Design Innovation for Disability in Kasese

FINAL TECHNICAL REPORT

Submitted By:

Bjarki Hallgrimsson, Principal Investigator

Navin Parekh, Collaborator

Dean Mellway, Collaborator

IDRC GRANT NO. 107108-00020702-007
Country/Region: Canada and Uganda

SEPTEMBER 30, 2014

CONTACTS:

Bjarki Hallgrimsson, Associate Professor, School of Industrial Design, Carleton University, Ottawa, Canada,
T: 1 613-520-5677, Email: bjarki.hallgrimsson@carleton.ca

Navin Parekh, President, CanUgan Disability Support, Ottawa, Canada
T: 1 613-224-8174, Email: canugan@canugan.org

Dean Mellway, Director, READ Initiative, Carleton University, Ottawa, Canada
T: 1 613 520-2600 x 1144, Email: dean.mellway@carleton.ca

RESEARCH INSTITUTION:

Carleton University, 1125 Colonel By Drive, Ottawa, Ontario, Canada, K1S 5B6
In collaboration with:
CanUgan Disability Support, 31-257 Botanica Private, Ottawa, Ontario Canada, K1Y 4P8

ACKNOWLEDGEMENTS:

We sincerely appreciate the support and assistance from the following people and organizations, which were instrumental in the project:

Baluku Peter, Bwambale Robert, KADUPEDI, Kasese, Uganda
Dr. Venny Nakazibwe, Dr. Kariko Buhwezi, Makerere University, Kampala, Uganda
Dr. Asher Bayo, Kyambogo University
Dr. Blair Rutherford, Institute of African Studies, Carleton University
Luc Mugeot, Eloisa Martinez, IDRC, Ottawa, Canada

As well as all the students from Canada and Uganda who worked tirelessly on this project.

COPYRIGHTS AND REVIEW:

ABSTRACT:

This report describes the research problems, objectives, methodology, activities and outputs as well as outcomes from a two-year collaborative project funded by IDRC through the Canadian Small Partnerships Grant. The project has included various Canadian as well as Ugandan stakeholders. The project focus was to design products with people living with disabilities (PWDs) in Kasese District in Western Uganda. Furthermore the project has studied how innovation can be an effective tool in terms of realizing outputs and outcomes. Nine undergraduate students and one master student partook in the project. One was an engineering student from Makerere University in Uganda, whereas the others were industrial design students from Carleton University in Canada. The study concludes that participatory design projects can lead to innovative new useful products that can be built by local craftsmen in Kasese with locally available tools and materials. The master thesis did expose many insights including the ability of recipients to make an income from some of the devices and the positive impact this can have on their lives.

TABLE OF CONTENTS

LIST OF FIGURES

I. BACKGROUND

It is estimated that professional design has typically been limited to the most affluent 10% of the world's population. In 2007 The Smithsonian Cooper-Hewitt, National Design Museum held a groundbreaking exhibition titled "Design for the other 90%". This exhibition explored a growing movement amongst design professionals to use design as a form of social entrepreneurship to "help alleviate the suffering of those lacking even the basic necessities" (Smith, 2007, p. 6). Such design activity is usually motivated by social and developmental needs and typically involves "non-commercial clients for example governments and NGO's" (IDSA). The international standard set to define extreme poverty is an income below $1.25/day. Whereas Uganda's last official census in 2002 measured 24 million people (Uganda Bureau of Statistics), the current estimate of the country's population is closer to 35 million people (CIA, 2013). In Uganda, the number of people living below $1.25/day is 38% (The World Bank), which thus represents 13 million people.

This report refers to "persons with disabilities". This emphasizes the person first and the disability second, while also acknowledging that disabilities range from mild to more severe. According to the World Health Organization "Disability is thus not just a health problem. It is a complex phenomenon, reflecting the interaction between features of a person's body and features of the society in which he or she lives". It affects approximately 15% of the world's population corresponding to about 1 billion people worldwide (WHO, 2012). In Uganda this percentage is estimated to be even higher, given a high prevalence of diseases, accidents and historical conflicts. As a result 5-6 million people are believed to be living with disabilities in Uganda. Studies from Uganda show that the poorest of the poor are usually persons with disabilities (Ahmed, et al., 2007).

This project involved many stakeholders. From Canada it included Carleton University's School of Industrial Design (SID), READ Initiative, Institute of African Studies and the CanUgan Disability Support organization, as well as members of the Ugandan Diaspora in Ottawa and Toronto, including Officials of the Uganda High Commission. Stakeholders in Kasese District, Uganda included: Kasese District Union of Persons with Disabilities (KADUPEDI), local tradespeople/makers of devices, end-users of assistive devices, municipal and district administration officials, organizations of women, children, land mine survivors and parents of children with disabilities, as well as officials of the Kingdom of Rwenzoruru.

The CanUgan Disability Support organization was started in 2010, to enhance the life of people with disabilities (PWDs) in Kasese district, Uganda. It is a joint project with a Ugandan umbrella organization, Kasese District Union of Persons with Disabilities (Kadupedi), which represents over 50,000 PWDs. The CanUgan Disability Support organization (www.canugan.org) had already funded 48 hand-pedaled tricycles that were built by a local manufacturer in the district. Local manufacturing was deemed necessary in order to support local employment and business.

Students and faculty at the School of Industrial Design at Carleton University have a long history of successful involvement in design for disability as well as inclusive and collaborative design approaches and methods. Through collaborative projects with the Canadian Paralympic Foundation as well as the Canadian Institute for the Blind (CNIB), design has been shown to be not only about problem solving but also about innovation and creating new opportunities and experiences. At the same time the Research Education Accessibility and Design (READ) initiative had been started at Carleton University with the mission to connect university researchers in the area of disability across campus and with the larger community. It was through the launch of READ that the School of Industrial Design was introduced to CanUgan. It became apparent that the 3 organizations could collaborate to provide better design to people with disabilities in Uganda. In addition it was envisioned that this would provide a good education for students interested in the growing area of design for social innovation both locally in Uganda and also in Canada. The project would also provide a case study and base for the resulting outcomes of the project.

II. PROBLEM STATEMENT

The initial focus was to assist CanUgan in designing a better hand operated tricycle to be built locally in Kasese in western Uganda. The idea of local production was seen as critical for a number of reasons. Firstly it was clear that many international charity organizations import and donate wheelchairs that are unsuitable for the local environment and needs (Oderyd & Hotchkiss, 2004). These imported wheelchairs are neither able to function given the state of roads and infrastructure nor is there an availability of local spare parts and in many cases the construction makes repairs impossible, due to the lack of local skills and equipment to repair aluminum frames. Initially the problem focus was therefore quite technical. The team including members from Kadupedi recognized that it would be valuable to improve the production capacity and quality of the tricycles by addressing a number of wheelchair/tricycle specific issues in regards to manufacturing, ergonomics and performance characteristics.

At the same time it was clear that the problem was not only technical. According to Baluku Peter, Coordinator of Kasese District Union of Persons With Disabilities (KADUPEDI), these people face the cultural stigma of being “non-providers”. This means that they are often seen as a burden in the extended family concept rather than as net contributors. Interestingly if an individual with a disability can contribute even something small to their family and/or income, this stigma can be lifted to a certain degree. The effort therefore grew quite quickly to also look at some of the cultural and social realities faced by people with disabilities in Kasese, to see how design might improve their lives in terms of empowering them economically.

Another problem to be researched was the problem associated with change in general. Would these projects and innovative solutions empower local manufacturers to become more innovative themselves? Could the idea of design with end users, especially economic outliers with a disability, be of interest to local universities in Uganda?

It became quite clear that the initial one-year project timeline would be insufficient to address some of the research questions. As a result a non-funded project extension was applied for and granted. Firstly contacts with the universities in Uganda had only been more established during the first field trip in 2013. It was clear from discussions with faculty at Makerere University in particular that they had expertise that would be valuable to the project. The hope was that this would lead to knowledge transfer and an increased focus on design for PWD's in Uganda under a closer direction of local universities. The question would need to be investigated through further collaboration and another trip to Uganda in 2014. A Master student from Carleton was brought on to study the interdisciplinary nature of this collaboration as part of the project extension.

In addition several new projects were realized in the co-development process after the first year that underlined the importance of economic empowerment and need for people with disabilities to break out of the poverty cycle and become providers in the community. The latter projects were actually closer to the objective of the project, namely to show and implement new and innovative products that can make a change in peoples lives by creating opportunities. Additional work would also be required to produce more prototypes to test the efficacy and realize the potential of new designs further.

The graduate student researched questions such as do the new products perform in the field? Are there further design modifications required? How does CanUgan support these longer-term objectives that actually have the potential to bring a person out of the poverty gap by enabling economic empowerment? In particular her focus was to investigate how and if the devices were helping the recipients in their income generation.

III. Project Objectives

OVERALL OBJECTIVE

To involve various stakeholders in Canada and in Uganda to design suitable and cost effective devices for persons with disabilities that can be built and maintained by local tradespeople in Kasese, Uganda.

The overall objective has been met beyond the team's expectations. Stakeholders in Canada and Uganda have been involved and have played meaningful roles in the design of suitable and cost effective devices for persons with disabilities built and maintained by local tradespeople in Kasese, Uganda. In addition, through meetings and consultations, faculty members at Makerere and Kyambogo universities as well the National Union of Disabled People of Uganda (NUDIPU) were involved.
The nature and extent of involvement of each stakeholder varied.

Specific Objectives

To build capacity on an individual level by:

A. *Helping people with disabilities (PWD) in one of the least developed areas of Uganda which is one of the least developed countries in the world.*

Design improvements and prototypes created by the team have helped and will continue to help PWDs in Kasese, one of the least developed areas of Uganda.

B. *Providing design assitance to a Ugandan manufacturer for better products, in particular hand-operated tricycles that can be cost effectively produced for under 200 CAD.*

Design improvements have considerably increased the strength, durability and ease-of-operating the hand-pedaled tricycle. Estimated at 370,000 Uganda shillings, its current cost is approximately $160 CAD, well below $200.

C. *Creating jobs and manufacturing expertise in Kasese, Uganda and identifying new program opportunities.*

With emphasis on locally made devices, the project has contributed to sustaining jobs and manufacturing expertise in Kasese. As well, designs and prototypes of ancillary devices like a rollator, a peanut grinder, a peanut sheller, a two-in-one wheelchair/tricycle, a tricycle with a mounted solar panel and a rolling chair has opened up a number of exciting new opportunities for the program.

D. *Providing representatives of KADUPEDI, the Kasese District Union of Persons with Disabilities, an opportunity to meet and exchange knowledge with disability community representatives in Canada.*

Two representatives of KADUPEDI, Baluku Peter and Bwambale Robert, visited Canada in May 2013. During their visit, they met and exchanged knowledge with two representatives from KADUPEDI and joined members of the disability community in Canada at the Annual Conference of the Canadian Association of African Studies held in Ottawa, May 2013. As well, they met and exchanged knowledge and perspectives with a number of PWDs in Canada at meetings held in Ottawa during their visit.

Added Objective

During the visit to Kasese in 2013, it became readily apparent that the top priority of PWDs was to acquire assistive devices to help them engage in income-generating activities. Hence, the following objective evolved:

E. *Designing and producing prototypes of devices to help PWDs engage in income-generating activities.*

A number of devices were designed to meet this objective: a peanut grinder, a tricycle with a mounted solar panel for charging mobile telephones, a peanut sheller, a rolling chair for farming, a rollator. In addition it was deemed critical to do additional research to investigate the viability of income generation. This became the focus of the graduate students research.

To build capacity at the institutional level by:

A. *Exchanging knowledge between the Uganda stakeholders locally in Kasese District as well as faculty and students at Universities in Uganda (Kyambogo and possibly Makerere University), Carleton university`s Faculty and students, as well as CanUgan Disability Support Project.*

Exchange of knowledge with Uganda stakeholders was ongoing process that continued before, during and after visits to Kasese in 2013 and 2014. Representatives of KADUPEDI provided the main link for exchange of information to stakeholders in Kasese, including Kio, the lead tricycle-maker and end users. In addition to sharing and exchanging knowledge on an ongoing basis, Students and faculty and a representative from CanUgan visited Makerere and Kyambogo Universities on both field trips. A large workshop was held in Kasese on February 14, 2014. Over twenty representatives attended it from local disabled people's organizations (DPOs). The group included representatives of KADIWOD (Kasese District Women with Disabilities), KALISA (Kasese Land Mine Survivors Association (KALISA), Hope for Children with Disabilities (HCD), Ruwenzori Association of Parents of Children with Disabilities (RAPCD), representatives of Kasese District and Kasese Town administrations, the Prime Minister of Rwenzoru Kingdom (which includes Kasese District), two faculty members and a student from Makerere University, and the chair and executive members of KADUPEDI. The workshop resulted in valuable exchange of information and ideas. Feedback from representatives of DPOs also led to refinements in the designs produced by the students. Furthermore, students and faculty were asked to present to Makerere students on both visits. This also resulted in one Makerere student becoming involved in the design project in the second year. Exchanges with Carleton university's Faculty and students and with CanUgan Disability Support have been ongoing throughout the project`s duration at events and functions organized by the School of Industrial Design, 1125@Carleton and others as well as at CanUgan's annual dinners and brunches.

B. *Generating a set of conceptual design ideas that will emerge as part of the ideation part of the Ottawa workshop event.*

This was achieved and this initial workshop was important to establish the emphasis on co-designing. Students in particular need to learn to reach out and approach end users and appreciate the knowledge they bring to the exercise by being intimately familiar with their own problems. The workshop hosted by Catapult designer Noel Wilson and Whirlwind design engineer Aaron Wieler, also framed the manufacturing realities of producing bicycle type products in Africa. Both consultants had extensive experience developing products in low-income countries and communities.

C. *Producing proof of conceptual ideas that can be tested for feasibility and that can inspire new products.*

To date 8 new designs for products have been proposed and developed by the student teams. All of the ideas have been prototyped in the field. Some of the ideas have been shown to be more feasible and useful than others, based on additional follow up research by a graduate student.

D. *Teaching university design students in Canada as well as Uganda about Design Democracy through a real life applied project with real end users and NGO`s.*

It is clear from speaking to the students that this has been a remarkable and eye opening experience for them all. The new appreciation these students have for not only for people with disabilities, but manufacturers that work with very few resources and the power of designing with rather than for others, was echoed in their presentations and interviews with the press.

E. *To Field-test and involve end users in the evaluation of new product concepts.*

To date 8 new designs for products have been proposed and developed by the student teams. All of the ideas have been prototyped in the field.

IV. Methodology

The overall framework of the research methodology was based on facilitating input from all stakeholders on the project. The research efforts therefore stressed communication and interaction between various parties including informal meetings and interviews, organized workshops, as well as field trips and interactions with end users. The research methods were qualitative. The graduate student research followed a qualitative approach of triangulation, where different sources of data would be compared to investigate overlap and apparent truths or to reveal contradictions.

Figure 1. Venn Diagram to show the triangulation of methods

Existing literature had an important function in terms of providing background research for Highly Qualified Personnel (HQP), namely students. To this end undergraduate as well as the graduate student had to do extensive literature reviews and gain other information as part of the secondary research efforts. These research results have been gathered in student reports, a Master of Design thesis as well as papers for conferences and journals.

The primary research methods used in this project were conducted through various means and were typically documented in student reports as well as blogs. They are briefly outlined below:

Stakeholder Meetings

During the early parts of the project, it was especially important to identify and involve all relevant stakeholders in the project. One method was to use Skype meetings that would enable Canadian and Ugandan stakeholders to introduce themselves and identify their roles in the project. This would evolve into face-to-face meetings both in Uganda and also in Canada during a visit by two members of Kadupedi in 2013.

Figure 2. Skype conference call between Canadian and Ugandan participants

Workshops

Workshops are important team building exercises. They help transcend many of the conceptual blocks that are inherent in any new design exercise involving a multitude of stakeholders. In this project the stakeholders span continents, cultures and social positions. Workshops were thus integral to the notion of enabling a strong collaborative culture and also to break down barriers. Workshops can also accelerate innovation, because they often provide a form of interaction that is immediate and grounded. For non-designers they provide a mediated set of activities where non-designers are encouraged and drawn into the creative process through tools that enable this involvement. Workshops were held initially in Ottawa, Canada where they were hosted by two consultants from California: Noel Wilson from Catapult Design and Aaron Wieler from Whirlwind Wheelchairs International. In the second year a significant and important workshop was held in Kasese district in Uganda. Members of various organizations attended the workshop for people

with disabilities in addition to Kadupedi. In addition, local politicians as well as faculty and students from Makerere University in Kampala attended the workshop event. During the event, ideas that had been developed during the two-year project timeline were discussed from a point of view of impact and relevance upon recipient's lives. Several recipients were also present to share their stories and experiences.

Figure 3. Workshop in Kasese

Ethnographic Research

Ethnographic research performed by designers is similar to methods used by anthropologists who immerse themselves in other peoples' lives and cultures in order to understand their experience and gain a deeper empathy for their needs. The ethnographic research was primarily observational during visits with end users in their villages that would be supplemented with diaries and photographs as well as informal and formal interviews. This research is important because what people tell you and what they actually do is not always the same.

Figure 4. Ethnographic research with end users in village used by undergraduate and graduate student reveals insights into how people spend their days

Questionnaires

These were used by most of the student researchers as they could be easily distributed remotely by sending them to Kadupedi who in turn gathered the results through translation where necessary. They were seen as instrumental in terms of gathering initial responses.

Interviews

The graduate student used interviews to engage with end users in Kasese.
" Interviews were used to get a first-hand experience of the product from the point-of-view of the user and to clarify and validate any questions that were unclear or unanswered after the first round of questionnaires."

Figure 5. Interview with Margaret (recipient) by graduate student Amanda Cox

Persona and Scenario Development

Insights and observation from both secondary and primary research results were compiled into descriptions of end users that specifically identify specific design needs and scenarios. These personas are important reminders of who is being designed for and what they do and why they do it. This persona provides a visually persuasive human reference during discussions and presentations to various stakeholders.

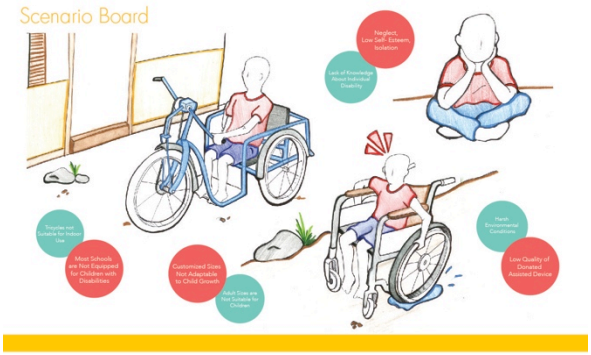

Figure 6. Scenario Board for wheelchair vs. tricycle for kids (Jennifer Vandermeer)

Ideation Methods

Ideation methods used in the project stressed a collaborative focus of working with rather than designing for end users. Given the distance the Internet was used as a means of collaboration initially, which was then followed by more close direct collaboration during the field trips. Specifically the ideation methods included brainstorming activities, mind map exercises and sketching. The sketching was typically done by design students but was circulated for feedback and comments to end users in Uganda.

In terms of fast and inclusive design methods, sketching is very beneficial because designers can present ideas to other stakeholders for evaluation without a lot of vested interest. The end users can see that the drawings are not final and just ideas, circulated for feedback and discussion. These sketches were frequently posted on a Blog so that end users could view them at their leisure and provide feedback at a later date through email or a Skype call.

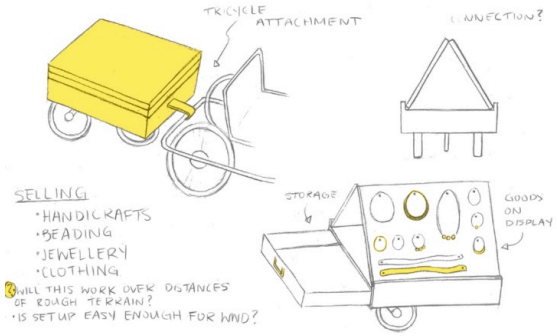

Figure 7. Sketch ideation uploaded on Blog for discussion (Zoe Krug)

Iterative prototyping

Prototyping was used as a generative research tool. Rather than focus on proving final ideas and designs for new products, the iterative approach meant that simple and quick prototypes were made to explore ideas through conversation and evaluation by various stakeholders. This allowed the end users to engage the design process by allowing their suggestions to be incorporated into the design. Sketches and simple small models made by students were sent to Kadupedi and Kio (the manufacturer) for evaluation. This usually resulted in some verbal and written feedback that would lead to another iteration of the design. This process was often repeated numerous times. Finally, during a field trip to Uganda, students would work alongside the manufacturer and end users to further develop the designs. This would typically result in radical quick evolution of the design. It is interesting to note that a student at Makerere University also adopted this method.


Figure 8. Quick cardboard prototype (left) and in field prototyping by Kio (right)

V. Project Activities

IDRC funding provided much need support to achieve a range of objectives and outputs.

Ugandan Scale Model Tricycle, Sep 2012

Kio (the Ugandan Manufacturer) designed and built a quarter scale model of a existing tricycle design that was transported to Canada by CanUgan representatives and made available to students as an initial prototype for study.

Figure 9. Quarter Scale Model Tricycle from Uganda

Initial Student Tricycle Full Scale Model, Oct 2012

With help from School of Industrial Design shop technicians, students built an initial full-scale model of a tricycle by reverse engineering the Ugandan quarter scale tricycle model. This initial hands-on learning exercise was a key step in allowing the students to gain confidence in their ability to build real working prototypes, while also allowing them to become familiar with hand operated tricycle operation.

Figure 10. Initial Full Scale Model Tricycle (Ruby Hadfield)

Ottawa Workshop, November 2012

Two consultants were invited from California to run a three-day workshop to share their knowledge and experience in design for low-income communities in the majority world. Consultant Noel Wilson from Catapult Design aided in developing the dialogue for students and faculty in terms of interacting over long distances and helped host a collaborative online Skype session with members of Kadupedi. Aaron Wieler from Whirlwind Wheelchairs International ran another workshop to introduce the team members to wheelchair and tricycle design and construction methods, particular to majority world scenarios.

Figure 11. Wheelchair-Tricycle Construction Workshop (Ruby Hadfield)

Finally a larger workshop and lecture was held in a Technology Science and Environment TSE class that introduced students campus wide to co-design principles and empathetic design methods.

Figure 12. TSE Lecture by Noel Wilson and Aaron Wieler

Uganda Field Trip, February 2013

A Canadian team comprised of four students and two faculty from the School of Industrial Design, were accompanied by a member from CanUgan for a two week fieldtrip to Uganda in February 2013. The team visited Makerere and Kyambogo University in Kampala. This was an opportunity for students and professors from Uganda and Canada to introduce each other to their institutions and their work. The team was also given a tour at both institutions of their prototyping facilities, which was quite eye opening. The Canadian team then departed for Kasese District in western Uganda, which was a tour that took 9 hours in a rented vehicle. While in Kasese, the team met with members of Kadupedi as well as visiting the homes of some of the current recipients of aid from CanUgan. Most of the time was spent working alongside Kio and his workers building and improving designs that had been forwarded as drawings before the arrival. Whereas Kio had started to build some of the devices, most underwent some modifications and improvements as well as evaluation and some testing by recipients. Four new products were prototyped and tested in the field, including a redesigned three-wheeled hand operated tricycle, a tough large wheel rollator, a solar charging kiosk to enable tricycle owners to operate a business and a ground-nut (peanut) grinding machine that was affixed to the hand cranked bicycle as another form of income generation.

Final Prototyping Year One and SID Year End Show

Students rebuilt the four projects built in Uganda, in Ottawa with assistance from the school's technicians. These prototypes were built mostly to replicate the work in Uganda and showcase prototypes to members of the Carleton community and other visitors to the year-end graduation show. The prototypes were prominently displayed in the Galleria of the University Centre for a three-day period and coincided with presentations as well as being featured in media interviews.

Kadupedi Visit to Canada and the CAAS Conference, May 2013

Two members from Kadupedi (Baluku Peter and Bwambale Robert), visited Canada in May 2013. Their trip was an opportunity to meet with members of the Ugandan diaspora as well as interact and meet PWDs in Canada. A roundtable event was held at the CAAS Conference attended by members of Carleton University, including READ, the School of Industrial Design as well as Institute of African Studies. Kadupedi held another presentation for members of IDRC including Senior Program Specialist Mr. Luc Mugeot. This event was attended by all of the Canadian collaborators including students.

Non-Funded Project Extension Year Two

Whereas the first year was seen as a tremendous success in terms of output and accomplishments, there were clearly new opportunities that had been identified and some objectives that had taken longer to initiate. Firstly it was clear that economic empowerment for PWD's was the larger and more pressing issue in the local context of Kasese. At the same time it was clear that Kadupedi and end users were extremely excited about the mobility devices affording some kind of business platform. The rollator for example could be more than a rollator, it could help one of the recipients offer her skills as a hair dresser beyond the confines of her home and also allowed her to carry the tools of her trade with her, if properly designed. Similarly the hand operated tricycle offered the possibility to charge mobile telephones or perform agricultural output. At the same time it would be important to then also investigate the economic viability of these new ideas. This thus resulted in a Master student being brought into the project, who would focus her interdisciplinary design thesis on investigating the economic potential and feasibility of such devices over a one year period with recipients. This also required the production of multiple solar charging stations, which were produced by Kio in Kasese. At this point the knowledge transfer on how to build such a kiosk had been accomplished, so that he could do this by himself when issued an order.

One objective had been to involve Ugandan universities more directly in the project. As a longer term strategy it was theorized that they would eventually be able to take over the project and operate it locally in Uganda. During the first year of the project, the relationship between the various institutions was still evolving. It was also important to be able to demonstrate the Canadian involvement and commitment by sharing successful outputs with the Ugandan institutions. In the second year Makerere was able to offer their involvement by inviting Ugandan students to partake as part of their fourth year final capstone project. Makerere chose one student for this pilot study. In addition a new cohort of students at Carleton continued the project. This was also essential in order to make the project continue as a student and faculty exchange between Makerere and Carleton University.

Many of the activities of the first year were in principle repeated in the second year including the field trip to Uganda. The field trip was however significantly more focused and preceded by collaborative research input from Kadupedi. They were for example asked to do some observational research, as well as help develop a selection process for recipients of the solar charging stations. This was

complemented by questionnaires designed by the graduate student. During this time the project was also greatly aided by professor Blair Rutherford at the Institute of African studies who acted as a co-supervisor for the master student.

Prototyping

A special note should be made on the prototyping activities that were integral to the methodology and success of the project. These were built both in Uganda and Canada. Prototyping costs in Uganda were lower than expected when executed in Kasese. It became clear that Kio had difficulty in estimating the cost for prototyping as he is not used to charging for his time, but rather for the work. Similarly the prototyping costs at Carleton University were kept artificially low due to the in kind assistance given by the technicians and the fact that the shops are available to the students free of charge. The student at Makerere had higher prototyping costs because he lacked such access and was relying on more expensive skilled labour that he had to pay for. The designs and prototyping output are shown and discussed in more detail in the next section of this report.

VI. Project Outputs

Academic Conference and Journal Papers

1. Cox, A. Hallgrimsson, B. "Co-Designing in Rural Uganda: Mobility Aids and Income-Generating Devices for People with Disabilities": Design with the other 90%: Changing the World by Design, 2014, Johannesburg, South Africa
2. Hallgrimsson, B. Liu, C. Hadley, R "Design for Extreme Poverty and Disability: A Social Innovation Project Case Study in Rural Uganda": *IDSA National Conference, 2013,Chicago, Ill, USA*
   http://www.idsa.org/sites/default/files/Hallgrimsson-Paper_Design_for_Extreme_Poverty_and_Disability.pdf

Academic Presentations

1. Project presentation to Institute of African Studies at Carleton University "brown bag seminar series" , Fall Semester 2013
2. 35th Annual Industrial Design Exhibition at Carleton University
   http://id.carleton.ca/exhibition2013/groups/

3. 36th Annual Industrial Design Exhibition at Carleton University
   http://id.carleton.ca/exhibition2014/groups/
4. 43rd Annual Conference of the Canadian Association of African Studies Roundtable with Baluku Peter and Mbwambale Robert from Kadupedi and CanUgan representative as well as READ representative and School of Industrial Design representative
5. International Summit on Accessibility, Ottawa, Ontario, June 2014
6. TSES Lecture by Noel Wilson from Catapult Design, November 2012
7. Presentation at 1125@Carleton, April 14, 2014
8. Exhibit of prototypes at Accessibility Summit 2014

Awards

1. Idea Student Award 2013, 2nd Place
2. Connect Enable Change Student Competition 2013, 3rd Place
3. Connect Enable Change Student Competition 2014 , Honourable Mention
   http://www.dx.org/index.cfm?pagepath=Education/CONNECT__EnAbling_Change_Design_Competition/Past_Winners&id=58554

Newspaper articles

1. http://metronews.ca/news/ottawa/1003456/carleton-students-fine-tune-tricycle-wheelchairs-for-ugandans-with-disabilities/
2. http://carletonnow.carleton.ca/may-2013/designing-on-the-ground-for-ugandans-with-disabilities/
3. http://carletonnow.carleton.ca/february-2014/carleton-students-making-a-difference-in-uganda/

Masters Thesis

1. Cox, A. “Products for People with Disabilities in the Majority World: Understanding the Complexities of Co-Designing Devices for Income-Generation in Rural Uganda.” MDes Thesis, Carleton University, April 2014

Workshops and Meetings

1. Carleton Mini Conference with representatives from Whirlwind Wheelchair International and Catapult Design as well as Skype to Kadupedi, November 2013
2. Trip to Uganda in February 2013
    - Visit to Kyambogo University
    - Visit to Makerere University
    - Visit to Kasese
    - Kadupedi meetings
    - Hands on prototyping workshops with manufacturer
3. CanUgan Brunch, April 7, 2013
4. Trip to Canada in May 2013
    - Presentation by Kadupedi to IDRC representatives at School of Industrial Design
5. Trip to Uganda 2014
    - Presentation to Faculty of CEDAT at Makerere University
    - Meeting with Dean of Disability Studies at Kyambogo University
    - Kasese workshop meeting with Makerere University professors and local stakeholders including civic officials
    - Hands on prototyping workshops with manufacturer
2. CanUgan Brunch, June 8th, 2014

Student Blogs

1. http://www.designwiththemajority.com
2. http://harambee-uganda.blogspot.ca

Student Course Reports and Working Prototypes

1. Wongkee, A. "Tricycle Frame", IDES 4310 Final Project Design Report, Carleton University, April 2013

Figure 13. Redesigned Bicycle Frame (Alyssa Wongkee)

This initial project focused on making incremental improvements to the existing tricycle. As a result the frame is now lighter yet stronger and all the frames are now built in this manner. The project is described in detail in her full report.

2. Theobald, A "Platform for Empowerment", IDES 4310 Final Project Design Report, Carleton University, April 2013

Figure 14. Solar Charging Kiosk for Hand Operated Tricycle (Andrew Theobald)

This is a design for a solar charging kiosk for the tricycle. This design utilized locally available materials and technologies to produce a solution that would be able to be

built locally. This system is very useful because even though most people have cell phones they often do not have electricity or a solar panel to charge their phones.

3. Liu, C. "Adaptive Tools, Human Powered Systems", IDES 4310 Final Project Design Report, Carleton University, April 2013

Figure 15. Adaptive Tools for Hand Operated Tricycle (Carmen Liu)

Ground peanuts form an important part of the daily diet in Kasese. This project took the form of a peanut grinder that transforms hand pedal power into a mobile grinding service to families living in the rural areas. This project received great interest as it provided an opportunity to be able to contribute to the family and community and be a provider.

4. Hadley, R. "Extended Mobility", IDES 4310 Final Project Design Report, Carleton University, April 2013

Figure 16. Rolling Walker for Kasese (Ruby Hadley)

The typical North American rollator would not withstand the local terrain and this simple rollator is strong and sturdy and can be assembled from locally available materials.

5. Williams, C. "African Peanut Sheller", IDES 4310 Final Project Design Report, Carleton University, April 2014

Figure 17. Final Model of Peanut Sheller with Plexiglass front to show operation

A hand operated peanut sheller. Some of the innovations include the fact that it is small and mobile but has a high throughput. The absence of metallic parts in the crusher also ensure that no metallic debris is present (a common problem with local agriculture machinery). Also the gentle nature of the crushing means that most of the peanuts come out whole, which is essential for being able to use the shelled peanuts as seedlings for new plants.

6. Garcia, L. "Designing for those with Disabilities in Rural Communities", IDES 4310 Final Project Design Report, Carleton University, April 2014

Figure 18. Rolling Gardening Chair for PWDs (Luis Garcia)

The notion of kitchen gardens was explored in this hand operated rolling gardening chair with seat and basket. Whereas many iterative prototypes were produced both in Uganda and Canada, this product has mechanical complexities that would benefit from further ergonomic and mechanical design development and cost analysis.

7. Vandermeer, J. "A Convertible Wheelchair for People with Disabilities in Rural Uganda", IDES 4310 Final Project Design Report, Carleton University, April 2014

Figure 19. Two in One Convertible Wheelchair Tricycle (Jennifer Vandermeer)

Children in particular require two types of mobility devices in order to go to school. The tricycle offers a good solution for travelling between the home and the school. But is not manoeuvrable in the classroom environment.

8. Krug, Z. "A Carrier for Goods and Children, so Mothers can Earn an Income while Caring for their Kids", IDES 4310 Final Project Design Report, Carleton University, April 2014

Figure 20. Tricycle Baby Carrier (Zoe Krug)

This project started as an examination of how to help women in particular to make an income from being able to transport goods on the tricycle. During the participatory design prototyping process in Uganda, local women made the student understand how many of them also needed to carry small children and babies with them to the market. The tricycle carrier was thus updated to include a childrens baby carrier.

9. Magoola, P. "Groundnut grinding mechanism for tricycle"

Figure 21. Re-engineered Local Made Peanut Grinder Mechanism (Perez Magoola)

This student project was the one project that was done in direct collaboration with Makerere University. It should be noted that the student focus here was not on envisioning a new idea or solution. The problem that was undertaken was instead an engineering implementation project. The project built on Carmen Liu's project from the previous year, but with the objective of redesigning the grinder mechanism so that the entire machine could be built with local methods in Uganda. Whereas the student has forwarded photos to the team, the final prototype has not yet been viewed or tested in the field in Kasese. The team has also requested a final report from the student.

VII. Project Outcomes

Project outcomes have varied over a wide range of behaviors, attitudes, practices, capacities, relationships and technologies. Project's specific contributions:

Scientific, research or knowledge innovation:

During the course of the two-year project it became apparent that the focus would not strictly be on providing new technical solutions, but to envision innovative possibilities for income generation and thus economic empowerment and a

reduction in stigmatization of PWDs. The research thus expanded to look at the income generating potential of a series of innovative devices produced in a local setting, partly envisioned by the end users through their participation. This has increased the knowledge and capacity of the research institution as well as the NGO and international members of the design and development community through numerous levels of dissemination including papers and conference presentations at different types of conferences and communities both in Canada, United States, Uganda and South Africa. The findings furthermore will contribute towards the body of knowledge in these fields by being available through open source publication. This is of course important for some of the majority world researchers who may not have the library support to obtain expensive journal articles.

Changes in behaviour, capacities, actions and relationships of researchers:

Eight undergraduate students were involved in designing assistive devices and developing prototypes. Over the course of the project, noticeable changes occurred in the students' behaviors, capacities, actions and relationships. Exposed to working with rudimentary tools and equipment in a roadside workshop, the students recognized the value of adapting skills to the working environment. While working in concert with end-users and local manufacturers in Kasese, the students learned the importance and impact of participatory design processes. Furthermore, the students learned the value of feedback from representatives of DPOs in Kasese, and, they modified their designs based on the feedback. Thus, the students developed empathetic behaviour, their capacities to design enhanced, their actions were collaborative rather than individualistic and they formed relationships of mutual respect with end-users and local manufacturers.

The graduate student learned important field research skills and provided qualitative insights about the project, the devices and most importantly the end users (or recipients). Her thesis is a useful document for both the team of researchers, the NGO as well as future generation of students and organizations wishing to do this type of work. It is noteworthy that her experience has also subsequently brought her to Ghana to work with Engineers Without Borders.

Changes in behaviour, capacities, actions and relationships of research users or those affected by the research process or findings:

The first and immediate user of research was Kio, the lead tricycle-maker. The project provided him with a unique opportunity to learn from Canadian researchers as he engaged with the students and their advisors throughout the two phases of the project. As the project progressed, his behaviour was positive and he accepted the students' designs. There were noticeable changes in his capacities and actions resulting from his interactions with the students and their advisors, which provided him with different and better ways to build and improve the devices. At the same time, he also suggested improvements in the designs produced by the students. This mutual sharing and learning led to a healthy and respectful relationship between him and the researchers. While the project has ended, he is looking forward to another opportunity to learn from and share with Canadians.

Other users of the research were the end-users of assistive devices. Like Kio, this was for the first time that these people were interacting with Canadian students and their advisors about assistive devices that would provide them independence, mobility and income-generating opportunities. So, they were keenly interested in and positive about participating in the process of development. They willingly arrived at Kio's workshop often spending enormous length of time commuting either because they had to depend on others for transportation or because they had to wait for private transport. A motivating factor was the opportunity for them to participate in the process. A few of them had interacted with visitors and volunteers from North America and Europe in the past, but, they had never been asked their views in the design of devices that would impact their lives profoundly. For them, this kind of approach reflected Canadians' respect for their views and experiences. As a result, they hold Canada in great respect and they long for continuing the cooperative and fruitful relationship between Uganda and Canada. This view was reflected time and again by representatives of DPOs and others who attended the workshop held in Kasese on February 14, 2014, referred to above.

Baluku Peter is KADUPEDI's Coordinator and the leader of CanUgan's local team. Bwambale Robert is CanUgan's treasurer. These two individuals provided the main conduit for communication and logistics right from the start of the project for two years from mid-2012 to mid-2014. In these roles, they were deeply involved in sharing their knowledge and perspectives as well as in communicating potential issues with the Canadian team. With their intimate knowledge of the needs of PWDs, they were of immense assistance to the team during visits to Kasese in 2013 and 2014. Having worked very closely with the Canadian team, their respect for Canada and relationship with Canadians has grown significantly. Both of them also travelled to Canada where they participated in the CAAS conference in May 2013.

The CanUgan Disability Support organization has been a keen supporter of this research, realizing that the in depth work done could help them. CanUgan has played a pivotal in this collaborative project by opening up its communication links with KADUPEDI, Kio, the tricycle-maker, and other stakeholders in Uganda including Makerere and Kyambogo Universities. In the context of CanUgan's mission to support PWDs with assistive devices, the project has had significant impact on CanUgan. It has opened up a number of exciting opportunities for CanUgan to support PWDs and this is changing its capacities and actions. For example, while economic empowerment of PWDs has been one of CanUgan's objectives from the very beginning, now with design of devices like the solar panel mounted tricycle, the peanut sheller, the rollator and peanut grinder, CanUgan now has a new vision of what this could mean in terms of locally made devices for PWDs looking for income-generating activities. Thus, the project has enhanced CanUgan's capacity and modified its actions to support PWDs. The project has also resulted in building a mutually respectful relationship between CanUgan and Carleton's SID and READ Initiative.

Policy Influence (e.g. expanded policy capacities of researchers; broadening policy horizons of policy makers; and affecting policy regimes)

The project has provided a clear case study that can be further examined in terms of collaboration outcomes between institutions of higher learning and not-for-profit NGOs working in the majority world. Such case studies are being generated internationally also by other organizations and universities and at the Cumulus design Conference in Johannesburg (Sep 22-25, 2014), the project was disseminated and discussed with the larger community of social innovative designers present at the conference. It also forms part of the growing body of knowledge in social innovative design that is showing evidence of influencing policy at various levels. Firstly the growing of the importance of design is being recognized in majority world countries and this is evident in the move from more traditional craft based design programs towards more professional design focuses particularly in Africa. There is also an opportunity to discuss the importance of the project at an upcoming design conference in July 2015 in Kampala at College of Engineering and Design and Art (CEDAT) at Makerere University. Positive and effective projects of this nature provide tangible evidence towards influencing policy and also in regards to realizing it's relevance within societies. The project has also provided a practical demonstration of the value and impact of exposing young Canadians to the realities of extreme poverty in a majority world country and helps make them better global citizens. Finally, the project underscores the importance of capacity building at the local level by involving local artisans and end-users in designing prototypes. In terms of broadening networks it has expanded the role of Carleton University in this important arena and made important connections between Canada and Uganda.

Technology development, adoption and adaptation

The project provided an excellent opportunity for a Ugandan artisan manufacturer (Kio) to broaden his capabilities. A simple but effective pipe bender is now being utilized instead of more rudimentary joining techniques. In terms of innovation, we have also seen the manufacturer have the courage to propose and develop his own ideas for products such as a mobile popcorn machine utilizing charcoal that he could sell to people. Working with the Canadian researchers has also in effect given Kio access to tools such as Computer Aided Design to formulate a sturdier and more secure tricycle design as well producing ancillary devices. At the same time, Canadian researchers learned that there are design limitations imposed by of a lack of appropriate tools and materials as well as skills-sets of local artisans. One of the designs (the two in one tricycle wheelchair) was for example pushed beyond the limits of local production and whereas it is a desired product from the end users perspective, more work needs to be done to understand how this product can be produced locally. The design itself was resolved at Carleton, but using better tools than are available to Kio.

Changes in the state of economic, social, health, political or enviromental conditions:

This project works towards short term as well as long-term goals. The short term goals have proven to be effective in that new devices and innovative solutions can

be co-designed with people in the community and also produced locally in the community utilizing local ingenuity and capabilities. In terms of longer term systemic outcomes, these can not be evaluated either by this project alone or in isolation. Design as an inherent tool for development is still under development as evidenced in the 2014 Cumulus Design With the Other 90% Conference in Johannesburg. That being said it holds a lot of promise and evidence to affect outcomes by the virtue of the participatory design practices that allow for local involvement and capacity building, especially as it applies to people (non-designers) recognizing their own potential. There is evidence for example that we have affected the notion of the stigma of PWDs being non-providers in some of the recipients who can see that in fact they can be providers. The research done by the graduate student did reveal certain important benefits for the end users of the solar charging tricycle kiosks. These included pride and accomplishment and meticulous bookkeeping. In addition the solar charging units were used to provide lighting indoors allowing students to read at night and also reducing the cost for kerosene and improving indoor safety.

What was learned about approaches or broad design elements for conducting research, building capacity or influencing policy or practice in the field and circumstances of the project?

First and foremost, the project drove home the importance of effective communication between Canadian researchers and users of research in Uganda. In addition to exchange of information, effective communication also plays a vital role in establishing mutual rapport and confidence. Because of the vast distance that separated the researchers from research users in Uganda, the need and importance of information communication technology (ICT) was also highlighted. Regarding capacity building, the project provided a number of valuable lessons:

1. Capacity cannot be built unless due account is taken of the local facilities, equipment and working environment and cultural milieu.
2. Mutual skills sets and experiences must be acknowledged for successful capacity building.
3. End-users must participate in the process.
4. Feedback and suggestions of local DPOs must be invited and taken into account.
5. Willingness to redesign and alter a previously conceived design is critical for success.

There were a few recommendations the authors would suggest for policy and practice in the field:

1. Policies and practices of institutions of higher learning, Canadian NGOs and partners in developing countries should be based on application of research in the field.
2. All parties involved in the project must be prepared to re-examine approaches, if usage of devices reveal obvious shortcomings, e.g. the peanut grinder designed in 2013 showed a number of difficulties in practice and the device had to be revisited by a Makerere University. This also points to the importance of having a local manufacturer be involved in the long term application of the project. Most for profit manufacturers, have competitors and have to incorporate improvements as part of their normal QA process. Why would these products differ in that regard?
3. Policies and practices must be continuously monitored and updated as necessary.

What contributed to these outcomes and what lessons did you draw from the experience?

A number of factors contributed to the outcomes described above:

1. There was a clear understanding and acceptance of mutual roles and responsibilities of the three collaborating partners, i.e. SID, READ Initiative and CanUgan. This was the foundation on which the rest of the project rested and it paved the way for successful implementation of the project as it proceeded from one phase to another over the period of two years.
2. The acceptance of and involvement in the project by CanUgan's Ugandan partner, KADUPEDI, represented throughout the project by two key members of CanUgan's local team, Baluku Peter and Bwambale Robert, ensured full cooperation and participation well before, during and after each of the two visits of the student researchers and their faculty advisors. It also ensured smooth interactions with the tricycle makers and helped enlist end-users.
3. Open and full acceptance of the students' designs by Kio, the lead tricycle-maker, made it easier for the students to present their prototypes, discuss the issues and where necessary, modify their designs.

4. The implementation of the project based on the notion of co-development, which provided end-users with rare opportunities to provide their input and share their experiences with the students. This approach also acknowledged acceptance of the value of their views in the design of devices. This was important for their self-esteem.
5. Students worked under tight deadlines to complete their designs and prototypes. This required a team of passionate and caring individuals who would take on additional challenges posed by the project circumstances. Students have to have very open minds in order to accept end users participating in the design process and be empathetic to their needs.
6. The leadership and guidance provided by faculty at Carleton as well as Makerere is critical to enabling projects with this type of complex scope. The leadership also played a critical role during visits to Uganda in interacting with tricycle-makers and end-users as well as other stakeholders.
7. Facilitation of communication and logistical arrangements provided by CanUgan, resulted in establishing rapport between Canadian team members with Ugandan stakeholders including local DPOs and Makerere and Kyambogo universities. This also ensured trouble-free visits to Kasese by the Canadian team.
8. Involvement of a wide array of stakeholders in Canada and Uganda which ensured a greater level of interest and input in the project.

VIII. Overall Assessment and Recommendations

Based on feedback from all organizations involved, it is clear that everyone involved thinks this project is very successful. A very substantial amount of output has been generated through the research project and capacity has been increased substantially at many levels.

This project and report and the numerous other disseminations form part of a growing and important body of knowledge in the area of *Design with the Other 90%*, an often overlooked problem in the design field that is increasingly gaining important attention by universities and NGO's alike.

Important presentations, workshops and meetings were made possible through the support of IDRC. Partnerships and collaborations have grown and expanded as a result of this funding. Internally it has lead to important connections within the university community between students and faculty in different departments, most notably between the School of Industrial Design and The Institute of African Studies and the READ initiate. Additionally it has raised the profile of the university where it comes to this type of international community based work, which has been acknowledged through requests from the university to display the project outputs at several venues including 1125@carleton, the universities new living lab. There have also been additional new collaborations and an increased interest from other departments. Externally it has grown the relationship between CanUgan and Carleton University and has exposed the important role that Carleton University fulfills in the community. Beyond Ottawa it has led to new connections between Carleton University and organizations specializing in design for low-income communities, especially as it pertains to design for people with disabilities. Additionally it has established a working relationship between Carleton University researchers and Makerere University researchers. A recent Conference in Johannesburg, South Africa has lead to new introductions and possibilities for more collaboration in Africa.

The project has also provided a practical demonstration of the value and impact of exposing young Canadians to the realities of extreme poverty in a majority world country and helps make them better global citizens. Additionally the project underscores the importance of capacity building at the local level by involving local artisans and end-users in designing prototypes. In terms of broadening networks it has expanded the role of Carleton University in this important arena and made important connections between Canada and Uganda. In addition, the project has provided a practical demonstration of how CanUgan, a small NGO, can pursue its objectives more effectively by collaborating with other institutions, which have greater expertise and resources. The same is true of CanUgan's partner Kadupedi. Equally important, the project has provided important lessons to Kio, the lead tricycle-maker about making more durable and useful devices.

There are some noteworthy reflections that raise additional questions and that hopefully will lead to more research. The first issue pertains to the long-term sustainability of the project. This is a general issue when it comes to examining the

efficacy of development projects. The plan as envisioned by this team would be to gradually increase and transfer the project to Uganda. This has been successful to some degree in that we have shown that the NGO, local manufacturer and Kadupedi now have new products that can benefit the local community. In terms of transferring the research to Makerere University this still requires some additional research support. Not for profit research is seen by this team as critical to social innovation, but continues to present a challenge. We are in consultations with Carleton University Research Office that continues to explore the possibilities.

There is a very generous and open interest that has been shown by Makerere University researchers, who are willing to assist students with such projects, but to date only one student has participated. This is due to a few factors. For one it takes time to develop a relationship, but given the success of this project several students have expressed an interest and thus more Ugandan students are likely to take part. We did however learn that those students who would take part face the additional financial burden of having to build and test prototypes. What made this worse and more difficult for our student in Uganda was the time and difficulty that he experienced in getting refunded. This also was a problem for Kio the manufacturer in Kasese. Given their financial position, it was very hard to afford to buy materials while they wait for over a month to get reimbursed. The rules required them to send original receipts to Ottawa. This was a difficult proposition given the exceedingly slow mail system from Uganda. The payment when approved then had to be wire transferred to the recipient's bank in Uganda, which added weeks again. We would encourage IDRC to consider new and more expeditious terms of reimbursement, given the many innovations that have happened in banking that need to be explored so that these unnecessary hardships are avoided in the future.

We have also experienced that the local manufacturer has issues with repeatability, quality control and tolerances. This has an effect on what products can and should be produced locally. One of the last projects is the two in one tricycle wheelchair. The mechanical complexity of the joint proved to be a challenge for local manufacturing and illustrates that at some point specialized machinery and parts are required. A successful well working mechanism has been prototyped in the school of industrial design laboratories upon return to Canada, but this design implementation has not been transferred to Uganda at this point. This could be a very important contribution if the design can be made. It will however require additional resources and efforts that go beyond the current scope of the project. At the same time it raises the question if this product or parts of it should perhaps be produced elsewhere followed by final assembly in Uganda.

Our final conclusion is that we will continue working together and pursuing new questions, opportunities and challenges. This may include new designs or betterment of the ones envisioned. It should also involve a growing involvement by universities in Uganda. At the moment we are thus pursuing funding opportunities to enable these to flourish.