Design for seniors, impact for all.

Product Design Specification

FALL 2019

This Product Design Specification is for KÜL MAYK's main product: the WATERFÜL pitcher. Our product is specifically designed for those with dehydration issues and anyone that needs to be reminded to drink water. To address the problems of the target user, our product features recirculating water flow to keep water fresh, the ergonomic handle to accommodate shaking hands, and blinking LEDs as the visual reminder. It is intended for use in any household space such as the living room, the kitchen or the bedroom.

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1. Product Identification

1.1. Product Name and Number of Models

1.1.1. Product Name

The name of our product is the WATERFÜL pitcher.

1.1.2. Basic Functions of Product

The WATERFÜL pitcher performs these basic functions:

- Subtly remind users to rehydrate through organic visual and audio stimuli.
- Circulate water continuously to prevent water from becoming still.
- Support ease of water dispensing through assisted pouring.
- Serve as a room centerpiece and decorate household space.

1.1.3. Special Features of Product

The WATERFÜL pitcher consists of these special features:

- A waterfall effect combines form and function by pumping water from the bottom of the pitcher through the pump and back into the pitcher from the top. This recirculating of water keeps the taste of water fresh by preventing increased acidity from dissolution of carbon dioxide/aldehydes/acetone in ambient air and draws attention to the pitcher by creating both motion and sound.
- Soft LEDs in the base of the system that acts as an additional notification to periodically remind users to rehydrate.
- Ergonomic and easily graspable handle with an integrated spout to allow easy usage of the device.
- A snap fitting casing that gives the user easy access to the potentiometers to tune the device.

1.1.4. Key Performance Targets

The WATERFÜL pitcher satisfies these key performance targets:

- The interface between pump and pitcher must not leak.
- The pitcher must not tip over when encountering moderate external force.
- The pitcher must be robust enough to withstand excessive speed and force when placed on the table or dropped.

- The system must be easy to clean and maintain.
- The spout must be able to turn without excessive force and have an intuitive handle.
- The settings and frequency of the device must be easily tunable.
- The LED lights and waterfall functions must last over 1000 cycles of use.

1.1.5. Service Environment Conditions

The WATERFÜL pitcher is intended to be used within the house in the living room, bedroom, and kitchen environment, encompassing countertops and even the refrigerator. As such, the device is expected to be serviceable within wet conditions. Furthermore, the pitcher should be able to handle water of different temperatures, including boiling (100°C) and ice cold (0°C) temperatures so that plastic and electronics must be able to withstand the range of temperature and abrasive force. The handle must be insulated so that the user can pick up the pitcher regardless of the water temperature. The pitcher must be able to contain a variety of liquids, including but not limited to water, juice, wine, tea, and coffee.

1.1.6. Prediction of Misuse Cases

We predict that the product will be improperly used in the following cases:

- Over-application of force when placing the pitcher.
- Accidental drops of the pitcher.
- Application of excessive heat or cold (placing the pitcher on a hot stove/oven)
- Excessive forces/pressing times on the buttons for customizing the LED lights.
- Switching the spout with excessive force.
- Leaving expired liquids inside the pitcher for an extended period of time.
- Excessive washing/soaking of the base with electronics.

1.1.7. Picture of Concept Products

Below shows a concept drawing of the WATERFÜL pitcher with its extensive features.

Figure 1: Initial rendering for WATERFÜL and its features

2. Market Identification

2.1. Target Market

The WATERFÜL pitcher is designed for elderly users but its impacts can be extrapolated towards users of all ages and genders with dehydration issues and health-conscious individuals who benefit from a system to remind of drinking water. The issues can stem from old age, mental health illnesses such as Alzheimers, motor-skill impairment from Parkinsons, or forgetfulness from a busy life. Especially as we age, we begin to lose our sensation of thirst. This phenomena is reflected even in scientific studies finding that adults older than 65 have the highest hospital admission rates for dehydration (UCLA School of Nursing) and that up to 31% of Long Term Care residents are dehydrated (Noll Physiological Research Center).

Thanks to the WATERFÜL pitcher's blinking LEDs and the waterfall effect, users can be worry-free about when to rehydrate. The spout also removes the need for strength to hold the heavy pitcher in order to pour water. We will initially focus on the U.S market, but will later expand to the Canadian market and beyond. The following is a description of a sample user:

George is a senior citizen at a living center who drinks as little as 3 cups of water a day. With Alzheimer's, he often forgets to rehydrate, unless it is time for him to take his pills during breakfast, lunch and dinner. He often relies on his caretaker to remind him to take his pills. Despite this, George wishes to be more independent and healthy. Any means of regaining independence and healthiness, without the feeling of being patronized, will help George alleviate his personal concerns and the stress on the caretaker.

2.1.1. Market Size

Since the WATERFÜL pitcher addresses hydration, a basic daily need for everyone, it has the potential to reach individuals of all ages. It represents a modern inexpensive solution to issues that everyone faces: not having enough daily water intake. The WATERFÜL pitcher may also enjoy sales as a novelty item for health-conscious audiences who like to purchase smart technology. While any individual can benefit from the use of the WATERFÜL pitcher, we will focus our market size analysis on our core base of potential users: senior citizens (age 65+) in living centers and hospital-admitted patients for dehydration . The Population Reference Bureau's "Fact Sheet: Aging in the United States" found that there are 52 million of senior citizens in 2018. As there are 95 percent of seniors living in the community (National Center for Biotechnology Information), we have 49.4 million seniors who are in the targeted living situation. Among this group, UCLA School of Nursing found that 40 percent are chronically dehydrated, leading us to have a total number of potential users of 19.8 million. Additionally, since our products also benefit users of all ages, we can expand our customer span to the general U.S population. This approach seems reasonable since 75 percent of Americans are chronically dehydrated, according to New York Hospital-Cornell Medical Center in 1998. However, we expect the first customer group to adopt the WATERFÜL pitcher is the group with severe dehydration issues. According to a research published by National Institutes of Health, 0.55 percent of all hospital admission cases are due to dehydration. In 2018, there were 36,510,207 hospital admissions (American Hospital

Association), which means there are 201,000 cases for dehydration. While this number might seem small compared to 19.8 million senior citizens living in the community, this means that this smaller market segment is more manageable to approach: forming partnership with hospitals and medical centers would provide consistent sales, which is especially important in the long run.

2.1.2. Consumer Behavior

According to Mintel's October 2018 report on water filtration, consumers are more likely to be influenced by benefits related to safety, convenience, and taste than secondary benefits (eg. attractive design or advertisement). The WATERFÜL pitcher features a unique spout that helps users pour water with ease, making it more convenient than any competitor's product as it removes the need to use strength and fine motor skills to lift the pitcher. To address safety concerns, our product will be safe for the dishwasher, and the electronics will be insulated so it can withstand 0^0C in the refrigerator. Taste of water is improved by the waterfall feature, which prevents water from getting stale.

According to the same report, nearly 40% of consumers use water pitchers with filtration because they do not feel safe drinking tap water, making it the top-cited reason why consumers use water filtration products. The report also remarks on customers' interest in trial is strong for some innovations. Innovations that provide greater convenience drive the most consumer interest. Since the WATERFÜL pitcher has multiple unique features, it will benefit from customers' interest in trial.

The report also reveals that adults aged 18-34 are significantly more likely than average to agree that they use water filtration products for environmental reasons, and adults aged 25-34 are significantly more likely than average to agree that they use products for cost-saving reasons. Additionally, renters are more likely than homeowners to own water filtration products, as they tend to be less invested in their homes and have less flexibility when modifying their space. This leads to the report's conclusion that renters' above-average ownership of water filtration products makes them a prime target for brands.

2.1.3. Survey Results

The KÜL MAYK team sent out a survey during the early stages of the product cycle to gauge potential consumer interest. From this survey, we found that our potential consumers would feel positive about paying $50 for the WATERFÜL pitcher. Survey participants also found the product to be desirable if they feature audio and visual stimuli, plus assisted pouring options.

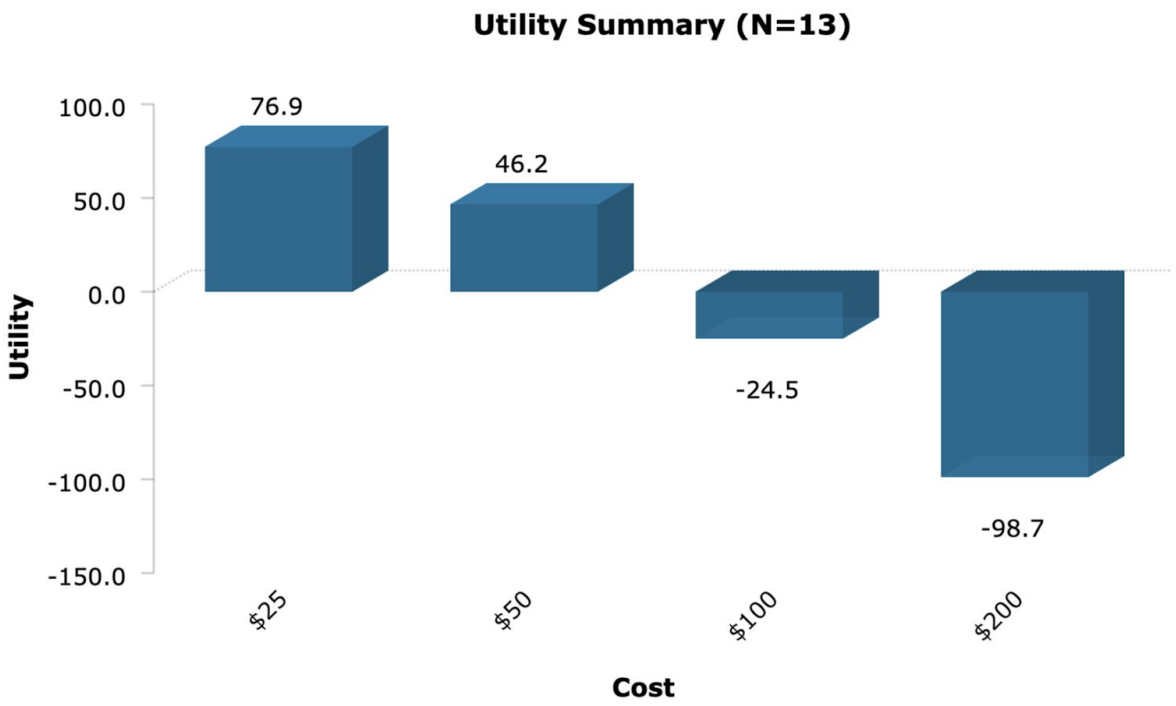


Figure 2: Survey Results for maximum product price.

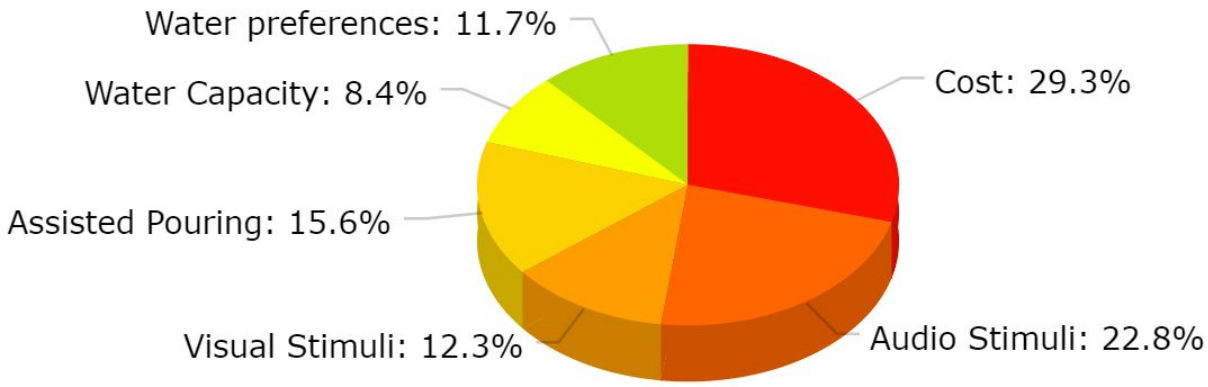


Figure 3: Survey Results for pitcher's feature preference.

2.2. Competitors

To better understand the market and improve the WATERFÜL pitcher, we performed research on current market products.

Table 1: Comparison of competitors' products.

HidrateSpark 2.0 $55.00 	• **Description**: Smart water bottle to track water intake, glows to remind users to drink more water. Use an app to keep track of daily goal. • **Differentation**: the WATERFÜL Smart Pitcher features a spout for easy pouring. The reminder system includes audio stimuli and the waterfall visual stimuli as well as glowing LEDs. Does not feature daily goal to remove stress from daily task completion.
H2O Pal $99.00 	• **Description**: Smart water bottle to track water intake, send a notification to phone to remind users to drink more water. Use an app to keep track of daily goal. • **Differentation**: the WATERFÜL Smart Pitcher features a spout for easy pouring. While the H2O Pal does not feature any stimuli on the pitcher itself, our reminder system includes audio stimuli and the waterfall visual stimuli as well as glowing LEDs. Does not feature daily goal to remove stress from daily task completion.
BuildLife 1 $18.96 	• **Description**: Water bottle with marked lines to track daily water intake progress. • **Differentation**: This product relies heavily on customers' hydrating awareness and discipline, as it does not feature any active reminder. The WATERFÜL Smart Pitcher actively encourages users to hydrate through visual and audio stimuli.
Brita Infinity Pitcher $44.99 	• **Description**: Wifi-connected water pitcher that automatically reorders replacement filters. • **Differentation**: This product only assists users in ordering filters, as it does not feature any active reminder. The WATERFÜL Smart Pitcher are more suitable for our designated users as it actively encourages users to hydrate through visual and audio stimuli.

KÜL MAYK

KOR Water Fall

$69.00

- **Description**: Aesthetic water filtration system, uses coconut shell as filter to purify and add taste.
- **Differentation**: This product only features one-time waterfall effect, compared to the repeating waterfall as a reminder. Multiple bad reviews from Amazon saying product leaks and overflows all over the countertop.

Prodyne

$19.99

- **Description**: Fruit Infusion Flavor Pitcher, used to make flavor-infused beverages.
- **Differentation**: This product is only for adding taste to water as it does not remind users to hydrate. It also requires strength and dexterity to pour water, compared to the use of the spout on the WATERFÜL Smart Pitcher.

KooK Drink Dispenser

$18.96

- **Description**: Drink dispenser, only for cold drinks.
- **Differentation**: This product's placement on the table is limited. As the spout is placed very low, the dispenser will required to be placed on the edge of the table. The WATERFÜL Smart Pitcher uses a pump-powered valve so that any cup can be placed directly under. Thus, it removes the risk of damaging the pitcher by accidentally knocking it over.

Links to above products:

HidrateSpark 2.0: https://www.amazon.com/Hidrate-Spark-Smart-Water-Bottle/dp/B01NBNMC8V

H20 Pal: https://www.h2opal.com

BuildLife 1: https://amzn.to/2PjI0CY

Brita Infinity Pitcher: https://amzn.to/2YPbKJU

KOR Water Fall: https://amzn.to/36BQyJJ

Prodyne: https://amzn.to/35naBeM

KooK Drink Dispenser: https://amzn.to/38A4shx

2.3. Branding Strategy

The branding of the WATERFÜL pitcher will highlight the unique features that it provides. It will be branded as a novel water pitcher product that is unprecedented in functions, perfect for the elderly, students, busy adults, health-conscious individuals or anyone that likes to have an aesthetic, dynamic and practical kitchen centerpiece. We will demonstrate the convenience of the pump-powered spout, as well as the waterfall effect as a gentle and adjustable reminder system. Our slogan will be *"Hydration: reimagine the art of water"* to emphasize on the beauty aspect of the waterfall and the soft LEDs, similar to a mini light show contained in the pitcher. We will highlight the valve mechanism as an elegant solution to water refill that does not require force to lift the pitcher, perfect for kids and seniors to use. Lastly, we want to paint the pitcher as the solution to dehydration issues that the majority of seniors are facing. Based on the finding that customers are looking for innovation in water pitchers, this will set us apart from the competition. Our biggest competitors, Brita, ZeroWater or PUR, only focus on the water filtration component.

In an effort to create a unique outlook for our product and brand, our team has chosen to go with a rather eccentric name: KÜL MAYK. Our theme color is crimson red, which sets us apart from the usual aqua-inspired blue theme color. These will send a message that KÜL MAYK is disruptive, not afraid to break the stalemate in water pitcher innovations as it includes unique functions.

Official Company Logo:

Figure 4: KÜL MAYK Logo

Logo Variations:

Figure 5: KÜL MAYK Logo variations

Water Pitcher Logo Evolution:

Figure 6: WATERFÜL logo

Website Pictures:

Our website is featured here; Kul Mayk Product Design. A few sample screenshots are seen below.

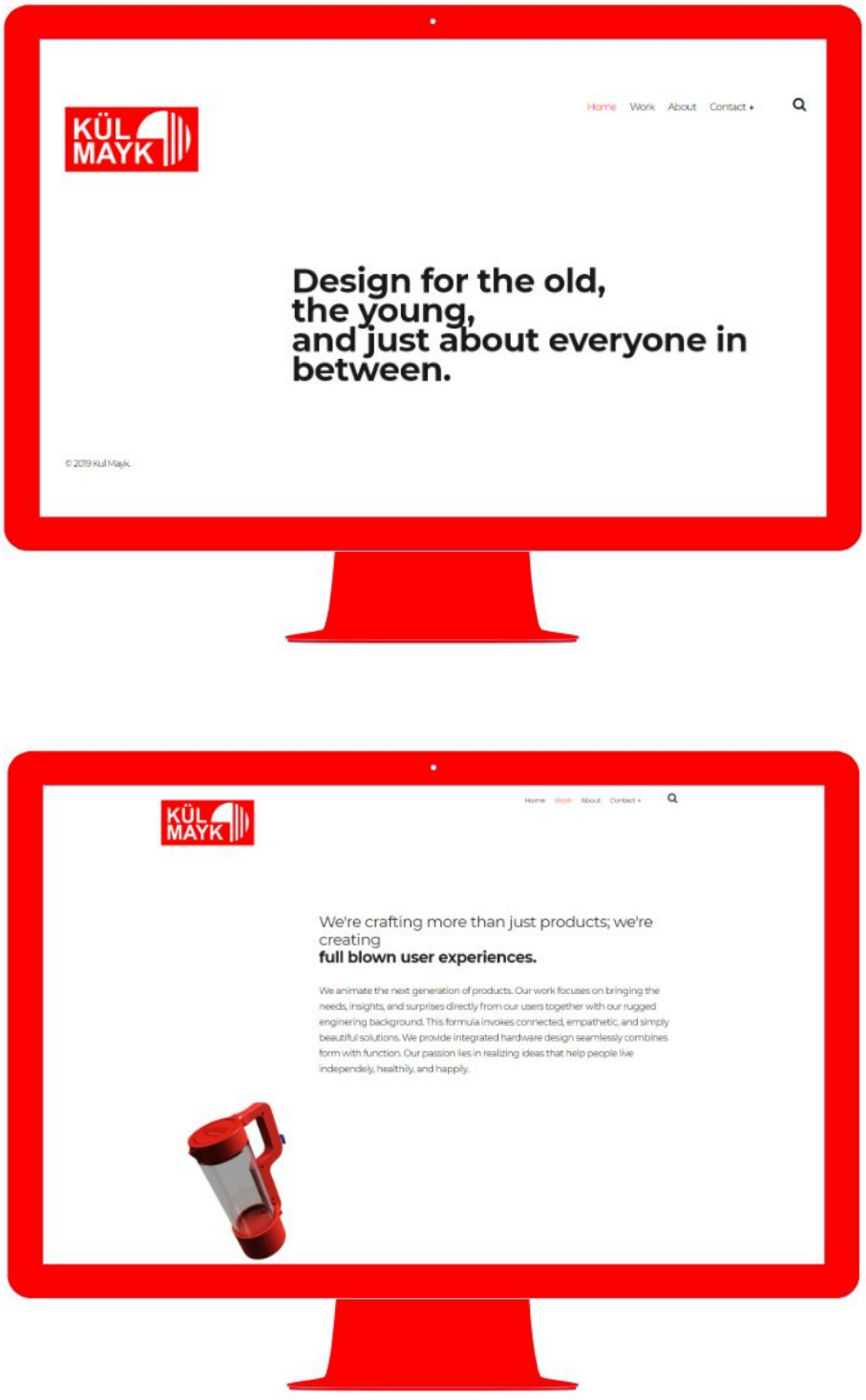


Figure 7: Website screenshots

2.3.1. Branding Timeline

The first quarter after launch, we will strongly focus marketing towards the household and elderly markets within our local area. To do this, we will rely on TV advertisements, product demos in public locations, the radio, as well as the local newspaper. As the product grows, we will begin to expand our marketing towards students as well considering the success of smart water bottles in the demographic. Within the first year, the WATERFÜL pitcher will be placed in department stores and personalized advertisements based on customers' age on social media such as Facebook and Instagram. To encourage early adoption, promotion codes/referral system will be introduced on our Kickstarter page.

The firm website can be found here: http://kulmayk.com/

3. Project Deadlines

3.1. Gate Review Dates

Table 2: Product review dates.

Gate Reviews	**Design Review 1:** Empathy fieldwork and product discovery	October 7, 2019
	Design Review 2: Working prototype and user testing	November 13, 2019
	Final Review: Final prototype expo and presentation	December 7, 2019

3.2. Total Completion Timeline

Table 3: Product timeline.

Empathize	Senior center fieldwork conducted	September 13, 2019
	All empathy fieldwork conducted	September 16, 2019
Define	Unpacking empathy field work and collecting emotional data points	September 18, 2019
	Identifying themes and groupings from unpacking data	September 25, 2019
	Creating personas and a flow diagram	September 27, 2019
	How Might We Statement Defined	September 29, 2019
Ideate	First round of brainstorming complete	September 30, 2019
	Second round of brainstorming complete	October 2, 2019
	Third round of brainstorming complete	October 3, 2019
	Top three ideas selected	October 6, 2019
	Design review 1	October 7, 2019
	Design 0 selected	October 11, 2019
Prototype	Bodystorming	October 16, 2019

	Prototype 0.1 constructed	October 17, 2019
	Key features defined	October 20, 2019
	Prototype 0.2 constructed	October 21, 2019
Test 1	Field testing with prototype 0.2	October 22, 2019
	Reaching out to friends and family	October 24, 2019
Iterate 1	Determining parts needed to build	October 26, 2019
	CAD designs completed	November 4, 2019
	Electrical systems integrated	November 10, 2019
Test 2	Testing through use and conversations with friends and family	November 12, 2019
	Design Review 3	November 13, 2019
	Testing at senior center	November 22, 2019
	Real world testing with Theresa's grandparents	November 27, 2019
Iterate 2	New parts received for assisted pouring	December 2, 2019
	New CAD with snap case and hinged lid completed	December 4, 2019
	Electrical systems reworked	December 6, 2019
Market Analysis	Market potential research	December 2, 2019
	Research on competing products	December 4, 2019
Manufacturing and scaling up	Analysis of scale up cost of production	December 4, 2019
	Exploration of manufacturing techniques	December 5, 2019
	Final Review	December 7, 2019
Iterate 3	Final part orders arrive	January 10, 2020
	Final CAD and assembly complete for prototype 3	January 30, 2020
	User testing and tweaks	February 20, 2020

Launch Preparation	Website launched	December 4, 2019
	Demo decks and marketing media produced	February 14, 2020
	Landing page opened to public	February 28, 2020
Low rate initial production (LRIP)	R&D completed and materials purchased	March, 2020
	Assembly machine purchased	April, 2020
	Initial production begins	May, 2020
Full rate production (FRP)	Projected monthly positive cash flow	July, 2020
	projected total positive cash flow	July 2021
	100,000th unit sold	Dec, 2021

4. Physical Description

4.1. List of Requirements

4.1.1. Customer Requirements before Concept Design

Customer requirements for the pitcher were found through doing user interviews as well as conducting a conjoint analysis survey.

Table 4: Customer Requirements.

Index	Category	Customer Requirement	Abstract Function Name
CR-1	Basics	hold enough water to hydrate someone for a few hours	Water Capacity
CR-2	Basics	have bold color contrasts between parts and surroundings	Visual Contrast / Color
CR-3	Basics	be able to function in a house on a hot day	Max Service Temperature
CR-4	Basics	be able to be stored in a fridge	Min Service Temperature
CR-5	Food Safety	be food safe	Foodsafe
CR-6	Insulation	keep cold water insulated	Insulation
CR-7	Easy to lift	be able to be gripped easily	Easy to Hold
CR-8	Easy to lift	be able to be lifted easily	Easy to Lift
CR-9	Hard to tip over	be difficult to tip over	Stability
CR-10	Remind users to drink	allow user (or caregiver) to set frequency of reminders	Reminder Frequency Adjustment
CR-11	Remind users to drink	allow user (or caregiver) to set intensity of light	Visual Intensity Adjustment
CR-12	Remind users to drink	prevent unintended users from messing with initial settings	Setting Adjustment Deterrent
CR-13	Waterfall effect (auditory)	create a waterfall effect inside the pitcher that gives a visual and auditory reminder to drink	Auditory Reminder
CR-14	Visual light effect	create a light effect that catches users' eye	Visual Reminder
CR-15	Easy to extract water	allow water to be extracted from the pitcher without having to lift the pitcher	Easy Pour Functionality
CR-16	Easy to recharge	connect to a power base that recharges the electronics in the pitcher	Power Connection
CR-17	Easy to clean	prevent mold and bacterial growth	Cleanability
CR-18	Easy to service	be easily taken apart	Take-apart Time

CR-19	Easy to service	be easily put back together	Re-assemble Time

4.1.2. Engineering Characteristics of Concept

Table 5: Engineering characteristics.

Index	Category	Functional Requirement	Abstract Function Name
FR-1	Basics	hold at least 6 cups of water	Water Capacity
FR-2	Basics	have high visual contrast between disparate parts, and between normal background colors for interiors (light or white colors)	Visual Contrast / Color
FR-3	Basics	be able to function at 120F	Max Service Temperature
FR-4	Basics	be able to be stored at 30F	Min Service Temperature
FR-5	Food Safety	comply with 21 CFR 174,175,177 (Code of Federal Regulations, Title 21 - Food and Drugs, Part 174 Indirect Food Additives: General, Part 175 - Indirect Food Additives: Adhesives and Components of Coatings, Part 177 - Indirect Food Additives: Polymers)	Foodsafe
FR-6	Insulation	keep 6 cups of water within 80% of its original temp for 3 hours	Insulation
FR-7	Easy to lift	have an ergonomically shaped handle where the valve knob shall not interfere with user's grip on handle	Easy to Hold
FR-8	Easy to lift	have a maximum weight of 2000g	Easy to Lift
FR-9	Hard to tip over	maintain a center of gravity below 10 cm, even when pitcher is full	Low CoG
FR-10	Hard to tip over	have a wide base	Stability
FR-11	Remind users to drink	allow user (or caregiver) to set frequency of reminders	Reminder Frequency Adjustment
FR-12	Remind users to drink	allow user (or caregiver) to set intensity of light	Visual Intensity Adjustment
FR-13	Remind users to drink	prevent unintended users from messing with initial settings by having a protective lid over the adjustment dials	Setting Adjustment Deterrent
FR-14	Waterfall effect (auditory)	pump water with enough force such that it reaches the top of the pitcher and cascades out of the spout with enough momentum to create an aesthetic waterfall shape and create a sound of 55 decibels	Auditory Reminder
FR-15	Visual light effect	activate LEDs to 400 lumens	Visual Reminder

FR-16	Easy to extract water	have a valve knob on the handle that causes water to be released from a spout at the bottom of the handle	Easy Pour Functionality
FR-17	Easy to extract water	valve knob should be able to turned with XX N of force or less	Max Knob Force
FR-18	Easy to recharge	connect to a power base that recharges the electronics in the pitcher	Power Connection
FR-19	Easy to clean	be able to receive and be cleaned by a pour-in cleaning solution	Chemically Compatible with Cleaner
FR-20	Easy to clean	have no sharp corners	Smooth Surfaces
FR-21	Easy to clean	have no rough surfaces that can grow bacteria	Smooth Textures
FR-22	Easy to service	be easily taken apart (XX% of study participants can take apart without instructions)	Take-apart Time
FR-23	Easy to service	be easily put back together (XX% of study participants can put back together without instructions)	Re-assemble Time

4.2. Key Design Changes (Senior Design)

4.2.1. Zac - Valve-actuated pump switch & food grade impeller pump

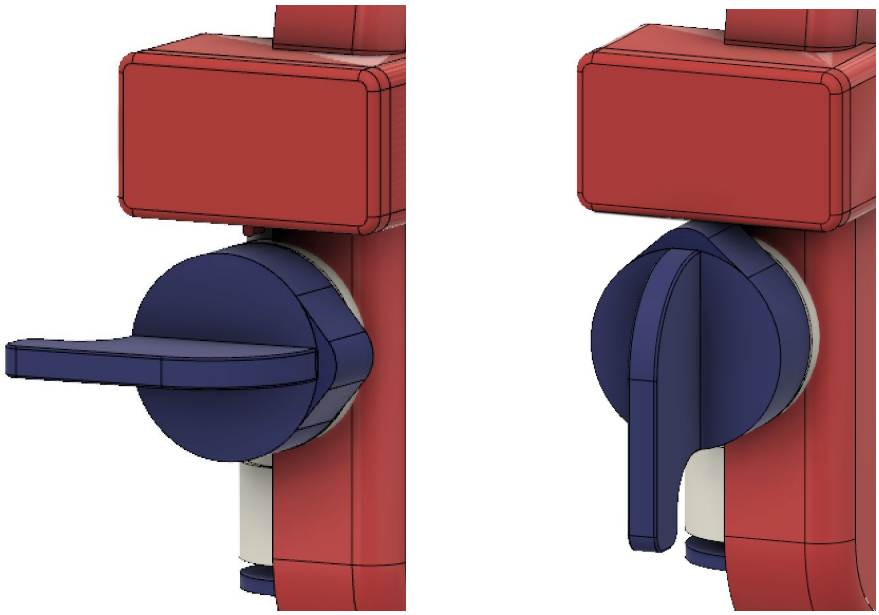


Figure 8: At left: Valve closed, switch open. At right: Valve open, switch depressed

Our previous pitcher iteration includes a valve/spigot that can be used for dispensing water from the handle, to ease the burden of lifting and pouring from the pitcher. With the valve open, a user would then need to manually activate the pump. To improve the ease of use of the

product, a switching system was added so that a small snap switch is depressed when the pouring valve is open. This switch is wired into the pitcher controller, and sends a signal to automatically turn on the pump when the valve is in the open position, and shut it off when in the closed position. A cam-like lobe is integrated into the valve handle, such that the snap switch is fully depressed when the valve is open, and fully open when the valve is closed.

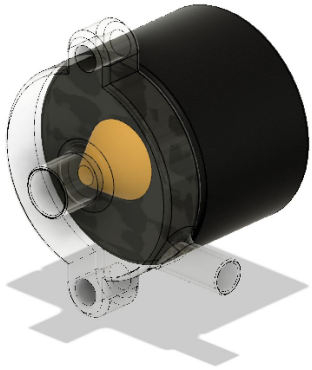


Figure 9: Food Grade Impeller Pump

Additionally, our previous prototypes included a pump that was not food grade. For our next iteration, a food grade impeller pump with a claimed volumetric flow rate of 2.2L was selected. An approximate CAD model based on the published dimensions was generated and is shown above.

4.2.2. Clara - Ergonomic handle, DFM changes

4.2.2.1. Ergonomic Handle

Our previous prototypes successfully integrated a pipe-splitter and valve into the handle, but failed to create an ergonomic shape that was easy to grip. Two key features were added to the handle in order to improve ergonomics: 1) a bent handle and 2) a thumb indent.

Figure 10: Ergonomic handle

The action of pouring requires a strong grip around the handle that holds the jug firmly in place, as well as mechanical leverage from the thumb (supported by wrist muscles) to tip the pitcher forward and down.

Creating a bulge where the fingers and palm can grasp increased the available area for gripping, which decreases grip pressure. Ergonomic research also dictates that a grip diameter of 1-2 inches maximizes grip strength, so the width of the improved handle was increased to 1.02 inches, with a depth of 1.2 inches. Conveniently, we were again able to combine form and function by moving the location of the pipe splitter upwards to the exact location the fingers will wrap around.

The change in handle angle also aids in pouring ability by decreasing the amount of travel the hand and wrist have to make in order to tip the pitcher. With a vertical handle, the wrist must bend from 0 degrees at vertical, to 90 degrees flat. With an angled handle (rough angle of 45 degrees), the wrist only needs to travel half that distance. Curving the handle angle also allowed more space for the hand to rest without hitting the valve at the bottom.

Finally, the thumbhold provides an inviting space for the thumb to rest and allows the grip posture to better emulate “natural fist posture” where the fingers wrap around the palm and the thumb sits on top.

4.2.2.2. Design For Manufacturing and Assembly Changes

Our prototype 2 water pitcher is a fairly complicated design to manufacture and assemble. The basic assembly of major components totals to almost 20 steps.

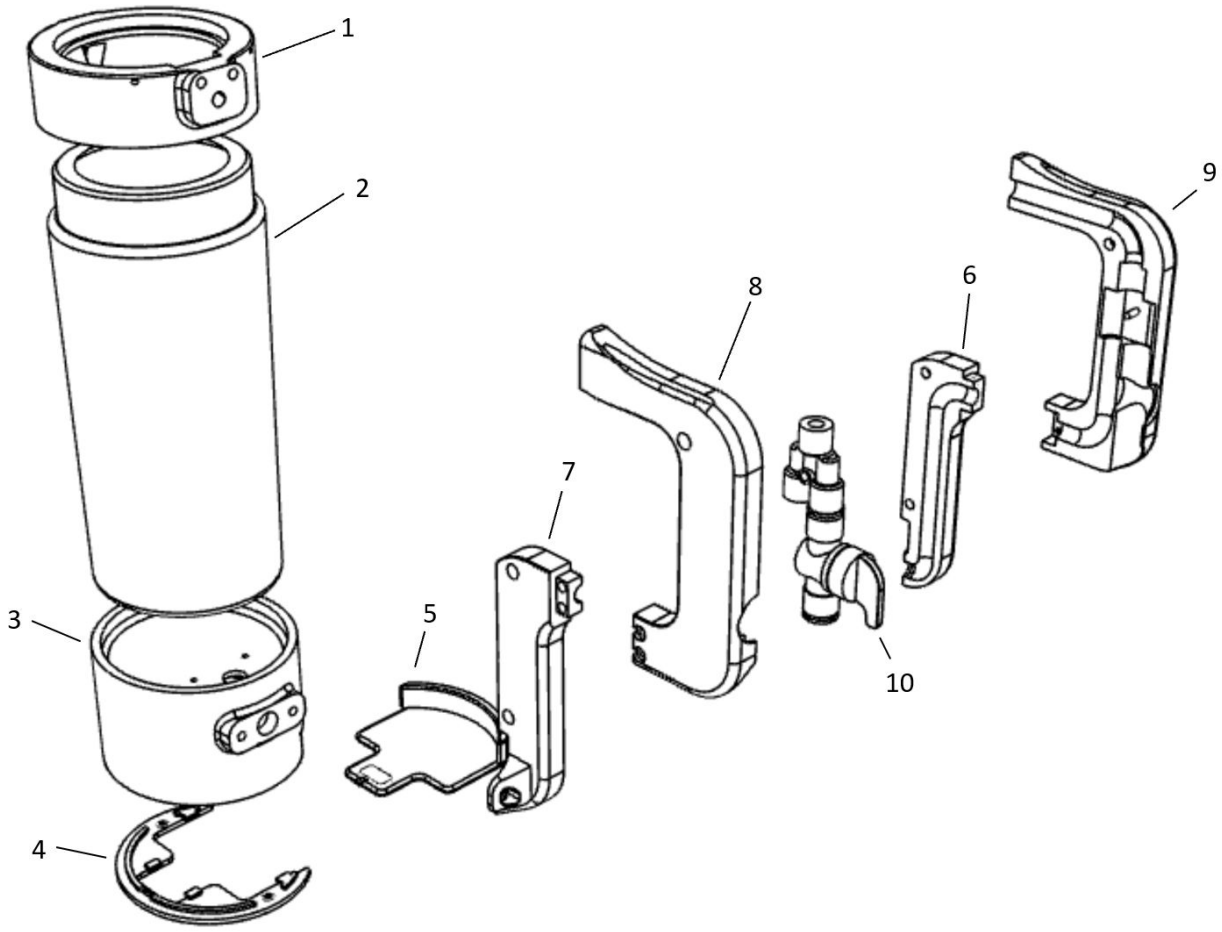


Figure 11: Exploded view assembly notes

Mechanical / System-level Assembly:

1. Insert bottom pipe (not shown) into bottom of pitcher belly (2)
2. Snap LED lights into the outer ring of the base (3)
3. Line up base (3) with bottom pipe (not shown) and thread it through the hole
4. Insert pump into base, fastening with pump bracket, and attach to the bottom pipe
5. Attach the cap (1) to the top of the pitcher belly (2), making sure to orient it correctly
6. Screw in the right side of the handle (6,9) to the cap (2) and base (3)
7. Connect tubes to the splitter and valve system (10)
8. Lower the entire tube/splitter/valve pipe system (10) into the right side handle (6,9)
9. Connect the bottom pipe to the pump, connect the upper pipe to the cap opening
10. Thread the electric wires from the valve system (10) into the base (3)
11. Attach the left side of the handle (7,8) to the right side of the handle (6,9)
12. Attach the left side of the handle (7,8) to the cap (1) and base (3)
13. Place the lid (not shown) inside the cap and thread the hinge through the cap and lid
14. Connect the pump wires, LED wires and potentiometer wires to the battery & Arduino
15. Snap the bottom plate (4) over the base (5) to seal the pitcher

Below is a summary of the desired changes to make our pitcher easier to manufacture and assemble, along with justification from principles of DFM/DFA.

Table 6: DFM changes

Change	Principle of DFM/DFA
combine some of base parts into a single part (dial plate, etc.)	reduce component count
create locating features for base and lid to attach to pitcher	prevent misalignment
snap fits between L & R sides of handle	minimize fasteners
snap fits between base and baseplate	minimize fasteners
create thin wall features	reduce weight
standardize all holes	standardize components
remove metal hinge in lid and instead use a single plastic part	reduce component count
divide into subassemblies: 1) Handle:valve/splitter/tubing, 2) Base:electronics/pump, 3) Pitcher Belly + lid	use subassemblies
countersink all screw holes	easy to fit in parts
create oblong holes	easy to fit in parts
modify baseplate to not be so "C" shaped	avoid tangling of components in mass
etch labels into dialplate	avoid added labels
etch labels into baseplate	avoid added labels

4.2.3. Crystal - Insulated body, food safe material

4.2.3.1. Dual-Lined Body

From our various emotion fieldwork experiences, a popular feature many people expressed an interest in for our pitcher is temperature control. Potential users said ideally they would want their beverages to either stay hot or stay cold for long periods of time. Moving forward from Prototype 2, our team looked into options for how to design an insulating but still clear pitcher base because the key feature of this product is its visible waterfall effect. After some research we decided that having a dual-lined pitcher body would be the best choice for the next iteration. It still provides transparency to see the pitcher contents and creates an insulation layer that can maintain the beverage temperature longer. Renderings for how this body would roughly look like by itself and attached to the lid base are below:

Figure 12: New body rendering

4.2.3.2. Food safe Material

Another design change that can be worked into future iterations is manufacturing with food safe materials. Common plastics used for containers meant to carry food are listed below along with their applications in common household products. Considering quality and costs, using high-density polyethylene (HDPE) would be the most reasonable food safe material. The material is safe, rigid, and resistant to heat. HDPE is especially compatible with manufacturing procedures such as injection molding. In addition, it is cost effective and sustainable, produced with recycled plastic.

Table 7: Foodsafe material summary.

Polyethylene terephthalate (PET) resin	Polypropylene (PP)	High-density polyethylene (HDPE)	Low-density polyethylene (LDPE)	Polycarbonate (PC)
ex. peanut butter jars	ex. bottle caps	ex. milk jugs	ex. squeeze bottles	ex. water jugs
				

4.3. Renderings and Analysis

The WATERFÜL pitcher prototype 2 is shown below in renderings and in full physical form as well. The renderings detail the novel portions of the structure including the hinged lid and the spout integrated within the handle. The constructed prototype differs slightly from the renderings in that the handle is broken up into four separate pieces for ease of manufacturing. The internal structure of the handle is shown in a cross section isometric view of an isolated handle half. As shown, the line from the pump in the base travels into a Y splitter. This splits the line into the spout valve and towards the top of the pitcher when the valve is closed.

Figure 13: Rendering of full pitcher assembly.

Figure 14: Rendering of hinged lid.

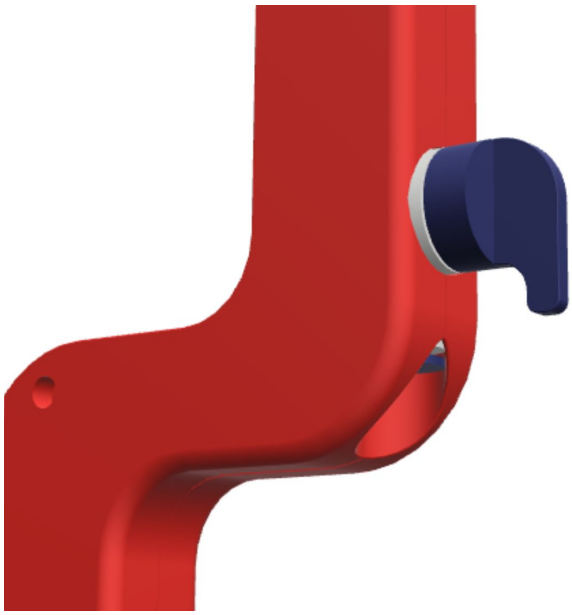


Figure 15: Rendering of handle spout.

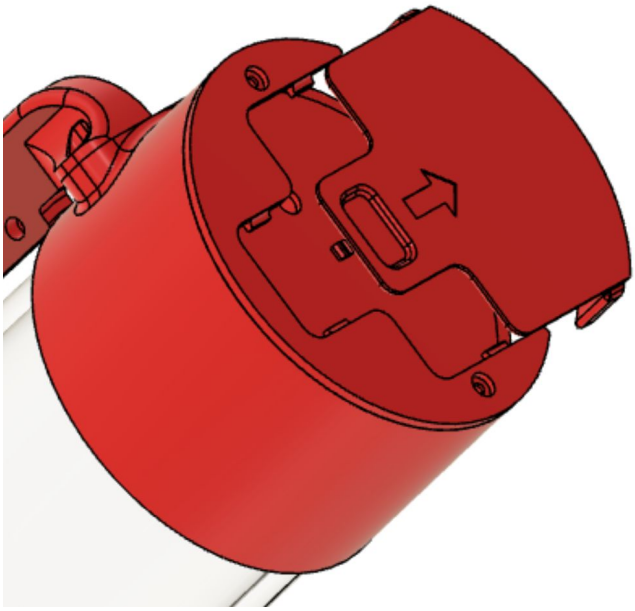


Figure 16: Rendering of the base lid.

Figure 17: Completed prototype 2.

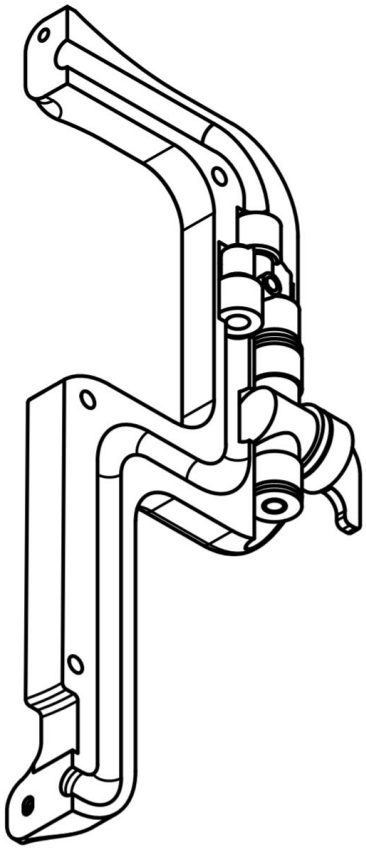


Figure 18: Isometric cross-section of handle spout.

4.3.1. Analytical Hierarchy Process

The Analytical Hierarchy Process (AHP) was used to interpret some of the main themes gathered during empathy fieldwork. The analysis concluded that our group was in agreement about the most important emotional categories identified during unpacking.

Table 8: AHP tables.

	Stress on Care Takers	Health	Resilience	Fun & Fulfillment	Connection with Others	Indepen-dence	sum
Stress on Care Takers	1	0.14	0.33	0.33	0.2	0.33	2.33
Health	5	1	5	3	0.33	1	15.33

Resilience	3	0.14	1	0.2	0.14	0.2	4.68
Fun & Fulfillment	3	0.33	3	1	0.33	1	8.66
Connection with Others	7	3	5	3	1	5	24
Independence	3	0.33	1	1	0.2	1	6.53
sum	19.33	4.72	11.2	10.66	2.81	13.33	

	Stress on Care Takers	Health	Resilience	Fun & Fulfillment	Connection with Others	Independence	Weights
Stress on Care Takers	0.05	0.03	0.02	0.04	0.09	0.04	0.04
Health	0.23	0.20	0.33	0.35	0.15	0.12	0.23
Resilience	0.14	0.03	0.07	0.02	0.06	0.02	0.06
Fun & Fulfillment	0.14	0.07	0.20	0.12	0.15	0.12	0.13
Connection with Others	0.32	0.61	0.33	0.35	0.45	0.59	0.44
Independence	0.14	0.07	0.07	0.12	0.09	0.12	0.10
sum	1	1	1	1	1	1	1

weighted sum vector		consistency vector
0.26	0.05	5.89
1.37	0.08	5.97
0.33	0.12	5.78
0.75	0.45	5.76
2.61	0.27	5.91
0.58	0.03	5.88
	average consistency (l)	5.87

	consistency index (l-n)/(n-1)	0.03
	consistency ratio, CR/RI	0.02
		Consistent/Informed!

4.3.2. Quality Functional Diagram (HOQ)

The Quality Functional Diagram (also known as the House of Quality) was used to take our customer requirements, functional requirements, and competitor analysis and find the most important functional requirements to focus on in our prototype.

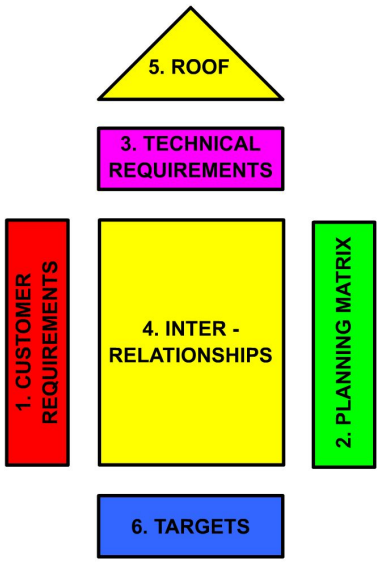


Figure 19: HOQ Overview

The first part of the QFD is the Customer Requirements, shown in detail below:

Row #	Max Relationship Value	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")
1	9	12.1	7.0	Be able to lift up pitcher
2	9	6.9	4.0	Provide visual stimuli
3	9	10.3	6.0	Provide audio stimuli
4	9	8.6	5.0	Remind at timed intervals
5	9	12.1	7.0	Be spill resistant
6	9	12.1	7.0	Allow for "tunability"
7	9	12.1	7.0	Be intuitive to use (not require instruction manual)
8	9	8.6	5.0	Water filtration
9	9	8.6	5.0	Temperature control
10	9	8.6	5.0	Flavor control

Figure 20: HOQ Customer Requirements.

These customer requirements were derived from our initial testing research with users using animated GIF's, verbal descriptions, and a rough "Prototype 0B" which had basic light and sound features. Each of the customer requirements were weighted on a scale of 1-10 with 1 being not important at all and 10 being extremely essential. The weights were decided by both through the number of times a certain requirement was brought up during an interview as well as the amount that users emphasized or expanded upon that requirement.

The second section of the HOQ is the Planning Matrix, or Competitive Analysis. For each customer requirement, we compared our pitcher on a 1-5 scale to other existing products on the market (see the Competitors, Market Identification section for more details).

Row #	Max Relationship Value	Relative Weight	Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats")	Our Company	Hidrate Spark 2.0	Brita Infinity	H2O Pal	Build Life 1	Competitor 5
1	9	12.1	7.0	Be able to lift up pitcher	1	3	2	3	1	
2	9	6.9	4.0	Provide visual stimuli	4	4	0	2	1	
3	9	10.3	6.0	Provide audio stimuli	4	0	0	2	0	
4	9	8.6	5.0	Remind at timed intervals	4	3	0	3	1	
5	9	12.1	7.0	Be spill resistant	2	3	2	3	3	
6	9	12.1	7.0	Allow for "tunability"	4	2	0	2	0	
7	9	12.1	7.0	Be intuitive to use (not require instruction manual)	3	3	2	2	5	
8	9	8.6	5.0	Water filtration	2	0	4	0	0	
9	9	8.6	5.0	Temperature control	3	1	1	1	1	
10	9	8.6	5.0	Flavor control	3	1	1	1	1	

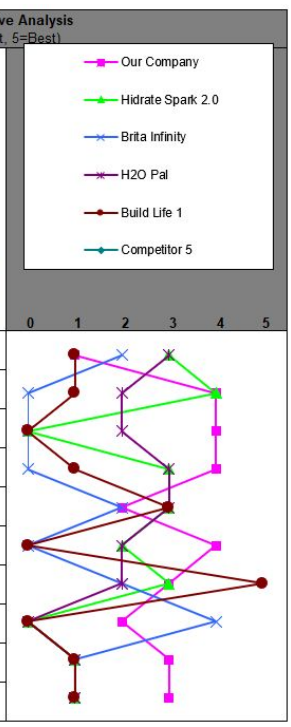


Figure 21: HOQ Planning Matrix.

The next part of the HOQ was the engineering characteristics, which describe the functional requirements of the system. These requirements are derived from customer requirements but translated into specific product attributes and performance metrics that can be measured. Above each characteristic, we indicated whether our product should maximize, minimize or hold steady that characteristic.

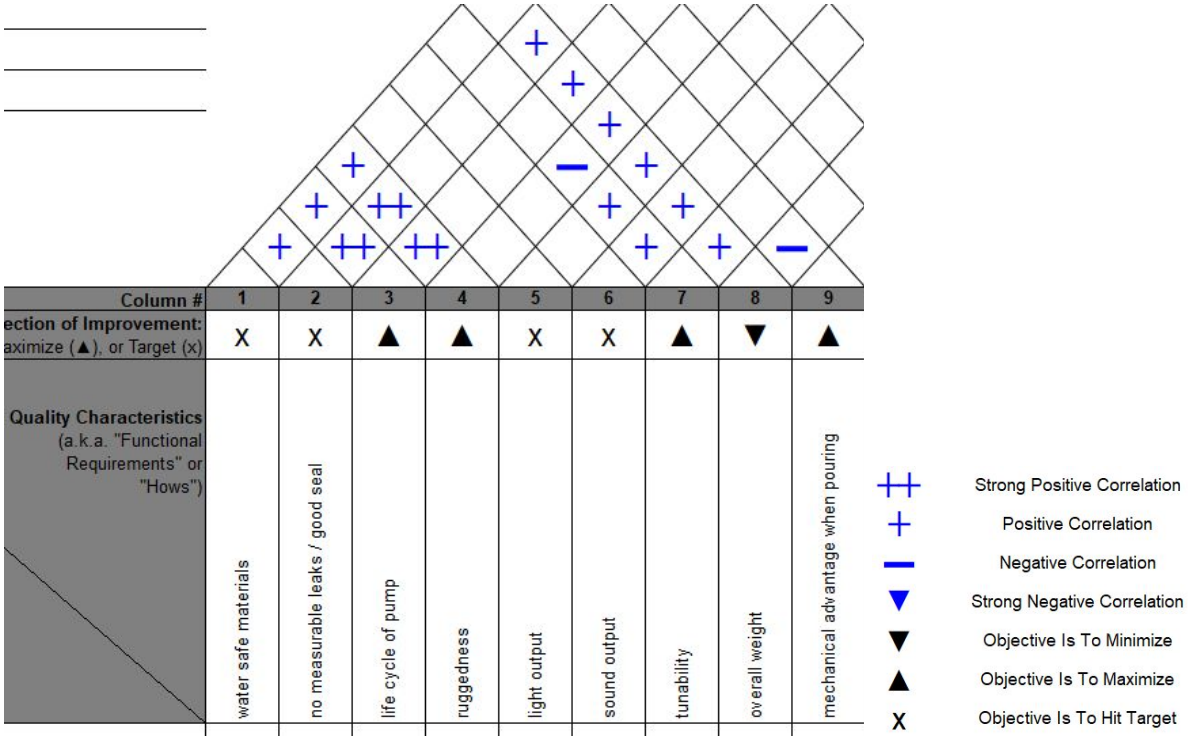


Figure 22: HOQ Engineering Characteristics.

Above the engineering characteristics is the “roof” of the House of Quality, in which each functional requirement is compared to the others. A “++” indicates a strong positive correlation between the two characteristics, i.e. improving one of the characteristics strongly improves the other. For instance, increasing the life cycle of the pump increases the ruggedness of the pitcher. A single “+” indicates a positive correlation, and a “-” indicates a negative correlation (increasing one characteristic worsens another, such as adding tunability decreases ruggedness since one more thing on the pitcher can break).

The engineering characteristics and customer requirements are combined in the middle portion of the matrix. Each customer requirement is compared to each engineering characteristic and it is decided whether there is a strong relationship, moderate relationship, or weak relationship between the two. Each of these levels corresponds to a weight of 9, 3, or 1, respectively, and is represented with a magenta symbol (see below).

⊖	Strong Relationship	9
O	Moderate Relationship	3
▲	Weak Relationship	1

	Direction of Improvement: Minimize (▼), Maximize (▲), or Target (x)	x	x	▲	▲	x	x	▲	▼	▲
Weight / Importance	Demanded Quality (a.k.a. "Customer Requirements" or "Whats") / Quality Characteristics (a.k.a. "Functional Requirements" or "Hows")	water safe materials	no measurable leaks / good seal	life cycle of pump	ruggedness	light output	sound output	tunability	overall weight	mechanical advantage when pouring
7.0	Be able to lift up pitcher	▲	▲	▲	O	▲	▲	▲	⊖	⊖
4.0	Provide visual stimuli	▲	▲	O	▲	⊖	▲	⊖	O	▲
6.0	Provide audio stimuli	▲	▲	▲	▲	▲	⊖	⊖	O	▲
5.0	Remind at timed intervals	▲	▲	O	O	⊖	⊖	⊖	▲	▲
7.0	Be spill resistant	▲	⊖	O	⊖	▲	▲	▲	O	O
7.0	Allow for "tunability"	▲	▲	O	O	O	O	⊖	▲	▲
7.0	Be intuitive to use (not require instruction manual)	▲	▲	▲	▲	O	O	⊖	▲	O
5.0	Water filtration	O	O	⊖	O	▲	▲	O	⊖	O
5.0	Temperature control	O	O	▲	O	▲	▲	⊖	⊖	O
5.0	Flavor control	▲	▲	▲	O	O	▲	▲	⊖	O

Figure 23: HOQ Matrix.

At the very bottom of the House of Quality, we defined Target or Limit Values for each of our engineering characteristics. We then rated how difficult it would be to achieve each values. Built-in functions in the table then took the difficulty levels of each engineering characteristic, as well as the weighted customer requirements and customer-engineering requirement relationships to give a final weighted total for each engineering characteristic. The higher weighted engineering characteristics were ones that were easy to achieve yet were highly valued by customers.

Target or Limit Value	must have water safe materials	must have no leaks	5 year lifespan	will not break if dropped from standing height	equivalent brightness to desk lamp	as loud as a microwave timer at loudest	have 4 different settings	less than 2 lbs	1:3 mech advantage
Difficulty (0=Easy to Accomplish, 10=Extremely Difficult)	4	4	3	6	4	4	7	5	7
Max Relationship Value in Column	3	9	9	9	9	9	9	9	9
Weight / Importance	134.5	231.0	248.3	313.8	289.7	300.0	586.2	462.1	296.6
Relative Weight	4.7	8.1	8.7	11.0	10.1	10.5	20.5	16.1	10.4

Figure 24: HOQ Target values.

The rankings for our engineering requirements are described graphically below:

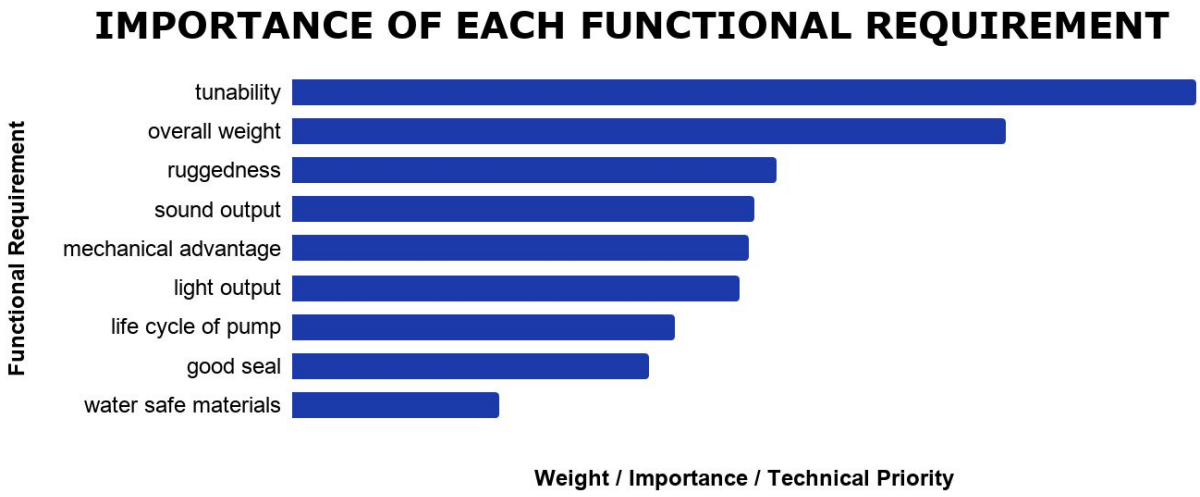


Figure 25: HOQ Importances chart.

5. Financial Requirements

5.1. Pricing Policy

The WATERFÜL pitcher will be priced at the $50 range. This amount was motivated by both competitor products and the results of the conjoint analysis survey conducted by the team. Section 2.1.3 details the results of our conjoint analysis, showing that consumers place priority in the costing of our product and are willing to pay up to $50 while maintaining a positive utility factor in the device. This data is once again highlighted below.

Section 2.2 details the similar products that WATERFÜL would be competing with. Products that are priced more than WATERFÜL offer very different features, and are marketed towards a very different demographic. Some of these devices are IoT connected and may prove difficult to use and overwhelming for seniors. However, all of these devices lack the unique organic stimuli that WATERFÜL provides, giving our product an edge in the market. Those that are priced less than WATERFÜL are simply lacking in features and novelty, once again separating their customer segment from ours.

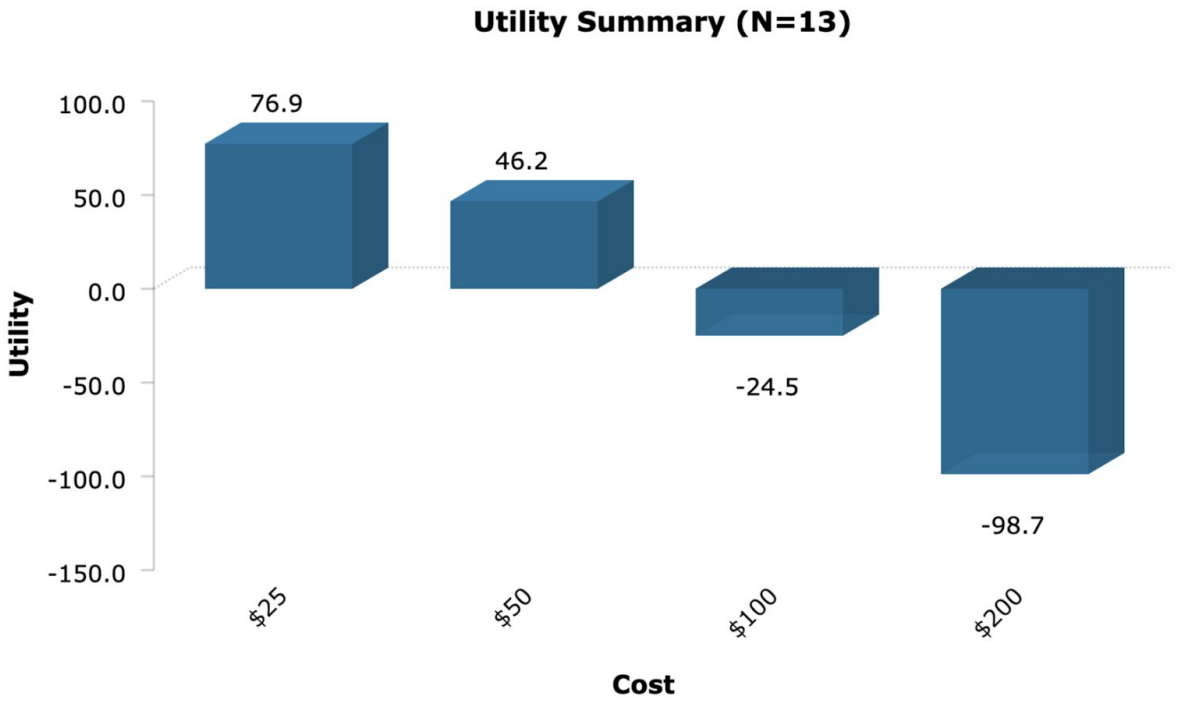


Figure 26: Conjoint analysis utility graph for product price.

5.2. Financial Executive Summary

Table 9: Financial Executive Summary for KÜL MAYK.

EXECUTIVE SUMMARY ($ in thousands)

Year	2020	2021	2022	2023	2024	2025
Sales	$550	$750	$1,100	$1,450	$1,750	$2,100
Gross Margin	$462	$630	$924	$1,217	$1,469	$1,763
Operating Profit	$34	$275	$569	$781	$1,034	$1,328
Percent of Sales	*6.23%*	*36.63%*	*51.69%*	*53.89%*	*59.10%*	*63.25%*
Total Headcount	7	7	7	8	8	8

5.3. Income Statement

Table 10: Projected Income Statement for KÜL MAYK.

INCOME STATEMENT ($ in thousands)

Year	2020	2021	2022	2023	2024	2025
WATERFÜLs Sold (thousands)	11	15	22	29	35	42
Sales	$550	$750	$1,100	$1,450	$1,750	$2,100
COG	$88	$120	$176	$233	$281	$337
Gross Margin	**$462**	**$630**	**$924**	**$1,217**	**$1,469**	**$1,763**
Percent of Sales	*83.96%*	*83.96%*	*83.96%*	*83.96%*	*83.96%*	*83.96%*
Rent	$30	$30	$30	$36	$36	$36
R&D & Engineering	$120	$60	$60	$60	$60	$60
Manufacturing & Operations	$105	$95	$95	$95	$95	$95
Sales & Marketing & Customer Support	$110	$110	$110	$184	$184	$184
Administrative	$60	$60	$60	$60	$60	$60
Operating Expenses	**$425**	**$355**	**$355**	**$435**	**$435**	**$435**
Capital Expenses	$3	$0	$0	$1	$0	$0
Operating Profit	$34	$275	$569	$781	$1,034	$1,328
Percent of Sales	*6.23%*	*36.63%*	*51.69%*	*53.89%*	*59.10%*	*63.25%*
Tax Rate	*20.00%*	*20.00%*	*20.00%*	*20.00%*	*20.00%*	*20.00%*
	$7	$55	$114	$156	$207	$266
Net Income	$27	$220	$455	$625	$827	$1,063
Percent of Sales	*4.99%*	*29.30%*	*41.35%*	*43.11%*	*47.28%*	*50.60%*

5.4. Operations Headcount

Table 11: Projected Employee Headcount for each division of KÜL MAYK.

Headcount

Year	2020	2021	2022	2023	2024	2025
R&D & Engineering	2	1	1	1	1	1
Manufacturing & Operations	2	2	2	2	2	2
Sales & Marketing & Customer Support	2	2	2	3	3	3
Administrative	1	2	2	2	2	2
Total Headcount	**7**	**7**	**7**	**8**	**8**	**8**

Headcount Rationale:

- R&D & Engineering: Most of the research and development efforts would be required during the first year of operation in order to arrive at a final, manufacturable design. After that, a single engineer would suffice to make changes based on market/manufacturer feedback.
- Manufacturing & Operations: For the first year, much of the manufacturing effort will be put into automating assembly, since all the parts will be ready-for-assembly upon shipping to our facility. After that, there will be a concentration on upkeep of machines and keeping up with demand.
- Sales & Marketing: During the first three years, Sales and Marketing efforts will be to introduce our product to market and push for acquiring deals with local stores and distributors. After widespread marketing, an additional team member will be brought on to keep up with increased projected sales during and after the fourth year in-market.
- Administrative: We expect administrative duties to be split amongst two people, including intake of shipped parts, maintenance and managing of our facility, and general management duties.

5.5. Warranties

A limited warranty will cover defects and damages during manufacturing and shipping, along with damages from normal usage and wear. Due to potential design changes in the future, we would have to specify that only approved filters be used, otherwise our warranty would be void. Our policy would need to be outlined before we sign with any stores, resellers, or distributers, as we would want to be the facilitator or our warranty. To minimize hassle for the consumer, only refunds will be offered, not replacements.

5.6. IRR/ROI

Looking at the first projected six years of operation, we created a model that showed us the viability of our business. With a six year NPV of $149,691, based upon an averaged discount rate of 10% (slightly below average of the past few years) our project is certainly a worthwhile venture. Our base model's detailed assumptions and figures can be seen below:

Table 12: Projected Cash Flows for first 6 years and IRR.

INVESTMENT REQUIRED	50000
CASH FLOW	
Year 1	58167
Year 2	312000
Year 3	662000
Year 4	952000
Year 5	1252000
Year 6	1265160
IRR	298.65%

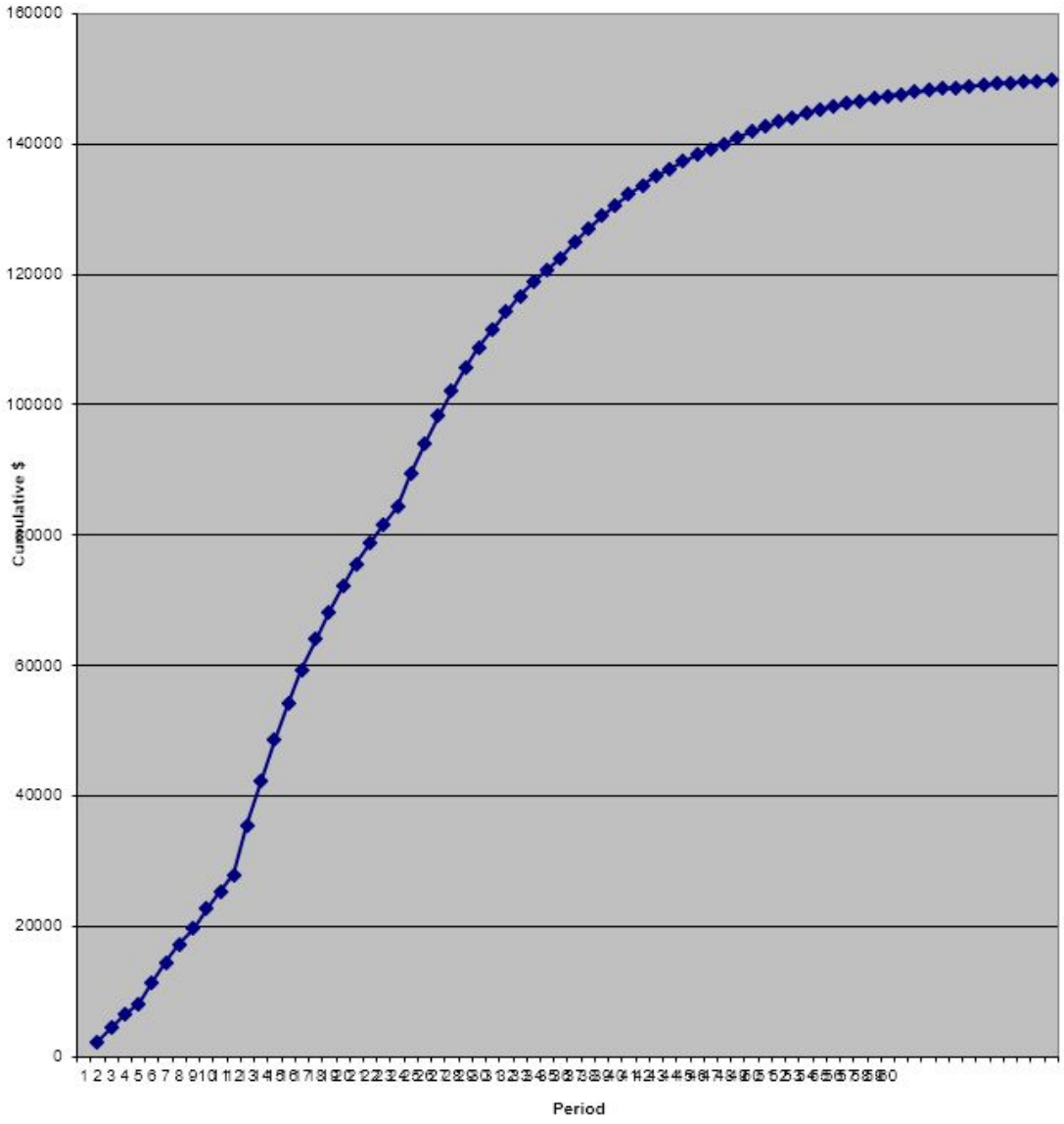


Figure 27: Cumulative Discounted Cash Flow for KÜL MAYK.

5.7. Capital Investment Required

Just under $50,000 will be needed to get the WATERFÜL pitcher to market successfully. This will fund the first month's activities, including salaries, development costs, initial sales, and manufacturing costs. After that, KÜL MAYK will be self sustaining, quickly increasing cash flow as can be seen in the analysis below.

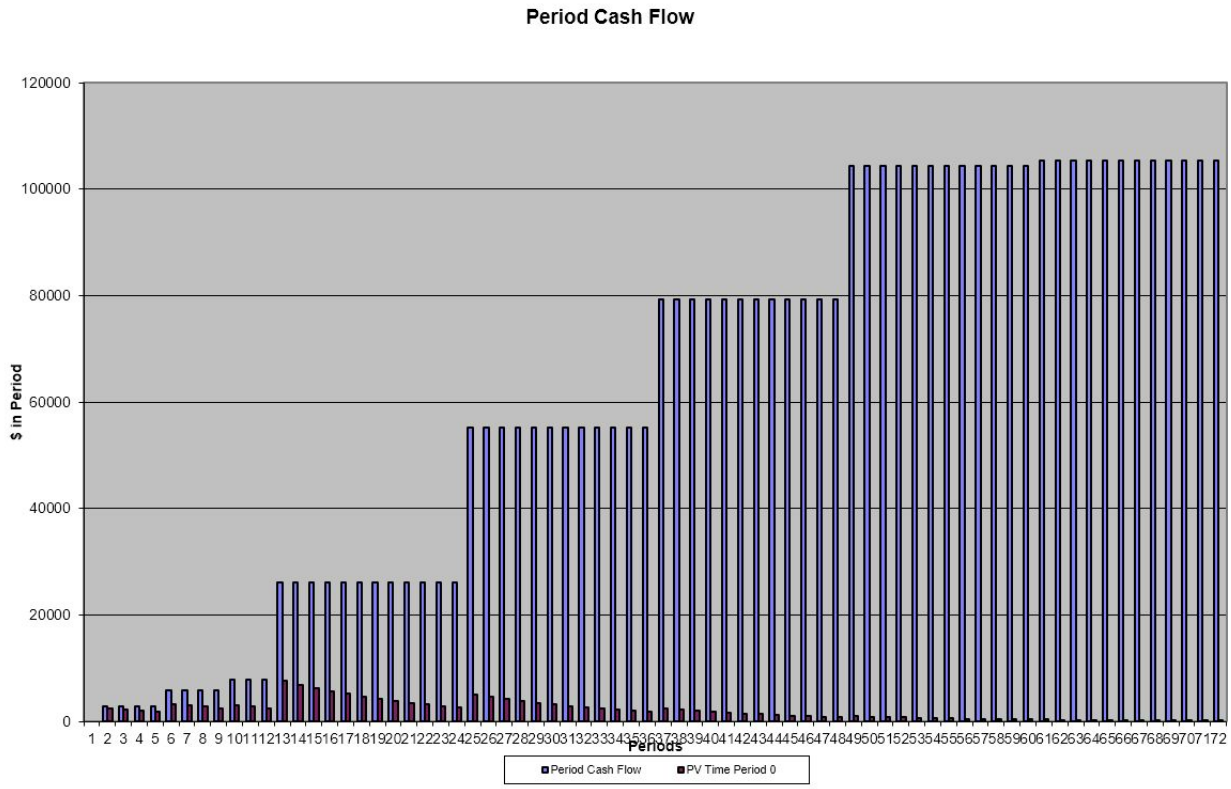


Figure 28: Capital Investment required for KÜL MAYK

5.8. Part Costs

5.8.1. Prototyping Costs

The total cost of prototyping to this point has totaled to $361.06 in material costs, without including costs of labor. The table below outlines specifically the cost of production for one unit of the WATERFÜL pitcher in prototyping stage. The individual components are separated into hardware and electronics and links to buy have been embedded in the Source column. The main costs in this system are the pitcher, Arduino microcontroller, and the 3D printed parts.

The cost for one prototype unit is $61.60.

As we move into FRP, the costs can be reduced drastically by creating a custom analog PCB to simplify the electronics and eliminate the need for a microcontroller. This design will also

minimize the space of the base unit. Furthermore, the pitcher and handle, base, and lid parts can be purchased for substantially less once they are on full scale production with injection molding.

Table 13: Bill of materials for single prototype unit.

Item	Qty	Unit cost	Total Cost	Source	Notes
Hardware					
Splitter	1	$1.33	$1.33	here	y splitter
Valve	1	$3.33	$3.33	here	push to connect for spout
Tubing	2	$0.15	$0.30	here	1/4 OD
Screws	15	$0.05	$0.75		M3 screws
Heat set inserts	15	$0.28	$4.20	here	Connecting pieces
Filament for 3D printing	1	$8.00	$8.00		
Pitcher	1	$14.73	$14.73	here	Shorter sleek pitcher
Marine Epoxy	0.2	5.79	$1.16	here	joining fitting to pump
Electronics					
Arduino Uno	1	$10.99	$10.99	here	microcontroller
9V battery	1	$1.38	$1.38	here	power
Potentiometer	1	$4.50	$4.50	here	dials on bottom
Pump	1	$5.00	$5.00	here	comparable pump
Relay	1	$2.90	$2.90	here	for activating the pump
Neopixels	$0.10	19.99	$2.00	here	lights for pump
Switch	1	$0.47	$0.47	here	on/off for prototype
Button	1	$0.67	$0.67	here	actuating the pump

5.8.2. Production Costs

At full scale production, the cost for one unit depends greatly on the number of units we plan to produce. As an initial investigation, we projected the cost of raw materials for one unit of a finished pitcher at a 5000 lot with a PCB and mass produced body components. The table below highlights these findings with links to quotes from various vendors.

The total cost for one production unit when producing a lot of 5,000 is $8.02.

Once again, economies of scale can push this cost even lower to maximize profits when selling the product at $50. Labor for assembly and R&D costs are also not factored into this analysis currently.

Table 14: Bill of materials for single production unit.

Item	Qty	Unit cost	Total Cost	Min Order Qty	Quote	Notes
Hardware						
Splitter	1	$0.07	$0.07		link	Y push to connect
Valve	1	$0.18	$0.18	1000	link	plastic push to connect
Tubing	0.5	$0.10	$0.05		link	0.10 per meter
O-Ring	1	$0.02	$0.02	1000	link	for seal on lid
Pump	1	$0.50	$0.50	1000	link	12V, used in coffee machines
Lid, Handle, and Base	1	$2.53	$2.53		link	3x3x6 envelope, injection molded
Pitcher	1	$0.70	$0.70	5000	link	Comparable glass model
Electronics						
PCB	1	$1.00	$1.00	1000	link	JLC 2"x2" - factored in with components mounted
18650 battery	3	$0.70	$2.10		link	for power, 3.7V
BMS	1	$0.55	$0.55		link	battery management system for balanced charging
Lights	0.2	$1.00	$0.20	1000	link	$1/meter - estimated 20 cm per unit
Potentiometer	2	$0.06	$0.12		link	Dial for device

6. Life Cycle Targets

6.1. Installation Costs

The product in its current form carries no installation cost. It arrives to the user in fully assembled condition.

6.2. Reliability (mean time to failure)

To maximize the reliability of the WATERFÜL pitcher, KÜL MAYK strongly recommends that the pump system run only when submerged. As the pump relies on fluid flow as its primary cooling mechanism, running the pump dry is liable to cause premature pump system failure. To optimize pump performance and lifespan, KÜL MAYK recommends strictly adhering to the supplied cleaning instructions. This will prevent mineral deposits from forming on the pump, which reduce performance and impart a higher workload on the pump. The pump system was identified as the expected failure point of the pitcher, and thus the estimated mean time to failure was based on pump failure.

The pump used claims a 20,000 hour lifespan under “normal use” and a 24 hour lifespan under a “heavy workload.” Factoring in potential misuses (excessively hot pitcher contents, lack of adherence to cleaning procedures, etc.) and a potentially misleading lifetime advertised by the pump manufacturer, KÜL MAYK estimates an effective pump lifespan of 2,000 hours of operation. Assuming an average daily pump operation of 1 hour, this yields an expected lifetime of approximately 5.5 years.

This estimate neglects gross misuse or abuse of the product, such as significant impacts, submersion of the entire pitcher, and running the pitcher dry, among other cases.

6.3. Failure Mode & Effect Analysis (FMEA)

Table 15: FMEA.

Failure Mode	Likelihood (1 - 5)	Severity	Detectability	Corrective Actions	Mitigation Measures
Cracking/shattering of pitcher due to impact	4	Moderate - Severe	Readily detectable	Sell replacement water vessels, user repair with epoxy/glue/etc.	Shatter-resistant materials, shock absorbent padding on likely impacted surfaces
Pump failure	3	Severe	Readily detectable	Replacement of pump unit	Over-specify pump for

				by user/KÜL MAYK company	safety margin, add feature to detect and stop dry-running
Interface leak	3	Moderate	Detectable	User repair via commercially available sealant	Redundant sealing measures, fewer interfaces requiring sealing
Battery failure	2	Low	Readily detectable	Battery replacement	Make battery replacement easy, with spare units available
Leak into electronics cavity	3	Severe	Likely detectable	Likely full-unit replacement	Redundant sealing measures, further compartmentalization of integrated electronics
Valve failure	1	Moderate	Detectable	Valve replacement by Kul Mayk (Mail-in repair)	Use of high-quality valve
Pump impeller calcification (from insufficient cleaning)	3	Low-Moderate	Detectable	Use of aggressive cleaning solution, possible pump replacement	Include cleaning instructions and market fluid system cleaning solution
LED lighting failure	2	Low	Detectable	Full-unit replacement	Reinforced wiring connections
Charging base	2	Severe	Detectable	Charging	Add backup

fails to charge unit				base replacement	charging option, robust base construction

7. Legal Requirements

7.1. Certification Process

NSF International is a public health and safety organization that has an extensive list of standards for various certifications for water-related products such as water bottles, water filter systems, and water pitchers. Since there are no existing federal regulations for residential water treatment systems, to be NSF Certified is not a requirement for a market product. However, earning the seal of approval does mean that the product has been extensively tested by a reputable third-party organization and has met or exceeded the strict guidelines of the American National Standards Institution (ANSI). This insurance of safety provides a valuable peace of mind for consumers.

The official list of certifications and their descriptions are provided below. The associated numbers reflect the order in which the standard was developed and does not signify a ranking system.

Table 16: NSF Certifications for Water Treatment Systems. Highlighted certifications are relevant to the WATERFÜL pitcher.

NSF/ANSI 42	Filters are certified to reduce aesthetic impurities such as chlorine and taste/odor. These can be point-of-use (under the sink, water pitcher, etc.) or point-of-entry (whole house) treatment systems.
NSF/ANSI 53	Filters are certified to reduce a contaminant with a health effect. Health effects are set in this standard as regulated by the U.S. Environmental Protection Agency (EPA) and Health Canada. Both standards 42 and 53 cover adsorption/filtration which is a process that occurs when liquid, gas or dissolved/suspended matter adheres to the surface of, or in the pores of, an adsorbent media. Carbon filters are an example of this type of product.
NSF/ANSI 44	Water softeners use a cation exchange resin that is regenerated with sodium or potassium chloride. The softener reduces hardness caused by calcium and magnesium ions and replaces them with sodium or potassium ions.
NSF/ANSI 55	Ultraviolet treatment systems use ultraviolet light to inactivate or kill bacteria, viruses and cysts in contaminated water (Class A systems) or to reduce the amount of non-disease causing bacteria in disinfected drinking water (Class B).
NSF/ANSI 58	Reverse osmosis systems incorporate a process that uses reverse pressure to force water through a semipermeable membrane. Most reverse osmosis systems incorporate one or more additional filters on either side of the membrane. These systems reduce contaminants that are regulated by Health Canada and EPA.
NSF/ANSI 62	Distillation systems heat water to the boiling point, and then collect the water vapor as it condenses, leaving behind contaminants such as heavy metals. Some contaminants that convert readily into gases, such as volatile organic chemicals, can carry over with the water vapor.
NSF/ANSI 177	Shower filters attach directly to the pipe just in front of the homeowner's showerhead and are certified to only reduce free available chlorine.
NSF/ANSI 244	The filters covered by this standard are intended for use only on public water supplies that

	have been treated or that are determined to be microbiologically safe. These filters are only intended for protection against intermittent microbiological contamination of otherwise safe drinking water. For example, prior to the issuance of a boil water advisory, you can be assured that your filtration system is protecting you from intermittent microbiological contamination. The standard also includes material safety and structural integrity, similar to other NSF/ANSI drinking water treatment unit standards. Manufacturers can claim bacteria, viruses and cysts reduction for their filtration system.
NSF/ANSI 401	Treatment systems for emerging contaminants include both point-of-use and point-of-entry systems that have been verified to reduce one or more of 15 emerging contaminants from drinking water. These emerging contaminants can be pharmaceuticals or chemicals not yet regulated by the EPA or Health Canada.
NSF P477	These point-of-use filters reduce microcystin (toxins produced by blue-green algae) below the health advisory set by the EPA.
NSF P473	PFOA/PFOS water filters or systems are evaluated on their ability to reduce PFOA and PFOS in drinking water and to meet strict material safety and structural requirements as defined in NSF/ANSI 53.
NSF P231	Microbiological water purifiers are certified for health and sanitation based on the recommendations of the EPA's Task Force Report, Guide Standard and Protocol for Testing Microbiological Water Purifiers (1987) (Annex B).
NSF/JWPA P72	Iodine radioisotope point-of-use treatment options are evaluated for reduction of all forms of iodine in drinking water. This protocol was developed in conjunction with the Japan Water Purifier Association (JWPA).

The NSF certification process is specific to the product and the type of certification, but generally follows these steps:

1. Application and information submission
2. Product evaluation
3. Product testing in lab
4. Manufacturing facility inspection, production confirmation, and product sampling
5. Test results review and acceptance
6. Contract signed and products listed
7. Annual plant inspection and retesting

7.2. Safety & Environmental Regulations

NSF verifies the following:

- The contaminant reduction claims shown on the label are true
- The system does not add anything harmful to the water at an unsafe level
- The product labeling, advertising and literature are not misleading

The American Water Works Association (AWWA) also provides a comprehensive list of standards that are aligned and updated as new technology is introduced for water treatment and delivery. The full list of AWWA/ANSI Standards can be found on their website here.

7.3. Potential Liability Issues

Potential liability issues may occur from mishandling, unintended injuries, or unrealistic user expectations. The WATERFÜL pitcher contains electronics and a water pump that are responsible for the distinguished technology of the product, including lights, recirculation of the water, and timed actuation of the pump. The pitcher is designed such that the above mechanisms are hidden away in the base compartment. There is still a chance that rough handling over time could result in loose wires that could cause the technology to stop working or cause user injury, although the chances are slim.

The WATERFÜL pitcher is an evolving product meant to be a dynamic household centerpiece, with the hope that it will improve hydration, especially in the elderly population. However, the daily consumption of fluids and the maintenance of drinking the recommended amount of water everyday is still up to the user. The user might expect immediate improvement in health after using the pitcher, but healthy habits take time and consistency to take effect. The pitcher also does not protect against risks conventionally associated with regular water pitchers, such as knocking over items and accidental spillages.

7.4. Intellectual Property Licensing Considerations

The smart water bottle industry is growing and a number of patents have already been filed related to the WATERFÜL pitcher. A summary of related patents are documented below.

Most of these patents either track fluid consumption or treat the fluid. The WATERFÜL pitcher does not focus on tracking water. Rather, the technology of this product is intended to provide subtle reminders for the user to drink water. The product overall has the goal of mitigating dehydration that could lead to serious health complications if left untreated.

Table 17 Summary of patents related to the the WATERFÜL pitcher.

Patent Number	Title	Publication Date
US20170280737A1	Device for uv-led liquid monitoring and treatment	2017-Oct-05
US6558537B1	Portable hydration system	2003-May-06
US6491811B2	Sensor for a water treatment apparatus	2002-Dec-10
US20080087624A1	Daily water bottle consumption system	2008-Apr-17
US7895939B2	Dual mode tea flask	2011-Mar-01
US20160025545A1	Liquid consumption tracker	2016-Jan-28

7.5. Utility Patent

A draft of a utility patent for the handle spout design used in the WATERFÜL pitcher is included in the supplemental materials in section 9.

8. Manufacturing Specifications

8.1. In-House Manufacturing

To minimize costs, the number of in-house manufactured parts will initially be low. The lid, handle, and base will all be manufactured in-house, as they require unique product features, or exact fits to a combination of sourced components.

Manufacturing methods for the custom parts were selected based on four key attributes: cost and associated batch size, material weight, tolerance capabilities, and food face material options. In order to keep manufacturing costs per product low, and in adherence with the market size, manufacturing methods that can produce cost-effective parts in batch sizes of approximately 5000 were focused on. Material density was also a key feature in order to adhere to the product requirements discussed in Section 4. A density of approximately XX (will do math to figure this number out) was determined to be ideal as it is light enough to carry the pitcher, while also maintaining a low center of gravity to reduce tipping. The valve and tube system requires precisely toleranced parts, of about ± 0.5 mm. Finally, the use cases of the product require food safe materials used throughout.

From these considerations, the potential manufacturing methods were narrowed to injection molding, compression molding, and rotational molding. Injection molding was chosen as it offered a wider variety of food safe materials to manufacture out of, was marginally cheaper for the expected batch size, and typically has a faster turn around, once the mold has been fabricated.

As discussed in Section 4, key design changes must be implemented to accommodate manufacturing. The main changes include introducing a uniform wall thickness, and introducing ribs within the handle to improve strength. Additionally, the handle will be chamfered to allow for easy removal from the mold, and connections will be changed from screws to snap fits.

High-Density Polyethylene (HDPE) will be used to manufacture the custom components. HDPE is food safe, rigid, and heat resistant, and offers suitable tolerance ranges when used with injection molding. Additionally, it offers a low price point, and is a sustainable option as it is produced using recycled material, in line with Kül Mayk's company values.

8.2. Sourced Components and Suppliers

A majority of the components will be sourced from external suppliers. These include all electronics, the internal valves and tubing, and the pump, as well as various fasteners and sealants. Figure XX details the approximate cost, batch size, and suppliers. Ordering in batch sizes of 1000-5000 minimizes minimize overall costs.

Table 18: Bill of Materials for Production Pitcher.

Item	Qty	Unit cost	Total Cost	Min Order Qty
Hardware				
Splitter	1	$0.07	$0.07	
Valve	1	$0.18	$0.18	1000
Tubing	0.5	$0.10	$0.05	
O-Ring	1	$0.02	$0.02	1000
Pump	1	$0.50	$0.50	1000
Lid, Handle, and Base	1	$2.53	$2.53	
Pitcher	1	$0.70	$0.70	5000
Electronics				
PCB	1	$1.00	$1.00	1000
18650 battery	3	$0.70	$2.10	
BMS	1	$0.55	$0.55	
Lights	0.2	$1.00	$0.20	1000
Potentiometer	2	$0.06	$0.12	

8.3. Potential Machinery

The primary machinery required will be for injection molding. In order to complete the in-house manufacturing, standard injection molding equipment will need to be purchased. This includes a material hopper, an injection ram, and a heating unit, as well as molds for the 3 custom parts. Our manufacturing process will be HACCP (Hazardous Analysis Critical Control Point) compliant, as well as follow GMA-Safe guidelines. All manufacturing employees will be trained to follow these guidelines and standards.

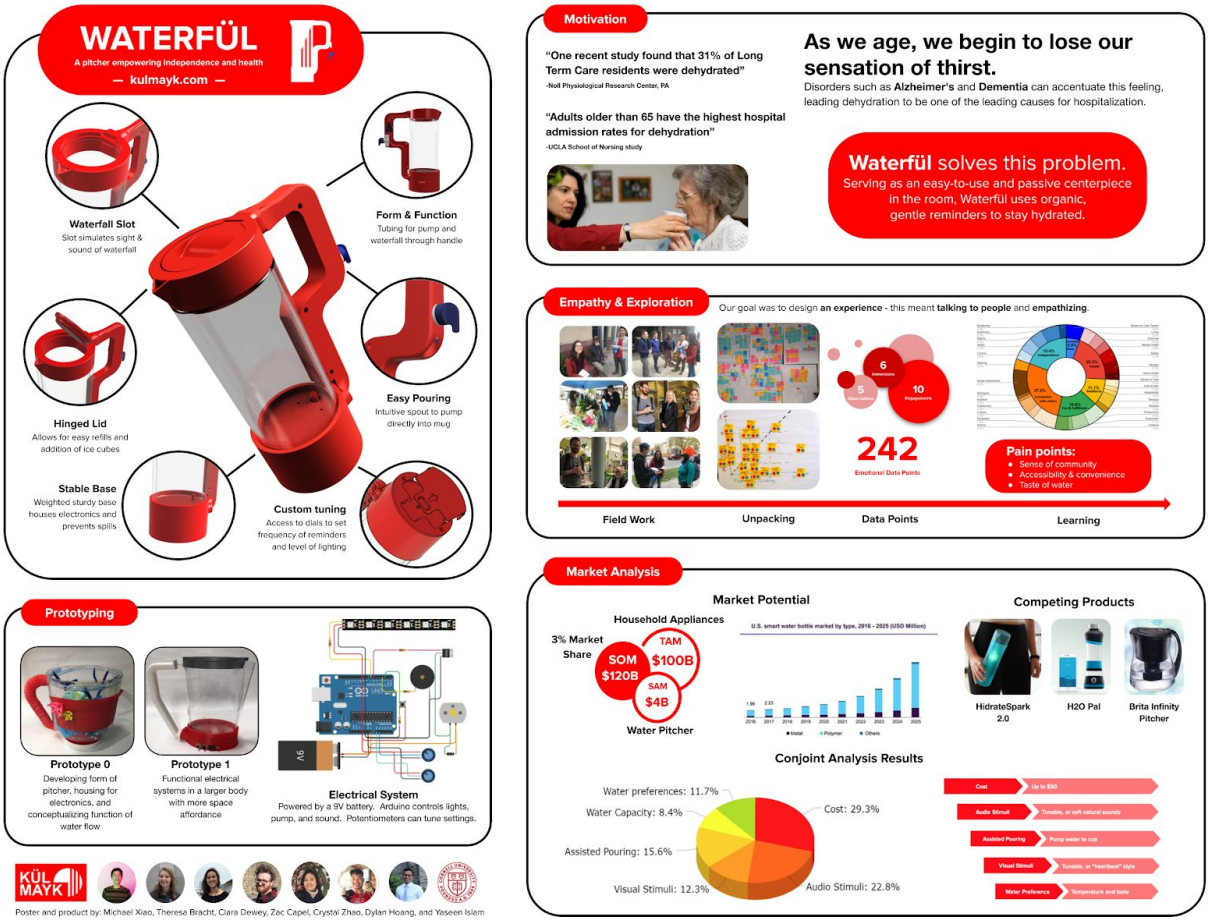
For assembly, there will be two distinct areas required. Electrical assembly will require grounded benches for worker safety, as well as electrical equipment for testing of the electrical assembly prior to final assembly. The secondary assembly area will be for final assembly, and will require a food safe environment, following the guidelines discussed above. An assembly line setup utilizing conveyor belts will be used to assemble the final components, and place in the packaging, which will be produced off site.

9. Supplemental Material

9.1. Utility Patent Draft

A utility patent of the integrated handle spout in the pitcher design is found on the next few pages of the report.

9.2. Poster



9.3. Team Picture

A special thanks to our advisors and instructors Rob Shepherd and Siri Simoncini, as well as the teaching staff of MAE 4340.

United States Patent

Kül Mayk

Patent Number: ###

Date of Patent: ###

[##] Integrated Handle Spout

[##] Inventors: Michael Xiao, Clara Dewey, Theresa Bracht, Crystal Zhao, Zachary Capel, Dylan Hoang, Yaseen Islam (Ithaca, NY)

[##] Assignee: Kül Mayk

[##] Appl. No.: ###

[##] Filed: ###

[##] Int Cl: B65D 1/02

[##] U.S. Cl.: D07/S543; D07/S386;

[##] References Cited:

US20140152002A1	2/2013	Crompton et al.
US20120273709	4/2011	Zhang
US20080099092A1	9/2004	Hasko et al.
US1637853A	3/1927	Brown
US3800988A	6/1968	Karlen et al.
US4492323	11/1981	Essen
US5425579	8/1994	Sampson

[##] Abstract:

Spouts are a common and intuitive interface that are used to dispense fluids. Embedding a spout within a handle of a pitcher unites form and function, allowing the spout to be perfectly positioned to dispense into a mug.

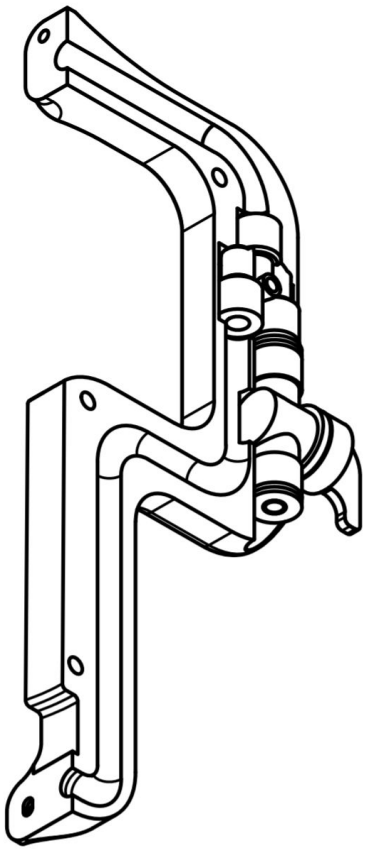


Figure 1: Isometric cross-section view

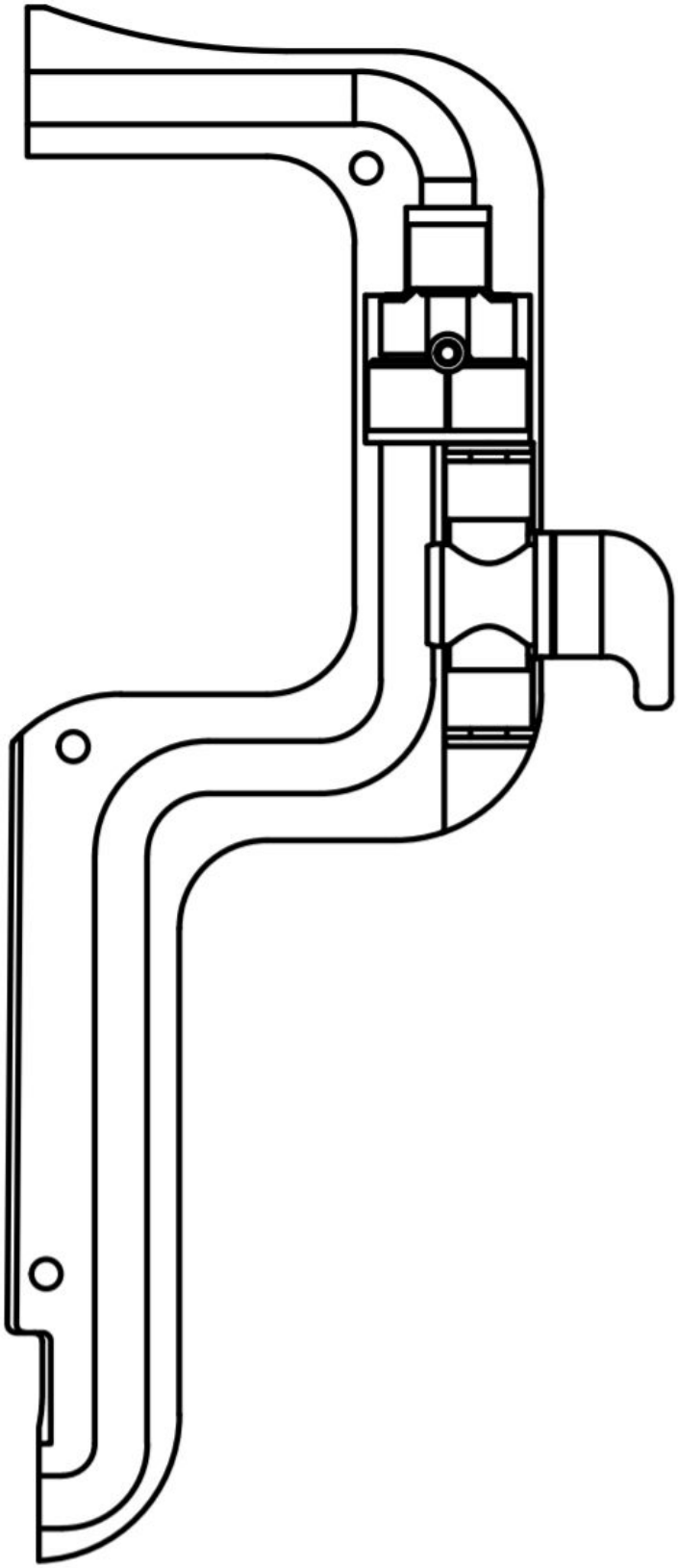


Figure 2: Side cross-section view

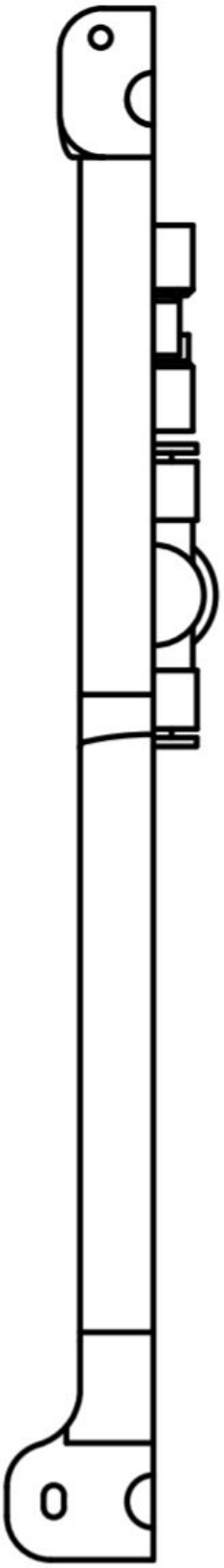


Figure 3: Front cross-section view

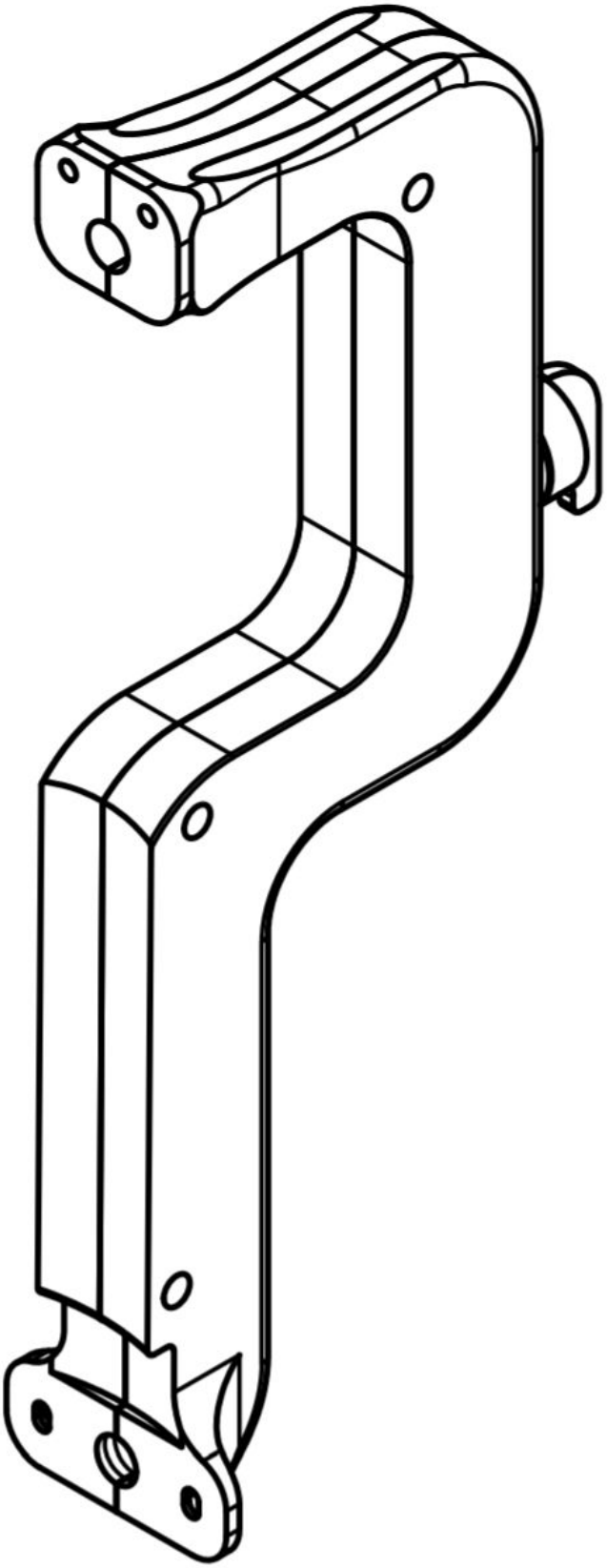


Figure 4: Isometric assembled view

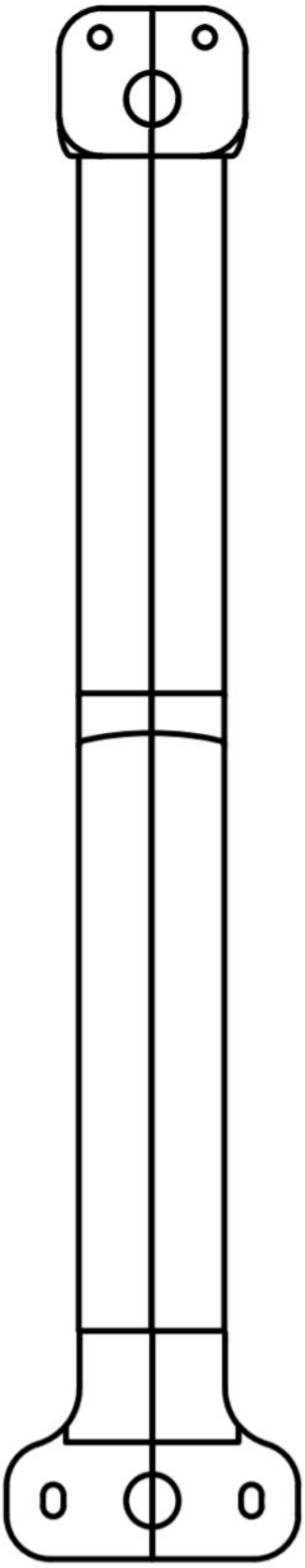


Figure 5: Front assembled view

WATER PITCHER HANDLE SPOUT

Field of the Invention

This invention relates to beverage containers, and especially those augmented with assisted pouring.

Background of the Invention

The spout has existed for centuries and has become the universally recognized system for dispensing water or other fluids. Usually, a spout relies on gravity to feed the containers contents into a secondary vessel. This limits the position of the spout near the bottom of a container, usually such that the container must be overhanging a ledge for a user to use it.

Making this intuitive and existing system more accessible can open the benefits of assisted pouring to a larger audience, especially those with limited mobility. Accordingly, there is a need for a new solution to integrate the spout with everyday water pitchers to further improve upon both devices.

Summary of the Invention

This invention augments the traditional pitcher handle by running tubing through it. This tubing can be hidden within the handle itself to combine form and function. A small water pump can be integrated into the base of a pitcher to pump water up into the handle. Tubing can connect from this pump and routed to a splitter.

The splitter branches into a valve and upwards towards the top connection point of the pitcher. When the valve is shut, this loop through the handle allows water to travel from the bottom of the pitcher back into the top. This cycling can prevent water from becoming still and also can be run through an in-line filter system to simultaneously filter the water. As water falls back into the top of the pitcher, it can also be used to get the attention or remind the user to rehydrate.

When the valve is open, it acts as a spout for the user. This method of assisted pouring means that the user can simply place their cup or mug underneath the handle to dispense water rather than having to pick up the pitcher or move it to the edge of a surface or table.

Brief Description of the Drawings

Fig. 1: an isometric cross-section view showing the 3D view of the internals of the handle. The splitter and valve are pictured.

Fig. 2: a side view of the cross-section showing the tubing, layout of components, and shape of handle.

Fig. 3: a front view of the cross-section showing the profile and attachment points to the pitcher.

Fig. 4: an isometric view of the assembled system showing the shape of the handle.

Fig. 5: a front view of the assembled system better detailing the aesthetic of the embedded handle and the attachment points to the pitcher.

Claims of the Invention

What is claimed is:

1. An integrated spout-handle system that allows for dual mode water dispensing by either allowing water to be pumped back up the tubing along said handle and recirculate into the pitcher body or to be dispensed out of said spout.
2. The handle of claim 1, wherein pouring motion is assisted by ergonomic shape and grip that emphasizes ease and style.
3. The spout-handle system of claim 1, wherein multiple types of water-carrying vessels, especially pitchers, can be extended to.

4. The spout-handle system of claim 1, wherein multiple beverages and cleaning solutions can be circulated.
5. The spout of claim 1, wherein food safe plastic tubing is connected above and below to allow for the dual functionality stated.
6. The tubing of claim 4, wherein one open end dispenses back into the body of the pitcher and the other end is attached to a food safe water pump.
7. A splitter valve connected to said spout that controls the switch between the dual functions that can be adjusted automatically and manually.
8. A method for manufacturing said ergonomic handle that allows for sturdy attachment to the pitcher and provides fit for said food safe tubing.