Using Appropriate Technology Principles in the Design of a Remediation Device for the Removal of Bacteria and Toxic Metals for Use in Rural Uganda

Presented by: Ava Bellizzi

Authors: Ava Bellizzi & Christina Kozlovsky
Faculty Advisor: Frank Jacobitz, PhD
Introduction

- **2.2 billion people** worldwide lack access to “safely managed” drinking water (World Health Organization, 2019).

- Only **7%** of the population of Uganda utilized **safely managed drinking water services** as of 2017 (UNICEF, 2019).

- **80%** of the population of Uganda lives in rural areas (Nayebare et al., 2014).
  - Poorest water quality due to reliance on groundwater and surface water sources (Nayebare et al., 2014).
What is Appropriate Technology?

A “strategy” for the developing world to achieve socioeconomic growth by “meeting their basic needs” through “developing their own skills” and utilizing “available resources in an environmentally sustainable manner” (Murphy et al., 2009).

“Technology with a human face, which, instead of making human hands and brains redundant, helps them to become far more productive than they ever had before” (Schumacher, 1973, p. 112)
Technical Project Overview

1. Collect water from local source
2. Bind and remove toxic metals using a banana peel and activated carbon tea bag
3. Trap and eliminate bacteria using eucalyptus tree xylem
4. Obtain safe drinking water
Methods

- Assessment of the following appropriate technology considerations as they relate to the engineering design process (Sianipar et al., 2013a):
  - Technical
  - Economic
  - Environmental
  - Socio-Cultural

- Evaluation of the extent to which the device encourages:
  - Sustainable development
  - “Community empowerment” (Sianipar et al., 2013b)
Results: Technical

- **Banana-activated carbon tea bag** capable of reducing concentration of manganese* (M. Klein, personal communication, September 23, 2019).

- **Eucalyptus xylem** is capable of removing all fecal coliforms
  - Confirmed through testing conducted in Uganda** (C. Kozlovsky, personal communication, January 29, 2020).
  - Uganda results validated through testing conducted through partnership with Azrieli College of Engineering Jerusalem*** (A. Shasha, personal communication, March 11, 2020).

- System can be used and maintained at household level

* Testing conducted by Molly Klein (Biochemistry)
** Testing conducted by Christina Kozlovsky (Mechanical Engineering)
*** Testing conducted by Ariel Shasha and Liron Kanisberg (Mechanical Engineering)
Results: Economic

- Goal for final design: $1.50/month per family
- Cost of prototype: $27 total
  - Durable and reusable
    - PVC pipe can last 25-40 years (Smith’s Plumbing Services, 2019)
- Cost of prototype machined parts only: $8 total
  - If replaced every 6 months, $1.33/month
- Utilizes local materials
- Can engage local talent for manufacturing
Results: Environmental

- Utilizes readily available materials
  - Banana peels
  - Eucalyptus tree branches
- No use of electrical power
- Reusable device
- Minimal waste generation
Results: Socio-Cultural

- Integration with daily routine
- Locally available materials
- Minimal education required for use and maintenance
- Acceptable for use by all
  - Women
  - Children
Discussion:
Sustainable Development & Community Empowerment

A “strategy” for the developing world to achieve socioeconomic growth by “meeting their basic needs”

**Technical**
- Produces quality drinking water
- Facilitates household-level filtration

**Economic**
- Affordable
- Discourages dependency through use of local resources

**Environmental**
- Requires no electric power
- Makes responsible use of local resources
- Generates minimal waste

**Socio-Cultural**
- Integrates with user’s existing routine
- Requires minimal education to use and maintenance
Discussion: Sustainable Development & Community Empowerment

through “developing their own skills” and utilizing “available resources in an environmentally sustainable manner” (Murphy et al., 2009).

Sustainable Development

- Social Learning (Murphy et al., 2009)
- Ongoing partnership (Amadei et al., 2009)
- Local manufacturing
“Technology with a human face, which,...helps them to become far more productive than they ever had before” (Schumacher, 1973, p. 112)

Community Empowerment

- Local responsibility for design, production, and ideation (Sianipar et al., 2013b)
Future Directions

- Ensure sustainable development
  - Mechanisms of social learning
  - Strengthening of partnerships
  - Scope of local manufacturing
- Encourage community empowerment
  - Potential for local businesses
  - Economic-social-political cohesion
- Conduct user testing (long-term)
- Begin community implementation (long-term)
Thank you!

Questions?
References


Image References

