the study is 10.

c) Vulnerable research population: ☐ Not applicable

Describe steps to be taken to ensure that the needs of research participants are respected and the collection of data method will ensure the safe and ethical conduct of the research. Where applicable describe your knowledge, training and experience working with the identified population.

Due to the fact that the participants might be children that require an assistive device, such as a wheelchair due to mobility impairment, the research can only begin after there is clear oral consent given from the parent, and then assent from the child. If either the consent or assent is not given then the research will not be conducted. This oral consent speech will be said by a translator (if the participant, guardian or parent does not speak English) so that both the participant and the parent/guardian fully understand the objectives of the study, the safety precautions being taken, the participant's ability to withdrawal at any time, and that this is a study to test the product not them. The oral consent speech for the parent, and the oral assent speech are presented at the end of this application.

3.2 Append the required recruitment documents. (Letters, Telephone scripts, emails, posters, etc. Please identify each clearly, example: Appendix 1: Letter of Invitation)

Section 4: Conflict of Interest/Power Relationships

4.1 Are potential research participants employees, clients or persons you have worked with in a professional or volunteer capacity (past or present)? ☐ Yes ☑ No

If **Yes:** Please explain your relationship to or authority over the potential participants and what steps you will take to ensure that the participants' decision to take part in the research will not be influenced by their relationship to you.

N/A

4.2 Are potential research participants, friends, relatives or students? ☐ Yes ☑ No

If **Yes:** Please explain your relationship to or authority over the potential participants and what steps you will take to ensure that the participants' decision to take part in the research will not be influenced by their relationship to you.

N/A

4.3 Do you or any members of the research team have any financial and/or commercialization interest in the research results? ☐ Yes ☑ No

If **Yes:** Please explain in detail your interest.

N/A

Section 5: Risks and Benefits

5.1 Risks to participants: (Check all that apply)

☑ Physical harm or discomfort (This includes any bodily contact, application of equipment, management of any substance.)

☑ Psychological/emotional harm (This includes feeling demeaned, embarrassed worried or upset.)

☐ Social and economic harm (This includes loss of status, reputation, ridicule form peers, family or friends.)

☐ Economic risk (This includes loss of income, threat to employment, loss of work time)

☐ Legal risk (This includes possible criminal charges or legal suit, duty to report.)

☐ Other inconveniences (This includes travel costs, disruption to normal activities, time commitment, etc.)

Explain in detail all possible risks to research participants.

The research is to evaluate product performance and will involve the participants using a tricycle. With the tricycle there is normal risk similar to that of a bicycle. These are minimal risks, but precautions will be taken to ensure that the participant is safe and comfortable. The participant and the parent/guardian will be well informed of these risks and they will be informed that they can stop the study at any time if they feel uncomfortable for any reason.

There is a possibility that the participants may experience embarrassment if they can not perform certain tasks when using the device. However, during the oral consent speech given to the participant, I or the translator will inform the participant that it is not their fault if they can not perform any task, it is the products fault and by doing this testing the participant will help us improve it.

There is terrorism that exists in the north east region of Uganda along the boarders of Kenya. Even though this is a potential risk, the location of the study is in the Kasese district, which is located in the south west region of Uganda. Currently there are no recognized advisories for this area and is a safe location for the study.

5.2 Managing risk: Describe what steps will be taken to reduce harm to participants.

The participant will be working with a tricycle so there are normal risks similar to those of a bicycle. Many precautions will be taken to ensure that these risks are minimal such as closely monitoring the child as they perform each task. In addition, the child will be well informed that they are allowed to withdraw at any time.

5.3 Deception: Is there any deception involved in this research project? ☐ Yes ☑ No

If **Yes:** Please describe why participants will be deceived, how the deception will be carried out and how and when you will debrief participants.

N/A

5.4 Are there any risks to you or the research team? ☑ Yes ☐ No

If **Yes:** Please describe the steps that will be taken to ensure researcher safety.

Due to the location that the study will take place, there are some risks to myself, the researcher, that must be addressed. There are infectious diseases such as malaria, meningitis, typhoid, yellow fever, hepatitis A, etc that exist in the country of Uganda. However, an appointment has been made on January 7th 2014 to get vaccinations to prevent me from becoming infected during my time there and therefore this action will prevent this risk from occurring.

There is also a general threat of terrorism in the north, eastern regions of Uganda near the boarders of Kenya. Even though Kasese is located in the south, western region of Uganda, I will be travelling with a group at all times and this group will also have a hired tour guide and driver to escort us.

5.5 Are there any benefits to the research participants? ☐ Yes ☑ No
If **Yes:** Please describe those benefits.

N/A

5.6 If you are working with an agency or community group describe what benefits they may receive from this research.

For this project, I am working with the non-profit organization CanUgan located in Ottawa, Ontario whom are also partnered with the organization KADUPEDI located in Kasese, Uganda. Both of these organizations provide assistive devices to those with disabilities in Uganda. The objective of this project is to design a new device or to improve an existing device to assist those with disabilities. This research and project will benefit them because afterwards the final designs created during this research will be added to the organization's portfolio of devices to be donated.

Section 6: Compensation/Remuneration

6.1 Will research participants (including an organization) receive compensation or remuneration for their participation? ☐ Yes ☑ No

If **Yes:**

7. Describe the compensation/remuneration (money, gift, transportation, childcare costs, etc.)

N/A

8. What is the monetary value of the compensation/remuneration?

N/A

6.2 Will you or members of the research team provide time or assistance to the community participants? ☐ Yes ☑ No

If **Yes:** Please describe the assistance that will be provided.

N/A

Section 7: Anonymity and Confidentiality

7.1 Anonymity (Treatment of the identity of participants)

a) Will the identity of participants be known to the researcher(s) during the collection of personal information, data gathering or testing?
☑ Yes ☐ No

b) Will the identity of participants be revealed in any reports, papers, research articles, recordings, photographs or presentations, etc?
☑ Yes ☐ No

c) Will the identity of participants be known to other participants in the study?
☑ Yes ☐ No

d) Will the identity of participants be known to non-participants in the study? (colleagues, family friends of the participants)
☑ Yes ☐ No

7.2 Confidentiality: (Attribution of responses and data)

a) The responses/data collected will not be attributed to participants.
☐ Yes ☑ No

b) The data collected will be attributed to participants
☑ Yes ☐ No

If YES to b):
Will participants have the opportunity to request that certain responses remain non-attributable?
☑ Yes ☐ No

7.3 Limitations on anonymity and confidentiality: If the researcher(s) anticipate a situation that may result in a duty to report the names of participants and other relevant information please describe those circumstances here.

N/A

Section 8: Informed Consent

8.1 Describe the procedures for obtaining informed consent for each part of the research project.

The participants that are recruited are from Uganda and it is likely that they will not speak English. Therefore, in order to obtain informed consent, it must be given orally. This consent will be asked by the researcher or by the translator (if the participant, guardian or parent does not speak English) after saying a speech informing them about the project.

Due to the fact that children may be the participants of this study, the research can only begin after there is clear oral consent given from the parent, and then assent of the child. If either the consent and assent are not given then the research will not be conducted.

8.2 Participant withdrawal: (Please explain the procedures for participants to withdraw from the research study.)

During the oral consent speech given by the translator, the adult participant or the parent/guardian and child participant will be informed that they can withdraw at any time. If at any time the participant wants to withdraw from the study (before or during) they just need to orally indicate it to either the person conducting the test or the translator (if they cannot speak English) and the testing will stop, and any recordings will be erased.

8.3 Future use of data:

The data that will be used for a personal blog, final presentation board and final report that will be stored on a personal hard drive and will only be shared upon request by students that are interested in continuing or improving the project research.

Before the study, the participants will be informed that they will be photographed and video recorded, and that this information will be used in a final presentation, report and online blog. If the participant wants their information to be confidential, they need to inform either the researcher or the translator at any point during the study, and precautions will be made to exercise this and any previously recorded data will be erased. The online blog is a secure website that requires a specific password and username known only by myself to upload content and it is only used for communicating my findings with my professor. If a participant wants to remain anonymous, their photographs or information will not be included in the blog. The address will be provided to all participants and if they have any concerns about the information posted on the blog they can contact me with the information provided in the oral script and I will take care of these concerns immediately. In addition to these precautions, the blog will be discontinued after the project has been concluded.

8.4 Append the required informed consent form (For Carleton researchers all consent forms must be on Carleton University letterhead.)

Section 9: Data Collection, Storage and Dissemination

9.1 On-line survey section only: ☑ Not applicable

Is the host survey company Canadian? ☐ Yes ☐ No

If **No**, in what country will the host data be stored?

N/A

Describe the process for transferring the data from the host server to you and verification that the host server is no longer in possession of the data.

N/A

9.2. Audio, video recording or photographs

Will the research participants be audio, video recorded or photographed? ☑ Yes ☐ No

If **Yes:** Please describe how the recordings or photographs will be used. If they are to be used in any presentations of the research participants must be made aware of this and consent to their use. If recordings or photographs are to be destroyed explain how and when this will occur.

The data is to be stored by researcher and used in future projects. The data collected will be used for a personal blog; final presentation board and final report that will be stored on a personal hard drive and will only be shared upon request by students that are interested in continuing or improving the project research.

9.3 Translation and transcription of data:

Will the research project require the services of a translator or transcriber? (Check **No** if researcher is translator) ☑ Yes ☐ No

If **Yes:** please describe what steps will be taken to ensure the privacy and confidentiality of the participants. Please provide a copy of the confidentiality agreement for the translator or transcriber.

The participants will be informed that they will be photographed and video recorded, and that this information will be used in a final presentation, report and online blog. If the participant wants their information to be confidential, they need to inform either the researcher or the translator at any point during the study, and precautions will be made to exercise this and any previously recorded data will be erased.

The translator will be required to sign a confidentiality agreement before they are allowed to begin translating for research (see appendix).

9.4 Storage of data: (Explain how the data will be stored during the course of the study. If the data will be used in future studies explain how it will be stored.)

During the research period, the data will be saved on a camera memory card, and observations will be transcribed into a notebook. The memory card and notebook will be only handled by myself and will be in my possession at all times. Later, the information will be deleted and destroyed from these mediums after being transferred to a personal computer hard drive that is secured by a password. This information will be synthesized into an online blog, final presentation and a final report.

9.5 Access to data: (Explain who will have access to the data during the course of the study.)

The researcher (myself) and the supervisor (Bjarki Hallgrimsson) will have access to the data during the course of the study.

9.6 Disposition of Data (After analysis and completion of report)

Data will be:

☐ **Returned to participants** (Describe in what format the data will be returned and approximate date it will be returned to participants.)

N/A

☐ **Destroyed** (Describe how the data will be destroyed and approximate date of destruction. This includes all audio tapes, digital recordings, videos and photographs.)

N/A

☑ **Data to be stored and used in future projects** (Describe how the data will be stored; including the storage format and how it may be used in future research projects. **NOTE**: the data can only be used in the same or related projects.)

The data that will be used for a personal blog, final presentation board and final report that will be stored on a personal hard drive and will only be shared upon request by students that are interested in continuing or improving the project research.

9.7 Dissemination: (Check all that apply)

☐ Academic journals
☐ Book(s)
☐ Conferences
☑ Final report to organization
☑ Web site/publication (open to the public)
☐ Workshops
☑ Classroom presentations/exercises
☐ Final report to participants, upon request

Section 10: Research Instrument

Append a copy of all research instruments for the project. This includes questionnaires, interview guides, sample questions, written tests and assignments, descriptions of apparatus and equipments.

The Device

This project is a wheelchair design that allows the user to attach and detach a front, third wheel that provides greater stability when traveling over rough terrain. This assistive device will be tested with participants for the purpose of determining the ease of the device's usability as well as the manufacturing feasibility of the product. Participants who live the rural areas in the district of Kasese, Uganda, will test this device. These participants are adults or children who experience a mobile disability that requires them to use an assistive device such as a wheelchair for transportation.

The Tasks

The participants will be asked to perform a series of tasks while using the assistive device. The tasks include:

- Attaching the accessory
- Detaching/storing the accessory
- Using the assistive device without the attached accessory (entering an indoor space, travelling indoors)
- Using the assistive device with the attached accessory (traveling on unpaved terrain such as stone, grass, etc, travelling uphill)

Follow-up Questions

During these tasks the participants will be either photographed, or videotaped while using the product so that the observational information can be stored and referred to at a later time. The participants will then be asked a series of questions after each task either by the researcher (myself) or by a translator if the participant does not speak English. Questions such as:

- Was that task easy to do?
- How would you improve the device based on your needs?
- What do you like about the device?
- What do you dislike about the device?
- Was that easier to use than the product you are using before? What product were you using before?

Oral Consent

Due to the fact that children might be the participants of this study, the research can only begin after there is clear oral consent given from the parent, and then the assent of the child. If either the consent and assent are not given then the research will not be conducted. This consent will be asked by the researcher or by the translator (if the participant, guardian or parent does not speak English).

Appendix 1: Interpreter/Translator Confidentiality Agreement

Name of Interpreter/Translator:_____

I am aware that in the course of this assignment by Carleton University as an interpreter or translator, I may have access to participants' confidential information and such information must be kept in confidence by me and used only in connection with the work assigned to me by Jennifer Vandermeer from Carleton University.

Therefore in consideration of my engagement as an interpreter/translator I agree:

1. I will hold in strict confidence and will not use, assist others to use, or disclose to anyone any information concerning such proprietary information except as such use or disclosure may be required in order to carry out any interpretation/translation assignment scheduled for me by Jennifer Vandermeer.
2. That I shall not derive any personal profit or advantage from any confidential information that I may acquire during my interpretation/translation services assigned to me.
3. That translated documents remain the property of the researcher of my services at all times.
4. I will not retain any information any such information for myself, including any and all means from which the information can be recovered or reproduced in any form.
5. That confidential data includes all personal information (e.g. names, medical information, etc) which may in any manner identify the participant.
6. That confidential data may be used only for purposes directly related to the research project.
7. That any personal use of confidential data is strictly prohibited.
8. I certify that I have read and understand the foregoing agreement.

_____

Interpreter/Translator Signature Date

Appendix 2: Parent/Guardian Oral Consent Script

"Good morning/afternoon, my name is Jennifer Vandermeer and I am an undergraduate student from Carleton University located in Canada. I am an industrial design student who is designing a new assistive device to specifically help children with mobility disabilities from the district of Kasese. I am here to ask you if your child would be allowed to participate in my research to test the product and evaluate its usability.

The product is a tricycle in which the front wheel can be detached from the base so that it can transform into a wheel chair. Therefore, the tricycle can be used to travel long distances, and the wheelchair can be used indoors when the front wheel is detached.

If you agree to participate, I will ask your child to perform a series of simple tasks with the product, followed by a few questions about what they think about the product and how it performed. This will take no more than 30 minutes of their time.

During this study, the child will be photographed and/or video recorded for information purposes. This information will be used in a online blog, final presentation and report that summarize the findings of this study. If you or the child wishes not to be photographed or video recorded please inform me, and we will not proceed.

The child will be working with a tricycle so there are normal risks similar to those of a bicycle. Many precautions will be taken to ensure that these risks are minimal and the child will be allowed to withdrawal at any time.

The participants will not be anonymous. The identity of participants will be revealed in a final report and presentation. The participant may be known to other participants, or non participants in the study.

The participants be known to me during the collection of personal information, data gathering or testing as well as my supervisor, Bjarki Hallgrimsson, will have access to any stored data that I have collected.

There are no benefits for participating in the study, but the child will be able to provide valuable feedback that may improve the product for future use.

Participation is voluntary and in order for the child to participate, you, the parent/guardian must give me permission. In addition, the child must also agree to participate before we proceed. If they agree to take part they have the right to refuse to answer any questions and they can end the interview at any time.

The project has been reviewed and approved by the Carleton University Research Ethics Board. If you have any questions or concerns you may contact the REB chair, Andy Adler at Carleton University 1325 Dunton Tower 1125 Colonel By Drive Ottawa, ON K1S 5B6. The telephone number is 613-520-2517 and the email is ethics@carleton.ca.

If you need to contact me for any reason my personal email is vandermeerjl@gmail.com and the online blog can be found at www.designwiththemajority.com.

Do you have any questions about me, my research, or our interview?

Do you give your child permission?"

Appendix 3: Child Participant Oral Assent Script

"Good morning/afternoon, my name is Jennifer Vandermeer and I am an undergraduate student from Carleton University located in Canada. I am an industrial design student who is designing a new assistive device to specifically help children like you with mobility disabilities from the district of Kasese. I am here to ask you would like to participate in my research to test the product and evaluate its usability.

This is a new tricycle where the front wheel can be removed so that it can transform into a wheelchair. Therefore, the tricycle can be used to travel long distances for you to get to school, and the wheelchair can be used indoors when the front wheel is removed.

If you agree to participate, I will ask you to do a series of simple tasks with the tricycle. After each task I will ask you few questions about what you think about the tricycle. It is not your fault if the tricycle does not work. It is the products fault and through testing you will help us improve it. This will take no more than 30 minutes.

During this study, we are going to take pictures and videos of you while you perform these tasks. These pictures and videos will be used later in an online blog, final report and presentation. If you do not want to have your picture taken or video taped, it is okay, we will not do it.

Is it okay that we take your picture or video tape you while you perform these tasks?

There risks are similar to those of a bicycle but we will be here the whole time to ensure that you are safe and comfortable. If you ever want to stop at any time, it is okay, and we will stop right away.

Do you have any questions about me, my research and the study?

Would you like to participate in the study?"

Appendix 4: Adult Participant Oral Consent Script

"Good morning/afternoon, my name is Jennifer Vandermeer and I am an undergraduate student from Carleton University located in Canada. I am an industrial design student who is designing a new assistive device to specifically help people with mobility disabilities from the district of Kasese. I am here to ask you if you would be like to participate in my research to test the product and evaluate its usability.

The product is a tricycle in which the front wheel can be detached from the base so that it can transform into a wheel chair. Therefore, the tricycle can be used to travel long distances, and the wheelchair can be used indoors when the front wheel is detached.

If you agree to participate, I will ask you to perform a series of simple tasks with the product, followed by a few questions about what you think about the product and how it performed. This will take no more than 30 minutes of your time.

During this study, you will be photographed and/or video recorded for information purposes. This information will be used in an online blog, final presentation and report that summarize the findings of this study. If you do not wish to be photographed or video recorded please inform me, and we will not proceed.

You will be working with a tricycle so there are normal risks similar to those of a bicycle. Many precautions will be taken to ensure that these risks are minimal and the you will be allowed to withdrawal at any time.

The participants will not be anonymous. The identity of participants will be revealed in a final report and presentation. The participant may be known to other participants, or non participants in the study.

The participants be known to me during the collection of personal information, data gathering or testing as well as my supervisor, Bjarki Hallgrimsson, will have access to any stored data that I have collected.

There are no benefits for participating in the study, but you will be able to provide valuable feedback that may improve the product for future use.

The project has been reviewed and approved by the Carleton University Research Ethics Board. If you have any questions or concerns you may contact the REB chair, Andy Adler at Carleton University 1325 Dunton Tower 1125 Colonel By Drive Ottawa, ON K1S 5B6. The telephone number is 613-520-2517 and the email is ethics@carleton.ca.

If you need to contact me for any reason my personal email is vandermeerjl@gmail.com and the online blog can be found at www.designwiththemajority.com.

Do you have any questions about me, my research, or our interview?

Would you like to participate in the study?

Carleton University
Canada's Capital University

Carleton University Research Office
Research Ethics Board
1325 Dunton Tower
1125 Colonel By Drive
Ottawa, ON K1S 5B6 Canada
Tel: 613-520-2517
ethics@carleton.ca

Ethics Clearance Form

This is to certify that the Carleton University Research Ethics Board has examined the application for ethical clearance. The REB found the research project to meet appropriate ethical standards as outlined in the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd edition* and, the *Carleton University Policies and Procedures for the Ethical Conduct of Research*.

X New clearance
□ Renewal of original clearance **Original date of clearance:**

Date of clearance	**3 January 2014**
Researcher	**Jennifer Vandermeer, Undergraduate student**
Department	**School of Industrial Design**
Supervisor	**Prof. Bjarki Hallgrimsson, School of Industrial Design**
Project number	**100869**
Title of project	**Tricycle attachment to assist people with mobility impairments in rural Uganda**

Clearance expires: **15 April 2014**

All researchers are governed by the following conditions:

Annual Status Report: You are required to submit an Annual Status Report to either renew clearance or close the file. Failure to submit the Annual Status Report will result in the immediate suspension of the project. Funded projects will have accounts suspended until the report is submitted and approved.

Changes to the project: Any changes to the project must be submitted to the Carleton University Research Ethics Board for approval. All changes must be approved prior to the continuance of the research.

Adverse events: Should any participant suffer adversely from their participation in the project you are required to report the matter to the Carleton University Research Ethics Board. You must submit a written record of the event and indicate what steps you have taken to resolve the situation.

Suspension or termination of clearance: Failure to conduct the research in accordance with the principles of the *Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans, 2nd edition* and the *Carleton University Policies and Procedures for the Ethical Conduct of Research* may result in the suspension or termination of the research project.

Andy Adler, Chair
Carleton University Research Ethics Board

Louise Heslop, Vice-Chair
Carleton University Research Ethics Board

Research Ethics Board
1325 Dunton Tower
Tel: 613-520-2517
ethics@carleton.ca

Ethics Annual Status Report
(Students)

If an Annual Status Report is not submitted by the expiry date the ethics clearance will automatically expire. All funding associated with the study will be suspended.

Complete and submit the report to the REB Coordinator at 1325 Dunton Tower or as a PDF document to ethics@carleton.ca

This is a request for ☐ Project Renewal ☑ Project Closure

Section 1: General Information

Researcher: Jennifer Vandermeer

Department/School: Industrial Design

University E-mail Address: jennifervandermeer@cmail.carleton.ca

Supervisor: Bjarki Hallgrimsson

Department/School: Industrial Design

University e-mail address: bjarki_hallgrimsson@carleton.ca

University telephone number: 613 520 5677

Project Title:

Tricycle Attachment to Assist People with Mobility Impairments in Rural Uganda

Protocol clearance number: 100869

Did this study require external Research Ethics Board approval? ☐ Yes ☑ No

If, Yes: Please identify the other REB(s) and the dates they provided clearance

N/A

Section 2: The project

Has this study been ongoing for 3 years? ☐ Yes ☑ No

If **Yes**: Please outline the recruitment procedures, risks and steps taken to ensure the safety of all research participants including the anonymity and confidentiality of participants and their information.

N/A

Have there been any changes to the project over the clearance period that were not brought to and cleared by the REB? ☐ Yes ☑ No

If **Yes**: Please explain those changes here:

N/A

Have there been any adverse events over the clearance period that was not brought to the attention of the REB? ☐ Yes ☑ No

If **Yes**: Please explain those events here:

N/A

Number of participants recruited who have completed the study: 1

Number of participants who have withdrawn from the study: 0

Number of active participants: 0

Expected completion date for study: February 18, 2014

Section 3: Declaration

I declare that the project information provided in this report is accurate.

J Vandermeer
Signature

MAR 13/2014
Date

I declare in my role as research supervisor that the project information provided in this report is accurate.

Signature

MAR 13/2014
Date

Design is ...
Jennifer Vandermeer

TWO IN ONE

A CONVERTIBLE WHEELCHAIR FOR PEOPLE WITH DISABILITIES IN RURAL UGANDA

A WHEELCHAIR THAT CAN BECOME A TRICYCLE

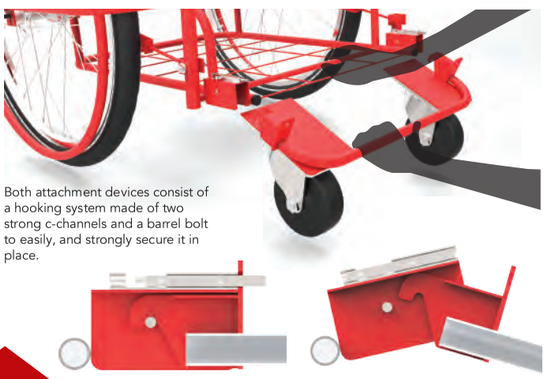
FINDING AN OPPORTUNITY

Imported devices made out of aluminum are difficult to fix when they break.

The hand pedaled tricycle is hard to maneuver and cannot travel indoors.

North American products cannot withstand Uganda's harsh road conditions.

HOW IT WORKS



Both attachment devices consist of a hooking system made of two strong c-channels and a barrel bolt to easily, and strongly secure it in place.

LOCAL MANUFACTURABILITY
All materials can be sourced and built by the local manufacturer.

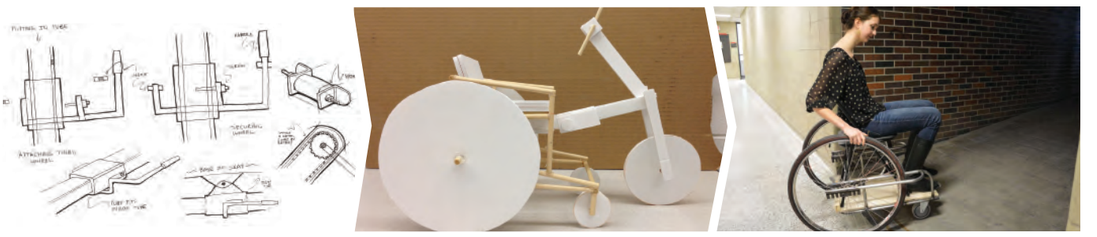
SAFETY ASSURANCE
Both the castor wheels and the tricycle are removable to prevent users from having both attached at the same time.

ENVIRONMENT
The steel frame and bicycle wheels can withstand harsh road conditions, reducing the frequency of repair.

ECONOMICALLY FEASIBLE
Total costs are reduced due to the decreased amount of metal and time used in it's manufacture.

EMPOWERMENT
Better maneuverability is achieved from a smaller width allowing users to travel both indoors and outdoors.

PROCESS WORK



REAL WORLD CONTEXT

THE OBJECTIVE
The objective was to tilt the wheelchair so that the castor wheels hovered above the ground when it became a tricycle.

THE PROBLEM
The castors were still exposed to large rocks, which increased the probability of tipping.

THE SOLUTION
The castors as a separate component ensures that users cannot ride the tricycle while these wheels are still attached.

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