

IDEA BOOK

Hippo Water International



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CATAPULTDESIGN

Catapult Design is a non-profit design consultancy providing engineering and implementation support to organizations in need of technologies or products capable of igniting social change. We focus on those opportunities where our services can be highly leveraged by partnering with organizations that have the capacity to bring our solutions to scale. Our product development, in-country implementation, and evaluation services are sold for a fee negotiated on a client-by-client basis.

The majority of our world's population lacks access to life's basic needs. We develop and implement human-centered products to help them thrive.

We are seasoned engineers, designers, implementers, and educators hailing from top product design and engineering firms in Silicon Valley. Our founding team has a track record of designing products, introducing technologies, and fostering trends that are appropriate, self-sustaining, environmentally friendly, and culturally sensitive. Our core offerings include the assessment, design development, implementation, and impact assessment of products and technologies in collaboration with both non-profit organizations and for-profit companies.



BACKGROUND

Hippo Water International (HWI) is completing a product redesign and manufacturing effort with Engineers Without Borders and Project H Design in San Francisco. As part of HWI's effort to continue to build their product line, they wish to explore options for incorporating water sanitation capabilities into their product.

HWI asked Catapult to investigate methods of incorporating water purification methods identified by Project H Design into the Hippo Water Roller. HWI was also curious about the potential for ultraviolet sterilization and the Hippo.

Catapult gathered a small team with backgrounds in mechanical engineering, product design, and marketing for an evening of idea generation. With this team we explored ways of integrating the water treatment methods identified by Project H, as well as additional methods, into the current product.

As a final step, we identified general metrics to compare each method against the others.

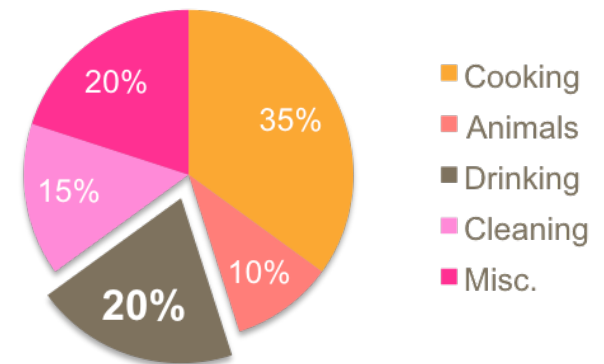




ASSUMPTIONS

To generate and develop ideas, we made the following assumptions:

- An integrated purification system is desired.
- Purification systems are individually owned, not community based.
- The water is treated in or as it leaves the Hippo, not a pre-fill treatment system.
- Effective elimination of bacteria, viruses, and sediment.
- Not all water transported in the Hippo is consumed; the majority is used for other purposes. Therefore, only a portion of the water needs to be cleaned. [see chart]
- Water is stored in the Hippo until used.



WATER CONTAMINANTS

There are three basic categories of water contaminants – particulates, chemicals, and micro-organisms. Here are examples of each:

Particulates

Chemicals (man-made and natural)

- Minerals (salts)

- VOCs (Volatile Organic Chemicals)

- Chlorine

- Heavy Metals

- Sewage treatment

- Air pollution

- Fuel

Microorganisms

- Protozoa (largest organism and most prevalent in Africa)

 - Giardia

 - Cryptosporidium

- Bacteria

 - E.Coli

 - Cholera

 - Salmonella

- Viruses (the smallest organism)

 - Hepatitis A

 - Poliovirus

 - Echovirus

No single purification method is 100% effective at removing all categories of contaminants.



STATE OF THE ART

Examples of what's available for *personal* water treatment...

Ultraviolet

- 1. Steripen \$86
- Steripen Filter \$13

- 2. AquaStar System \$90
- AquaStar UV Purifier \$49

Carbon Filter

- 3. LifeSaver Water Bottle \$150
- Lifesaver Filter \$30

Potters for Peace Ceramics

- 4. Ceramic Filter \$10-\$25
- Replacement Filter \$4-\$6

Chemical

- 5. PUR Packet \$0.05



EXPLORATION

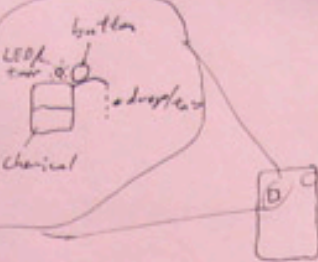
Chemical
Distillation
Filter
Ultraviolet Light



Add x # of tablets or drops



Dose water



add nanosilver



unscrew cap = dose



chlorine
iodine
micro pur
resin bed

metering
spout



Cap = measurement


purifier dispenses
right dose when unscrewed



meter into flow

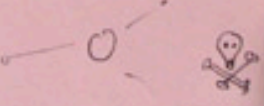


embedded
chemicals into
plastic

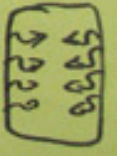


GOOD offgassing

Irradiation?
radioactive



plastic
releases
chemical



CHEMICAL

The addition of chemicals – such as iodine or chlorine – to the Hippo water supply

Chlorine and iodine are the primary chemicals used for sterilizing water.

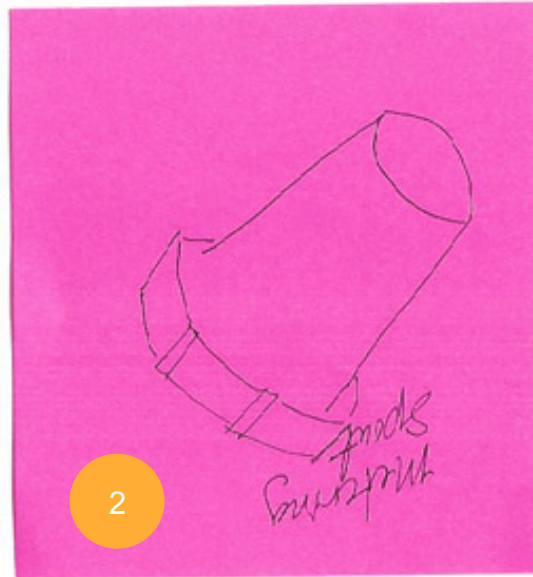
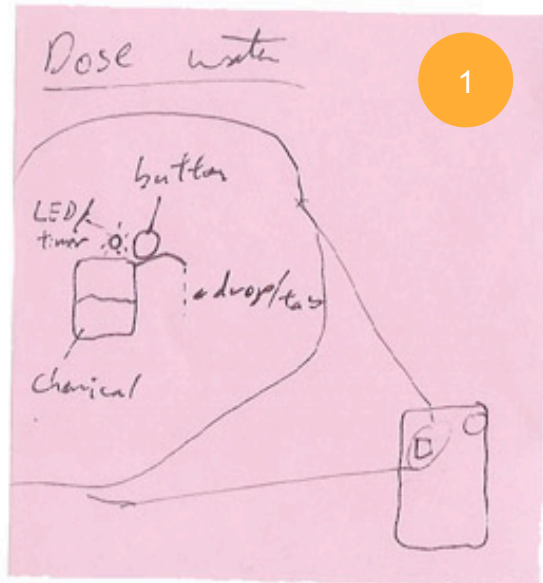
Both have proven effective against viruses, bacteria, and protozoa, depending on the concentration and time. Chemical additives are not filters and cannot remove particulates in the water.

Chemical solutions are low-cost and becoming more and more readily available in developing countries. Proctor & Gamble's PUR packets program is a widespread effort in Africa.

Drawbacks:

- Many stories of lack of acceptance of chemical solutions.
- Iodine leaves a bad taste and does not produce clarity in water like chlorine does.
- Pregnant women should not drink water purified with iodine.
- Too high a dosage of chlorine causes illness or death.
- All chemical solutions need to be used with a filter to remove particles.

CHEMICAL

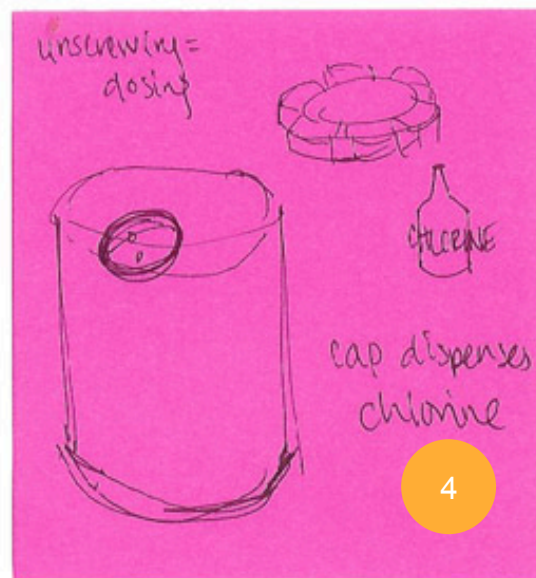
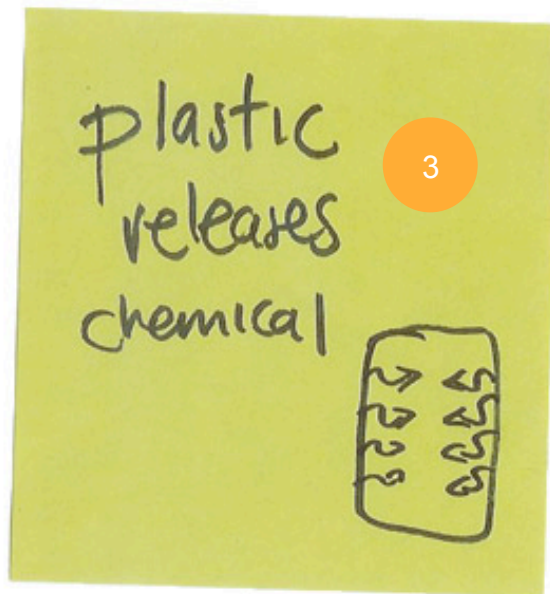


1. Water is auto-dosed with chemical via an electronic mechanism. LED blinks to indicate a dose has been administered.

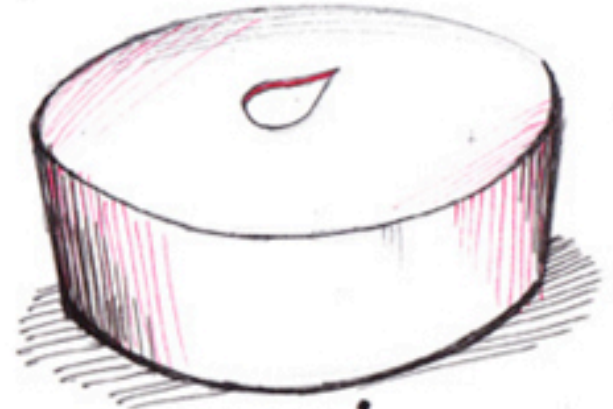
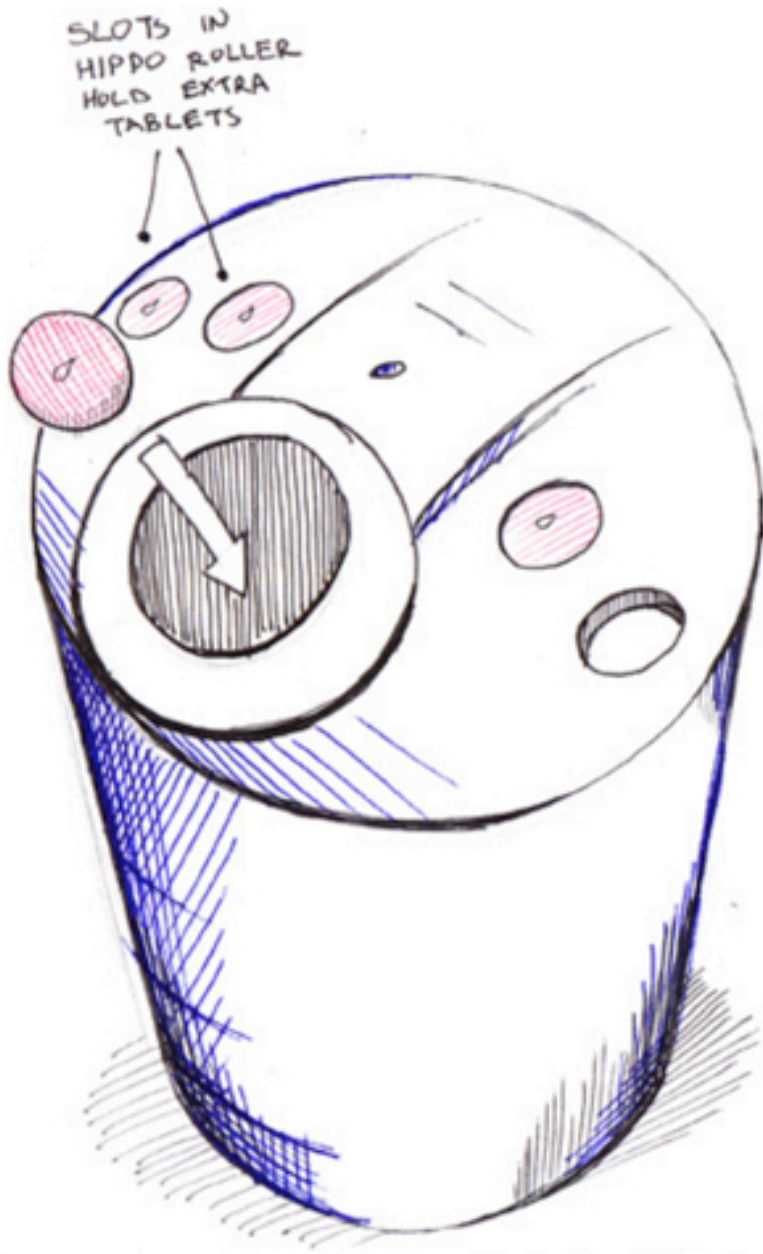
2. An accessory spout meters out the proper dosage of chemical.

3. The chemical is ingrained in the Hippo plastic body and leeches regularly, purifying the water in the process.

4. The dispenser is part of the cap and activated when the cap is screwed on.



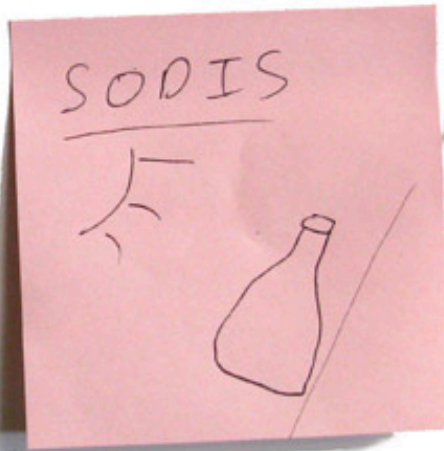
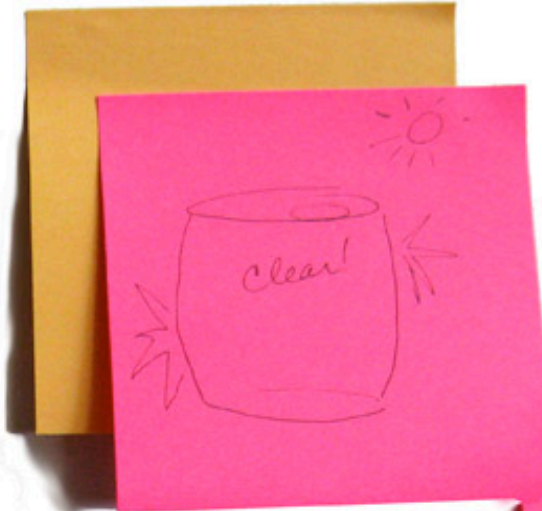
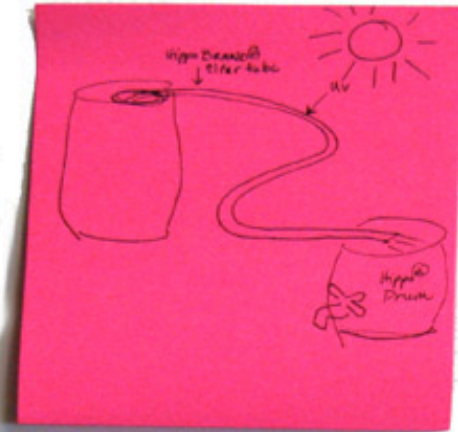
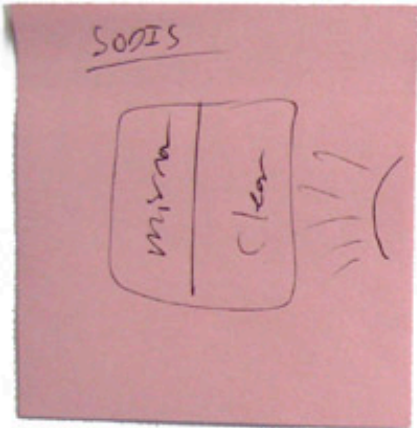
CHEMICAL



EACH TABLET
FILTERS AN
ENTIRE FILLED
HIPPO ROLLER

In a typical usage scenario, users would be supplied with doses of chemical to apply to drinking water supply. The dose would be either manually or mechanically administered.

CHEMICAL



SOLAR

Exposing Hippo to heat in an effort to treat the water.

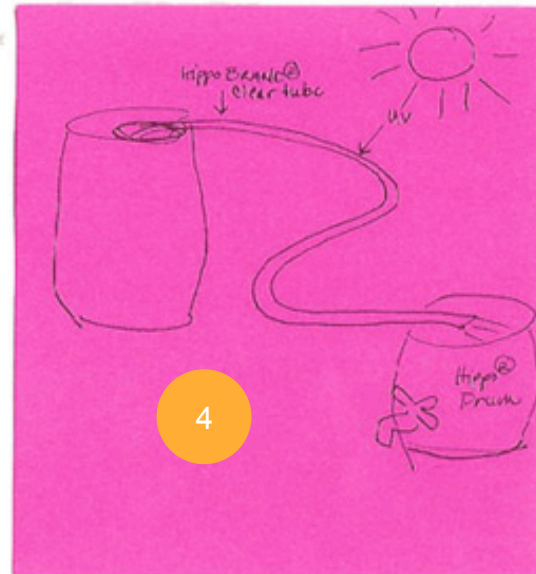
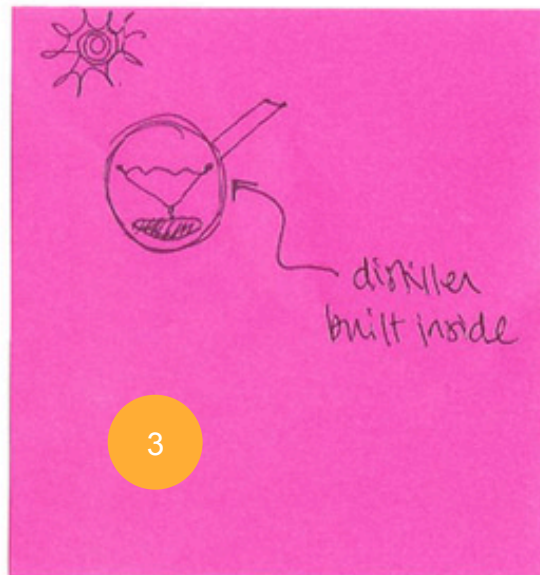
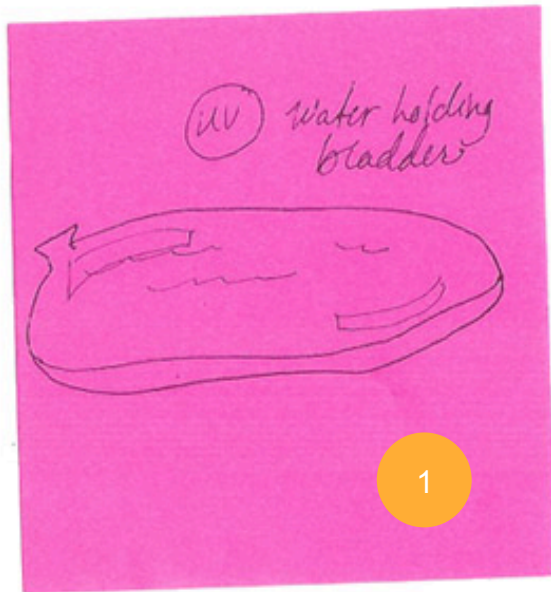
Applying heat to water can purify through boiling or solar distillation. Solar distillers capture condensation from evaporated water, therefore it's effective against all micro-organisms, particles, and most chemicals (depending on the contaminant).

Solar stills can typically be generated from local materials for fairly low-cost.

Drawbacks:

- The distilling process is extremely slow.
- Generally, only small amounts of liquid are produced daily.
- Would require a material change or a completely separate compartment from the Hippo Roller.

SOLAR



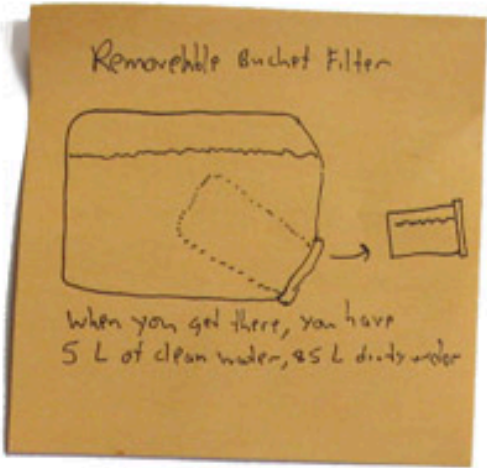
1. Water is stored in a bladder that separates from the Hippo and is placed in the sun.

2. The Hippo polyethylene is molded half black/half clear.

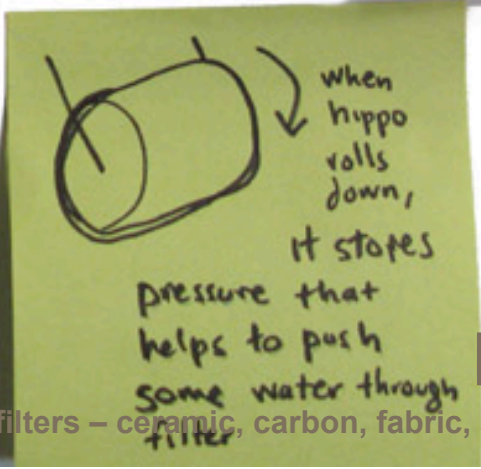
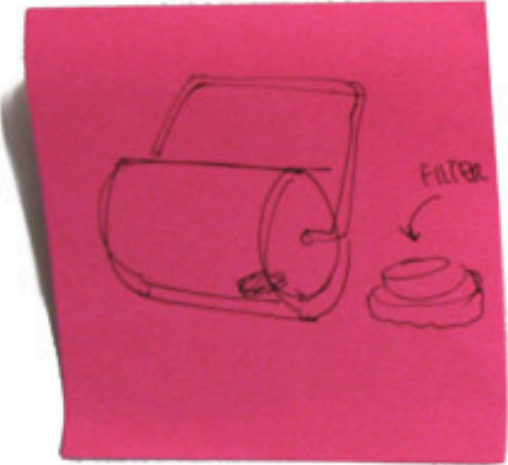
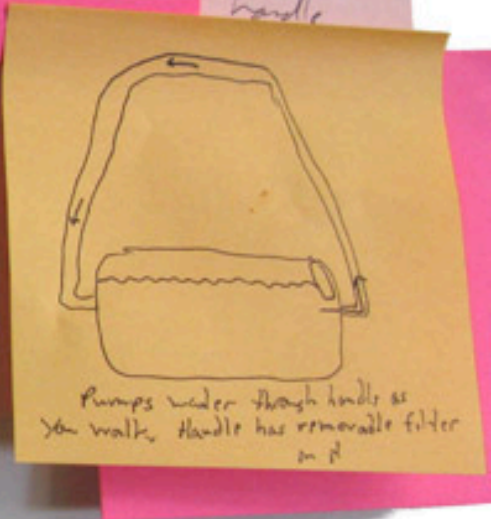
3. A reflective distiller is built inside the Hippo – like a ship in a bottle.

4. When drinking water is needed, it's siphoned out through a Hippo branded distillation tube into a clean container.

SOLAR



handle



FILTERS

Methods of incorporating filters – ceramic, carbon, fabric, sand – to the Hippo

CARBON/CHARCOAL

Carbon is seldom used as a sole filter. It's typically part of bigger filtration system. Carbon filters remove chemicals by attracting them on a molecular level. When all the surfaces are covered, the filter must be replaced.

Carbon filters are rated in microns, or the measurement of their pore size. The smaller the pore size, the larger the surface area and the more affective the filter is. One micron is the maximum pore size recommended to affectively filter out contaminants and pathogens.

Carbon filters can improve taste and odor.

Drawbacks:

- Typically used in conjunction with another purification method.
- Filters must be replaced regularly and be made available to the end-user.
- Carbon filters are not able to remove viruses because the pore size is too large.

CERAMIC

Ceramic filters are similar to carbon filters in terms of operation. Ceramic elements have the smallest pore size and are highly effective when used in conjunction with nanosilver coating.

Drawbacks:

- Most Ceramic filters require nanosilver, or silver colloid, for maximum efficacy. Silver colloid is not local to all regions.
- Ceramic filters do not remove chemicals (heavy metals and VOCs), bad tastes, or pollutants from water.
- Delicate and difficult to integrate into the Hippo.

SAND

Sand filters are classified as either Rapid Sand Filters or Slow Sand Filters (aka Bio-sand Filters). Rapid sand filtration uses larger particle sizes for expedited filtration, but is typically used in conjunction with another purification method.

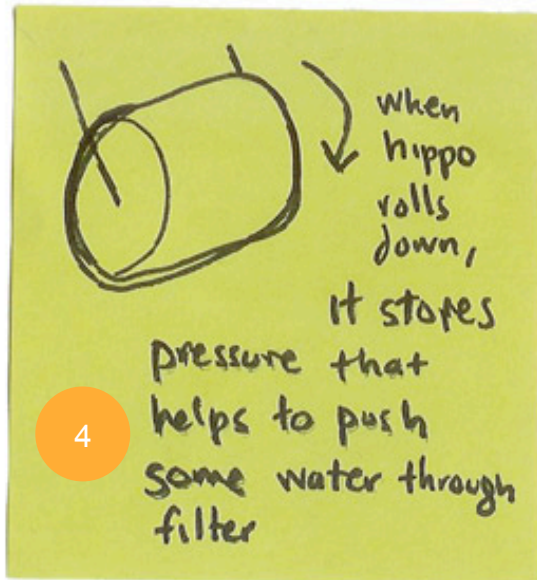
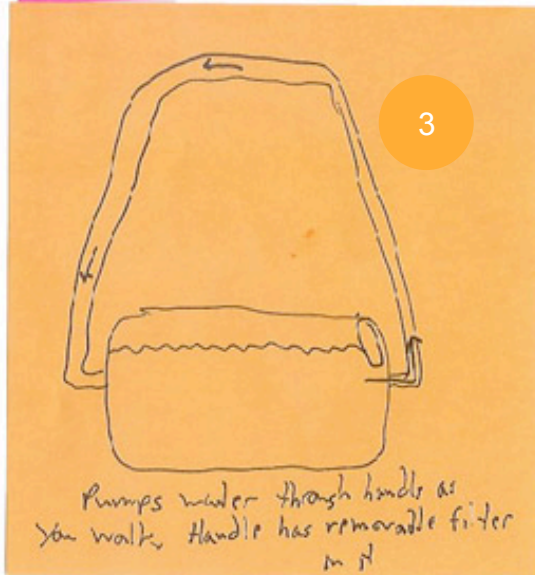
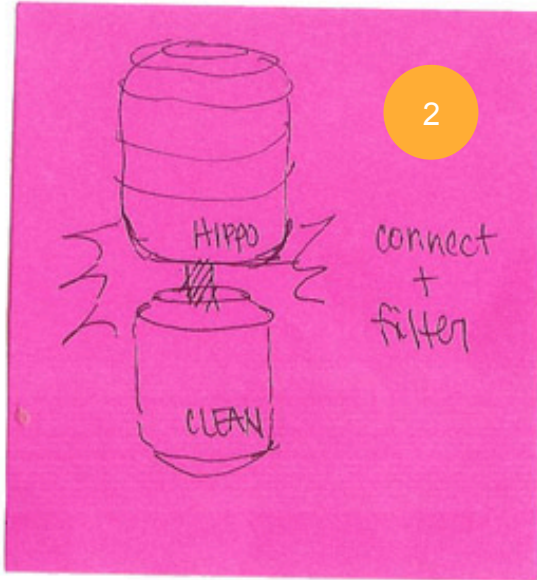
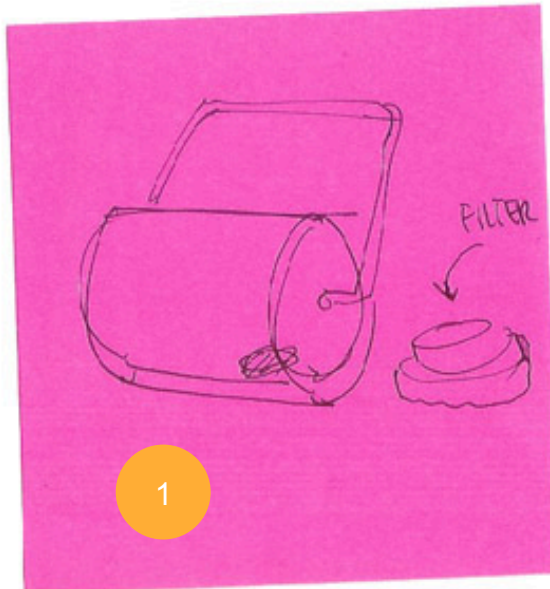
Slow sand filters use much finer particles and rely upon a natural buildup of biological mass on the top layer to remove viruses.

Sand filters can be readily produced locally if the right sand is present.

Drawbacks:

- Bio build up on the surface of bio-sand filter is sometimes counter-intuitive to "clean."
- A constant flow of water must pass through a slow sand filter to achieve efficacy, otherwise the bio buildup dies.
- Many parts of Africa don't have proper sand for filtration; shipping in sand is expensive.
- Cannot incorporate into Hippo.

FILTER



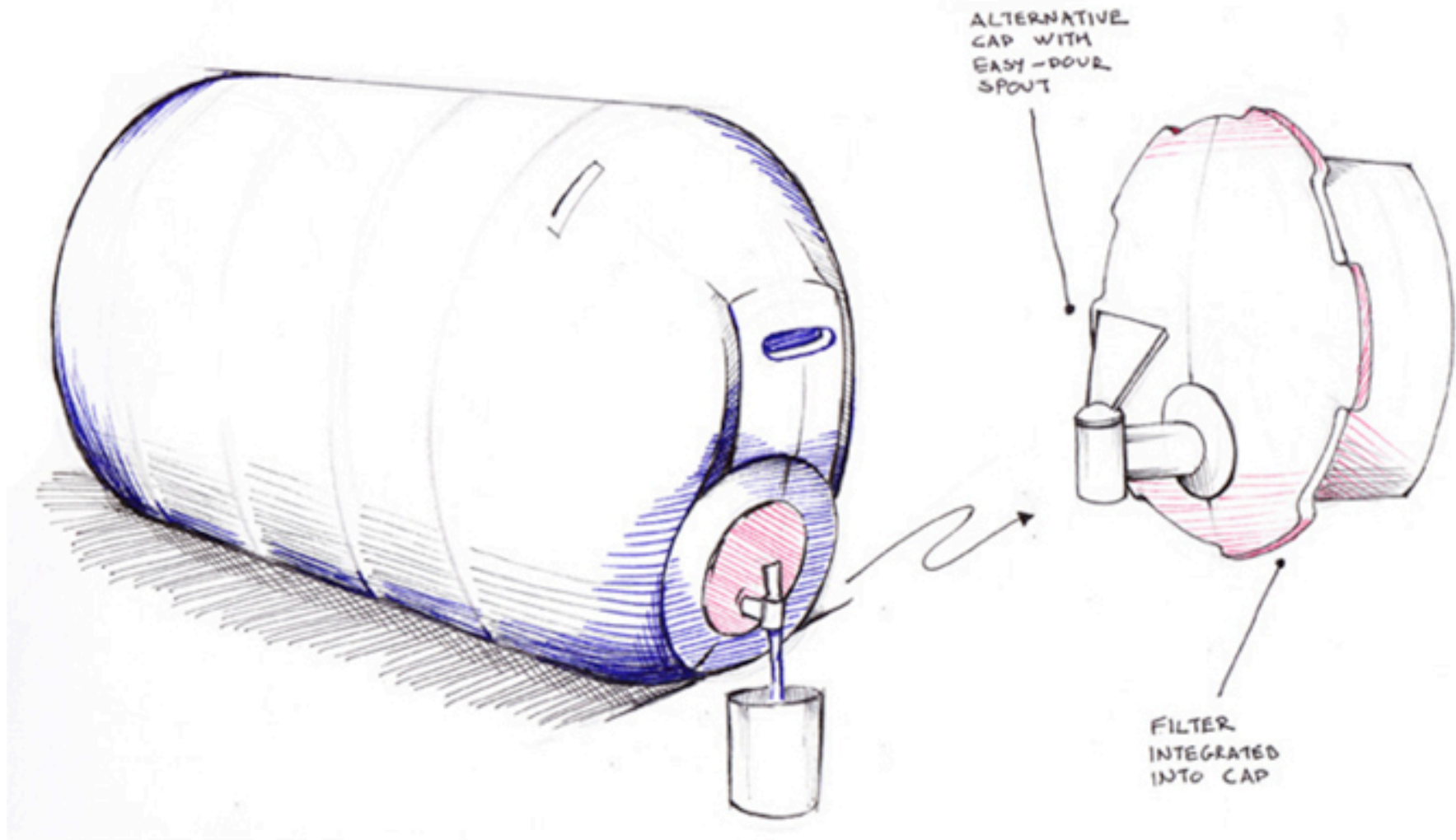
1. Carbon or ceramic filter is housed within the Hippo cap.

2. A separate mini-Hippo with a built-in filter, attaches to the regular Hippo when drinking water is needed.

3. A filter is built into the handle.

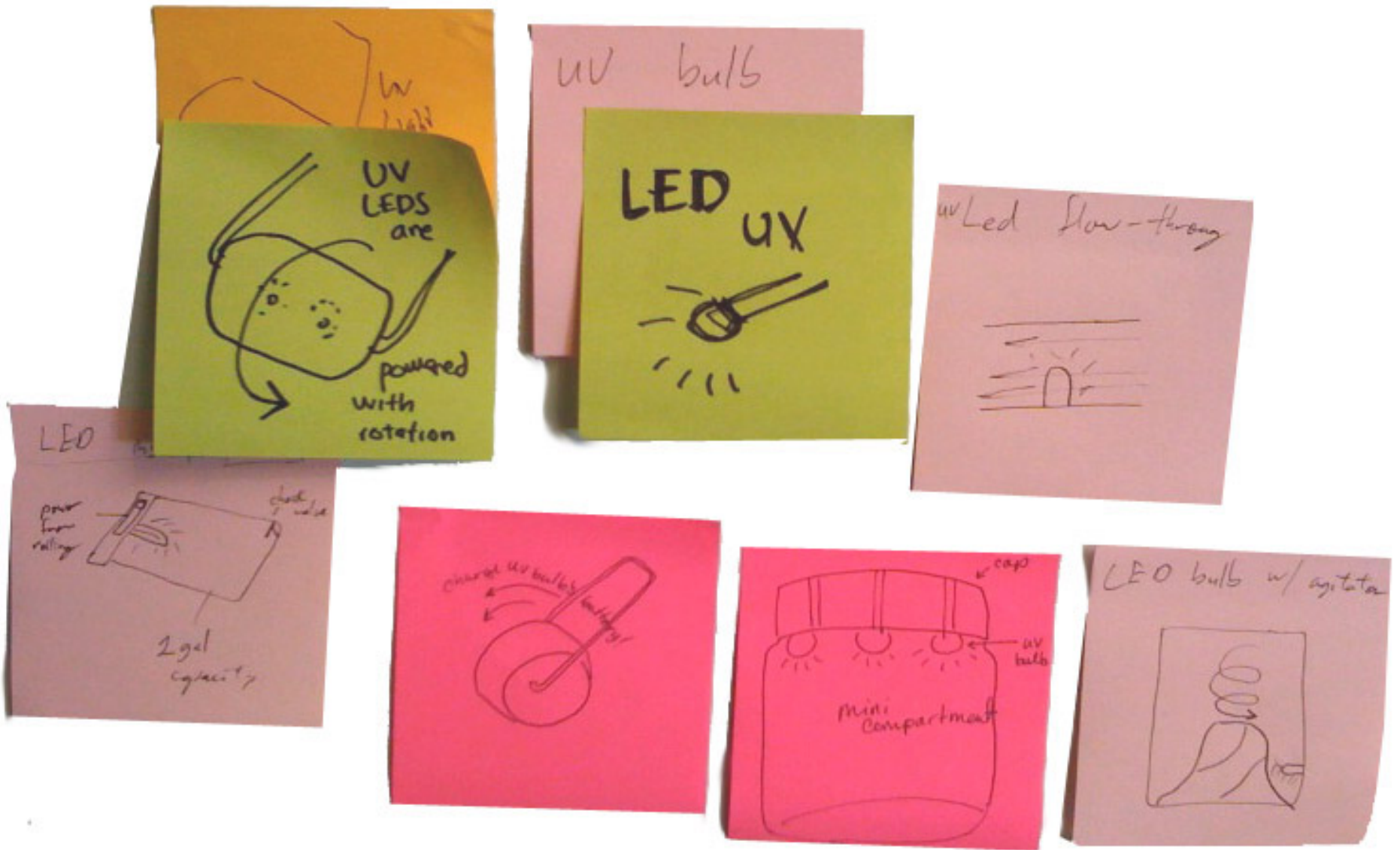
4. Method of pushing the water through the filter as the Hippo rolls home.

FILTER



A filter can be incorporated into the point of exit more simply than other methods, reducing development cost.

FILTER



ULTRAVIOLET LIGHT

Methods of exposing the Hippo to ultraviolet radiation.

Ultraviolet light emitted from UV bulbs or UV LEDs kills microorganisms. UV light can sterilize a container of water (static), or sterilize a continuously flowing stream of water (dynamic).

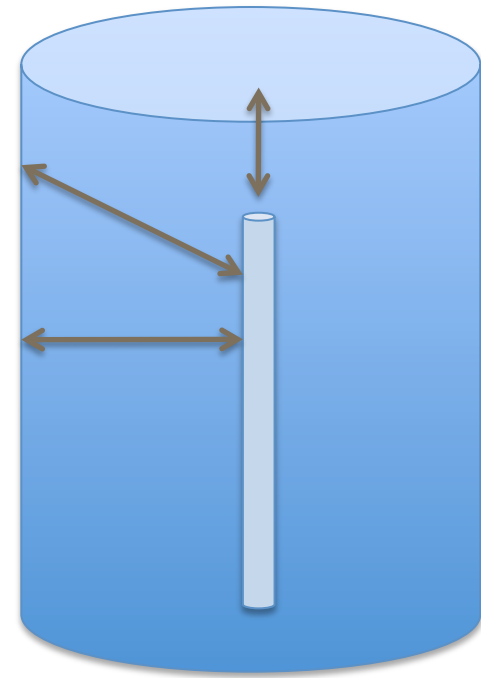
In either case, UV sterilization hinges on the “dwell time”, or the amount of time water is exposed to the UV light source.

A UV bulb’s power and wavelength is specified based on the amount of water that needs to be purified. Smaller, less powerful bulbs mean longer exposure times; larger, more powerful bulbs mean less exposure time. Exposure time can be shortened by agitating the water.

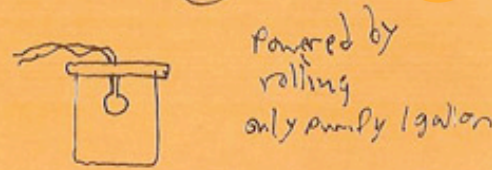
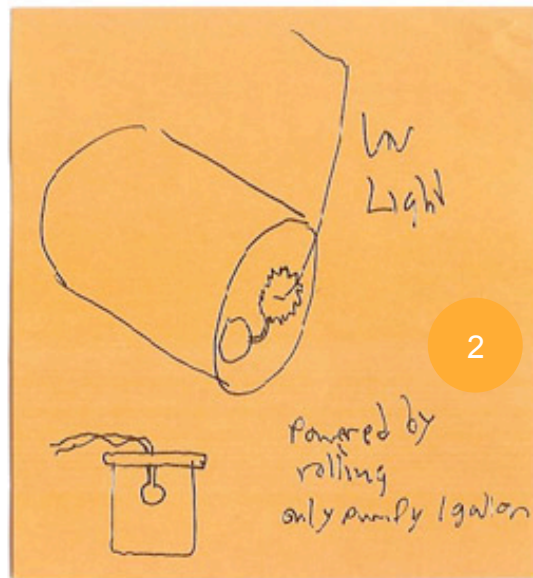
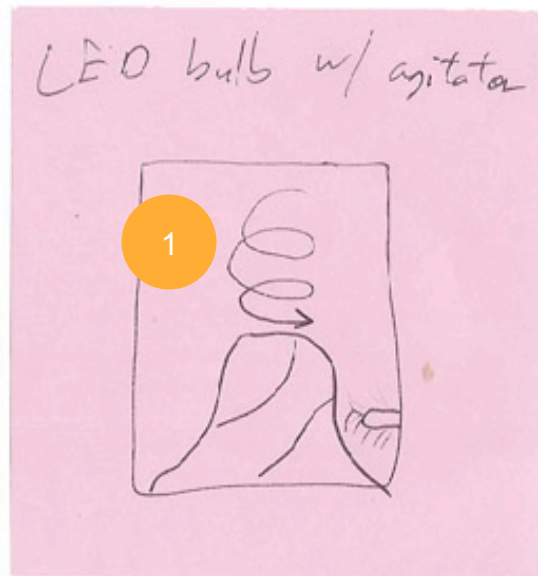
Drawbacks:

- UV requires electricity.
- UV bulb has to “warm up” before working.
- “Instant-start” UV bulbs are more expensive.
- Instant-start bulbs have a shorter lifetime than slow-start bulbs.
- Mixture of water and electrical circuitry requires good design/engineering practices.
- Bulb must be kept dry.
- UV systems require a secondary filtration process to get rid of particles.
- High voltages required to power UV bulbs
- Need at least a kilovolt to strike a lamp.
- UV bulb requires replacement every 6-12 months.
- High up-front development costs
- UV bulbs are delicate.

The allowable distance between the edge of the water container and the UV bulb is dependent on the power and wavelength of the bulb.



ULTRAVIOLET LIGHT

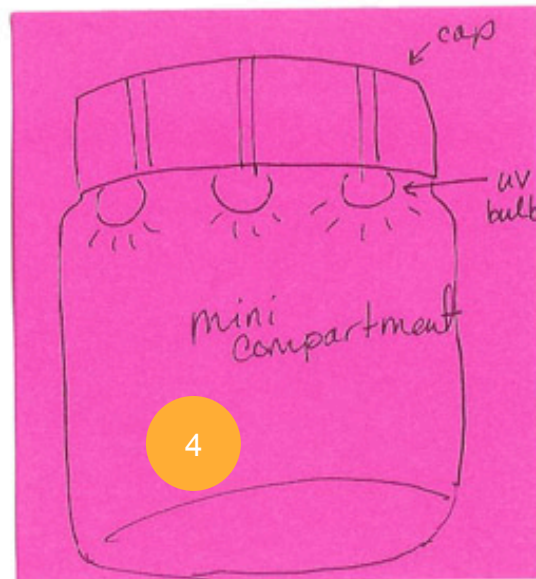
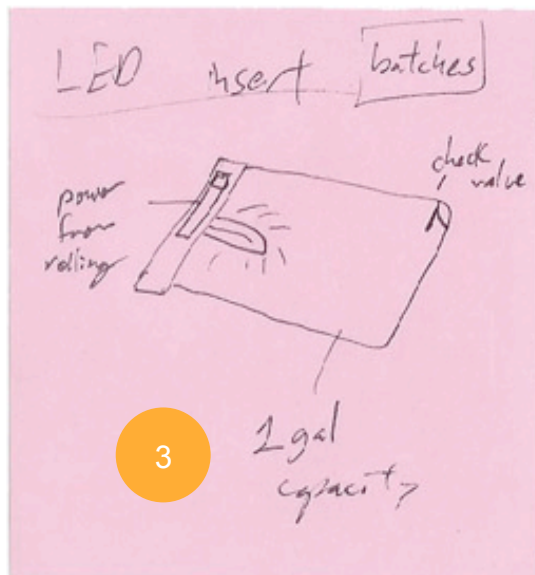


1. Small LED bulb with built-in agitator to expedite sterilization.

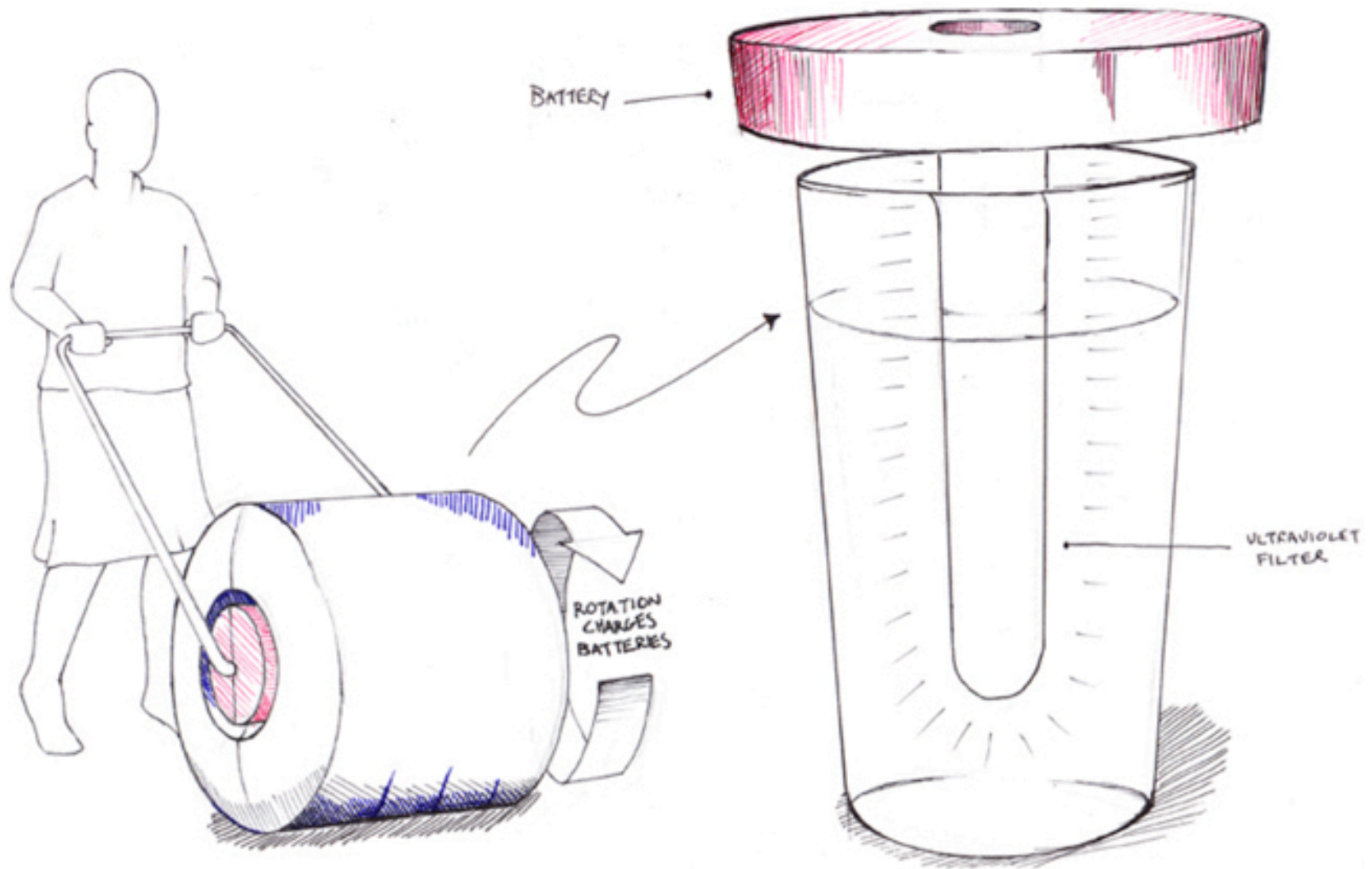
2. Rolling powers an UV bulb powerful enough to sterilize 1 gallon.

3. Similar to idea 2, but including a check valve, or a one-way inlet for water.

4. Separate UV compartment with a series of UV LEDs or bulbs built in.



ULTRAVIOLET LIGHT



UV sterilization is achieved in batches, such as purifying a water bottle, or in continuous flow. The bulb size is dependent on how much water needs to be purified at a time.

ULTRAVIOLET LIGHT

SOLUTION EFFICACY

A look at the effect of each treatment method on the prominent water contaminants.

	Eliminates Bacteria	Eliminates Viruses	Removes Cryptosporidium	Removes Giardia	Removes Particles	Removes Chemicals	Potential to meet WHO standards
Chlorine (Chemical)	X	3	3	3			High
Iodine (Chemical)	X	3	3	3			High
Boiling	X	X	X	X		2	High
Ultraviolet	X	X	X	X			High (4)
Carbon Filter ¹	X		X	X	X	X	Medium
Ceramic Filter w/ nano-silver	X		X	X	X		High
Fine Sand Filter	X		X	X	X		Medium (5)
Distillation	X	X	X	X	X	6	High

1 Pore size of 1 micron or smaller

2 Does not remove chemicals with higher boiling points than water

3 Highly dependent on contact time

4 Only effective after filtration process

5 Highly dependent on the maintenance of the bio layer

6 Does not remove chemicals with a lower boiling point than water

Notes:

Chlorine and Iodine effectiveness depends on concentration and time.

UV disinfection depends on concentration, time and water quality.



ENGINEERING METRICS

A quick look at how we defined metrics to compare each technology from an engineering and design perspective...

Technology Heavy: *how technologically advanced is the method?*

Retail Support: *does technology require retail/maintenance support?*

Cost of Goods: *determines retail/upfront cost to consumer.*

Maintenance Schedule: *maintenance frequency and requirements to achieve results.*

Maintenance Cost: *cost of replacement parts required for maintenance.*

Product Cost Over Two Years: *upfront cost plus maintenance cost over two years.*

Integration Difficulty: *ease of integrating treatment technology into current Hippo.*

Part Count: *increased part count as a result of incorporating technology.*

Alien Factor: *is the technology understandable to a uneducated consumer?*

Durability: *how delicate is the technology?*

Enables Local Manufacturing: *can this technology support local manufacturing?*

Behavior Modifications: *does purification alter consumer interaction with the Hippo?*

Changes to Industrial Design: *how will the integration affect the current ID?*

Time to Purify: *how long does this technology need to purify 90L of water?*

Flow Rate: *how is the flow rate affected by the technology?*



	Ceramic	Carbon	Ultraviolet	Bio-Sand	Distillation	Chemical
Technology Heavy	low	low	high	low	medium	medium
Retail Support	need specified ceramic pots	need specified carbon filter	need specified UV bulbs			need access to chemicals
Cost of Goods	low	low/medium	high	low	low/medium	low/medium
Maintenance Schedule	replace system every 5 yrs	replace filter every few months	Bulb replacement, 6-12mo.	clean and sift	clean	none
Maintenance Cost	cost of ceramic pot (\$)	cost of filter (\$-\$\$)	cost of lamp, cost to power (\$\$\$)	none	none	none
Product Cost Over Time	low	medium	high	low	low/medium	low
Integration Difficulty	high	low	medium	high	medium	low/medium
Part Count	low	low	high	low	low	medium/high
Alien Factor	low	low	high	low/medium	medium	high
Durability	medium	medium	low	high	high	medium
Enables Local Manufacturing	high	low	low	high	medium	low
Behavioral Modifications	medium	medium	high	high	low/medium	low/medium
Changes to Industrial Design	medium/high	low	high	medium/high	high	low
Time to Purify	medium	medium	medium	medium	high (most time)	low (least time)
Flow Rate	medium	medium	medium/high	low/medium	low	high

Scale	positive				negative
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RESOURCES

Akvo.org

[WaterHealth International](#)

[World Health Organization guidelines for drinking-water quality](#)

[Emergency Essentials](#)

[Center for Disease Control and Prevention](#)

Biosand.org

[Frequency Rising](#)





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