

# Portable pit latrine seats to increase sanitation for disabled individuals in Lira, Uganda

Mei-Li Hey<sup>1</sup>, Harrison

Schmachtenberger<sup>1</sup> and Mikaya LD

Lumori<sup>2</sup>

1. University of San Diego, Department of Mechanical Engineering, Shiley Marcos School of Engineering, San Diego, USA
2. University of San Diego, Department of Electrical Engineering, Shiley Marcos School of Engineering, San Diego, USA

Correspondence:

Mikaya LD Lumori

[mlumori@sandiego.edu](mailto:mlumori@sandiego.edu)

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## ABSTRACT

This paper presents a viable solution that evolved over several years of research to mitigate the sanitation problems faced by individuals in rural areas of Uganda, particularly those with disabilities, addressed in our first paper (Schmachtenberger et al.). The solution is based on interviews and contacts with affected individuals in Lira, Northern Uganda, where the most commonly used sanitation facility is a pit latrine. To that end three types of design considerations and requirements for effective pit latrine assistive devices were adopted in the development of the technology discussed in this paper. Ultimately, three different designs were fabricated after synthesizing the requirements, preliminary user feedback, and engineering knowledge of mechanical design. The deliverables from these designs are three different assistive devices whose common feature is a portable seat that can be used safely in a pit latrine. The good results from several field tests engendered the development of more locally reproducible and cost-effective, assistive seat devices over a period of 3-5 years. Results from data collected over the years will be published in another manuscript, subsequently.

**Keywords:** sanitation, latrine, Uganda, disabled, technology

## INTRODUCTION

In 2014 a landmine victim from Lira, Northern Uganda, spent several months as a visiting scholar at the Institute of Peace and Justice (IPJ), University of San Diego (USD). She had struggled for years to find viable, safe sanitary assistive devices for her own personal use and for other disabled Ugandans whom she visited regularly in rural areas of Lira. She shared and discussed her problems in a conversation with USD members which led to the involvement of USD engineering students and professors to embark on solving her daunting problem.<sup>[1]</sup> Consequently, three different teams of students and professors made trips during the academic years 2016/2017, 2017/2018 and 2018/2019 to carry out interviews and field studies, and to collect data and pertinent, local information on the requirements and designs that were acceptable to the disabled individuals. The authors of this article all participated in the three field trips to Uganda.

The trips revealed many sanitation shortcomings. For an example, the main type of facility being implemented to improve sanitation in Lira and other rural parts of Uganda is a pit latrine. Moreover, there is no widely implemented device, facility, or other solution to enable those with disabilities to use the available pit latrines independently.<sup>[2,3]</sup> To solve this problem, we applied research to design three different variations and iterations of a pit latrine assistive device. User feedback was documented during each in-field research trip and then reviewed while designing the next set of prototypes. This resulted in three assistive devices, discussed below.

## METHODS USED IN THE DESIGN OF PIT LATRINE ASSISTIVE DEVICES

The methods used to collect data on design requirements for the assistive devices

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comprised recorded interviews, including conversations with disabled individuals. The interviews were conducted by our Ugandan partner, translating our questions to the local language, Luo, and keeping detailed notes. Thus, a local person conducting the interviews ensured genuine responses. Approximately 20 interviews were conducted at the Lira District Union for Disabled Individuals and through members of the Uganda Landmine Survivors' association. Photos documenting the users of the device and the pit latrines that we studied are also stored and referenced. Besides, we had fabrication manuals of the specific device designs that were presented to the beneficiaries, including notes of the local tools and materials. Subsequent papers will discuss user feedback on each device presented in this paper after a minimum of 30 days with the device.

### Requirements

One main design constraint is that the device must be portable. Since no one owns the latrines, it is often unclear whose responsibility it is to maintain the cleanliness of the pit latrines. The portability of the device encourages ownership and maintenance on the device itself. The portability of a personalized device is also important to avoid the negative social stigmas of sharing a toilet seat with others.

The social acceptability of the devices is a key design characteristic. If the device is not socially acceptable, then it will not be implemented by its users and the problem will persist. To satisfy this design requirement, it is pertinent that the development of the device involves the users directly to determine what is going to be socially accepted.

The solution needs to be accessible by deprived groups, so it must satisfy the requirement of being low-cost. For the purposes of designing early prototype devices, based on the average household earning in Uganda, the simplest version of a pit latrine assistive device should cost no more than \$12 USD.<sup>[4]</sup> Studies have shown that pricing aid technology and constructive services, even among low-income groups, shows a positive response in adoption because it associates value with the good or service.<sup>[5]</sup>

Also, to increase acceptability, sense of ownership, and accessibility, the design must be manufactured from locally available tools and materials. During our in-field research trips, data were gathered about what materials could be found in Kampala and what materials could be found in Lira. All three designs used readily available materials, consistent with the data from these studies.

### Engineering methodology

Stress analysis on a theoretical level was conducted for each design using basic principles of material mechanics

and mechanical design engineering. A distributed load approximation on the seat of each device was utilized to estimate the stress on the material and the margins of safety in the designs. Stresses and bending moments were calculated to ensure that the right materials and material thicknesses were used in the design, and longevity of the material based on these loads was also calculated. Lessons learned from previous prototyping and material selection also helped in the engineering design process.

### RESULTS

Figure 1 shows a simple, portable tripod toilet stool that can be made with hand tools for approximately \$8 USD. The design utilizes 0.75-inch-thick plywood seat and legs fabricated from two-by-fours (2-inch x 4-inch) lumber. Both materials are readily available in Lira. Devices are painted with a latex paint that fills porous woods and enables the device to be easily cleaned.

Figure 2 is a foldable latrine assistive device that costs approximately \$13 USD to fabricate in Uganda. The hand rails provide support while the user is getting onto the seat, and there are several contact points with the ground to make the device feel more stable. The design of this device requires use of plywood that is 9 cm thick and a total of 12 hinges, and it also uses a wood paint that ensures ease of maintenance. All of the material can be found in a local carpentry shop in any rural parts of Uganda.



Figure 1. Tripod Stool (Credit to: L. Utrecht and M. Hey)

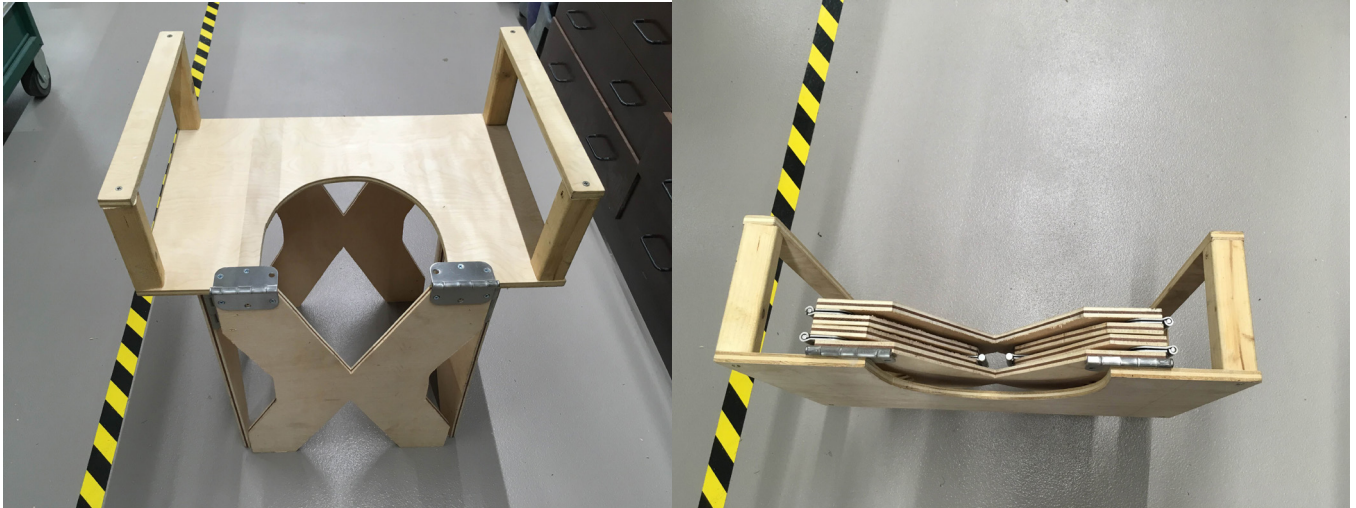


Figure 2. Portable Assistive Device (Credit: C. Avery and M. Hey)

Figure 3 shows a pit latrine assistive device that also serves as a dual-purpose mobility device. This is the design created by the 2017-2018 USD research team to meet all requirements and needs outlined by users. The device can be constructed for less than \$30 USD in Uganda, which is far cheaper than anything currently available. One disabled lady who has a business found this device ideal for carrying fabric and ornaments to sell, draped on the frame of the seat. She was able to test it successfully, walking without use of her prosthesis.

Figure 4 depicts three USD students instructing two disabled local students on how to construct a seat, with a fourth local student sitting on a newly constructed seat to test its robustness.

Figure 5 depicts USD team of students and a professor with four Ave Maria students and our Uganda contact.

## DISCUSSION

The design of each device was based on feedback from users and manufacturers on previous research trips. The preference on which device would best serve a user depended on the user's particular disability. Each device was designed to serve a portion of the disabled population and has features that cater to this portion. For example, the Tripod design was most favoured by individuals who used crutches, because they are able to hang the device off of their crutch and easily carry it to the latrine. Many of the individuals who used crutches had the strength and mobility to be able to squat low and then fold the device back up to carry home. The manufacturability of the tripod is easy, according to local carpenters.

The box seat in figure 2 was mainly designed for low-strength individuals who need the support of hand rails to lift themselves. This device received positive feedback unanimously from all users during in-field testing, and



Figure 3. Mobile PVC Walker (Credit: K. Forsythe, M. Kliegel, D. Giles and T. Bongiovanni)

many users expressed that it felt the most stable. Also, the shape of the device hides its intended use, so the social acceptability of this device was highest as well. Several of these devices have been constructed in Uganda by carpenters and carpentry students, who all confirm that the design is easy to manufacture.

During the device introduction trip, Ugandans expressed the problem of mobility assistive devices costing around \$300 USD, an amount that is unattainable for most Ugandan citizens. Surprisingly, they also revealed that it is cheaper to hire another person to carry the disabled individual from place to place, rather than purchase an assistive device. For those who also need mobility

assistance to the pit latrines, the walker in Figure 3 was the most preferred device, as it serves a dual purpose for the user to be able to get to the latrine in the first place. This device is the most complicated and expensive to manufacture.

### CONCLUSION

It was clear from the feedback on the assistive devices that the foldable box (Figure 2) is the most widely accepted design, as it balances cost, portability, and manufacturability. Further, the foldable box was the most popular amongst children, and unanimously deemed the most appropriate for solving sanitation issues related to child illness.<sup>[6]</sup> On the other hand, the PVC Walker device (Figure 3) was the preferred design of the people who tested the devices, as it also serves as a mobility device. Although the PVC Walker is more time consuming and expensive to produce, manufacturers still believe that they would be able to make a profit on these devices. Both the foldable box and PVC Walker designs were regarded as easily manufacturable by Ugandans due to the simplicity of their component materials, a characteristic which eliminated other designs.

All designs incorporated a paint sealant that the manufacturers recommended in order to maintain cleanliness and enable the seats to repel liquid. The ease of maintaining the devices and their perceived cleanliness will be further evaluated once the devices are distributed to users and surveys are collected after a 30-day period of use. These results will be discussed further in a subsequent paper.

As far as future work is concerned, further technological improvements and the promotion of research and development of affordable sanitation technologies is key in achieving improved sanitation.<sup>[7]</sup> Therefore, our future work will include multiple distribution cycles of the fabricated pit latrine assistive devices presented in this paper. Surveys will be collected to gather data on the usability of the devices, along with feedback on any improvements that can be made. Future work also includes data collection on how current sanitation solutions affect the general population, compared with disabled individuals in particular.

**Conflicts of Interest:** None

#### References

1. Orech MA. Conversation with Woman Peacemaker Margaret Arach Orech of Uganda. University of San Diego, 4 Nov. 2014.



Figure 4. USD Students team and students with disabilities from Ave Maria Fabricating Devices



Figure 5. USD team with students with disabilities from Ave Maria and Margaret Orech

2. Schmachtenberger H, Avery C, Hey ML. Design and introduction of pit-latrines assistive devices in Lira, Uganda. Global Humanitarian Technology Conference (GHTC), 2016 (pp. 770-775). IEEE.
3. Schmachtenberger H, Hey M-L, Lumori MLD.. Sanitation resources for disabled individuals in Uganda. South Sudan Medical Journal 2022; 15(1):16-19
4. Uganda Bureau of Statistics (UBOS). 2014. Uganda National Household Survey 2012/2013. Kampala.
5. Stanfield J. Self Help and Sustainability in Education in Developing Countries. SSRN Electronic Journal 2010; <https://doi.org/10.2139/ssrn.1734292>
6. UNICEF. Situation Analysis of Children in Uganda. 2015 Retrieved July 20, 2018. [https://www.unicef.org/uganda/WASH\\_print\(1\).pdf](https://www.unicef.org/uganda/WASH_print(1).pdf)
7. National Sanitation Task Force. The National Sanitation Policy for Uganda. August 1997. Retrieved June 28, 2018. <https://www.ircwash.org/sites/default/files/824-UG-14076.pdf>